

Framework for Adaptive Reuse of Expressway Leftover Landscapes in Sri Lanka: A Landscape Architectural Perspective

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Abstract

In the wake of rapid urbanization and infrastructure development, the landscape architectural realm faces a pressing challenge, which is how to repurpose and revitalize the leftover landscapes generated by expressway construction projects. This case study project explores the transformative potential of repurposing these residual spaces, reimagining them as vibrant, functional, and sustainable elements within the selected context. The case study was based on the central expressway of Sri Lanka, specifically the Nakalagamuwa Interchange of Section 02 of the expressway project. The case study aims to create a framework for repurposing Sri Lankan expressways' leftover landscapes that mitigates the negative impacts of mass linear developments while promoting ecological regeneration and strengthening social bonds. This research for conceptualizing, designing, planning, and maintenance will be guided using the concluded framework, within the context of Sri Lankan expressway residual landscapes. Through adaptive reuse, community-centered design, multifunctional spaces, and sustainable practices. The research project seeks to create a conceptual framework that transforms infrastructure into community assets that enhance quality of life, celebrate local heritage, and promote environmental sustainability. The analysis was done under categories of geo-spatial formations with soil profile, natural hydrological systems, socio-cultural landscapes, and ecosystems. The research will address the natural land disturbances, deforestation, hydrological changes, habitat disruption, and sustainable use of natural resources while resulting in a conceptual framework to mitigate the above consequences. Research formulation was based on the 15th goal (Life on Land) of the UN's sustainable development goals and the theoretical framework was based on the golden circle theory. For the case study location selection, land resources were categorized under 3 categories: leftover lands after earth resource extraction, unfunctional spaces created by newly constructed structures, and left behind land after the project completion.

Keywords: Sustainable landscape design; adaptive reuse; expressway infrastructure; leftover landscapes; landscape fragmentation.

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Introduction

In response to the rapid expansion of urban life, this study aims to create a symbiotic relationship between infrastructure and nature, offering a sustainable alternative to the fast-paced development activities in Sri Lanka. This project addresses context-specific landscape development for the leftover spaces in the central expressway project, rooted in principles of sustainability, biodiversity, and inclusivity, through a meticulous examination of the existing linear landscape. The project will identify key areas of ecological vulnerability and social disconnect. Design interventions will approach the restoration and enhancement of ecological corridors by establishing social nodes that encourage interaction and community engagement along these mass linear structures.

The research aims to create a landscape design that mitigates the negative impacts of mass linear developments, promotes ecological regeneration, and strengthens social bonds. This project can be considered a pilot project for conceptualizing, planning, and designing landscape interventions within the context of expressway residual landscapes in the Sri Lankan context.

Objectives of the project

- Sustainable re-use of leftover land created by expressway construction
- Mitigating the social pressure from the oversized expressway infrastructure
- Finding context-specific and socially responsive design approaches
- Acknowledgement of leftover spaces through geological and ecological rejuvenation

In the realm of urban design, landscape architecture, and infrastructure design, there is a wealth of research based on residual landscapes and their utilisation in green infrastructure development. All the research studies were based on the urban context, and they did not address the rural context, agricultural lands and natural landscapes. As an outcome of this research study, that research gap will be addressed because the case study context is the central expressway, which runs across the least amount of urban fabric among all the expressways in Sri Lanka.

Expressways of Sri Lanka

Sri Lanka currently has over 271 km of designated expressways serving the southern, western and central parts of the country. All e-grade highways in Sri Lanka are access-controlled, toll roads with speed limits in the range of 80-100 kmph.

Central Expressway of Sri Lanka

The central expressway (EO4), is an under-construction project that will link the Sri Lankan capital, Colombo, with Dambulla & Kandy. It will provide a fast alternative to the existing A1 Colombo - Kandy & A6 Ambepussa – Trincomalee highways. The expressway starts at the Kadawatha interchange on the E02 Outer circular expressway and traverses through Gampaha, Kurunegala & Matale districts.

Sustainable development and SDGs

Sustainable development is a framework for meeting human needs today without compromising the ability of future generations to meet their own (Brundtland Commission, 1987). This concept balances social, economic, and environmental progress, recognising their interdependence. The Sustainable Development Goals (SDGs) are a set of 17 universal goals adopted by the United Nations in 2015 to guide global efforts toward a more sustainable future by 2030 (United Nations, 2015). They build on the principles of sustainable development and provide a comprehensive

blueprint for addressing critical issues such as poverty, inequality, climate change, and environmental degradation.



Fig. 1: Project approach that derived from sustainable development goals
Source: author

Life on land

In this research study 15th goal – Life on Land from the SDGs is rooted as the baseline concept. SDG 15 underscores the imperative to combat land degradation and restore terrestrial ecosystems, specifically aiming for conservation of forests, wetlands, and drylands, land degradation neutrality, and halting biodiversity loss (United Nations, n.d.). In Sri Lanka, a biodiversity hotspot with decreasing per-capita land availability, engineers bear a professional and ethical responsibility to pursue sustainable land-use solutions aligned with these SDG principles (Institution of Engineers Sri Lanka, 2021).

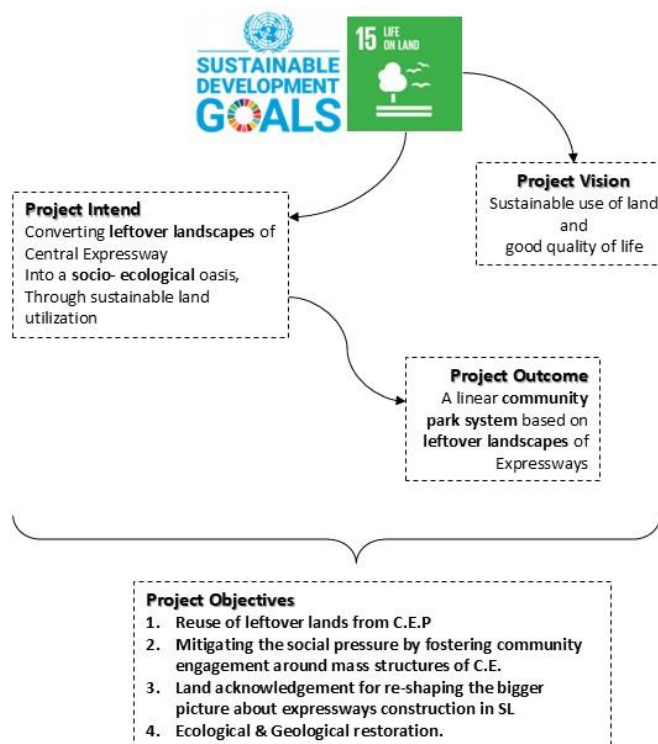


Fig. 2: Research project formation that shows the research design
Source: author

Literature review

Since the 1950s, scholars' and researchers' interest in urban highways and their impact on urban fabric has become prominent in both academic and popular culture writings (Mohamed Anuar & Ahmad, 2017). To what extent cities have altered spaces under the elevated highways can be found in both academic writings and popular writings, such as magazines, newspapers, and electronic media. In the Western context, the contemporary approach on how the leftover spaces have been transformed into vibrant spaces (Hauck, Keller, & Kleinekort, 2011). For the past three years, revitalisation of spaces under the elevated structures has become one of an important topic in the Online journals related to architecture, landscape architecture and urban planning and design (Jaffe, 2015)

Leftover land from road infrastructure construction.

left-over spaces also generally appear to be undefined in use, ownership, management, and function. The vacant spaces suggest ambiguity regarding specified use as well as function. These leftover spaces project a sense of abandonment and lost opportunities in contrast to the highly managed and planned infrastructure above it (Hauck, Keller, & Kleinekort, 2011). Despite the lost spaces which are often associated with negative activities or characteristics and unstable, the duo has been optimistic about this issue. They emphasised how the gap spaces generated by elevated railways can be explored to improve the urban system connectivity (Mohamed Anuar & Ahmad, 2017).

Most of the leftover spaces that were discussed in this study are created by elevated expressway structures. The function of elevated urban highways that could transfer and mobile people around cities is understandable. Conversely, the presence of this urban type of infrastructure somehow generates specific spaces with idiosyncratic spatial characteristics (Hauck and Kleinekort, 2011). Often, elevated highways of the first generation have little aesthetic value (Figure 5), which were built with steel and pre-fab concrete (Samuel, 2006)

these are spaces with unincorporated margins, interior islands void of activity, oversights; these areas are simply uninhabited, unsafe, unproductive. these are spaces with unincorporated margins, interior islands void of activity, oversights; these areas are simply uninhabited, unsafe, unproductive. In a nutshell, they are foreign to the urban system, mentally exterior in the physical interior of the city, its negative image.

Mariani & Barron, 2014

Adaptive re-use of leftover landscapes

Future studies could include the studies on the needs of the surrounding communities in accordance with using residual infrastructural space as green spaces for leisure and enhancement of quality of life, as well as looking at the technical aspects, such as safety, planning policy and regulations (Mohamed Anuar & Abdullah, 2017). Undefined, unusable spaces have emerged as the number of highways has increased in line with the needs and demands. The areas under highway viaducts and bridges are defined as unused spaces, in other words, dead spaces. Landscape architecture sees them as part of the urban space's landscape system, land use, traffic, and public areas (Akinci, Demir, & Demirel, 2016). The interdependence between infrastructure and urban development has always been one of the most important topics of urban planning (Hauck and

Kleinekort, 2011). These places can shelter the homeless and people with bad behaviors can congregate under them since they are protected from the rain and sun. Therefore, they have a negative effect. The spaces under the highway bridges are largely neglected. However, these spaces provide the connection with urban areas and can have many designs and uses. Designing them properly will reduce their frightening, cold and dark effect and enable people to use them (Akinci, Demir, & Demirel, 2016).

The urban fabric and its spaces shall be perceived as a system that is well integrated and functions efficiently. Hence, the proactive steps should be taken into consideration by landscape architects, architects, planners and designers alike. The challenges associated with these types of spaces shall be viewed from a different perspective. The existence of leftover spaces at the study area should be taken as an opportunity to reimagine and reinstate the spaces as a form of urban connector. These interstitial spaces could be transformed into a space that supports human-scaled activities as a direct contrast to the vehicular-scaled activities right above

Mohamed Anuar & Ahmad, 2017

This has changed the landscape and highway transportation by directly affecting civil and transportation engineering. Planning, design, planting, and technical work are important ways to ensure sustainability in landscape architecture. The positive effects of technological development are undeniable. However, careless use, pollution, and destruction of nature as if its resources were unlimited have raised the issue of sustainability (Akinci, Demir, & Demirel, 2016). State and federal government agencies may create programs that encourage residual elevated highway space use for public amenities, useful community assets, as well as natural city assets and to enhance the green network system of a city (Mohamed Anuar & Ahmad, 2017).

Mitigative measures and precautions

Sustainable landscape architecture creates ecological designs for the outdoor and urban environment. It begins with appropriate systems which address function, cost, energy efficiency, beauty, the and environment (Bean & Yang, 2017). According to Akinci, Demir, & Demirel designs should be created with users in mind to give meaning to spaces and make them more useful. Some operations and arrangements for strengthening the spatial identity of these spaces and bringing vitality and variety to them are opportunities to make the environment more beautiful.

The Sustainable Sites Initiative stresses site selection, planning, and the recognition of ecosystem services. Sustainable landscape architecture integrates ecological, social, cultural, and economic factors rather than focusing only on the environment.

- Native planting and community-based conservation strategies reconnect people to landscapes, strengthening cultural identity
- Vertical landscapes and public-oriented living systems create new social spaces even in leftover or constrained sites
- Water systems, Stormwater management, water harvesting, and constructed wetlands for ecological resilience.
- Soil & erosion control: Highlights erosion prevention and landscape-level interventions to stabilize disturbed sites.
- Xeriscaping and native planting strategies to restore ecological balance and reduce resource use (Bean & Yang, 2017).

Many innovative design ideas and solutions can be seen around the world in the spaces under bridges. These spaces may be small or large. They are usually shady, dim and neglected. They sometimes play an important role in connecting different areas to each other. Therefore, these areas should be analyzed well and opened for active or passive uses. However, another issue that should be considered in design is that they are under traffic routes. This means noise, vibration, dust, security, and visual quality should also be taken into consideration. Usually, temporary solutions such as green areas are recommended for the spaces under highway bridges. From the perspective of people's needs, the walls of the piers of the bridge can be colored artistically or illuminated. Market stalls, stations, plantations, cafes, parking areas, or sports areas can be established. Entertainment, recreation, or education spaces can be established for children. Open-air stages can be found. Buffets or small shopping malls can be established in these spaces

Akinci, Demir, & Demirel, 2016

A brief framework for green infrastructure reintroduction for underutilized land was found, under the urban circumstances only. This research study will look beyond urban canvases. A multi-scale green infrastructure approach to establish an operational framework that results in functional landscapes within patchworks of abandoned, vacant, or underutilized properties. The framework can be broken into the following components:

1. Analyze the landscape and regional context for site-scale implementation
2. Engage the community with long-term vision and short-term opportunities
3. Identify the typology of potential green infrastructure activities
4. Create implementation project selection criteria
5. Optimize the project investment portfolio (Allen, 2014)

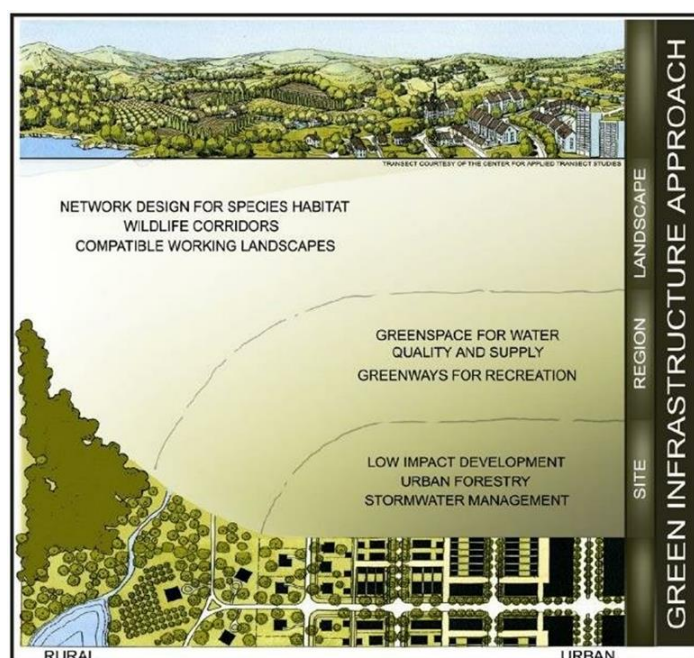


Fig. 3: Scale of green infrastructure planning
Source: Allen, 2014

Placemaking is the approach to the type of Neglected Urban Open Space - NUOS controls the choice of the appropriate Urban Revitalization technique. When applying this approach, it requires

conducting a detailed analysis of the urban form and socio-economic aspects of the area, in addition to enhancing community engagement in the development process as a qualitative and quantitative tool. In addition, the type of NUOS as a leftover space can provide communities with a network of successful and productive spaces by using the place-making as an applicable approach to be adopted by city officials and planning authorities (Abd El Gawad, Al-Hagla, & Nassar, 2019).



Fig. 4: Shows the place-making criteria required to create successful places

Source: www.pps.org

Temporary use does not offer a permanent solution for the sustainability of these spaces. These areas should be addressed as part of their environment. In conclusion, these areas should be given identity and spirit when they are planned and designed. The results of this study should be evaluated in line with the areas and their environment, considering the future circumstances (Akinci, Demir, & Demirel, 2016).

Theoretical Framework

In this research project's case study areas consist of diverse landscape typologies wrapping around a mass linear structure, which is expressways, which can be interpreted as a moment when nature and humans meet. Considering the context and the outcome of the project theoretical framework is structured as below. This theoretical base will guide the project to identify certain typologies, case study locations, and design approaches for the framework.

In this theoretical framework primary theory is Landscape urbanism, under which ecological, social and cultural aspects were considered to follow the key principles of landscape urbanism. Which is Integration, Ecological Function, Diversity, Adaptability, and Community Engagement. Two supporting theories were used to strengthen the theoretical approach because those theories will justify not only the onsite findings and observation but also the qualitative and quantitative results. Place attachment theory and the drosscape concept are used to reflect the human connection and landscape transformational approaches in this study. To find the design framework that adaptively reuses the leftover landscapes, this theoretical framework needed a design process theory that is

effective in the specific Sri Lankan scenarios. The author used the golden circle theory. Yet simple as why, how, and what, but efficiently aligning with sustainable design approaches.

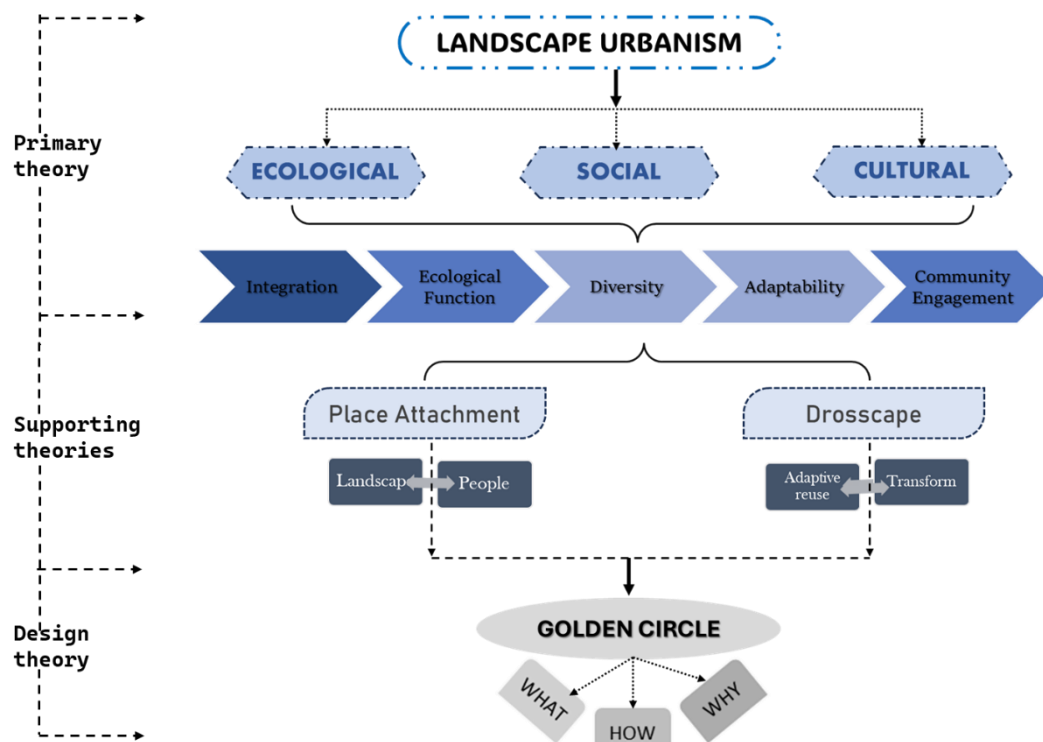


Fig. 5: Theoretical framework of the research study
Source: Author

Landscape Urbanism is affirmed as an established, rather than emerging, approach to urbanism characterized by an emphasis on ecological systems, process, and horizontality over static form (Gary, 2011). Landscape Urbanism positions landscape as the primary medium of urban order and design, particularly suitable for complex, dynamic urban conditions (Corner, 2006). It emerged as a critique of traditional urban design, emphasizing horizontal field conditions rather than static, object-based architecture (Waldheim, 2006). The theory supports adaptive reuse of marginal and leftover urban lands by integrating ecological processes with design strategies (Corner, 2006; Waldheim, 2006). Landscape Urbanism also aligns with contemporary sustainable urbanism practices by prioritizing infrastructure, ecology, and open-ended adaptability (Shane, 2011)

Place attachment is often conceptualized through a tripartite model encompassing Person, Process, and Place dimensions, offering a comprehensive way to understand emotional bonds to landscapes (Jorgensen & Stedman, 2009). Long-standing place attachment persists despite globalization and mobility pressures, though research tends to emphasize the Person dimension more than the Place or Process components (Scannell & Gifford, 2011). Strong place attachment in collectivist cultures is associated with higher levels of pro-environmental behavior, demonstrating its potential role in ecological stewardship and sustainable design (Meta-analysis; positive effect found) (2021)

The concept of drosscape positions “waste landscapes” as products of urban sprawl and industrial obsolescence—spaces ripe for creative reuse (Berger, 2006). Drosscapes emerge not as static relics, but as dynamic urban byproducts capable of being repurposed through design innovation

(Berger, 2006). Berger (2006) encourages designers to act as agents of integration transforming fragmented, unused lands into socially and ecologically productive elements.

Methodology

This study will employ a mixed-methods research design, combining both quantitative and qualitative approaches with a multi-layered case study. In the methodology, it approaches the case study and questionnaire survey based on an exploratory and descriptive study, alongside a spatial analysis. At the early stages of this research project author identified 3 typologies of leftover landscapes through onsite observations and geospatial analysis.

In the case study selection author selected the location among 4 other interchanges, which covered the highest density of leftover landscapes, ensuring diversity of typologies considering scale, context, and conditions. In the primary data collection stage author used 3 separate site visits with valid variables like time of the day, day of the week and month. Through those visits, spatial evaluations were conducted by photometric recordings and the use of QGIS mapping tools to capture spatial qualities like land use, connectivity, accessibility, and ecological context. Also, questionnaires and interviews were conducted with local communities, commuters, few stakeholders to capture the user perception, place attachment, and usability. Secondary data sources are published environmental impact assessment reports by RDA, and several case study documents. The author used qualitative data that was recorded through satellite imagery analysis to justify the context and to defend the need for the research addressing the research gap.

In the data analysis, qualitative analysis was conducted for the questionnaire and interview responses to discover the place attachment and user perception. In quantitative analysis, descriptive statistics from the responses were used in the end analysis, and cross-comparison among the 3 typologies provided a strong and reliable conclusion. In theoretical application of the findings provides a potential framework structure as below

- Landscape Urbanism: To analyze spatial transformation potential.
- Drosscape: To frame leftover landscapes as potential resources, not waste.
- Place Attachment: To interpret community perceptions and emotional ties.
- Golden Circle: To structure design framework → *Why (vision)* → *How (strategies)* → *What (design interventions)*.

As the outcome of the research project author provides an evaluation/conclusion and a brief framework. The conclusion will reveal the current condition, potentials, and limitations of leftover spaces. The framework will provide a step-by-step design, planning, and management framework for adaptive reuse, guided by your theories and analysis. These outcomes are considered not only descriptive but also prescriptive in the world of landscape urbanism.

A purposive sampling technique was employed to select 36 participants, comprising commuters, residents, and stakeholders. The questionnaire had 15 semi-structured questions that were tested in a pilot poll to make sure they were clear and useful. Participants were selected from diverse demographic and professional backgrounds to mitigate potential biases in survey responses. To get rid of situational bias, surveys were done at different times and days of the week. Responses were kept secret to encourage honest criticism. Some interchange sites have limited access due to safety regulations, and there is a limited amount of time for community participation. But using multiple data sources (like observations, surveys, and GIS) to triangulate made the results more reliable.

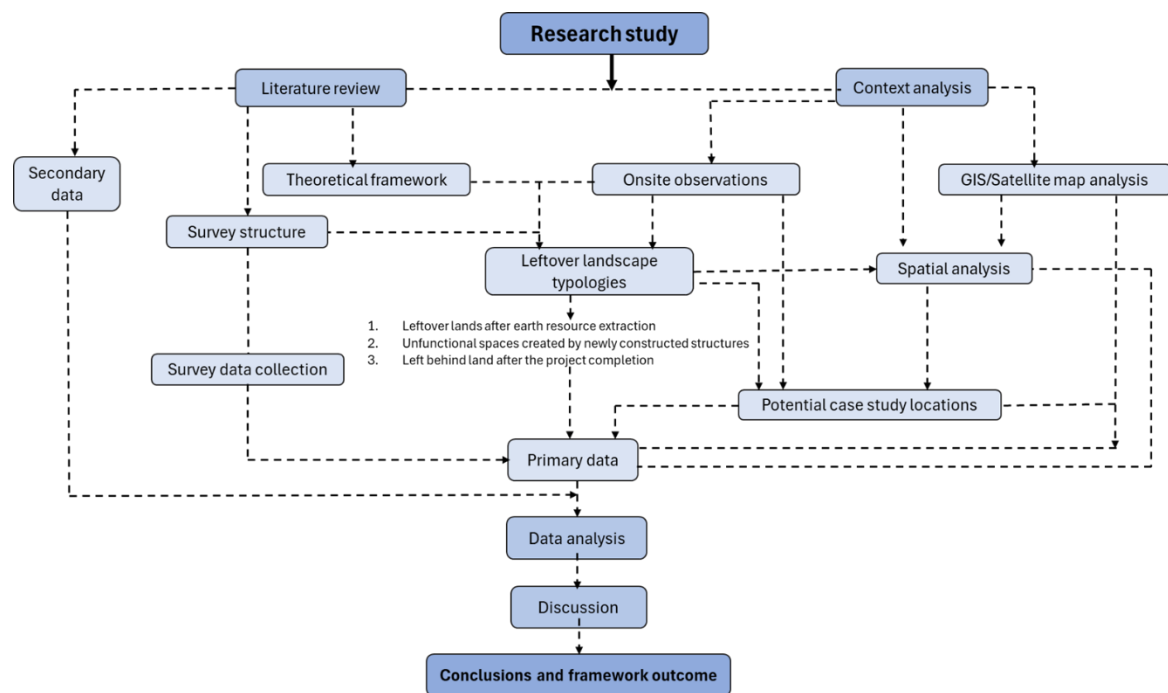


Fig. 6: Methodology of the research study

Source: Author

Study context

This research is based on the central expressway of srilanka. Exact stretch is section 2, which is from Mirigama to Kurunegala. The Central Expressway (E04) of Sri Lanka is a 137 km long highway designed to connect the Outer Circular Expressway in Kadawatha to Dambulla, with a link road to Kandy. Considering other expressways, this one is the least intertwined in urban areas. The central part of the country consists of rural landscapes, natural landscapes and cultivations. This expressway is being built in four main sections, each with a specific length and route

Table 16: Sections of the Central Expressway

Section	Route	Length (km)
Section 1	Kadawatha to Meerigama	37.1 km
Section 2	Meerigama to Kurunegala	40.9 km
Section 3	Pothuhera to Galagedara (Kandy link)	32.5 km
Section 4	Kurunegala to Dambulla	58.6 km

Section 01 of the CEP is still under construction and Section 02 was completed in 2022 with 4 interchanges and 1 system interchanges. includes interchanges at Meerigama, Nakalagamuwa, Dambokka, Kurunegala, and Yaggapitiya. This section also has a link road to This stretch consists of 8.9km of via ducts and 123 culverts and costs 80.71 billion rupees, which is funded by local bank loans. Construction of this project is divided among the local large-scale infrastructure construction companies under the main 4 packages.

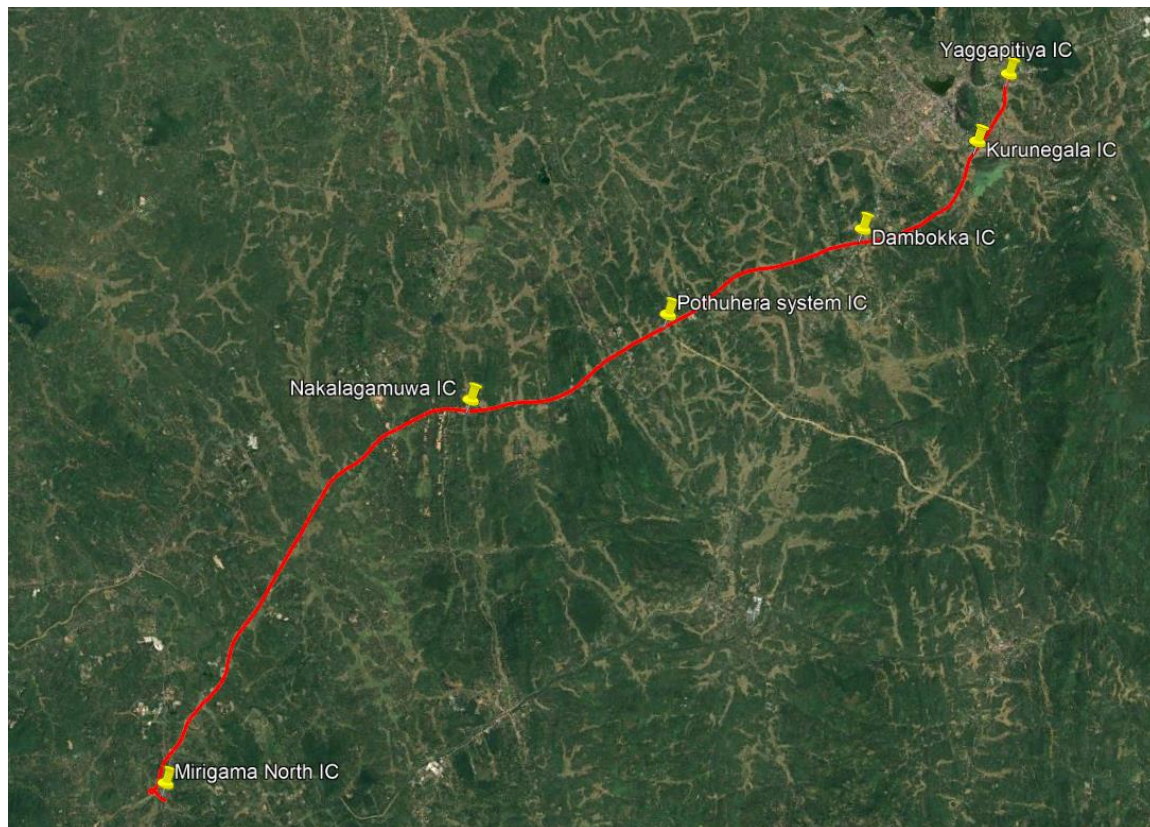


Fig. 7: CEP section 02 stretch and Interchanges
Source: Author

The selected case study location is the Nakalagamuwa interchange and the surrounding area. After thorough spatial analysis and on-site observations, this area held the highest density of leftover spaces. 3 rounds of site observations, and according to the drosscape concept, this location holds the highest potential to conduct the case study and the rest of the study.

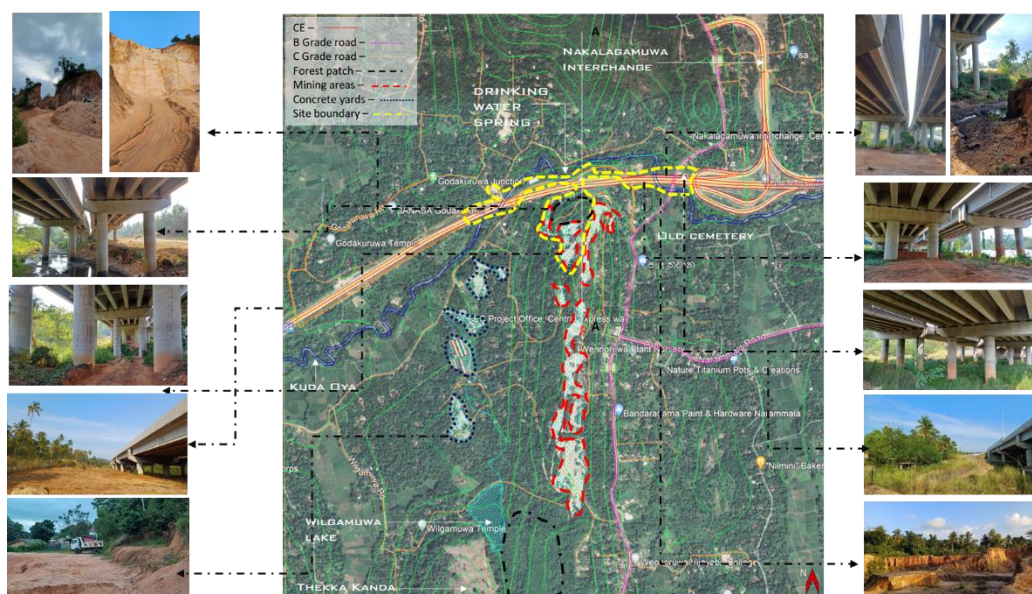


Fig. 8: Spatial analysis and justifications for Nakalagamuwa Interchanges
Source: Author

Findings and analysis

Typologies of leftover landscapes

After spatial analysis, theoretical analysis, literature review and strong onsite observations, we concluded as below 3 categories. The Sri Lankan context differs from the other countries to some extent because of the expressways planning in this always biased towards non-urban landscapes for various reasons, such as cost reduction. Those typologies are intertwined with the lifecycle of an expressway according to the theoretical framework.

1. Leftover lands after earth resource extraction
2. Unfunctional spaces created by newly constructed structures
3. Left behind land after the project completion

The above three categories follow the temporal sequence of expressway development:

- Pre-construction (extraction)
- Construction (structural voids)
- Post-construction (abandoned lots)

Table 2: Typologies of leftover landscapes

Unfunctional spaces created by newly constructed structures	Leftover lands after earth resource extraction	Left behind land after the project completion
 Under viaducts, bridges, culverts, and buffer strips	 Borrow pits, quarries, cut-and-fill scars, soil stockpile sites	 Abandoned staging areas, contractor yards, temporary camps, parking yards

Spatial map analysis

Through the satellite imagery analysis in this section expressway runs across 4.97 km of urban setting, 0.90 km of semi-urban context and 36.34 km of rural context. That means 86% of the central expressway's section 02 runs across rural landscapes, 2% across semi-urban landscapes and 12% across urban landscapes. Those percentages prove urban context-based research could not align with the Sri Lankan context; to fill that gap, this kind of context-specific study needs to be conducted. Percentages were calculated based on the linear expansion of section 02, it was not based on the expansion of surface area.

Table 3: Land use across the expressway stretch

Area	Expressway length (km)	Percentage
Urban	4.97	12%
Semi-Urban	0.9	2%
Rural	36.34	86%

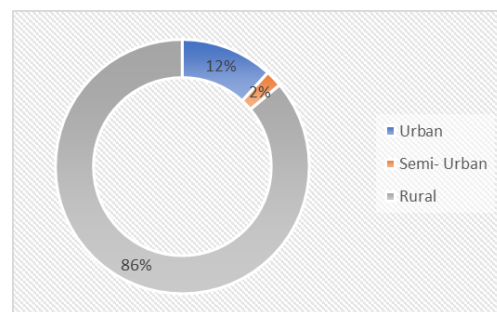


Fig. 9: Land use across the expressway
Source: Author

After completing the analysis of the above results, it does not give a strong base to argue the point efficiently. Conducting the same analysis comprehensively, the following details were revealed. It provides evidence that the first analysis was accurate, even though it is not as comprehensive as the secondary analysis.

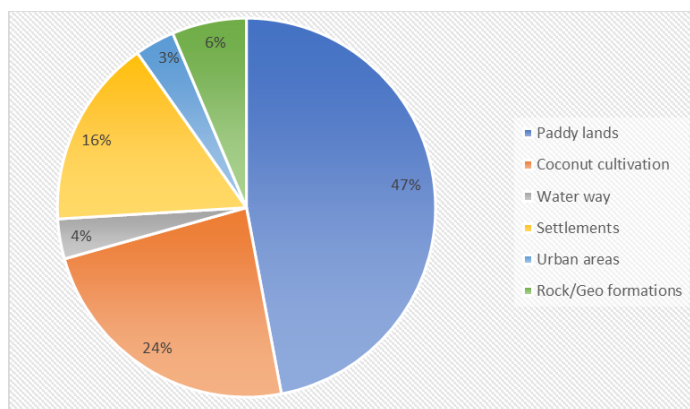


Fig. 10: Detailed Land use across the expressway
Source: Author

Table 4: Detailed Land use across the expressway

Land type	Expressway length (km)	Percentage
Paddy lands	19.85	47%
Coconut cultivation	9.96	24%
Water way	1.44	4%
Settlements	6.82	16%
Urban areas	1.44	3%
Rock/Geo formations	2.69	6%

To strengthen the land use patterns around the expressway surface area analysis conducted using QGIS tools, the results from that provided a reliable land use pattern outcome. This visually represents connectivity, accessibility, linkage, and space attachment while tying natural and man-made elements to build the research findings. This GIS data representation shows how road infrastructure layout, hydrological connectivity, and geomorphological patterns can all approach the framework of the adaptive reuse for the leftover lands. As mentioned in the theoretical framework, the primary theory of landscape urbanism will guide the findings of this analysis.

Land use

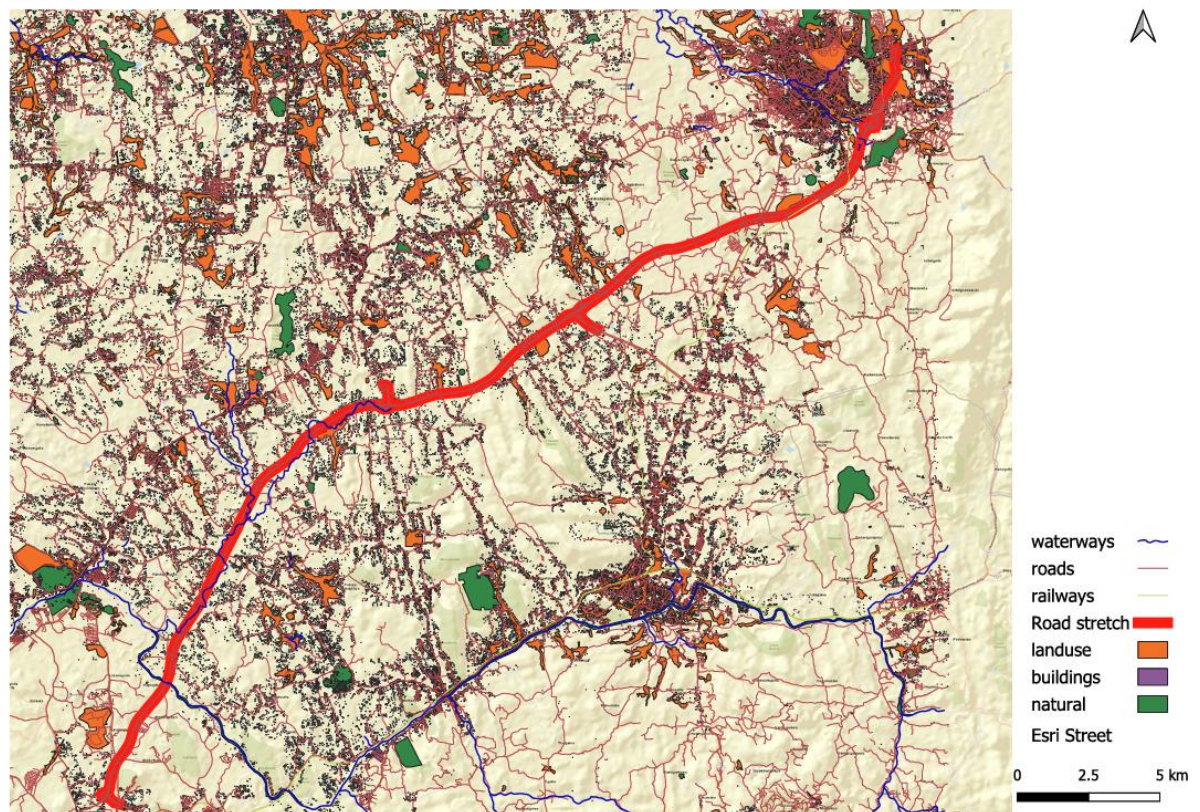


Fig. 11: GIS Land use analysis of the context
Source: Author

Questionnaire survey

A survey was conducted on interviews with 36 participants who were found around the case study locations. The survey consists of 2 parts based on how they interact with the area. Dwellers, vendors, and community members went through the whole questionnaire, and outsiders participated in the general questions, which is part 1 of the questionnaire. Participant varied as below,

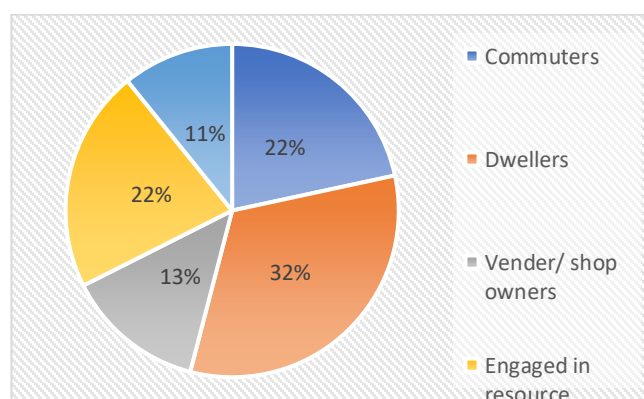


Fig. 12: Responses of the questioner
Source: Author

Participants responded to how they engaged in the leftover spaces in their day-to-day life, which describes how place attachment affects the landscape and the user. Most of them engaged with these spaces for agricultural activities, and with the primary water source, which was also used

for agricultural purposes. The reason for the higher number of responses recorded for parking is that the elevated expressway structures provide shelter and are directly connected through vehicular transportation.

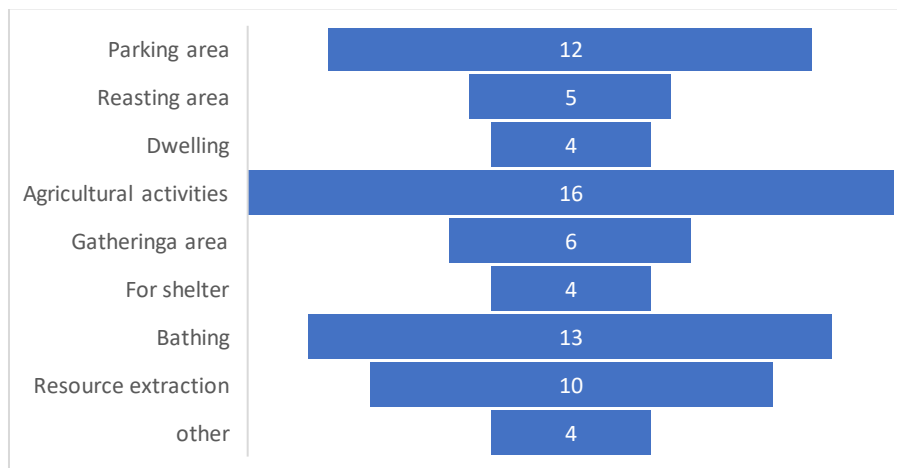


Fig. 13: Usage of the leftover landscapes
Source: Author

In the 1 st part, they responded as below for several design approaches (which are listed below) for the leftover spaces. The results of the survey reveal a very high preference by the respondents for the redevelopment of residual spaces as productive and interactive spaces. The most supported were the assembly areas for farm operations and people's meeting areas, which reflect the wish of the community for productive and interactive spaces that promote livelihood and social connections.

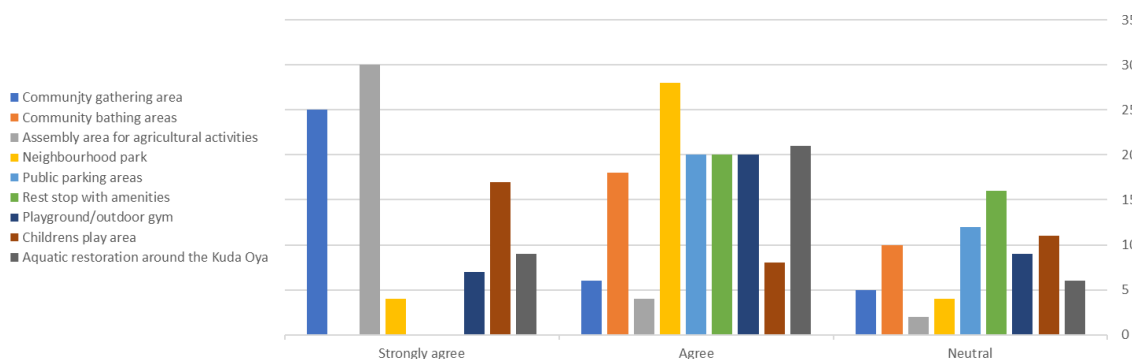


Fig. 14: Responses to the suggested approaches for leftover spaces
Source: Author

Neighborhood parks, similarly, were the most consensus ones, reflecting a very high desire for accessible greens and recreational spaces. Secondary items like playgrounds, outdoor gyms, children's play spaces, and public parking spaces also garnered significant support, pointing towards the value of active lifestyles promotion and infrastructure support. Responses to rest stop facilities with amenities and aquatic restoration efforts were more mixed, reflecting location- and community-specific relevance. Overall, the research suggests that a remnant space design scheme should be dedicated to productive and recreational functions along with ancillary facilities to facilitate inclusiveness and adaptability.

Part 2 of the questionnaire is based on 12 different leftover spaces that come under the 3 main typologies. The questionnaire data, compiled from 26 respondents, provides a detailed perspective on the potential for repurposing spaces created by expressway construction. The analysis focuses on 12 distinct locations, with the provided table summarizing the most frequent responses to a set of five key questions. The findings consistently show that the public views these spaces not as liabilities but as opportunities for adaptive reuse. A vast majority of the locations, such as the "Soil mining site," "Granite mining site," and "Paddy field stretch," are identified as having significant potential for transformation. The proposed uses, including creating "community spaces," "ecosystem restoration," and a "regenerative aquatic ecosystem," reflect a strong communal desire for environmental and social improvements.

			QUESTIONS BASED ON THE FRAMEWORK				
			Status before the expressway	Current status	Potential	Can it be a leftover space according to your openian	If yes, can it be adaptively reused
LEFTOVER LANDSCAPE LOCATIONS	1	Soil mining site	Naturally existed as a mountain	Highly degraded and unsustainably excavated land	Regulated reuse of earth resources in a functioning manner	Yes	Yes
	2	Granite mining site	Naturally existed as a rock formation	Illegal mining ground without proper acknowledgement of land formations	Creating an innovatively designed community space with the elevation and great view points	Yes	Yes
	3	Kuda oya river crossing	Un interrupted waterway	Degrading river banks with illegal water pumping	Converting into a Proper bathing area for the public	Yes	Yes
	4	Alawwa -Polgahawela rd overpass area	Connectivity road	Using as a resting area for drivers under the elevated expressway structures	Providing basic amenities for the drivers	Maybe	Yes
	5	Area near the coconut pantation	Large coconut plantation	Degrading open land without vegetation	Creating a community playground	Yes	Yes
	6	Near the house cluster	Used to have 3 more houses there	Open ground unattended	Community park	Yes	Yes
	7	Area parallel to kuda oya	Riparian vegetation	Underutilised cleared land is with soil erosion and unstable river banks	Ecosystem restoration	yes	Yes
	8	Cemetry area	Active cemetry area	Abandoned cemetery	Turning into meaningful community parking area	Yes	Yes
	9	Paddy field strtch	Functioning pady land	Land field area without proper draingnage	regenarative aquatic ecosystem	Yes	Yes
	10	Teak plantation area	Timber forest	Cleared land for the expressway reservation currently degrading	Native reforesting	Yes	Yes
	11	Area near the shops along the B grade road	Local dwelling area	Still functioning same	Spacial uplifting	No	Yes
	12	Area under the interchange's tool booth & exits	Used to be a paddy land	Unaccessible dark enclosed spaces created by the elevated stuctures	Introducing small food stalls and kiosks to create positive interactions	Maybe	Yes

Table 5: Summarized findings from the questionnaire based on 12 locations

Moreover, the survey highlights a crucial recognition among respondents that these spaces, despite their current degraded or unattended status, can be integrated back into the community. The high frequency of "Yes" responses in the "Can it be a leftover space" and "If yes, can it be adaptively reused" columns demonstrates a proactive and optimistic perspective. This suggests that the public is willing to engage in solutions to mitigate the negative impacts of large-scale infrastructure projects, turning what would otherwise be considered blighted areas into valuable community assets. The compilation of these most common answers serves as a valuable guide for future urban planning and development.

Discussion

The survey data reveal a composite public sentiment toward the impacts of expressway building. While the vast majority (31 of 36 respondents) is convinced that expressway building would adversely affect the environment and society, the perceived impact on the respondents themselves is more ambivalent, with 21 out of 27 respondents being indirectly affected. Further, there is overall discontent regarding the quality of life and post-building views. Most of those surveyed (33 out of 36) disagreed or strongly disagreed that the overall quality of life was enhanced after the expressway construction. Besides, 26 out of 36 of those surveyed were not satisfied or very dissatisfied with the area as it existed after construction. This is as opposed to the survey findings indicating that most (30 out of 36) individuals feel the remaining spaces from expressway construction can be reused through adaptation.

Overall, the survey indicates a wide disparity between what the public perceives regarding expressway projects and what they think is the resultant impact. Despite the recognition by the respondents of adaptive reuse opportunities in the vacant spaces, their own experience factors negative impacts on their own quality of life and neighborhood setting, demanding greater urban planning and post-project management to follow in line with what the community perceives.

Nasir and Raziah (2019) conducted research on Kuala Lumpur's elevated roadways revealed analogous community perspectives concerning unutilized spaces beneath expressways. Their study found that people were using the space in unregulated ways, like selling food, setting up temporary shelters, parking, and getting rid of trash. These were all adaptive but unregulated responses to the space being left empty.

The Kuala Lumpur research highlighted the absence of institutional coordination and design intervention as significant obstacles to change in Sri Lanka, where public sentiment reflects both dissatisfaction and an urgent need for coordinated reuse. Both studies agree that these "lost spaces" could be used again by the community, but Malaysia shows that without clear urban planning rules, these changes are only temporary or informal. This analysis indicates that Sri Lanka's remaining landscapes necessitate proactive governance and participatory design initiatives to transition from tolerated to structured, sustainable public spaces.

Conclusion and framework

This research project demonstrates a compelling model of recycling the negative impacts of linear infrastructure, such as Sri Lanka's expressways, into ecological and social rejuvenation. By shifting the approach from merely thinking of such developments as utilitarian corridors to viewing them as linear landscapes, the project can distinctly suggest a path toward nature-infrastructure harmony. The findings confirm that a strategic intervention, founded on the principles of sustainability, biodiversity, and inclusion, can reverse adverse environmental and social effects. The attentive study of some residual areas, and the general popular consensus in favor of their adaptive reuse are strong evidence of the coherence of this vision. In conclusion, this project provides a replicable model for future projects, showing that it is possible to create green, peaceful alternatives to high-speed highways and thereby form social bonds and create a healthier, stronger environment for all.

This framework gives a systematic approach of adaptive reuse for linear infrastructure development projects in abandoned spaces. It works by systematically categorizing these spaces

in three typologies: "**Leftover lands after earth resource extraction**," "**Unfunctional spaces created by newly developed structures**," and "**Left-behind land after project completion**." For each typology, the model shows the original status and typical impacts, presenting an open picture of the conditions.

The center of the framework lies in its "Adaptive Reuse Potential" column, where it proposes real, tangible ideas for ecological and social rebirth. This process is then anchored by a "Design Approach through Theoretical Lens" that provides every solution with a guiding philosophy through reference to well-tested design philosophies such as "Drosscape" and "Ecological Urbanism." Essentially, the framework serves as a broad, step-by-step guide for blighted area redevelopment into beneficial, sustainable, and socially cohesive community asset. When looking at how conclusions drawn from this study project would be applicable to future research, this can be utilized as a foundation, though specifically geared towards this study in relation to the rural environment of Sri Lanka. Being a developing country, the most important selection criteria for the landscapes utilized throughout this study are the same across urban, semi-urban, and rural areas. Looking at the rate at which the city is expanding and growing, it may not remain valid over an extended period.

It is important to acknowledge the limitations of this study, primarily stemming from its nature as a case study focused on a single expressway in a predominantly rural context. While this approach provided a rich, in-depth understanding of the specific challenges and opportunities within this unique setting, it also limits the generalizability of the findings. The social, economic, and environmental conditions of the studied rural area may not be directly applicable to urban expressway contexts or to rural expressways in different geographical and cultural settings. Factors such as land-use patterns, population density, community needs, and local government policies vary significantly and would require separate investigation. Therefore, while this framework offers a valuable methodology and a set of principles for adaptive reuse, its specific application must be tailored to the distinct characteristics of each project and its surrounding community.

There are significant policy and governance issues in Sri Lanka in this matter. The main challenges arise from the existing legislative and institutional framework, namely the Land Acquisition Act, which does not require a post-construction land-use plan for residual plots. Such fragmented plots of land tend to fall under the vague purview of the Road Development Authority (RDA) or the Ministry of Land, resulting in a lack of definite ownership and purpose. This plan will be an asset in avoiding negative outcomes by putting forward policy coordination and governance solutions. It fills the gap of non-cooperation between agencies by proposing legal channels for leasing or handing over these plots to Local Authorities or Community-Based Organizations (CBOs). Furthermore, the findings will validate a Corridor-Specific Land Use Policy requiring Landscape Architectural analysis and incorporating adaptive reuse into Environmental Management Plans (EMPs), transforming "leftover" space into productive linear parks, community assets, or ecological corridors. This research will secure the long-term sustainability and success of these landscapes by providing sustainable models of funding maintenance, such as Public-Private Partnerships or community trusts, and turn a negative social and environmental externality into an asset of public value.

Typology	Subcategory	Original status / functions	Typical Impacts and current status	Adaptive Reuse Potential	Design approach through Theoretical Lens
1. Leftover lands after earth resource extraction	Borrow mining sites & quarries	Naturally existed as mountains and rock formations	Landscape scars, waterlogging, erosion, safety hazards Highly degraded and unsustainably excavated land	Convert to wetlands, stormwater ponds, ecological habitats, and recreational lakes	Drosscape – turning degraded lands into productive ecologies
	Cut-and-fill scars	Natural geomorphological forms with naturally sustaining watersheds	Loss of topsoil, slope instability, and visual disruption, cleared land for the expressway reservation, which is currently degrading	Reforestation, terraced agroforestry, slope parks, introducing native ground covers	Landscape Urbanism – integration of ecology + engineering
	Spoil disposal mounds	Natural geomorphological forms before reshaping	Soil infertility, dust, invasive species colonization Degrading open land without vegetation covers	Bio-remediation, wildflower meadows, urban forestry	Ecological Urbanism
	Interchange & ramp islands	Used to be paddy lands, other cultivations with houses and home gardens	Unused fenced pockets, visual clutter Inaccessible dark enclosed spaces created by the elevated structures	Pocket parks, pollinator gardens, solar farms, rest stops with amenities	Landscape Urbanism – infrastructure as landscape
2. Unfunctional spaces created by newly constructed structures	Un-utilised land fillings in reservation margins	Former agricultural lands	Land field area without proper drainage	Introducing regenerative aquatic ecosystem Native reforestation	Ecological Urbanism
	Existing roadway crossings	Typically a b or c grade roads	Using as a resting area for drivers under the elevated expressway structures	Providing basic amenities for the drivers As rest stops near interchanges	Social Urbanism – linking community & space
	Waterway crossings	An uninterrupted waterway with riparian vegetation and ecosystems	Degrading waterway's natural forms and water pollution with illegal activities	Creating a public recreational area, restructuring the riverbanks	Social Urbanism – linking community & space
	Under/overpass voids	Used to be paddy lands and other cultivations with houses and home gardens	Dark, unsafe spaces, social disconnect Missused areas that lead to homeless encroachment	Community markets, bike lanes, play areas, art spaces Introducing small food stalls and kiosks to create positive interactions	Place Attachment – reclaiming neglected voids
3. Left-behind land after project completion	Buffer & edge strips	Used to be paddy lands and other cultivations with houses and home gardens	Noise, dust, unmaintained green belts	Linear greenways, agro-belts, biodiversity corridors regenerative eco system introductions	Drosscape + Green Infrastructure
	Abandoned camps	Used to be paddy lands and other cultivations with houses and home gardens	Soil contamination, visual blight, informal dumping	Community centers, sports grounds, revitalized parks, Creating a community playground	Place Attachment – turning abandonment into value
	Staging yards & stockpile areas	Used to be paddy lands and other cultivations with houses and home gardens	Soil compaction, barren grounds Cleared land for the expressway reservation currently degrading	Urban farms, nurseries, civic plazas Common ground for agricultural purposes	Landscape Urbanism
	Isolated leftover parcels near settlements	Directly utilized land by the neighborhood communities	Social neglect, safety issues, weed growth	Community gardens, cultural nodes, playgrounds	Social Urbanism – linking community & space

Table 6: Finalized framework for the adaptive reuse for the leftover spaces

References:

- United Nations. (n.d.). Goal 15: Life on land. United Nations Department of Economic and Social Affairs, Sustainable Development. <https://sdgs.un.org/goals/goal15>
- Institution of Engineers Sri Lanka. (2021). Sustainable development goals and the role of engineers in Sri Lanka. SLEN 58. <https://iesl.lk/SLEN/58/SDG.php>
- Mohamed Anuar, M. I. N., & Ahmad, R. (2017). Elevated highways and its lost spaces: A review of Kuala Lumpur's seldom seen. *Environment-Behaviour Proceedings Journal*, 2(6), 279–285.
<https://doi.org/10.21834/e-bpj.v2i6.966>
- Hauck, T., Keller, R., & Kleinekort, V. (Eds.). (2011). *Infrastructural urbanism: Addressing the in-between*. DOM Publishers
- Jaffe, E. (2015). Reviving the Dead Space Under Elevated Structures.
<https://www.citylab.com/design/2015/06/bringing-the-dead-spaces-under-an-elevated-back-to-life/396236/>. Latest accessed 25/08/2017
- Samuel, P. (2008). Innovative roadway design: Making highways more likeable (R. W. Poole, Jr., Project Director). Reason Foundation. <https://reason.org/policy-study/innovative-roadway-design/>
- Smith, J. (2014). Reading the margins: Interpreting terrain vague. In M. Mariani & P. Barron (Eds.), *Terrain vague: Interstices at the edge of the pale* (pp. 25–40). Routledge
- Mohamed Anuar, M. I. N. B., & Abdullah, S. A. (2017). Reappropriation of elevated highway residual space through green infrastructure planning. *Environment-Behaviour Proceedings Journal*, 2(6), 275–278.
<https://doi.org/10.21834/e-bpj.v2i6.965>
- Akinci, Y. C., Demir, S., & Demirel, O. (2016). Landscape architecture and creating innovative spaces under highway overpasses. In *Environmental sustainability and landscape management* (Chapter 1).
- ang, B., & Bean, S. (2017). Standards in sustainable landscape architecture. *Frontiers of Architectural Research*, 6(3), 378–391. <https://doi.org/10.1016/j.foar.2017.05.004>
- Allen, W. L. III. (2014). A green infrastructure framework for vacant and underutilized urban lands. *Journal of Conservation Planning*, 10, 43–51
- Abd El Gawad, N. S., Al-Hagla, K. S., & Nassar, D. M. (2019). Place making as an approach to revitalize neglected urban open spaces (NUOS): A case study on Rod El Farag Flyover in Shoubra, Cairo. *Alexandria Engineering Journal*, 58(4), 1243–1254.
- Corner, J. (2006). Terra Fluxus. In C. Waldheim (Ed.), *The landscape urbanism reader* (pp. 21–33). Princeton Architectural Press.
- Shane, D. G. (2011). *Urban design since 1945: A global perspective*. Wiley.
- Waldheim, C. (2006). Landscape as urbanism. In C. Waldheim (Ed.), *The landscape urbanism reader* (pp. 35–53). Princeton Architectural Press.
- Waldheim, C. (2016). *Landscape as urbanism: A general theory*. Princeton University Press.

Jorgensen, B. S., & Stedman, R. C. (2009). Defining place attachment: A tripartite organising framework. *Journal of Environmental Psychology*. <https://doi.org/10.1016/j.jenvp.2009>.

Scannell, L., & Gifford, R. (2011). Place attachment: How far have we come in the last 40 years? *Journal of Environmental Psychology*, 31(3), 207–230. <https://doi.org/10.1016/j.jenvp.2010.10.001>

A meta-analysis of the relationship between place attachment and pro-environmental behaviour. (2021). *Journal of Business Research*, 123, 208–219. <https://doi.org/10.1016/j.jbusres.2020.09.045>

Berger, A. M. (2006). *Drosscape: Wasting land in urban America*. Princeton Architectural Press.