Climate Resilience in Urban Transport Planning: A Case Study of Cosmo City's Wetland Dilemma

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ABSTRACT

Urban transport planning in climate-sensitive regions requires balancing accessibility needs with environmental sustainability, particularly in informal settlements. This paper examines the dilemma surrounding an operational informal taxi rank located in an ecologically sensitive area near a wetland in Cosmo City, Johannesburg. Ideally situated for community access, the rank serves as a vital transit hub for workers, scholars, and traders. However, its location raises concerns about climate resilience and ecological impact, as the area is prone to flooding and holds significant biodiversity value. While formalising the rank would enhance safety and infrastructure, relocation to a non-wetland area risks underutilisation, as seen with a nearby formal facility that remains unused due to its inconvenient location. Using available environmental, land use and transport data, this paper explores the trade-offs between environmental risks and community benefits in maintaining the taxi rank's current location. By weighing climate resilience considerations against transport accessibility needs, the study offers insights into adaptive strategies for transport infrastructure in vulnerable urban areas. This case presents a broader challenge for Southern African cities, emphasising the need for context-sensitive solutions that address both climate resilience and societal demands. The paper invites debate on sustainable urban transport planning in high-density, climate-sensitive regions.

Keywords: Climate resilience, informal taxi rank, wetland preservation, transport accessibility.

1. INTRODUCTION

1.1 Background and Context

The Zandspruit Transport Master Plan (TMP) was commissioned by the City of Johannesburg to develop a feasible medium- to long-term solution for transport challenges in Zandspruit and surrounding areas. The study aimed to create a transport framework that aligns with principles of sustainable urban development, including compact, well-connected transport networks, prioritisation of pedestrian movement and non-motorised transport (NMT), and improved connectivity between areas of economic opportunity and historically deprived communities. A multi-disciplinary team, including transport planners, traffic engineers, and urban designers, was appointed to undertake this work.

One of the key aspects assessed in the TMP was public transport operations. Minibus taxis being the dominant mode of public transport in the area, resulted in a proliferation of formal and informal taxi ranks. One such facility, the Angola Informal Rank, located at the intersection of Angola Avenue and South Africa Drive in Cosmo City, emerged as an important operational hub. This informal rank serves a high volume of commuters, including workers, scholars, and traders, providing a link between residential areas, services, and economic opportunities. However, it lacks formal infrastructure, operating as an open, unpaved space with no designated transport facilities or services as shown in Figure 1.

Site Details

Town/Suburb:	Cosmo City Extension 2
Zoning:	Public Open Space
Ownership:	Municipality, City of Johannesburg
Area/size:	0,83 Hectares

Streetview

Figure 1: Site Locality and Description (SANBI GIS, Google Earth, CGIS GeoLIS)

The site benefits from high accessibility due to its location along South Africa Drive—a Class 3 minor arterial route that links to major arterials in the province such as the R512 (Malibongwe Drive). Angola Avenue, functions as a Class 4 urban collector and distributor street. This positioning makes the rank highly convenient for users but despite its functional significance, land use zoning and environmental data revealed that the rank is situated within an environmentally sensitive area, adjacent to a wetland. This poses a significant planning dilemma: while the rank's location offers high accessibility and public transport efficiency, it also raises serious concerns regarding, biodiversity preservation, climate resilience, and long-term sustainability of safe public transport operations. The presence of the wetland increases vulnerability to seasonal flooding, while the ecological importance of the area may limit public transport infrastructure development potential.

1.2 Aim of Study

This paper builds on the TMP's recommendation for an environmental and technical feasibility study of the Angola Informal Rank and investigates whether formalisation, relocation, or alternative design interventions could mitigate the transport-environment conflict. The study aims to:

- Assess the rank's role in local mobility and transport accessibility.
- Evaluate environmental risks, particularly flooding and biodiversity sensitivity.
- Examine relocation options and their impact on commuter behaviour.
- Explore the feasibility of environmentally responsive formalisation to enhance climate resilience.
- Contribute to broader debates on climate-resilient urban transport planning and public transport in dense informal settlements.

The paper is structured into five sections. Section 2 outlines the research problem and describes the methods employed in the study. Section 3 presents the case study analysis and findings, while Section 4 provides discusses the findings. Finally, Section 5 concludes the paper with key insights and broader implications for sustainable urban transport planning.

2. RESEARCH PROBLEM & METHODOLOGY

2.1 Research Problem

Urbanisation in Southern African cities often outpaces formal infrastructure planning, creating tension between rapid development and environmental protection. In Cosmo City, Johannesburg, intensifying residential densities—reaching up to 100 dwelling units per hectare—have increased demand for informal transport services. A direct consequence of this urban expansion has been the emergence of the Angola Informal Taxi Rank, which developed in response to increased public transport demand. Figure 2 shows that the rank is situated within an environmentally sensitive area as per the City of Johannesburg's Bio-regional Sector Plan 2012. The map highlights the overlap between urban expansion and ecological zones with a natural drainage system located approximately 200 m east of the site. Development around the site has contributed to increased economic activity and housing provision, but it has also altered natural drainage patterns, increasing impervious surfaces that contribute to higher runoff and localised flooding. This study frames the issue through the lens of climate resilience, defined here as the capacity of infrastructure and communities to function and adapt amid climate-related risks like flooding. It examines whether adaptive formalisation strategies can preserve the transport utility of the Angola Taxi Rank while enhancing its resilience to environmental stressors.

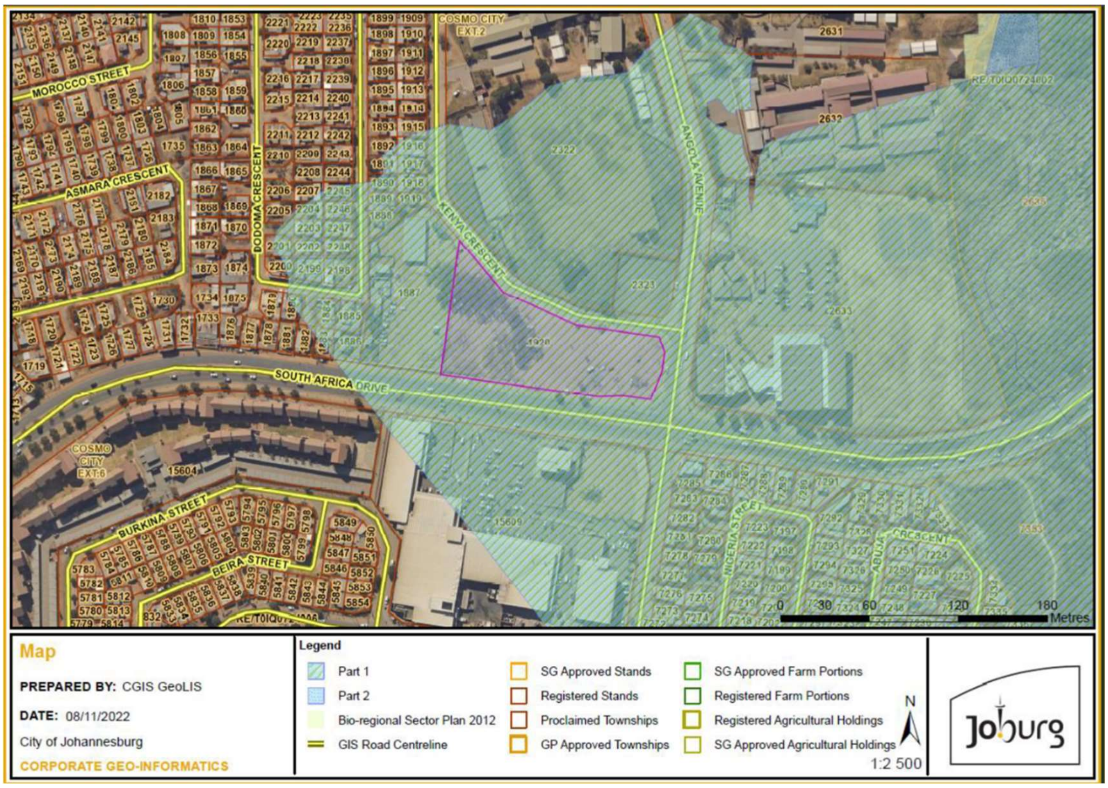

Figure 2: Spatial Context of the Angola Informal Taxi Rank within the Environmentally Sensitive Area

Urbanisation and transport infrastructure contribute significantly to environmental degradation, leading to habitat fragmentation, increased surface runoff, and pollution (WRC, 2001). The construction of impervious surfaces, such as roads, buildings, and parking areas, exacerbates flooding risks and groundwater depletion, further intensifying the vulnerability of ecosystems and communities. Given this context, the core research problem is how informal public transport facilities in rapidly-urbanising and climate-sensitive areas can be adapted to balance public transport accessibility while enhancing their resilience to climate-induced risks Addressing this challenge requires a multifaceted approach that integrates spatial analysis, environmental assessments, and transport and public transport planning strategies.

2.2 Methodology

This study adopts a case study approach to assess the trade-offs between public transport accessibility and climate resilience. It integrates spatial, environmental, and transport and public transport data, beginning with a site analysis of land use patterns, transport infrastructure, and accessibility using GIS data and planning reports. An environmental assessment is conducted using South Africa's National Environmental Screening Tool, which generates a Screening Report for the site. Stakeholder insights are drawn from previous planning studies and the study concludes by evaluating strategies for formalising, relocating, or adapting the Angola Informal Taxi Rank.

3. CASE STUDY ANALYSIS

This chapter analyses the Angola Informal Taxi Rank within the broader Zandspruit context, focusing on the spatial, environmental, and transport factors influencing its viability. A basic risk and opportunity assessment is conducted to identify key trade-offs in urban mobility and environmental conservation, culminating in an exploration of potential strategies and solutions that balance public transport accessibility, infrastructure needs, and climate resilience.

3.1 Site Analysis

The Angola Informal Rank is well- within Cosmo City's busiest commercial and social hub, anchored by the Cosmo City shopping centre (Figure 3). The node features mixed land uses, including retail, schools, and residential areas, with several educational institutions nearby. The adjacent Multipurpose Centre offers healthcare, recreational, and community services, reinforcing the area's public function. Informal trading strips along South Africa Drive and Angola Avenue further integrates economic and transport functions, creating a dynamic urban environment where public transport, commercial activity, and pedestrian movement intersect.

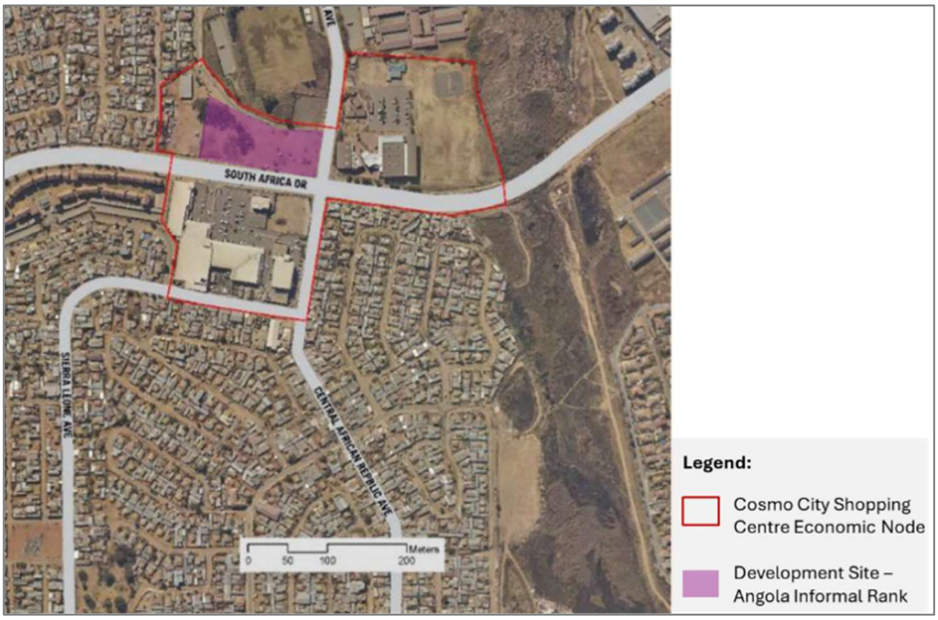

Figure 3: Cosmo City Shopping Centre Economic Node

3.1.1 Land Use Trends

Figure 4 illustrates past and projected urban growth and densification in Zandspruit and its surrounds. The green-shaded areas represent natural and ecologically sensitive spaces, while the red areas indicate urban growth and densification. Trends suggest continued expansion of formal residential developments, supported by policy frameworks and ongoing housing projects.

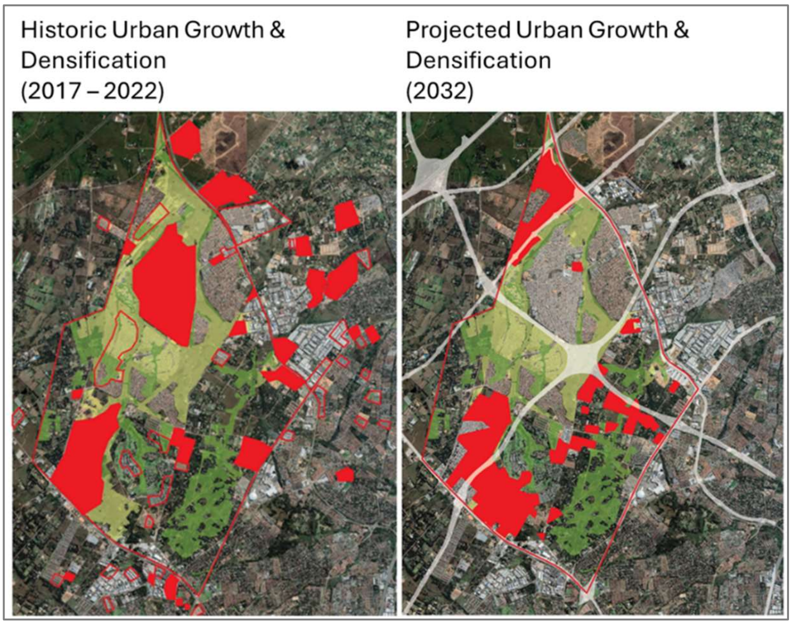

Figure 4: Urban Expansion Trends in Zandspruit and Surrounding Area - Highlighting Encroachment on Natural Spaces (Zandspruit TMP, 2022)

Encroachment on Natural Spaces and Ecological Systems

Urban expansion is steadily reducing natural open spaces, especially along planned PWV and K-routes (depicted as grey lines in the second image) that cut through ecologically sensitive areas. This encroachment heightens environmental risks, including increased flooding, biodiversity loss, disrupted groundwater recharge, and wetland degradation due to runoff and pollution.

3.2 Contextualising the Transport and Public Transport Demand

Although passenger and commuter-specific data for the Angola Informal Rank is unavailable, pedestrian counts, traffic volumes, and limited journey time surveys on adjacent roads serve as proxies for transport activity and are indicative of how people and vehicles interact with the rank. The data is summarised in Table 1 and discussed thereafter.

Table 1: Traffic Data

Road	Peak Hour		Total Traffic Volumes (vph)	Minibus Taxi Volumes (vph)	Pedestrian Flows – Sidewalks (pph)
South Africa Dr	AM	06h45 - 07h45	1700	365 (21%)	536
	PM	16h15 - 17h15	1533	408 (27%)	456
Angola Ave	AM	06h45 - 07h45	1163	337 (29%)	476
	PM	16h15 - 17h15	740	172 (23%)	168

- South Africa Drive experiences the highest traffic volumes, with 1700 vehicles per hour (vph) in the AM peak and 1533 vph in the PM peak, reinforcing its function as a primary arterial route.
- Angola Avenue records lower traffic volumes, at 1163 vph in the AM peak and 740 vph in the PM peak.
- Minibus taxis account for a substantial proportion of total traffic, representing between 21% and 29% of peak hour traffic at the taxi rank vicinity (an average of 25%). This high volume suggests potential congestion challenges, especially since rank operations are informal, leading to stopping and waiting along the roadway.

- South Africa Drive exhibits the highest pedestrian volumes, with 536 pedestrians per hour (pph) in the AM peak and 456 pph in the PM peak. This indicates a busy corridor supporting taxis, informal trade, and commercial activity.
- Angola Avenue sees significant pedestrian activity in the AM peak (476 pph), but pedestrian volumes drop sharply in the evening (168 pph), suggesting that morning pedestrian traffic includes school and work commuters.
- The convergence of high pedestrian volumes and minibus taxi operations necessitates safety interventions, such as dedicated pedestrian crossings, speed calming measures, and improved sidewalk infrastructure.
- AM peak volumes exceed PM peaks on both roads, reflecting higher morning congestion driven by work and school commutes. Suggesting increased demand for public transport and road space in the morning rush, and more time-sensitive travel pattern in the AM peak, whereas PM peak travel may be more dispersed, with commuters returning home at varied times.

3.3 Catchment Analysis and Alternative Site Evaluation

Understanding how well the Angola Informal Taxi Rank serves its surrounding community is essential for assessing its long-term viability. This section presents a pedestrian catchment analysis using a 20-minute walking time threshold to compare the spatial accessibility of the current rank with two alternative sites.

Figure 5 displays the walking catchment areas for three locations:

a. **Orange Zone (Central):** The existing Angola Informal Taxi Rank, which is centrally located within Cosmo City.
b. **Red Zone (Top Right):** The Cosmo City Public Transport Facility, a formal, purpose-built node with designated taxi bays, lighting, pedestrian infrastructure, and trading stalls.
c. **Blue Zone (Bottom Left):** Vacant municipal-owned land, proposed by the community as a possible alternative rank site.

Each coloured zone represents the area reachable on foot within 20 minutes from that location. Although the travel-time is the same across all three, the shaded areas differ in coverage and reach due to factors like road network density, pedestrian routes, and barriers. The Angola Informal Rank (orange) has the most balanced and expansive central coverage, overlapping with key commercial, residential, and educational land uses. The formal facility (red), although well-equipped, is located on the periphery of the activity node, reducing its reach to the southern and western parts of the community. The blue zone, while centrally located, covers fewer high-density residential zones and is less integrated with current pedestrian desire lines and trading activity. The analysis confirms that location, not just infrastructure, plays a critical role in ensuring the usability of a transport facility. While the rank demonstrates strong functional accessibility, its formalisation must still align with planning regulations such as Environmental Impact Assessments (EIAs) and Integrated Public Transport Network (IPTN) frameworks. These ensure legal compliance and help manage the environmental and social impacts of infrastructure development.

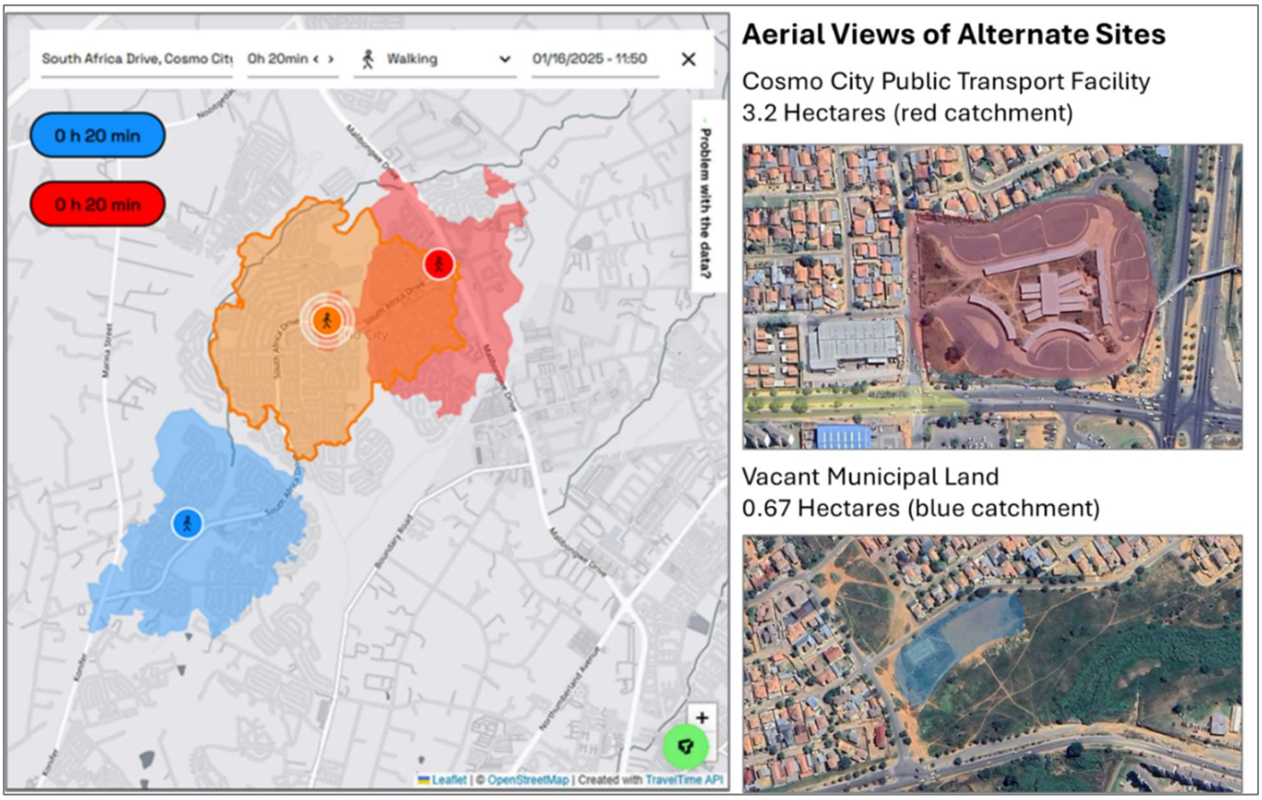

Figure 5: Travel Time Map

3.4 Environmental Assessment

To evaluate the environmental constraints associated with the Angola Informal Taxi Rank, a pre-screening analysis was conducted using South Africa's National Web-Based Environmental Screening Tool, developed by the Department of Forestry, Fisheries and the Environment (DFFE). This online platform generates an automated Environmental Screening Report based on the geographic coordinates of a proposed development site. It draws from national datasets compiled by entities such as SANBI, DALRRD, SAHRA, and the Department of Water and Sanitation, providing a spatial overview of environmental sensitivities. The tool assesses the environmental sensitivity of the site across various themes using a classification system ranging from "low" to "very high" sensitivity, with recommendations on whether additional EIA processes or specialist studies are required in accordance with the National Environmental Management Act (NEMA). Outputs of the screening assessment are depicted in Figure 6.

3.4.1 Development Incentives, Restrictions, Exclusions or Prohibitions

The site falls with the Gauteng Provincial Environmental Management Framework (EMF) 2021 – Urban Development Zone 1 which is intended to promote urban infill, densification, and the concentration of development within established urban areas. This aligns with the Gauteng Spatial Development Framework (GSDF), which seeks to create a more compact and efficient city-region, limiting urban sprawl into rural and ecologically sensitive areas. While Urban Development Zone 1 encourages infrastructure investment and land-use intensification, it does not exempt projects from environmental compliance requirements.

3.4.2 Environmental Sensitivities

The indicative environmental sensitivities of the site are mapped in Figure 6 with only the highest environmental sensitivities shown and discussed.

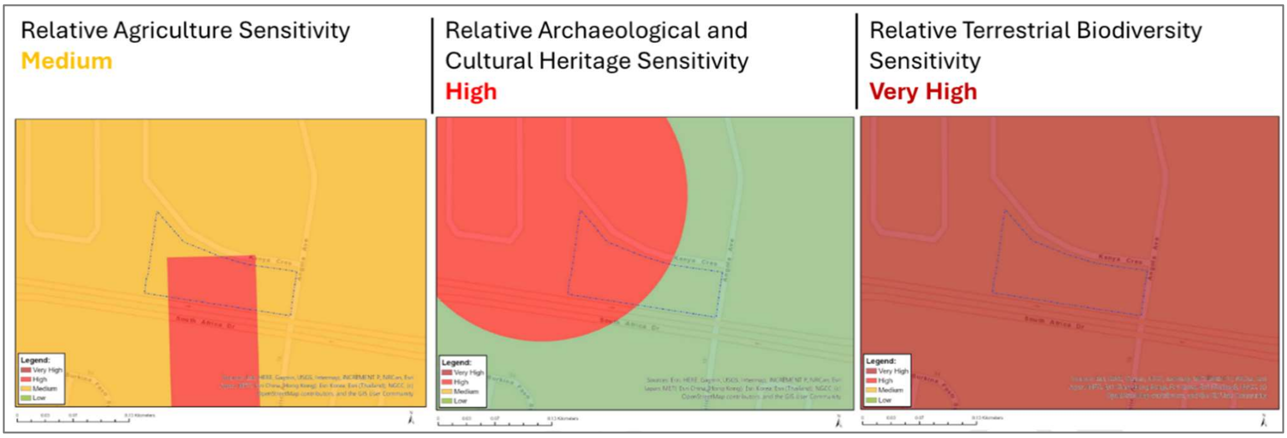

Figure 6: Maps of Environmental Sensitivities

- **Agricultural:** The site presents medium to high agricultural sensitivities implying moderate to significant potential for agricultural use based on factors such as soil quality, land capability, and environmental conditions.
- **Archaeological and Cultural Heritage:** The site is within 150 meters of a Grade IIIa heritage site, a designation that indicates regional cultural significance. Any development within this buffer zone requires a heritage impact assessment (HIA) to prevent the loss or degradation of cultural and historical assets and conservation measures, such as buffer zones, re-vegetation efforts, or green infrastructure integration, should be explored to mitigate habitat destruction.
- **Terrestrial Biodiversity:** The site lies within a "Very High Sensitivity" area for Egoli Granite Grassland, a critically endangered vegetation type. Development in such areas risks further degrading already scarce ecosystems.
- **Hydrology and Aquatic Biodiversity:** Although the site's direct aquatic sensitivity is low, its hydrological connections to the wetland and its role in managing runoff suggest that a detailed hydrology assessment is necessary.
- **Proximity to Wetlands and Flood-Prone Areas:** The site is located within 200 meters of a wetland and is known to experience periodic flooding, particularly near an existing bridge. Wetlands provide critical ecosystem services, including water filtration, flood attenuation, and biodiversity support. Disturbance or pollution could negatively impact their functionality.

3.4.3 Contradictions in Biodiversity Classification

The site's biodiversity classification differs across environmental planning tools, revealing inconsistencies in conservation assessments. The Gauteng Conservation Plan does not label the site as a Critical Biodiversity Area (CBA) or Ecological Support Area (ESA), although it lies within 150 meters of both *(*Figure 7). In contrast, the City of Johannesburg's Bioregional Plan identifies the site as part of a CBA (Figure 2). CBAs are critical for biodiversity conservation and must be protected in their natural or near-natural state to ensure ecosystem functioning and resilience. ESAs are not necessarily biodiversity hotspots but play an important role in supporting ecological processes, such as water filtration, pollination, and wildlife movement corridors. This discrepancy between conservation planning tools underscores the complexity of urban ecological management and underscores the need for a site-specific EIA to determine the true conservation value of the site and inform decision-making.

Figure 7: Site locality in context of the Gauteng Conservation Plan (SANBI BGIS, 2011)

3.4.4 Hydrological Considerations and River Catchment Impacts

Figure 8 depicts the National Freshwater Ecosystem Priority Areas (NFEPA) wetland map which confirms the existence of a wetland system within 200 metres of the site. The wetland system forms part of a natural watercourse that flows northward through Cosmo City and is a tributary of the Jukskei River. Two major known challenges of the Jukskei river catchment are sewage pollution and flooding (Zandspruit TMP, 2022). The tributary stream within Cosmo City faces the same challenges, with the added burden of illegal waste dumping, further exacerbating water quality and drainage issues. The wetland has not been encroached on by developments, but the water is highly polluted with sewage, wastewater and litter. Many invasive species are evident within the wetland. These hydrological challenges necessitate an integrated stormwater management approach, ensuring that any transport infrastructure modifications do not contribute to further degradation of the water system.

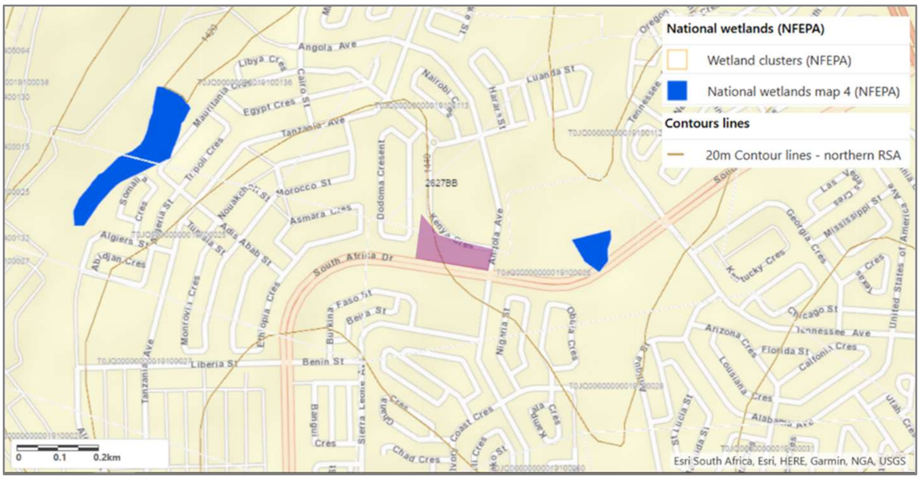

Figure 8: Site locality in context of the National Freshwater Ecosystem Priority Areas (SANBI BGIS, 2011)

3.5 <u>Stakeholder Engagement Insights</u>

Stakeholder engagement during the development of the TMP shed light on serious infrastructure challenges, environmental misalignment, and congestion issues affecting transport operations around the Angola Informal Taxi Rank. One of the most pressing concerns is the flooding of the South Africa Drive bridge, which often reduces traffic flow to a single lane, worsening congestion. Poor stormwater management results in water accumulation at this low-lying point, compounded by an under-capacity sewer system that frequently overflows at Angola Avenue, creating both environmental and public health risks.

The City of Johannesburg's EISD as a key stakeholder raised concerns that transport network planning in Cosmo City overlooked the area's hydrological characteristics, particularly its seep wetlands. Roads were constructed without accounting for natural drainage patterns, leading to persistent road erosion, potholes, and increased maintenance challenges for the Johannesburg Roads Agency (JRA). This highlights the need for future road infrastructure upgrades to integrate hydrological and climate resilience considerations to prevent recurring structural failures.

4. DISCUSSION

The case study analysis has revealed a complex interplay between public transport accessibility, socio-economic imperatives, and environmental sensitivities in the context of the Angola Informal Taxi Rank. The location of the rank presents both benefits and challenges—while it serves as a critical mobility hub, its placement within an ecologically sensitive wetland and flood-prone area necessitates careful planning. This section evaluates the implications of formalising the rank in its current location versus relocating it, within the broader policy and governance context.

4.1 Trade-Offs in Transport Infrastructure Planning

The planning of urban public transport routes, facilities and transport infrastructure is inherently a balancing act between conflicting priorities, requiring careful assessment of costs, benefits, and long-term implications. In the case of the Angola Informal Taxi Rank, the primary trade-offs revolve around public transport efficiency (effectiveness and integration), climate resilience, socio-economic impacts, and policy enforcement. In this study, climate resilience refers to the ability of the rank and the surrounding transport and drainage infrastructure to withstand, adapt to, and recover from climate-related hazards, particularly flooding.

4.1.1 Formalisation vs. Climate Resilience

The formalisation of the rank could improve passenger and commuter safety, transport efficiency, and economic stability by introducing dedicated loading zones, improved infrastructure, and controlled trading spaces. However, the vulnerability of the site to climate-induced flooding presents a major risk. Without adaptive design, intensifying rainfall could render the site unsustainable, leading to costly degradation and heightened community vulnerability.

4.1.2 Relocation vs. Commuter Behaviour and Economic Stability

Alternative relocation sites show poor accessibility and connectivity based on catchment analysis. The nearby formal facility remains underused, highlighting that infrastructure alone doesn't determine success—passenger and commuter behaviour and travel convenience are key determining factors. While relocation may address environmental concerns, it risks disrupting established travel patterns and livelihoods. As Cervero & Golub (2007) note, relocation efforts that ignore user behaviour often result in non-compliance, and could lead to reduced ridership, increased transport costs for commuters, and continued informal operations at the current site.

4.2 Policy and Governance Challenges

The governance landscape in Johannesburg presents both opportunities and constraints in addressing the challenges faced at the Angola Informal Taxi Rank. While the Bio-regional Plan (2012) and Gauteng Environmental Management Framework (2021) emphasise ecological protection and sustainable development, rapid urbanisation, informal settlements, and increasing transport and public transport demands often strain the enforcement of these policies, creating a complex regulatory landscape where ecological conservation and mobility needs must be balanced. Effective intervention at the Angola Rank requires policy alignment and interdepartmental collaboration between transport, environmental, and infrastructure planning authorities to integrate ecological and transport policies into a unified framework. The City of Johannesburg's Environmental Sustainability Strategy underscores the importance of viewing natural ecosystems as part of urban infrastructure rather than as passive environmental constraints. This perspective should be embedded in governance mechanisms to promote resilient, sustainable, and legally compliant transport and public transport planning.

One of the underlying pressures on infrastructure demand in the study area stems from the proliferation of backyard dwellings within formal residential areas. While addressing housing needs, they also increase the burden on transport services, utilities, and social infrastructure. There is an urgent need for policy intervention from local authorities to assess whether these informal residential expansions can be integrated into municipal service provision models while generating revenue to sustain infrastructure investment. Formalising the Angola Rank is a necessary intervention to enhance transport and public transport integration, effectiveness and efficiency, improve commuter safety, and introduce structured infrastructure solutions. However, this process must be complemented by regular maintenance measures to ensure the functionality of stormwater drainage and flood mitigation systems. Scheduled inspections and maintenance protocols should be enforced to prevent blockages and system failures, while contingency plans for extreme weather events should be developed, including evacuation strategies and emergency transport rerouting options to safeguard commuters and operators.

Achieving a sustainable, resilient, functional, and legally compliant public transport hub in Cosmo City requires an integrated governance approach that brings together transport and public transport planning, environmental management, and community-based urban development strategies. This will ensure that mobility solutions are not only efficient and accessible but also resilient to long-term ecological and climate challenges.

4.3 Contextualised Strategies and Solutions for the Angola Informal Taxi

Formalising the Angola Informal Rank requires a context-sensitive, climate-resilient approach that integrates green infrastructure, land-use efficiency, and participatory planning. Drawing from the CSIR Green Book and various literature, this section proposes a multi-faceted solution that integrates nature-based infrastructure design, multi-modal transport planning, and participatory governance mechanisms. The formalisation of Angola Rank aligns with Transit Oriented Development (TOD) principles, which aim to create mixed-use, walkable urban environments centred around public transport environments.

4.3.1 Formalised Public Transport Facility with Green Infrastructure

For public transport facilities that require structural support and stormwater absorption comparable to natural open spaces, permeable surface designs should incorporate materials and systems that have been scientifically tested for both load-bearing capacity and hydraulic performance. A consultation of various literature and guidelines reveals that an integrated solution for this rank comprising below elements and strategies could work:

Integrated Permeable Interlocking Concrete Pavers (PICP)	● High-strength concrete blocks with small gaps filled with permeable aggregates. The sub-base is designed to store and filter stormwater. ● The load-bearing capacity is suitable for heavy vehicles like buses and public transport structures. ● Research by Collins et al. (2008) demonstrates that PICP systems reduce peak runoff by up to 98%, depending on the base design and rainfall intensity.

	● PICP is proposed for the loading bays and parking areas. ● PICP with gritstone-filled joints is proposed for informal trading stall areas. This combination ensures both drainage and durable surfaces for pedestrian and commercial activity.
Porous Asphalt	● Porous asphalt is like conventional asphalt but includes larger aggregates, leaving voids for water to infiltrate. It is supported by a permeable sub-base for structural strength and water storage. ● Capable of supporting heavy vehicles. ● High permeability, with an infiltration rate of 2.5–3.5 mm/s (Jayawickrama et al., 2021). ● Porous Asphalt is proposed to be used for driveways and cycle pathways.
Geo-cellular Units	● Installed beneath the aggregate layers to provide additional stormwater storage. ● These will store excess water during heavy rainfall, releasing it slowly to reduce the risk of flooding while replenishing groundwater levels

4.3.2 Wetland Protection Measures

To address the site's environmental sensitivity, the CSIR Green Book recommends rehabilitating wetlands using natural barriers, such as constructed berms, reforestation buffers, native vegetation planting, removal of invasive species and controlled water channels. These should be applied to protect the surrounding wetland while allowing managed transport operations.

4.3.3 Enhanced the Resilience of Adjacent Built Infrastructure

The existing school and multi-purpose centre adjacent to the wetland must be integrated into the broader resilience strategy. These institutions face risks of flooding, poor drainage, and compromised accessibility, requiring climate-adaptive interventions. Proposed measures include:

Flood Protection and Green Buffers	● Installing raised embankments, artificial floodplains, and green infiltration zones around the properties to divert excess stormwater into controlled channels and to the natural stream.
Upgrade Drainage Systems with Permeable Surface Enhancements	● Converting paved schoolyards and parking areas into permeable surfaces to improve drainage and reduce runoff into the wetland.
Rainwater Harvesting	● Retrofit rooftop rainwater harvesting for sustainable water use and reduced run-off.
Solid Waste Management	● Designated waste collection zones and educational programs for informal traders and commuters may help curb illegal dumping in public open spaces reduce littering and improve the wetland's ecological health.

4.3.4 Strengthening Public Transport and Environmental Linkages

To create a **cohesive urban system**, better linkages between the rank, the wetland, and adjacent developments must be established. This is proposed as follows:

Safe Pedestrian Connectivity	● Developing well-designed pedestrian pathways and cycle-friendly routes that integrate the wetland as a natural transit corridor rather than a barrier.
Green Public Spaces	● Creating pocket parks and eco-friendly transit waiting areas around the rank to blend transport infrastructure with environmental preservation.

By adopting this multi-layered approach, the Angola Informal Taxi Rank can be reimagined as a resilient, multi-functional public transport node that supports urban mobility, economic activity, and environmental stewardship.

4.4 Long-Term Benefits for the Wetland and Community

Enhanced Wetland Functionality	● By restoring the wetland buffer zone and managing stormwater more effectively, the formalisation project will strengthen the wetland's role as a flood mitigation system and biodiversity haven. ● Reduced sedimentation and pollutant loads will improve water quality and enhance the ecosystem services provided by the wetland.
Climate Resilience	● The integration of sustainable design elements will ensure that the rank and surrounding wetland can withstand increasing rainfall intensities and other climate-related stresses. ● Reduced urban heat island effects from green infrastructure will improve the site's microclimate.
Social and Economic Gains	● Retrofit rooftop rainwater harvesting for sustainable water use and reduced run-off.
Solid Waste Management	● The rank will become a safe, organized, and attractive transport hub that supports economic activities while creating a sense of place for the community. Improved access to transport will benefit workers, students, and small business owners, contributing to the overall development of Cosmo City.

5. Conclusion

This study has demonstrated the complexity of integrating public transport infrastructure within environmentally sensitive zones. The Angola Informal Rank presents a case where transport needs must be reconciled with climate resilience and ecological conservation. Through a contextualised, hybrid planning approach, sustainable solutions can be adopted to retain accessibility while safeguarding the wetland ecosystem.

Rather than viewing ecological constraints as obstacles to development, they should be seen as opportunities to design more resilient and adaptive urban systems. The case of the Angola Informal Taxi Rank exemplifies the need for this integrated approach, where the natural environment is not a passive element to be worked around but an active component of the city's infrastructure that supports flood mitigation, climate adaptation, and overall urban functionality. By leveraging ecological infrastructure—such as wetlands, permeable surfaces, and green stormwater management systems—alongside transport and public transport infrastructure, cities can enhance long-term sustainability while meeting mobility needs.

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