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Research Paper

Prioritizing Climate-Resilient Road Infrastructure Strategies in Greater Honiara, Solomon Islands

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Abstract

Climate change poses significant risks to road infrastructure. Despite growing research on climate vulnerability in SIDS, limited studies have prioritized road adaptation strategies. This study contributes by identifying priority strategies for climate-resilient road infrastructure in Greater Honiara. The research utilizes secondary data to examine the climate patterns and the state of the road network. It also involves collecting questionnaire data through purposive sampling of 40 respondents, including urban planners, engineers, experts, academics, and local government representatives. In addition, 10 participants were selected for follow-up semi-structured interviews based on their knowledge and experience. Descriptive analysis, the Analytic Hierarchy Process (AHP), and Multi-Criteria Analysis (MCA) were applied to prioritize climate-resilient road adaptation strategies. Extreme rainfall and flooding were identified as the most significant threats. AHP results indicate durability as the most important criterion, followed by suitability and affordability. MCA results ranked sustainable drainage systems as the highest-priority strategy across all zones in Greater Honiara. Therefore, the study helps address a research gap by identifying suitable climate adaptation strategies for different zones in Greater Honiara. The findings provide guidance for improving climate-resilient road infrastructure planning and management in the Solomon Islands.

Keywords: Road infrastructure; Climate change impacts; Greater Honiara; Adaptation strategies; Climate resilience.

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1. Introduction

Climate change has emerged as one of the most critical global challenges affecting natural and human systems, with infrastructure increasingly recognized as one of the most vulnerable sectors (IPCC, 2021; K. Liu et al., 2023). Rising global temperatures, accelerating sea-level rise, and the growing frequency and intensity of extreme weather events such as heavy rainfall, floods, and tropical cyclones pose serious risks to infrastructure worldwide. The impacts of climate change on the sustainability and performance of infrastructure systems have become increasingly apparent, especially in vulnerable regions exposed to environmental and climate-related hazards. Adaptation and resilience approaches are thus becoming important considerations in development planning to reduce long-term risks and improve sustainability outcomes (Pamungkas and Rudiarto, 2026). Furthermore, effective climate governance and integrated planning approaches are needed to strengthen infrastructure resilience and support sustainable development goals (Lestari, 2024). Integrating climate-resilient approaches into infrastructure development can improve the durability of infrastructure and reduce future environmental and economic risks. Road networks are particularly sensitive to these stressors because they are directly exposed to climatic conditions and rely heavily on stable soil structures and effective drainage systems (Almeida & Picado-Santos, 2022; Chinowsky et al., 2014).

Resilient infrastructure, innovation, and sustainable industrialization are important drivers of sustainable development (Küfeoğlu, 2022). Developing climate-resilient road infrastructure is important for maintaining transport connectivity, reducing damage, and ensuring access to essential services. Strengthening the resilience of roads can contribute to sustainable urban development, improve community accessibility, and support long-term economic growth (Temmer, 2017; United Nations, 2015). Fuldauer et al. (2022) highlighted that climate adaptation strategies play a crucial role in protecting sustainable development achievements and strengthening resilience to climate-related hazards.

The economic and social importance of the road network in Greater Honiara cannot be overstated. Roads connect residential areas with commercial centers, government institutions, schools, hospitals, and ports. Disruptions to the road system will have cascading effects on economic stability, public safety, and social well-being. During the major flood disaster of April 2014, thousands of residents were displaced, and key transport corridors were rendered unusable, highlighting the fragility of the urban transport system under extreme climate conditions (Trundle & McEvoy, 2016). The flood caused extensive damage and economic losses estimated at SBD 787.3 million (USD 107.8 million), which accounted for approximately 9.2% of the Solomon Islands' GDP (Government of Solomon Islands & World Bank, 2014). Existing literature has highlighted the vulnerability of infrastructure systems in Pacific Island countries and emphasized the importance of climate-resilient design and adaptation strategies (de Abreu et al., 2022; Hoang, 2022; World Bank, 2017). Studies have examined national-level risk profiles, climate projections, and general adaptation frameworks. For example, Trundle and McEvoy (2016) developed an urban resilience and climate action plan for Honiara, emphasizing governance and planning challenges. Similarly, identified flooding, sedimentation, and inadequate drainage as major urban infrastructure problems.

Previous studies have reported that climate change poses serious risks to road infrastructure through physical deterioration and service disruption. Santos (2022) found that climate-related hazards can cause extensive road damage, including surface degradation and structural failures, with more than 60 identified impact types affecting road infrastructure. Similarly, Ametepey et al. (2023) and Pathan et al. (2024) highlighted that roads are highly exposed to flooding, extreme temperatures, and soil subsidence, which can disrupt transportation networks and economic activities. In addition, Auerbach et al. (2016) emphasized that structured risk assessment and adaptation planning are essential to improve long-term infrastructure sustainability under changing climate conditions. In contrast to Setiadi (2018), the resilience of urban infrastructure systems to climate impacts can be significantly improved by integrating local adaptation actions with institutional support systems, using appropriate technical measures, and undertaking continuous planning processes. This approach highlights the necessity of coordinated action at various levels of governance to achieve sustainable and resilient urban development. Hence, it is recommended to include the climate adaptation strategies in the infrastructure development to ensure the long-term urban sustainability and resilience. These studies collectively show the importance of strengthening road infrastructure resilience to reduce climate risks and maintain reliable transport systems.

Small Island Developing States (SIDS) are among the region's most vulnerable to climate change due to their geographic exposure, small land area, fragile ecosystems, and limited financial and institutional capacity (Hoang, 2022; World Bank, 2017). In Pacific Island countries, transport infrastructure is often concentrated in narrow coastal strips and steep terrains, making it highly susceptible to sea-level rise, coastal erosion, flooding, and landslides (Trundle & McEvoy, 2016). Moreover, limited redundancy in road networks means that disruption of even a single corridor can isolate communities and severely affect access to markets, healthcare, and emergency services (Leal Filho et al., 2020).

Greater Honiara, the capital and largest urban center of the Solomon Islands, exemplifies these challenges. Over the past two decades, the city has experienced rapid demographic growth and spatial expansion. This growth has placed increasing strain on transport infrastructure that was not originally designed to accommodate current traffic volumes or future climate risks. The city's road network frequently suffers from pavement deterioration, drainage failure, slope instability, and erosion, particularly during periods of heavy rainfall (Trundle & McEvoy, 2016; Jansson et al., 2025). Low-lying urban areas along river corridors are prone to recurrent flooding, while coastal road segments are increasingly exposed to sea-level rise and storm surges.

Addressing this gap is particularly important because climate impacts manifest differently across local contexts depending on topography, land use, and infrastructure characteristics. A city-scale analysis provides more actionable insights for planners and policymakers than national-level generalizations. Furthermore, understanding the specific mechanisms through which climate hazards damage road infrastructure is essential for designing targeted adaptation strategies and prioritizing investment in vulnerable areas (Almeida & Picado-Santos, 2022; Chinowsky et al., 2014). The study also has significance in contributing to Sustainable Development Goal (SDG) 9: Industry, Innovation and Infrastructure through improving resilient infrastructure development; SDG 11: Sustainable Cities and Communities through improving urban transport sustainability; and SDG 13: Climate Action through improving adaptation strategies to mitigate climate-related risks to road infrastructure (United Nations, 2025).

Based on the empirical evidence in the Greater Honiara Area, this research addresses three main questions: (1) what are key climate change threats affecting road infrastructure, (2) what are the observed impacts of climate hazards on road condition, drainage performance, and overall network functionality, and (3) what are adaptation strategies required to enhance road infrastructure resilience in small island urban settings.

2. Methods

2.1. Analytical Framework

In order to analyze the impact of climate-related hazards on the performance and vulnerability of the road infrastructure in Greater Honiara, this study adopts the climate exposure-impact-adaptation framework. The framework combines the ideas of climate risk assessment, the theory of infrastructure vulnerability, and the research on urban resilience (Chinowsky et al., 2014; de Abreu et al., 2022; Hoang, 2022). It offers a systematic methodology of connecting climatic stressors with infrastructure attributes and perceived effects, hence providing a systematic evaluation of road infrastructure vulnerability within a Small Island Developing State (SIDS) urban setting.

According to IPCC (2022), the interaction of hazard, exposure, and vulnerability is the cause of climate risk. Climate hazards describe physical climate-related events or trends that could destroy infrastructure. There are four hazards that are considered in this study. First, extreme rainfall and flooding events increase surface runoff and strain drainage systems, causing waterlogging and weakening pavements (Almeida & Picado-Santos, 2022; Wang et al., 2024). Heavy rainfall increases, particularly in urban areas with inadequate drainage infrastructure and unplanned development. Second, sea-level rise, storm surge, and erosion of coastal areas lead to the embankment and the degradation of coastal roads (de Abreu et al., 2022; World Bank, 2017). Third, extreme weather events, heavy storms, and heavy rain can block roads with fallen trees and damage road surfaces. Fourth, rising temperatures and heat load boost the rate of asphalt softening, thermal cracking, and material aging, thereby shortening the pavement service life and raising maintenance expenses (Chinowsky et al., 2014). These risks were chosen due to the fact that they are the most prominent climate-related risks revealed in the past research on the topic of Pacific Island urban infrastructure and have a direct impact on the geographic and climatic situation of Greater Honiara (Trundle & McEvoy, 2016; World Bank, 2017). Table 1 shows different climate triggers and their potential impacts on road infrastructure.

Table 1. Climate Threat Variable and Potential Impact on Road Infrastructure

Climate Threat	Description	Potential Impact on Road Infrastructure
Intense rainfall and Flooding	• High precipitation increased the runoff • Overflow of water due to blocked drains and river swelling.	• Causes erosion, flooding, and pavement degradation. Unstable slopes are triggered by rain or deforestation • Blockage on the road, road damage, and vulnerable communities cannot not access services • Weakens the road base edge, causes potholes, and makes roads not accessible.
Sea level rise	• The high rise of sea levels is affecting the coastal zone area.	• Low-lying coastal roads and saltwater-affected inland areas
Extreme weather event (Tropical cyclones)	• Heavy storms with strong winds and heavy rain.	• The road was blocked by a fallen tree, damaged road surfaces, and collapsed culverts.
Extreme heat	• Increased average and extreme daytime temperatures.	• Softening asphalt, damage road and cracking.

The framework of this study (Figure 1) conceptualizes climate change as a set of environmental drivers that generate physical hazards and extreme natural phenomena, such as sea level rise, heavy rainfall, and increasing temperatures, which in turn influence infrastructure condition and performance of road materials, leading to increased maintenance costs and structural distress. Next, as climate change significantly influences road infrastructure, sustainable adaptation is required over time. This paper operationalizes this concept by analyzing the impacts of climate risks on specific types of roads, and the extent to which increasing or reducing infrastructure susceptibility amplifies or blunts the effects.

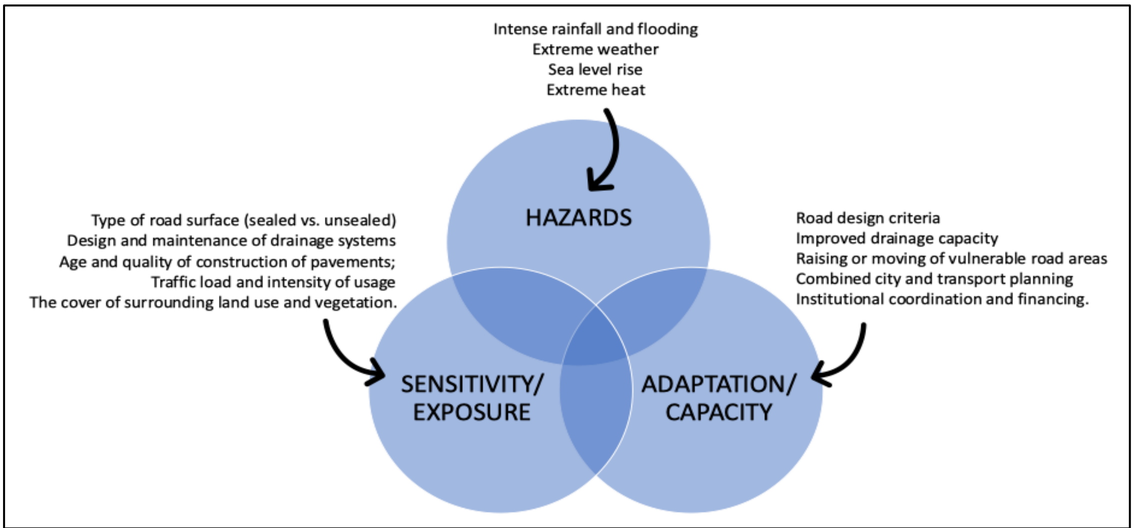

Figure 1. Analytical Framework

Other than physical hazards and extreme phenomena triggered by climate change, location and physical properties of infrastructure assets determine the exposure or sensitivity in the context of the transport infrastructure (K. Liu et al., 2023). The exposure to infrastructure denotes the extent to which road infrastructure is situated in environmentally dangerous areas, including floodplains, coastal areas, and steep slopes (K. Liu et al., 2023). The physical characteristics which affect the response of roads to climatic stress determine infrastructure sensitivity, and they include (Chinowsky et al., 2014): (1) Type of road surface (sealed vs. unsealed); (2) Design and maintenance of drainage systems; (3) Age and quality of construction of pavements; (4) Traffic load and intensity of usage and (5) The cover of surrounding land use and vegetation. For example, unsealed roads and drainage systems that are not well-maintained are more sensitive to rainfall and flooding, whereas old pavements are more prone to thermal cracking and fatigue of materials. Besides that, the informal settlements and unplanned construction usually block drainage systems, thus augmenting the vulnerability and susceptibility to flood effects (Jansson et al., 2025).

The last element of the framework includes adaptation capacity or resilience responses. The concept of adaptation refers to modifications to infrastructure design, management, and planning aimed at reducing susceptibility and enhancing system resilience (IPCC, 2021).

At the macro level, we can distinguish the responses or solutions into three major categories. Firstly, the policy solution. It focuses on reforming urban governance and creates opportunities for other interventions. This solution, for example, includes integrating climate risk considerations and resilience across multiple sectors, creating adaptation frameworks for transport, and directing action toward vulnerable communities. Policy measures include restricting development in flood-prone areas, improving land-use planning regulations, and incorporating climate risk screening into infrastructure investment decisions. Strengthening institutional coordination between transport authorities, urban planners, and environmental agencies would also help reduce infrastructure exposure to climate hazards. Optimal combinations of these policies consider equity and effective governance through frameworks like regulatory models, financial incentives, and participatory systems across the sectors on key aspects of infrastructure planning and implementation (Arifai & Arsyad, 2025). Secondly, the urban planning and design solutions. This solution focuses on the upgrading of the overall urban infrastructure layout and urban form, which can use, for example, the sponge city design to greatly reduce the run-off and risks of flooding around the road network and reinforcement learning decision tools to determine where and when adaptation measures should be taken and how to allocate limited resources (Costa et al., 2024). Another example is green urban design, which emphasizes the integration of urban greening, the development of green corridors, bioswales, and retention structures (Arifai & Arsyad, 2025).

Thirdly, the technical and engineering solutions. This solution focuses on the micro context of road infrastructure, which includes, for example, the maintenance of existing road infrastructure and drainage systems, regular clearing of culverts, upgrading drainage capacity, and timely pavement repairs. Basically, it involves infrastructure maintenance, continuous repair, and rehabilitation (Serrao-Neumann et al., 2011). In a more advance, several key measures under this category include elevating vulnerable road segments, upgrading the road standards, improving drainage design and capacity to accommodate higher rainfall intensity, developing resilient road networks using more heat-resistant pavement materials, and protecting coastal road corridors with seawalls, revetments, or embankment stabilization measures (Arifai & Arsyad, 2025). In addition, the selection of road construction materials plays an important role in strengthening infrastructure resilience under climate change conditions. The use of climate-resilient and sustainable materials such as polymer-modified asphalt, recycled asphalt pavement (RAP), fiber-reinforced asphalt mixtures, and improved pavement preservation technologies can enhance resistance to moisture damage, temperature fluctuations, rutting, and premature pavement deterioration while extending service life and reducing maintenance requirements (Airey & Mohammed, 2008; Plati, 2019; Sousa et al., 2021). These measures can reduce the impacts of heavy rainfall and surface runoff on road deterioration. Improved maintenance practices would help extend the service life of road infrastructure and reduce the frequency of flood-related disruptions. Briefly, these engineering interventions aim to reduce the long-term structural vulnerability of the road network to climate hazards. Meanwhile, Foukona (2021) and the National Transport Fund Secretariat (2016) suggest several responses consisting of: (1) Road design criteria; (2) Improved drainage capacity; (3) Raising or moving of vulnerable road areas; (4) Combined city and transport planning; and (5) The mechanisms of institutional coordination and financing.

The overlapping interaction between these three elements (e.g., hazard intensity, exposure or sensitivity, and capacity) determines the level of impact, and it represents vulnerability in the context of the transport infrastructure (K. Liu et al., 2023). Based on the above framework, with a case of Greater Honiara, this study diagnoses impacts and vulnerabilities and provides a foundation for identifying policy-relevant strategies to improve the resilience of road infrastructure.

2.2. Study Area

The Greater Honiara Area (GHA) is the largest urban region in the Solomon Islands and includes the national capital, Honiara, and surrounding peri-urban areas. Greater Honiara covers an area of approximately 22 km² and is situated along the northern coast of Guadalcanal Island, bordered by rivers such as the Mataniko, Lunga, and White River, and surrounded by steep hills. Population projections indicate that the urban population is expected to double by 2036, reflecting sustained rapid urban growth. The city's low elevation and coastal location increase its exposure to flooding, sea-level rise, and erosion. For analytical purposes, the study area was divided into three zones based on observed vulnerability to climate hazards. These are:

- Zone I, from White River to Point Cruz, where the Honiara City Council (CBD) area is located. There has been a long-term observation of the flood-prone road section in this zone, and landslides often occur following heavy rain.
- Zone II, from Chinatown to Kukum Highway. Roads in this zone are subject to the increasing sea-level rise and coastal erosion and experience frequent flash floods during the wet season.
- Zone III, from Ranadi to Henderson, where Prince Philip Highway and Aola Road are located. Roads in this zone are subject to coastal erosion, sea-level rise, and experience frequent flash floods during the wet season. Figure 2 indicates the Greater Honiara Area (GHA) and three zone sample units under this study.

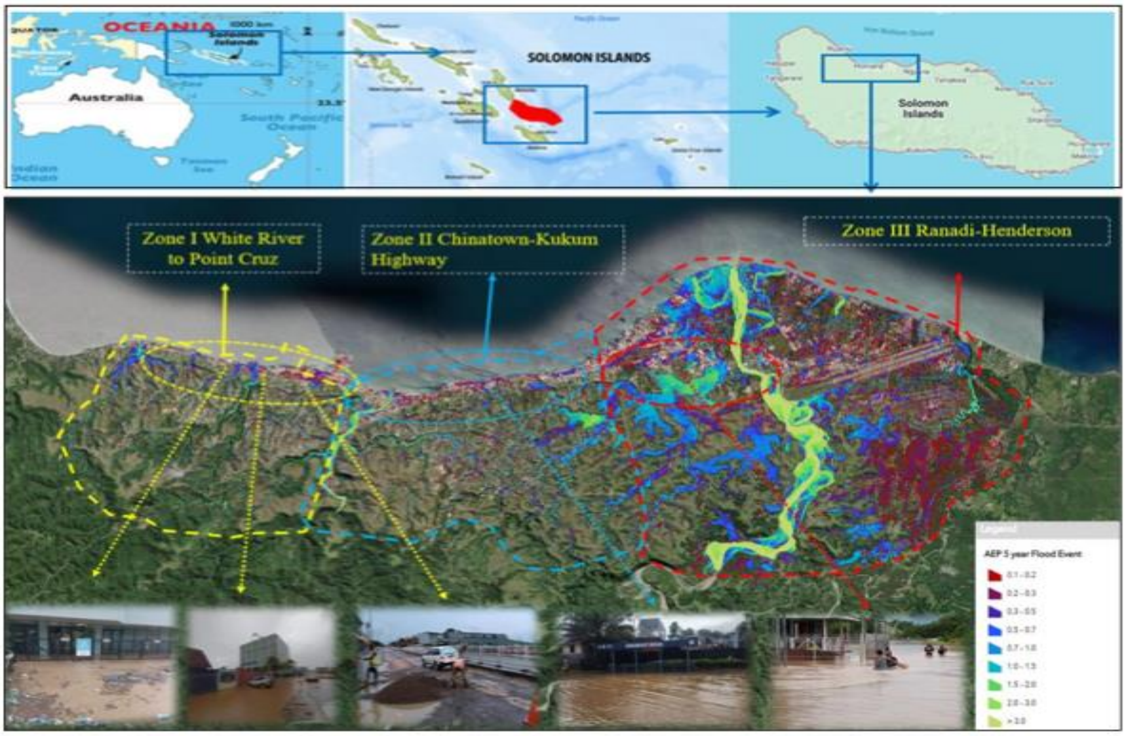

Figure 2. Study Area.
Source: Adapted from Asian Development Bank & Ministry of Lands, Housing (2016) and the Earthstar Geographic's Geospatial and Research Climate Change Division

2.3. Data Sources and Collection

This study uses both secondary and primary data. Secondary data were collected from multiple authoritative sources to ensure reliability and consistency. Secondary data are widely used in understanding the climatic aspects and indicators of the study area. Climate data such as rainfall, sea-level data, and temperature records are from the national meteorological services and regional climate monitoring agencies, while road infrastructure data such as road classification and condition and infrastructure development and maintenance come from transport authorities and transport asset management system datasets (Ministry of Infrastructure and Development, 2019). This study also utilize data from policy and planning documents, such as National Development Strategies (2016), National Transport Planning Reports (2017-2036), Climate Adaptation and Disaster Risk Management Policies

National Disaster Council (2018) and relevant academic peer-reviewed articles on climate change impacts on transport infrastructure and studies focusing on urban vulnerability of the Pacific Island SIDS (de Abreu et al., 2022; Leal Filho et al., 2020; Trundle & McEvoy, 2016).

Primary data from field surveys are mainly useful to synthesize infrastructure performance, vulnerability, and risk patterns as well as the perceived impacts on road infrastructure (Almeida & Picado-Santos, 2022; Chinowsky et al., 2014). Collection of primary data involved the distribution of a questionnaire with a purposive sampling method to 40 targeted knowledgeable respondents, who also represent urban planners, engineers, and experts (20 persons), academics (5 persons), and government officers (15 persons). It is a closed-ended questionnaire with a total of 84 questions using Likert-scale responses to quantify perceived climatic variables and impacts, perceptions of road disruptions, and adaptation measures for each zone. The questionnaire used a 5-point Likert scale to assess respondents' perceptions of climate-related impacts and adaptation priorities. The scale ranged from 1 to 5, where 1 represented 'No Impact' and 5 represented 'Severe Impact'. Verbal descriptions were provided for each scale point to improve respondent understanding and consistency during data collection. The questionnaire also asked the respondent to rank the importance of criteria (e.g., durability, affordability, suitability) to adaptation strategies (e.g., sustainable drainage system, permeable pavement, elevated road, reinforced road, and enhanced coastal protection). These respondents were considered knowledgeable based on their professional background and involvement in infrastructure-related activities. In addition, 10 respondents were selected for follow-up semi-structured interviews to obtain more detailed insights into climate-related road infrastructure challenges and adaptation priorities:

- 6 (six) experts who were also government officers of the Ministry for the Environment (1 person in the General Director of Climate Change Division), the Ministry of Meteorology Affairs (2 persons), and the Ministry for Infrastructure (3 persons).
- 4 (four) academics with a background in Civil Engineering and Planning, who came from Solomon Islands University (3 persons) and Fiji National University (1 person).

2.4. Analysis Methods

This study employs a descriptive analysis based on both primary and secondary data sources, enabling triangulation and strengthening the validity of the findings (Creswell, 2009; Chand, 2026). Descriptive analysis employs statistical methods (e.g., frequency distributions, proportions, and mean scores) to identify patterns and trends in historical data, utilizing various visualization techniques such as histograms and dashboards to enhance understanding of complex datasets (Geetha & Sujatha, 2024). In this study, descriptive statistical analysis was applied to organize and explain the data obtained from questionnaire responses, document analysis, and secondary sources. The percentage calculations, for example, were used to determine the relative importance of each climate threat, while mean scores were computed to rank the impact level of extreme rainfall, flooding, coastal erosion, and landslides on road infrastructure. The descriptive analysis based on secondary data was implemented to understand the existing condition of road infrastructure in the three study zones.

Additionally, we employed the Analytic Hierarchy Process (AHP), which has been proven to be a useful decision-making support tool by helping stakeholders rank and balance various objectives (Rezvani et al., 2023). It has led to applications in various fields such as urban planning Almeida, 2023) (Marzouk & Azab, 2024), coastal zone management Baláž et al., 2021), and many others. In this study, AHP was used to determine the relative importance of the selected evaluation criteria: durability, affordability, and suitability. A pairwise comparison matrix was developed based on the 10 expert respondents' judgment. An AHP analysis was conducted using the standard pairwise comparison and matrix normalization procedures, based on Saaty's 1–9 scale, to calculate priority weights (Saaty 1980). The results showed durability had the highest weighting (0.595), followed by suitability (0.277) and affordability (0.129). Individual pairwise comparison responses were reviewed during the analysis process to ensure acceptable consistency before aggregation of the final results. In accordance with standard AHP practice, a Consistency Ratio (CR) value below 0.10 was considered acceptable for validating the reliability of the respondents' judgments.

Lastly, we employed Multi-Criteria Analysis (MCA) to prioritize sustainable adaptation strategies for Greater Honiara. The process involved identifying potential adaptation options, selecting sustainability-related evaluation criteria, assigning weights to each criterion based on its importance, and scoring each strategy on a five-point scale. A weighted score was calculated to identify the most suitable and feasible adaptation measure to improve climate resilience in the road network. Multi-Criteria Analysis (MCA) was applied to evaluate and rank climate adaptation strategies across three criteria: durability, affordability, and suitability. MCA helps decision-makers compare options by considering a mix of important factors, such as technical needs, social impacts, and location risks (Nickdoost et al., 2024). This method is especially helpful in places where detailed data is limited, like the Solomon Islands, and it also encourages local stakeholders' participation and awareness (Kappes et al., 2017).

2.5. Research Ethics

Ethical procedures were approved by Diponegoro University. Participation was voluntary, informed consent was obtained from all respondents and interviewees, and all data were anonymized prior to analysis.

3. Results

The following section elaborates the operationalization of the climate exposure-impact-adaptation framework. Before the exploration on the exposure, the accompanying effects on the road infrastructure and the proposed adaptation measures, it begins with the climatic hazard analysis in the Greater Honiara Area (GHA).

3.1. Climate Change Hazards

Figure 3 shows that Greater Honiara experiences consistently high rainfall throughout the study period, with noticeable fluctuations between 2010 and 2024. Rainfall was generally higher during 2015–2019, with the highest monthly totals occurring in February and March. The wet season, which extends from December to March, is characterised by intense rainfall that can exceed the capacity of existing drainage systems. Future climate projections indicate that total annual rainfall in the Solomon Islands is likely to remain within the range of natural variability, although extreme rainfall events may become more intense over time. Projections of the 25-year return level of 5-day cumulative rainfall by 2050 are generally comparable to historical observations. However, under a high-emissions scenario (RCP8.5), annual maximum 5-day rainfall is projected to increase slightly towards the end of the century (World Bank Group, 2021).

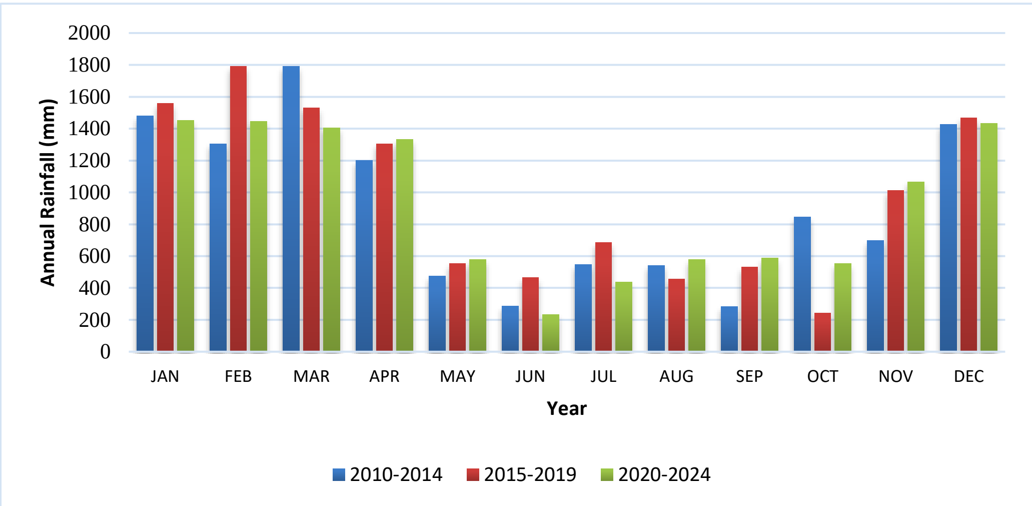

Figure 3. Annual Rainfall Trend in Greater Honiara (2010-2024).
MECDM (2025)

Table 2 and Figure 4 present annual sea-level data for Honiara from 2011 to 2025 indicating noticeable interannual variability with a general tendency toward higher sea levels in recent years. Mean sea level decreased from 0.803 m in 2011 to approximately 0.620 m in 2016 before increasing steadily after 2017. The highest mean sea level was recorded in 2022 (0.899 m), while elevated values also occurred during 2021 and 2025. Maximum sea levels increased from 1.325 m in 2011 to 1.433 m in 2025, suggesting more frequent occurrences of higher water levels during recent years. Although fluctuations are evident throughout the study period, the overall pattern indicates a gradual rise in sea level at Honiara.

According to the IPCC Sixth Assessment Report, global mean sea level (GMSL) has risen more rapidly during the 20th century than in any previous century over the last 3,000 years, with high confidence. From 1901 to 2018, sea level increased by about 0.20 m (ranging from 0.15 to 0.25 m). The rate of sea-level rise has accelerated since the late 1960s. It increased from an average of 2.3 mm per year during 1971–2018 to about 3.7 mm per year during 2006–2018, indicating a clear acceleration in recent decades. The report also shows that observed sea-level rise is well explained by the combined contributions of different physical processes. Ocean thermal expansion due to warming water accounts for about 38% of the increase, while melting glaciers contribute about 41%. In recent decades, the loss of ice from Greenland and Antarctica has increased significantly, with their contribution to sea-level rise becoming about four times higher in 2010–2019 compared to 1992–1999.

At the regional scale, sea-level rise is uneven. The Western Pacific experienced faster sea-level rise than the Eastern Pacific between 1993 and 2018. These differences are influenced by ocean circulation changes, variations in Earth's gravity and shape due to ice loss and water redistribution, and vertical land movement. Short-term and medium-term variations are mainly driven by ocean dynamics, while long-term human-induced signals in regional sea-level change are expected to become more evident in most regions by around 2100.

The values shown in Table 2 and Figure 4 present a maximum of 1.175–1.433 m, a minimum of 0.064–0.279 m, and a mean of 0.620–0.899 m, representing water levels measured by a tide gauge using a fixed reference point (datum). These values indicate observed water elevation and should not be interpreted as the actual amount of sea-level rise between years.

Table 2. Annual Sea-level Rise trend in Solomon Islands (2011-2025).

Year	Maximum (m)	Minimum (m)	Mean (m)
2011	1.325	0.227	0.803
2012	1.329	0.151	0.760
2013	1.206	0.179	0.733
2014	1.205	0.198	0.721
2015	1.175	0.173	0.647
2016	1.189	0.064	0.620
2017	1.303	0.129	0.744
2018	1.246	0.234	0.763
2019	1.208	0.177	0.702
2020	1.300	0.155	0.751
2021	1.401	0.211	0.863
2022	1.407	0.279	0.899
2023	1.398	0.112	0.814
2024	1.340	0.180	0.744
2025	1.433	0.146	0.822

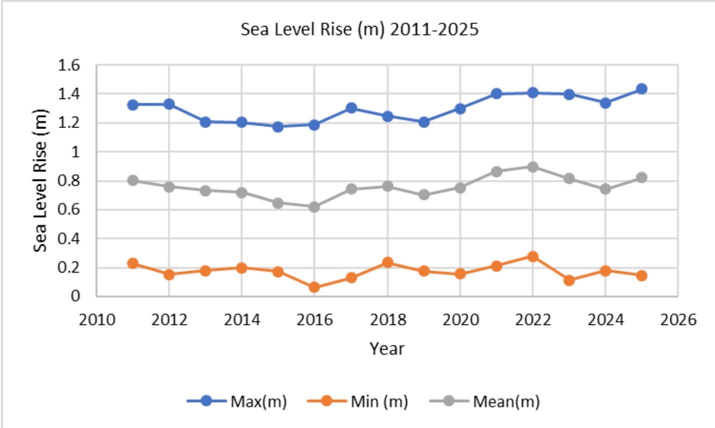

Figure 4. Annual Sea Level Rise (2011-2025).
Source: Author's compilation/calculations based on Bureau of Meteorology National Tidal Center data (2025).
https://www.bom.gov.au/ntc/IDO70061/IDO70061ATD.shtml

Table 3 and Figure 5 show that the annual air temperature record for Honiara indicates a generally warm and stable climate over the 15-year period. Maximum temperatures range from approximately 38 to 41 °C, while minimum temperatures range from 27.8 to 29.1 °C, resulting in mean temperatures consistently between 32 and 34 °C. Although year-to-year fluctuations are minor, there is a slight upward trend in both maximum and mean temperatures in the later years (2020–2025), suggesting a gradual warming pattern. The narrow range between minimum and maximum values indicates relatively small diurnal and seasonal variability, characteristic of the tropical climate in the Solomon Islands.

Table 3. Annual Air Temperature trend at Honiara, Solomon Islands (2011-2025).

Year	Max_Air_Temp_℃	Min_Air_Temp_℃	Mean_Temp_℃
2011	38.14	27.81	32.41
2012	38.14	27.93	32.40
2013	39.43	28.26	32.55
2014	38.42	28.3	32.64
2015	38.43	28.02	32.44
2016	38.93	28.51	32.93
2017	38.30	28.51	32.73
2018	38.44	28.27	32.66
2019	38.81	28.50	32.92
2020	40.07	28.94	33.37
2021	39.80	28.67	33.44
2022	39.70	28.53	33.21
2023	40.41	28.74	33.26
2024	40.69	29.27	33.61
2025	39.95	28.90	33.33

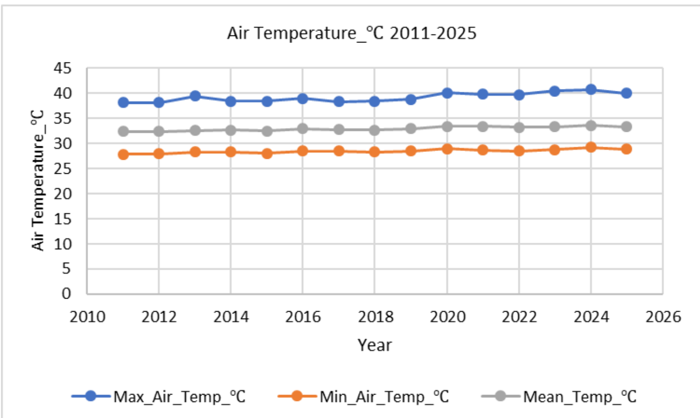

Figure 5. Annual air temperature trend at Honiara, Solomon Islands (2011-2025).
Source: Author's compilation/calculations based on Bureau of Meteorology National Tidal Center data (2025).
https://www.bom.gov.au/ntc/IDO70061/IDO70061ATD.shtml

In contrast, the average monthly mean, maximum, and minimum temperatures, as well as rainfall, in the Solomon Islands from 1991 to 2020, are presented in the Solomon Islands Climate Risk Country Profile by the (World Bank Group, 2021). The temperature trends illustrated that the forecast temperature changes (°C) for the Solomon Islands are based on four different emissions scenarios. Emissions scenarios are evaluated in two decades, around the years 2050 and 2090. The projection is made concerning the temperature averages spanning from 1986 to 2005. The projections show that earlier, wider estimates of warming, which ranged up to 5.4°C by 2100, may now be narrowing. This shows a more advanced understanding of climate sensitivity and radiative forcing; the risk of the Earth experiencing at least moderate-to-high warming appears greater than that considered in the last IPCC report (AR5) (Gillett, 2013). So, climate projections based on the worst-case-possible emissions scenario (RCP8.5) are used to facilitate decisions designed to manage these potential challenges (World Bank Group, 2021). Meanwhile, Chinowsky et al. (2014) highlight that climate change may lead to an estimated additional cost of US$596 million to maintain and repair road infrastructure due to temperature and precipitation impacts through 2050.

3.2. Exposure of Road Infrastructure

There are three classifications of roads in Greater Honiara: main, feeder, and access. Main roads are the arterial network connecting both within and intercity mobility. Their function is to handle heavy traffic and support long-distance travel. Mendana Avenue, Kukum Highway, and Prince Philip Highway are the of main roads. The characteristics are often two-lane or more and paved, used for heavy-load buses, loader trucks, and major commuting, and maintained by the national or provincial government.

A feeder road is basically a secondary road that connects smaller areas or settlements to the main roads. The function of the feeder road is to improve accessibility by connecting people and commuters to essential services. In Greater Honiara, for example, these roads connect areas like Panatina Ridge to Kukum Highway and Vavaya Ridge to Mendana Road. Minibusses operate on feeder roads connecting communities, markets, or schools to the main arterial road network.

The access road is a local road that provides entry to individual homes, buildings, or small clusters. The function is to provide a final link in the road hierarchy that provides direct access to properties. In Greater Honiara, access roads are found within settlements such as Burns Creek and White River. The characteristics of these roads are often unpaved or gravel, have low traffic volumes, are maintained by communities or local councils, and are vulnerable to flooding or erosion. Table 4 detailed description of the structural attributes and the current state of the roads in the Greater Honiara Area.

Table 4. Comparison of Sealed, Unsealed, and Total Road Lengths by Classification in 2019 and 2025

Road Classification	Length (km)		Sealed (km)		Unsealed (km)	
	2019	2025	2019	2025	2019	2025
Main	0.00	0.00	12.00	15.00	0.00	0.00
Feeder	43.48	40.18	34.30	26.15	29.5	14.27
Access	87.77	84.13	3.40	14.25	72.4	69.86
Subtotal	131.25	124.31	49.70	52.18	101.9	84.13

Source: MID (2019)

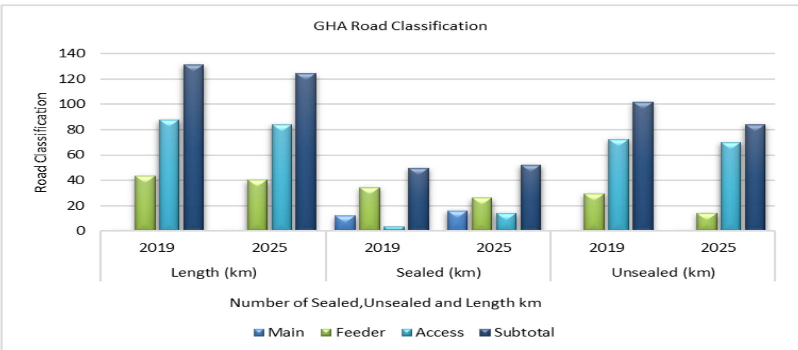

Figure 6. Comparison of Sealed, Unsealed, and Total Road Lengths by Classification in 2019 and 2025
Source: MID (2019)

As shown in Table 4, the network is mainly made up of feeder and access roads, which are mainly used to handle residential and local traffic needs. Main roads make up a smaller part of the total network but carry the highest amount of traffic and form the network by connecting major economic and administrative hubs. The findings also suggest that roads that are not sealed take up a considerable portion of the total network. At the same time, although some feeder and access roads have been upgraded and rehabilitated, many of them are still not tarmac, which increases their vulnerability to rainfall and flooding. Figure 6 illustrates the status of the conditions of the road types. The percentage of unsealed roads is fairly high particularly in lowlands and flood-prone areas. Although the sealed roads usually work well, there are still a few segments that are considered poor or very poor, which indicates that there is a constant maintenance problem.

Table 5. Rating of Road Condition based on the Type of Road Surface in 2025

Type of Road Surface	Condition Rate (Km)					
	Very Good	Good	Moderate	Poor	Very Poor	Total
Unsealed (Km)	4.16	18.52	39.06	21.64	0.75	84.13
Sealed (Km)	7.83	18.65	8.37	4.43	0.90	40.18

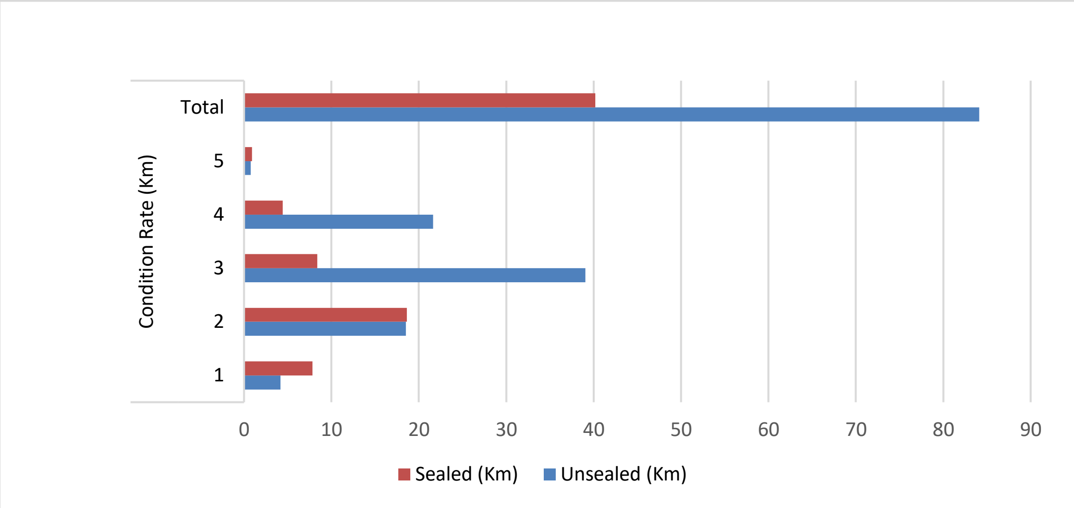

Figure 7. Rating of Road Condition based on the Type of Road Surface
Source: MID (2019). Note: 1 (very good), 2 (good), 3 (moderate), 4 (poor), 5 (very poor)

Table 5 and Figure 7 summarize the condition of both sealed and unsealed road networks and their rating. Unsealed roads stretch for 84.13 km compared to 40.18 km for sealed roads. The majority of unsealed roads are in fair condition (39.06 km), which means the roads in minor surface degradation or potholes. Just to keep maintenance or improvement and around 21.64 km of road is in poor condition, and these roads is difficult to access during bad weather. There are only a small number of unsealed roads in very good condition (4.16 km); these roads are accessible, minor damage, they only need normal maintenance, which around 0.75 km of road is in very poor condition. On the other hand, most of the sealed roads, around 18.65 km are good condition, indicating they are accessible and safe to use, and 8.37 km are in fair condition, which suggests that the paved roads are looked after more. There are 4.43 km of sealed roads in poor condition and 0.9 km in very poor condition.

The predominance of unsealed roads within the study area has important implications for the selection and effectiveness of climate adaptation strategies. Although the AHP-MCA analysis evaluated a range of climate-resilient road interventions, their practical applicability is influenced by the existing road surface conditions. Strategies such as permeable pavement and reinforced pavement systems are primarily designed for sealed roads and therefore have limited relevance across much of the current road network. In contrast, adaptation measures targeted at unsealed roads, including gravel road upgrading, improved surface compaction, routine maintenance, and enhanced drainage systems, are more suitable for local conditions. These measures directly address the key climate-related challenges identified in the study, particularly erosion, surface deterioration, water accumulation, and reduced accessibility during periods of intense rainfall.

3.3. The Impact of Climatic Hazard to Road Infrastructure

This sub-section describes climate-related destruction of road infrastructure in the study areas. The road in Greater Honiara because of its condition is one of the assets which are sensitive for being exposed to climatic hazards including extreme weather. More heavy rainfall, flooding, and rising sea level, damage road infrastructure leading to economic problems and safety risks. Figure 8 shows the climate change negatively impacts road infrastructure in Greater Honiara. The top image shows road surface erosion in Zone I and how the asphalt road damage by the runoff due to heavy rainfall and floods. The rest of images show urban flood conditions in Zone II and Zone III wherein roads and surrounding structures are fully covered by water creating unsafe accessibility and impassable roads. Low-lying coastal road in Zone I to III, which has short distance to beach are directly exposed to tidal flooding as well. Poorly constructed drainage and blocked drainage channels also contribute in exacerbating the destruction of road infrastructure. It emphasizes how climate change-related heavy rainfall and flooding are significant contributors and directly impacts road infrastructure through the declining structural strength of roads, the formation of potholes, and the erosion of road surfaces.

Zone I (CBD) Area

Zone I (CBD) Area

Zone II (Vura Road)

Zone II (Kukum Highway)

Zone III (Randi West side of the GHA)

Zone III (Randi West side of the GHA)

Figure 8. The Impact of Extreme Weather on Road Infrastructure
Source: Ministry of Infrastructure Development's Facebook press release (2025); Solomon Star News (2018).

The observation data revealed that significant categories of the observed effects, which are also the most commonly reported impacts, include: (1) pothole formation, (2) pavement cracking, (3) erosion of road shoulders, (4) drainage failure, and (5) temporary road closure. The relation of each climate variable and its impact on road infrastructure in each zone is summarized in Table 6.

Table 6. Climate Variable and the Impact Level on Road Infrastructure in GHA

Zone	Climate Variables	Mean Score	Dominant Impact Level	Percentage at Dominant Level (%)	Overall Ranking
I	Heavy Rainfall & Flooding	3.00	Moderate	66.7	1
	Extreme Heat/Temperature	2.81	Moderate	75.0	2
	Soil Erosion	2.58	Minor	52.8	3
	Sea Level Rise	2.06	Minor	63.9	4
	Coastal Erosion	2.06	Minor	75.0	5
	Landslides	1.25	None	75.0	6
II	Heavy Rainfall & Flooding	3.14	Moderate	86.1	1
	Extreme Heat/Temperature	3.06	Moderate	77.8	2
	Soil Erosion	2.81	Moderate	80.6	3
	Sea Level Rise	2.58	Moderate	55.6	4
	Coastal Erosion	2.06	Minor	83.3	5
	Landslides	1.03	None	97.2	6
III	Heavy Rainfall & Flooding	3.11	Moderate	77.8	1
	Extreme Heat/Temperature	2.25	Minor	75.0	2
	Soil Erosion	2.22	Minor	77.8	3
	Sea Level Rise	1.17	None	86.1	4
	Coastal Erosion	1.16	None	83.9	5
	Landslides	1.06	None	94.4	6

The study finds that heavy rainfall leading to floods and extreme heat or temperature are the most critical climate variables affecting road infrastructure in GHA. However, the level of impact is different across study zones, with Zone III receiving the least impact and Zone II experiencing the highest impact. Figure 9 shows the severity of climate change impacts in the GHA.

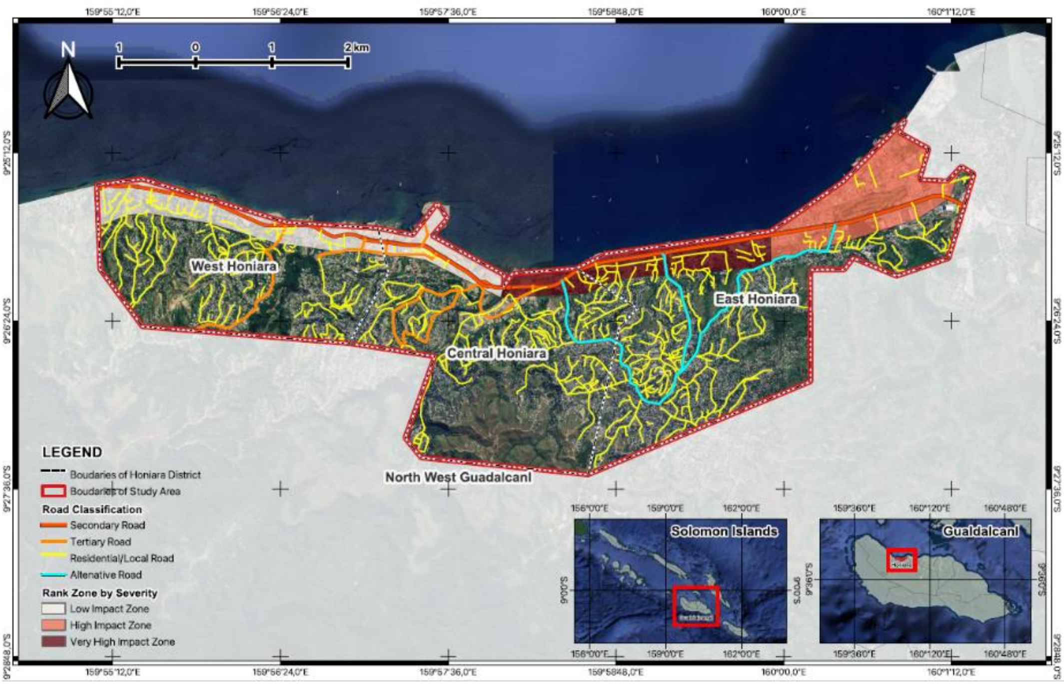

Figure 9. The Map of Severity of Climate Change Impact
Adapted from the Honiara Flood Hazard Map available on the CCD Geospatial Open Data Portal (https://portal-ccd-geospatial.opendata.arcgis.com/). Flood depth data for the 5-year Annual Exceedance Probability (AEP) event were extracted and processed using QGIS version 3.40.15, with conversion from KMZ to shape file format for analysis by the Ministry of Infrastructure Development (MID).

3.4. Road Adaptation Criteria and Responses

The analysis of climate-related hazards and their impacts on road infrastructure in the Greater Honiara Area highlights the need for targeted policy interventions to strengthen infrastructure resilience. Among the identified alternatives, the in-depth interview revealed that a combined strategy prioritizing climate-resilient road design supported by integrated planning measures is recommended as the most effective approach for enhancing infrastructure resilience in Greater Honiara. Furthermore, engineering upgrades provide the most direct protection against the physical impacts of climate hazards, particularly flooding, coastal erosion, and temperature-related pavement degradation. In this context, Table 7 and Table 8 show the pairwise matrix of the road adaptation criteria based on expert judgment and their Consistency Ratio (CR) calculation, respectively. The study suggests that durability was considered much more important than affordability and was therefore assigned a value of 5. Durability was also judged to be more important than suitability, with a value of 2, indicating slight to moderate importance. Similarly, suitability was considered more important than affordability, and was assigned a value of 2. Reciprocal values (1/5 and 1/2) were automatically applied to maintain matrix consistency. This structured comparison reflects the priority of long-term road performance (durability) while still considering practical feasibility (suitability) and cost aspects (affordability). The matrix was then normalized to derive the priority weights used in the subsequent Multi-Criteria Analysis (MCA).

Table 7. Pairwise Matrix of Road Adaptation Criteria

Criteria	Durability	Affordability	Suitability	Weight Scores Vectors
Durability	1	5	2	0.595
Affordability	1/5	1	1/2	0.129
Suitability	1/2	2	1	0.277

Table 8. Consistency Ratio (CR) Calculation

No	Calculation	Formula	Result
1	Weight (Priority Vector)	$w_i = \frac{\sum n_{ij}}{n}$	(1×0.595) +(5×0.129) +(2×0.277) =1.794 (0.2×0.595) +(1×0.129) +(0.5×0.277) =0.387 (0.5×0.595) +(2×0.129) +(1×0.277) =0.833
2	Eigenvalue (λmax) (Aw=Matrix × Weight Vector)	$\lambda_{max} = \frac{\sum_{i=1}^{n} \lambda_i}{n}$	λ1 = 1.794 / 0.595=3.014 λ2 = 0.387 / 0.129 =3.000 λ3 = 0.833 / 0.277 =3.007 λmax= (3.014+3.000+3.007)/3= 3.007 **λmax ≈ 3.007**
3	Consistency Index (CI)	n $CI = \frac{\lambda_{max} - n}{n - 1}$	CI = (λmax − n) / (n − 1) CI = (3.007 − 3) / 2 CI = 0.007 / 2 **CI = 0.0035**
4	Consistency Ratio (CR)	$CR = \frac{CI}{RI}$	0.0035/0.58 **CR = 0.006** Since CR < 0.1 The matrix is Acceptably Consistent
5	*W*i = Normalised weight of criterion *i* *Vi* = Importance score given to criterion *i*∑*Vi* = Total of all importance scores	$W_i = \frac{V_i}{\sum_{i=1}^{n} V_i}$	Durability = 0.595 Affordability= 0.129 Suitability =0.277
6	*Score j* = Total score of strategy j *Pij* = Performance score of strategy j on criterion *i* *Wi* = Weight of criterion *i*	$\text{Score}_j = \sum_{i=1}^{n} (P_{ij} \times W_i)$	Final Score= (Dx0.595) +(Ax0.129) + (Sx0.277) =(4.50x0.595) +(3.58x0.129) +(4.33x0.277) =**4.34 Weight**

The priority weights of each criterion were calculated by normalizing the pairwise comparison matrix and deriving the eigenvector (priority vector). The results showed that durability obtained the highest weight (0.595), followed by suitability (0.277), and affordability (0.129). This indicates that durability is considered the most important factor in evaluating climate-resilient road infrastructure strategies in Honiara.

To test the reliability of the judgments, the Consistency Ratio (CR) was calculated. The Consistency Index (CI) was first determined using the maximum eigenvalue (λmax), and then divided by the Random Index (RI) value of 0.58 for a 3×3 matrix. The computed CR value was 0.006, which is below the acceptable threshold of 0.10. This confirms that the pairwise comparisons are consistent and the results are reliable for further analysis. The final weights were then used in the Multi-Criteria Analysis (MCA) to rank the proposed adaptation strategies. Table 9 shows the intervention priority for road infrastructure adaptation in GHA.

Table 9. Strategy Priorities for Road Adaptation in GHA

Zone	Strategies	Mean Score of Criteria			Weight	Rank
		Durability	**Affordability**	**Suitability**		
I	Sustainable Drainage	**4.50**	**3.58**	**4.33**	**4.34**	**1**
	Reinforced Road	4.44	3.14	4.17	4.20	2
	Permeable Pavement	3.31	4.19	4.22	3.67	3
	Elevated Road	4.19	2.17	2.28	3.66	4
	Coastal Protection	3.14	2.92	3.28	3.15	5
II	Sustainable Drainage	**4.81**	**4.06**	**3.14**	**4.25**	**1**
	Reinforced Road	4.20	3.03	3.92	4.00	2
	Coastal Protection	4.03	3.17	4.00	3.91	3
	Permeable Pavement	3.25	4.25	4.40	3.70	4
	Elevated Road	4.06	2.81	2.36	3.42	5
III	Sustainable Drainage	**4.22**	**3.80**	**3.75**	**4.04**	**1**
	Elevated Road	4.40	2.61	3.70	3.98	2
	Permeable Pavement	3.20	4.17	4.72	3.74	3
	Reinforced Road	4.17	3.17	3.11	3.75	4
	Coastal Protection	1.06	1.25	1.25	1.14	5

This study suggests that sustainable drainage is the most important strategy among interventions and remains relevant across all zones. Next, the second important strategy is road reinforcement, particularly for Zones I and II, while it is elevated road intervention, especially for Zone III. Finally, the third important intervention is the development of permeable pavement, particularly for Zones I and III, while coastal protection is a strategically important intervention for Zone II.

However, technical interventions alone cannot address the underlying drivers of infrastructure vulnerability, such as unplanned urban expansion and inadequate land-use management. Therefore, climate-resilient infrastructure design should be complemented by planning policies that reduce exposure to climate risks. Implementing a coordinated approach that combines improved engineering standards with climate-sensitive planning frameworks will enable policymakers to address both the immediate and long-term impacts of climate change on road infrastructure. This integrated strategy is essential for strengthening the resilience, reliability, and sustainability of transport systems in the Greater Honiara Area.

4. Discussion

This study examined the impacts of climate change on road infrastructure in the Greater Honiara Area (GHA) by analyzing climate hazards and their observed effects on road condition, drainage performance, and overall network functionality. The results demonstrate that road infrastructure in GHA is highly vulnerable to multiple climate-related stressors, particularly extreme rainfall, flooding, sea-level rise, coastal erosion, and increasing temperatures. These findings reinforce existing evidence from Pacific Island Small Island Developing States (SIDS) that transport systems are among the most climate-sensitive components of urban infrastructure (de Abreu et al., 2022; Trundle & McEvoy, 2016; World Bank, 2017).

Flooding and extreme rainfall emerged as the most immediate and damaging hazards affecting road infrastructure. Recurrent inundation accelerates pavement degradation, weakens subgrade structures, and disrupts traffic movement. This pattern is consistent with studies conducted in tropical urban environments, where rainfall-induced erosion and prolonged waterlogging significantly reduce pavement service life and increase maintenance costs (Almeida & Picado-Santos, 2022; Wang et al., 2024). In Greater Honiara, the combination of intense rainfall and inadequate drainage systems exacerbates these impacts.

Many feeder and access roads lack engineered drainage, and blocked or poorly maintained culverts prolong inundation periods, intensifying pavement deterioration.

The observed vulnerability of low-lying and river-adjacent road segments reflects the role of exposure and land-use planning in shaping infrastructure risk. Similar findings have been reported in urban studies across Southeast Asia and the Pacific, where informal settlements and unregulated development encroach upon floodplains and drainage corridors (Leal Filho et al., 2020; Jansson et al., 2025). In Greater Honiara, rapid urban expansion has outpaced infrastructure provision, resulting in road networks that are highly exposed to hydrological hazards. This underscores the importance of integrating climate risk considerations into urban growth management and transport planning.

Sea-level rise and coastal erosion present longer-term but equally significant threats to road infrastructure, particularly along narrow coastal strips where physical buffers are limited. The exposure of coastal road segments to saline intrusion and storm surges contributes to embankment instability and structural weakening. These findings align with regional assessments showing that coastal transport corridors in Pacific Island countries face increasing risk from rising sea levels and extreme events (de (Abreu et al., 2022; Hoang, 2022; World Bank, 2017). In many cases, protective infrastructure such as seawalls and revetments is either absent or poorly maintained, leaving roads directly exposed to wave action and tidal flooding.

Temperature increases further compound infrastructure vulnerability by accelerating asphalt ageing, thermal cracking, and surface deformation. Previous studies have demonstrated that higher temperatures significantly shorten pavement service life and increase maintenance demands (Chinowsky et al., 2014; Shao et al., 2017). In Greater Honiara, heat stress interacts with moisture from rainfall and flooding, producing synergistic effects that intensify material fatigue. Roads exposed to both heat and frequent inundation show higher rates of deterioration than those subject to a single stressor, highlighting the importance of considering compound climate risks rather than isolated hazards.

Beyond physical impacts, institutional and governance factors play a critical role in shaping road infrastructure vulnerability. Fragmented responsibilities among transport, land-use planning, and environmental agencies hinder coordinated adaptation efforts. Financial constraints limit the ability to invest in climate-resilient road design and large-scale drainage upgrades. These challenges mirror those identified in other SIDS, where limited fiscal capacity and competing development priorities restrict adaptation implementation (Leal Filho et al., 2020; Trundle & McEvoy, 2016).

The findings suggest that technical engineering solutions alone are insufficient to ensure road resilience. While improved pavement materials and drainage capacity are essential, they must be complemented by integrated planning frameworks, regulatory enforcement, and community engagement. Targeted adaptation strategies focusing on the most vulnerable road segments, particularly in flood-prone and coastal zones, offer a practical pathway for enhancing resilience. Such strategies may include elevating critical road corridors, redesigning drainage systems based on future rainfall projections, and incorporating climate risk screening into transport investment decisions (de Abreu et al., 2022; Hoang, 2022; World Bank, 2017). Integrated and long-term approach is required for adapting to climate change in urban areas, with the incorporation of policy support, governance, infrastructure planning and stakeholder participation. But effective adaptation must not only respond to current climate risks, but also build resilience to future environmental change. Connecting local action with institutional support, suitable adaptation measures and continuous planning processes can increase the resilience of urban infrastructure systems to impacts related to climate. Hence, climate adaptation should be integrated into infrastructure development strategies to enable sustainable and resilient urban development (Setiadi, 2018).

Importantly, this study demonstrates the value of localized empirical analysis for understanding climate impacts on infrastructure. National-level vulnerability assessments provide broad insights, but city-scale studies reveal specific mechanisms through which climate hazards affect infrastructure performance. This localized perspective is essential for designing effective, context-specific adaptation measures and for prioritizing limited resources in high-risk areas.

Triangulation was undertaken by comparing evidence derived from secondary climate data, questionnaire surveys, interviews, and combined AHP-MCA results. The comparison revealed a consistent pattern across the four data sources. Secondary climate data demonstrated increasing rainfall intensity and recurrent flooding events in Greater Honiara, highlighting flood-related risks to road infrastructure. These findings were supported by questionnaire responses, which identified flooding and drainage deficiencies as the principal factors contributing to road deterioration. Similar concerns emerged from stakeholder interviews, where inadequate drainage capacity was frequently identified as a key constraint affecting road network resilience. The AHP-MCA results further reinforced these findings by ranking drainage improvement among the highest-priority adaptation measures. The convergence of evidence suggests that drainage inadequacy represents a critical vulnerability within the existing road network and should be prioritized within climate-resilient infrastructure planning strategies. Nevertheless, some variation was observed regarding road widening measures.

This study has several limitations that may influence the interpretation of the findings. First, the AHP analysis was conducted using a panel of 10 experts. This occurred because the study focused on participants with specific technical knowledge and professional experience in road infrastructure, planning, and climate-related issues in the Solomon Islands. Because of the limited number of qualified experts available in the study context, the sample size remained relatively small. Although acceptable for AHP studies, a larger expert panel could provide broader opinions and improve the robustness of the prioritization results.

Second, the study did not include detailed cost analysis or cost–benefit analysis (CBA). This limitation occurred because of restricted access to updated financial, construction, and maintenance cost data for road infrastructure projects in the Solomon Islands. As a result, the study mainly focused on technical suitability and adaptation priorities rather than economic feasibility.

Third, limitations were identified in the sea-level dataset used in the study, particularly regarding baseline interpretation and variability representation. These issues may have occurred because the data were derived from processed regional datasets, including anomalies and adjusted observations, rather than direct measurements of annual sea-level rise. Consequently, some values may appear inconsistent when interpreted without reference to the baseline conditions.

Fourth, the study relied mainly on 2019 road infrastructure data from the Ministry of Infrastructure Development because more recent and comprehensive national infrastructure datasets were not publicly available during the study period. As infrastructure conditions may change over time, some road conditions and network characteristics may differ from current conditions.

Finally, the study focused only on the Greater Honiara Area (GHA). This occurred because GHA represents the country's main urban and transport center and experiences significant exposure to climate-related infrastructure risks. However, environmental, geographic, and infrastructure conditions may differ across other provinces and Pacific Small Island Developing States (SIDS). Therefore, the findings may not be directly generalizable to other island contexts without further comparative studies.

4.1. Policy Implementation Strategies

Effective implementation of climate-resilient road infrastructure policies in Greater Honiara requires coordinated action across government institutions, infrastructure agencies, and development partners. Four important strategic aspects, namely: (1) Institutionalization, (2) Timing, (3) Financing, and (4) Monitoring and Evaluation, are discussed in this section.

Institutional Responsibilities

Implementation should involve collaboration between several key institutions. The Ministry of Infrastructure Development should lead infrastructure upgrades and maintenance programs. The Honiara City Council should integrate climate risk considerations into urban development planning and local infrastructure management. National planning agencies should incorporate climate-resilient transport strategies into national development frameworks. International development partners such as the Asian Development Bank and the World Bank may provide technical and financial support for large-scale infrastructure adaptation projects

Implementation Phases

Policy implementation can be organized into three phases: short, medium, and long-term. In the short-term (1-3 years), priority actions should focus on improving drainage systems, strengthening routine road maintenance, and conducting vulnerability assessments of critical road segments. Meanwhile, in the medium-term (3-7 years), infrastructure rehabilitation programs should incorporate climate-resilient road design standards. Coastal road sections exposed to erosion and flooding should be elevated or protected using appropriate engineering measures. Finally, in the long-term (7–15 years), urban transport planning should fully integrate climate risk assessments into infrastructure investment decisions. Long-term monitoring systems should track climate impacts on infrastructure performance and guide adaptive management.

Financing Mechanisms

Financing climate-resilient infrastructure requires a combination of national government investment and international climate finance. Potential funding sources include national infrastructure budgets, development partner programs, and international climate adaptation funds such as the Green Climate Fund. Public–private partnerships may also support infrastructure development and maintenance.

Monitoring and Evaluation

Monitoring mechanisms should track infrastructure performance and climate hazard trends over time. Indicators may include road condition ratings, frequency of flood-related road closures, and maintenance costs associated with climate-related damage. Regular infrastructure assessments and climate risk reviews will allow policymakers to adjust adaptation strategies as climate conditions evolve.

Conclusion

This study assessed the impacts of climate change on road infrastructure in the Greater Honiara Area by examining key climate-related hazards using a climate exposure-impact-adaptation analytical framework. The research identified extreme rainfall, flooding, sea-level rise, coastal erosion, and increasing temperatures as major stressors affecting urban road systems. The findings indicate that recurrent flooding and intense rainfall are the most immediate drivers of pavement deterioration and drainage system failure. Sea-level rise and coastal erosion pose growing risks to low-lying coastal road corridors through saline intrusion and embankment instability. Rising temperatures accelerate material fatigue and reduce pavement service life, further increasing maintenance demands. These combined impacts disrupt transport services, elevate infrastructure costs, and undermine access to essential services such as healthcare, education, and emergency response. Overall, the results highlight that climate change is not only an environmental challenge for Greater Honiara but also a major threat to urban mobility, economic stability, and social well-being.

Based on the implementation-phase analysis, priority drainage improvements and routine road maintenance should be implemented in Zones I and II within the first 1–3 years to reduce flooding impacts, minimize pavement damage, and improve transport accessibility during extreme weather conditions. In the medium and long term, climate-resilient road design standards, coastal protection measures, and integrated land-use planning should be strengthened to support sustainable infrastructure development. The findings highlight the importance of combining engineering interventions, climate-sensitive planning, and institutional coordination to strengthen road infrastructure resilience in the Solomon Islands. The study also contributes to the limited research on climate-resilient transport infrastructure in Pacific Small Island Developing States (SIDS) and provides practical insights for future infrastructure planning and disaster risk reduction initiatives in the Solomon Islands.

The study underscores the urgent need for climate-resilient road infrastructure in Greater Honiara. Adaptation strategies should include climate-sensitive road design standards, enhanced drainage capacity, and protection of vulnerable coastal road segments. Equally important is the integration of climate adaptation into urban planning and transport policy frameworks. Strengthened institutional coordination among infrastructure, land-use, and environmental agencies is essential for ensuring coherent and effective implementation. By providing a localized empirical assessment of road infrastructure vulnerability in a Pacific Small Island Developing State urban context, this research contributes to the limited body of literature on climate change impacts on urban transport systems in the region. It offers policy-relevant insights that can inform future infrastructure investment, disaster risk reduction strategies, and sustainable urban development planning in the Solomon Islands. Ultimately, enhancing the resilience of road infrastructure in Greater Honiara is not only a technical necessity but also a social and economic imperative. As climate risks intensify, proactive and integrated adaptation measures will be critical for safeguarding mobility, livelihoods, and long-term urban sustainability.

This study provides a basis for future research that can make use of primary field data, climate scenario modeling, and economic evaluation of adaptation measures to better understand the long-term effectiveness of climate-resilient road infrastructure in Greater Honiara. Comparative studies of other urban areas in the Solomon Islands may also provide broader evidence for national infrastructure

Declaration of Generative AI Use

I hereby declare that this manuscript was prepared without the use of artificial intelligence (AI) tools for generating, writing, or substantially modifying the content. The ideas, analysis, interpretation, arguments, and written text presented in this manuscript are largely my own work. I take full responsibility for the accuracy, originality, and integrity of the manuscript and for ensuring that all sources are appropriately acknowledged and cited.

Author Contributions

The first author contributed to the first draft writing, literature review, data collection, quantitative analysis, and conclusion. The second author focused on conceptualization, editing of the manuscript, discussion, and conclusion.

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