



Analysing Heat Resilience in Freetown, Sierra Leone A Site Suitability Analysis for Tree Planting

Nancy Obonyo & Valena McEwen
Keough School of Global Affairs

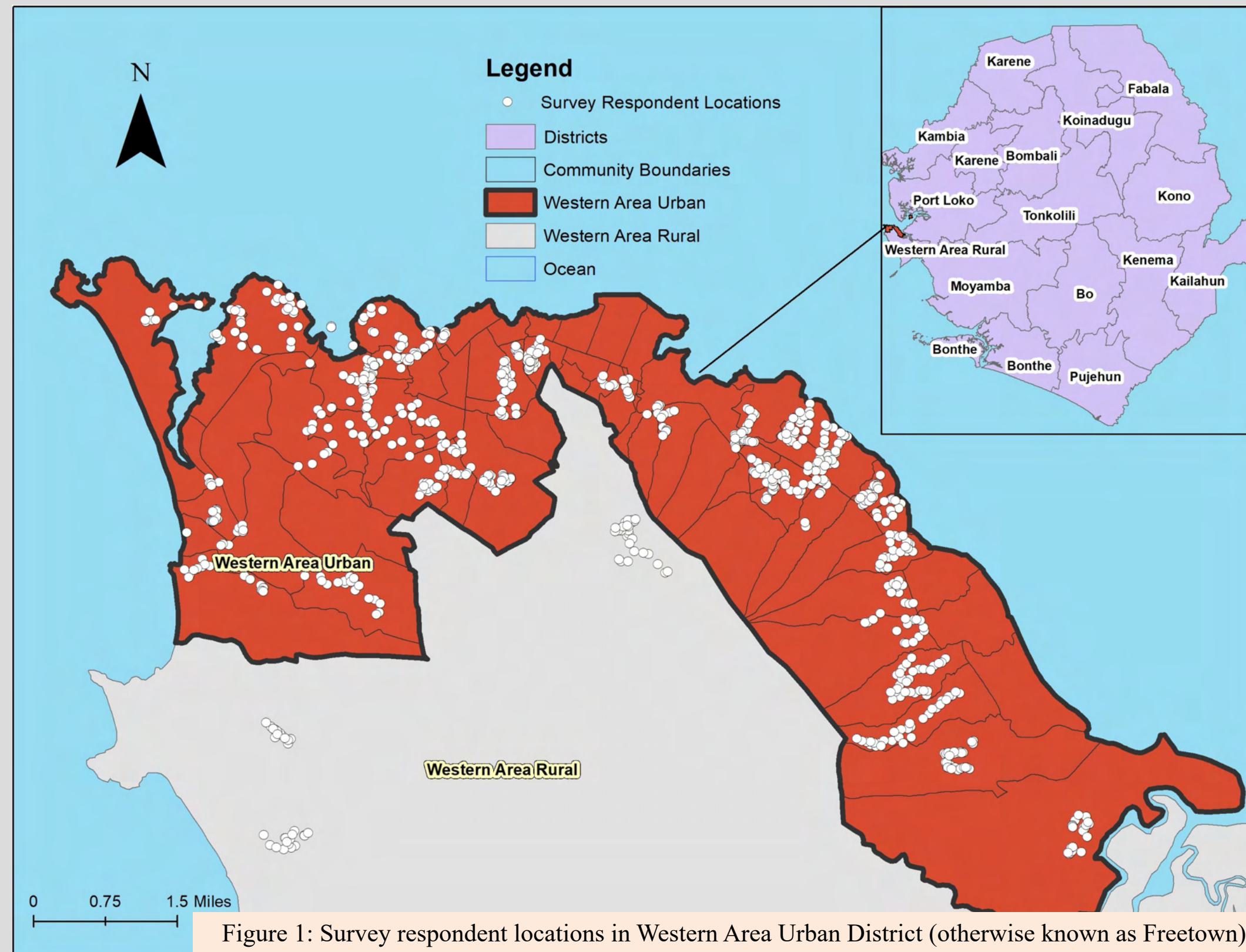


Abstract

Freetown, Sierra Leone, is expected to experience more frequent and intense episodes over the next couple of decades as a result of climate change. Its local government is interested in building long term resilience against extreme heat, especially through green infrastructure, targeting the most vulnerable communities. This research analyzes a survey of more than 930 respondents in Freetown to spatially identify 11 communities that have high vulnerability and low adaptability. It recommends 7 sites within Allen Town 2, Portee, Grassfield, Quarry, Coconut Farm, Kissy Bypass and Brookfields for tree planting, using data from the city's existing tree planting campaign.

1. Introduction

Extreme heat is an imminent climate risk for Freetown, the capital of Sierra Leone (Figure 1). Mean temperatures during the hottest months over the last decade averaged about 39°C/102°F between 2013 and 2022, the fifth warmest in the country (World Bank, 2023). Heat risk in Freetown is exacerbated by the urban heat island effect and Freetown is projected to endure some of the longest warm spells, reaching up to 220 days by 2040-2059 as a result of climate change (World Bank, 2023). The local government is being proactive about mitigating the impact of extreme heat on its residents, appointing a Chief Heat Officer in 2021, responsible for minimizing the impact of extreme heat on the population of Freetown. Currently, the city is interested in understanding how it can build on its current tree planting initiative, which has demonstrated an excellent tree survival rate of 80% (Earthshot Prize, 2023).



2. Research Objective

Conducting a site suitability analysis to identify communities with high vulnerability and low adaptation to extreme heat risks that should be prioritized for the next phase of tree planting.

3. Methodology

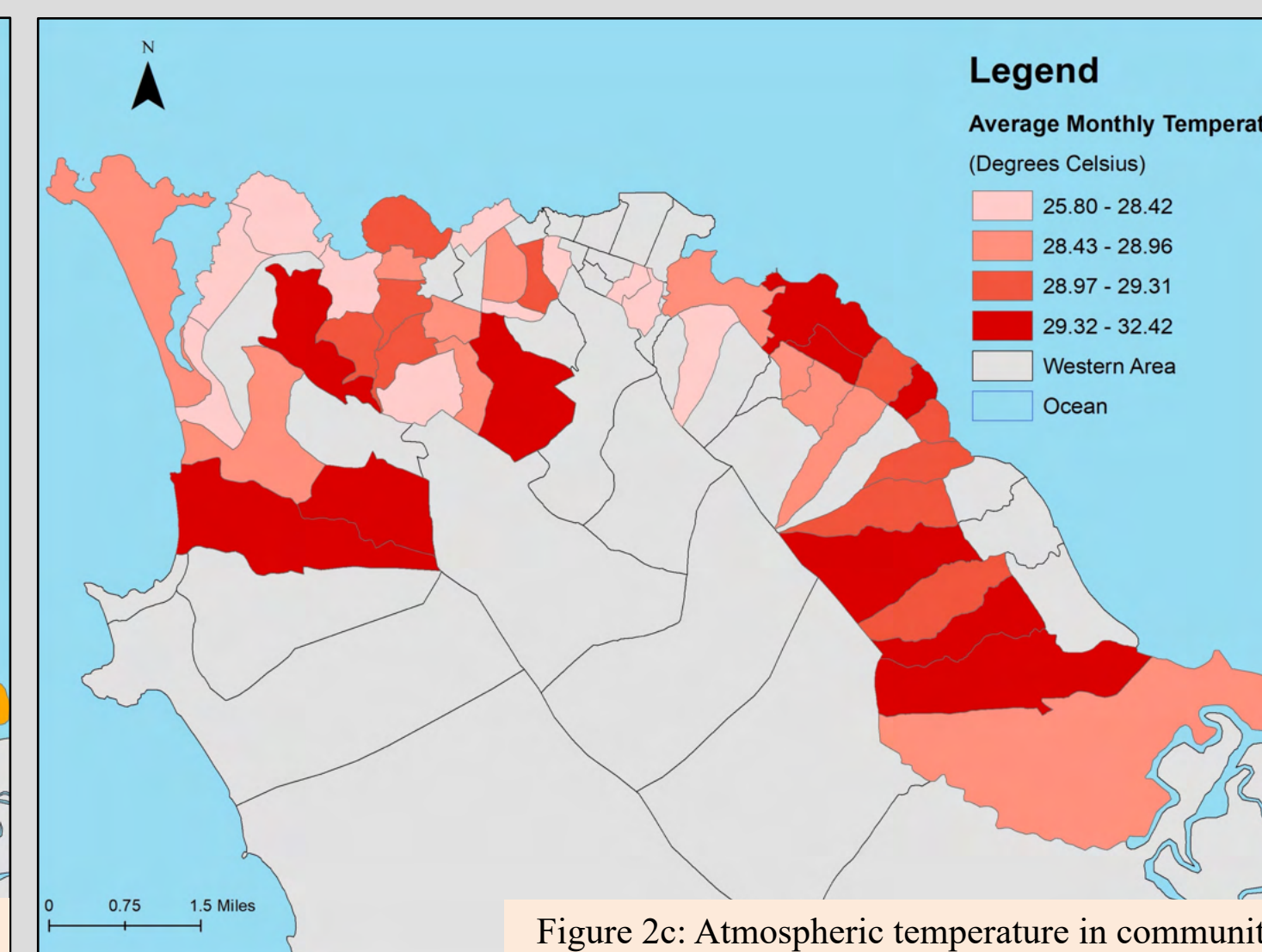
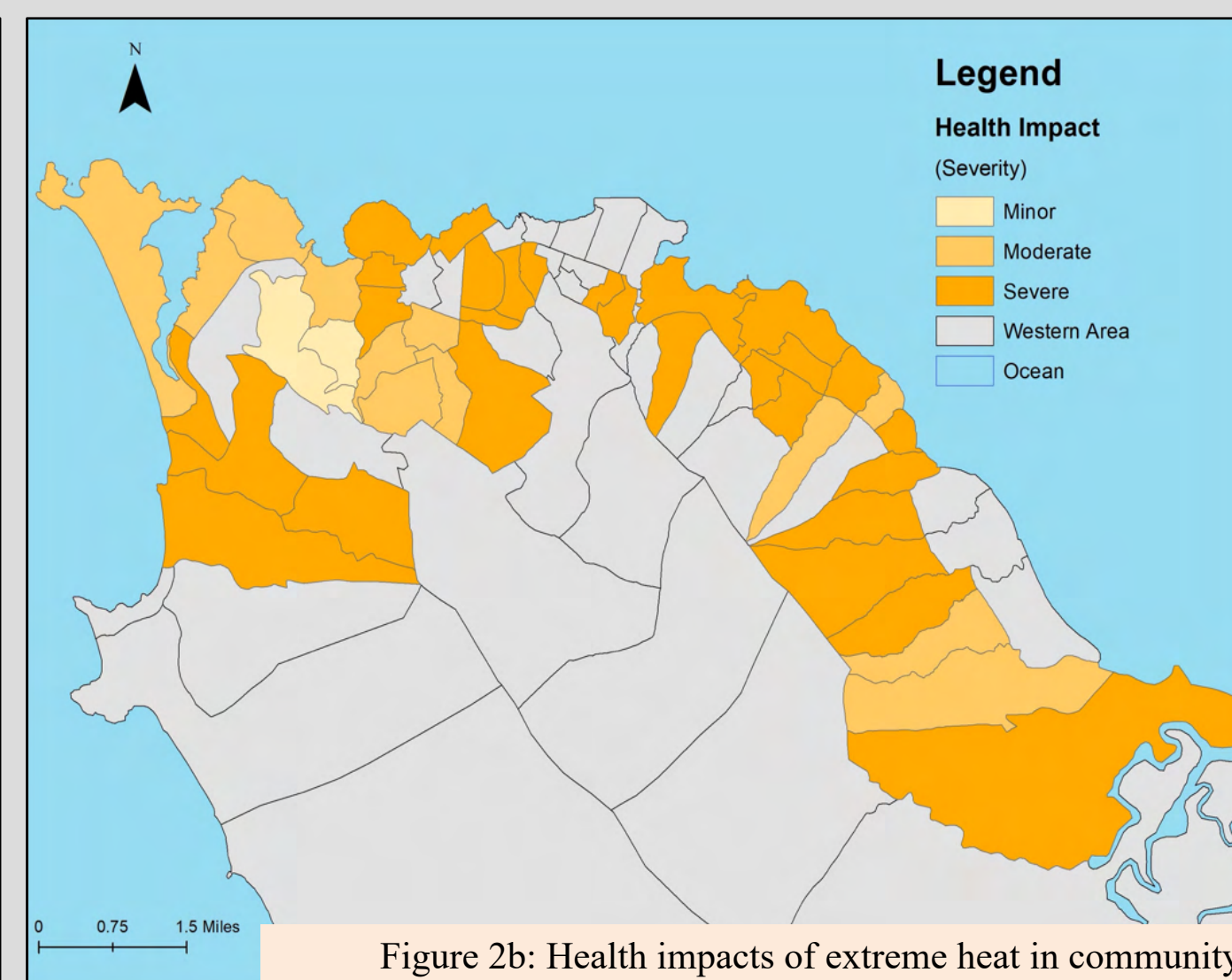
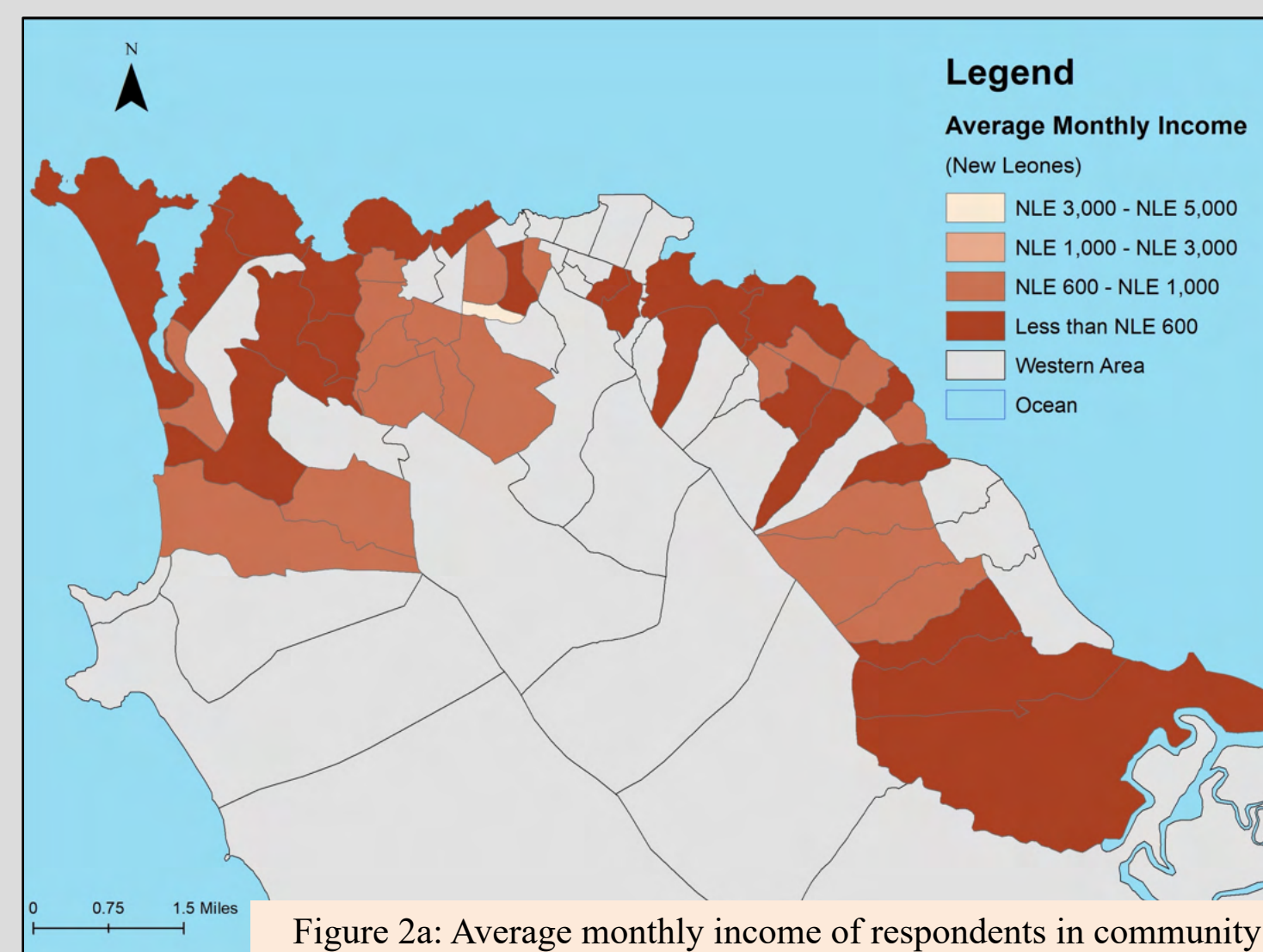
The data used for this study was collected through a survey of 930 respondents from 87 communities in the Western Area Urban and Rural Districts. The location of each interview was geocoded and mapped using latitude and longitude information in ArcMap 10.8.3. Communities with four or fewer interviews were not considered representative and were excluded. The factors that affect vulnerability and adaptability to extreme heat were analyzed at the community level using choropleth maps. Communities with high vulnerability and low adaptability were identified as high priority communities for heat resilience interventions.

3. Methodology Continued

Communities with high vulnerability and high adaptability were also identified for other interventions that could reduce their vulnerability. The geocoordinates of trees planted in the first phase of Freetown City Council's "Freetown The Tree Town" Campaign were incorporated to determine specific locations/sites for planting trees within high priority communities to help reduce the impact of extreme heat.

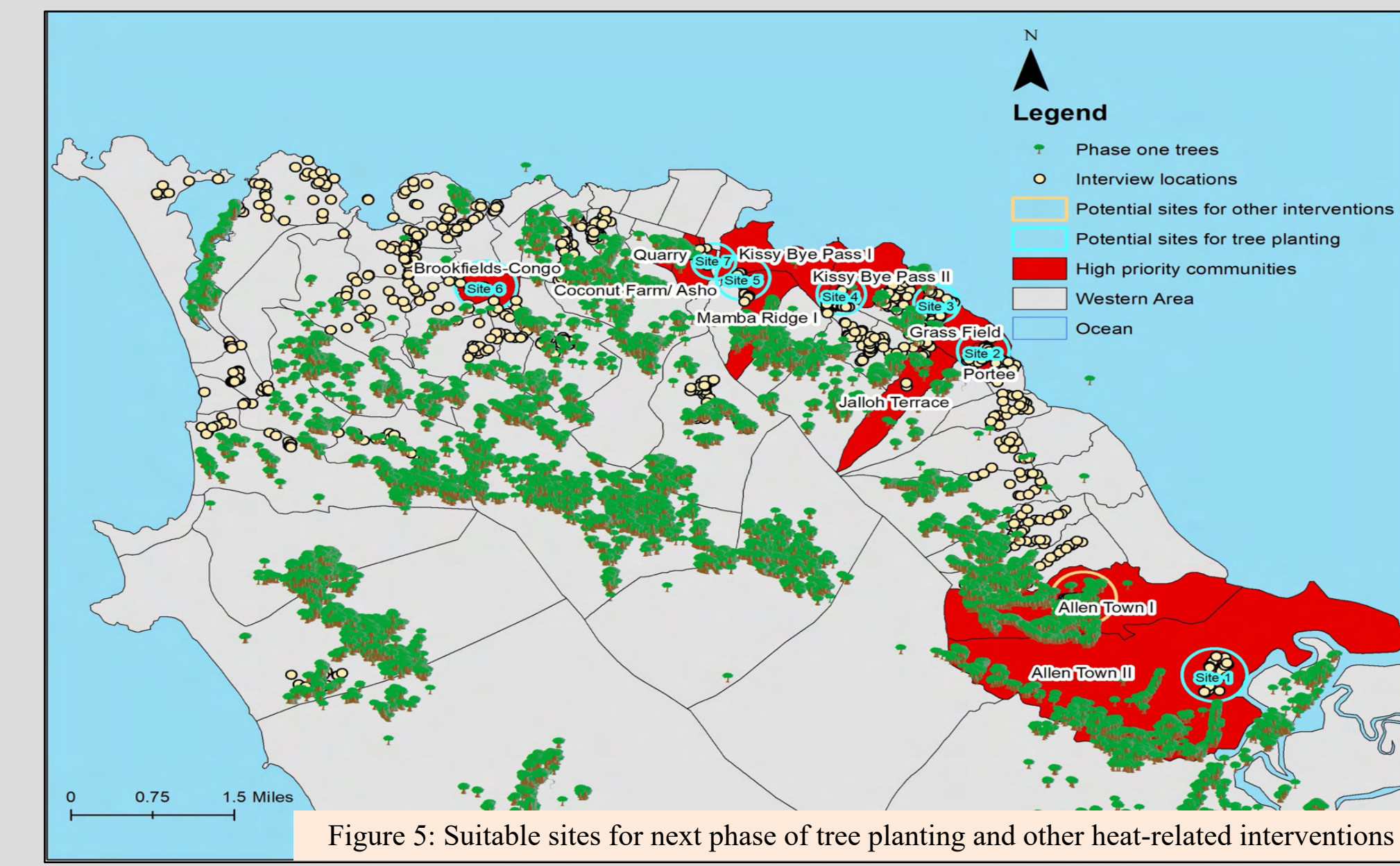
Developing the Vulnerability Index: Data was collected on 6 factors that increase respondents' vulnerability to the impacts of extreme heat. These included access to public services, level of income, type of housing, ownership of cooling equipment, impact on health and atmospheric temperature at interview locations. For each respondent, each factor was coded to ensure that higher scores indicated higher vulnerability. Original scores were then normalized and equally weighted to develop the vulnerability index. Figures 2(a), 2(b), and 2(c) depict the normalized scores distribution for temperature, income, and health impacts, which were 3 of the 6 factors used to estimate community-level vulnerability. These figures are indicative of the vulnerability of communities.

Developing the Adaptability Index: Data was also collected on personal strategies that respondents used to cope during periods of extreme heat. Respondents were given 14 coping strategy options, including increasing water intake, wearing lighter clothing, use of air conditioning and seeking shade. Each respondent chose the strategies they used and they received scores equal to the fraction of to strategies they used. These scores were normalized to develop the adaptability index.



4. Findings and Conclusion Continued

Finding 2
Based on the assessment where trees had been planted during the first phase of the "Freetown The Tree Town" Campaign, we identified seven sites where few to no trees had been planted within high priority communities (See Figure 5). These sites were selected for the next phase of tree planting, aimed at reducing vulnerability and increasing adaptability to extreme heat risks. However, we see that despite previous tree planting efforts, the surveyed locations in Allen Town 1 continue to have high vulnerability and low adaptability. This brings us to the conclusion that while tree planting is a recommended long term strategy to build resilience against extreme heat, it may need to be complemented by other more immediate efforts to reduce vulnerability.



4. Findings & Conclusion

This research resulted in two main findings:

- The identification of 17 communities with high vulnerability to extreme heat but varying levels of adaptability to it.
- The identification of 7 sites for tree planting within high priority communities, and an eighth site in which the city would need other interventions to reduce heat vulnerability.

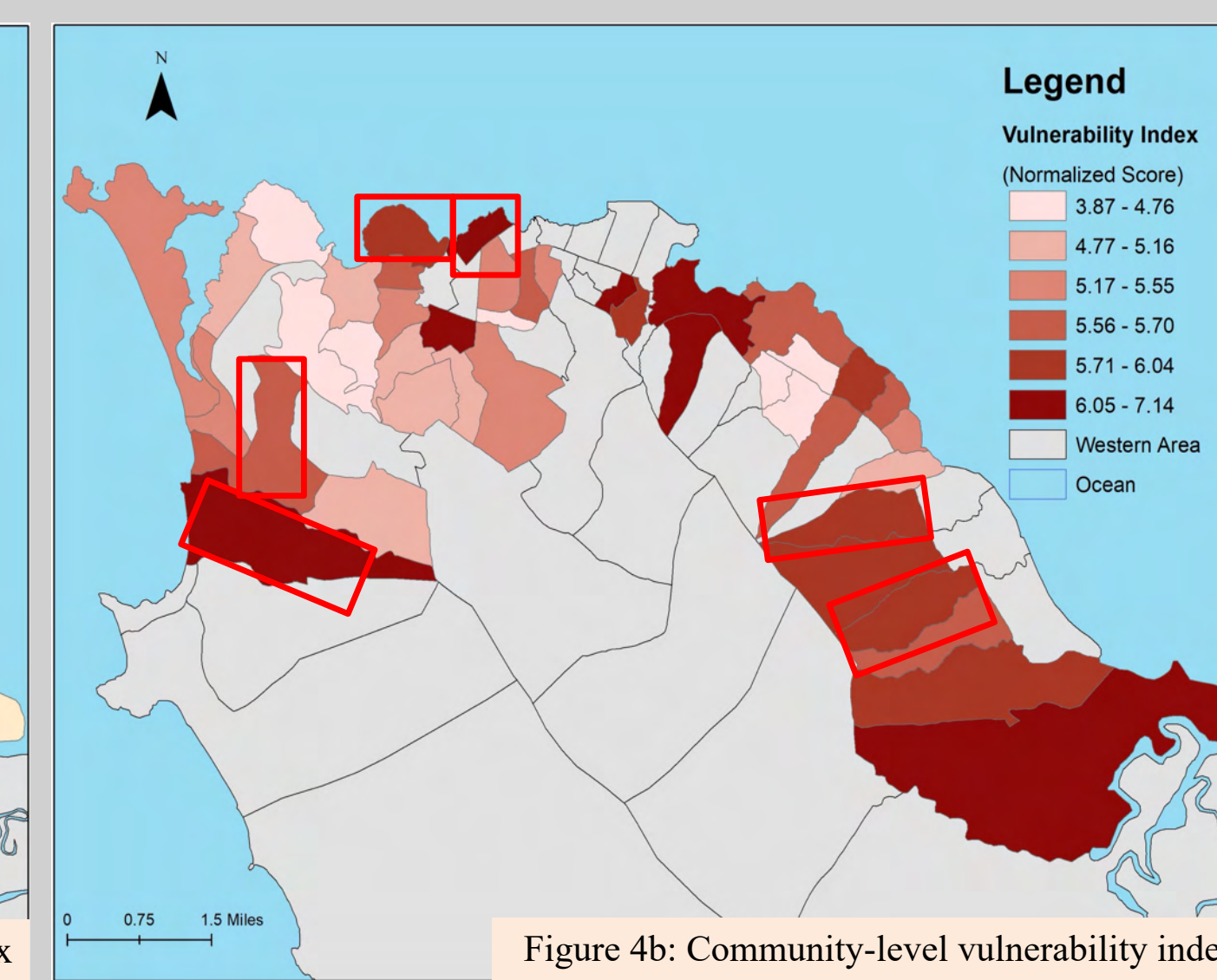
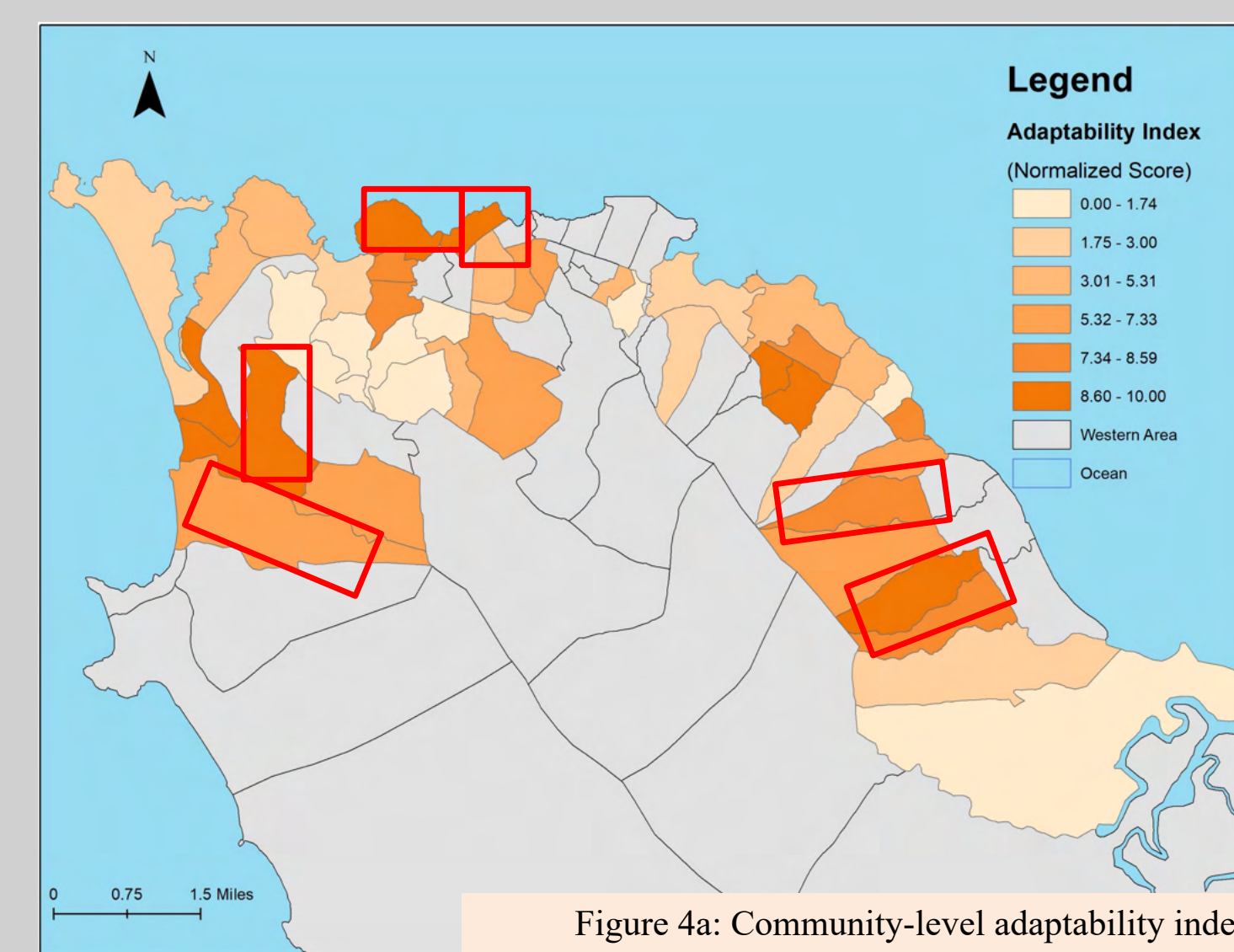
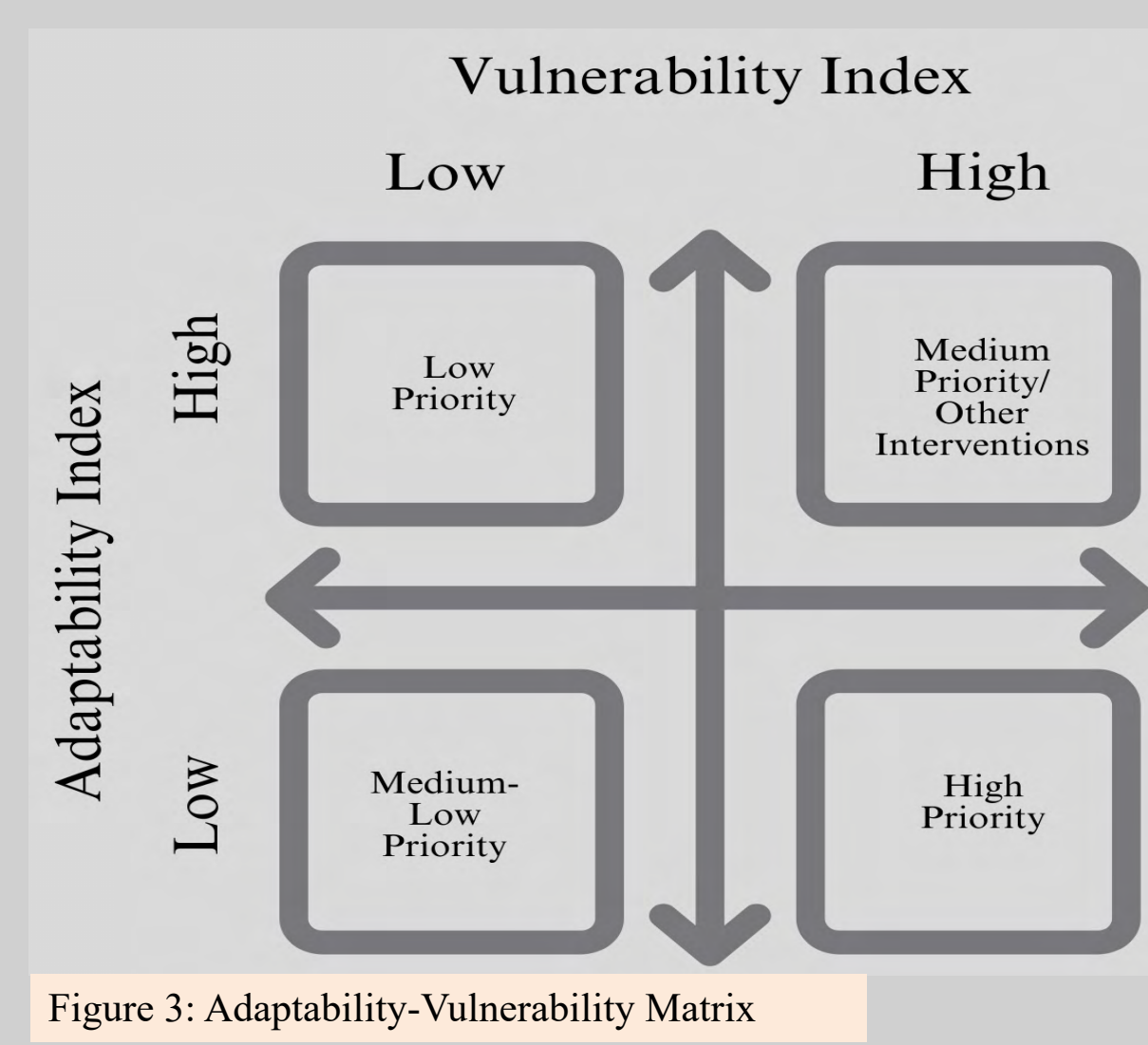
Finding 1

We identified four categories of communities along the vulnerability and adaptability spectrums. They are low adaptability-low vulnerability, low adaptability-high vulnerability, high adaptability-high vulnerability and high adaptability-low vulnerability (See Figure 3). High vulnerability is defined by vulnerability index scores being in the top 50th percentile (a score greater than 5.56). Similarly, low adaptability by being in the lower 50th percentile of the adaptability index (with a score lower than 5.32).

Based on these criteria, we have identified 11 high priority communities which have high vulnerability and low adaptability (see Table 1). Additionally, we also identify 6 communities (Juba-Kaningo, Lumley, Kingtom, Connaught Hospital, Robis and Congo Water 2) that despite having high adaptability also have high vulnerability to extreme heat (see Figure 4a&4b).

Table 1: List of high priority communities in Freetown for heat-related tree planting intervention

High Priority Communities	Vulnerability Index	Adaptability Index
Allen Town I	5.75	1.77
Allen Town II	6.36	1.74
Jalloh Terrace	5.66	2.50
Portee	5.63	0.66
Grassfields	5.97	5.31
Kissy Bye Pass I	6.10	3.00
Kissy Bye Pass II	5.70	4.38
Mamba Ridge I	6.06	2.27
Coconut Farm	6.04	0
Quarry	6.55	3.57
Brookfields-Congo	6.06	0



5. Recommendations

- In high priority communities with limited tree planting, tree planting is carried out in the 7 sites identified to mitigate long-term vulnerability.
- In Allen Town 1, which continues to be high priority despite extensive tree planting, simultaneous interventions to reduce vulnerability and increase adaptability. These include launching a community-wide awareness campaign to educate residents about personal coping strategies and supporting the introduction of a heat-linked microinsurance payment system for residents whenever temperatures reach a certain threshold, like in other low income cities (Ro, 2023).
- In the 6 other communities with high vulnerability and high adaptability, vulnerability can be reduced by improving access to water, which was the least accessible service according to the survey (about 60% of respondents had access). This can be done through water trucking, which the city did during the COVID-19 pandemic. The city can also support home improvements, such as cool roofs and shading, for poor residents.

6. References & Data Sources

- Adrienne Arshitt-Rockefeller Foundation Resilience Center (2023). *Hot cities, chilled economies: Impact of extreme heat on global cities*. <https://onehillresilient.org/hot-cities-chilled-economies-freetown/>
- Earthshot Prize. (2023). *Freetown the tree town*. <https://earthshotprize.org/winners-finalists/freetown-the-tree-town/#:~:text=The%20city%20has%20over%20a%20million%20trees,survival%20rate%20of%2080%20over%2080%20trees>
- Freetown City Council. (2023). *Climate action strategy: 2023 - 2030*. <https://fcc.gov.sl/wp-content/uploads/2023/01/CAP-Freetown-FINAL.pdf>
- Ro, C. (2023, May 27). *The New Type Of Insurance That Protects Indian Women During Extreme Heat*. Forbes. <https://www.forbes.com/sites/christinero/2023/05/27/the-new-type-of-insurance-that-protects-indian-women-during-extreme-heat/#5h-4c4b761278c7>
- World Bank. (2023). *Sustainable cities: Urban areas and climate change in Sierra Leone*. Washington D.C.: World Bank Group. <https://documents1.worldbank.org/curated/en/099060723154042808/pdf/P179704070452020060006567ab093e.pdf>
- Survey data: Freetown City Council. Conducted April 2023.
- Geographic Boundary Data: humldata.org. Accessed April 2024.