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The Evaluation and Comparison of Resilience for Shelters in Old and New Urban Districts: A Case Study in Kunming City, China

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Abstract: As a critical resource in emergency response and a pivotal element in disaster prevention and risk reduction, shelters play a central role in the holistic continuum of rescue and relief efforts. However, existing research often overlooks the comprehensive assessment and enhancement of shelter resilience. This study proposes a novel safety–robustness–accessibility (SRA) model aimed at evaluating and enhancing the overall resilience of shelters in the face of disasters. Firstly, a resilience assessment system for shelters was established, leveraging multi-source data and encompassing diverse dimensions, including safety, robustness, and accessibility. Subsequently, the entropy weight method was utilized to determine the weights of the assessment indicators. The case study and comparative analysis were conducted on shelters situated in two urban areas, old and new, in Kunming City, China, namely Wuhua District and Chenggong District. The findings reveal a higher quantity of shelters in Wuhua District compared to Chenggong District; however, the overall resilience level is relatively low, predominantly categorized as "Mid-Low" grade, constituting a substantial 57.94%. Conversely, shelters in Chenggong District exhibit a relatively high resilience level, predominantly classified as "Medium" grade, accounting for 33.77%. This study furnishes valuable data references and specific strategies aimed at enhancing the resilience of urban shelters against disasters. It offers crucial insights for urban planning and management to strengthen shelter resilience, thereby contributing to the development of a more resilient and sustainable urban future.

Keywords: shelters; resilience; old and new urban districts; disaster; urban safety

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1. Introduction

In recent years, the global frequency of various disasters, including earthquakes, hurricanes, and floods, has escalated significantly [1–3]. These events not only result in substantial human casualties and property losses but also exert a profound impact on socioeconomic development, causing considerable distress in people's lives [4,5]. Consequently, the imperative of fortifying prevention, response, and rescue capabilities, alongside fostering international cooperation, has become a pressing and collective undertaking for nations worldwide [6–8]. These efforts represent crucial initiatives for upholding human security and social stability [9].

Shelters, as pivotal facilities offering safety and protection during natural disasters or emergencies, play an indispensable role in these endeavors [10,11]. In the face of disasters, shelters serve as secure havens for individuals, constituting the last line of defense for life [12,13]. Simultaneously, they serve as vital hubs for emergency evacuation and refuge [14,15]. The significance of shelters in preserving public safety and safeguarding life and property cannot be overstated, making the establishment of a robust shelter system an integral component of modern society [16].

The term "resilience" is derived from the Latin word "Resilio", meaning "to return to the original state" [17]. Holling first introduced the concept of resilience into the study of ecosystems, defining it as "the ability of an ecosystem to return to a stable state after being perturbed", thus providing a theoretical basis for the study of urban resilience [18,19]. Subsequently, resilience has garnered considerable attention in the academic realm, with widespread applications in urban systems [20–24]. Alawi et al. [25] assessed and compared the resilience levels of 169 public open spaces in three different regions of Chongqing, China. Wu et al. [26] assessed the time-dependent resilience performance of transportation networks by considering evolving travel demands, with traffic efficiency and safety as key indicators. Liu et al. [27] evaluated the urban resilience in four provinces in the North–South Seismic Belt of China via four dimensions: social, economic, infrastructure, and ecology. While many scholars have delved into the resilience of cities during and after disasters, few have undertaken resilience assessments specifically focused on urban shelters. The critical role of shelters in disaster scenarios, coupled with the dearth of research on their resilience assessment, underscores the urgency of addressing this gap.

This study aims to establish a new model for evaluating the resilience of shelters from a multidimensional perspective. Firstly, this study establishes a theoretical framework for the resilience of shelters based on "safety–robustness–accessibility (SRA)" based on multi-source data. Among them, safety focuses on ensuring the structural integrity of shelters and their ability to withstand various hazards such as earthquakes, landslides, or collapses. Robustness refers to the ability of a shelter to withstand and recover from adverse events. Accessibility refers to the ease with which individuals can reach shelters and access basic services during an emergency. Secondly, this study assesses and compares the resilience levels of shelters in the older urban area (Wuhua District) and the newer urban area (Chenggong District) in Kunming. The novelty of this study lies in integrating resilience considerations into shelter planning, ensuring their effectiveness in both daily use and disaster scenarios. The outcomes of this study furnish urban planners and policymakers with a crucial foundation for creating highly resilient shelters, thereby mitigating the costs of destruction and loss of life and advancing the resilience and sustainability of cities.

The subsequent sections are structured as follows: Section 2 presents an overview of the study area and data. Section 3 details the methodology employed for shelter resilience assessment. Section 4 displays the results of the shelter resilience assessment and comparison. Sections 5 and 6 offer a discussion and conclusion of the experimental findings, respectively.

2. Study Area and Data

2.1. Study Area

Situated in the southwestern region of China, Kunming serves as the capital of Yunnan Province, featuring seven districts, six counties, and one county-level city within its administrative boundaries. Wuhua District, one of these administrative divisions, spans a total area of 397.86 square kilometers. The district poses unique challenges for large-scale planning and redevelopment owing to its early development planning, heightened population density, economic affluence, concentrated presence of essential institutions, and saturation of urban land. The primary urban expanse of Kunming persistently extends southward, characterized by notably high residential density in the southern regions. Conversely, Chenggong District, designated as the new administrative center of the Kunming government since 2011, encompasses a total area of 461 square kilometers. Distinguished by a more recent initiation of urbanization and a systematically designed urban plan, Chenggong District stands out for its scientific and rational urban development [28,29]. Consequently, Wuhua District and Chenggong District are purposively selected as representative samples in this study, symbolizing Kunming's old and new urban areas, respectively, as shown in Figure 1.

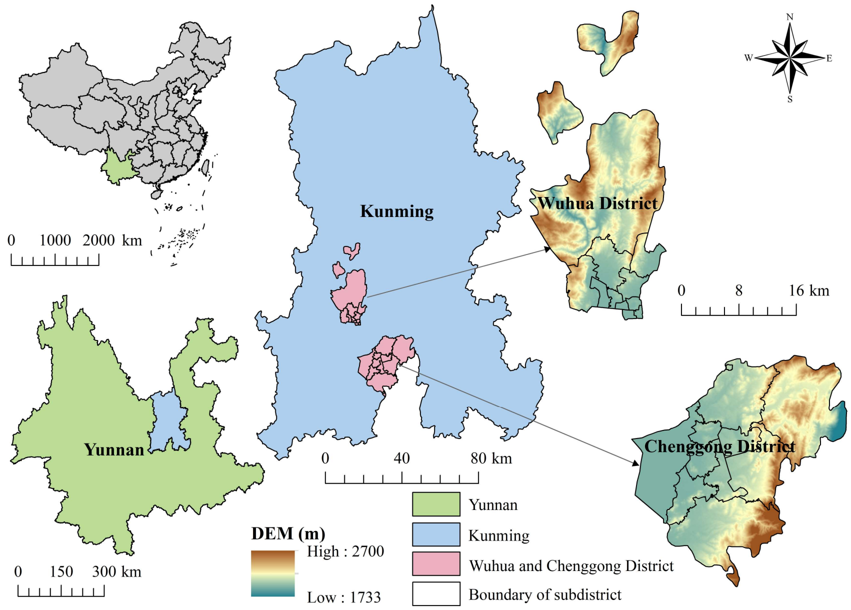

Figure 1. Study area.

2.2. Data

This study conducted a comprehensive assessment of shelter resilience, considering safety, robustness, and accessibility as key dimensions [30,31]. A total of nine assessment indicators were chosen, as detailed in Table 1. Safety considerations encompassed slope, distance from faults, and distance from buildings. Minimizing slopes contributes to shelter stability, mitigating the risk of landslides or collapses [32]. Greater distance from faults enhances earthquake resilience, while increased separation from buildings diminishes the vulnerability to structural collapse. Robustness was evaluated via the shelter's area, population density, and the Total Nighttime Light Index (TNLI). Larger shelters provide increased capacity for accommodating people and equipment, offering more secure space during catastrophic events. Population density serves as a crucial factor influencing labor force levels and significantly impacts the recovery process post-emergency [33]. TNLI, representing the level of infrastructure and public services surrounding the shelter, serves as an indicator of resilience and post-disaster recovery. The accessibility dimension focused on proximity to roads, hospitals, and water [34]. Closeness to roads influences the speed at which individuals can reach a shelter during emergencies. Proximity to hospitals reflects ease of access to medical assistance. Additionally, proximity to water relates to the accessibility of drinking water and other essential water resources, crucial aspects for the well-being of shelter occupants.

Table 1. Resilience assessment indicators.

Target Level	Criterion Level	Indicator Level
Resilience	Safety	Slope
		Distance from faults
		Distance from Buildings
	Robustness	Area
		Population density
		TNLI
	Accessibility	Distance from roads
		Distance from hospitals
		Distance from water

This study relies on a diverse array of data sources for the assessment of shelter resilience. Administrative boundary data were procured from the National Geomatics Center of China. Shelters and road network data were sourced from the Open Street Map. Building data, boasting an accuracy rate of 0.97 as of 2020, were acquired from the National Tibetan Plateau Data Center, a dataset generated by the lab of smart city sensing and stimulation at Nanjing Normal University [35,36]. Supplementary data for the shelters were meticulously generated via manual vectorization, utilizing high-resolution images from Google Earth as the foundational map. These supplementary data were further transformed into manipulable shape files via format and coordinate conversion. The diverse and complementary nature of these data sources is detailed in Table 2.

Table 2. Data sources.

Data Type		Data Sources
Administrative boundary (2023)		http://www.ngcc.cn/ngcc/ (accessed on 1 November 2023)
Shelters	Most (2023)	https://www.openstreetmap.org (accessed on 1 November 2023)
	Supplement (2023)	https://earth.google.com/web/ (accessed on 1 November 2023)
Road Network (2023)		https://www.openstreetmap.org (accessed on 10 November 2023)
Buildings	97% accuracy (2020)	https://data.tpdc.ac.cn/en/data/60dac98deec4-41df-9ad5-b1563e5c532c/ (accessed on 10 November 2023)
	100% accuracy (2023)	https://www.openstreetmap.org (accessed on 10 November 2023)
Nighttime light (2022)		https://engine-aiearth.aliyun.com (accessed on 10 November 2023)

3. Methodology

For the resilience assessment in this study, a total of 359 shelters in Wuhua District and 77 shelters in Chenggong District were chosen. Given the substantial contrast in area size and the concentrated distribution of shelters, the geographic location and distribution characteristics of the shelters are visually depicted using circles in this study, as illustrated in Figure 2. Wuhua District has a more concentrated distribution of shelters, mainly in the south, while Chenggong District has a more even distribution of shelters, but more in the central and western parts of the district.

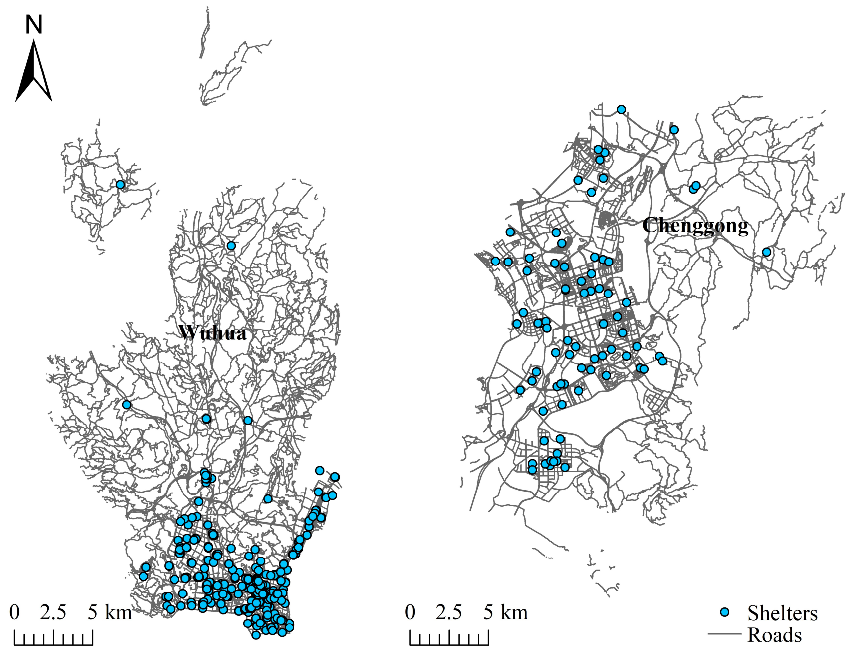

Figure 2. Shelters in Wuhua District and Chenggong District.

3.1. Nighttime Light Index Calculation

In this study, nighttime light indices were extracted using the National Polar-orbiting Partnership–Visible Infrared Imaging Radiometer Suite (NPP-VIIRS) nighttime light data [37,38]. The TNLI was selected as the primary index for computation and analysis [39,40]. The TNLI was derived by summing the digital number (DN) values of light within administrative units, formulated as follows:

$$TNLI = \sum_{i=1}^{n} DN_i \quad (1)$$

where n is the number of rasters, and DN_i is the radiation value of the image element corresponding to each raster.

3.2. Data Normalization

To account for variations in units across different indicators, it is imperative to normalize each indicator, ensuring that their values are standardized within the range of 0 to 1 [41]. The normalization calculation for positive indicators is outlined in Equation (2), while Equation (3) illustrates the normalization equation for negative indicators.

$$Y_{ij} = \frac{X_{ij} - X_{min}}{X_{max} - X_{min}} \quad (2)$$

$$Y_{ij} = \frac{X_{max} - X_{ij}}{X_{max} - X_{min}} \quad (3)$$

where Y_{ij} is the normalized value, X_{ij} is the attribute value of an indicator, X_{max} is the maximum value of an indicator, X_{min} is the minimum value of an indicator, n is the number of objects (i = 1, 2, 3, …, n), and m is the number of indicators (j = 1, 2, 3, …, m).

3.3. Determination of Assessment Indicator Weights

The entropy weight method provides significant benefits as a decision-making technique for determining indicator weights [42,43]. This aspect ensures objectivity by eliminating the need for subjective judgments or expert opinions. Secondly, the method effectively deals with the uncertainty associated with each indicator data point, leading to a more systematic and rational allocation of weights. This approach reduces the risk of arbitrary decisions or overreliance on a single indicator, which is a concern in other methods [44,45]. The j indicator of the i object accounts for the weight of that indicator among all objects:

$$P_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}} \tag{4}$$

Entropy serves as an indicator of the divergence among the values of indicators and is employed to quantify the information content within an indicator. The calculation of entropy is expressed as follows:

$$E_j = -\frac{1}{\ln n}\sum_{i=1}^{n} P_{ij} \ln P_{ij} \tag{5}$$

Utilizing Equation (6) to ascertain the weights of the assessment indicators, Table 3 presents the outcomes for these weights.

$$W_j = \frac{1 - E_j}{\sum_{j=1}^{m}(1 - E_j)} \tag{6}$$

where P_{ij} is the j indicator of the i object accounts for the weight of that indicator among all objects, E_j is the entropy of the j indicator, and W_j is the weight of the j indicator.

Table 3. Weight of indicators for resilience assessment.

Target Level	Criterion Level	Weight	Indicator Level	Weight
Resilience	Safety	0.225	Slope	0.008
			Distance from faults	0.080
			Distance from Buildings	0.137
	Robustness	0.756	Area	0.680
			Population density	0.037
			TNLI	0.039
	Accessibility	0.019	Distance from roads	0.004
			Distance from hospitals	0.002
			Distance from water	0.013

3.4. Calculation of the Shelter Resilience Index

The comprehensive index of shelter resilience is the weighted result of all indicators of safety, robustness, and accessibility. The equation for calculating the resilience index is as follows:

$$R = \sum_{j=1}^{m} Y_{ij} \times W_j \tag{7}$$

where R is the shelter resilience index.

4. Results

4.1. Percentage of Resilience Levels

Based on the proposed SRA model, the SRA dimensional resilience and total resilience of Wuhua District and Chenggong District were estimated. This study employed the natural breaks classification method to categorize them into five grades, including “Low”, “Mid-Low”, “Medium”, “Mid-High”, and “High”. Given the substantial difference in the number of shelters in the two districts, comparative analyses were conducted by calculating the percentage of the total number of shelters for each grade in each district separately (as presented in Table 4). Figure 3 visually represents the distribution of shelters in the two districts concerning safety, robustness, accessibility, and overall resilience. In Wuhua District, a higher number of shelters received "Medium" and "Mid-Low" ratings, constituting a combined percentage of 62.28%. Notably, the resilience level of shelters in Wuhua District is predominantly characterized by the "Mid-Low" rating, accounting for 57.94% of the total. Conversely, the distribution of shelters across various grades in Chenggong District is relatively balanced, with a notable presence of shelters receiving a "Mid-High" rating, totaling 23.90%. Furthermore, the resilience level of shelters in Chenggong District is predominantly marked by the "Medium" rating, encompassing 33.77%. Noteworthy is the observation that shelters in Chenggong District exhibit higher safety ratings, with no shelters falling into the "Low" and "Mid-Low" categories. Instead, they predominantly cluster in the "Mid-High" grades, constituting a substantial 70.13%.

Table 4. Percentage of resilience levels.

Subdistrict	Level	Safety	Robustness	Accessibility	Resilience
Wuhua	Low	19.78%	6.13%	5.85%	8.64%
	Mid-Low	44.57%	51.81%	23.40%	57.94%
	Medium	31.48%	40.67%	29.53%	32.03%
	Mid-High	3.34%	0.84%	24.79%	0.84%
	High	0.84%	0.56%	16.43%	0.56%
Chenggong	Low	0.00%	31.17%	22.08%	16.88%
	Mid-Low	0.00%	20.78%	29.87%	23.38%
	Medium	6.49%	20.78%	25.97%	33.77%
	Mid-High	70.13%	18.18%	14.29%	16.88%
	High	23.38%	9.09%	7.79%	9.09%

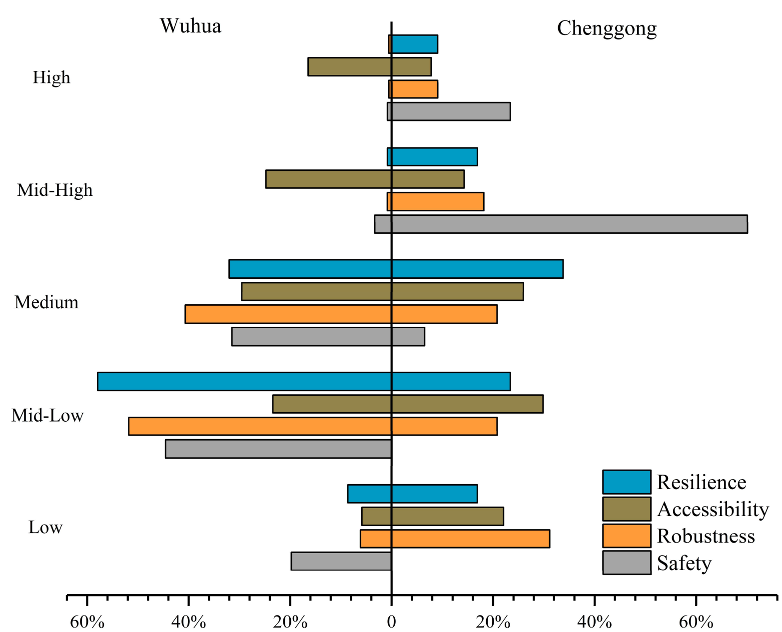

Figure 3. Percentage of resilience levels in Wuhua District and Chenggong District.

4.2. Spatial Distribution of Resilience Assessment Criteria

4.2.1. Safety

The safety of shelters pertains to their resilience in the face of disasters, encompassing factors such as the geographical slope, proximity to faults, and distance from buildings. In the context of two specific regions, Wuhua District and Chenggong District, the safety assessment of shelters reveals notable differences, as depicted in Figure 4. The figure illustrates that, overall, the safety of shelters in Wuhua District tends to be low, with a predominant concentration in the "Medium" and "Low" grades. This suggests that despite the presence of a larger number of shelters in this area, their collective safety level is relatively insufficient. As a consequence, these shelters are more susceptible to adverse impacts and damage caused by disasters. This assessment underscores the urgent need for improvements in the safety and resilience of shelters within Wuhua District to better protect inhabitants and assets from potential disasters. In contrast, the safety of shelters in Chenggong District is relatively high, primarily falling within the "Mid-High" and "High" grades. This indicates a superior level of safety and reliability among shelters in this region, offering better protection against potential disasters. The higher safety rating implies that shelters in Chenggong District are better equipped to withstand the impacts of disasters, reducing the risk of damage and ensuring the safety of occupants during such events.

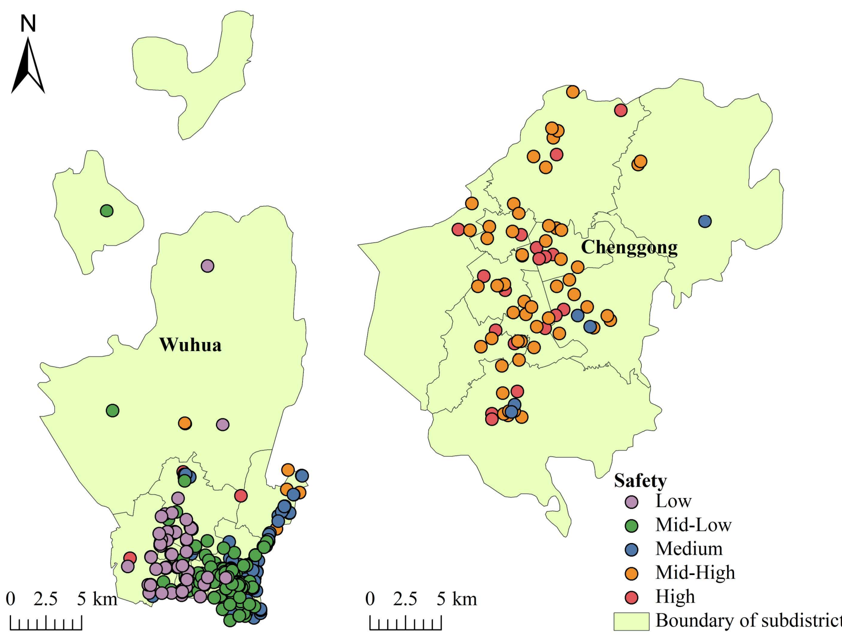

Figure 4. Spatial distribution of safety in Wuhua District and Chenggong District.

4.2.2. Robustness

The concept of robustness in shelters is crucial for ensuring their ability to maintain core functions and provide secure refuge during diverse disasters, crises, or emergencies. Robustness factors encompass the area of shelters, population density, and TNLI. Figure 5 illustrates the rank distribution of the robustness of shelters in Wuhua District and Chenggong District. In Wuhua District, the robustness of shelters predominantly falls within the "Medium" and "Mid-Low" grades. This indicates that while some shelters may possess moderate robustness, a significant portion falls into a lower robustness category. This distribution underscores the potential vulnerability of shelters within Wuhua District during disasters, suggesting limitations in their ability to adequately withstand and respond to various emergencies. In Chenggong District, the distribution of shelters across robustness classes is relatively uniform, but there is a notable prevalence of shelters classified as "Low". While there is a more uniform distribution compared to Wuhua District, the prevalence of shelters categorized as "Low" suggests a widespread challenge in achieving sufficient robustness levels across shelters in Chenggong District.

4.2.3. Accessibility

Shelter accessibility refers to the ease with which people can reach essential facilities in emergencies, encompassing factors such as distance to roads, hospitals, and water. Figure 6 shows the distribution of shelter accessibility across all levels in Wuhua District and Chenggong District. Overall, the accessibility of shelters in both regions is dispersed across various levels. Specifically, Wuhua District exhibits a relatively low number of "Low" type shelters, whereas Chenggong District has a limited number of "High" type shelters. The majority of shelters in both regions fall into the "Mid-Low", "Medium", and "Mid-High" grades, indicating a relatively small gap between the two regions in terms of shelter accessibility. Overall, the assessment suggests that while there may be slight variations in the distribution of shelter accessibility between Wuhua District and Chenggong District, both regions exhibit a generally adequate level of accessibility across their shelter infrastructure.

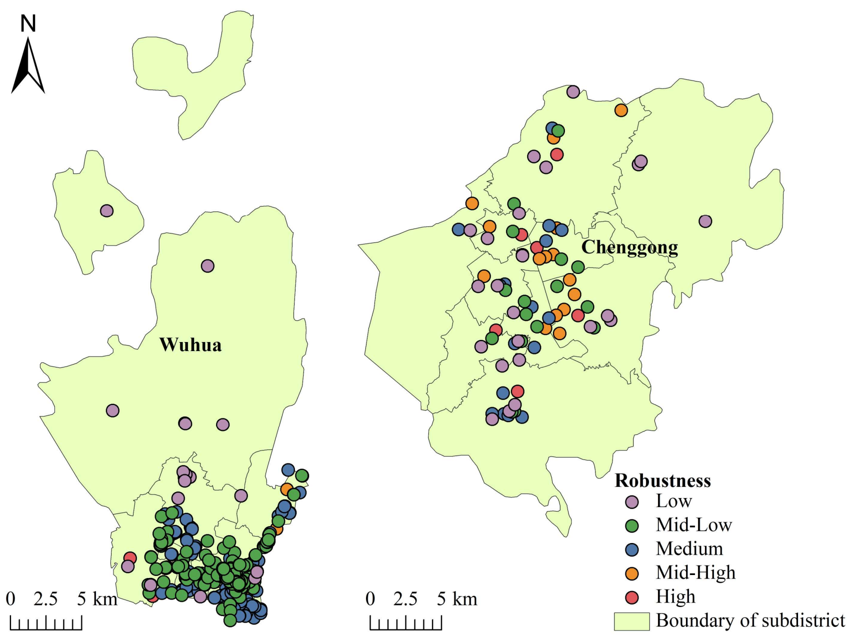

Figure 5. Spatial distribution of robustness in Wuhua District and Chenggong District.

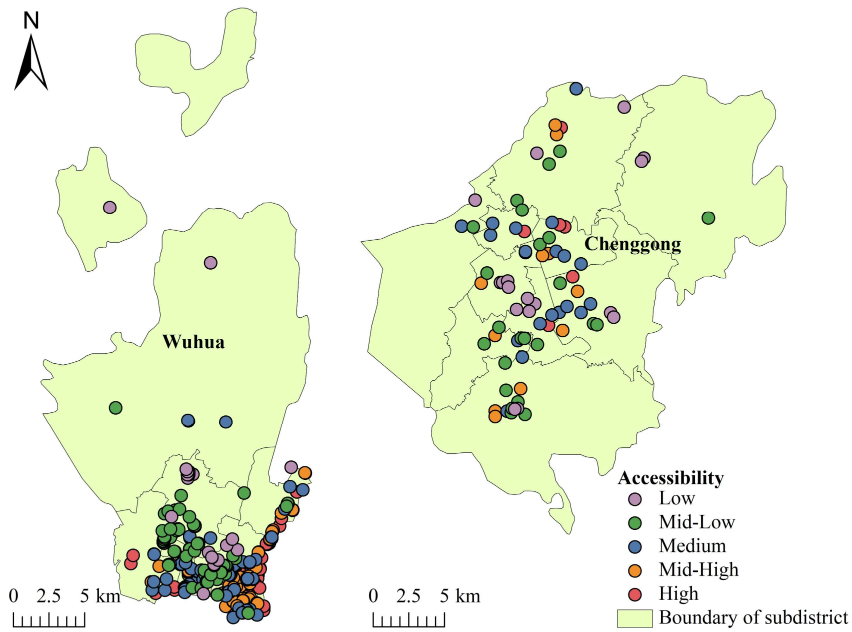

Figure 6. Spatial distribution of accessibility in Wuhua District and Chenggong District.

4.2.4. Resilience

In this study, after comprehensively considering the safety, robustness, and accessibility of shelters, the overall resilience level of shelters was further assessed. By integrating these dimensions, a comprehensive understanding of the shelters' ability to withstand and recover from various disruptions is obtained. The distribution of resilience levels among shelters, as depicted in Figure 7, closely mirrors the distribution of robustness levels. This alignment highlights the significant influence of robustness on overall resilience, indicating that shelters with higher robustness tend to demonstrate superior resilience, as they are better equipped to endure and rebound from adversities. The findings reveal that shelters in Wuhua District have relatively limited performance in terms of resilience level, which is mainly distributed in the range of "Medium" and "Mid-Low" grades. This observation underscores potential vulnerabilities within the district's shelter infrastructure, which may pose challenges in effectively mitigating and recovering from emergencies or disasters. Conversely, shelters in Chenggong District show a more balanced distribution in terms of resilience level, with a relatively large number of shelters in the "Medium" grade. This indicates a comparatively higher level of preparedness and adaptability within the shelter infrastructure of Chenggong District.

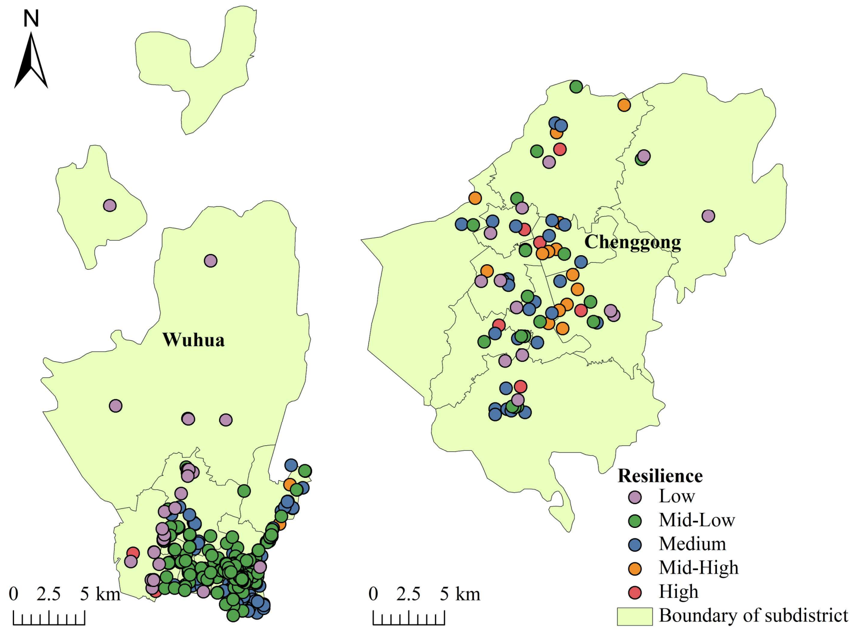

Figure 7. Spatial distribution of resilience in Wuhua District and Chenggong District.

5. Discussion

5.1. The Primary Contributions of This Study

This study conducts a comprehensive assessment and comparison of shelter resilience in the old urban area (Wuhua District) and the new urban area (Chenggong District) based on the SRA model. The findings reveal significant disparities between the two districts across resilience levels and the assessed dimensions of shelter performance. Wuhua District exhibits weaker performance, particularly in terms of safety and robustness, indicating a need for enhanced disaster risk management and urban planning to fortify sheltering infrastructure and minimize disaster-related damage. In contrast, Chenggong District, with its superior safety record, can serve as a valuable reference for other districts. The main contributions that are considered in this study are as follows:

- Comprehensive Resilience Assessment: This study provides a thorough evaluation of shelter resilience in Wuhua and Chenggong Districts, considering multiple dimensions such as safety, robustness, and accessibility. The multidimensional analysis offers a holistic perspective on the efficacy of evacuation sites in confronting natural disasters.
- Spatial Distribution Comparison: The study compares the spatial distribution of shelters in the old and new districts, highlighting differences in safety, robustness, accessibility, and overall resilience. These insights provide a foundation for tailored disaster risk management and urban planning strategies.
- Detailed Data and Visualization: The study presents detailed data and visualizations to elucidate and compare the resilience levels of shelters in Wuhua and Chenggong Districts. This information serves as a robust reference for urban disaster risk management and planning. Additionally, the study offers methodological insights and research ideas for similar endeavors in different contexts.

5.2. Possible Strategies for Enhancing Resilience

The resilience assessment of shelters in this study provides crucial insights into urban safety risk management for disaster prevention and relief. However, relevant authorities must enhance the resilience levels of shelters, optimize their spatial layout, and ensure a well-distributed network across the entire area, thereby bolstering protection and rescue capabilities. The following strategies are proposed to improve shelter resilience in both new and old urban areas.

For New Urban Areas (e.g., Chenggong District):

- Integrated Planning: Incorporate shelters as a fundamental component in the initial stages of urban planning. Strategically plan their locations, sizes, and numbers to ensure comprehensive coverage throughout the new urban area.
- Quality Construction: Emphasize high-quality construction practices by utilizing standardized materials. Ensure construction quality and safety by focusing on the configuration of essential facilities and equipment, such as fire-fighting systems, emergency lighting, and well-designed escape routes.

For Old Urban Areas (e.g., Wuhua District):

- Regular Maintenance and Repair: Implement a routine maintenance schedule to ensure the ongoing integrity and safety of existing shelters. Regular inspections and repairs are essential for upkeeping facilities and equipment.
- Tailored Resilience Improvement: Recognize the distinctive characteristics of buildings in old urban areas, including aging structures and those prone to collapse. Factor in these considerations during shelter design to enhance their resilience and adaptability to the unique challenges posed by old urban environments.

These strategies, tailored to the specific needs of new and old urban areas, aim to fortify the overall resilience of shelters, thereby contributing to more effective disaster preparedness and response capabilities within urban settings.

5.3. Limitations and Future Research Recommendations

While this study lays significant groundwork for mitigating urban vulnerability to disasters, it also exhibits certain limitations that warrant further refinement and enhancement. First, although this study is based on multi-source data, the selection of resilience assessment indicators could be more comprehensive and detailed. There may be other geographic and environmental factors that also affect the resilience of shelters, so consideration can be given to including more assessment indicators to improve the accuracy of the assessment. Secondly, future studies could cover a wider range of areas, assess the resilience of shelters in different geographical areas, and conduct comprehensive comparative analyses to obtain more comprehensive results and conclusions. In addition, the methodology of this study mainly relies on the analysis of existing data and lacks field investigation and validation of the real situation. Future research can combine field investigation and model simulation to more accurately assess the resilience level and effectiveness of sheltered places. Finally, this study puts forward policy recommendations on the planning of shelters in new and old urban areas, but the feasibility and effectiveness of the specific implementation need to be further studied and evaluated. Future research can delve into the implementation process, policy impacts, and applicability of the relevant policies and make corrections and optimizations in light of the actual situation. In summary, future research endeavors could focus on improving data sources, expanding the range of assessment indicators, broadening regional coverage, and refining methodological approaches. By doing so, studies can enhance the accuracy and feasibility of resilience assessments, providing more effective guidance for shelter planning and construction while contributing to the ongoing discourse on urban disaster preparedness.

6. Conclusions

The resilience assessment of shelters conducted in this study holds significant implications for safeguarding lives, maintaining social order, and fostering long-term sustainable societal development. This study constructs a multidimensional shelter resilience evaluation model based on SRA to explore the resilience of shelters. Leveraging multi-source data, the study explores three resilience assessment criteria with nine indicators, ensuring that shelters are well-equipped to effectively respond to disasters. The safety assessment considers slope, distance from faults, and buildings to fortify shelters against seismic events. Robustness assessment includes the area, population density, and TNLI to enhance shelters' ability to withstand various challenges. Accessibility assessment factors in distance from roads, hospitals, and water, ensuring swift and convenient evacuation site access. This study applied these resilience assessment criteria to shelters in Wuhua District and Chenggong District, as well as evaluating their resilience levels and disaster prevention capabilities. The findings reveal a notable difference between the districts, with Wuhua District having a larger number of shelters but a lower overall resilience level, primarily dominated by the "Mid-Low" grade at 57.94%. In contrast, Chenggong District exhibits a higher overall resilience level, primarily characterized by the "Medium" grade, accounting for 33.77%. In response to this observation, the study proposes policy recommendations for shelter planning in both new and old urban areas. Emphasizing the planning and construction of shelters in new urban areas and strengthening the maintenance and management of existing shelters in old cities are highlighted as key strategies.

Furthermore, this study provides references and specific strategies to enhance the resilience level of shelters in Wuhua District and Chenggong District. Overall, this study introduces new perspectives and methods for shelter resilience assessment, contributing to the improvement in disaster prevention and resilience efforts, ultimately safeguarding lives and ensuring social order stability.

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