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Exploring and Enhancing Community Disaster Resilience: Perspectives from Different Types of Communities

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Abstract: This study aimed to explore the differences in various aspects of community disaster resilience and how to enhance disaster resilience tailored to different community types. The evaluation results were validated using the flood event that occurred in Zhengzhou on 20 July 2021 (hereinafter referred to as the "7.20" rainstorm disaster). The main results of the analysis showed that the respondents' overall evaluation of their community's resilience to the "7.20" disaster was relatively high. Commercial housing communities performed the best, followed by urban village communities, and employee family housing communities performed the worst. Specifically, commercial housing communities scored highest in three dimensions: human capital, physical infrastructure, and adaptation. Urban village communities scored highest in the three dimensions of social capital, institutional capital, and community competence, while employee family housing communities consistently ranked the lowest in each dimension. The most significant disparities were found in human capital, followed by community competence and social capital, adaptation, and, lastly, institutional capital and physical infrastructure. Targeted improvement strategies and measures are suggested for each type of community, offering valuable recommendations for relevant government agencies aiming to enhance community disaster resilience and disaster risk reduction.

Keywords: flood disaster; community disaster resilience; climate emergency; disaster risk reduction

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1. Introduction

In the past few years, resilience has gained attention in the political sphere, the field of crisis management, and the news media, drawing the attention of scholars and policymakers from various disciplines and sectors. Resilience is an innovative way of thinking about disaster governance and is a rather modern concept in the context of disaster management [1,2]. Communities are increasingly recognizing the importance of identifying resources and formulating strategies for their utilization in the event of a disaster, thereby enhancing their readiness for emergencies. These proactive measures serve to mitigate the adverse impacts of disasters and bolster the resilience of the affected populations [3]. In particular, one of today's most significant global challenges is climate change, posing numerous ecological, environmental, social, and economic threats to human survival and development. Extreme weather and climate events are on the rise, exceeding the capacity of both natural and human systems to adapt and resulting in irreversible consequences [4].

Communities play a pivotal role in disaster resilience, whether it involves combating a pandemic like COVID-19 or addressing natural disasters such as floods and heavy rainfall due to sudden climate changes. Community resilience and the effectiveness of disaster recovery efforts have a direct impact on reducing disaster recovery time, making community-level responses indispensable in disaster loss reduction and disaster management. Concurrently, community resilience and its role in responding to disasters have gained significance as integral components of disaster prevention and mitigation efforts.

The concept of disaster resilience has evolved to introduce novel perspectives in disaster management, particularly in the context of comprehensive multi-hazard prevention. Rather than regarding society's obligation as merely adapting to the failures that precipitate local-level disasters, resilience is viewed as the capability to diminish the risk and repercussions of crises and disasters at the grassroots level. This entails more than just grasping the adaptive potential of social systems. Despite the involvement of higher tiers of government, emergency management frequently places greater responsibility for service delivery on local authorities [5]. When local, state, and federal governments are aligned in their understanding of their respective roles and responsibilities, the whole system functions more effectively. However, discrepancies in these perceptions can lead to confusion, conflict, or in severe cases, a complete breakdown in disaster response. Therefore, it is crucial for officials at each level of government to have a clear understanding of their specific responsibilities to manage disasters effectively. Nonetheless, achieving such alignment is challenging. Problems may arise when other involved parties hold unrealistic or inappropriate expectations regarding government actions in disaster scenarios [6].

Particularly for those societies whose regions rely on resources sensitive to climate change, the vulnerability of societies to risks related to climate change may exacerbate ongoing social and fiscal challenges. Therefore, understanding the local context of vulnerability is essential for effective adaptation. This is related to the need to strengthen communities' adaptive, absorptive, and resilient capacities, which has emerged as a key concept in modern urban planning, emergency response, and disaster management [7–9], and in particular community resilience [10–12]. The internal resilience of a community and its driving factors are spatially variable, which means that the community's performance in the face of disasters is also different due to various factors in its components [13]. Therefore, it is crucial to research and assess community disaster resilience in the context of climate emergencies, considering a range of community types.

Hence, this study addresses the following questions: Are there substantial variations in the resilience levels among diverse urban communities? How do distinct measurement dimensions accurately portray the resilience levels within these different community types? What are the most effective approaches to developing tailored strategies for each community type, thereby fostering the creation of resilient communities and enhancing their disaster resilience levels?

2. Theoretical Background

2.1. Community

It is vital to first define the term "community" before discussing community disaster resilience. Despite numerous attempts to define it in various ways, the literature lacks a universally accepted definition [14]. The academic literature has employed a variety of definitions of the community up to this point, but no single term has garnered widespread agreement [15].

The term community traces its roots to ancient Rome and holds multiple interpretations from diverse disciplinary perspectives [16]. Community is a term that can encompass a broad spectrum of meanings, most of which are relevant in the context of emergency management. A community is essentially a group sharing several common elements. While it is often defined by geographical location, it can also encompass shared experiences or functions. This broad definition implies that the concept of community can be applied to a diverse array of groups that may require interaction with emergency management systems [17]. Geographic locations can vary in scale, ranging from something as small as a neighborhood to something as extensive as a major metropolitan area. Similarly, shared experiences might be rooted in aspects such as ethnic identity, professional interests, or recreational hobbies [18].

It is crucial to acknowledge that the geographical context significantly influences the experience of social capital in the study of disasters and resilience. Geographically, locations often serve as settings for social interactions [19]. Communities can be established

through networks and relationships among individuals who share common identities or interests. Geographic communities are groups of people delineated by specific geographical boundaries and united by shared bonds [20].

Thus, in the realm of disaster management science research, a community is regarded as a distinct entity, separate from individuals and society, functioning as a collective unit. Typically, a community comprises built, natural, social, and economic elements that interact, possess well-defined boundaries, and share a common destiny [21]. Sharing common interests is an often-used definition of a community [22,23]. Social networks can influence the collective behavior of a community, impacting its resilience to disasters. Large-scale events like disasters affect every member of a community, often prompting them to come together in response to crises or tragedies [24]. Large-scale disaster response necessitates collaboration across multiple organizations, intergovernmental agencies, and various sectors. Both preparedness and recovery rely on social networks where authority is distributed, responsibilities are widespread, and resources are extensively shared.

The disaster-affected community encompasses anyone connected to those impacted by a disaster through various social networks. In times of crisis, community members share a common fate, or at the very least, a shared reality [19]. Some argue that communities should be defined on a case-by-case basis, allowing for multiple scales (from community to county) to serve as appropriate analytical units for resilience assessment [13,25,26].

In this study, a community is defined as a social group consisting of individuals who are closely related to one another, live in a shared residence, and are socially integrated. Communities are dynamic systems composed of individuals and groups that are interconnected.

2.2. Community Disaster Resilience

In the broader context of resilience, the field of community resilience continues to evolve. Despite the frequent use of the term "community resilience" in discussions related to sustainability and disaster risk reduction, a universally accepted definition for either term remains elusive. The precise definition of community disaster resilience remains a subject of ongoing debate among academics. When applied to social systems, resilience often places a greater emphasis on governance, environmental factors, and the organizational aspects of social communities linked to disaster mitigation and preparedness, as opposed to natural systems. In practice, society is increasingly focused on developing strategies to enhance and strive towards enhancing the overall resilience of communities in the face of various formidable disasters [27]. A new catastrophe-handling culture has emerged as a result of the term "resilience" being used in disaster discourse [28].

This study explores the concept of community resilience particularly in the context of disasters. It is often defined as a community's capacity to effectively manage natural catastrophes, endure their impact, and subsequently recover [29–34]. In considering the ability of a community system, or part of a system, to absorb and recover from disaster events, it is important to note that "resistance" is distinct from the concept of "resilience". Moreover, it is worth mentioning that resistance is not in opposition to resilience; rather, resilience encompasses resistance. So, focusing exclusively on either resilience or resistance can result in inadequacies. In essence, a community's resources should be sufficient not only to withstand disruptions but also to prevent interruptions that can weaken community functioning without the need for adaptation [35,36].

Sharifi and Yamagata's analysis [15] defines community resilience as the capacity of a community to adapt more successfully to unfavorable events and restore equilibrium. In addition to outcome-based metrics like speed of recovery and loss estimation, the definition also emphasizes the use of participatory approaches and process-based metrics. Norris et al. [21] highlight the challenges in defining CR, and that the idea of community resilience is challenged by the evolving definition of community as an organization with geographic borders and a shared purpose, consisting of constructed nature, and natural resources.

Consequently, research on community resilience has branched into two primary strands: one primarily focuses on community resilience as a means to shield residents from suffering physical or mental health issues in the aftermath of disasters. The other approach discusses good organizational behavior and catastrophe management, which is significantly more focused on community resilience. To put it another way, he says that building a resilient community is "the act of tying a collection of adaptive capacities to positive functional and adaptive trajectories" [21].

Building and achieving community resilience relies heavily on effectively controlling risks using various risk reduction strategies. However, the transformative effects of natural disasters on the physical, social, and psychological facets of our lives can make this task challenging. After a disaster, as well as during the recovery and reconstruction phases, communities are faced with a new reality that often differs significantly from their pre-disaster norms. As a result, people must adjust to the changed reality (either the disaster itself or the social response to it) [37]. According to Collins et al. [38], defining resilience follows Paton's opinion that it is a consequence rather than a process. Second, the situation determines the proper meaning of resilience. Learning from natural disasters is subtler. No single disaster typically prompts major change on its own. Instead, significant changes, such as the enactment of disaster management legislation like the Stafford Act, often occur after several major disasters have taken place [39].

The ability of a community to deal with calamities while lessening its susceptibility to them, and utilizing its location and people, is referred to as community resilience. Communities that are disaster-resistant are more robust and able to deal with disasters, making them less exposed to them [40]. The capacity of a community or its elements to recover from the negative impacts of a tragedy is known as community resilience. Communities are able to adapt and respond to emergencies in a catastrophe or risk setting through the use of this adaptable, changeable, and recoverable capacity, all while maintaining crucial systems and preserving the distinctiveness of the community [41]. According to Buckle [42], who examined the idea of community resilience, a community is defined as "a big social group." The operations, readiness, and resilience of hotels might face enormous obstacles from impending and perhaps catastrophic disasters. Communities and organizations are intertwined [43]. As a result, "passive and active aspects" that integrate adversity rehabilitation (pre-element) and environmental alteration to mitigate future disasters (post-element) are necessary for community resilience [44]. This includes the capacity for adversity recovery before a disaster strikes and the ability to modify the environment to reduce the impact of future disasters.

Therefore, the concept of community resilience is not only about the ability to recover quickly from the direct consequences of a disaster but also about learning from, responding to, and adapting to disasters. Resilience draws attention to the community's ability to adapt and aligns emergency management's conceptualization with the adaptation discourse, paving the way for advancement in the practice of disaster and emergency management.

3. Materials and Methods

3.1. Study Area

Henan Province is located in central China and is one of the most populous provinces in China. The topography of the province is high in the east and low in the west, consisting mainly of the Yellow River Basin and the mountains in the south [45]. Zhengzhou City, located in the center of Henan Province, is the capital and largest city of the province (Figure 1). Due to its geographical location, it is subject to monsoons and rainfall all year round and often suffers from heavy rainfall and flooding [46]. In July 2021, Henan Province in China endured an exceptionally powerful rainstorm that lasted from 17 July to 23 July, triggering severe flooding [47]. As documented in the "Investigation Report of the '7.20' Extraordinary Rainstorm Disaster in Zhengzhou, Henan Province", this rainstorm was a natural disaster responsible for extensive property damage, casualties, and widespread flooding in both urban areas and rivers. Additionally, it led to various other calamities,

including building collapses, landslides, and subway accidents, as reported by the Disaster Investigation Team of the State Council in 2022. Verified sources have indicated that this disaster affected a total of 14,786,000 individuals, resulting in direct economic losses of RMB 120.6 billion as of 30 September. Tragically, 398 individuals lost their lives or went missing as a consequence of this tragic event [48].

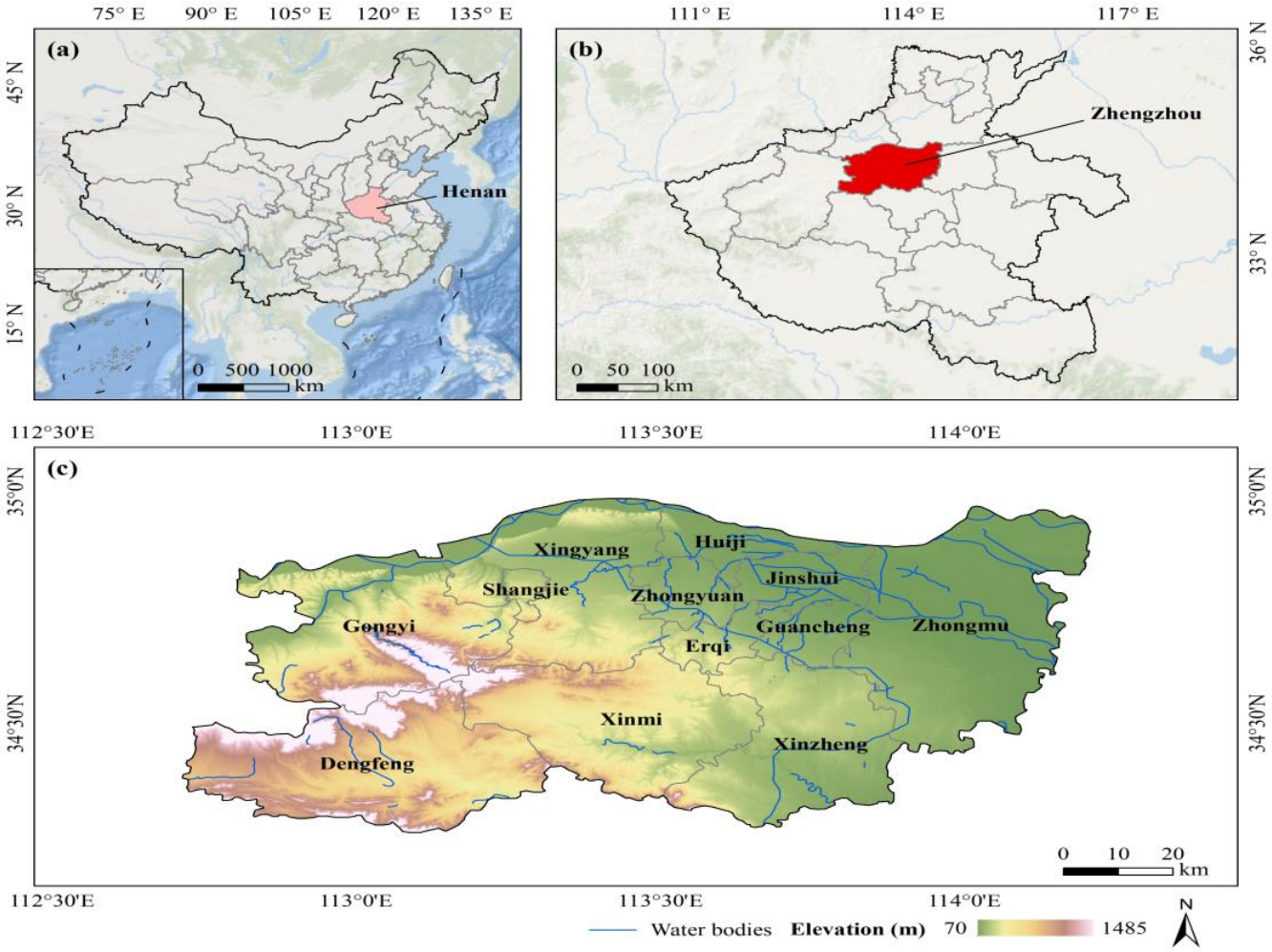

Figure 1. (**a**) Location of Henan Province in China; (**b**) Location of Zhengzhou City in Henan Province; (**c**) Administrative districts of Zhengzhou City.

3.2. Data Source

This study used a questionnaire survey to collect data. The comprehensive resilience index values of different types of communities were compared to reveal the differences in community resilience levels and to compare the differences in the resilience of various types of communities in different dimensions such as human capital, social capital, physical infrastructure, institutional capital, community competence, and adaptation, and to explore the reasons for them. The questionnaire questions were designed in three parts. The first part was demographic characteristics-related questions, which mainly included basic information about respondents, including gender, age, occupation, income level, home ownership, type of community of residence, etc. The second part was a section on personal perceptions, knowledge, and experiences of disasters. The third part was mainly for scoring the six dimensions of community disaster resilience and the total evaluation index, with questions set for each dimension. The questionnaire was designed using the Likert five-point scale (1–5 scale). Questionnaires were randomly distributed to community residents in Zhengzhou City, especially those who had experienced the flooding event. The questionnaire survey in this study was commissioned by a questionnaire company in

China (Wenjuan Xing) for distribution through an online route. It was distributed from 21 April to 1 May 2023, and 396 questionnaires were collected. After excluding 18 invalid responses, the final number of valid questionnaires was 378. In this study, Cronbach's alpha was used to test the internal consistency. Based on the results, the reliability coefficient of human capital was 0.746, the overall reliability coefficient of social capital was 0.832, the overall reliability coefficient of physical infrastructure was 0.857. The overall reliability coefficient of institutional capital was 0.884, 0.837 for community competence, and 0.849 for adaptation. The reliability coefficients ranged from 0 to 1, and the closer to 1, the higher the reliability.

Based on the analysis results presented in Table 1, within the sample of 264 commercial housing community residents, gender distribution was nearly equal, with men and women constituting 41.3% and 58.7% of the sample, respectively. The age structure primarily consisted of young and middle-aged individuals. Specifically, 45.8% fell within the age range of 31 to 40, and 34.5% were aged between 21 and 30. The majority of the interviewed families, 188 individuals, held university degrees, accounting for 71.2% of the sample. In terms of occupations, the predominant occupation among commercial community residents was employment in companies, making up 62.1% of the sample. Regarding income, the most common monthly earnings fell within the range of RMB 5000 (USD 694) to RMB 8000 RMB (USD 1111), with 91 individuals (34.5%) falling into this category. The next most common income bracket was RMB 8000 (USD 1111) to RMB 12,000 (USD 1667), which accounted for 27.3% of the sample and included 72 individuals.

The distribution of monthly household income showed the following patterns within the surveyed households: the majority of households (47.3%) reported monthly incomes ranging from RMB 10,000 (USD 1389) to RMB 20,000 (USD 2778). The next most common income bracket was RMB 20,000 (USD 2778) to RMB 30,000 (USD 4167), accounting for 25.8% of households. Households with monthly incomes below RMB 10,000 (USD 1389) constituted 16.7% of the total. Households with monthly incomes exceeding RMB 30,000 were the least common, making up only 1.9% of all households. A total of 46 individuals earned less than RMB 5000 (USD 694), representing 17.4% of the households.

Regarding homeownership: the majority of residents (88.3%) owned their houses independently. A smaller percentage (8%) resided in rented houses. Some residents (2.7%) lived in staff dormitories. A few individuals (1.1%) had temporary accommodation with relatives or friends. Concerning the length of residence, more than 60% of residents had lived in their current homes for more than 5 years. Approximately 34.8% of residents had lived in their residence for 1 to 5 years.

Table 1. Characteristics of commercial housing community residents (N = 264).

Characteristics		Frequency	Percentage	Characteristics		Frequency	Percentage
Gender	Male	109	41.3	Monthly income (RMB)	<5000	46	17.4
	Female	155	58.7		5000–8000	91	34.5
Age	20	8	3.0		8000–12,000	72	27.3
	21–30	91	34.5		>12,000	55	20.8
	31–40	121	45.8	Monthly family income (RMB)	<10,000	44	16.7
	41–50	16	6.1		10,000–20,000	125	47.3
	51–60	18	6.8		20,000–30,000	68	25.8
	60	10	3.8		>30,000	27	10.2

Table 1. *Cont.*

Characteristics		Frequency	Percentage	Characteristics		Frequency	Percentage
Education	Less than high school	6	2.3	Home ownership	Own house	233	88.3
	High school	16	6.1		Rented house	21	8.0
	College	32	12.1		Temporary stay with relatives or friends	3	1.1
	Four-year university degree	188	71.2		Staff dormitory	7	2.7
	Graduate school	22	8.3	Length of residence	<1 year	6	2.3
Occupation	Student	24	9.1		1–5 years	92	34.8
	Government or public institution staff	35	13.3		5–10 years	83	31.4
	Company employee	164	62.1		>10 years	83	31.4
	Company owner or self-employed	27	10.2				
	Freelancer	11	4.2				
	Other	3	1.1				

Note: 1000 Chinese yuan (1 USD = 7.198 RMB).

According to the analysis results shown in Table 2, within the sample of 53 employee family housing community residents, gender distribution showed a relatively even split, with men comprising 54.7% and women representing 45.3% of the sample. The age structure primarily centered on the 21–30 age group, accounting for more than 50% of the respondents. The majority of individuals held bachelor's degrees as their highest education level, with 33 individuals accounting for 62.3% in this category. In terms of occupation, employee family housing community residents were predominantly employed by companies, making up 39.6% of the sample.

Regarding personal monthly income, the most common range was between RMB 5000 (USD 694) and RMB 8000 (USD 1111), accounting for 41.5% of respondents. The next most prevalent income bracket was below RMB 5000 (USD 694), constituting 24.5% of respondents. Conversely, individuals with incomes exceeding RMB 12,000 (USD 1667) were the least common, making up 11.3% of the sample.

Family monthly income was primarily in the range of RMB 10,000 (USD 1389) to RMB 20,000 (USD 2778), with 56.6% of families falling into this category. Families with incomes below RMB 10,000 (USD 1389) constituted 24.5% of the total, followed by families with monthly incomes exceeding RMB 30,000 (USD 4167) at 13.2%.

In terms of homeownership, the majority of residents (75.5%) owned their houses independently. A smaller percentage (15.1%) resided in rented houses. Some residents (9.4%) lived in employee dormitories. No individuals reported temporary accommodations with relatives or friends, which aligns with the characteristics of the employee family housing community.

Concerning the length of residence, 37.7% of the residents had lived in their current homes for 1–5 years; 30.2% had a residence duration ranging from 5 to 10 years and 24.5% had resided in their homes for more than 10 years.

Table 2. Characteristics of employee family housing community residents (N = 53).

Characteristics		Frequency	Percentage	Characteristics		Frequency	Percentage
Gender	Male	29	54.7	Monthly income (RMB)	<5000	13	24.5
	Female	24	45.3		5000–8000	22	41.5
Age	≤20	3	5.7		8000–12,000	12	22.6
	21–30	27	50.9		>12,000	6	11.3
	31–40	14	26.4	Monthly family income (RMB)	<10,000	13	24.5
	41–50	3	5.7		10,000–20,000	30	56.6
	51–60	2	3.8		20,000–30,000	3	5.7
	≥61	4	7.5		>30,000	7	13.2
Education	Less than high school	0	0.0	Home ownership	Own house	40	75.5
	High school	4	7.5		Rented house	8	15.1
	College	9	17.0		Temporary stay with relatives or friends	0	0.0
	Four-year university degree	33	62.3		Staff dormitory	5	9.4
	Graduate school	7	13.2	Length of residence	<1 year	4	7.5
Occupation	Student	13	24.5		1–5 years	20	37.7
	Government or public institution staff	13	24.5		5–10 years	16	30.2
	Company employee	21	39.6		>10 years	13	24.5
	Company owner or self-employed	3	5.7				
	Freelancer	2	3.8				
	Other	1	1.9				

Note: 1000 Chinese yuan (1 USD = 7.198 RMB).

According to the analysis results (Table 3), from a survey of 61 urban village community residents, gender distribution showed that females were the majority, accounting for 60.7%, while males made up 39.3% of the sample. The age distribution was primarily concentrated in the 21–30 and 31–40 age groups, together accounting for more than 60% of respondents. In terms of education, the majority of residents had achieved university and bachelor's degrees, representing a total of 75.4%. Regarding occupation, a significant portion of urban village community residents were employed by companies, making up 49.2% of the sample.

Monthly individual income was most commonly found in the range of RMB 5000 (USD 694) to RMB 8000 (USD 1111), constituting 44.3% of respondents. The next most prevalent income bracket was below RMB 5000 (USD 694), accounting for 31.1%. Conversely, individuals with incomes exceeding RMB 12,000 (USD 1667) were the least common, making up 4.9% of the sample.

For monthly household income, the majority of households fell within the range of less than RMB 10,000 (USD 1389), accounting for 45.9%. The next most common income bracket was RMB 10,000 (USD 1389) to RMB 20,000 (USD 2778), constituting 37.7% of the total. A smaller proportion (11.5%) reported monthly incomes higher than RMB 30,000 (USD 4167).

Regarding homeownership, most residents (67.2%) owned their houses independently. A smaller percentage (21.3%) resided in rental housing.

Concerning the length of residence, 36.1% of the residents had lived in their current homes for 1–5 years; 34.4% had a residence duration exceeding 10 years, and 21.3% had resided in their homes for 5–10 years.

Table 3. Characteristics of urban village community residents (*N* = 61).

Characteristics		Frequency	Percentage	Characteristics		Frequency	Percentage
Gender	Male	24	39.3	Monthly income (RMB)	<5000	19	31.1
	Female	37	60.7		5000–8000	27	44.3
Age	≤20	5	8.2		8000–12,000	12	19.7
	21–30	25	41.0		>12000	3	4.9
	31–40	17	27.9	Monthly family income (RMB)	<10,000	28	45.9
	41–50	4	6.6		10,000–20,000	23	37.7
	51–60	7	11.5		20,000–30,000	3	4.9
	≥61	3	4.9		>30,000	7	11.5
Education	Less than high school	8	13.1	Home ownership	Own house	41	67.2
	High school	6	9.8		Rented house	13	21.3
	College	18	29.5		Temporary stay with relatives or friends	1	1.6
	Four-year university degree	28	45.9		Staff dormitory	6	9.8
	Graduate school	1	1.6	Length of residence	<1 year	5	8.2
Occupation	Student	13	21.3		1–5 years	22	36.1
	Government or public institution staff	1	1.6		5–10 years	13	21.3
	Company employee	30	49.2		>10 years	21	34.4
	Company owner or self-employed	11	18.0				
	Freelancer	3	4.9				
	Other	3	4.9				

Note: 1000 Chinese yuan (1 USD = 7.198 RMB).

3.3. Variables and Measurements

The establishment of the comprehensive evaluation indicators in this study was based on a synthesis of related literature. It aggregated all the indicators from the included literature, considered the actual situation and characteristics of the urban community, screened for duplicate or similar indicators, and validated, improved, and refined the measurement tools. The six variables, namely human capital, social capital, physical infrastructure, institutional capital, community competence, and adaptation, complement each other and constitute the resilience of communities to natural disasters. A system was developed to measure and assess the resilience of communities.

The six variables of community disaster resilience were refined and then divided into the specific measurement areas. The precise measuring techniques were based on the body of research, and data accessibility and measurability were also taken into account.

In the study, human capital described people's educational background [11,21,22,49–51], income level [21,25,51], disaster risk perception [33], physical health [21], and psychological well-being [52]. The social capital dimension mainly included social network relationships [10,53], trust in the community [53,54], community recognition [19,21], and community cohesion [19,33]. The physical infrastructure dimension mainly included disaster communication service [22], disaster transportation support [49,55], shelter availability [51], health and medical system [51,56], and living environment of the community [57,58]. The institutional capital dimension mainly included disaster responsibility organization structures [41], mitigation and evacuation plans [8,22,59], disaster preparedness [33,41], disaster response and recovery [22,33,60], and institutional collaboration and coordination [22,61,62]. The community competence dimensions mainly included leadership [63,64], disaster education, training, and drills [34,37], information and communication [21,65], and collective efficacy [27,52]. This study measured and assessed adaptation through four secondary variables: innovative disaster management strategies [21,66], learning [33,52,67], critical reflection [21,68], flexibility, and creativity [21,69].

3.4. Data Analysis

In the data analysis part, the study used SPSS 26 and Excel 2019 to organize and calculate the collected data. We obtained the basic data through questionnaires, standardizing the data accordingly, and conducting descriptive analyses of the samples of the three types of communities. Then, firstly, the scores of the dimensions of each community were summed up and averaged to arrive at the composite assessed value of each community; that is, the composite disaster resilience level of each type of urban community. Secondly, the different measurement dimensions were calculated at the level of the three types of communities, to explore the differences between different types of communities in various dimensions. Finally, a comprehensive comparison and analysis were performed to discern the variations in resilience levels among the three types of communities.

4. Results

4.1. Differences in Dimensions of Three Types of Communities

As shown in Figure 2, the community disaster resilience scores ranged from 3 to 4, with a mean value of about 3.72, which was slightly higher than 3.5 but did not reach 4, indicating a relatively high overall assessment of community resilience to the "7.20" rainstorm disaster by the respondents, and the overall community disaster resilience performance was good, although there was still some room for improvement. Specifically, the highest score was for commercial housing communities at 3.7609, followed by urban village communities at 3.7269, and employee family housing communities scored the lowest at 3.6959.

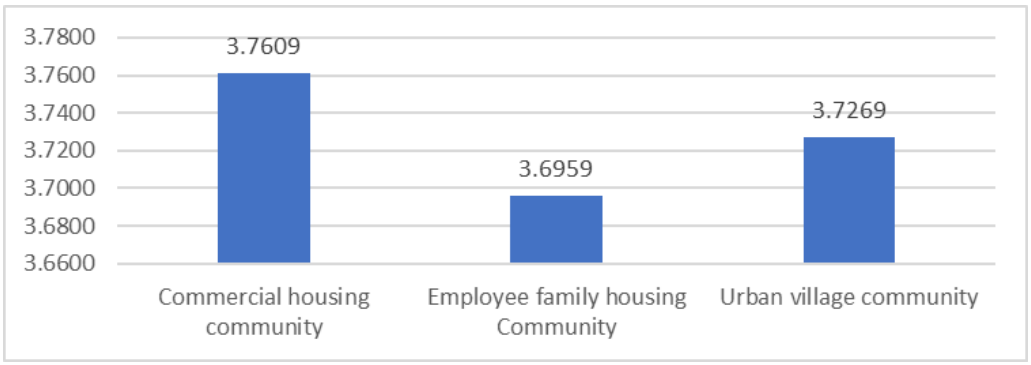

Figure 2. Overall evaluation of disaster resilience in different types of communities.

The statistical analysis of the questionnaire data revealed differences in human capital across various community types (as shown in Figure 3). Commercial housing communities scored the highest with 3.7282, closely followed by employee family housing communities at 3.6698, and urban village communities ranked last with a score of 3.4754.

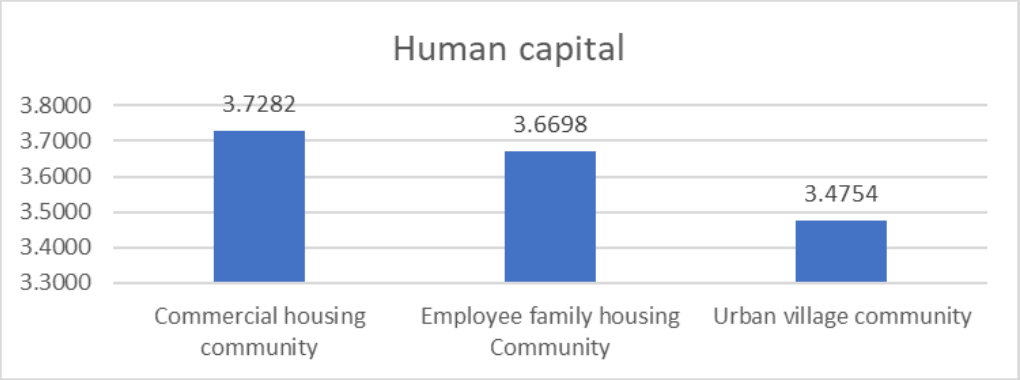

Figure 3. Differences in the human capital dimension of three types of communities.

From the perspective of the social capital of different types of communities (Figure 4), urban village communities had the highest score of 3.9180, followed by commercial housing communities at 3.8864, and finally employee family housing communities at 3.7972. Urban village communities were primarily inhabited by former village residents who shared deep connections among themselves and with their communities. Residents often provided mutual assistance and trusted one another, leading to a strong sense of community identification and cohesion. Social networks within urban village communities were robust, fostering closer relationships among family, friends, and neighbors compared to those found in commercial housing communities and employee family housing communities. To enhance the disaster resilience of communities, it is essential to build social capital within these communities [70].

Figure 4. Differences in the social capital dimension of three types of communities.

From the perspective of the physical infrastructure of different types of communities (Figure 5), the commercial housing communities had the highest score of 3.5758, followed by the urban village communities with 3.5525, and finally the employee family communities with 3.5453. The physical infrastructure in commercial housing communities was more advanced and comprehensive compared to the other two types of communities.

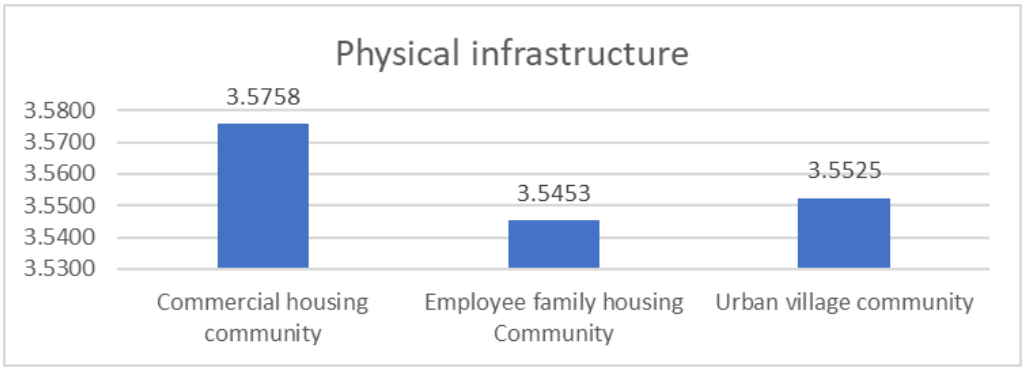

Figure 5. Differences in the physical infrastructure dimension of three types of communities.

Regarding the institutional capital of different community types (as indicated in Figure 6), urban village communities led with the highest score of 3.7721, followed by commercial housing communities at 3.7648, and family home communities at 3.734. The unique and closely-knit nature of urban village communities contributed to their more professional management. Residents in these communities were generally more informed about disaster management policies and response strategies.

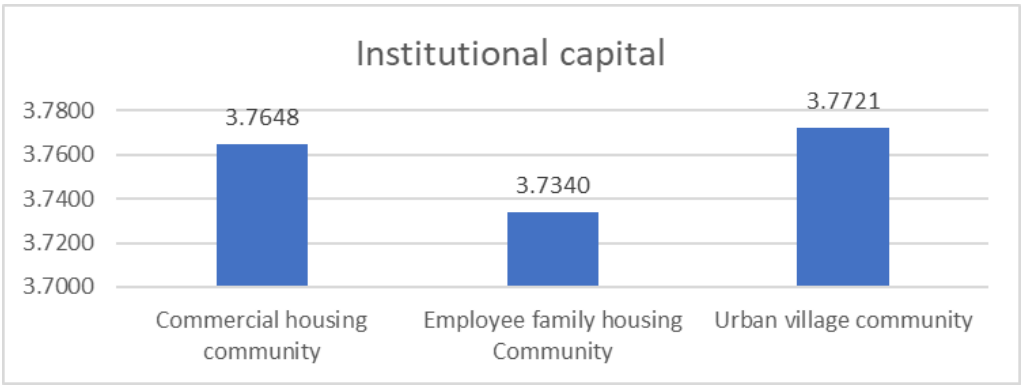

Figure 6. Differences in the institutional capital dimension of three types of communities.

From the perspective of community competence in different types of communities (Figure 7), again, associated with institutional capital, urban village communities had the highest score at 3.8463, followed by commercial housing communities at 3.7969 and finally employee family housing communities at 3.6887. Compared with commercial housing communities and employee family housing community, urban village communities had higher institutional capital scores and correspondingly higher community competence.

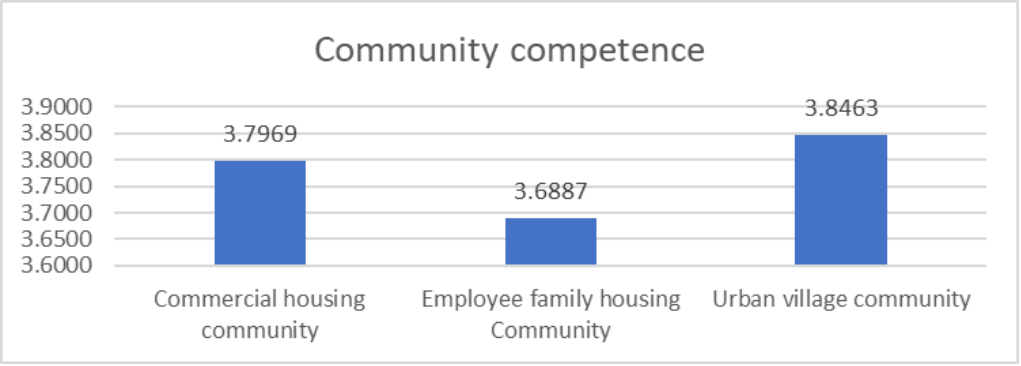

Figure 7. Differences in the community competence dimension of three types of communities.

In terms of the adaptation of different types of communities (Figure 8), commercial housing communities had the highest score of 3.8134, followed by urban village communities with 3.7971, and finally, employee family housing communities with 3.7406. Overall, commercial housing communities had a higher level of adaptation and were more diverse, flexible, and creative than the other two types of communities. Unlike the other two types of communities, which were based on geographical location or workplace attributes, residents in commercial housing communities came from a wider range of sources but were more vibrant and energetic.

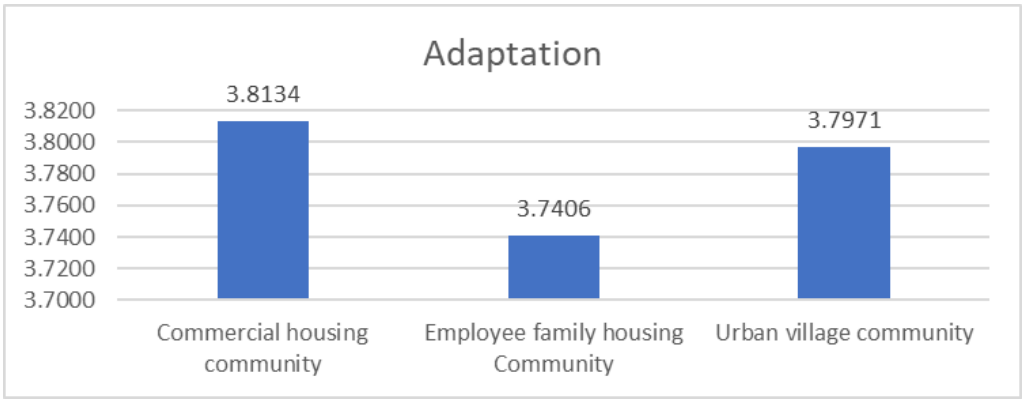

Figure 8. Differences in the adaptation dimension of three types of communities.

4.2. Differences in Disaster Resilience of Different Communities

In a comprehensive view (Figure 9), the resilience index of each dimension was concentrated between 3.5 and 4.0, indicating that overall community resilience was at a moderate level. Comparing the resilience values of each dimension, we can see that social capital > adaptation > community competence > institutional capital > human capital > physical infrastructure. With social capital scoring the highest, however, there were serious weaknesses in physical infrastructure.

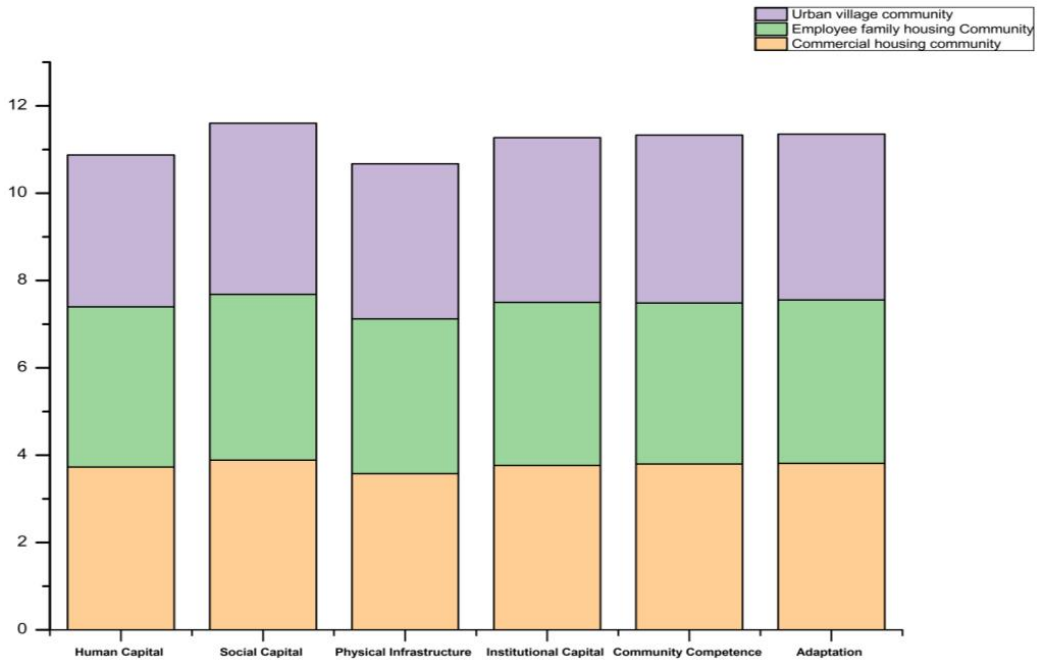

Figure 9. Comparisons among six dimensions across three types of communities.

Meanwhile, by aggregating the scores of each dimension of the three different types of communities into a radar chart (Figure 10), it can be seen that the three types of communities had the greatest differences in human capital, followed by community competence, social capital, adaptation, and finally institutional capital and physical infrastructure. The differences in each dimension stemmed from the distinct characteristics of each community type, including resident composition, community physical environment, and management approaches. Consequently, these variations contributed to slight differences in resilience when facing disasters.

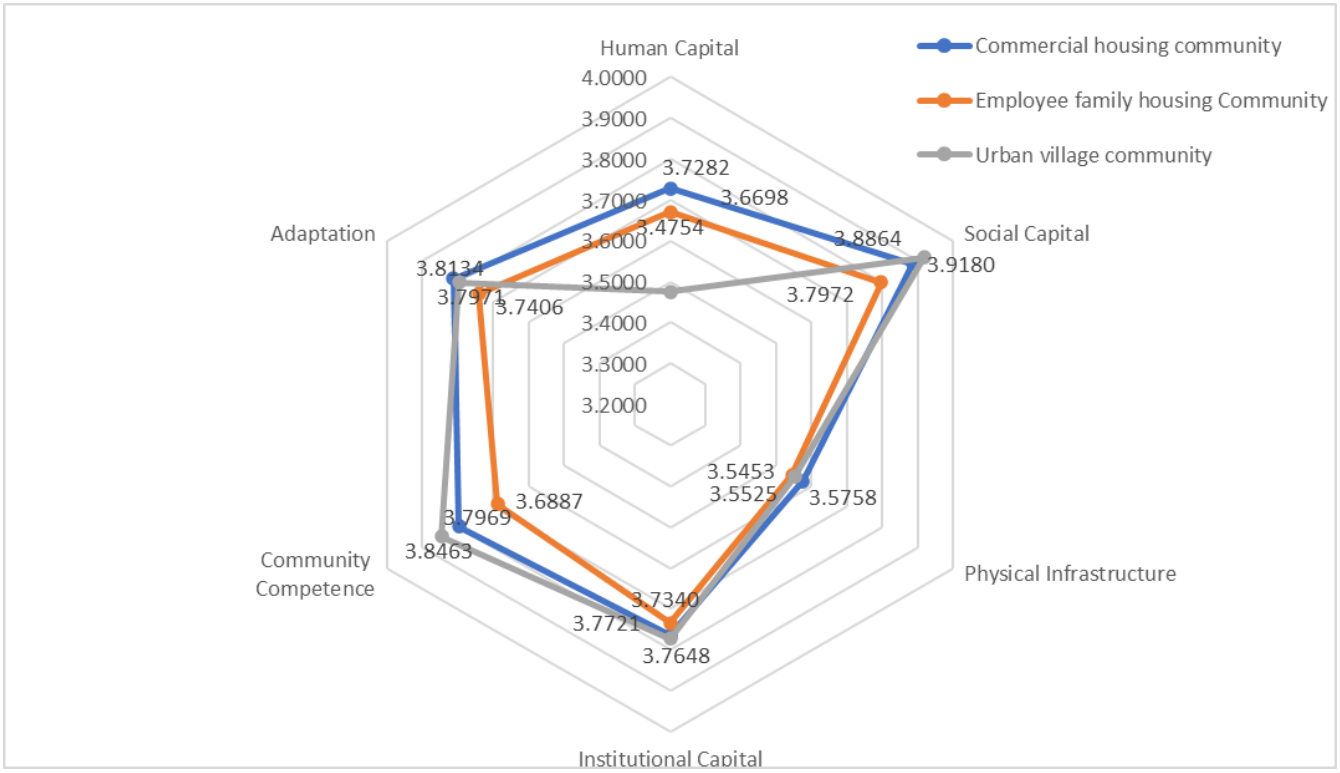

Figure 10. Radar chart of community resilience in six dimensions.

The results showed that commercial housing communities had the highest scores in the three dimensions of human capital, physical infrastructure capital, and adaptation; urban village communities had the highest scores in the three dimensions of social capital, institutional capital, and community competence; and employee family housing communities had the lowest scores in each dimension. The differences between the three types of communities in each dimension could also be seen, with the three types of communities having the highest differences in human capital, followed by community competence and social capital, adaptation, and finally institutional capital and physical infrastructure. There were some differences among the three types of communities in each dimension because there were large differences among the various types of communities in terms of the composition of the residents, the physical environment of the community, and the management style, so there were slight differences in resilience in the face of disaster occurrence.

5. Discussion

Disaster management and urban planning have turned their urgent attention to improving community resilience in the context of the climate emergency, including self-organization, self-adaptation, and self-recovery before the offer of outside support. Communities can aid planners in better understanding the community's decision-making process before a disaster, as well as in identifying possibilities and sources of support for resilience [71]. Communities become stronger, safer, and more secure as their resilience grows.

Based on the problems exposed by the different communities in the disaster response process obtained from the previous analysis, we integrated the community human capital, social capital, physical infrastructure, institutional capital, community competence, and adaptation, which were included in the resilience scores. As Cutter's findings show, the use of a common set of variables to measure different aspects of community resilience shows that the Midwest and Northeast regions of the United States have higher levels of community resilience than the rest of the United States to provide policymakers with guidance on where different communities are scoring higher [13]. Because community circumstances vary widely and communities are unique in terms of history, geography, demographics, culture, and infrastructure, the risks faced by each community are different, and bottom-up interventions (where the community participates in building up its resilience) are critical [72]. Resilience building follows a dynamic structure that varies greatly by the level of development of different types of communities, as there is no single source of resilience, or even a one-size-fits-all capital dimension, which means that policies and interventions have to be tailor-made [73]. We propose strategies for optimizing the resilience of urban communities and adapting to sudden-onset disasters from these six perspectives. Once a sudden disaster occurs, it is usually led at the national level, and the regional, city, and community sectors must work together to cope with the disaster, and the community, as the first line of defense, is very important to improve disaster resilience. Due to limited resources, future efforts to improve disaster resilience should focus on the most important disaster resilience practices that should be integrated into community/urban development plans [74]. Communities are also the groups most likely to benefit from disaster resilience [75]. From the research results, it is clear that all types of communities were able to carry out disaster response and post-disaster recovery work in an orderly manner under the leadership of government departments, but the problems faced by different types of communities differed in the process. Therefore, while grasping the comprehensive strategy of community disaster response and resilience enhancement, it is also necessary to tailor and precisely apply the strategy to different types of communities and propose a targeted and adaptive path for them.

As the main type of urban community, commercial housing communities had relatively well-developed community living infrastructure and supporting facilities, with the majority of young and middle-aged people and relatively high education level. The three dimensions of human capital, physical infrastructure capital, and adaptation of commercial housing communities had the highest scores; however, there was room for improvement in their social capital, institutional capital, and community competence, as they tended to have a lower sense of community identity and cohesion. Recognizing the significant role of social capital in improving community resilience, the focus should be on two key factors: reliability and participation. It is equally important to encourage active participation from residents within the community. Having defined policy objectives, political determination, and technical skills (including leadership and administrative ability) are essential components for implementing effective mitigation measures. Disaster resilience can be increased by including psychological factors such as social-individual traits, judgments based on personal experience, and community traditions [76]. Identification with the community is positively associated with a shared destiny, collective efficacy, and well-being [77]. Therefore, residents of commercial housing communities should cultivate a sense of community and establish relationships at different levels with individuals, communities, and institutions, believing that individual actions can mitigate risk and even collectively develop risk management needs and strategies under uncertainty (community engagement and collective efficacy). Furthermore, when residents feel that their needs are being met, they are more likely to trust community institutions and the information they provide and to use this information to make preparedness decisions [78,79]. When organizing information campaigns to enhance trust in the institution, it is important to consider the possibility that a lack of confidence in the institution may affect risk communication [80].

Urban village communities had the highest scores in the three dimensions of social capital, institutional capital, and community competence because of the special nature of their composition; however, there was room for improvement in their human capital, physical infrastructure, and adaptation. Urban village communities face challenges such as complex demographics, high population and residential densities, low-quality infrastructure, uneven building quality, cluttered living environments, and neighborhood amenities that vary widely by geographic location, raising concerns. To enhance disaster resilience, it is important to focus on factors at three levels: individual, community, and environmental. Firstly, on an individual level, enhancing personal health, strong family relationships, and financial stability are keys to resilience against disasters. Secondly, for communities, fostering economic growth, building social capital, and promoting cultural inclusion are crucial for disaster resilience. Lastly, at the environmental level, focusing on the recovery of infrastructure, effective government, and the restoration of natural environments plays a significant role in strengthening disaster resilience [81]. Therefore, upgrading the physical infrastructure of urban village communities and ensuring good infrastructure and living environments are crucial to the normal functioning of the community, especially in times of unrest. A comprehensive public service system of material conditions and social services is conducive to the allocation of resources for communities to cope with emergencies and makes a positive contribution to the resilience of the community [82]. At the same time, other characteristics such as age, household income, and education that represent human capital may lead to different outcomes in the face of disasters and crises [83]. Age, sex, and race, culture, economics, and other variables may have an impact on these [76]. For example, affluent individuals usually have more choices in the face of disasters compared to less well-off individuals. This also highlights the fact that the household income of the urban village community was the lowest among the three communities. Given this human capital situation in the urban village community, government-planned and led reconstruction projects will promote the renewal of this community, playing a decisive role in reshaping and enhancing its resilience [82].

Employee family housing communities mainly consisted of institutional or enterprise employees, who were less equipped to handle unexpected disasters and performed the worst of the three types of communities. Residents of the employee family housing community were all employees of their own units and had a high degree of occupational convergence, so they carried out their social relations in a relatively closed social space and formed a strong employee-family atmosphere, but seldom cared about or participated in the public affairs of the community [84]. The motto of community-based disaster risk management (CBDRM) is community participation, which motivates local people to participate and work together to understand and prepare for disaster risks [85]. At the same time, precisely because of the unique characteristics of employee family housing, which is linked to work, there was a high degree of dependence on the organization. As a "society of acquaintances", this strong bond can translate into higher levels of trust and broader shared norms when facing disasters [86,87]. It is therefore possible to start with the governing body of the employee family housing community, especially strengthening the institutions' prevention and early warning systems. Developing comprehensive emergency plans is crucial to guiding community management in emergency prevention, control, and response [88]. It would also be useful to utilize the characteristics and advantages of employees in the work units to establish a community network emergency platform for employee family housing. The process of planning for community emergencies and disaster relief will increase the input of human and material resources from the workplaces, government, properties, social organizations, and volunteers. In addition, raising the risk awareness of employee residents and their family members in the community through the work units will foster a sense of belonging to the community and enrich their knowledge of disaster resilience, which will further enhance the community's ability to cope with disasters.

This study compared the differences in resilience of different types of communities, but it did not spatially compare the differences in community resilience among different cities

in different countries. Therefore, it is important to think more about the risk characteristics faced by cities in future research, and it is not enough to analyze only heavy rainfall, flooding disasters, or individual cities. As urbanization and climate change intensify, the effects of disasters will be more obvious, and cross-border and cross-domain cooperation based on multi-hazard analysis and disaster research will be an important research direction in the future. Meanwhile, to conduct more systematic and scientific research on community disaster resilience, it is recommended to explore comparative analyses among different countries and cities in the future.

6. Conclusions

This research was conducted to examine the significance of differences in resilience among various types of communities during the Zhengzhou "7.20" rainstorm and to identify ways to enhance disaster resilience for each community type. The major findings, based on the analysis of collected questionnaire responses, are summarized as follows:

(1) The overall evaluation of disaster resilience in different types of communities ranged from 3 to 4, with a mean value of about 3.72. This result showed that the respondents' overall evaluation of their community's resilience to the "7.20" rainstorm disaster was relatively high.
(2) In general, the highest score was for commercial housing communities at 3.7609, followed by urban village communities at 3.7269, and employee family home communities scored the lowest at 3.6959. In terms of community resilience to respond to sudden rainstorm disasters, commercial housing communities performed the best, followed by urban village communities. Employee family housing communities performed the worst.
(3) Specifically, commercial housing communities scored highest in the three dimensions of human capital, physical infrastructure capital, and adaptation. Urban village communities scored highest in the three dimensions of social capital, institutional capital, and community competence, and employee family housing communities scored the lowest in each dimension.
(4) There were some differences among the three types of communities in each dimension. The three types of communities differed the most in human capital, followed by community competence and social capital, adaptation, and finally institutional capital and physical infrastructure.

These insights offer valuable guidance for local authorities on tailoring flood disaster prevention and enhancing community disaster resilience to fit the specific needs of different community types and dimensions.

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