INDICATOR-BASED ASSESSMENT OF POST-DISASTER RECOVERY CAPACITY OF THE MIGRANT HOUSEHOLDS: A CASE STUDY OF TYPHOON YAGI IN 2024

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Abstract: *Enhancing post-disaster recovery capacity is crucial for reducing disaster risk as climate-driven disasters intensify. This study examines the capacity of post-disaster recovery of migrant households in a ward in Hanoi, Viet Nam, after historical Typhoon Yagi in 2024. The study adopted a framework with 34 indicators across four dimensions, including housing recovery, economic stability, public service accessibility, and social cohesion. Data were collected via observation, in-depth interviews with 17 local authorities and residents, and semi-structured interviews with 57 migrants. The data were normalized on a 0-1 scale, where 0 and 1 represent the lowest and highest capacity, respectively. Results showed that public service accessibility scored relatively high (0.8) due to efficient and reliable public services supporting migrants. In contrast, social cohesion scored low (0.3) due to limited social support and community engagement. Housing recovery and economic stability scored 0.4, indicating persistent challenges in home repair and financial resources after the disaster. Overall, the capability of post-disaster recovery of migrant families was moderate at 0.5. In-depth interviews underscored these households' vulnerability, reflecting economic instability and poor housing conditions. These findings provide a scientific basis for developing disaster recovery plans and formulating strategies and policies that address the needs of migrant communities in disaster risk reduction and climate change mitigation.*

Keywords: *Indicator-based assessment, migrant household, post-disaster recovery, typhoon Yagi.*

1. Introduction

Migration is widespread in low and middle-income countries, especially those experiencing rapid economic growth and structural transformation [1]. In Viet Nam, the shift from an agricultural to an industrial economy drives labor migration from rural to urban areas, influenced by household factors such as income and education [2], [3]. These migrant households are particularly vulnerable due to socioeconomic instability and limited access to formal support systems, making them susceptible to climate change impacts [4].

Recent research has started to explore the resilience of internal migrant groups throughout the disaster timeline [5-7], but the focus has been mainly on rural households' post-disaster, neglecting urban migrants [8-11]. Despite significant risks from climate-related hazards like flooding and heat stress, urban economic migrants from low-income rural areas remain underrepresented in disaster and climate resilience studies. Addressing this gap is crucial for developing inclusive disaster risk reduction strategies and equitable climate adaptation policies in rapidly developing urban areas.

Viet Nam's intensive market-oriented reforms

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have increased labor migration from rural to urbanized provinces, driven by employment opportunities and economic activities [12]. The country is highly vulnerable to climate change, experiencing frequent natural disasters such as floods and storms [13]. Super Typhoon Yagi in 2024, the most powerful typhoon to hit the East Sea in 30 years [14], caused extensive damage in Viet Nam, with losses exceeding VND 36,388 billion (USD 1,491 million) and recovery costs estimated at VND 53,964 billion (USD 2,212 million) [15]. The typhoon severely impacted several provinces in Viet Nam's Red River Delta, including Hanoi, which experienced its highest river levels in two decades. The Vietnamese Government responded with Resolution No. 143/NQ-CP to address the aftermath, focusing on stabilizing the population, recovering production and business, fostering economic growth, and controlling inflation [16]. While various vulnerable groups received attention in the aftermath, internal migrants residing in Hanoi remain largely overlooked. One such affected area is a ward in Hanoi, outside the Red River dike. Historically, the ward has attracted many internal migrants seeking employment and shelter. However, its location makes it highly susceptible to disaster risks, including flooding and tropical storms. The ward was severely impacted by Typhoon Yagi, highlighting the urgent need for inclusive disaster risk management and targeted support for marginalized urban populations.

This study aims to fill this gap by investigating the post-disaster recovery capacity of internal migrant households in urban Viet Nam, using the case of Typhoon Yagi in 2024. The case of Typhoon Yagi provides a relevant context to examine how migrant households cope with, respond to, and recover from disasters in an urban setting. The results may provide insights and recommendations for enhancing the post-disaster recovery capacity of vulnerable people.

2. Framework

While pre-disaster preparedness is critical, effective post-disaster recovery is equally essential and, if implemented strategically, can serve as a development opportunity [17]. Recovery planning aims to restore disrupted systems and reduce future risk through an integrated disaster risk reduction approach [17]. However, existing literature identifies numerous barriers to successful recovery, classified into five major categories: Financial and economic constraints, social vulnerability, housing and infrastructure reconstruction challenges, environmental concerns, and coordination and resource limitations [18].

The Sendai Framework for Disaster Risk Reduction 2015-2030 emphasizes enhancing preparedness and promoting "Building Back Better" in the recovery, rehabilitation, and reconstruction phases [19]. This approach involves four key pillars: (1) Risk reduction through resilient infrastructure, improved structural design, and land-use planning; (2) Community recovery by addressing psychosocial well-being and restoring economic activities; (3) Implementation via efficient and coordinated recovery actions; (4) Monitoring and evaluation to track progress and improve future interventions [20].

World Bank [21] has developed a sector-specific assessment framework for post-disaster recovery ability, outlining recovery criteria across key sectors such as employment, finance, and others. The International Organization for Migration (IOM) has operationalized the Sendai Framework by supporting risk-informed recovery programs [22]. This framework includes hazard-resistant shelter construction, community infrastructure development, access to essential services, and debris removal linked to cash-for-work programs, planned relocation assistance, and sustainable livelihood restoration [22]. Horney et al. [23] proposed a set of 79 indicators to measure disaster recovery outcomes, which help characterize recovery progress, identify systemic weaknesses, and inform proactive planning. A previous study by Horney et al. [24] developed a comprehensive set of indicators to assess post-disaster community recovery, adopting a United States case study.

This study integrates conceptual and practical frameworks related to disaster recovery. This

study employs a set of indicators derived from the Recovery and Reconstruction Needs Assessment Framework [25], encompassing key sectors such as housing, essential services, cultural spaces, and public infrastructure, including clean water and sanitation, community facilities, transportation, and communication. In addition, the study incorporates the World Bank's sector-specific assessment framework for the capability of post-disaster recovery [21]. Accordingly, four dimensions of housing recovery (HR), economic stability (ES), access to public services (AS), and social cohesion (SC) were used to assess the post-disaster recovery capacity. Recovery capacity is the ability of a community, organization or society to restore and improve livelihoods, health, and economic, physical, social, cultural, and environmental assets following a disaster [26]. Housing recovery refers to restoring and rebuilding homes and residential areas and repairing or reconstructing damaged structures after a disaster. Economic stability means having reliable income sources, job security, and access to financial resources. Social cohesion refers to the strength of relationships and solidarity among community members.

3. Materials and methods

3.1. Indicator-based assessment of post-disaster recovery capacity

This study proposed 34 indicators belonging to four dimensions (HR, ES, AS, and SC) to quantify the disaster recovery capacity after Typhoon Yagi (Table 1). This indicator set was proposed based on the reported indicators [21], [24], [25], data availability, and the suitability of the practical situation of the study region.

Table 1. Indicators for assessment of post-disaster recovery capacity

Dimension	Indicator	Code	Description
Housing recovery (HR)	Historical flood damage	HR1	Frequency of being impacted and quantity of damage types by floods over the past 5 years
	Historical typhoon damage	HR2	Frequency of being impacted, quantity of damage types, and level of damage by typhoons over the past 5 years
	Current damage	HR3	Quantity of damage types and level of damage due to Typhoon Yagi
	Frequency of reconstruction	HR4	Frequency of repairing houses due to the impacts of disasters over the past 5 years and Typhoon Yagi
	Training	HR5	Participation in the training on knowledge and skills to prevent and recover after floods and typhoons
	Awareness	HR6	Awareness of how to improve disaster management skills and actions to enhance the coping capacity after Typhoon Yagi
	Fundamental needs	HR7	Quantities of essential tools to cope with typhoons and floods
	House status	HR8	Status of the houses of the informants
	Evidence	HR9	Level of evidence of the floods on the houses
Economic stability (ES)	Duration of employment	ES1	Duration to make the household’s business or employment as usual after Typhoon Yagi
	Disruption of employment	ES2	Disruption of the household’s business or employment due to Typhoon Yagi
	Employment bankrupt	ES3	Quantities of businesses or employment bankrupt due to Typhoon Yagi

Dimension	Indicator	Code	Description
	Restoring ability	ES4	Ability to restore the household's business after Typhoon Yagi
	Governmental support	ES5	Financial support from the governmental authorities to restore the household business after Typhoon Yagi
	Non-governmental support	ES6	Financial support from the non-governmental authorities to recover the household business after Typhoon Yagi
	Gift-in-kind	ES7	Quantities of gift-in-kind received after Typhoon Yagi
	Sustainable earning sources	ES8	Ability to access a sustainable earning source in adverse disasters
	Financial accessibility	ES9	Ability to access a financial resource to recover the business when being impacted by disasters
	External financial accessibility	ES10	Ability to access financial resources of the Government and non-government agencies
Public service accessibility (AS)	Public transportation efficiency	AS1	Efficiency of the public transportation infrastructure during natural disasters
	Fresh-water accessibility	AS2	Ability to access fresh water from various sources and toilets within the community during natural disasters
	Medical accessibility	AS3	Ability to access clinics and medical institutions for medical treatment during natural disasters
	Food and necessities accessibility	AS4	Ability to access the sources of food and necessities during natural disasters
	Public space accessibility	AS5	Ability to access public spaces (e.g., cultural spaces, spiritual or religious spaces, schools) during natural disasters
	Post-disaster public transportation efficiency	AS6	Efficiency of the public transportation infrastructure after natural disasters
	Post-disaster fresh-water accessibility	AS7	Ability to access fresh water from various sources and toilets within the community after natural disasters
	Post-disaster medical accessibility	AS8	Ability to access clinics and medical institutions for medical treatment after natural disasters
	Post-disaster food and necessities accessibility	AS9	Ability to access the sources of food and necessities after natural disasters
	Post-disaster public space accessibility	AS10	Ability to access the public spaces (e.g., the cultural spaces, spiritual or religious spaces, schools) after natural disasters
Social cohesion (SC)	Information frequency	SC1	Frequency of updated information during the typhoons
	Information channel types	SC2	Quantity of channels to obtain information about typhoons and floods
	Alerts and notifications	SC3	Frequency of obtaining alerts or notifications about Typhoon Yagi
	Disaster and post-disaster supports	SC4	Quantity of support received during and after the natural disasters
	Social participation	SC5	Participation in a social organization

3.2. Social survey

Social surveys conducted in the study area include pre-surveys, in-depth interviews, and semi-structured interviews. Pre-surveys are crucial for assessing relocated households' current status Typhoon Yagi's impacts and establishing the indicator set. This observation was carried out on December 6-8, 2024. In-depth and semi-structured were performed in February 2025 for important information related to the impacts of Typhoon Yagi the households' disaster recovery status, and capacity. In-depth interviews were conducted with 02 local authorities and 15 local people. These in-depth interviews offered valuable qualitative insights, facilitating a more comprehensive understanding of the local narratives from both residents and authorities. These qualitative data sources serve as a means of triangulation to validate and enrich the findings obtained from the survey data. In addition, 57/256 households were randomly semi-structured interviewed, ensuring a confidence level of 90% and a margin of error of 10% [27]. These households were selected based on the high level impact, the experienced, their direct experience with Typhoon Yagi evacuation, and challenges they faced during recovery. The descriptions of semi-structured interviews are as follows: The male and female percentages were 33% and 67%, respectively. The percentage of interviewed migrants aged 15-64 and 65 years old and above was 77% and 23%, respectively. The educational backgrounds of the informants indicate a majority of primary and secondary education, including 53% of primary school education and 30% of secondary school education.

3.3. Data analysis

The data of 34 indicators in Table 1 have various units and values requiring normalization on a scale of 0-1. These data were analyzed by the Min-Max method (scale 0-1) [28], as defined in Equation (1):

$$x_{ij} = \frac{X_{ij} - MinX_{ij}}{MaxX_{ij} - MinX_{ij}} \quad (1)$$

Where x_{ij} denotes the standardized score of indicator represents the normalized value of indicator *i* of for the household *j*; X_{ij} refers to the value of the indicator i for the household *j*; $MaxX_{ji}$ and $MinX_{ij}$ indicate the maximum and minimum values of indicator *i* for the household *j*, respectively.

The capacity of post-disaster recovery values was calculated by the mean values of indicators. The scale for assessing the recovery capability (scale of 0-1) is classified following the categorical scales [28]: Very low recovery capacity (0.0-0.2), low recovery capacity (0.2-0.4), moderate recovery capacity (0.4-0.6), relatively high recovery capacity (0.6-0.8), and high recovery capacity (0.8-1.0).

SPSS 20.0 was used for statistical data analysis using a T-test, One-way ANOVA, and correlation.

The in-depth interviews were transcribed and manually coded using a thematic approach to identify key narrative themes local authorities and residents expressed. These qualitative findings provided additional evidence that complemented the results from the quantitative data.

4. Results and discussion

4.1. Housing recovery (HR)

Housing recovery is central to disaster recovery strategies and action plans. The housing recovery results of indicator HR1-HR9 were investigated from the current impact of Typhoon Yagi in 2024 compared to the disasters over the past five years, including the extent of damage and subsequent repair or reconstruction efforts.

The semi-structured interview results on historical flood damage (HR1) showed that 98% of households experienced floods in the past 5 years. Typhoon Yagi caused substantial damage to migrant housing, with most households reporting damage to housing and belongings. 85% of households reported that they were affected by typhoons approximately 5-6 times over the past 5 years (HR2). Survey data from households in the study area indicate that approximately 60% of migrant

families experienced property damage due to natural disasters such as floods and others, and about 30% reported damage to property, furniture, and housing (Figure 1). This indicates that households frequently suffer damage to housing, assets, and furniture annually.

Regarding the damage by Typhoon Yagi (HR3), 72% of surveyed households experienced damage to belongings, and 26% reported damage to both housing and belongings due to Yagi (Figure 2). These figures are consistent with the damage caused by natural disasters over the past five years. In terms of the damage to housing, furniture, and other assets caused by Typhoon Yagi, 64% of households reported that Yagi caused moderate damage to their housing, furniture, and assets, 32% reported minor damage, and 2% of migrant households confirmed severe damage to their housing and furniture (Figure 3). Since Typhoon Yagi was one of the strongest storms, the damage to housing, furniture, and assets was more severe than the damage caused by floods over the past five years. For example, 65% of households reported minor damage due to floods in the past five years compared to 32% due to Typhoon Yagi, and 28% reported moderate damage in the past five years compared to 64% caused by Yagi (Figure 4). This demonstrates that the greater the intensity of natural disasters, the more significant the damage to housing, furniture, and assets.

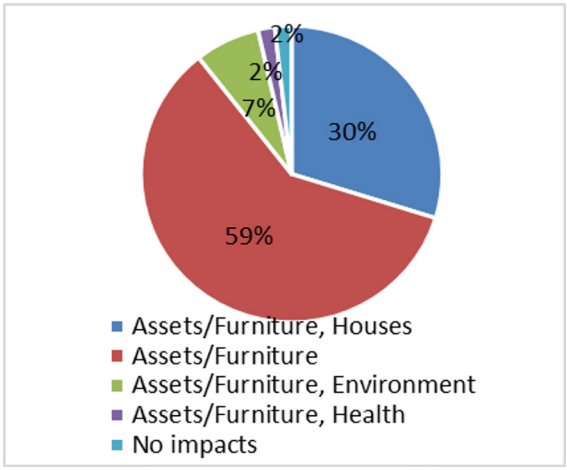

Figure 1. Impacts of floods over the past five years (% interviewed households)

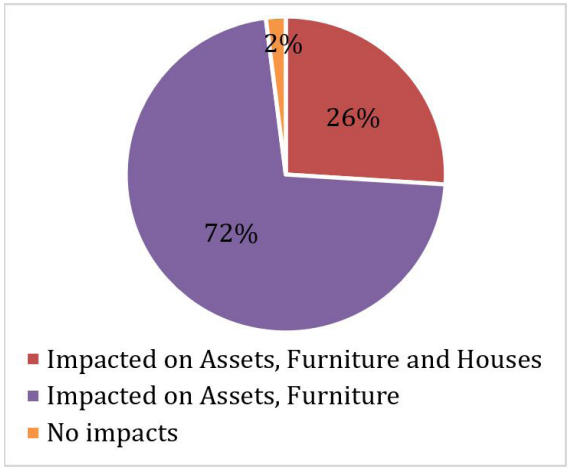

Figure 2. Impacts of Typhoon Yagi (% interviewed households)

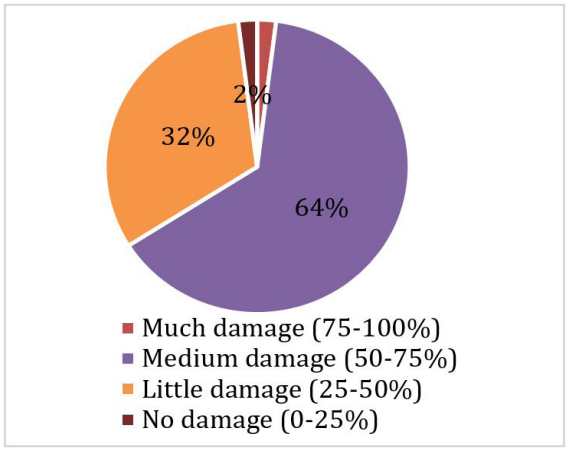

Figure 3. The extent of impacts by Typhoon Yagi (% interviewed households)

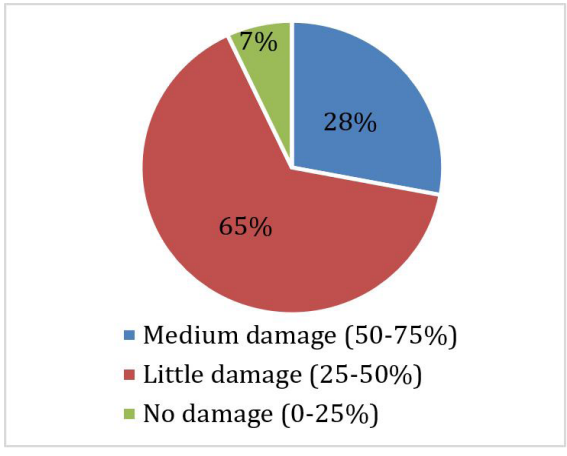

Figure 4. The extent of impacts by typhoons over the past five years (% interviewed households)

The survey results of frequency of reconstruction (HR4) revealed that 93% of relocated households did not reinforce or repair their houses after Typhoon Yagi or other natural disasters in the past five years. Only 7% of migrant families reported repairing their houses 1-2 times within this period, and even for the damage caused by Yagi, they only carried out moderate repairs. In contrast, the rest did not repair at all. Most of the households' homes in this area were submerged in floodwaters, with some completely underwater and others submerged up to about one meter deep. Their furniture was also affected, except for those who managed to relocate their belongings. Furthermore, 87% of the households participating in this study live in temporary houses. Despite the damage, households did not repair their homes or furniture, primarily because their homes were rented and due to economic constraints. Consequently, they chose to live in damaged rooms and use flood-affected furniture. In-depth interviews revealed that while households did not lose their belongings during storms and floods, their household appliances became unusable. However, they were reluctant to replace or repair these appliances due to financial constraints.

The result of participation among migrant households in training courses (HR5) showed that 86% of households had no idea about training programs related to knowledge and skills for pre- and post-disaster prevention and recovery, highlighting the critical need for improved communication and outreach regarding disaster preparedness training programs.

The awareness and actions of migrant households to improve their disaster management capacity (HR6) reveal a significant gap in disaster management knowledge and actions among households. 89% of respondents reported not knowing how to enhance their disaster management capacity, indicating a critical need for education and training. Following Typhoon Yagi, most households (93%) did not take any action to improve their disaster coping capacity. This lack of action could be attributed to the aforementioned knowledge gap and other potential barriers, such as economic constraints or a lack of resources.

Additionally, indicator HR7 assesses the availability of essential items needed to cope with floods and typhoons among migrant families. 91% of the interviewed households possess at least one essential item crucial for their daily needs and disaster preparedness. However, only 7% of households reported having more than three essential items, indicating a limited capacity to stockpile necessary resources.

The results on housing conditions of migrant households (HR8) showed that 88% of the households interviewed live in temporary houses, 84% of the houses do not exhibit symptoms of flood damage, and only 16% have minor symptoms (HR9). This lack of visible damage is not necessarily indicative of effective recovery but rather reflects the already poor state of these houses. Observations showed that these were dilapidated, damp, and shabby boarding houses. Although Typhoon Yagi caused damage, the old and poor quality of the houses obscured the flood traces. The residents did not make changes due to economic difficulties, renting conditions, and being accustomed to living under dilapidated roofs. Despite worsening conditions, they continued to survive in these homes.

Housing recovery analysis highlights the significant impact of Typhoon Yagi on migrants, revealing a pattern of frequent and substantial damage to housing and belongings over the past five years. Despite the severity of the damage, economic constraints and rental conditions have hindered effective recovery and repair efforts. The lack of awareness and participation in disaster preparedness training further exacerbates the vulnerability of these households.

4.2. Economic stability (ES)

The economic recovery of the migrant community in this study is evaluated based on the impact on employment, business, economic damage, recovery from the disaster, and access to financial support to mitigate economic damage.

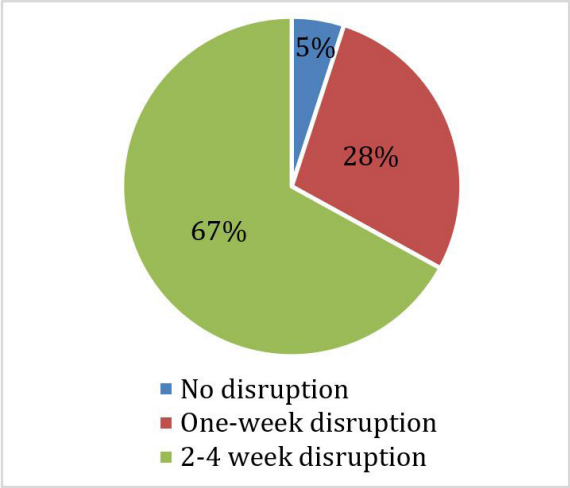

Figure 5. Disruption of employment and business due to Typhoon Yagi (% interviewed households)

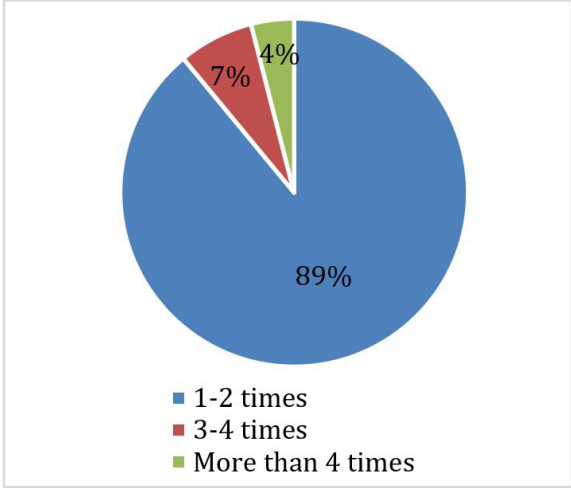

Figure 6. Frequency of getting updates about Typhoon Yagi (% interviewed households)

The study reveals that 100% of the surveyed migrant families had to temporarily halt their manual labor or business activities during and immediately after the storm due to flooding. The duration of this work suspension varied as follows: 67% of households reported suspending work for 2 to 4 weeks, 28% for 1 week, and only 5% did not suspend work at all (ES1) (Figure 5). This reflects the nature of relocated households' work, primarily hired workers and manual laborers around the nearby market. Their work was also temporarily suspended when storms and floods disrupted the market's operations. Consequently, their economic losses were self-assessed based on the number of lost working days, with 67% losing between half a month to a month's wages due to the suspension. The survey indicated that their daily earnings ranged from 50,000 VND to 300,000 VND, depending on the job and household. Notably, those earning the most from manual labor often worked from around 7:00 p.m. to 8:00 a.m. the next day, totalling about 12 hours at a nearby market. The lowest earners were elderly individuals aged 65 and over, who could no longer work, lacked family support, and relied on income from collecting and selling rubbish.

Interviews also showed that 100% of households could return to their previous livelihoods immediately after the storm, with almost no costs required to resume work (ES2 and ES3). This is due to the nature of their labor, which does not require capital but rather simple tools like carts or motorbikes, which remained safe during the storm. However, some elderly individuals who ran small businesses, such as selling tea, reported minor economic losses due to damaged equipment. The results show that all households recovered their businesses after the typhoon, further demonstrating their ability to bounce back quickly from disaster impacts (ES4).

In the case of Typhoon Yagi, migrant households reported not receiving financial support or capital to restore their businesses or jobs from government agencies or external organizations (ES5 and ES6). They also did not find opportunities to access other income sources during or after the storm. However, they did receive in-kind support, such as rice and instant noodles, during and after the flood to sustain themselves when their homes were flooded, and they had to evacuate to locations arranged by local authorities (ES7). The survey also showed that 95% of households could not access sustainable earning sources during severe weather or disasters (ES8). This lack of access to stable income sources during crises further exacerbates their economic vulnerability. Furthermore, the research indicates that migrant families did not have access to financial resources during the disaster (ES9 and ES10). This accessibility shortage

exacerbates economic challenges, hindering long-term recovery and resilience.

The study highlights the significant economic vulnerability of migrant households in the face of natural disasters like Typhoon Yagi. The temporary suspension of work and the lack of financial support underscore the precarious nature of their livelihoods. Despite their resilience in returning to work quickly, the community's dependence on manual labor and the absence of alternative income sources or financial aid reveal critical areas for improvement in disaster preparedness and support systems.

4.3. Access to public services (AS)

This study concerns the access of migrants directly affected by the floods caused by Typhoon Yagi in 2024 to public facilities and services. These include transportation means, toilets, clean water sources for daily use, medical examination and treatment facilities for emergency support, essential food supplies, and cultural spaces for religious and belief practices during and immediately after storms and floods.

The study results indicated that people greatly valued transportation efficiency during and after the storm (AS1). The efficiency of the public transportation infrastructure during natural disasters (AS1) was confirmed by 56 out of 57 interviewees who assessed its high functionality during and after disasters to move safely, access essential services, and reach safe locations.

They had full access to public facilities, clean water for daily use, medical services, food supplies, and even spaces for religious practices (AS2-AS4). When a flood warning was issued, the authorities in the study area promptly evacuated at-risk households, including the relocated households covered in this study. They provided adequate food, essential supplies, and temporary accommodation to avoid the flood, ensuring people could access transportation and public facilities fully. In addition, after Typhoon Yagi, 100% of migrant families in the study ward could access all essential services such as clean water, necessary healthcare, food, and public toilets (AS6-AS10). Despite post-severe disasters, the ability to access these essential services reflects the effectiveness of local infrastructure and community support systems in the study area. This accessibility to essential services is vital for maintaining health and well-being, reflecting the effectiveness of local infrastructure and community support systems.

4.4. Social cohesion (SC)

Social cohesion plays a crucial role in the capability of post-disaster recovery. Strong social networks and community bonds can significantly enhance the ability of households to recover from disasters. When communities are cohesive, they can better mobilize resources, provide mutual support, and share information essential for effective disaster response and recovery.

The semi-structured interview demonstrated that 95% of migrant households were updated once or twice daily on the news of floods and typhoons, while 5% received updates more than four times daily (SC1) (Figure 6). Regarding information channels (SC2), about 79% of migrant households received information via one or two channels. This highlighted the undiversified notification approach, reducing their ability to respond effectively to disasters. In particular, 89% of households were updated once or twice daily on the continuing news of Typhoon Yagi (SC3). Regarding post-disaster support (SC4), about 89% of households received gift-in-kind support, which likely included essential items such as food, water, and other necessities. Notably, indicator SC5 reveals that none of the households participate in social organizations in their temporary residences in the study ward. This lack of social organization involvement may impact their ability to mobilize collective resources and support during disasters. The semi-structured result is consistent with the in-depth interview. Among the in-depth interview participants aged 65 and above, many have lost connections with their hometowns, been rejected by relatives, or have a history of imprisonment, leading to isolation.

They avoid joining civil society organizations due to feelings of inferiority stemming from poverty and limited education. While they may feel comfortable in isolation, this separation means they often lack support during natural disasters, relying solely on aid from authorities or charitable organizations. This reflects the reality of migrant families in the study area.

4.5. Integrated assessment of post-disaster recovery capacity

Housing Recovery (HR): The normalized value of 0.4 for housing recovery indicates that the recovery capability of migrant households in terms of housing is relatively low (Figure 7). This suggests significant challenges in repairing and maintaining homes after disasters. The temporary nature of their housing and economic constraints likely contribute to this lower score, highlighting the need for targeted support to improve housing resilience.

Economic Stability (ES): The normalized value of 0.4 for economic stability reflects moderate economic resilience among migrant households (Figure 7). While they can recover their employment and business activities relatively quickly after disasters, overall economic stability is still constrained by limited financial resources and the nature of their employment. This score indicates room for improvement in financial support and economic opportunities to enhance their stability.

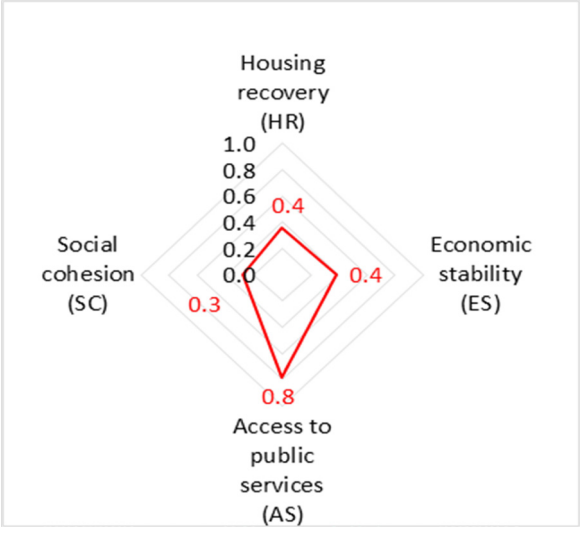

Figure 7. Post-disaster recovery capacity of migrants

Access to Public Services (AS): The normalized value of 0.8 for access to public services is relatively high, indicating that migrant families have good access to essential services during and after disasters (Figure 7). This includes public transport, fresh water, sanitation facilities, medical clinics, and food sources. The high score reflects the efficiency and reliability of public services in supporting the community during times of crisis, which is a positive aspect of their overall resilience.

Social Cohesion (SC): The normalized value of 0.3 for social cohesion is relatively low, suggesting limited social support and community engagement among migrant households (Figure 7). The lack of participation in social or civil organizations and reliance on external support for evacuation and recovery indicate a need to strengthen social networks and community-based initiatives to enhance social cohesion and collective resilience. The relatively low social cohesion was also indicated by Su et al. [29] after studying the impacts of social networks on migrants' ability to recover after Typhoon Haiyan in the Philippines in 2013.

The average normalized value of post-disaster recovery capability was 0.5, indicating a moderate level of ability to recover, with

notable strengths in access to public services but significant challenges in housing recovery, economic stability, and social cohesion. The result of this study is consistent with the moderate post-disaster recovery ability of migrant households, mostly without land or houses in the study ward [30]. Chowdhury and Parida [30] investigated the disaster recovery of households experiencing severe flooding in the Bhadrak region of Odisha, India, in 2014 by economic and housing structure-related outcomes. The authors reported that poor and landless households were more constrained in recovering after disasters.

The HR, ES, AS, SC, and recovery capacity were positively correlated ($r=0.35$-0.99, $N=57$, $p<0.05$), implying the correlation among dimensions and contribution to recovery capacity. In addition, HR values of migrants with high school education were significantly higher than those of primary and secondary school education ($p < 0.05$). While this group does not represent the entire migrant community, it highlights key resilience factors (e.g., knowledge, awareness courses, and disaster prevention solutions). These elements enhance their ability to withstand natural disasters, which is crucial for local authorities in developing response strategies. In addition, statistical analysis demonstrated no correlation and differences ($p > 0.05$) in the capability for post-disaster recovery among the migrants. Though they are different in age, residence duration, gender, job, and income, statistical analysis shows similar recovery abilities from natural disasters among migrant groups in the study ward. They all experienced frequent storms and floods, and Typhoon Yagi affected them similarly: Evacuation, work stoppage, damage to houses and belongings, lack of community connection, and limited financial support or access to loans and income sources during and after the storm. This result agrees with the previous finding that there were no apparent differences in recovery capacity among factors such as occupancy type, land use type, or property value [31].

The high scores in the indicators of access to public works and services reflect the disaster management capacity of local authorities. Prior to and during Typhoon Yagi, measures were taken to mitigate the impacts of natural disasters, including evacuating people from flood-prone areas and homes at risk of destruction, preparing accommodations for evacuees, and ensuring the availability of necessities, electricity, and water for those relocated to safe places. Interviews with displaced households confirmed full access to essential public works and services during and after the storm. This response capacity has been integrated into all storm and flood prevention programs. However, it is crucial to consider the ability of authorities to support community recovery from natural disasters. From the perspective of "building back better", it is evident that migrants in the area did not improve their ability to cope with natural disasters, even after severe storms like Typhoon Yagi. Their homes were damaged, their jobs were disrupted, and they lacked preventive measures post-Yagi. These findings highlight the need for targeted interventions to address vulnerabilities and enhance the community's resilience.

In-depth interviews with local authorities and residents highlighted the heightened vulnerability of migrants in the study area. The narratives indicated that most of the interviewed residents were renters who lacked the financial capacity to reconstruct or secure well-constructed housing. Many expressed no intention to undertake repairs due to the temporary nature of their rental arrangements. This underscores this group's lack of resilient infrastructure during and after disasters. Furthermore, observations and narratives revealed that most interviewed individuals had unstable economic livelihoods, relying on temporary jobs such as scrap collection and manual labor. The combination of economic instability and substandard housing significantly exacerbates the vulnerability of this marginalized group. In addition, insights from local authorities suggested that most residents in this area are migrant households who rarely complete formal registration, complicating local governance and management efforts and further intensifying their precarious conditions.

4.6. Solutions for enhancing post-disaster recovery capacity

From the above-mentioned results, five solutions are proposed to enhance the post-disaster recovery capability of the study area:

+ Enhancing social cohesion: Relatively low social cohesion (0.3 on a 0-1 scale) indicates prioritized actions for developing community engagement, such as programs encouraging migrant households to participate. These activities help foster community bonds and collective resilience, making it easier for households to support each other during disasters. In addition, offering regular disaster preparedness training sessions that include community-based initiatives can empower households with the knowledge and skills needed to respond to and recover from disasters effectively.

+ Enhancing housing recovery capacity: To improve housing recovery ability, it is essential to provide targeted financial support for housing repairs and maintenance for migrant families. This could include subsidies, grants, or low-interest loans to help them rebuild and improve their homes. In addition, developing temporary housing programs that offer safe and resilient shelters during the recovery period can reduce the burden on tenants and ensure secure living conditions while permanent repairs are made. This recommendation aligns with the Government's policy to eliminate temporary and dilapidated houses nationwide, as outlined in Decision No. 1243/QD-TTg and Decision No. 126/QD-BCĐ [32, 33]. Although migrant households in urban areas like the study site are not specifically mentioned as beneficiaries, this program sets a foundation for housing support for those living in temporary and dilapidated conditions, including migrant households in the study ward. Solid, safe, and disaster-resistant housing is crucial for the resilience of migrant households.

+ Improving economic stability: Enhancing economic stability requires implementing job training and employment programs focused on disaster-resilient industries. These programs can help migrant households secure stable and sustainable employment, improving their economic resilience. Establishing microfinance initiatives that provide small loans to support business recovery and growth can also help households rebuild their livelihoods and improve financial stability. This recommendation aligns with the Natural Disaster Prevention Fund's operational program under Decree No. 78/2021/ND-CP [34]. However, specific solutions are needed for migrant households, such as those in the study ward, to ensure they benefit from the Fund and enhance their economic resilience against natural disasters.

+ Strengthening access to public services: Continued investment in and maintenance of robust public infrastructure is crucial to ensure that essential services like transportation, water, sanitation, medical care, and food sources remain accessible during and after disasters. Conducting community awareness campaigns to inform households about available public services and how to access them during emergencies can further enhance their preparedness and response capabilities.

+ Improve communication and support systems: To ensure that disaster-related information is disseminated through multiple channels, such as social media, community meetings, and local radio broadcasts, can help reach all households and keep them informed. Implementing mechanisms to ensure equitable aid distribution, coordinated with local organizations and government agencies, can guarantee that all households receive necessary support during and after disasters.

Addressing these areas makes it possible to significantly enhance the overall recovery capability and resilience of migrants in the study ward. These targeted interventions can help build a more robust and supportive community capable of effectively responding to and recovering from future disasters.

5. Conclusions

This study investigates the post-disaster recovery capability of migrant households in a ward in Hanoi, Viet Nam, after exposure to the historical Typhoon Yagi in 2024. The

indicator-based assessment method was applied with 34 indicators developing from 4 dimensions: Housing recovery, economic stability, public service accessibility, and social cohesion. The findings demonstrated the medium level of the capability of post-disaster recovery of migrants with a value of 0.5 on a scale of 0-1. This capacity could be enhanced significantly by strengthening social networks and community-based initiatives to promote the current score of social cohesion (0.3). Also, the improvement in providing financial support, economic opportunities and housing resilience is necessitated to promote economic stability and housing recovery because of the low score of 0.4. A high level of access to public service (0.8) highlighted the favorable access to essential services during and after the disasters of migrant households. Some solutions (e.g., enhancing social cohesion, enhancing the ability of housing recovery, strengthening access to public services, and improving communication and support systems) should be addressed to build an effectively supportive community responding to and recovering from unexpected disasters. Further studies should be conducted on expanding the interviewed sample size and geographical scope, incorporating mixed methods, and focusing on policy implementation and community engagement for more effective and inclusive disaster management strategies that better support vulnerable populations.

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