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Case Study Paper

Mapping disaster resilience: Insight into two selected wards of Dhaka South City Corporation

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Abstract

Urban disasters have become an area of concern because of the high concentration of people and the complexity of systems in urban areas. Increased frequency and severity of climatic events have also made the urban areas hotspots for the damage of resources and casualty. Extensive research has been carried out to explore the physical risk and vulnerability profile of Dhaka city, while a holistic overview from the resilience perspective is rare. In this paper an index-based measure to determine the level of resilience in two wards of Dhaka South City Corporation (DSCC) has been attempted. Based on the areal expansion of DSCC in 2017, its administrative units can be categorized into two groups: old wards and newly added wards. Disaster resilience in the most densely populated ward in each group were selected as study areas. This study used Urban Disaster Resilience Index method to quantify resilience level based on five dimensions: physical, social, economic, institutional, and natural. Both wards displayed the highest resilience in physical attributes and exhibited the lowest resilience for institutional attributes. The overall score demonstrates that Ward 61 possesses lower resilience than Ward 33 because of its poor performance in water and drainage, sanitation and solid waste, education, and awareness, social capital, income, crisis management, knowledge dissemination, ecosystem services and land use. The findings reinforce the importance of investigating spatial variance in resilience and its underlying causes.

Keywords: Resilience index, urban disasters, disaster risk reduction, climate change adaptation

1. Introduction

Worldwide, the upward trend of urbanization is intensifying the challenges of disaster risk reduction. Urban areas are usually a set of settlements and infrastructure in a confined area where people's livelihood is supported by interrelated systems (Albala-Bertrand, 2003). Because of the high concentration of people, infrastructure, and complexity of systems, urban disasters can lead to significantly greater impacts (Skidmore & Lim, 2020). Therefore, strengthening the resilience of cities by adopting integrated, age and gender-responsive policies and plans have been placed as a key commitment in the New Urban Agenda 2016. IPCC Assessment Reports have also manifested urban risk mitigation and adaptation with greater significance. It also called upon the countries and researchers to further risk mitigation and adaptation research for increased urban resilience and sustainability (Monteiro et al, 2022).

The term resilience implies the ability to cope with uncertainties and surrounding complexities. In sustainability studies, various attributes of resilience have been

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described by researchers to investigate complex urban systems (Tang, 2019). Moreover, the capacity for resilience in case of a disaster is typically regarded to be at the core of the resilience concept. In disaster studies, resilience measure generally denotes the absorptive, adaptive, and transformative capacity to shocks. The advantage of this concept lies in its disaster-independent nature. It can be applied at any time and can map the existing state of capacity regardless of whether these capacities are actually used in case of a disaster (or a simulation) and if they are effective (Winderl, 2014). Previous studies have focused on various qualitative and quantitative methods of assessing resilience. But Winderl (2014) has especially addressed the scorecard-based resilience matrix approach as the most simple and rapid tool. It is effective not only to engage the community in planning but also to create a "cycle of quality improvement" for local authorities.

Kazemi and Andalib (2015) have discussed the ten most cited urban resiliency models of disasters between 2009 and 2015 and concluded that all of them are applied to natural hazards and some are dedicated to climatic disasters. Various studies have scrutinized the community-level resilience in coastal districts of Bangladesh (Morelli et al., 2021; Ahmed et al., 2016; Bari et al., 2021), while an empirical measure of resilience in Dhaka and other metropolitan cities is not widely available. Instead, most of the studies carried out on Dhaka have adopted risk and vulnerability assessment tools. Many of those studies were devoted to only hydrometeorological hazards and some are particularly focused on fire hazards. Nonetheless, in Dhaka, a holistic disaster resilience assessment effort has been applied by Parvin and Shaw (2011). The study has been carried out at the zone level before the city was divided into two different city corporations. The zone-level resilience status restricts us from perceiving a micro understanding regarding the capacity at the ward level. This study has tried to fill the gap and applied ward-based resilience assessment techniques in the two highly populated wards of Dhaka South City Corporation.

2. Study area

The Local Government (City Corporation) Amendment Bill 2011 enacted on 29 November 2011 segregated the Dhaka South City Corporation (DSCC) as a self-governing body that was previously a part of the undivided Dhaka City Corporation. Further, in 2017, DSCC undertook a major jurisdictional change. An additional 64.17 km^2 of peripheral land under eight union parishads amalgamated within the existing area. Consequently, the total number of wards jumped from 57 to 75, which almost doubled its administrative area. Two wards were selected for this study of resilience assessment: one from the expanded area and another from the old area. Only two areas were selected due to time and resource constraints. The objective was to compare the resilience profile among two wards that have similar demographic risk propensity. Therefore, the two wards having the highest population density—one from the old city jurisdiction and another one from the later expanded area—were selected for the assessment. Following this criteria, wards 33 and 61 were selected as sample for the study. Ward 33 covers a large chunk of old Dhaka that includes Agamashi Lane, Aga Sadeque Lane, Ali Naki Deuri, Abdul Hadi Lane, B.K. Ganguli Lane, Chankharpool, Nawab Katara, and Uttar Bangshal., whereas ward 61 consists of peripheral neighbourhoods such as Nurbag,

Dania, Kutubkhali, Rasulpur, Daspara and Noyapara. A systematic comparison is drawn between the wards to unveil the resilience status and the underlying reasons. This study aims to examine the resilience capacity of the following wards based on physical, social, economic, institutional, and environmental dimensions. The outcome of the assessment is expected to guide the establishment of a more comprehensive disaster management plan.

3. Methodology

This study was done using the Urban Disaster Resilience Index (UDRI) method—a planning tool based on the Climate Disaster Resilience Index (CDRI) and introduced by the International Environment and Disaster Management Laboratory of Kyoto University along with its partner organizations including CITYNET and UNISDR in 2008 (Kabir, 2018). UDRI is constructed upon five pillars (Table 1): physical, social, economic, institutional, and natural. They are further divided into 25 components and 125 variables. To compute the UDRI scores, the local situation of wards was assessed, and micro-level analysis was conducted by face-to-face interviews with ward councillors and city officials.

Table 1. Dimensions and parameters of UDRI

Physical	Social	Economic	Institutional	Natural
Electricity	Population	Income	Mainstreaming of DRR and CCA	Intensity/severity of natural hazards
Water and drainage system	Health	Employment	Effectiveness of ward's crisis management framework	Frequency of natural hazards
Sanitation and solid waste disposal	Education and awareness	Household assets	Knowledge dissemination and management	Ecosystem services
Accessibility of roads	Social capital	Finance and savings	Institutional collaboration with other organisations and stakeholders	Land-use in natural terms
Housing and land-use	Community preparedness during a disaster	Budget and subsidy	Good governance	Environmental policies

During the interview, respondents used a 5-point rating scale to assess the resilience level for each variable (X_i), where 1 means the worst situation and 5 means the best. Respondents were also requested to assign weights (W_i) from 1 to 5 to the variables and parameters (W'_i) to reflect the priorities of the ward and the relevance of the indicators to the local context. Here 1 indicates the lowest importance and 5 means the highest importance. It is notable that variables and parameters are subject to assigned weights, but dimensions are constant and are equally important resilient factors regardless of the geographical context. The Weighted Mean Index (WMI) method is used to calculate the

parameter scores, and the Aggregate Weighted Mean Index (AWMI) method is used to determine the dimension scores. The overall UDRI score of a ward is a simple average of the indices of the five dimensions. The index value ranges from 1 to 5. Higher UDRI values are equivalent to higher resilience to cope with urban disasters.

The WMI method was used to calculate the parameter scores by using the following equation:

$$WMI = (\Sigma W_i * X_i) / \Sigma W_i \quad (1)$$

where WMI is the weighted mean index, W_i is the weight assigned to the variable i, and X_i is the score assigned to the variable by the respondents. This equation was applied to all 25 parameters to obtain their corresponding scores.

The AWMI method was used to calculate the dimension scores by using the following equation:

$$AWMI = (\Sigma W'_i * P_i) / \Sigma W'_i \quad (2)$$

where AWMI is the aggregate weighted mean index, W'_i is the weight assigned to the parameter i, and P_i is the parameter score obtained using the WMI method. This equation was applied to the five dimensions to obtain their corresponding scores.

The reason for using both WMI and AWMI methods is that the WMI method allows for the calculation of parameter scores, which are then used to calculate dimension scores using the AWMI method. This approach provides a more comprehensive and detailed analysis of resilience, as it allows for the examination of the individual parameters as well as the overall dimensions.

4. Result and findings

The study determined the resilience level of Ward No. 33 and 61 of Dhaka South City Corporation (DSCC) with the identification of disaster history, existing challenges, and performance of services concerning physical, social, economic, institutional, and natural attributes. It also accumulated key issues emphasized by ward councillors and officials to enhance urban disaster resilience.

4.1. Overall level of resilience

The overall Urban Disaster Resilience Index (UDRI) scores were determined as 2.24 and 2.01 for Ward 33 and Ward 61 respectively, where both values represent a medium level of resilience (Table 2). It is noticeable that the physical dimension has the highest resilience, and the institutional dimension has the lowest resilience in both areas. It indicates that the development challenges and limitations are somewhat similar in both areas.

Table 2. UDRI scores for the study area

	Physical	Social	Economic	Institutional	Natural	Overall
Ward 33	2.88	2.64	2.47	1.59	1.62	2.24
Ward 61	2.39	2.35	2.32	1.40	1.58	2.01

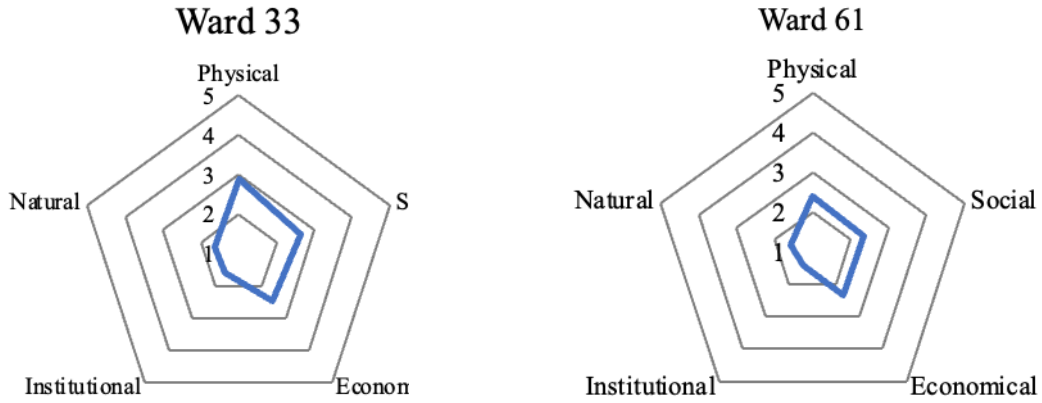

Figure 1. Overall level of resilience in the study area.

4.2. Physical resilience

Physical resilience is measured in terms of electricity, water and drainage system, sanitation and solid waste disposal, accessibility of roads, and housing and land use. Physical attributes had the highest resilience among the five dimensions in both wards. In Figure 2, the bigger polygon for ward 33 represents its higher resilience than that of ward 61. Among the five physical parameters, electricity supply is recorded to have the highest resilience in both areas with 100% coverage and more than 76% supply of regular demand. Ward 61 has significantly low resilience in terms of water supply and drainage. During the field survey, respondents reported the problem of the severe water crisis. Water scarcity reaches its peak in the dry season. Moreover, piped water of DWASA remains unusable most of the time because of odour and dirt. Though both wards endure severe waterlogging in monsoon due to poor drainage facilities, ward 66 is in more miserable condition. Most of the roads become unusable for commutes after moderate rainfall. Preventive interventions against waterlogging, such as sewage removal or dredging of adjacent waterbodies, are found to be directed by the local community rather than the City Corporation. Inadequate waste collection service is evident in ward 33.

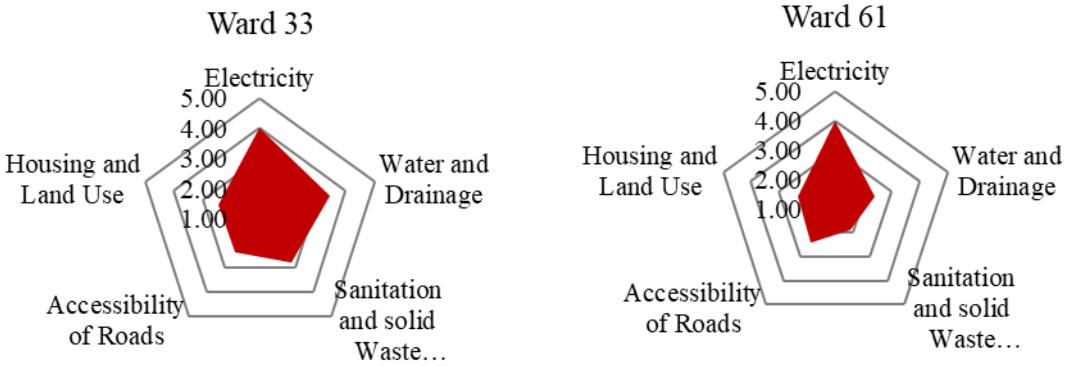

Figure 2. Level of resilience in the physical dimension

Ward authority's limited capacity leaves 40% of the daily waste uncollected. Both wards scored 2.40 for road accessibility which implies most of the roads are inaccessible for emergency vehicles. Regarding housing and land use, resilience status is better in ward 33. In ward 61, not only the roads but the settlements are also at risk of inundation as around 80% of the houses are placed below the plinth level of the road.

4.3. Social resilience

Parameters considered to measure social resilience are population, health, education and awareness, social capital, and community preparedness. As shown in Figure 3, ward 33 accounted for a resilience score of 2.80 which is slightly better than 2.73 of ward 61. Moreover, ward 61 is also lagging ward 33 in terms of all social parameters. Both wards were found to have the highest resilience for health aspects because of the prevalence of primary health services and low outbreak rate of water and vector-borne disease as seen in Figure 3.

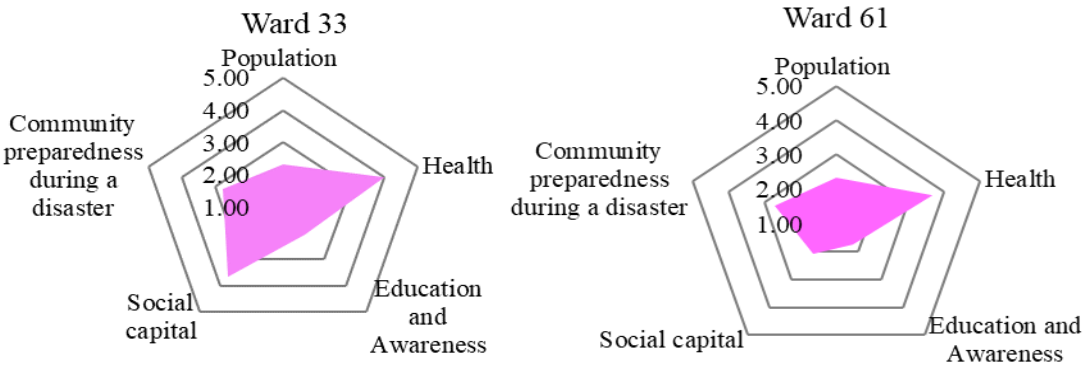

Figure 3. Level of resilience in the social dimension

The lowest social resilience was found for disaster education and awareness in both areas. Though disaster management policy documents specified certain roles at the ward level, it is yet to be exercised on the ground. Some supports from the NGOs, CBOs, and religious groups exist but are predominantly devoted to post-disaster relief aid and not to disaster mitigation and preparedness. The resilience score on population parameter is equal for the wards as high density was set as the study area selection criteria and both wards exhibited extremely high population density and similar traits of landuse.

Ward 33 has stronger social capital which is reflected through a higher score (3.67). It is widely known that social ties are deeply rooted in the communities of the early settlers of old Dhaka. These original inhabitants inherited land and property and have lived there for generations. Such a trait has created a unique social fabric and interconnectedness. Mosque-based Panchayats were formed in different areas within the ward that play vital roles in community activities and consensus building. On the other hand, Ward 61 is located on the outskirts and inhabited by mostly migrants and lower-income people. Because of such concentration of migrants and temporary settlers, social connections and consensus-building capacity have not taken root.

4.4. Economic resilience

A nominal difference is found in terms of economic attributes of resilience between the wards. As indicated in Figure 4, Ward 33 and 61 scored 2.39 and 2.32 respectively. The parameters considered under this dimension are income levels, employment, household asset, finance and savings, and budget and subsidies. It is intriguing that both areas encountered equal scores for finance and savings, and budget and subsidy. This may be due to underlying variables, such as credit and insurance facility, and budgetary provision for subsidies/incentives, that are aligned with a national framework and are unlikely to vary at the micro level.

The standing orders on disaster (MoDM, 2019) issued by the government of Bangladesh, has explicitly outlined the roles of City Corporations as well as the ward administration. But through the field survey, it has been found that ward offices do not have the authority to take and execute decisions. Budget allocation and execution of development works are directed centrally. Therefore, decisions on relief and subsidies to rebuild houses and livelihood after disasters are not in the hands of the ward authority. Thus, ward offices fail to carry out the expected interventions in line with the disaster management policies and plans.

Both areas performed quite well in employment parameters and ward 61 even scored more due to its high employment of labour and youth in the formal sector, low rate of child labour, and less daytime population from outside. Nonetheless, these wards have significantly low household assets because of sizable slum population.

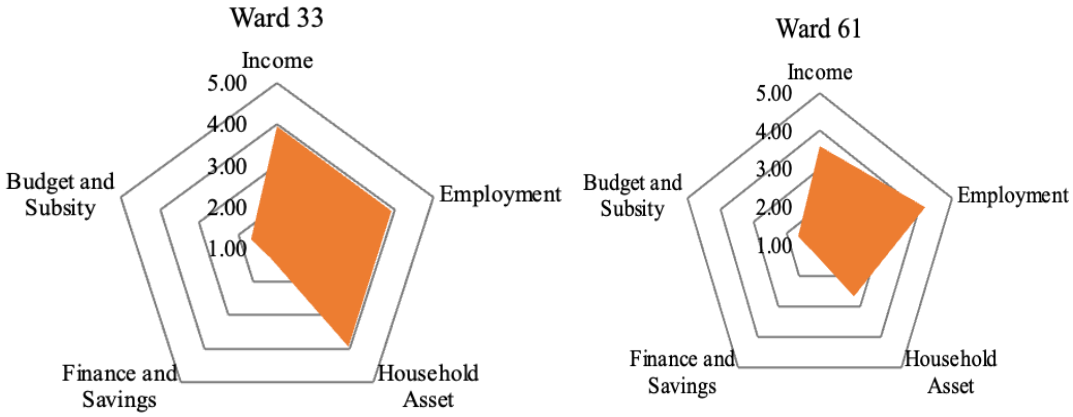

Figure 4: Level of resilience in the economic dimension

4.5. Institutional resilience

Institutional resilience had the lowest score of all five dimensions as shown by the small polygons in Figure 5. Institutional capacity is measured in terms of mainstreaming of Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA), effectiveness of the city's crisis management framework, effectiveness of the city's institutions to respond to a disaster, institutional collaboration with other organizations and stakeholders, and good governance.

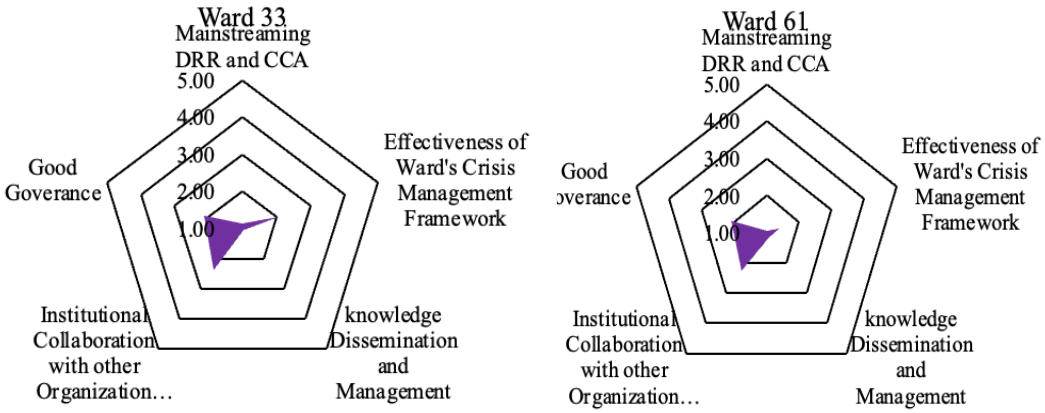

Figure 5. Level of resilience in the institutional dimension

Both wards experienced low resilience in terms of mainstreaming DRR and CCA since the required manpower and logistics for local planning are not available at the ward level; therefore, community participation in planning does not exist in a formal manner. It was also revealed in the field survey that a few NGOs (e.g., NGO, PSTC) had implemented projects in ward 33 in which 50 volunteers were trained on emergency response, whereas no such intervention had taken place in ward 61. Furthermore, ward 33 has one playground, park, and a community centre which can be used as evacuation centre during a disaster. On the other hand, no community centre, park, playground, or any large open space is available in ward 61. Hence, the crisis management framework appeared to be a little stronger in ward 33 than in 61.

The historically strong social fabric of old Dhaka promotes disaster resilience by boosting the community's capacity for collaboration and information dissemination. At present, 18 mosque-based *panchayet* committees are functioning in ward 33 and they can be the potential network for steering knowledge dissemination and emergency response-related activities. All these factors attributed to slightly better resilience to ward 33 regarding good governance and institutional collaboration capacity.

4.6. Environmental/natural resilience

Environmental resilience is measured in terms of the intensity and frequency of natural hazards, ecosystem services, land use, and environmental policies. As shown in Figure 6, the slightly bigger pentagon of ward 33 represents higher resilience than ward 61. While recalling previous disasters, councillors from both wards mentioned flood and fire as the most prevalent hazards in their area.

The severity of previous disasters was much more serious in ward 33. The area called Nimtoli is in this ward, where a tragic fire incident killed 120 people in 2010. There was a chemical warehouse situated on the ground floor of a residential building where the fire had originated. The government has committed to take legal action against the illegal warehouses and factories (Imam, 2010). But during the interview, the ward councillors informed that till then many factories and chemical *godowns* (warehouses/storerooms) were operating in their areas and fire incidents became a regular phenomenon.

Moreover, narrow roads make rescue operations extremely difficult for fire service and ambulances. Thus, higher intensity of hazard demonstrates lower resilience in ward 33.

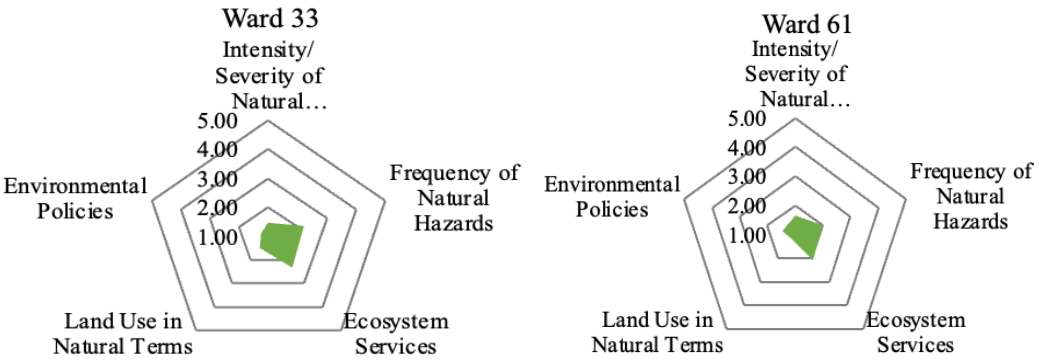

Figure 6. Level of resilience in the environmental dimension

On the other hand, ward 61 does not have a record of devastating fires but prolonged water logging disrupts people's daily life. So, there is a high frequency of hazards as well as lower resilience in ward 61.

Resilience scores regarding land use are 1.47 (ward 33) and 1.40 (ward 63). Considering the land-use change over the last 50 years, ward 33 was a part of Dhaka city since the British period and most of the settlements were developed a long time ago. So, detrimental land use changes and loss of greenery did not happen in the near past which pushed the resilience a little higher than ward 61. On the contrary, a lower resilience in terms of environmental policies is found because of inadequate waste collection facility.

5. Discussion

The study pointed out the governing factors of resilience in two wards of DSCC. It revealed that ward 33 outperforms ward 61 in 17 out of 25 resilience parameters which consequently led to a greater overall score. Here it is noticeable that ward 61 was brought under the DSCC administration in 2017, whereas ward 33 became part of the metropolitan area even before the birth of the country in 1971. One of the goals of the study is to investigate how these distinctive spatial features influence the resilience performance of an area.

Ward 61 is geographically low-lying and susceptible to flooding. The area was completely devastated by the floods of 1988 and 1998. The pre-existing vulnerability is further triggered by the Dhaka-Narayanganj-Demra (DND) embankment project that was constructed in 1960 to prevent floods and produce crops using irrigation canals. But since 1980, there has been rapid land use change in this area, and the irrigated agricultural lands were converted to residential, commercial, and industrial plots (Mukul, 2017). Once there were several canals including the River Konso in the DND embankment area. The canals were used as irrigation channels. The Konso and other canals have already been encroached and filled up with garbage. The extinction of rivers and canals disrupted the water flow and is responsible for widespread flooding (Alam, 2016).

Moreover, if we look at the population density, ward 33 has a much higher density than ward 61, around four times greater. It is often assumed that areas with higher population density have higher risk and lower resilience. But this study validates that resilience is much more complex than we assume. Despite the comparatively low population pressure, ward 61 exhibited limited values of indicators like water and drainage, sanitation and solid waste, education and awareness, social capital, income, management framework, knowledge dissemination, ecosystem services, and land use. Broadly, it sums up the poor governance and service delivery capacity of the ward and the gap has not been created suddenly. The area experienced a population boom after the construction of Mayor Hanif Flyover. Road connectivity improved and people's access to commercial areas and educational institutions became easier. While it was a union council, before being incorporated into the DSCC, the increasing population severely strained the capacity of the existing infrastructure and service provisions. The union council office struggled to cope with the unprecedented population growth with limited resources and manpower allocation from the central government.

These long-held problems cannot be solved immediately after being converted into city corporation. The situation is aptly presented by Bhattacharjee and Khan (2016): "eight union parishads are included in DSCC since the UPs have witnessed rapid urbanization and the residents were demanding for the inclusion in city corporation for better civic amenities such as better road condition, garbage management, mosquito menace, and street lighting. With a high rate of urbanization, gigantic residential and commercial buildings, industries, hospitals, and educational institutions have been set up in the unions, but the UPs [union councils] do not have the capacity to provide proper civic services to them".

During the physical visit to ward 61 in 2020, it was found that, though the ward had been taken under DSCC jurisdiction for two years, no development work had started, nor the required manpower had been allocated. The newly elected ward councillor said that development planning was in progress, and a few more years will be required to see the progress. So, to conclude, it is obvious that limited resources, lack of civic services, and poor delivery of utility services are the key contributors to the poor level of disaster resilience.

It is important to note that resilience factors are not independent components of natural, socioeconomic, or infrastructural services, but are rather interconnected and their combined output represents resilience. Institutional issues, such as the incorporation of disaster risk reduction into development planning and its implementation, can significantly reduce exposure to disasters. The opposite scenario is seen in both wards where non-compliance with environmental and building regulations has led to unsustainable population density and minimal green space. Furthermore, the demographic profile of the wards is diverse, with moderate numbers of slum dwellers. Therefore, access to water, sanitation, and solid waste services is not equally available to all residents. Additionally, residents' awareness and knowledge regarding the risks and impacts of disasters is limited. The lack of institutional arrangements for public awareness programs or disaster drills by the ward administration is evident, as the ward offices lack the administrative power, financial resources, and personnel allocation. As a result, the lack of awareness and civic sense exacerbates environmental degradation, loss

of greenery and water bodies, and improper disposal of solid waste. Thus, the performance of one dimension can significantly impact other dimensions, highlighting the need for a comprehensive and integrated approach to building resilience.

6. Conclusion

Investing in risk reduction for achieving resilience is set as a key priority by the United Nations (UNISDR, 2015). Hence, a comprehensive approach to assessing as well as increasing resilience is essential. This study scrutinized factors affecting the coping capacity of two wards in various disaster risks. UDRI assessment results act as a baseline to formulate plans and policies. Besides the systematic comparison between the two areas of Dhaka city, this study discovered some gaps in existing risk management practices in the metropolitan area. An obsession for physical development and a vision to achieve resilience through hardware infrastructure is prevalent from the national to the grassroots level. The ongoing infrastructure development projects validate the notion and prove that social aspects of resilience are often ignored. Another, finding of this study is that local-level bodies are not equipped to act on disaster risk reduction issues. Despite the defined responsibilities in the standing orders on disaster (MoDM, 2019), ward level administration does not have the institutional and fiscal authority to act on those. Moreover, local government and other urban service-providing bodies are needed to be empowered with proper training, capacity building, logistics, and manpower.

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7. References

Ahmed, B., Kelman, I., Heather , F. K., & Saha, M. (2016). Community resilience to cyclone disasters in coastal Bangladesh. *Sustainability*, *8*(8), 805. https://doi.org/10.3390/su8080805

Alam, H. (2016, September 21). DND canal encroachment rampant. *The Daily Star*. https://www.thedailystar.net/city/canal-encroachment-major-reason-dnd-waterlogging-1287256

Albala-Bertrand, J. M. (2003). Urban disasters and globalization. In A. Kreimer, M. Arnold, & A. Carlin, *Building safer cities: The future of disaster risk* (pp. 75–82). The World Bank.

Bari, E., Khan , Z. H., & Haque, A. (2021). Local strategies to build climate resilient communities in Bangladesh. In P. Mukhopadhyay, A. Haque, M. Nepal, & M. Shamim (Eds.), *Climate Change and Community Resilience* (pp. 175–190). Springer.

Bhattacharjee, P. P., & Khan, M. R. (2017, May 7). Govt to double size of Dhaka city area. *The Daily Star.* https://www.thedailystar.net/frontpage/govt-double-size-dhaka-city-area-1219972

Imam, H. (2010, July 10). Nimtoli tragedy: The worst nightmare. *The Daily Star.* https://www.thedailystar.net/news-detail-142316

Kabir, H. M., Sato, M., Habiba, U., & Yousuf, T. B. (2018). Assessment of Urban Disaster Resilience Index in Dhaka North City Corporation (DNCC), Bangladesh. *7th International Conference on Building Resilience: Using scientific knowledge to inform policy* (pp. 1107–1114). Elsevier.

Kazemi, D., & Andalib, A. (2015). Comparative-analytical assessment of urban disaster resilience models. *Journal of Applied Environmental and Biological Sciences*, 503-512.

MoDM. (2019). *Standing orders on disaster 2019.* Ministry of Disaster Management and Relief, Government of Bangladesh.

Monteiro , A., Ankrah, J., Madureira, H., & Pacheco, M. O. (2022). Climate risk mitigation and adaptation concerns in urban areas: A systematic review of the impact of IPCC assessment reports. *Climate*, *10*(8), 115. https://doi.org/10.3390/cli10080115

Morelli, A., Taramelli, A., Bozzeda, F., Valentini, E., Colangelo, M. A., & Cueto, Y. R. (2021). The disaster resilience assessment of coastal areas: A method for improving the stakeholders' participation. *Ocean & Coastal Management*.

Mukul, A. N. (2017, August 8). Resolve suffering of waterlogged people in DND embankment area. *risingbd.com*. https://www.risingbd.com/english/Resolve-suffering-of-waterlogged-people-in-DND-embankment-area/47118

Parvin, G. A., & Shaw, R. (2012). Climate disaster resilience of Dhaka City Corporation: An empirical assessment at zone level. *Risks, Hazards & Crisis in Public Policy*.

Skidmore, M., & Lim, J. (2020, October). *Natural disasters and their impact on cities.* https://www.oxfordbibliographies.com/view/document/obo-9780190922481/obo-9780190922481-0014.xml

Tang J. (2019) Assessment of resilience in complex urban systems. In W. Leal Filho, A. Azul, L. Brandli, P. Özuyar, T. Wall. (Eds.) *Encyclopedia of the UN sustainable development goals: Industry, innovation and infrastructure* (pp. 1–10). Springer. https://doi.org/10.1007/978-3-319-71059-4_71-1

UNISDR. (2015). *Sendai framework for disaster risk reduction 2015–2030*. United Nations Office for Disaster Risk Reduction. https://www.preventionweb.net/files/43291_sendaiframework fordrren.pdf

Winderl, T. (2014). *Disaster resilience measurements.* United Nations Development Program.