

# Assessing urban resilience of Khulna City in response to environmental and socioeconomic challenges

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## Abstract

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The study introduces a paradigm for evaluating the resilience index of Khulna city (KCC) and its surrounding regions in response to unfavorable developments and disasters. To that end, primary data concerning housing conditions and prevalent disasters in the region was gathered from locals. Additionally, a survey of key informants and expert opinions, together with other secondary data sources, including land use and land cover (LULC) developments during the last two decade, were utilized to compute the preparation score, vulnerability score, and resilience index in KCC and its sub-districts. The findings indicated that participants perceive elevated water salinity, waterlogging, and cyclones as the predominant disasters occurring in the region over the past 15 years. The KCC region had the greatest resilience index (0.99), owing to its minimal vulnerabilities in infrastructure. However, a significant vulnerability in the economic factor was identified in the primary urban area, mostly due to housing challenges and rising rental demands. The land use and land cover evaluation indicated a decline in agricultural and vegetation areas, along with a rapid expansion of urban zones. Consequently, improving infrastructure in sub-districts while focusing on vertical development in the central city could bolster resilience in Khulna by augmenting environmental and economic readiness.

## 1. Introduction

In recent decades, the population impacted by disasters has increased significantly. In 2005, droughts, floods, and tropical storms resulted in around 100,000 fatalities and \$250 billion in damages [1], constituting 80% of life-threatening natural disasters worldwide [2]. Since 2007, over fifty percent of the global population has resided in urban areas, with several rapidly expanding cities situated in emerging nations, predominantly in Africa and Asia [3]. Developing countries experienced the majority of the effects and losses, representing 97% of the affected communities worldwide. Consequently, to guarantee more sustainable, resilient, and livable cities in the twenty-first century, it is essential to implement new techniques that bolster urban ecosystems against disturbances [4].

Since the early 2000s, the development of disaster-resilient metropolitan areas has been a paramount focus for emergency planning agencies worldwide. Resilient cultures endure less harm and recover more swiftly when faced with a devastating disaster [5]. Urban resilience is the capacity of a community or city to prepare for, absorb, and adapt to real or projected adverse occurrences promptly and efficiently, encompassing the regeneration and restoration of fundamental functions and structures [5][6]. The International Society for Ecological Systems defines urban resilience as the capacity of a socio-ecological system to withstand shocks and sustain functionality amid external demands from climate change and urbanization. It encompasses the capacity of an urban entity to adapt and



develop into more advantageous configurations that enhance the system's sustainability and equip it for future adverse consequences [7][8].

Due to climate change, metropolitan areas will be vulnerable to many challenges. The immediate consequences will include floods, rising sea levels, temperature increases, and extreme weather occurrences. Conversely, others will manifest as indirect consequences that resonate throughout the systems upon which metropolitan areas rely, including energy, transportation, and telecommunications [9]. Consequently, investigations on environmental concerns and urban resilience are more multidisciplinary and thorough [10]. Coastal cities are particularly susceptible to elevated sea levels and coastal inundation. Cities significantly contribute to climate change due to elevated energy consumption and carbon emissions [11], necessitating the development of more sustainable urban environments.

Tropical cyclones, storm surges, flooding, coastal erosion, and salt intrusion are prevalent phenomena in Bangladesh. Throughout the years, these disasters have caused substantial fatalities and property damage, undermining local development efforts in coastal Bangladesh [12]. In recent decades, the magnitude and occurrence of these occurrences have escalated significantly [13]. The country is already afflicted by numerous difficulties, including excessive population density. Land scarcity, food security, public health, illiteracy, and similar challenges require attention. The challenges are further exacerbated by the aforementioned types of tragedies. Bangladesh ranks as the sixth most susceptible nation to climate change, second in fatality rates [14], and is the most vulnerable country to tropical cyclones [12]. Consequently, to reestablish order and harmony in disaster-prone regions, it is essential to enhance resilience against these threats. More importantly, it is essential to understand the current resilience of cities against climate-related calamities.

Khulna is situated in the southwest of Bangladesh, where the effects of climate change are anticipated to be especially pronounced due to its geographic position. The landscape is level and inadequately drained, resembling a deltaic plain. The entire territory is around 5 meters above sea level, with heights varying from 0.45 to 23 meters [15]. The region is presently facing recurrent and intense urban and flash floods, intensified by increased precipitation and elevated sea levels due to climate change [16]. Thus, the susceptibility to catastrophic disasters is apparent in the region, and its resilience has not yet been sufficiently developed to endure them. Humans are believed to consciously influence the processes of diminishing, sustaining, or enhancing resilience. This study discusses the present condition of climatic and urban resilience in the Khulna region and the possible practical implications of the urban resilience index within this setting. The objective of the project is to establish a framework for evaluating the resilience of Khulna regions in Bangladesh against natural and anthropogenic events, and to apply this framework by analyzing the resilience of areas susceptible to disasters.

## 2. Material and Methods

### 2.1. Study area

Khulna is the third largest city in Bangladesh, situated in the southwestern coastal part of the country (Fig. 1) at a latitude of  $22^{\circ} 51' 8''$  N and a longitude of  $89^{\circ} 32' 35''$  E. The area is 4,389 square kilometers, and the population surpasses 2.3 million. The district is bordered by Joshore and Narail to the north, Bagerhat to the east, Satkhira to the west, and the Bay of Bengal to the south. The Bangladeshi government has recognized the coastal zone as "vulnerable to adverse ecological processes" and categorized it as one of the three "neglected regions" [17]. Furthermore, the city is categorized as one of the susceptible coastal cities at danger

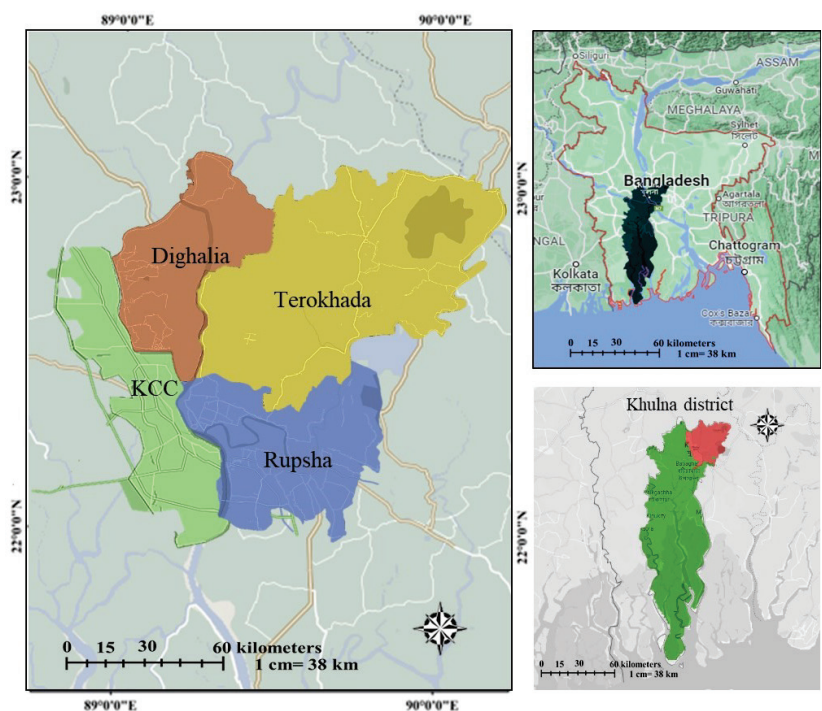


Figure 1. Location of Khulna district (KCC: Khulna City Corporation)

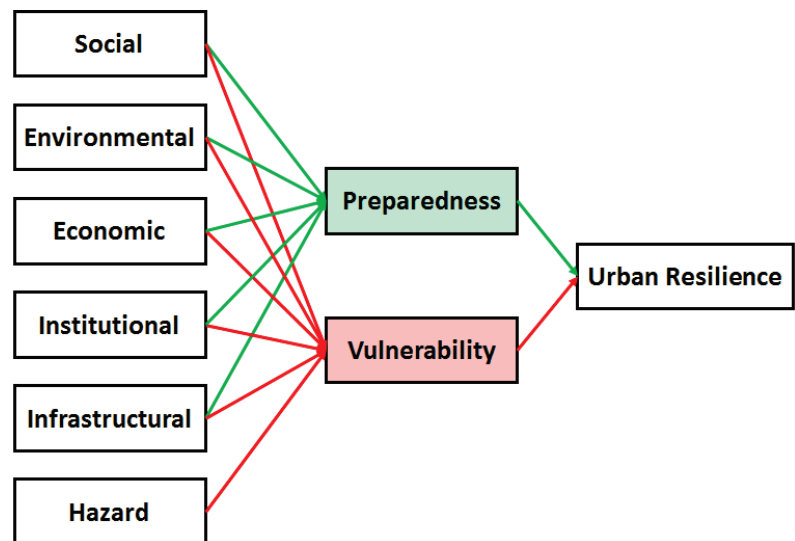
from climate change impacts [18]. Soils with low organic matter content are adversely impacted by salinity, inadequate quality irrigation water during winter, variations in annual precipitation, heavy-textured soils (silty clay to clay), and persistent waterlogging due to insufficient drainage, all of which hinder crop growth in the region's arid conditions [19].

This study examines four contiguous regions of Khulna district: Khulna City Corporation (KCC), Dighalia sub-district, Rupsha sub-district, and Terokhada sub-district (Fig. 1). The KCC city center comprises approximately one-fourth of the overall city area and is characterized by high population density. The area predominantly consists of multi-story residential and commercial structures. The remainder of the city comprises a blend of urban and peri-urban zones. The city contains numerous slums and low-income neighborhoods. The Khulna region faces a rising frequency and intensity of cyclones, accompanied by storm surges, fluvial floods from nearby rivers, pluvial flooding and waterlogging, saline intrusion into rivers and groundwater aquifers, as well as heat waves combined with water scarcity. Consequently, addressing the repercussions of climate change in urban environments necessitates a multifaceted approach that enhances the resilience of urban systems (including interconnected infrastructure), optimizes the efficacy of institutions (responsible for urban planning and management), and bolsters the capabilities of stakeholders (individuals, households, and communities) [9].

## 2.2. Developing Resilience Index (RI)

The suggested resilience index (RI) relies on the Simpson framework (Fig. 2) [20], which defines community resilience as the ratio of community readiness to vulnerability. Preparedness (P) denotes the ability to manage disasters [20], whereas vulnerability (V) is characterized as the likelihood of loss [21].

In this concept, the resilience of the region is assessed by contrasting preparedness with vulnerability (exposure to disaster). The objective for the community is to enhance preparedness capabilities and reduce vulnerability. Increased readiness leads to enhanced resilience, whereas elevated vulnerability results in diminished resilience. The preparedness and vulnerability scores are assessed utilizing the Analytic Hierarchy Process (AHP) [22][23]. Preparedness and vulnerability comprised 5 and 6 dimensions, respectively (Fig. 2), with 33 and 31 sub-dimensions (Detailed in the Supplementary Tables 1 and 2). The information necessary for this framework was acquired through reconnaissance surveys and secondary data sources.



**Figure 2. The proposed framework of urban resilience estimation illustrating the dimensions of preparedness and vulnerability [20].**

## 2.3. Data collection

A reconnaissance survey was completed at the beginning of the study to provide an insight to the current condition of social, institutional, economic, infrastructure and environmental indicators that are present in the study area. To collect related data consultation was completed with experts and respected officials of the study area.

A sample size (n) that was representative of the population was determined by Eq. 1, Where a critical value (Z=1.96) at 95% confidence level, a 50% prevalence (p), and a tolerable error (d) of 0.05 where considered, resulting in a sample size of 384 participants.

$$n = \frac{Z^2(p)(1-p)}{d^2} \approx 384$$

### 2.3.1. Questionnaire survey

The total sample size is adjusted to 120 families for data collection from each designated area. A total of 50 households were surveyed from KCC utilizing stratified random sampling. Seventy residences were surveyed from the Dighalia, Rupsha, and Terokhada sub-districts. The questionnaire for primary data collection encompassed the socio-economic state of the study population, including housing conditions and the principal crises or risks encountered in the past 15 years.

### 2.3.2. Key informant interviews (KIIs)

This interview is a qualitative, in-depth discussion with individuals with firsthand knowledge of the neighborhood, including local leaders, professionals, or citizens. The group comprised permanent inhabitants and individuals with comprehensive knowledge of the area. These individuals can discern the fundamental causes of issues and their own innovative methods for resolving them (Supplementary Tables 1 and 2). Only face-to-face interviews were conducted for KII.

### 2.3.3. Expert opinion survey

The viewpoints of experts on several issues concerning climate change, environmental conditions, disasters, livelihoods, social security, and the role of government (Supplementary Tables 1 and 2) were also examined. Experts were consulted on several aspects of the study to achieve the objectives. Experts were selected among senior officials and executives of KCC, Khulna Development Authority (KDA), Khulna Water Supply and Sewerage Authority (KWASA), and representatives from NGOs.

### 2.3.4. Secondary data collection

To complete the framework dimensions with requisite information, secondary data were derived from reports and statistical data provided by the Bangladesh Bureau of Statistics (BBS), United Nations, Water Resources Planning Organization (WARPO), censuses, and additional datasets (Supplementary Tables 1 and 2).

Data from Landsat-5, Landsat-8, and the Digital Elevation Model (DEM) provided by the United States Geological Survey were utilized to categorize land use and land cover (LULC) in the studied area into five classifications (urban land, water bodies, agricultural land, vegetation, and vacant land) over the past two decades (2001, 2011, and 2021). Geographical and administrative data were obtained from the Bangladesh Agricultural Research Council's website [24].

## 2.4. Resilience Index (RI) estimation

The preparedness index (PI) is determined by the aggregate of the weighted scores of all dimensions (PD), while the dimension score is derived from the sum of the weighted scores of all sub-dimensions (PS). The sub-dimension score is determined by the mean of its indicators' scores.

$$PI = \sum_{i=1}^{i=NP} yiPDi$$

$$PDi = \sum_{j=1}^{j=MPi} xjiPSji$$

$$PSji = \frac{\sum_{k=1}^{k=LPj} PCijk}{LPj}$$

$PI$  = preparedness score of the area

$PD_i$  = score of preparedness dimension  $i$

$PS_{ji}$  = score of sub-dimension  $j$  of preparedness dimension  $i$

$PC_{kji}$  = score of indicator k of sub-dimension j of preparedness dimension i  $w_i$  = weight of preparedness dimension i  $u_{ji}$  = weight of sub-dimension j of preparedness dimension i

$NP$  = number of dimensions of preparedness

$MP_i$  = number of sub-dimensions of preparedness dimension i

$LP_j$  = number of indicators of preparedness sub-dimensions j

The vulnerability score (VI) is calculated similar to preparedness score:

$$VI = \sum_{i=1}^{i=NV} y_i VD_i$$

$$VD_i = \sum_{j=1}^{j=MP_i} x_{ji} VS_{ji}$$

$$VS_{ji} = \frac{\sum_{k=1}^{k=LV_j} VC_{ijk}}{LV_j}$$

$VI$  = vulnerability score of the area

$VD_i$  = score of vulnerability dimension i

$VS_{ji}$  = score of sub-dimension j of vulnerability dimension i

$VC_{kji}$  = score of indicator k of sub-dimension j of vulnerability dimension i  $y_i$  = weight of vulnerability dimension i  $x_{ji}$  = weight of sub-dimension j of vulnerability dimension i

$NV$  = number of dimensions of vulnerability

$MP_i$  = number of sub-dimensions of vulnerability dimension i

$LV_j$  = number of indicators of vulnerability sub-dimensions j

The resilience score (RI) is then calculated as the ratio of preparedness score to vulnerability score.

$$RI = \frac{PI}{VI}$$

If the RI value is below one, it signifies that the region lacks resilience to natural disasters, since its potential to recover is inferior to its vulnerability. If the value equals 1, it indicates that the area possesses sufficient capability to mitigate its vulnerability. A value exceeding one indicates that the area possesses resilience against natural disasters, demonstrating its ability to surmount susceptibility.

### 3. Results

#### 3.1. Homeowning status

Khulna City Corporation had a lower proportion of owned residences (29.99%) and the largest prevalence of rental households (62.5%) in comparison to the sub-districts. This results from individuals relocating from rural and peripheral regions in pursuit of employment opportunities and improved living conditions. The respondents indicated that improved educational facilities for their children constitute another cause for their migration from rural areas. KCC has the highest percentage of individuals residing rent-free at 7.45%. This encompasses residing in informal squatter settlements or on government-designated khash land. In comparison to KCC, the other sub-districts (namely Terokhada, Dighalia, and Rupsha) have the highest number of homeowners. In the Terokhada sub-district, 96.31% of respondents reported home ownership, in Rupsha 71.41% own a home, and in Dighalia, the figure is 78.03. The quantity of rent-free housing is similarly diminished in the sub-district regions (Fig. 3).

### 3.2. Main crisis or risks experienced in last 15 years

The field survey indicated that KCC, Digholia, Rupsha, and Terokhada experience significant salinity issues in both water and soil. Between 20% and 29% of respondents in the research area reported encountering highly saline water in tube well sources (Fig. 4). This issue intensifies in KCC during the summer when water levels fall below normal and salt concentration rises. Furthermore, the water supply from KWSA is often insufficient due to excessive demand and water is frequently absent. Conversely, participants from Rupsha and Terokhada indicated that they encounter salt intrusion in both soil and water. Salinity impedes the growth of certain crops and trees. Water salinity significantly jeopardizes agricultural productivity and land utilization, as only a limited number of crops exhibit resistance to elevated salt concentrations in water, and irrigation with saline water leads to soil infertility.

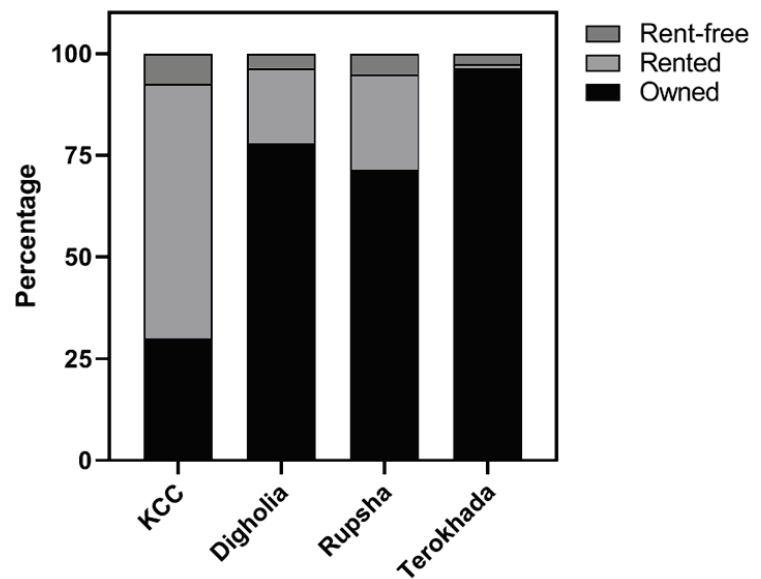


Figure 3. Homeowning status reported by residences of Khulna City Corporation (KCC) and Khulna sub districts Dighalia, Rupsha, and Terokhada, through field survey in 2020-2021

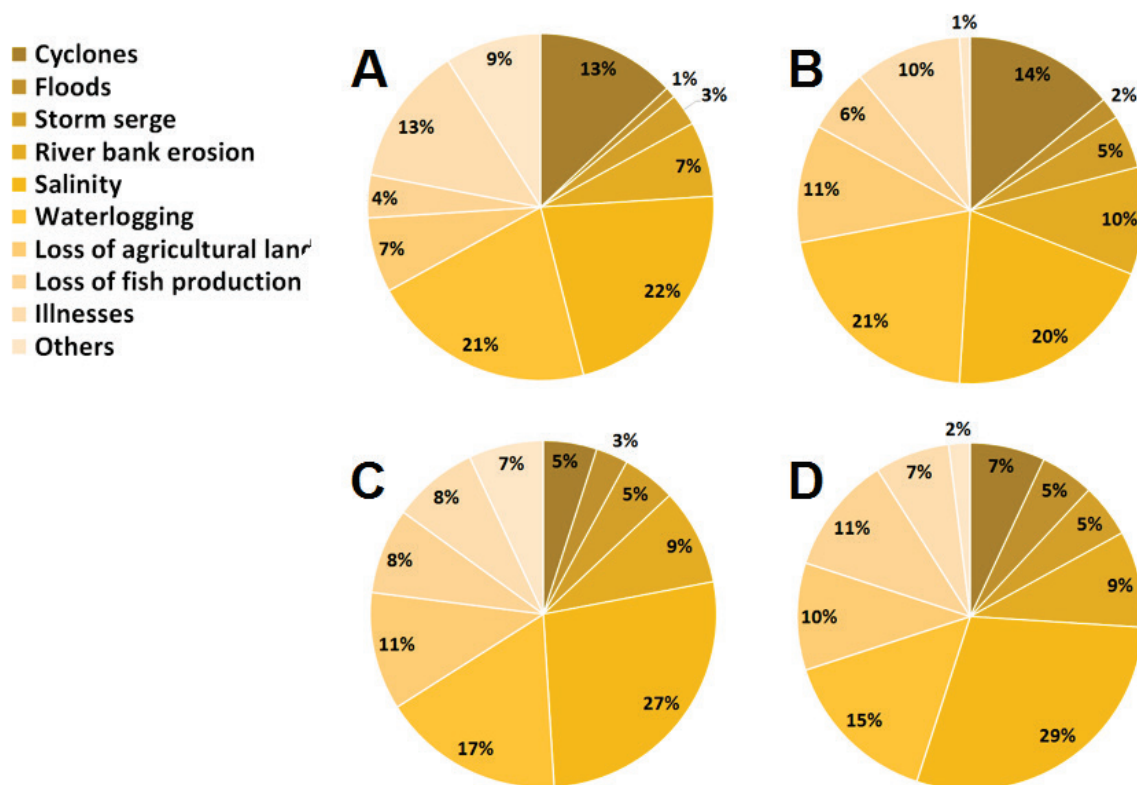


Figure 4. Main crisis or risks experienced in last 15 years reported by residences of Khulna City Corporation (KCC) (A) and Khulna sub districts Dighalia (B), Rupsha (C), and Terokhada (D), through field survey in 2020-21

Waterlogging constitutes a significant danger identified in the region. 21% of individuals in KCC and Dighalia indicated that they experience waterlogging during the rainy season. Even minimal precipitation inundates the roads and infrastructure. The graph indicates that the Rupsha and Terokhada sub-districts also experience waterlogging issues, with 17% and 15% of respondents, respectively, reporting such problems. As a result, a significant portion of agricultural land is being lost owing to saline intrusion, population growth, and urban expansion, with 10-11% of respondents in the sub-districts indicating a loss of their agricultural fields. Cyclones are a significant concern for respondents, particularly in KCC and Dighalia sub-district (Fig. 4).

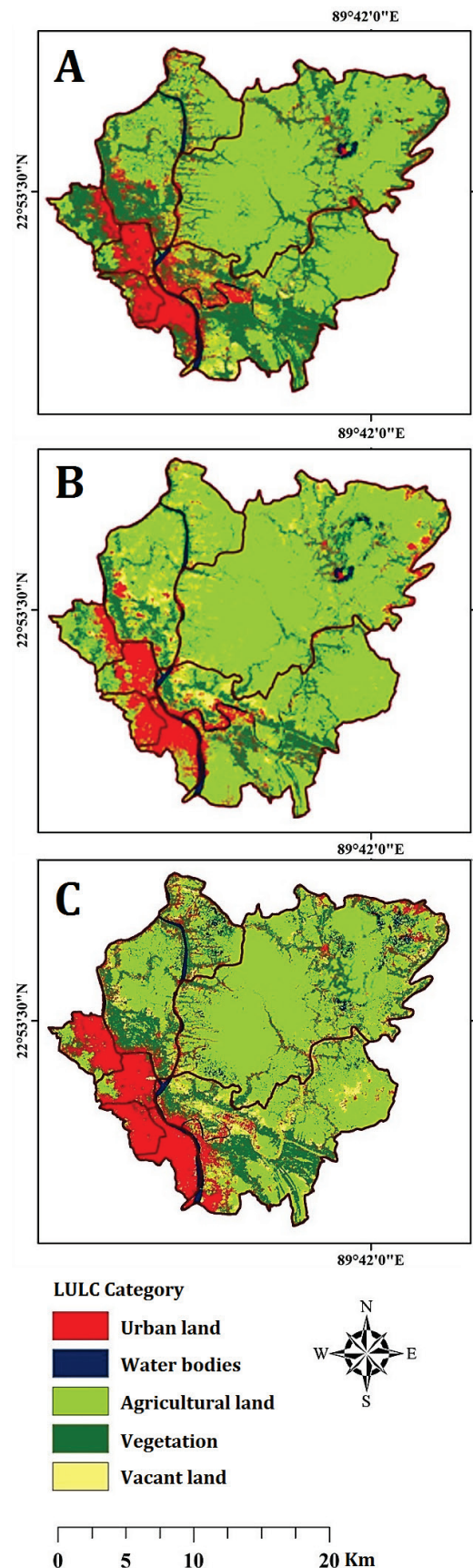
### 3.3. Land use land cover (LULC) assessment

The LULC assessment indicated a significant reduction in agricultural land and vegetation areas over the analyzed period (Fig. 5) (Table 1). A significant rise in urban areas was noted over the period of 2001-2021. A reduction of 34.26 km<sup>2</sup> in agricultural land and vegetation zones, alongside an expansion of 40.61 km<sup>2</sup> in urban areas, was seen between 2001 and 2021. Of the newly constructed urban areas, 30.63 km<sup>2</sup> were identified in the sub-districts of Dighalia, Rupsha, and Terokhada, while 9.98 km<sup>2</sup> were established in KCC. Therefore, the urban expansion rate in the sub-districts is equivalent to that of KCC (Table 1).

### 3.4. Resilience Index (RI)

The equilibrium between VI and PI scores for the environmental component indicates the significant resilience of KCC regarding environmental factors. Although KCC had a lower PI than Dighalia, its VI score was significantly lower to that of the other sub-districts. This observation is mostly ascribed to KCC exhibiting the lowest infrastructure vulnerability score (0.68) in contrast to the other studied areas, which scored above 2. This led to RI in KCC exceeding all other regions (Table 2). Despite KCC being regarded as the economic capital of the study area due to job possibilities and elevated wages, the substantial expenditures and low homeownership rates, coupled with the high demand for rental properties, have led to significant economic vulnerability and a subpar preparedness score.

**Figure 5. Land use and land cover (LULC) changes in study area over the years 2001 (A), 2011 (B), and 2021 (C)**



**Table 1. Percentage of land use and land cover (LULC) changes in study area over the years 2001-2021**

| LULC Type | Urban land |       | Water bodies |      | Agricultural land |       | Vegetation |       | Vacant land |      | Total area |
|-----------|------------|-------|--------------|------|-------------------|-------|------------|-------|-------------|------|------------|
| 2001      | Km2        | %     | Km2          | %    | Km2               | %     | Km2        | %     | Km2         | %    |            |
| KCC       | 31.03      | 59.64 | 5.6          | 9.02 | 0.45              | 0.72  | 12.36      | 26.35 | 2.2         | 3.54 | 45.65      |
| Dighalia  | 2.5        | 3.24  | 2.75         | 3.56 | 64.19             | 83.19 | 6.29       | 8.15  | 1.43        | 1.85 | 77.16      |
| Rupsha    | 2.01       | 1.71  | 7.01         | 5.97 | 96.11             | 81.87 | 6.91       | 5.89  | 5.36        | 4.57 | 117.4      |
| Terokhada | 1.33       | 0.7   | 4            | 2.1  | 160.32            | 84.11 | 23.09      | 12.11 | 1.32        | 0.69 | 190.6      |
| 2011      |            |       |              |      |                   |       |            |       |             |      |            |
| KCC       | 35.56      | 62.61 | 5.01         | 7.73 | 0.4               | 0.62  | 11.02      | 24.73 | 3.05        | 4.71 | 45.65      |
| Dighalia  | 6.22       | 8.06  | 2.46         | 3.19 | 61.21             | 79.33 | 5.99       | 7.76  | 1.56        | 2.02 | 77.16      |
| Rupsha    | 8.05       | 6.86  | 6.37         | 5.43 | 91.75             | 78.15 | 5.46       | 4.65  | 5.77        | 4.91 | 117.4      |
| Terokhada | 9.81       | 5.15  | 3.94         | 2.07 | 155.32            | 81.49 | 19.43      | 10.19 | 2.12        | 1.11 | 190.6      |
| 2021      |            |       |              |      |                   |       |            |       |             |      |            |
| KCC       | 41.01      | 66.39 | 4.95         | 7.64 | 0.36              | 0.56  | 10.02      | 18.56 | 4.3         | 6.64 | 45.65      |
| Dighalia  | 9.22       | 11.95 | 2.43         | 3.15 | 57.79             | 74.9  | 5.22       | 6.77  | 1.89        | 2.45 | 77.16      |
| Rupsha    | 12.03      | 10.25 | 5.69         | 4.85 | 88.95             | 75.77 | 4.95       | 4.22  | 5.84        | 4.97 | 117.4      |
| Terokhada | 15.22      | 7.99  | 3.15         | 1.65 | 150.78            | 79.11 | 17.39      | 9.12  | 3.41        | 1.79 | 190.6      |

**Table2. Weights of preparedness (PI) and vulnerability (VI) dimensions, and Resilience Index (RI) in study area**

| Dimensions            | KCC  |      | Dighalia |      | Rupsha |      | Terokhada |      |
|-----------------------|------|------|----------|------|--------|------|-----------|------|
|                       | PI   | VI   | PI       | VI   | PI     | VI   | PI        | VI   |
| Environment           | 2.11 | 2.09 | 1.73     | 1.81 | 1.40   | 1.91 | 1.22      | 1.93 |
| Infrastructure        | 1.91 | 0.68 | 2.13     | 2.13 | 1.50   | 2.24 | 1.50      | 2.24 |
| Economic              | 4.00 | 3.64 | 5.00     | 5.00 | 4.00   | 3.00 | 4.00      | 3.00 |
| Social                | 1.56 | 1.73 | 1.61     | 1.61 | 1.42   | 1.81 | 1.42      | 1.84 |
| Institutions          | 1.69 | 1.45 | 1.86     | 1.86 | 1.46   | 2.38 | 1.46      | 2.45 |
| Hazard                | -    | 4.14 | -        | 4.14 | -      | 4.14 | -         | 4.14 |
| Total score           | 2.26 | 2.29 | 2.47     | 2.76 | 1.95   | 2.58 | 1.92      | 2.60 |
| Resilience Index (RI) | 0.99 |      | 0.89     |      | 0.76   |      | 0.74      |      |

## 4. Discussion

Disasters and catastrophe management are significant issues in Bangladesh. This paper presents a contemporary survey of prevalent disasters experienced by Khulna residents over the past 15 years, incorporating expert insights on the preparedness, vulnerability, and resilience of KCC and its sub-districts. This document aims to elucidate the principal aspects of the study and identify efficient strategies for minimizing prevalent disasters as indicated by the survey.

Cyclones have posed a significant threat to populations in Bangladesh for centuries. Nonetheless, the peril posed by this natural threat has escalated both nationally and worldwide due to ongoing climate change, particularly in light of recent urban expansion akin to that observed in the study region over the past two decades (Fig. 5) (Table 1). Thirteen percent of the participants in KCC regarded cyclones as a significant natural calamity. The exacerbation of the issue would be attributed to the expansion of urban areas and the reduction of vegetation and forested regions. Since the late 1990s, numerous techniques have been proposed to alleviate the impacts of cyclones, including the construction of cyclone shelters, coastal embankments, afforestation, early warning systems, and the improvement of pre- and post-disaster management (preparedness) [25]. The mortality associated with cyclones in Bangladesh has

markedly decreased due to enhanced protective strategies; however, additional study is required to mitigate the hazards further [26].

Elevated water salinity and waterlogging were the most often reported disasters in KCC and all sub-districts (Fig. 4). In the context of limited water resources, water salinity has emerged as a national concern in Bangladesh, particularly in coastal and riverine areas, where the utilization of saline water correlates with a rise in hospital visits for cardiovascular diseases, diarrhea, and abdominal pain [27]. This significant issue has escalated over the past fifty years, severely affecting water availability and agricultural production systems in numerous regions [28], hence jeopardizing crop yields and food security, particularly in the south-western and south-central coastal zones. Conversely, waterlogging is exerting a significant socio-economic impact, particularly on women and children, the most vulnerable segments of the society [29]. Emphasizing coping techniques is essential to enhance the community's resilience to these two challenges. Salt-tolerant high-value crop production was recognized as a viable solution for agricultural systems affected by rising water salinity. Experts recommended the installation of sluice gates to regulate saltwater incursion from tributary rivers [30]. Conversely, enhancing drainage infrastructure and effective environmental sanitation management is essential to mitigate waterlogging issues. Moreover, the enforcement and routine maintenance of drainage systems must be performed consistently to alleviate this risk [31].

The KCC area exhibits the greatest overall resiliency. This enhanced resilience is mostly attributed to the equilibrium between substantial preparedness and controllable vulnerabilities (Table 2). Infrastructure, in particular, was determined to be less susceptible than the sub-districts. Dighalia, despite being well-equipped economically and institutionally, suffers from significant vulnerability, particularly in the economic sector. Rupsha and Terokhada exhibit the lowest resilience, characterized by inadequate planning and heightened risk across all dimensions. Notwithstanding the nearly balanced resilience index in the examined region, greater emphasis should be placed on improving infrastructure and augmenting employment prospects in the sub-districts. Addressing housing challenges in the KCC region through vertical and planned urbanization is essential to alleviate the current economic crisis. Moreover, additional efforts should focus on the environmental aspect by restricting urban expansion, particularly in suburban regions, to mitigate the loss of agricultural and vegetative land.

## 5. Conclusion

The limited water resources, waterlogging, and cyclones are among the major disasters facing the development in Khulna area, Bangladesh. Despite an almost balanced resilience index in the main city (KCC) the sub districts still suffer from increased vulnerabilities. Further development to the infrastructure in the sub districts accompanied by finding new job opportunities in these areas is necessary for sustainable development. Vertical urbanization might solve housing issue and the uncontrolled urban expansion in KCC, which would positively reflect on the environmental and economic dimensions in this region, leading to enhanced resilience and reduced vulnerability.

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## Data availability statement

The authors declared that data and data sources used in the preparation of this manuscript are mentioned in the text and its supplementary tables. Datasets used in the preparation of this manuscript will be available upon reasonable request from the corresponding author.

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