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Reclaiming Geomorphic Integrity in Shaping Dhaka North City Corporation in a Sustainable Way: The Case of Dakshinkhan Thana, Bangladesh

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Abstract

The Dhaka City Corporation, including the Dhaka North (DNCC) and Dhaka South City Corporation (DSCC) has been developing by ignoring the geomorphic controls and causing geoenvironmental deterioration. Comprehending the adverse impacts of such geoenvironmental decline, the present study delved into one of the newly developing urban areas of the DNCC, Dakshinkhan Thana. The objectives of the study were to investigate the reasons and causes of purchasing lands, to explore the consequences of natural hazards and disasters, to evaluate the significance of incorporating geomorphic controls, and to find mitigation measures to develop a sustainable plan for Dakshinkhan Thana. After being established in 2006, the Dakshinkhan Thana has experienced severe geomorphic deterioration due to lack of proper governance by the concerned national and local stakeholders, ignorance, and negligence of the land developers and local communities. Consequently, the study area has become a congested, vegetation-less, unhealthy, and long-enduring waterlogged urban settlement without any urban amenities. Nevertheless, the location, size, and geomorphologic controls of Dakshinkhan Thana were appropriate for developing a green urban area surrounded by water and provided with all the urban amenities. Hence the present study attempted to recommend the ways to incorporate geomorphic controls into the future sustainable plan for Dakshinkhan Thana.

Keywords: *Geomorphic Controls, National Disaster Management Plan, Geomorphic Integrity, Sustainable Land Use Plan, Dhaka Structure Plan*

Introduction

Dhaka City has gone through a glorious heritage and history for its physiographic, socio-economic, and politically strategic locations since its initiation as the capital of the Subah Bangla in 1610. The geomorphic controls such as physiography, land elevation, flood ability, and hydrology played a vital role in determining the initiation, growth, and Land Use and Land cover (LULC) pattern of a city at the initial stage. From the late 1990s, socio-economic stimuli like massive population influx and demand-supply imbalance of land tended the DCC to grow towards the eastern and western low-lying depressions. The previous land use plans for Dhaka City, such as the Master Plan, 1917 by Patrick Geddes; Master Plan by Macfarlane, Minoprio, and Spencely 1959; the Dhaka Structure Plan by RAJUK (1990-2015); and the recent Dhaka Structure Plan by RAJUK (2016-2035) focused on the conservation of physiography, land elevation, flood-ability,

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flood-flow zones, and open lands. However, the consequences of ignoring the geomorphic controls in these land use plans ensued into geoenvironmental deterioration and socioeconomic vulnerability, turning the DCC into one of the third least liveable cities in the world (EIU 2026). The present study selected Dakshinkhan Thana as the study area and emphasized incorporating geomorphic controls in its future sustainable development. Karim et al. (2019); Ahmad (2018); Reynard et al. (2017); Ahmad (2009); mentioned that geomorphology and geology directly or indirectly influence the geomorphic state of an urban area. These papers mentioned the occupation of the high (5 meters and above AMSL) and medium (2.5 meters to 5 meters AMSL) elevated lands of the Madhupur Terrace, its adjacent low-elevated (Lower than 2.5 meters AMSL) land, and the depression around the DCC to provide land for various purposes during the 1990s and 2000s. The consequences are prolonged waterlogging in the wet season, groundwater depletion, deterioration of natural geomorphic controls, and worsening of the socioeconomic status (SES) of the study area, especially in the wet season (Karim et al., 2019; Ahmad, 2018; and Mowla and Islam, 2013; Sultana et al., 2009; JIKA, 1991).

These studies recommended incorporating Dhaka city's surface and subsurface geomorphology and geology, proper monitoring and implementing appropriate ground movement techniques, and optimizing the conservation of the natural drainage system while constructing new urban structures in low-lying depression areas. The DWASA (2014) created an updated topography map and prepared a Water Supply Master Plan for the DCC for 50 years. Mowla and Islam (2013) recommended law enforcement regarding earth-filling and urban development, afforestation of terrestrial and aquatic vegetation along road sides and water bodies. Adelia and Khorshiddoustb (2011) examined the geomorphic controls, such as soil, land slope, unstable lands, and the ecological, hydro-climatic, and socioeconomic factors in selecting nine solid waste disposal sites. Ahmad (2009) recommended conserving the existing water bodies and excavating the filled-up ones to turn the DCC into a socioeconomically sustainable urban area. Mentioning the DCC as one of the earthquake-vulnerable zones, Shaha (2015); Hussaini et al. (2015); and Rahman et al.(2011) stated the severity of the Bengal earthquake of 1885 (Magnitude 7.0) and the Great Assam earthquake of 1897 (Magnitude 8.7), the epicenters of which were only around 30 km from Dhaka. These studies mentioned education level, financial ability to implement earthquake resistance, and efficiency of its laws to regulate the welfare of its people were the hidden causes of earthquake vulnerability.

The Comprehensive Disaster Management Programme (CDMP) developed a comprehensive Earthquake Contingency Plan (ECP) for the DCC in 2010, where geo-hazard disasters, precisely earthquake hazard risk reduction and emergency response techniques have been focused (UN 2019). Bilham (2014) mentioned rapid and unplanned urban growth, low SES, lower level of education, financial disability, inefficiency in regulating the people's welfare laws, and violation of the 'Building Code' for profit maximization as the key factors of earthquake vulnerabilities in urban centres. Ahmed et al. (2009) examined the spatio-temporal dynamics of growth and transformation of Dhaka City over 55 years (1952-2007) through an interrelationship between the morphological structure of artificial environments and social networks. Mentioning the significance of conserving the open lands, Garcia et al. (2020); Ahmad (2003); Dani (1962); Minoprio and Spencely (1959); and Taylor (1840) depicted the historical, geographical, climatic, and socio-cultural perspective of Dhaka from the early 1960s to 1900 with urban maps of Dhaka city. These studies recommended conservation of open lands (Poit, 2017). Adelia and Khorshiddoust (2011) stated that urban geomorphology determines short- and long-term scaling for industrial site and waste disposal site selection.

Nahrin (2008); Swapan et al. (2017); and Ahamed and Hasan (2010) mentioned that violation of geomorphic controls during urban planning exerts adverse impacts on the SES of the DCC, ensuing in social insecurity and crime incidents. Jahan (2012) stated that rural-urban migration impact the SES and geoenvironmental aspects in the DCC. Shajahan and Nilufar (2013) proposed a revised spatial structure of the DCC by connecting the surrounding rivers with the inland khals for establishing a sustainable transport system. In another study, Islam and Ahmed (2011) predicted the transformation of built-up areas on the water bodies, cultivated lands, and vegetation land types, eventually deleting biodiversity and human life. The Rajdhani Unnayan Kartripakkha (RAJUK), in their Dhaka Structure Plan (2016-2035), determined six Land use plan objectives to conserve the sensitive land areas of the DCC for environmental protection. The accelerating rate of water body and open space occupation for different LULC and rapid unplanned development in the flood-flow zones for urban encroachments were mentioned as the causes of fragile ecosystems, and vulnerable natural drainage systems that eventually endanger the geoenvironmental sustainability of the DCC. The RAJUK has emphasized preserving the existing khals, rivers, lakes, other water bodies, open spaces, and forest areas to ensure future development with more efficiency, effectiveness, and sustainability to enhance the quality of Dhaka city.

The earlier literature examined urbanization patterns, land-use change, agricultural land, wetland, and vegetation coverage loss, natural drainage depletion, waterlogging, and geomorphic vulnerabilities. However, comprehensive framework for incorporating geomorphic controls in sustainable urban land-use planning was not conducted. Even the Dhaka Structure Plans (1990-2015 and 2016-2035) (RAZUK 1990 and 2015) placed little emphasis on the consequences of neglecting the incorporation of geomorphic controls in land use planning, and the processes of reclaiming geomorphic integrity in developing a sustainable land use plan for Dakshinkhan Thana. Hence, the present study attempted to address the research gap by evaluating the existing geomorphic state, identifying the impacts of ignoring the geomorphic controls, and recommending incorporation strategies to reclaim the geoenvironment sustainability of the Dakshinkhan Thana of the DNCC.

Main Objectives

The main objective of the study was to focus on incorporating Geomorphic Controls in future sustainable land use plans for the DNCC. The specific objectives to achieve the main objective were:

i) To reveal the existing geoenvironmental state of the Dakshinkhan Thana
ii) To find out the land use and Land cover (LULC) change pattern of Dakshinkhan Thana
iii) To investigate the adverse effects of ignoring the geomorphic controls during Sustainable plan of the Dakshinkhan Thana

Conceptual Framework

The conceptual framework of the study illustrates the cause and effect relationship between LULC changes and geoenvironmental deterioration in the study area. Till the initiation, geomorphic controls has been altered in Dakshinkhan Thana due to rapid unplanned urbanization, and illegal encroachment. This has caused geomorphic deteriorations in the DCC. The study found that reclaiming the geomorphic integrity could be accomplished by restoring the water bodies, developing Eco-Land Use Zoning, and developing ‘Green Belts and Urban Forest’ in the Dakshinkhan Thana. The approaches towards sustainable development, were adaptation, coping,

resilience, conservation of the physical features, and conservation of environmental components of Dakshinkhan Thana has also been discussed in the study (Fig.1).

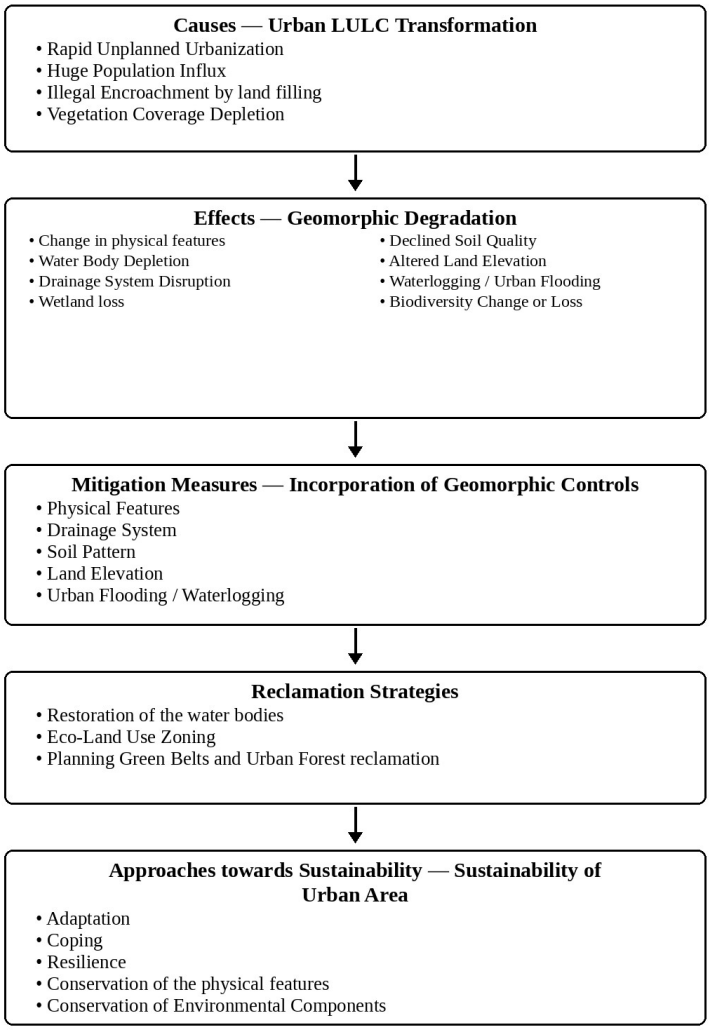

Fig.1: Conceptual Framework

Materials and Methods

Research Approach

The research was conducted in both qualitative and quantitative approaches to collect, analyze, and integrate the data. For the qualitative research approach, KIIs and questionnaire survey was conducted among the residents. For the quantitative research approach, Landsat images of the study area were used to show the geomorphic controls of the DCC.

Study Area

The Dakshinkhan Thana, Zone-7 of the DNCC, was selected as the sample area (Fig. 2). Despite being a comparatively newly developed part and one of the largest Thana of the DNCC under the RAJUK jurisdiction, Dakshinkhan Thana has been dealing with a rapid, highly mixed, and complex urbanization process.

Data Sources

Primary Data Sources

A semi-structured questionnaire with twenty four questions was used for a household survey of fifty landowners and tenants. A semi-structured questionnaire with seventeen questions was used for the KIIs with one officer from the Geological Survey, Bangladesh (GSB), and one officer from RAJUK, one founding-settler land owner, and one land broker living in the study area.

Secondary Sources

Satellite Images

Two Radiomterically and Atmospherically Corrected Temporal Landsat satellite images of two representative years, 2011 and 2021, were collected to analyze and measure the land elevation, and size of the water bodies, depressions or back swamps, and lowlands in the Dakshinkhan Thana (Table 1).

Table 1: Landsat Images of the Study Area

Year	Satellite	Spatial Resolution
2011	Landsat 5 TM	30 m
2021	Landsat 8 OLI/TIRS	30 m

Source: EROS Centre, USGS 2020

Processes of Satellite Image Analysis

The images were analyzed with three ArcGIS extensions discussed below:

(i) Normalized Difference Method for Built-up Index (NDBI) for Built-up Area

The Normalized Difference Built-up Index (NDBI) extension of ArcGIS was applied to create built-up area maps of the Dakshinkhan Thana for the years 2011 and 2021. The formulae used to

interpret the NDBI values is- NDBI = (SWIR -NIR) / (SWIR+ NIR), where the SWIR means 'Short Wave Infrared Light', and NIR means the pixel values from the 'Near-infrared' band, a part of the electromagnetic spectrum. The NDBI values range from -1 to +1, with positive higher values indicating the built-up areas.

(ii) Normalized Difference Vegetation Index (NDVI) method for Waterbody and Settlements

Two LULC maps were created from the Landsat images for the years of 2011 and 2021 to show the waterbodies and settlements with the Normalized Difference Vegetation Index (NDVI) method. The equation of NDVI is-

(NIR - R) / (NIR + R), where NDVI stand for Normalized Difference Vegetation Index; R represents the Red (the longest wavelength in the visible spectrum), and the NIR means the Near Infra-red wave lengths just outside the visible part of the electromagnetic spectrum. The scale of NDVI ranges from -1.0 and +1.0, where the values from -1 to 0 represent Waterbodies and values -0.1 to 0.1 represents Barren rocks and Sands.

(iii) The Advanced Spaceborne Thermal Emission and Reflection Radiometer Digital Elevation (ASTER DEM) Method for Elevation Contour

The imaging sensor ASTER of the Terra satellite was used to convert the satellite images with Digital Elevation Model (DEM) to create elevation contour maps of the Dakshinkhan Thana for 2011 and 2021.

The secondary data were collected from relevant books, journal articles, and national publications such as the Banglapedia, the Dhaka Structure Plan by RAJUK (1995-2025 and 2016-2035), and the GSB reports. The data collected from the KIIs were analyzed with Ms. Excel and cross-checked with different sources.

Data Presentation

The attributed data were presented in graphical forms like maps, graphs, tables, and flowcharts.

Findings and Analysis

Administrative Profile

The Dakshinkhan Thana, located between 23°50' and 23°53' north latitudes and between 90°24' to 90°27' east longitudes , covers 11.08 km^2 consisting six mahallas under one ward (Banglapedia 2021). The Thana is bounded by the Gazipur Sadar upazila on the north, Khilkhet Thana on the South, Uttar Khan Thana on the east, and Uttar and Biman Bandar Thana on the west (Fig.2).

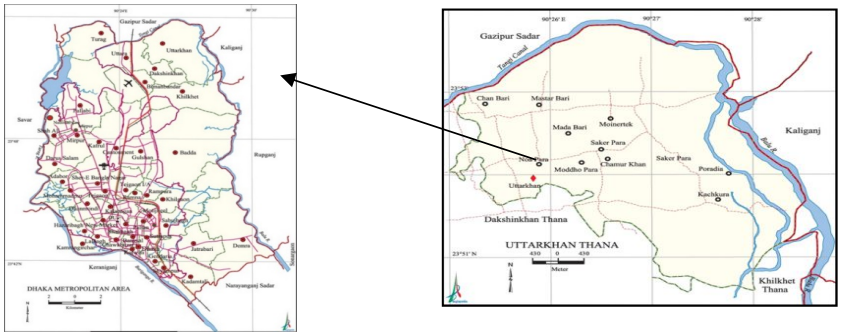

Fig.2: Dhaka City Corporation and Dakshinkhan Thana
Source: Banglapedia 2015

Land Use

Previously known as Dakshinkhan Union, the Thana was formed in 2006 and is governed by the Dakshinkhan Thana Counselor under the jurisdiction of the DNCC. Dakshinkhan Thana is a densely populated and congested urban agglomeration (Table 2, Fig.3 and Fig.4). The Bare soil (open lands) occupied about 2.9448 km^2 in 2011, which was entirely covered with settlements in 2021 (Table 2, Fig.3 and Fig.4). In 2011, natural waterbodies (depressions or back swamps) covered a total of 0.3952 sq.km (Fig.2 and Table 2), which entirely depleted in 2021 (Fig.3, Fig.4, and Table 2). The Fig.3 and Table 2 illustrate an increase submerged low-elevation areas in 2011 (0.6615 km^2) than that in 2021 (1.224 km^2) due to an increased long enduring waterlogging. The area covered by the settlements increased almost twice in 2021 (4.8 $km^{2)}$ than in 2011 (7.8 km^2) (Fig.3, Fig.4 and Table 2). At present, the entire study area suffers from severe waterlogging from May to September, with the highest depth during monsoon rain (Fig.3).

Table 2: Size of Different Land Uses: 2011 and 2021
Source: Ahmad, 2020-2021

Size of Different Land Uses (Sq.km.)	**Study Years**	
	2011	2021
Bare Soil	2.9448	
Low Land	0.6615	1.224
Settlement	4.9995	7.776
Water Body	0.3952	----

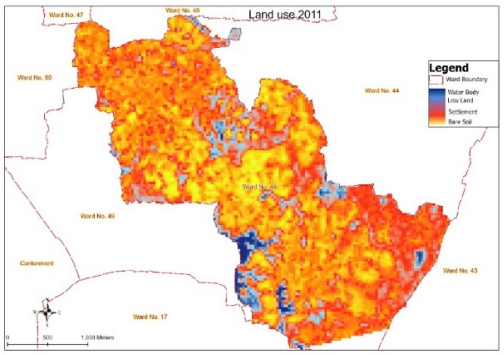

Fig. 3: Land Use Maps of Dakshinkhan Thana: 2011
Source: Ahmad, 2020-2021

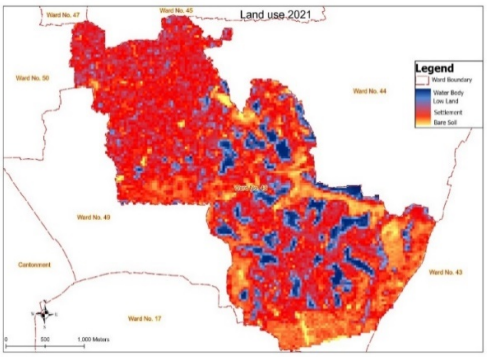

Fig. 4: Land Use Maps of Dakshinkhan Thana: 2021
Source: Ahmad, 2020-2021

Even the lowlands surrounding the natural waterbodies get inundated with water logging for four to five months (Fig. 3 and Fig. 4). The study found that rapid unplanned growth of settlements within a period of 10 years from 2011 to 2021 turned the Dakshinkhan Thana into highly congested, naturally hazardous urban agglomeration (Fig. 3 and Fig. 4). Most of the respondent land owners (90%) constructed their buildings by taking permission from the Dakshinkhan Thana authority in the early 2010s. Only a small percentage of the landowners took permission from the RAJUK and followed the Building Rules during the construction of the buildings. The vast land of bare soil in 2011 has been observed to be occupied by both planned and unplanned urban settlements in 2021 (Fig.3 and Fig.4).

Demographic Profile

The total population of Dakshinkhan Thana was 1, 77,760 and the density was 16,043 per km^2 (Dakshinkhan Thana, Banglapedia 2021). The population ratio showed male majority (99743:78017). The percentage of Muslims (19813) were followed by Hindus (6455), Buddhists (921), Christians (296), and individuals of other religions (275) in 2021. The average literacy rate for the same year was reported to be 68.87% (Dakshinkhan Thana, Banglapedia 2021).

Geomorphic Profile

The Dakshinkhan Thana, the eastern sub-flood flow zone of DNCC, is comprised of low land and abandoned channels (Fig.5). Even in the late 1990s, the Thana was characterized mainly by low flood lands, numerous khals, depressions, gully fills, and abandoned channels ranging from 1.5 to 5 meters AMSL, spotted with segregated high elevated Pleistocene terrace lands of 5 to 6 meters AMSL in average (Fig.6) (Ahmad,2007 and Ahmad, 2018). The main khals were the Gobindapur Khal, Kashaibari-Boalia Khal, and Behnai Khal (Datta and Mandal, 2017).

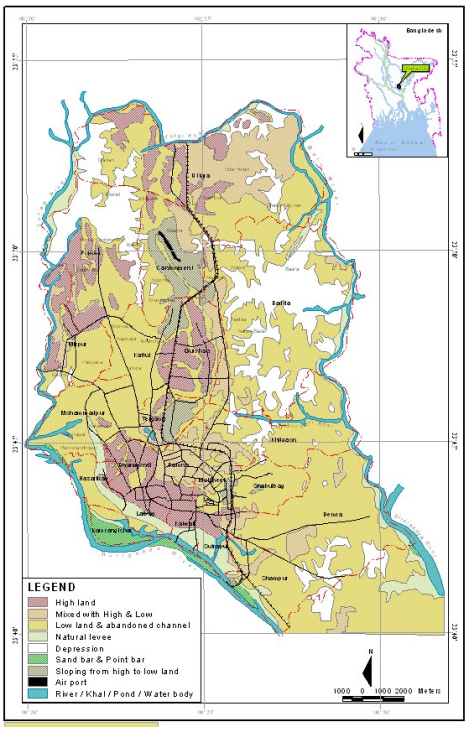

Fig. 5: Geomorphological Situation of DCC
Source: Ahmad, 2007

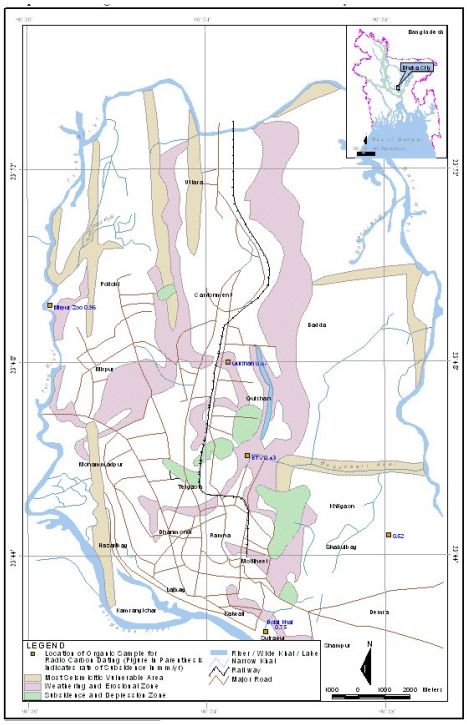

Fig. 6: Weathering, Erosion, and Subsidence Zone in DCC
Source: Ahmad, 2007

Geologic Structure

The Dakshinkhan Thana is located on eastern edge of Madhupur Terrace, with an elevated landmass (8m AMSL) bounded by floodplains of the rivers Ganges, Brahmaputra, and Buriganga. Surrounded by numerous faults, the Terrace has elevated dome-shaped low hillocks and Dish-shaped depressions resulting from erosion (Bijoy Soil Investigator, 2014). The study area is located at a shallow depression of the terrace (Bijoy Soil Investigator, 2014). The study area is a vulnerable zone of weathering and erosion with numerous faults and lineaments. There is a significant subsidence and depression zone following a north-south direction along the western side of Dakshinkhan Thana and a fault line following the Behnai Khal in an east-west direction (Fig.6). The Dakshinkhan Thana was within the normal flooded zone even in the year even in the year 1998 (Ahmad, 2009). The present study observed waterlogging as the primary natural hazard in the monsoon season, from May to September.

Tectonic Features and Seismic Vulnerability

The study area is bounded by several faults resulting from vertical movement, while lateral movement is also reported. The Balu Fault (F2) on the eastern side is stretched north-south, downthrown to the south (Ahmad, 2018). The Behnai khal at the easternmost side of the study area flows in a southwest direction along the lineament (L2) (Ahmad, 2007). Tectonically, Dakshinkhan is located in the deeper part of the Bengal Basin with no surface folding or faulting.

The Dakshinkhan Thana is within the Seismic Zone II with a seismic coefficient is around 0.05 (Bijoy Soil Investigator, 2014).

Land Elevation

The contour map of Dakshinkhan Thana shows that the number of contour lines with 4m to 6 m AMSL elevation is the highest (236-237). A total of 154 to 173 contour lines show 8 m to 12 m AMSL elevations. Only 01 contour line represents the lowest elevation (-2 m), and another contour line with the highest elevation of 18 m AMSL. On the other hand, 03 contour lines are aligned with the Mean Sea Level (MSL). Another 20 contour lines represent low land with 2m AMSL elevation (Fig.7).

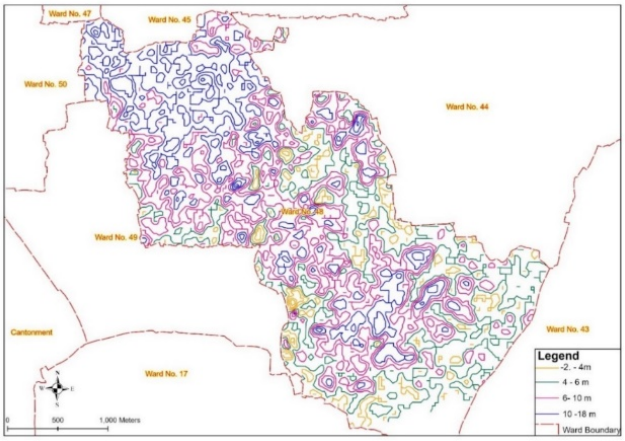

Fig.7: Contour lines of Dakshinkhan Thana

Source: Ahmad, 2020-2021

Drainage System

The Dakshinkhan lies on the flood-flow zones on the eastern flank of the DNCC (Fig.5). The rivers Balu and Tongi Khal delineate the northern and eastern sides of the Dakshinkhan Thana. The Behnai khal at the easternmost side of the study area is one of the essential khals in the study area. The drainage system of the study area has become stagnant due to the encroachment of water bodies by earth-filling, waste disposal, construction roads, and other establishments.

Soil Composition

The older alluvium soil in the Madhupur Terrace has developed on the Madhupur clays. The soil is low in nutrients, slightly acidic, and red or brown. The soil is primarily silty clay with a trace of fine sand (Bijoy Soil Investigator, 2014).

Climatic Situation

The temperature of the Dakshinkhan Thana varies from 19° to 32° Celsius (Abrar et al., 2022). Dakshinkhan Thana is within a tropical wet and dry climate. Almost 80% of the rainfall occurs in

the monsoon season, from 339.4 millimeters in May to 373.1 millimeters in September (BMD, retrieved on 29.7.2023).

Socioeconomic Status of Respondents

Age and Sex

A total of thirteen male and seven female respondents were interviewed. Among them Majority (13) were males, and only 07 respondents were female. Among them, the highest number (10) of respondents were of age group 60-70. Five respondents were from the age group 30-40, and the age group 40-50 (Fig.8).

Education and Religion

Among the 20 respondents, the highest number (09) were graduates, followed by 08 respondents who passed H.S.C. Only two respondents passed S.S.C. while the least (01) held a Master degree. However, all the respondents were Muslims.

Occupation and Monthly Income

The highest percentage of respondents (55%) earned from the Private Services sector, followed by Government Services (20%). The lowest percentage of respondents work as Home Makers, who are the female members of households and take every responsibility of the family as their husbands work in other countries (Fig.8).The highest number of respondents were from the Lower middle-income group (07), closely followed by the Upper Middle-income group (06), and Low income (05).Only two respondents were from the High-income group (Fig.9 and Fig.10).

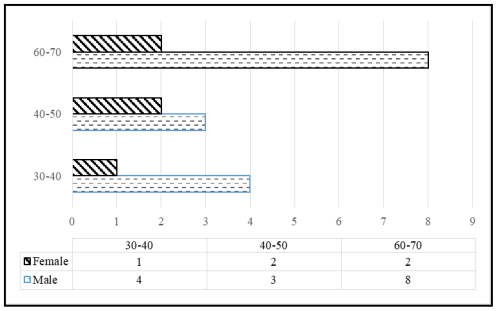

Fig. 8: Age -Sex Structure of Respondents
Source: Ahmad, 2020-2021

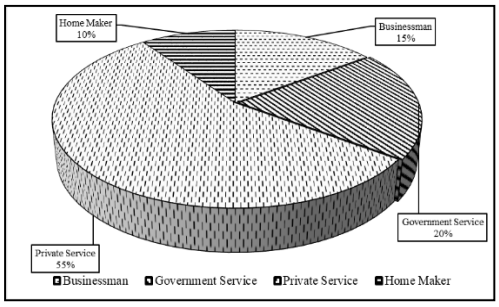

Fig.9: Occupation of Respondents
Source: Ahmad, 2020-2021

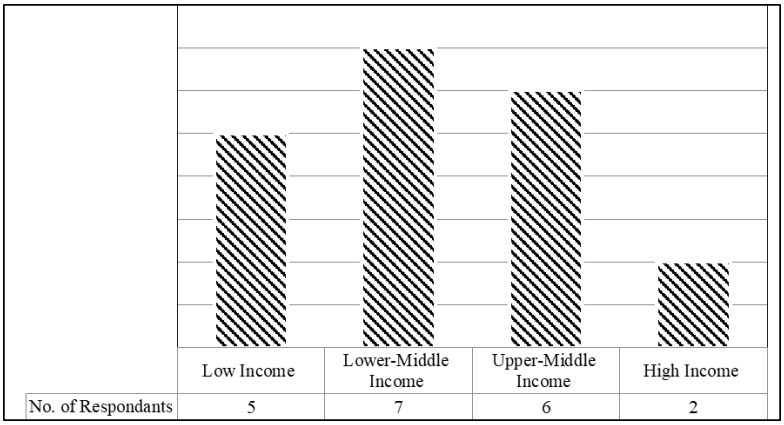

Fig.10: Income Group of Respondents

Source: Ahmad, 2020-2021

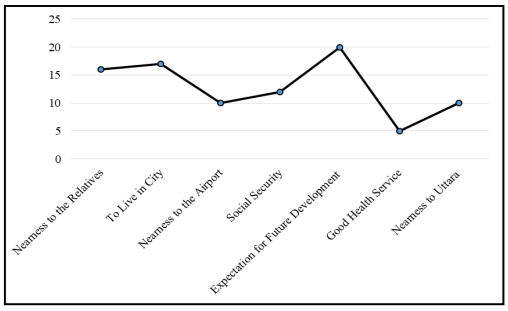

Fig. 11: Reasons for Buying Land in Dakshinkhan
Source: Ahmad, 2020-2021

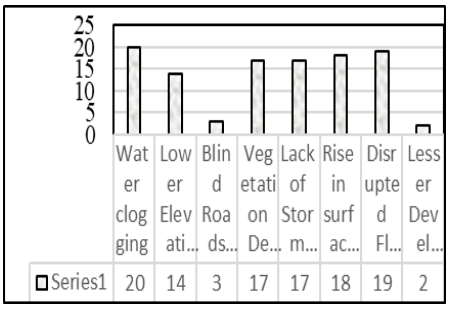

Fig. 12: Natural Hazards and Disasters in Dakshinkhan Thana
Source: Ahmad, 2020-2021

Reasons and Consequences of Purchasing Land in Dakshinkhan Thana

Most of the land plots were bought during the last two decades like the early 1990 to the recent years of 2000. The respondents mentioned several reasons for buying land in Dakshinkhan Thana (Fig.11). Among them, the highest number of reasons for purchasing land was 'Nearness to

Highway or Main road' (19), followed by the reasons like 'Lesser Price' (18), 'Social Securities' (17), and 'Expectation for Future Development' (16). However, 'Nearness to Airport' (12) was one of the primary reasons for households where a family member works abroad. Another significant reason for purchasing land in the Dakshinkhan Thana was the 'Nearness to Uttar Model Town' where better education facilities are available. Among other reasons, the availability of 'All kinds of facilities' (13) and access to 'Good Health Services' (05) were mentioned as the reasons of purchasing lands in Dakshinkhan Thana (Fig.11).

Table 2: Age-Sex and SES Preferred for Urban Disaster Management Volunteers

Age		**Sex**		**Income Group**			**Education Status**	
Adult	Young	Male	Female	High	Middle	Low	Educated	Uneducated
16	18	20	15	10	19	07	17	18

Discussion

Urbanization, LULC, and Geomorphic Degradation in Dakshinkhan Thana

The findings of the study reveal a rapid LULC change in Dakshinkhan Thana, from a geomorphically shaped rural area (5.0 km² to 7.8 km²) to a densely populated urban area within only a decade (2011-2021). The Geomorphic Controls, such as land elevation, abandoned channels, khals, depressions, and flood-flow zones of the study area were mostly land-filled, demonstrating the urban expansion at the expense of the natural geomorphic state (Ahmed et al. 2022). The consequences are rapid unplanned LULC change causing imbalance in hydrological state, disruption and fragmentation of the natural drainage system, and an accelerated rate of prolonged waterlogging for four to five months a year (Islam, K. & Ahmed, F., 2022; Dewan[1], A. M. & Yamaguchi, Y., 2009; Dewan[2], A. M. & Yamaguchi, Y., 2009).

LULC Change and Water Logging in Dakshinkhan Thana

Dakshinkhan Thana is geomorphically a shallow depression on the eastern flank of the Madhupur Terrace, sloping down from the higher Pleistocene Terrace at the west flank (Banglapedia, 2021).The area functioned as the flood flow zone and water retention zone of DNCC in the monsoon season (Banglapedia, 2021; Karim et al., 2019; Islam et al., 2021). Hence, the study area was supposed to be planned considering its role as the natural drainage system to avoid the adverse impacts of persistent water logging (Mowla and Islam, 2013*;* Islam et al., 2010; Ahmad, 2009).The paper found that land filling and compartmentalization of the depression has resulted in prolonged water logging and flood vulnerability, which has been declining SES of the study area.

Natural Hazards and Consequences: Respondent's Feedback

The natural hazards and disasters in Dakshinkhan Thana have accelerated rapidly due to unplanned and unscrupulous construction of high-rise buildings, narrow roads, and lack of proper administrative governance (13).

All respondents identified waterlogging as the primary geoenvironmental hazard in Dakshinkhan Thana (Fig.12). Other hazards mentioned by respondents included disrupted flood flow zones (19), rising surface temperature (18), lack of a stormwater drainage system (17), low land elevation (14), vegetation depletion due to excessive tree cutting (07), blind roads (03), and lesser development (02), all of which hinder socioeconomic and structural development.

Geomorphic Degradation and SES of Dakshinkhan Thana

The study revealed that the relationship among geomorphic controls, the geoenvironment, LULC change patterns, and social behaviour in response to these factors is highly complex in an urban area. Deterioration of the geomorphic controls has resulted in a decline in SES of the Thana as well. Although most of the respondents purchased land because of accessibility, lower land prices, social security, and nearness to the national Airport and highway, and expectations of future development, prolonged and persistent waterlogging in the study area has been deteriorating the SES in all aspects. The students have to stay home during monsoon waterlogging; movement of elderly and sick people gets restricted; the connecting roads get inundated and severely damaged. This situation shows a paradox in urban development, where short-term economic benefits cause long-term geoenvironmental and socioeconomic deterioration. For future sustainable land use plan of the Dakshinkhan Thana, reclaiming geomorphic integrity is urgently needed (Fig.13).

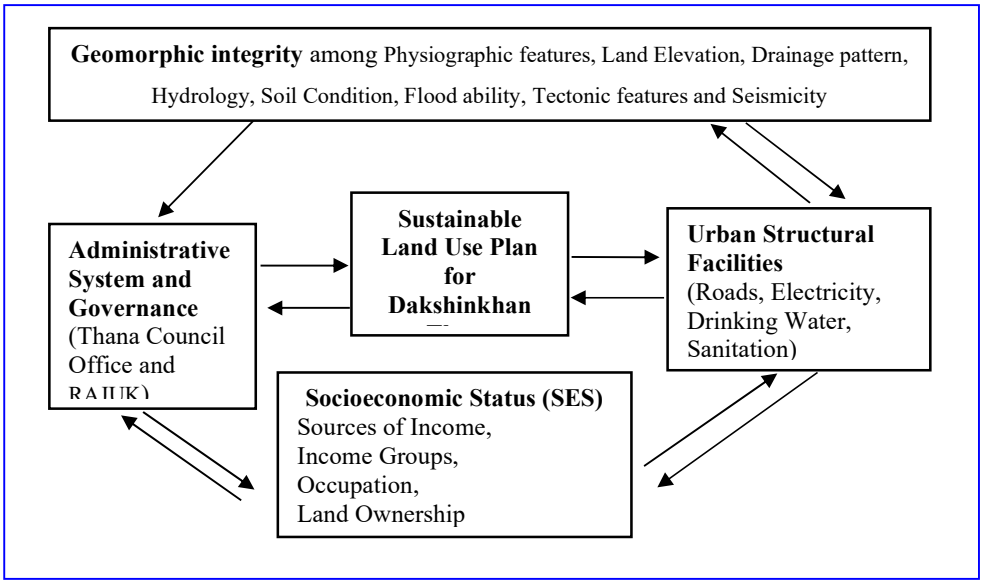

Fig. 13: Impacts of reclaiming geomorphic integrity for Sustainable Land Use Planning in Dakshinkhan Thana

Geomorphic Degradation and Governance in Dakshinkhan Thana

According to the respondents, besides the natural obstacles, the Dakshinkhan Thana has been confronted with uncontrolled urban growth, weak governance, and poor enforcement of planning.

Mitigation Measures taken by Respondents of Dakshinkhan Thana

All the respondents mentioned placing rubbles on the neighborhood roads to make the inundated roads higher. They took this initiative by themselves to lessen the difficulties of crossing through 2ft. to 3 ft. water during waterlogging in the rainy season.

Recommendations

1) Conserve existing water bodies, excavate depleted khals, and improve stormwater drainage system to ensure uninterrupted surface runoff
2) Broaden the roads by evicting the slums, squatters, and street markets
3) Confirm implementation of RAJUK approved 'Building Construction Act', specifically for conservation of open green areas in each plot
5) Implement the Earthquake Contingency Plan (2019) for further urban construction, and
6) Form all age and gender-inclusive volunteer groups from the Thana and train them about urban disaster management.

Conclusion

The Dakshinkhan Thana is one of the significant urban areas in the DNCC. The location of the Thana is almost at the central area of the DNCC. The importance of the Dakshinkhan Thana was enhanced after the inclusion of the area within the Dhaka Structure Plan by RAJUK in 1990. Since then, people from different socioeconomic levels have bought lands, built houses, and rented to live in the Thana. In 2006, Dakshinkhan Union turned into a Thana due to its increasing importance as an urban agglomeration accommodating the increasing number of permanent residents and various institutions. Consequently, the Dakshinkhan Thana has become a densely populated area with highly mixed LULC and minimum urban amenities. The situation in Dakshinkhan Thana depicts the ignorance, negligence, unawareness, and lack of proper governance that has turned the Thana into a congested, unhealthy, and vulnerable geoenvironmental area. The geomorphic controls have been entirely neglected to provide land for urban development. The consequences are the decline of the physiographic features, drainage congestion, and waterlogging for four to five months. All these have caused a decline in the SES of the residents. Nevertheless, the geomorphic controls of the Dakshinkhan Thana might be reclaimed at a large scale by developing a sustainable land use plan.

Contribution of the Study

The study is expected to indicate the major constraints of sustainable development of most of the wards in DNCC. Reclamation of the Geomorphic Controls of the wards and their conservation from further deterioration would ensure the sustainable development of the DNCC.

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