A study on landscape fabric of low-cost settlements in Sylhet, Bangladesh

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Summary

Low-cost settlement (LCS), also known as slums, is a prevalent feature of many cities across the world. These densely populated areas often accommodate a significant portion of the urban population, providing affordable housing for low-income residents. However, LCS can face challenges related to inadequate infrastructure, sanitation, and overall environmental quality. This study delves into the fabric of existing LCS landscape development in Sylhet City, Bangladesh that include overall built environment, vegetation, sanitation, waste management, playground for children, space for socialization, security and other service facilities etc. Using a mixed-methods approach involving data collection, image analysis, physical surveys, and questionnaires, the research explores outdoor landscape patterns, dwelling types, spatial morphology, and environmental conditions within these settlements. The investigation also focuses on the pattern used on the land surface, layout of circulation spaces, connectivity, and the socio-economic conditions of the slums within the Sylhet City Corporation area. Ultimately, this research aims to contribute to further studies on low-cost settlements at a regional or national level based on context, and to propose solutions to the challenges identified.

Keywords

1. Introduction

Human settlements have evolved from Palaeolithic caves to urban centers in the Iron Age, showcasing progress in architecture, technology, and urban planning [Kennedy 2019]. These settlements vary from rural villages to vibrant cities, promoting social interaction and innovation. Each type of settlements, whether suburban neighbourhoods or refugee camps, encounters distinct challenges. Gaining insight into these settlements is essential for creating sustainable and resilient communities for the future.

The rapid urban growth of Sylhet city has resulted in a rise of low-cost settlements (LCS), which are essential for accommodating low-income groups. Nonetheless, these areas frequently encounter issues like overcrowding, limited access to basic services, and exposure to environmental risks. Tackling these challenges is crucial for promoting fair and sustainable urban development in Sylhet, especially given the rising population density and the effects of climate change. This study aims to analyze the current situation of these settlements and propose strategies for their enhancement. The primary objective is to identify and tackle the socioeconomic, spatial, and environmental challenges faced by residents. Following objectives guided this research.

- Assessing Living and Landscape Conditions: Evaluating the adequacy of housing and outdoor land-use patterns, access to amenities, and socioeconomic stability in selected slums.
- Analyzing the Spatial Dynamics of Outdoor Landscape: Investigating land-use patterns, connectivity, and environmental features through satellite imagery and field data.
- Developing Sustainable Strategies: Proposals of land-use and landscape pattern as guidelines to improve the physical, social, and economic conditions of these settlements.
- Establishing Resilience Frameworks: Creating a landscape assessment protocol (LAP) based on global standards to boost resilience, waste management, less pollution, healthy outdoor spaces, and overall quality of life.

By addressing these objectives, the study aims to contribute to the development of resilient and inclusive urban environments. The findings will provide a foundation for sustainable urban slum development in Sylhet city, highlighting the necessity for equitable solutions to improve the living standards of low-income urban dwellers.

2. Theoretical framework

2.1. Impact of migration on rural and urban settlements

Rural settlements, as defined by Cloke [1983], differ from open countryside due to diverse processes shaping built and unbuilt environments [Coppock 1977]. While population thresholds, such as Moss's [1978] suggestion of 200–5000, are often used, Thorburn [1971] emphasizes understanding rural settlements through their functional and aesthetic purposes and residents' perspectives. These settlements are predomi-

nantly tied to primary economic activities like agriculture and resource extraction, and may develop naturally or through planned interventions [NCERT 2007]. They reflect a strong connection to the land, shaped by socio-cultural and environmental factors. Rural settlements can be classified into four types [NCERT 2007] :

- Compact or Nucleated Settlements: Houses are closely built around a central site, distinct from farmlands.
- Semi-Compact Settlements: Houses are small and loosely clustered with scattered hamlets.
- Hamlet Settlements: Fragmented units are often separated by fields.
- Dispersed Settlements: Scattered houses or huts, ranging from individual units to small clusters.

Urban settlements are primarily characterized by non-agricultural activities (secondary and tertiary sectors). They develop either organically through population growth and demand or via planned initiatives [Caves and Rozer 2005]. These areas offer better jobs opportunities, educational resources, and amenities, which drives rural-urban migration. In cities, informal dwellings and slums are common, housing the urban poor who seek affordability amidst rapid urbanization [UNHCR 2001]. Unplanned settlements grow around urban areas due to people migration (caused by push and pull factor) from rural in search of a better life. The low-cost settlement/ slum exhibit an in-between pattern of rural and urban fabric, with poor outdoor spatial arrangement, health hazards, lack of social safety and security, pollution, poor landscape and crimes takes place.

Migration refers to the movement of individuals from one location to another for the purpose of living or working, which can occur over various distances and timeframes (BBC). From 2001 to 2011, India experienced rural and urban population growth rates of 12% and 32%, respectively, largely fueled by migration from rural areas to urban centers in search of better opportunities and amenities [Rasool et al. 2012, Parkins 2010, Dyson 2011]. The International Organization for Migration (IOM) indicates that 70% of slum residents in Dhaka have experience environmental shocks. Research by the Centre for Urban Studies (CUS) documented slum populations of 275,000 in 1974, 718,143 (across 2,156 slums) in 1991, 1.5 million (in 3,007 slums) in 1996, and 3.4 million (in 4,966 slums) by 2005 [CUS 2005]. Migration is driven by push factors such as unemployment, inadequate living conditions, and natural disasters, while pull factors, such as job availability, better living conditions, and access to services, draw people to new areas [Kainth 2009]. Ravenstein's laws suggest that internal migration typically involves short distances toward industrial and commercial hubs, with women often migrating locally more than men, mainly for economic reasons [Ravenstein 1889].

The impact of migration on urban low-cost settlements is multifaceted. The migration from rural to urban settings cause informal and unplanned settlement growth. Existing infrastructure cannot satisfy service needs like sanitation, electricity and water. Environmental degradation and pollution are a common phenomenon in low-cost settlements. Moreover, low-cost settlements have become a symbol of urban

inequality due to the concentration of poverty within cities. However, migrants bring diverse cultures, languages, and traditions which often shape urban identity. On the other hand, so-called urban locals do not accept migrants, considering them outsiders and creating social isolation. Consequently, low-cost settlements often become disconnected from the surrounding social circle, forced into a kind of social void.

2.2. Rise of urban slums as low-cost settlement (LCS) in Bangladesh

In Bangladesh, the number of people living in poverty in urban areas is alarming. People migrate to cities due to the economic vitality. The Slum Census preliminary report 2014 from BBS reveals that the number of slum dwellers increased fourfold in the last 17 years [Islam 2015 and BBS 2014]. The rapid growth of rural-urban migration has been a common feature of developing countries. In China, for instance [Wang et al. 2000] identified the scale of the floating population in cities related to rural-urban migration, as well as the consequences of this influx of migrants. In Bangladesh, too, the flow of migrants to major cities has alarmed the observers. Rural-urban migration flows increased dramatically during the famine of 1974 [BBS 1996]. Therefore, the share of rural migrants as a share of the urban population rose to 8.9% from 5.2% in 1961. A distinct selectivity concerning age, sex, caste, marital status, education and occupation is evident in rural-urban migration [Millington 2000]. Of 491 urban locations in Bangladesh, only the four largest cities (Dhaka, Rajshahi, Chittagong and Khulna) are officially recognized as metropolitan cities. About 22% of the 129 million people in Bangladesh live in urban areas. The level of urbanization in Bangladesh is comparatively low, but the pace is high, ranging from 7 to 11% over the last five decades [Islam 1996]. During the decade from 1951, the total urban population rose from 1.8 to 2.6 million. The factors responsible for such growth were the large-scale migration of Muslims from India after Partition in 1947, and the development of new centers of trade, commerce, industry and administration in the region after the formation of Bangladesh in 1971 [Islam 1999]. Migration describes the movement of individuals to a new place of residence for at least six months, with internal migration affecting population growth and resource distribution. Slum dwellings experience in-migration due to uncontrollable conditions, with residents often moving abruptly between neighborhoods.

2.3. Landscape management for low-cost settlement (LCS) planning in Sylhet

The history of migration in Sylhet is closely tied to the labor influx during the British colonial period, particularly for jobs in tea cultivation and manufacturing. This led to the establishment of slums near the tea estates, which often lacked adequate water, sanitation, and healthcare facilities [Sadek 2006]. The situation worsened after the 1947 partition, as migration from India intensified the housing crisis. By 2004, Sylhet was home to 11,927 slum households, representing 2.01% of the city's population. The slums in Sylhet are characterized by overcrowding, poor living conditions, and insufficient infrastructure.

Recent research that focuses on the complex socio-economic and environmental conditions affecting life in Sylhet's slums [Islam et al. 2023] gives a clear overview of the poor living conditions in the city It also highlights that although the majority of houses are semi-pucca, and a significant number of residents have access to deep tube wells and sanitary latrines, the collective ownership of such amenities, along with poor waste management, renders these groups even more susceptible. Migration patterns strongly influence the demographic makeup of such slums, since the majority of their residents are climate-displaced people from low-lying and erosion-prone districts such as Sunamganj and Habiganj. This is also examined in reports by the International Centre for Climate Change and Development [ICCCAD 2024] and the International Organization for Migration [IOM 2022], which explain how climate displacement is driving rapid informal urban growth in cities like Sylhet. UNFPA [2016] presents a detailed account of the challenges of urbanization and migration, emphasizing the need for inclusive planning to serve the urban poor. Despite environmental and infrastructural constraints, such as flood-prone areas and poor drainage, these slum communities demonstrate resilience through tight-knit social groups, retained cultural traditions, and informal economies, such as rickshaw pulling, day laboring, and small-scale vending. While Sylhet's economy is heavily driven by global remittances, such money flows seldom reach its slum dwellers, who are also mostly isolated from such wealth streams. Further research by ICCCAD [2024] highlights the adaptations of poor urban migrants, drawing on how survival in such unstable places is sustained through shared adaptation strategies and resourcefulness. Together, these studies paint a detailed picture of Sylhet's slums as vibrant but neglected urban fringes, created by environmental vulnerability, economic precariousness, and cultural continuity.

Sylhet slum research is intended to capture the complex interaction of migration, poverty, and poor urban services [Islam et al. 2023]. Surveys and focus group interviews employed to study the livelihood of 138 slum dwellers discovered high illiteracy and insecure income rates, with the majority of the residents engaged in informal activities, such as rickshaw pulling and day laboring. The research revealed that limited access to healthcare and high levels of diseases spread as persistent problems. In terms of sanitation, Ahmed et al. [2008] took surveys and visual inspections in five low-income slums and found that only 14.5% of residents used sanitary latrines at first, but this number has increased to 78% following community-based interventions. Similarly, Reza et al. [2019], using questionnaires and FGDs, found that 80% of slum residents defecated in the open and that the disposal practices were not hygienic [Kamal 2018].

Qualitative interviews used to examine water and sanitation practices found the prevalence of untreated supply water and unhygienic practices among migrant households. Ahmed et al. [2017], using structured questionnaires, explored waste disposal practices, noting an uncertainty about whether the responsibility lay with landlords or residents. Health issues were also looked into in greater detail by [Hussain and Wakkas 2019], who studied slum-residing adolescent girls, finding poor access to healthcare and low rates of awareness regarding menstrual hygiene [Sharma 2022]. Food insecu-

rity was studied using logistic regression, identifying family size and migration recency as determinants of lowering food security.

Apart from research based in Sylhet, international research has also demonstrated the applicability of spatial analysis techniques, such as the landscape assessment procedure (LAP), to understanding the situation in slums. For instance, Bhan and Jana [2013] employed GIS-based mapping and participatory spatial analysis to examine land-use patterns, topography, and access to infrastructure in their research on informal settlements in Delhi. Their landscape-oriented methodology permitted intimate visualizations of the manner in which informal settlements form within urban constraints, offering vital information for slum planning and upgrading. Such tools are particularly useful in rendering apparent micro-scale spatial processes not readily visible in traditional survey-based methodology, and in offering reproducible templates for similarly afflicted cities like Sylhet of unplanned urbanization and land tenure insecurity. Together, these studies unveil the scale of social and infrastructural challenges facing residents of Sylhet's slums. Through the integration of quantitative and qualitative methods, researchers have built a nuanced portrait of existence in these settlements, one defined by precarious livelihoods, unsanitary conditions, and the need for focused, community-based intervention.

3. Methodology

This research followed a mixed-method approach combining qualitative and quantitative methodologies (Fig. 1). To gain insights into socioeconomic and demographic factors, a standardized questionnaire was created and distributed to a representative sample of households in each selected slum. This questionnaire aimed to collect information on socio-cultural aspects, employment, income stability, access to essential services, and residents' perceptions of their living conditions. Additionally, interviews and open-ended survey responses provided a deeper understanding of community dynamics and the needs of the residents. Simultaneously, satellite image analysis was performed using tools such as Google Maps to improve the field surveys. This analysis offered further insights into settlement density, land-use characteristics, spatial patterns, and connectivity. Through the integration of field data with remote sensing, this study gained a more comprehensive perspective on the spatial dynamics within the low-cost settlements in Sylhet.

After completing data collection, both quantitative and qualitative analyses were carried out. Quantitative data from the surveys were examined using descriptive statistics in order to emphasize key findings regarding living conditions, amenities, and demographics. Thematic analysis of qualitative data, including interview transcripts and open-ended responses, revealed recurring themes related to socio-cultural dynamics and settlement patterns. The findings were then used to develop master plans and architectural sections for each slum. These visual representations incorporated insights on housing types, spatial organization, and environmental challenges, offering targeted strategies for improving living conditions. Master plans also addressed broader issues, such as access to services, flood resilience, and social spaces.
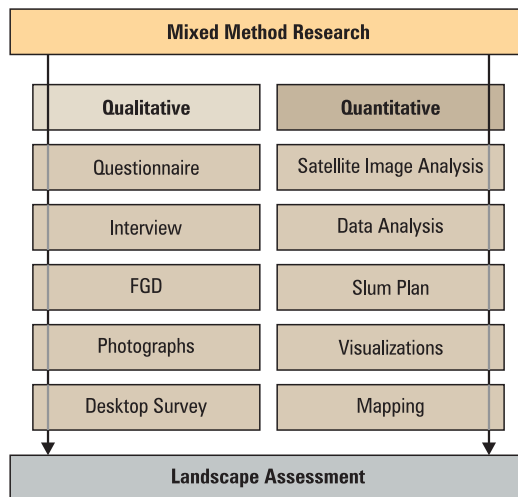
Source: Authors' own study

Fig. 1. Diagram of the mixed-method research

Finally, a landscape assessment protocol (LAP) was formulated using global standards from organizations such as WHO, UN-Habitat, and the World Bank. This protocol evaluated key factors such as housing adequacy, essential services, waste management, flood resilience, and socioeconomic stability. The LAP provided actionable recommendations for sustainable and resilient urban planning, ensuring the proposed strategies align with equitable development principles.

In short, this comprehensive methodology integrates diverse data collection methods and analytical techniques to deliver valuable insights into Sylhet's low-cost settlements. It establishes a robust framework for assessing vulnerabilities, identifying needs, and proposing sustainable solutions for urban improvement.

This methodology provides a comprehensive framework for assessing and addressing the challenges of low-cost settlements in Sylhet (Table 1), ensuring sustainable and equitable urban development strategies.

Table 1. A comprehensive framework of LCS selection and assessment for the case area

Step	Activities	Tools/Approach	Outcomes
Selection of slums	Identified 13 slums based on location, impact, and diversity.	Criteria: geography, economic impact, stakeholder analysis.	Representative sample of Sylhet's low-cost settlements.
Physical surveys	Inspections of housing, amenities, and spatial organization.	Observations, photographs, and field notes.	Insights into built environment and spatial features.

Table 1. cont.

Step	Activities	Tools/Approach	Outcomes
Socioeconomic survey	Questionnaire on demographics, income, and living conditions.	Standardized survey, interviews.	Socioeconomic and cultural data for analysis.
Satellite image analysis	Examined land-use, settlement density, and connectivity.	Google Maps, remote sensing tools.	Spatial patterns and environmental insights.
Data analysis	Statistical and thematic analysis of collected data.	Descriptive statistics, thematic coding.	Patterns in settlement dynamics and needs identified.
Master planning	Created architectural sections and master plans for each slum.	CAD, and visualization tools.	Comprehensive development strategies for LCS.
Landscape assessment	Applied global protocols for housing, health, and resilience.	WHO, UN-Habitat, World Bank frameworks.	Framework for sustainable improvements in LCS.

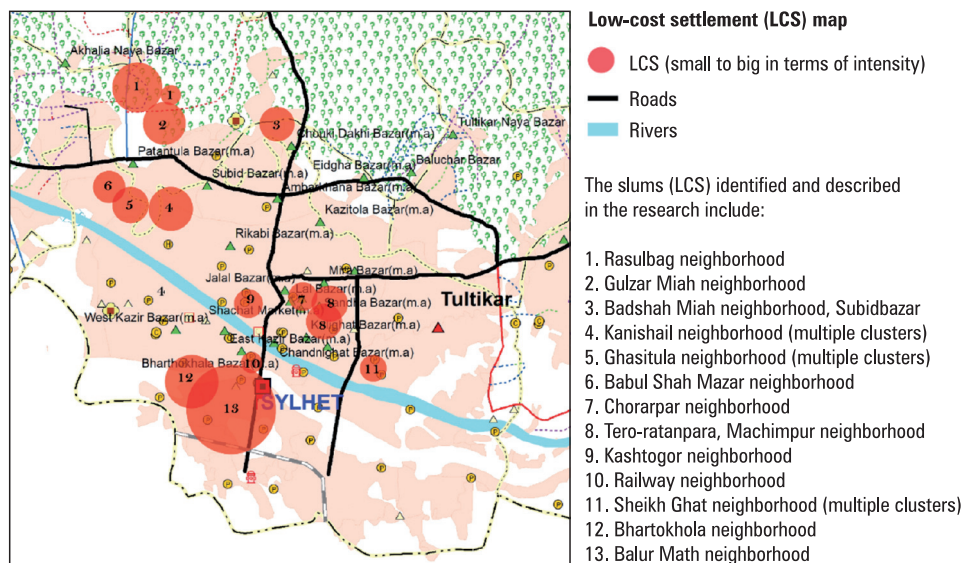## 4. Results and discussion

4.1. Survey results of slums of Sylhet

Sylhet, a Northeast region of Bangladesh, is a third fastest developing city in Bangladesh. A large population is migrating into this urban area from different regions of Bangladesh in search for a better life due to a variety of push-pull factors. Although the migrants find some work opportunities and economic benefits, they cannot afford a livable accommodation infrastructure within their income range, so they end up living in unplanned, unauthorized and poor slums. Thus, the LCS develops in the city. This study remarkably found 13 numbers of LCS (Fig. 2) existing in this urban area shown in the map bellow. These were the object of this research.

4.1.1. Rasulbag neighborhood

This particular LCS (Fig. 3) is located on a hillside. The built forms were stacked like steps, with ramps and a slopping concrete path connecting them through the main alley of the neighborhood. An alleyway (averaging 8ft in width) divides the neighborhood into two parts and serves as the main circulation route. Irregular drainage runs through the middle of the alley. Open spaces were used for storing fuel wood collected from the trees on the hillocks. There are no green spaces on the alley sides or beside the built form. The built forms are 'adha-pucca', with corrugated sheet or thatched roofs, and brick or thatch walls. In some cases, open drains flow through the alleys. Open sanitation systems are common, next to every house in the alley. At the far end of the neighborhood, the slope increases and the concrete alley disappears, and instead sandbags are used as steps to reach the houses.

Low-cost settlement (LCS) map

● LCS (small to big in terms of intensity)
— Roads
— Rivers

The slums (LCS) identified and described
in the research include:

1. Rasulbag neighborhood
2. Gulzar Miah neighborhood
3. Badshah Miah neighborhood, Subidbazar
4. Kanishail neighborhood (multiple clusters)
5. Ghasitula neighborhood (multiple clusters)
6. Babul Shah Mazar neighborhood
7. Chorarpar neighborhood
8. Tero-ratanpara, Machimpur neighborhood
9. Kashtogor neighborhood
10. Railway neighborhood
11. Sheikh Ghat neighborhood (multiple clusters)
12. Bhartokhola neighborhood
13. Balur Math neighborhood

Source: Authors' own study

Fig. 2. Low-cost informal settlements of Sylhet

1. Rickshaw stand
2. Lane (concrete)
3. Semi outdoor verandah
4. Latrine
5. Semipaved path
6. Handpump zone

Source: Authors' own study

Fig. 3. Landscape fabric of Rasulbag

4.1.2. Gulzar Miah neighborhood

It was an LCS area (Fig. 4) accommodating 300 families and was one of the largest. But due to urbanization, buildings people moved to other places. Now, 15–20 families reside in this area. The one-floored, brick and tin-shed houses surrounding a central courtyard. The concrete courtyard (8–10 ft) is a place that contains activities such as neighborhood interaction and a play zone for children. There are no trees or plants in this area. It is a regular rectilinear area with housing units. This LCS is clean and has a proper sanitation and drainage system. The common occupation of people living here is van driver, rickshaw puller, house maid etc.

Source: Authors' own study

Fig. 4. Landscape fabric of Gulzar Miah

4.1.3. Badshah Miah neighborhood

It is a decentralized slum area (Fig. 5), now serving 8–12 families. The area, nearby Subidbazar, contains a courtyard surrounded by multiple built forms in a shape like a 'U'. The courtyard is mainly used for drying washed clothes. But it also serves multiple other purposes like neighbor interaction, play zone for kids, vegetation and parking for vans and rickshaws. There is an unmaintained zone at the corner of the area where the slum dwellers dump their waste, but as it is unplanned, so the waste spreads throughout the whole neighborhood. A central open drain (width = 1ft) runs through the courtyard. Every house has its own vegetation space fenced in the courtyard and an open sanitation that is linked with the house but placed on the side of the courtyard. Greenery and certain gardens can be seen, but they are unplanned and not well maintained. There are subclusters of this slum within the Subirbazar area that centralizes them.

Source: Authors' own study

Fig. 5. Landscape fabric of Badshah Miah

4.1.4 Kanishail neighborhood

Kanishail neighborhood (Fig. 6) has been clustered into many areas, each containing 12–16 families. Some clusters have central concrete courtyard-like spaces, but others have only linear circulation spaces merging with front yard varrandah, like spaces extended through the roof. Tube wells are set at the right corner of the entry and serve the users. The courtyard is used mostly for drying clothes, but also a play zone and 'adda' (sharing) spaces for women and senior citizens. A sanitary latrine in the middle and a kitchen zone is located in the end part of the cluster that opens towards the courtyard. Drain is open and circulates through the edge of the courtyard. Houses are 'adha-paka', corrugated-shed roofs with thatched or brick walls. There is no greenery or vegetation in any of these clusters.
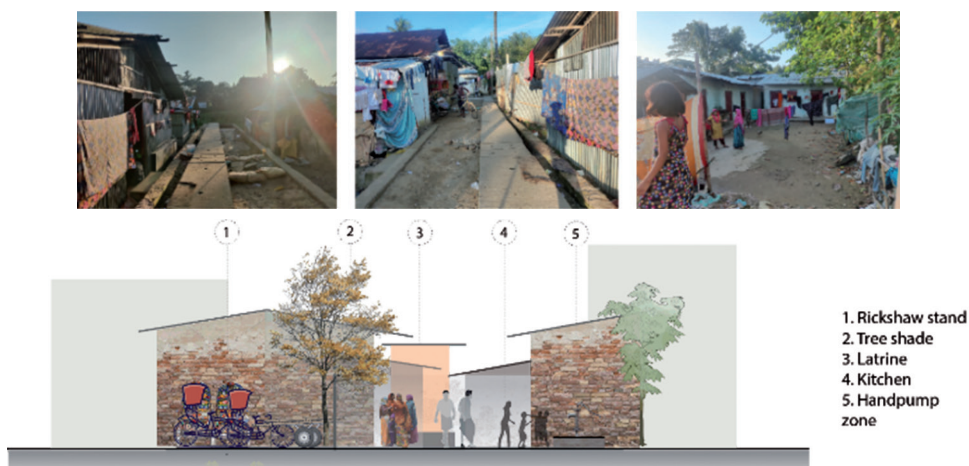

Source: Authors' own study

Fig. 6. Landscape fabric of Kanishail

4.1.5. Ghasitula neighborhood

This decentralized colony (Fig. 7) is located on the opposite side of the Surma river. Some of the clusters are abandoned but some are still inhabited and contain 8–10 families. Fishermen, rickshaw pullers, van drivers etc. live in these settlements with their families. There is no courtyard, just a single lane with doors opening onto the units. Tin sheet shed houses have front yards with verandahs and sheds with tinned roof extensions. The bamboo that holds the extended roof separates the outdoors from semi-outdoor area. Pets such as chicken, ducks, goat, lamb etc. can be found grazing in the lane. Sanitary latrine and cooking area are at the end of the cluster.
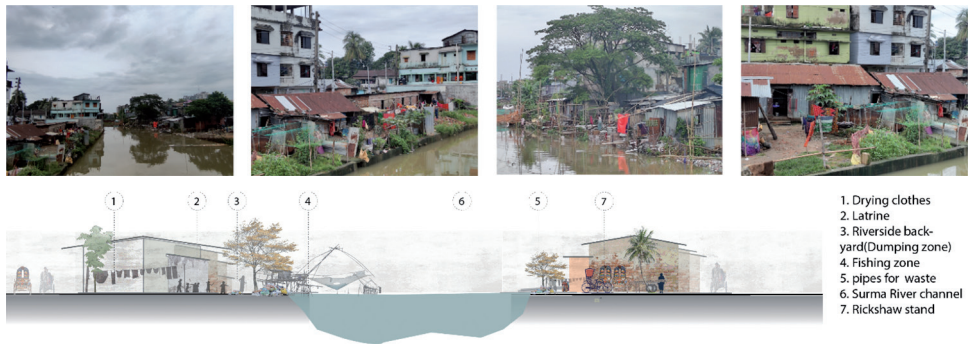

1. Rickshaw stand
2. Tree shade
3. Latrine
4. Kitchen
5. Handpump zone

Source: Authors' own study

Fig. 7. Landscape fabric of Ghasitula

4.1.6. Chorarpar neighborhood

It is located on both sides of the Surma river channel, housing 50–60 families of fishermen, farmers, rickshaw pullers, van drivers (Fig. 8). The subarterial road connects with the houses, and the backyard faces the river. This neighborhood has a deeper connection with the river, as the backyard and the riverfront is used as a for socializing and play zone for kids. It is also used for drying clothes and vegetation and for grazing pets. Each unit is connected to a sanitary latrine connects and the pipes from these are open directly into the river. Some of the houses have bamboo fish traps. The houses are made of thatched or tin roofs and walls, and they are arranged in a regular pattern. A certain number of trees are scattered throughout the landscape, and there are irregular dumping zones in the area.

1. Drying clothes
2. Latrine
3. Riverside back-yard(Dumping zone)
4. Fishing zone
5. pipes for waste
6. Surma River channel
7. Rickshaw stand

Source: Authors' own study

Fig. 8. Landscape fabric of Chorarpar

4.1.7. Tero-ratanpara neighborhood

It is a neighborhood (Fig. 9) of 50–60 families, mostly van drivers and rickshaw pullers. There is no courtyard, just a single lane with doors opening into the housing units. These are tin shed houses with front yards, like verandahs. A main circulation – pathway of 5ft width connects every house. The pathway is also used for storing jars to collect water from the municipality water truck. Apart from that the pathway is also used for socializing and as a playing zone for kids. Since it is inhabited mostly by rickshaw puller and van driver families, it is also used to park those vehicles which interfere with the setting. The drainage system is closed and runs slab in the middle of the road.

1. Rickshaw stand
2. Paved Lane
3. Handpump zone

Source: Authors' own study

Fig. 9. Landscape fabric of Tero-ratanpara

4.1.8. Kashtogor neighborhood

Around 40–60 families live in this neighborhood (Fig. 10), mostly sweepers, scavengers etc. It's a crowded colony that includes a 4-storied building and a semi-'pucca' houses. The pathways are very damp and narrow, with a slab drainage in the middle. They also serve as a social interaction space for the neighbors and a hiring space for sweeping. The area is covered with shade, and the paths and houses do not receive proper sunlight. Besides, the area is connected to a 8 ft drain leads to the Surma river. During the monsoon, the drain fills up and wastewater floods the whole area. There is a Hindu temple next to the houses, and the Nat-mondir is used for gatherings and meetings as well as religious activities. The frontage of the neighborhood connects with a subarterial road, which functions as a hub for illegal businesses, such as drug dealing. Overall, the landscape is shady, shallow and dark, and there are no trees or greenery.
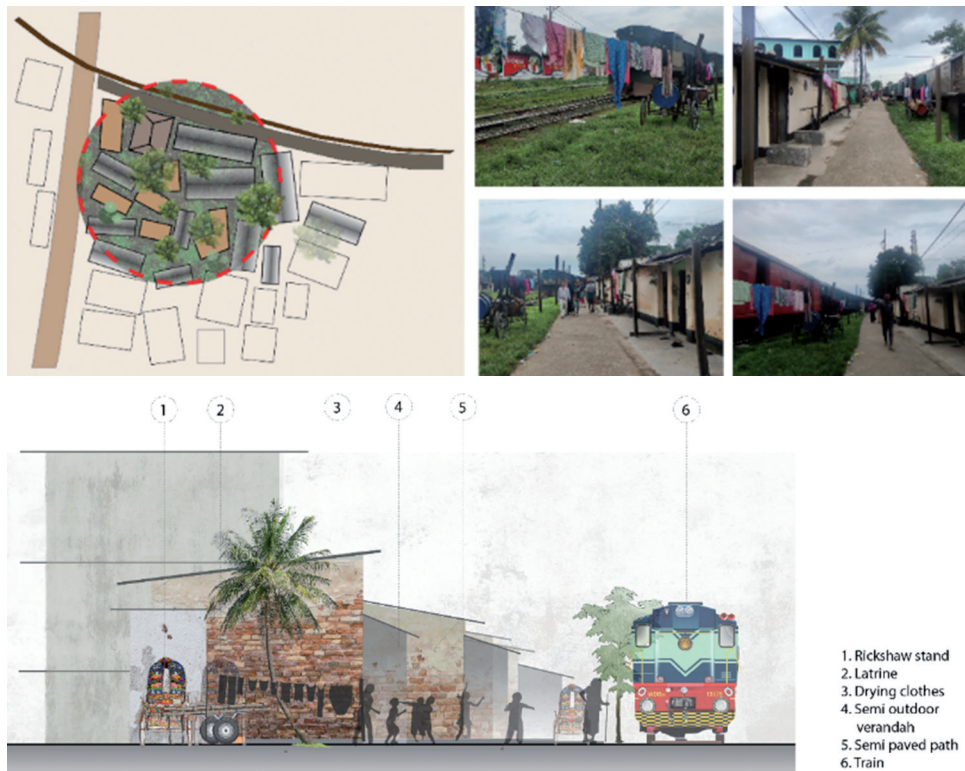

Source: Authors' own study

Fig. 10. Landscape fabric of Kashtogor

4.1.9. Railway neighborhood

The railway neighborhood (Fig. 11) is located next to the central railway, following the rail line. More than 300 families reside in the area. Each family has 6–8 members on average. In total, about 2000 people live here. A pitched pathway of 10 ft is in the middle of the rail line and the neighborhood, and thus works as a circulation space. Houses are 'adha-pucca' with semi-outdoor spaces shaded by extended roofs. People living in this neighborhood use this space for multi activities, such as cycling, socializing, refreshment, drying clothes etc. Adjacent to the rail tracks, the semi-outdoor area opens towards a subarterial road that connects the colony with main roads. This landscape contains very green grass and trees that merge with road, creating a buffer from

rail tracks. Thus, children are playing in a high-risk zone without any safety measures, while bazaars are also settled in this narrow landscape.

Source: Authors' own study

Fig. 11. Landscape fabric of Railway neighborhood

1. Rickshaw stand
2. Latrine
3. Drying clothes
4. Semi outdoor verandah
5. Semi paved path
6. Train

4.1.10. Sheikh Ghat neighborhood

Sheikh Ghat neighborhood (Fig. 12) has been clustered in multiple areas, each containing 12–16 families. Each family has 5–6 members on average. It is a small scattered community consisting of 100-120 people. Some clusters have central concrete courtyard-like spaces, but others have only linear circulation spaces merging with front yard 'varrandah', covered by roof extensions. The area has an unmaintained dumping zone, open drainage system, and waste across the paths of the neighborhood. There is also a 5 feet wide prominent circulation pathway. The houses are thatched and tin shed. During the monsoon, the drain fills up and wastewater submerges the entire area. The whole landscape of this LCS is messy, and there is no proper sanitation and drainage system. The most common occupations of the people living here are van driver, rickshaw puller, and house maid.

1. Rickshaw stand
2. Tree shade
3. Latrine
4. Kitchen
5. Handpump zone

Source: Authors' own study

Fig. 12. Landscape fabric of Sheikh Ghat

4.1.11. Bhartokhola neighborhood

It is a neighborhood (Fig. 13) of 50‒60 families, mostly fisherman, van drivers and rickshaw pullers. There is no courtyard, just a single lane with doors opening into housing units. The houses are thatched and tin shed. The area contains an open drainage system, waste spread across the paths of the neighborhood, and a 5 feet wide prominent circulation pathway. It is located next to the Surma river. Each family has 4‒6 members on average. The neighborhood consists of 240‒300 inhabitants. The sub-arterial road connects with the houses, while and the backyards face the river. The neighborhood has a deep connection with the river, as backyards and riverfronts are used for circulation, socializing and playing by kids. People bathe in the Surma river, and during the monsoon season, the drain fills up and wastewater floods the entire area. The lane is used as a public interaction space, children are seen playing, and women gathered for regular 'adda' (sharing) in their leisure. Overall, the narrow lane is used for social gathering and integration of the whole colony.

Source: Authors' own study

Fig. 13. Landscape fabric of Bharthokhola

4.1.12. Balur Math neighborhood

Balur Math (Fig. 14) is one of the largest low-cost settlements in Sylhet. It is next to the central bus terminal, thus residents of this neighborhood mostly do odd jobs in the terminal. Other occupational groups, such as rickshaw pullers, van drivers, porters and day laborers can be found here. During the monsoon season, the narrow lanes fill up and wastewater floods the entire area. There are various kinds of houses, some are thatched, some are tin sheds. People here live below the poverty line and earn a very low daily wag. At least 300–400 families live here, which makes it a huge hub that connects to a centralized market area.

The area expands from here. There is an open drainage system, waste spreads across the paths of the neighborhood, and a prominent 5 feet wide circulation pathway Each family has 5–6 members on average. Most people migrated here from different parts of the country in search of a better life, but now live in this slum. Children play in the central market area and women can be seen gossiping here and there. Each house consists of an average of 8 small units, all houses are scattered around in a regular rectilinear shape, and every house has a small kitchen and latrine zone.

Source: Authors' own study

Fig. 14. Landscape fabric of Balur Math

4.1.13. Babul Shah Mazar neighborhood

This LCS (Fig. 15) is built around the Babul Shah Mazar. It is located on the bank of Surma river, housing fishermen and their families. It contains around 25–30 families. The Mazar works as a community space, creating a socializing spot within the landscape. There is an unmaintained dumping zone, open drainage system, waste spreads across the paths of the neighborhood, and a 5 feet wide prominent circulation pathway. The houses are thatched and tin shed. Front yards are used for multiple purposes, such as refreshment and cleaning the dishes, due to its connection to the central drainage. There are 6 permanent toilets connected with the main drainage that runs through the landscape. Irregular patterned houses with semi-outdoor spaces are joined to the main pathway, and are being used as social interaction zone for women, senior and children.

Source: Authors' own study

Fig. 15. Landscape fabric of Babul Shah Mazar

4.2. Landscape Assessment Protocol (LAP)

Based on the survey data from 13 study areas, a landscape assessment protocol (LAP) matrix was prepared. This table helped to identify potential scope for landscape intervention in 13 low-cost settlements. The assessment protocol incudes 31 criteria under 10 parameters (Tables 2, 3). A numeric value was added with each site for every criterion. The total value shows the quality class and standers for conservation the study area.

Table 2. The LAP summary for 7 study areas

Parameters	Criteria	Rasulbag	Gulzar Miah	Badshah Miah	Kanishail	Ghasitula	Chorarpar	Tero-ratan para
Population density and demographics	Access to basic services	4	6	2	4	3	2	4
	Density (people per sq. ft)							
	Migratory patterns							
Physical infrastructure	Housing quality	5	7	4	4	4	4	6
	Infrastructure and services							
	Pathways							
Environmental health	Air and water quality	4	6	4	5	3	2	4
	Waste management							
	Disaster vulnerability							
Social interaction	Common spaces	6	6	5	4	4	4	5
	Community gathering space							
Economic activity	Bazaar pattern	4	6	4	5	5	5	5
	Shops pattern							
	Entrepreneurship							
Cultural and social aspect	Functions	4	5	5	6	4	6	6
	Beliefs and customs							
	Traditions							
Safety and security	Crimes	4	8	4	4	4	4	5
	Placement							
	Land security							

Table 2. cont.

Parameters	Criteria	Rasulbag	Gulzar Miah	Badshah Miah	Kanishail	Ghasitula	Chorarpar	Tero-ratan para
Drainage infrastructure and flood resilience	Drainage quality	3	6	4	5	1	2	3
	Planned drainage infrastructure							
	Flood record							
Access to basic services	Connectivity	2	6	2	4	3	2	3
	Planned street infrastructure							
	Quality of roads							
Pollution	Air	2	4	3	3	2	4	6
	Water							
	Waste							
	Noise							
	Land							
Total		**38**	**60**	**37**	**44**	**33**	**35**	**47**

Table 3. The LAP summary for 6 study areas

Parameters	Criteria	Kashtogor	Railway neighborhood	Sheikh Ghat	Bhartokhola	Balur Math	Babul Shah Mazar
Population density and demographics	Access to basic services	2	3	3	1	1	2
	Density (people per sq. ft)						
	Migratory patterns						
Physical infrastructure	Housing quality	2	4	2	1	2	2
	Infrastructure and services						
	Pathways						

Environmental health	Air and water quality	2	4	3	2	1	1
	Waste management						
	Disaster vulnerability						
Social interaction	Common spaces	2	5	3	2	3	4
	Community gathering space						
Economic activity	Bazaar pattern	4	6	4	3	2	3
	Shops pattern						
	Entrepreneurship						
Cultural and social aspect	Functions	6	4	3	3	4	6
	Beliefs and customs						
	Traditions						
Safety and security	Crimes	1	2	4	1	1	2
	Placement						
	Land security						
Drainage infrastructure and flood resilience	Drainage quality	1	5	5	2	1	1
	Planned drainage infrastructure						
	Flood record						
Access to basic services	Connectivity	3	5	3	1	1	1
	Planned street infrastructure						
	Quality of roads						
Pollution	Air	1	6	3	1	1	1
	Water						
	Waste						
	Noise						
	Land						
Total		**24**	**44**	**33**	**17**	**17**	**23**

Table 4. Quality classes proposed for the current version of the LAP conservation index (LAP CI)

Quality class condition	Condition description	LAP CI	Mapping Color
Excellent	Favorable conservation condition. Natural/ semi-natural landscape or exceptional quality cultural landscape with high degree of natural elements and features.	≥ 85	Dark green
Good	Favorable conservation condition. Near natural or cultural landscape with slight degradation; high quality urban or peri-urban landscape	70–84	Green
Moderate	Unfavorable conservation condition. Moderately degraded landscape with various modern changes and pressures.	50–69	Yellow
Poor	Unfavorable conservation condition. Degraded landscape. Moderately degraded urban or peri-urban area	31–49	Orange
Bad	Unfavorable conservation condition. Severely degraded non-urban landscape or degraded cultural/urban landscape	≤ 30	Red

4.3. Landscape challenges for 13 study areas

The analysis of landscape fabrics in low-cost settlements (LCS) within Sylhet revealed distinctive features across various neighborhoods, each presenting unique challenges and characteristics. Among the major components observed is the housing infrastructure in areas such as Rasulbag neighborhood, where dwellings are constructed in a tiered topography, utilizing stacked plans on slopes. This tiered arrangement creates small lanes and open drainage systems that contribute to the overall spatial morphology of the settlement. Conversely, Gulzar Miah showcases a more organized layout with a central concrete courtyard serving as a communal space for playing, socializing, and other activities.

Movement within these colonies predominantly occurs through alleyways or narrow pathways, a common feature observed in neighborhoods, such as Badshah Miah, where open drainage and careless waste disposal within the U-shaped central courtyard present challenges for residents. In contrast, neighborhoods, such as Kanishail, demonstrate variability in the presence and utilization of central courtyards, highlighting the diversity in spatial organization and community dynamics across different LCS in Sylhet.

Drainage emerges as a critical issue, particularly evident during the monsoon season, impacting neighborhoods, such as Bhartokhola and Chorarpar, that are situated closer to the Surma river. The proximity to the river contributes to gathering spaces for community events but also poses risks of flooding and hygiene concerns due to inadequate drainage infrastructure. The prevalence of open drainage systems

underscores the need for improved infrastructure to mitigate flood risks and enhance sanitation in these vulnerable settlements.

The analysis further highlights the scarcity of green spaces within LCS, particularly notable in Kashtogor, where few trees line the pathways amidst dense housing. This limited greenery exacerbates the harsh summer climate, contributing to a landscape characterized by restricted open spaces and high population density. Waste management remains a significant challenge across neighborhoods, with improper disposal practices leading to unsanitary conditions and visual clutter in places like Badshah Miah.

The overall landscape challenges within these LCS areas highlight the need for holistic interventions to improve living conditions and resilience. Addressing issues such as poor drainage, inadequate waste management, and limited green spaces requires integrated urban planning strategies that prioritize community needs and environmental sustainability. By recognizing the diverse characteristics and challenges across different neighborhoodswithin Sylhet City, targeted interventions can be developed to enhance the quality of life and promote sustainable development in low-cost settlements.

5. Recommendations and conclusion

The LCS areas in Sylhet, when compared to those in Dhaka and Chattogram, present a more organized living environment with improved house conditions and landscapes, but they lack essential amenities, such as proper sanitation, standard housing, and green spaces. This organized yet incomplete living standard often attracts people from flood-prone villages in the Sylhet region seeking better living conditions, leading to the formation of slums. The influx of people to these areas means that many end up working as rickshaw pullers, hawkers or day laborers. Some resort to illegal businesses or prostitution due to financial necessity. Women in these areas are particularly vulnerable, often lacking access to sanitation and health facilities, as well as a voice within the family. Policies and communal awareness can change the fabric of these LCS areas of Sylhet. Here are some recommendations given below:

- The LCS areas, including Teroratan-para and Chorarpar, have historically faced water shortages, with residents often waiting for hours for City Corporation water supply vehicles. Given Sylhet's reputation for abundant annual rainfall, rainwater harvesting presents a viable solution to this issue. By collecting and storing rainwater in containers and through roof drains, water can be supplied to large numbers of localities. Furthermore, the establishment of small-scale rainwater harvesting plants in these 13 LCS areas could significantly improve water access.

- In terms of low-cost housing prototypes, the prevalent use of CI sheets for roofing in congested areas results in increased temperatures due to their high reflectivity. A more suitable alternative would be cement sheets, which have lower reflectance, generate less heat, and are equally affordable. It is essential to prioritize locally sourced, easily accessible materials and construction techniques when designing housing. By manufacturing prefabricated, low-cost modules, we can elevate living standards and maintain the landscape. This strategy combines the benefits of ce-

ment sheets for improved heat insulation with sustainable and cost-effective housing solutions for Balur Math, Bhartokhola, Babul Shah Mazar neighborhood, Teroratanpara, Ghashitula neighborhood, etc.

- Drainage and sanitation in LCS areas can be improved by addressing the common issue of narrow, open drains. Moreover, open latrines allow human waste to directly enter the Surma river channel, or other nearby water sources, causing outbreaks of cholera, dysentery, and other waterborne diseases. To tackle this problem, drains should be covered with slabs and connected to latrine lines, preventing waste from being disposed of into water bodies. Installing shared latrines or manure-storing latrines in neighborhoods will help manage human waste effectively, ensuring it does not contaminate the river. This approach enhances sanitation and promotes public health by reducing the risk of waterborne diseases.

- Green corridors are absent in all 13 LCS areas, and trees and green zones are scarce. The entire ground surface is paved, resulting in a hard, heat-trapping landscape. To mitigate this, a specific percentage of green surfaces should be designated within LCS, contributing to the overall number required for growth. Utilizing vegetation, easy-growing, and medicinal plants as boundaries can ensure a more balanced and eco-friendly living environment. This approach not only reduces heat absorption but also fosters a healthier and greener community.

- Seven LCS areas (Balurmath, Bhartokhola, Chorarpar etc.) along the Surma river are directly affected by rising water levels due to heavy rainfall in Meghalaya and Cherapunji, which funnels water towards Sylhet. Consequently, flooding in these riverside LCS areas disrupts the livelihoods of local residents. In order to address this issue, two potential solutions are: 1) relocation of the riverside LCS areas, if feasible; 2) construction of embankments along the riverbanks to prevent floodwaters from reaching the affected areas. Implementing one of these strategies would help protect these communities from the adverse effects of flooding, ensuring a safer and more stable living environment.

- Women in many low-income, crowded-spaces (LCS) areas, such as Kashtogor, Balur Math, Sheikh Ghat, Ghashitula etc., are eager to work but often lack an entrepreneurial mindset, which can hinder their progress. By establishing three community centers, we can serve 13 LCS areas by providing training and counseling, and by helping women and young people to develop the skills needed for pilot projects or online businesses. This initiative could enhance their livelihoods, improve their roles within the household, and help to reduce social issues such as drug trafficking and prostitution, which are often prevalent in LCS areas.

This research presents an in-depth analysis of the spatial morphology, socio-cultural dynamics, and environmental effects of low-cost communities (LCS) in Sylhet, Bangladesh. The results show how people of LCS come from a variety of socioeconomic origins and follow different cultural norms. They also highlight issues including congestion, floods, and a shortage of green space. The study highlights the potential for enhanced community well-being through strategic landscape planning that prioritizes

waste management, drainage, and green area development. It also paves the way for future research on urban poverty and landscape connectivity, as well as sustainable urban development and improved quality of life for Sylhet city's slum populations.

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