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BUILDING URBAN RESILIENCE
An unplanned built-up area in Dhaka

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Abstract
The prevalence of continual increase of population, poor construction standards, lack of law enforcement and monitoring, construction on filled up canals and water bodies as well as unplanned growth in hazard prone areas in Dhaka is turning the whole city into a source of potential hazards. As a result, both the built up and growing areas possess great risks of hazardous incidents like fire, water logging, collapse of structures, and earthquake etc. This paper emphasizes the need to address the risks in unplanned built up areas and takes into account an area (part of ward No. 14 & 15) as a case with prior illustration of context of Dhaka city. It analyzes vulnerabilities of the area in terms of infrastructures exposed to risks like fire and earthquake etc and emergency response. Finally it aims to develop some notions towards building resilience and as an outcome it recommends some short, medium and long term action plans. Among the actions it prioritizes recovery of connectivity and open spaces within the area in order to ensure minimum safety. Methodology of the whole process includes literature review, analyzing secondary data, and primary data collection from site through observation and conversation with the local residents.

Keywords: *Urban resilience, unplanned built up area, infrastructures, response, and urban intervention*

1. Introduction
Bangladesh is a deltaic country located at the lower part of Ganges-Brahmaputra-Meghna basins; and well known to be highly disaster prone. The unique geographical setting, physiographic features and hydraulic system make it one of the most flood and cyclone prone areas of the world as well as exposed to violent tornadoes, Nor'westers, river erosion etc. The tectonic setup also reveals that, it lies in the seismically active zone, where several devastating earthquakes occurred in the past [Paul.et al, 2010]. All these make Bangladesh a disaster risk hotspot, ranked fifth in the top 15 countries with highest risks [World Disaster Report, 2012]. Huge population is aggravating the risks as well.

A major consequence of the recurring disasters is found in the movement of people; movement towards more inland or urban areas. It is found that rural-urban migration cause 40% of increase in urban population and in some cities this figure is as high as 70% [Parvin et al, 2013]. High population growth in the urban centres, especially in the capital city Dhaka, is in one hand generating increasing demands of infrastructures and in the other hand exacerbating hazard induced risks. Lack of law enforcement and monitoring resulting in poor construction standards, construction on filled up canals and water bodies, unplanned-uncontrolled growth in hazard prone areas, increased slum settlements- is turning the whole city into a source of potential hazards. Faster growth of cities with insensitive or non-inclusive urban land use planning, urban development and management lead to higher disaster risks [Sharma et al, 2011]. As a result incidences like fire, water logging, and collapse of structures are evident in the built up areas; and the persisting uncontrolled growth is posing threat of higher mortality due to collapse, fire and earthquake as well. Besides, the unplanned development is hindering post disaster response activities.

The paper suggests that it is high time to address the vulnerable areas and intervene accordingly to achieve resilience. Among the components of urban resilience the write up focuses on infrastructures and in a context of built up area it realizes resilience as the residents' preparedness to respond and strengthening of the area's post disaster response activities (i.e. mobility of fire fighting vehicles). As a case this particular study takes into account an unplanned residential area covering Hazaribagh and Zigatola (part of Ward 14 & 15) which had, to a great extent, developed around the Tannery industry. It has grown on lands adjacent to river Buriganga and possesses a risk of liquefaction during an earthquake. Keeping this in mind vulnerabilities regarding infrastructures are depicted here particularly with respect to fire and earthquake hazard. Discussions have been made on ways of fostering resilience by short, medium and long term action plans.

2. Methodology

The methodology of the study includes literature survey, site survey through observation and conversation with the residents, taking photographs, analyzing primary and secondary data. In addition to it the site was given as a studio project where the proposed measures were exercised to verify its likelihood. The paper contains a brief illustration of context of Dhaka from literature review followed by observations from study area and recommendations.

3. Concept of Urban Resilience

Risk of urban areas due to hazards is likely to be higher than rural because of its complex and sophisticated nature as well as greater population density.

Because all governments have an obligation to protect their citizens, resilience can be seen as a public good [Lall, et al. 2009].

Resilience refers to the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to, and recover from the effects of a hazard promptly and efficiently by preserving and restoring essential basic structures [UNISDR 2011b]. Concept of urban resilience takes into account four components like infrastructural, economic, institutional and social resilience [Jha (ed), 2013].

Urban infrastructure refers to the systems and services that are critically important for emergency response and the quick recovery of a community and its economy [Jha (ed), 2013]. Infrastructural resilience refers to a reduction in the vulnerability of built structures, such as buildings and transportation systems. It also refers to sheltering capacity, health care facilities, the vulnerability of buildings to hazards, critical infrastructure, and the availability of roads for evacuations and post-disaster supply lines [Jha (ed), 2013]. Building urban resilience often incorporate urban up gradation.

4. Context of Dhaka city- Risk and vulnerabilities

The urbanization of Bangladesh is interlinked with the intense development of Dhaka City which has developed as a politico-administrative centre [Hossain. 2008]. Due to the concentration of both domestic and foreign investment Dhaka City has experienced massive migration from the rural population in recent decades but a critical downside to this has been the dramatic rise in poverty [Hossain, 2008]. According to 2011 Census population of Dhaka city is 89, 06,039 living in an area of 316 sq km and number of household is 20, 34,146. During the last three decades, the average annual growth has been over seven percent which led to rapid expansion of Dhaka city both horizontally and vertically [Ahsan et al, 2013]. It is projected to become the fourth largest city with 22 million populations in the world by 2015 [Rashid et al, 2013]. It is developed spontaneously without observing any rigid planning guidelines or regulations and has exhibited a series of informal and organic spatial patterns [Nilufar et al, 2016]. The intervening ditches, swamps, and marshes were filled in, not in any planned manner, but as exigencies arose and private initiatives dominated the process [Huq et al. 2003]. Within this context some areas have been planned and sub divided into plots and infrastructures are constructed by authority; and in contrast a large of the city has developed organically where the land is subdivided through private or community initiatives and roads are laid to serve their needs without any approved plan [Nilufar et al, 2016].

The central part of Dhaka city is already built up and its expansion is restricted by rivers, canals and low lying flood prone areas around the city; however ignoring such barriers Dhaka is expanding towards all direction through rapid development of housing estates [Parvin et al, 2013]. More than 49% of the wetland areas decreased over the period 1960 to 2008 [Islam et al, 2012]. According to a Report of Dhaka WASA, there were 65 canals in pre-liberation Dhaka and now the number of canals is 26 [Wahra (ed), 2012]. Dhaka Metropolitan Development Plan 1995-2015 indicates eight flood–flow zones and advised to keep those as retention ponds; however many of these areas are already encroached [Parvin et al, 2013]. This way reduction in natural drainage and retentions is hampering the natural flow of water and causing severe water logging and flooding almost every year in recent decade [Parvin et al, 2013].
Extensive use of ground water but minimum recharge is directing towards high risk of drinking water scarcity. Under developed sewerage and waste disposal pose a question of sustainability of the dense communities. The fire safety issue is not highly emphasized from the city planning perspective in Bangladesh [Islam et al, 2008]. In one hand with the increase in population the fire fighting/rescue service is not being developed and in the other hand the infrastructures are not developed as well in accordance with available services. Hence the organically developed areas possess risk of unimaginable loss due to fire, earthquake and earthquake induced fire.

Dhaka lies in the second risky zone in terms of earthquake impact and it is conceivable that the Dhaka region may experience earthquakes with damage greater than intensity VIII, the level assumed based on 1897 Great Indian earthquake [Ansary et al, 2013]. As a number of development has occurred over low lying and filled up lands, incidence of liquefaction in areas are also presumed. The challenge also lies in managing the post disaster response in terms of manpower and rescuing equipments as well as debris management. The major constraint despite of the realization of the risk lies in weak implementation of national plans and policies resulting in exacerbation of the risks due to disasters.

5. Discussion on Study Area

The study area lies in the south west of Dhaka having Buriganga (embankment protected) in the west and planned Dhanmondi residential area in the east. An important feature of this ward is the Hazaribagh tannery industry. The floodplain is gradually being encroached and developed westward beyond the embankment towards the river. The particular ward is listed among the first ten with high population and building density. As the tannery is under relocation process the focus is confined within the residential areas (Zigatola and Hazaribagh) considering only its effects on it. Moreover very small amount of data of this study site have been found due to probably lack of documentation

and updating, while, the site has seemed quite vulnerable during investigation and observation.

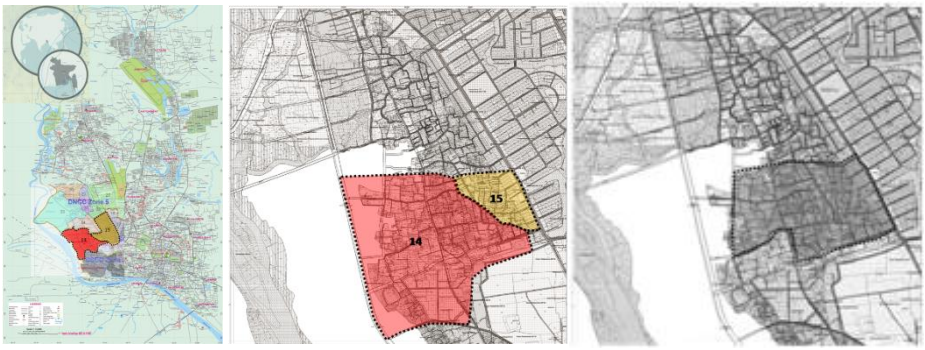

Figure 01: (from left) map showing ward location with respect to Dhaka city, study area with respect to wards and detail surveyed area

5.1. VULNERABILITIES AND PROBLEMS ADDRESSED

The paper addresses vulnerabilities of the area with respect to its location and infrastructures like road networks, utilities etc; as well as it aims to outline the risks it may encounter due to those vulnerabilities.

5.1.1 Vulnerabilities due to location – Soil condition

A major vulnerability of this area is its location being on a zone that, according to the document on Dhaka profile and Earthquake Risk Atlas, possesses a high impact index due to liquefaction; engendering great devastation during an earthquake with respect to a M 7.5 Madhupur fault earthquake scenario [World Bank, 2014]. Moreover the tannery confined area is highly contaminated and soils of part of surrounded residential zone are affected as well. These facts possess unseen threat for the residents.

5.1.2 Lacking legibility in road layout

Following the unplanned development of the area the roads are also laid in a haphazard manner impeding legibility. The wider roads suddenly fall into narrow ones and sometimes form meandering streets. The majority access roads have dead ends. This pattern is likely to engender disorder during an emergency (i.e. fire) by causing bottle neck situations or traps. Moreover it will deter any emergency evacuation with mass of people unaware of destination and not in regular practice of drills.

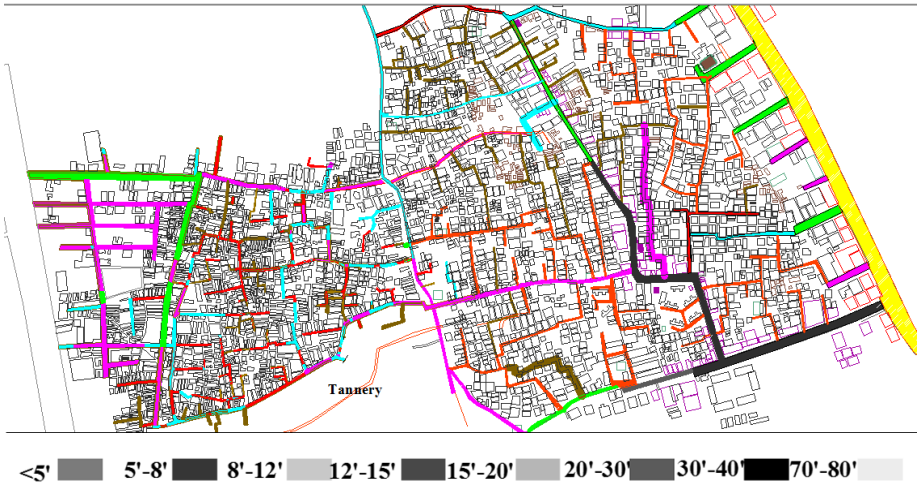

Figure 02: detail map of the surveyed area showing blocks and road networks with demarcation of width

5.1.3 Varying and insufficient road width

The access roads are mainly laid in favour of the lands and buildings that contain varying widths along a continuous road. The site plan provided above depicts the situation which reveals prevalence of roads having width below 5ft through which hardly a rickshaw or bike can move. On the other hand, the fire fighting vehicles engaged in providing emergency service consist of specific types of rescue truck/ambulance and twin vehicles having length of 16-25ft that require 20-30ft wide road for smooth operation and turning. It has limited length of water carrying pipes and container and most of the time rely on existing water source within affected site. Even if an 8 ft wide vehicle move through a 10 ft road it is likely to hinder other vehicles such as ambulance or people to move across. Only a fire bike can move through roads having width within10-5 ft that has very lower capacity. Similarly access of ambulance and its parking will face similar dilemma. Moreover narrow roads resulting in insufficient distance between buildings is likely to get blocked if building collapse during earthquake as well as spread fire rapidly in buildings. This situation is also likely to cause one safe building to suffer due to fall of a weaker structure on it because of the proximity between buildings. Delay in fire fighting is likely to intensify the damage.

5.1.4 Absence of alternative routes

As mentioned earlier the presence of dead ends within community does not provide alternative routes. This can be a major threat or trap during an emergency when people may try to evacuate or get away from any hazard. Both pedestrian and vehicle movement is likely to face this dilemma during an emergency period. This will certainly worsen any response mechanism.

5.1.5 Presence of gate locks

Few gate locks have been found in the area mainly maintained by a single housing complex or smaller communities. However, some gate locks are situated at the end of roads that restrict access of others. This will hinder movement of people and vehicle during any emergency.

5.1.6 Absence of open space

The study area is devoid of any park or playground except for the openness in colonies due to its fewer building footprints. Open spaces in communities play a vital role in residents' life. It serves as platform for people's interaction, children's playground, Physical exercises etc; in one word community space as well as landmarks to the community. The study area is not only disadvantaged with respect to community spaces but also exacerbating risks by limiting its capacity to manage a disaster. During any emergency a park or playground in proper location may prove to be very effective for sheltering people, parking of ambulance or rescue vehicles, providing medical aids, establishing incident manager's office etc. So an open space can amplify a community's capacity by triggering a planned and smooth response mechanism.

5.1.7 Improper drainage

The site doesn't fall within the perimeter or a planned drainage and sewerage system. Residential wastes fall into the drainage which most of cases are not covered. Open drainage lines are found to be containing garbage like cans, bags etc causing an unhealthy environment and logging of drainage. As heard from the residents, a heavy rainfall for hours is likely of causing logging of water on road in some areas that converged with drainage water generate unhealthy environment. Open and unplanned drainage is likely to favour breeding place of vectors as well.

5.1.8 Unplanned installation of gas supply

Supply of gas through metal pipes is found to be laid arbitrary and visible from roads; located adjacent to boundary walls can initiate hazard if hit by cars or collapsed building parts during earthquake; this may discharge gas to environment

5.1.9 Spontaneous assignment of electric posts and wires

Several electric posts are found to be irrationally placed on road decreasing the actual road width. The following pictures also depict the hazardous situation of convoluted electric wires with little or no distance from the buildings. The scenario poses a great risk of fire if not in regular period but during any small earthquake or heavy storm. This unreasonable position of posts is likely to hamper vehicular movement during a disaster aftermath.

Figure 03: (from left) electric post and wire; narrow road; drainage condition; transformer adjoining buildings; unprotected gas pipes

5.1.10 Insufficient set back between buildings

Set back between two buildings are found in major cases to be improper or in cases absent excluding few. Mainly because majority of the buildings are constructed before the establishment of building rules or those constructed later violated the rules. Inadequate distance between two buildings not only deprives the building's interior from proper light and ventilation but also provoke hazard risks like spreading of fire or damage of other structures due to collapse of adjacent one.

6. Proposals and Discussions

To achieve resilience in a dense and unplanned built up urban area the paper recommends to prioritize issues and find out critical sectors to intervene. As the area is grown unplanned and without consideration of risk preventing parameters, to develop the whole area considering all the resilience components is a time intensive approach. Therefore the paper suggests interventions in different phases and proposes a three phase action plan. Concern is to keep the interference to a minimum level while ensuring mandatory safety.

The proposals emphasize on betterment of connectivity and reclamation of open or community space which can ensure mobility of emergency vehicles and preliminary shelter spaces during emergency respectively. These, to a great extent, can save lives within a haphazardly built up area. The proposals are derived from the understandings of the context of the study area, literature

review on building urban resilience as well as stance of the Dhaka city in realizing urban resilience and prevailing land development regulations

6.1. SHORT TERM ACTION PLAN

The short term action plan is confined in approaches that can be followed immediately without any physical alteration of the setting; aiming to avoid chaos and loss of lives during any emergency. It may begin with meeting or workshop of representative of residents of different neighborhood from the ward along with authority personnel and other stakeholders like representatives from fire fighting agency, urban designers, earthquake experts or experts in field of resilience etc. Focus of the workshop would be to analyze existing scenario of the whole area and come up with an effective response plan. Residents from different neighborhoods can recommend potentials within their area like wider road, open space, temporary settlements, water bodies, properly designed structures etc if any. Few successive meeting can come up with selection of volunteers, dividing of roles and responsibilities, planning of evacuation routes, delineation of roads for rescue vehicles, places for temporary shelter or preliminary medical aids, health facilities and schools to operate during any emergency. To ensure better connectivity for unhindered response operation during emergency, preparedness planning with proper drill can be done in the following ways.

- Designate roads of 10 ft and below as one way traffic
- Designate roads above 20 ft as both way traffic
- Demarcate roads favorable for emergency vehicles to operate according to its width as well as connectivity with broader city and its service; and specify separate road for people's movement.
- Designate any refusal space within the building or in the community (open space or safe structure etc)
- Demarcate roads according to prevailing fire fighting vehicles so it can operate accordingly etc.
- Introduce (weekly, monthly, etc) programs involving community like cleaning waste on road, drain, sewer, etc to improve livable environment, prevent water logging, etc.

6.2. MEDIUM TERM ACTION PLAN

Intervening into the physical setting of the built up area to a moderate level is realized as the medium term proposals. Following the short term actions it may include widening of major roads found to be essential for mobility of emergency vehicles and establish the emergency use of a community place if any; or consolidate different open space to serve as a whole through land re-adjustment laws. To ensure better mobility and response operation widening of road may include following measures –

- Widening road(<10ft) up to 10 ft and operate it as one way traffic
- Widening road above 10 ft and operate it as both way traffic
- Ensure mandatory turning radius in the corner plots according to the vehicles of the existing fire fighting service
- Removing and relocating the electric poles that is unreasonably placed on roads
- Awarding incentives for the affected residences or structures
- Demarcate parking & operation zones in relevant intervals for rescue and fire vehicles etc ensuring relevant support like water supply
- Identify the bad condition of the sewer, drain, dustbin, etc of buildings and roads. Major intervention can be- development and construction of soak-pit, connecting the disconnected drains, opening up drain ways for proper water runoff, etc.

6.3. LONG TERM ACTION PLAN

The long term proposal is concerned with an urban renewal process where the entire area can undergo development with risk sensitive approach as priority. This approach can begin with a risk assessment of segmented areas culminating in vulnerability mapping of the entire area; which is likely to guide the zoning and find the major vulnerabilities. This will also incorporate retrofitting of critical and vulnerable structures. Nevertheless the prevailing extent of emergency service (i.e. vehicles, water source, length of pipes, ladders etc) must be considered in the development.

It also recommends that the area must go through urban consolidation process if necessary to reclaim open space; the less dense areas or areas with more informal structures (slums or tin shade) can be reclaimed as open space within a super street block providing densification in the other with proper incentives.

Restructuring the drainage, sewer and garbage collection systems with the area consolidation project should be adopted considering the reuse of waste material and water.

For this particular area concept of phytoremediation can be considered for the decontamination of soils affected from adjacent tannery.

7. Conclusion

As a considerable land within Dhaka city is developed unplanned, the paper attempts to draw awareness on it for being highly vulnerable. It assumes that for built up areas it is not wise to come up with initial ideas of developing a land with risk sensitive approaches. The write up hence recommends that the risk reduction strategies for this type area should focus on the preparedness planning and effective response mechanisms based on available urban services. The extent of intervention is distinguished here in different phases assuming

that either of it can apply to an area depending on its setting (i.e. economy, residents' awareness, willingness of authority etc) as well as completion of each phase may direct to its subsequent for a complete transformation of the area into a resilient community eventually. For the unplanned developed areas it is presumed that most of the constructions either followed previous regulations which is now outdated or violated the prevailing ones. In this connection the paper comes up with the recommendations that there should be clear strategies in the regulations for built structures as well concerning the minimum safety issues; and while upgrading the laws consideration of safety issues again is a must. Despite of the realization of building resilience the major challenge lies in implementation of plans; hence strengthening of monitoring process must also be taken into account.

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