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Identifying the Gap between Available and Required OpenSpace for Potential Emergency Assembly Points (EAP) in Dhaka City: A Case Study of Mirpur Area

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Abstract: In Bangladesh, multi-hazard risks in urban areas are being exacerbated by rapid urbanization and unregulated population growth day by day. In Dhaka city, the lack of open spaces increases the magnitude of the vulnerability of urban hazards and natural disasters due to excessive population density and infrastructural development. Mirpur, one of the densely populated areas in Dhaka, has a narrow road, meager space between the buildings with no dedicated open spaces for the residents. These factors put a threat to the inhabitants during rapid onset urban hazards. This study investigates the condition of the existing open spaces and the requirement for potential emergency assembly points in the Mirpur area. An inventory of existing open spaces in the study location is prepared using Google Earth image and Geographical Information System (GIS) in this study. According to the findings, there are insufficient open spaces for the current inhabitantsfor any type of urban hazard. Only sixdesignated open spaces are found available in the study area of Pallabi and Mirpur 12 (Wards 2, 7, and 15) which are approximately 90 acres. They can accommodatearound 43,390 residents, which is only 19.7% of the total occupants, the rest 80.3% of the occupants will be left unserved during an emergency. An additional 24.33 acres of land are required for the accommodation of the current population of the study area. This study also provides some guidelines for utilizing open spaces as emergency assembly points. It suggests developing further mechanisms to provide sufficient open spaces and regulatory framework.

Keywords: Urbanization, Open Space, Emergency Assembly Point (EAP), Discarded Population

1. Introduction:

Asia-Pacific area is one of the world's most at-risk regions, with its cities serving as the epicenter of different types of natural and manmade disasters. Rapid urbanization is one of the underlying causes of these increasing risks to disasters. The bulk of Asia's urbanization takes place in the seven developing countries, including Bangladesh, one of the fastest-growing nations. As disasters are becoming more severe and frequent in metropolitan areas, which house half of the world's population and get the major hits. With a geographic size of slightly over 148,000 sq km and a population of over 160 million people, Bangladesh is ranked fifth among the world's top fifteen high-risk countries [1]. The city faces various types of hazards due to the rapid population growth and urban development, posing significant risks to the residents [2]. Dhaka city is vulnerable to both natural and man-made disasters. Because of the infrastructure, the area is susceptible to fire hazards, earthquakes, building collapse, etc. These disasters need rapid response and, in these situations, many of these evacuees, particularly the lower-income populations, rely on evacuation shelters for temporary housing as evacuation shelters are almost exclusively dual-use shelters, where the facility's primary purpose is for some other public use due to the expense and limited use [3]. However, the lack of open spaces has turned the condition into more complex for disaster risk reduction.

Publicly accessible open areas in the urban areas planned and constructed for human interaction and recreation are referredas urban open spaces. This includes parks, playgrounds, and gardens [4]. During any urban hazard, the open spaces in the area can be used as emergency assembly spaces where people can seek shelter temporarily. Although open space is one of the most basic city structure elements, there is no such centralized regulation to use the potential of as an emergency assembly point. Many researchers have conducted baseline and advanced studies on open spaces [5] such as Allan and Bryant [6] stated in their study that the city's open space network, including squares and parks, acted as temporary safe zones before being used for shelter and aid distribution. The open space network enables easy to complex facilities such as assembly, accommodation, delivery of goods and services, and temporary settlement after a significant earthquake. People can adjust their crisis time settlement for days, months, or even years using the open spaces as a shelter and a temporary home [6]. They emphasized the significance of spatial and functional diversity and the location

selection of open spaces [7]. Venn and Niemelä [8]&Haq [9] mentioned that interdisciplinary and integrative techniques should enhance open green areas in the city and optimize applicable regulations. Fan et al.[10] focused on the use of urban green spaces as disaster shelters and their established ecological role. However, Şenik and Uzun [11] opined that it's critical to locate assembly points and temporary shelters near some urban occupancy areas (hospitals, main roads) while keeping them away from others (areas with food risk, fuel stations, existing buildings).

Mirpur area is densely populated and vulnerable to various urban disasters. The study area of this research includes Pallabi and Mirpur 12 in the Mirpur region ofDhaka Division, Bangladesh. These two sections contained Wards 2, 7 (partially), and 15 (partially).

The area's infrastructure is in poor condition. In most of the sites, there is little space between the buildings because they are so close together. Most of the structures are not constructed following the building code. The area's roads are incredibly narrow. According to Fire Service officials, unplanned urbanization, the rise of random commercial establishments such as garments, industry, markets, and offices through filing canals and water sources, and the growth of non-approved high buildings are among the top areas on the list [12]**.** The area is vulnerable to fire hazards due to narrow roads, a lack of fire extinguishing systems in shops or business establishments, and illegal power connections. The area lacks a proper building code, which may lead to potential urban disasters. The site has already faced several fire accidents in Chandrabindu Fashion House (2018), City Park Building (2019), Mirpur 14 Slum (2019), and Cholontika Slum (2017). Not only for fire hazards, but the area is also vulnerable to other on spot disasters like building collapse and earthquake [13].

Hence, identifying the gap between available and required amount of open spaces that can be used as potential emergency assembly points (EAP), is essential. So that, in case of any emergency like an earthquake or fire accident, people can gather at the accessible assembly points. These will help in disaster response and recovery as the community people can gather there immediately and stay until their houses become livable again. Open spaces and shelters are an urban asset for making a city disaster resilient.

However, the assembly points should be a nearby area where residents can reach by walking. As per Koren and Rus [14] resilient streets should be wide enough and free of obstacles. Emergency point placement planning is focused on standards, requirements, and guidelines established by emergency managers and humanitarian organizations, which are mostly based on post-disaster assessments [15]. The SPHERE Project provides provisions for strategic planning, settlement planning, covering living space, infrastructure, and environmental impact for shelter and settlements [16].

This paper is based on the concept of reducing multi-hazard risk in the specific area by identifying appropriate emergency assembly points and what kind of emergency plan can be taken for emergency evacuation in any multi-hazard situation.

The research's primary goal is to manage the risk of multiple hazards in the selected area by proposing suitable spaces for emergency assembly points by identifying potential open spaces for the emergency assembly points in the study area using spatial analysis on ArcMap.

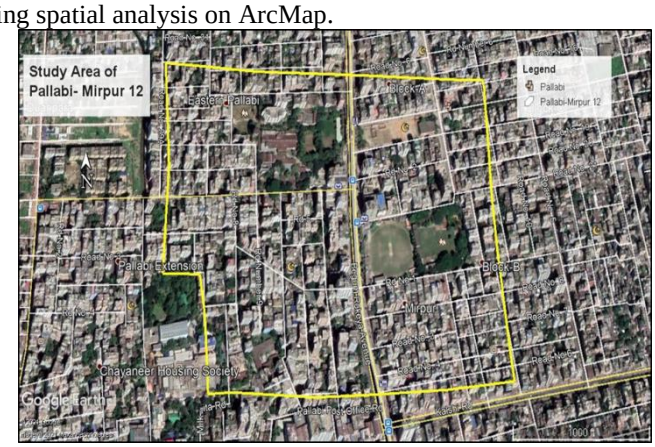

Figure 1: Study Area of Pallabi and Mirpur 12 *(Source: Google Earth)*

2. Methodology:

This research has used spatial analysis using Google Earth Tool and ArcGIS. At first, the existing open spaces in the study locations are selected in Google Earth, then the selected plots are exported into ArcMap as shape files for spatial analysis and calculations. From the input of attribute tables of the polygon shape files, the total area is measured for the available open spaces which can be used as potential EAP. Then, the observational survey is conducted to validate the potential EAP in the real ground. The existing conditions, accessibility, access road, surrounding land uses, location of emergency service centers, etc. factors were observed in the

selected locations through a checklist. The criteria of an ideal EAP have been set out from the literature and international guidelines. The qualitative assessment of the selected EAP is done by a focus group discussion (FGD). It is held with the residents of the study area who are the users of those assembly points to understand their perceptions on EAP and the challenges faced by them to access those locations.

For the required number of areas to accommodate the study population in the emergency, the standard space/person ratio is fixed and then calculated for the totalresidents of the study area. Then the gap is found out by subtracting the available areas from the required areas forEAP. Finally, the discarded population is measured who cannot be accommodated in the available potential EAPs.Some suggestions and guidelines are provided to incorporatemore EAPs, and management procedures are mentioned so that people can be shifted and sheltered in the EAPs (Figure 2).

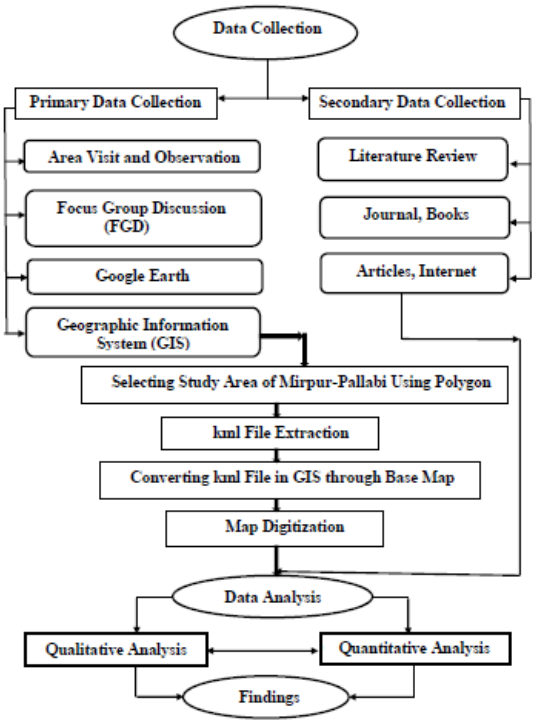

Figure 2: Flowchart of Methodology *(Source: Author, 2021)*

3. Results and Discussion

For our data analysis, we used Google earth, from which we selected our study area through a polygon, and we showed thepolygon area of the open spaces. Then in GIS, we digitized our shape file, and through polyline and polygon, we showed the road network and potential assembly point. After that, in the attribute table, we showed land use, polygon area, ward no, total population, and calculated area accommodation for the people in that specific area.

In this study, the author demonstrated the calculation of the area accommodation based on the assembled point area, ward distribution, and accessibility of identified open spaces.

3.1 Existing Open Spaces of the Study Area:

After conducting an area survey, a total of 6 open spaces are selected in the study area. (Figure 3) which are *Pallabi Eidgah Maydan, City Club Ground, M.D.C Model Institute Field, Pallabi M.I Model High School Field, Mawts Open Playground and Adjacent Open Field of MawtsPlayground***.**After identifying possible open spaces (6) for the study area, a qualitative analysis was conducted to determine the **accessibility** of these specific areas (Figure 4). The specified places of schools and college field, playground, Eidgah Maydan, all government authorized, are considered accessible for the study areas nearby residents [17]. The identified potential assembly points were in Mirpur 12 and Pallabi area. These areas in total are approximately 260,335 sq. ft. which is enough to be considered as open spacefor assembling places during an emergency for the residing people (Table 1).

3.2 Accommodation of the Population According to Assembly Point Area:

During an emergency, six square feet per person is a good rule of thumb for a standing crowd [18]. It means each person needs approximately a six sq. ft. area around himself or herself to stand. Suppose we are planning how many people can assemble in an open space in an emergency. In that case, we have to divide the total area of that open space by six to determine the area accommodation of that place. The equation will be,

Accommodation of population=

$$\frac{Total\ Area}{Area\ needed\ for\ 1\ person\ to\ stand\ comfortably}$$

According to our calculations (Table 2), the total areaneeded for the population of three wards is 13, 21, 746 square feet. Only 43,390 people will fit in our designated assembly point. So, the discarded population is 1, 76, 901, and if there is an emergency, this population would need approximately 10, 61, 411 square feet of space. Since space is limited and the population is large, some alternative guidelines can minimize vulnerability and risk.

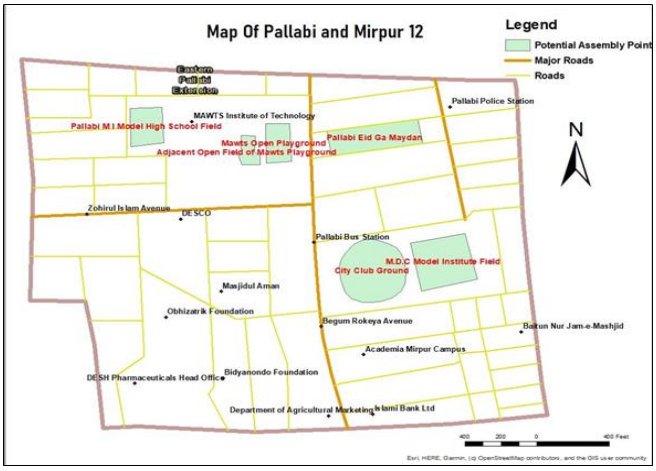

Figure 3: Map of Potential Assembly Points (Source: Author, 202

Table 1: Total area and accommodation capacity of the available open spaces

Name	**Location**	**Land Use Type**	**Total Area (sq ft.)**	**Accessibility**	**Ward Population***(Source: Statistics BD,2011)*	**No. of person the space can accommodate (Total area/6 sq.ft)**
Pallabi Eidgah Maydan	Ward No 15 (Part)	Public Space	65,985	Accessible	16,993	10,998
City Club Ground	Ward No. 02	Playground	89,313	Accessible	1,51,868	14,886
M.D.C Model Institute Field	Ward No. 02	Educationa l Purposes	49,872	Accessible	1,51,868	8,312
Pallabi M.I Model High School Field	Ward No. 07(part)	Educationa l Purpose	31,747	Accessible	51,430	5,291
Mawts Open Playground	Ward No. 07 (Part)	Playground	14,210	Accessible	51,430	2,368
Adjacent Open Field of Mawts Playground	Ward No. 07 (Part	Open Area	9,208	Accessible	51,430	1,535

(Source: Author, 2021)

Total Populationof the study area	= 1699 + 151868 + 51430 = 2,20,291
Population Capacity	= 10998 + 14886 + 8312 + 5291 + 2368 + 1535 = 43,390
Discarded Population = Total Population - Population Capacity	= 220291 - 43390 = 1,76,901
Total Assembly Area	=65985 + 89313 + 49872 + 31747 + 14210 + 9208 = 2, 60, 335 sq. ft.
Total area needed for total population	= (220291 x 6) sq. ft. = 13,21,746 sq. ft.
Area needed for discarded population = (Total area needed for total population - Total Assembly Area)	= (1321746 - 260335) sq. ft. = ***10,61,411 sq. ft. or 24.33 Acre***

Table 2: Total number of discarded Population

(Source: Author, 2021)

4. Recommendations:

Public open spaces should be considered for sustainable use, and for that, proper management is needed [19]. A solid vision for appropriate use and conservation of public open spaces should be developed to improve accountability, efficiency, and responsibility in public land properties and comparable techniques. After analysis in the Mirpur area, we can consider some recommendations to improve the living standard in the area during an emergency.

4.1 Fire Safety:

The road surrounding the open spaces should be free of obstacles so that the fire department can quickly respond. There should be training, awareness-raising for fire prevention, as it is an emerging situation.

4.2 Building Code and Building Maintenance:

One of the most critical aspects for mitigating any hazard impact is good infrastructure. When constructing any infrastructure or building, rules and regulations must be followed. The Bangladesh National Building Code (BNBC) has specific rules and guidelines to follow while constructing buildings. There is a lack of rules for a disaster resilient building. It is now necessary to focus more on building codes and disaster resilience [20]. Combining the design and planning of emergency shelters and public open spaces into the construction of urban resilience may improve disaster management [21]. We have found slums in the study area; the conditions of those slums are not good. While establishing those slums, proper maintenance should be done.

4.3 Drills:

The community people can participate in drills to enhance their knowledge of the emergency and know what to expect. People will be more motivated and will recall exercises more quickly because they are realistic. They will understand how to go to the assembly point and which route they should take. Drills should include simulated structural destruction, human injuries, active search and rescue, mass transportation, and other operations. Drills/Training should be done routinely. There should be a plan to cover all building tenants in training them on essential fire prevention, safety hazards, emergency procedures, and fire extinguishing methods.

4.4 Committee on Disaster Management:

The government, associated stakeholders, and organizations can establish rules and regulations and maintain these places. They should adopt effective planning policies, approaches, and creative design methods to ensure fair distribution, inclusion and access, connectivity, and the consistency of public-space networks in the city [22]. There should be a disaster management committee to take strategic approaches and do proper planning for the community.

4.5 Traffic Control:

Congestion on city roads and highways results in a significant loss of network infrastructure and, thus, more insufficient throughput, which can be alleviated with the proper management techniques and techniques

[23]. In an emergency, our study area's busy and narrow roadways could create further delays. A good road network is required to deal with any crisis.

4.6 Land Use Zoning:

Since there is a critical shortage of open space, Land Use Zoning should prioritize protecting and restoring natural open areas, historical and cultural places, and other environmentally significant sites. The local government may ease the baseline zoning rule to allow for more consistent site planning across all areas, resulting in a better site planning exercise and interaction between buildings and open spaces. Illegal settlements should be eliminated, and space can be used as a recreational zone.

5. Conclusion:

Dhaka city has become one of the world's twenty most vulnerable cities in the world, making it one of the least livable cities. It is a rapidly growing unplanned city with significant vulnerabilities. The research area contains a wide range of infrastructure, including houses, tin sheds, and slums. There are fewer open spaces, and their maintenance is inadequate. A city's public open spaces are a valuable resource. It can be used as a temporary shelter where people can stay in times of emergency and where relief distribution can be done. A policy and procedure for open space can make Dhaka better for a disaster-resilient city. Also, a proper evacuation plan in an open space can reduce the vulnerability of the community. For the overall improvement of the public open spaces, governments and organizations working for disaster risk reduction can make plans and procedures. They should initiate and support to create and conserve more open spaces. Prioritizing open space maintenance will help to protect the environment and facilitate the community.

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