



Shortage of evacuation spaces for earthquake disaster in Pokhara Metropolitan City, Nepal

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Abstract

Earthquakes, as one of the most destructive natural hazards, pose significant threats to human lives and infrastructure. The aftermath of an earthquake often results in cascading events, including structural damages, floods, and landslides, leading to considerable loss of life and property. Factors influencing the severity of these disasters include population density, construction standards, and emergency preparedness. Effective emergency preparedness aims to minimize these losses during natural disasters. This research aimed at identifying and assessing the open public spaces available in three sampled wards – 1, 7 and 17 of Pokhara Metropolitan City. This research focused on the critical issues of earthquake preparedness in the city of Pokhara, a region at high risk of seismic activity. The study employed various research methods such as focus group discussions, questionnaire surveys, and map surveys to collect the data. ArcGIS was employed for assessing the open spaces and mapping purposes. Despite being among the 20 most disaster-prone countries globally, Nepal lacks robust governance for disaster preparedness, particularly in Pokhara. Results revealed significant disparities in open space availability and holding capacities among the selected wards, with ward no. 17 having the lowest open space area followed by ward no. 1 and 7 relatively. Those wards have a total of 156,657.41 m², 566,320 m² and 84,103.29 m² respectively. There was good road access to the most of the open spaces. However, basic facilities such as public toilets and drinking water are lacking in many areas. The findings also emphasize the need for policy review, careful selection of open spaces, maintenance of basic facilities, and the development of emergency evacuation plans. Public awareness campaigns are also recommended to sensitize residents of Pokhara about potential natural disasters, mitigation measures, and evacuation plans. This study contributes valuable insights to the broader field of disaster management and urban planning, particularly in earthquake-prone regions.

Keywords: Pokhara, earthquake, open spaces, evacuation plan and preparedness

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1 Introduction

Earthquake is one of the most destructive natural hazards that can occur at any time. In most cases, destruction to human lives is caused by the cascading events that follow after the earthquake. Damages to manmade buildings and infrastructures often lead to the death of people, and natural calamities such as floods and landslides often contribute to additional loss of lives. The degree of disaster and losses from earthquake hazards depends on factors like population density, construction standards, and emergency pre-

paredness (UNDP/BCPR, 2015). As such, an emergency response plan is one of such preparedness strategies that might reduce the aftermath of an earthquake. It includes the capacity and knowledge to anticipate and respond to the impact of likely hazard events (ADPC, 1997; UN-ISDR and UN-OCHA, 2008). Furthermore, preparedness also includes actions taken in anticipation of the event and to be taken during and immediately after the event. The emergency response plan is one of the adjustments (IOM/UNDP, 2017) and is crucial for effective response and recovery at

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all levels of disaster management (WCDR, 2005) to reduce or avoid the effects of natural disasters.

The response and recovery are the phases of post-disaster scenario. Search and rescue of the victims and survival are the most important parameters in the response phase. Besides that, available open space and a proper evacuation route from the place of incidents to open space with basic facilities play a crucial role in the whole scenario of response and recovery phases of post disaster scenario (Anhorn and Khazai, 2015). The sound planning of disaster management considers open space and the evacuation route. The open space which is the land owned by the government or other public organizations and dedicated for conservation or the social motives is recognized as the “green infrastructure” (Anhorn and Khazai, 2015; UN, 2020) whereas evacuation route considers additional criteria such as vulnerability of buildings along the route to open space is important for the effective post-earthquake rescue plan. Open spaces include parks, gardens, trails, habitat corridors, utility reserves, sports grounds, and conservation reserves. Some open space sites may have buildings and services on them to enhance their capacity to meet the needs for which they are reserved or because their uses are compatible with the open space purposes. The importance of open space ranges not only in the provision of opportunities for recreational activities but also in providing a range of social, economic, and cultural benefits or values to the community (Anhorn and Khazai, 2015; Pokharel and Khanal, 2018). Therefore, open spaces which are an integral part of land use planning are important to the urban environment and quality of urban life. These land-use features are increasingly recognized in the cities of developed countries. However, in developing countries like Nepal, there is no general agreement on the desirable planning criteria on how much open space is needed, where the open space is to be located, and how the open space should be used. Moreover, there are no such standards at the policy level for the placement and quality of open space.

Nepal is situated in a seismically active zone with a high probability of a massive earthquake. Therefore, Nepal has been ranked in the 11th position in terms of risk from earthquakes (UNDP/BCPR, 2015; Pokharel et al., 2024). In addition, Nepal is among the 20 most disaster-prone countries in the world, both natural and man induced. Furthermore, Nepali cities which are densely populated and located in the zones are prone to multi-hazards. Nepal, with a history of centralized and reactive disaster management approach, suffers from frequent natural disasters such as earthquakes, floods, landslides and thunderstorms. A series of past earthquakes including the recent two major earthquake events – Gorkha on 25 April, 2015 and Jajarkot on 3 November, 2023 has clearly indicated the poor disaster risk management in Nepal. That has continuously led the country to develop and implement an effective disaster management plan. However, governance arrangements remain weak/insufficient for disaster preparedness. Furthermore, major Nepali cities such as Pokhara and Kathmandu which lie in seismic hazard zones with increased levels of risk due to high urban sprawl rates and consequent high physical exposures lack disaster preparedness. Weak social

networks among migrant populations may further increase the risk from natural disasters (UNDP/BCPR, 2015; Rimal et al., 2015). However, the governance of Nepal has not fully recognized the need for open space management as a powerful disaster risk management tool in one hand. On the other hand, there is no scientific attention in assessing the open spaces to use them for emergency evacuation. Therefore, this study aimed at assessing the disaster preparedness plan and status and availability of evacuation spaces taking Pokhara Metropolitan City as a case. We estimated the total holding capacity of each open space and ranked them based on the basic facilities available within the easily accessible distance. This study is expected to sensitize the Nepali government particularly the cities which lies in disaster prone areas but are poor in disaster risk management. In addition, there would be more attention of policy makers and managers in planning for, managing and assessing the open spaces as a part of disaster risk management plan.

2 Methodology

2.1 Study Area

Pokhara Metropolitan City, hereafter Pokhara is situated on the southern foot of Annapurna Himalaya range in Kaski district. It is the second largest urban center in the hills of Nepal. The city which is divided into 33 administrative wards (Fig. 1) covers an area of 464.24 km² with a total population of 513504. According to the national population census, 2078 Field (CBS, 2021), there are 140,459 households with a total of 1,106/km² population density. The literacy rate is 88.7% (male, 94.2% and female 83.7%). 1.9% of the total population (1.8% female and 2.2% male) have some kind of disability. Those include 38.4% physical disability, 4% blind and 7.4% of the disabled population have multiple disability.

Pokhara is surrounded by Madi Rural Municipality and Rupa Rural Municipality on the East, Annapurna Rural Municipality, Parbat and Syangja District on the West, Machhapuchhre and Madi Rural Municipality on the North and Syangja and Tanahu districts on the South. The highest elevation of Pokhara is 1,740 m and the lowest elevation is 827 m from sea level.

2.2 Research Design

We selected only three different wards of Pokhara by following a stratified sampling technique. For that, we ranked all 33 wards with their total population size by following the national population census, 2078 (CBS, 2021). Then we picked up ward no. 17 which holds the highest population with 46,005 (22,066 males and 23,939 females) among the wards. Then, we chose ward no. 1 which is one of the smallest wards by area (Fig. 1) but it is one of the wards with the highest population density. Furthermore, officially, the total population of the ward no. 1 is 13947. However, there is one of the largest colleges in Nepal, Prithvi Narayan Campus (<https://prnc.tu.edu.np>) where students from outside Pokhara also reside temporarily. If we consider the population of students and academic and administrative staff of the campus, ward no. 1 is an area to

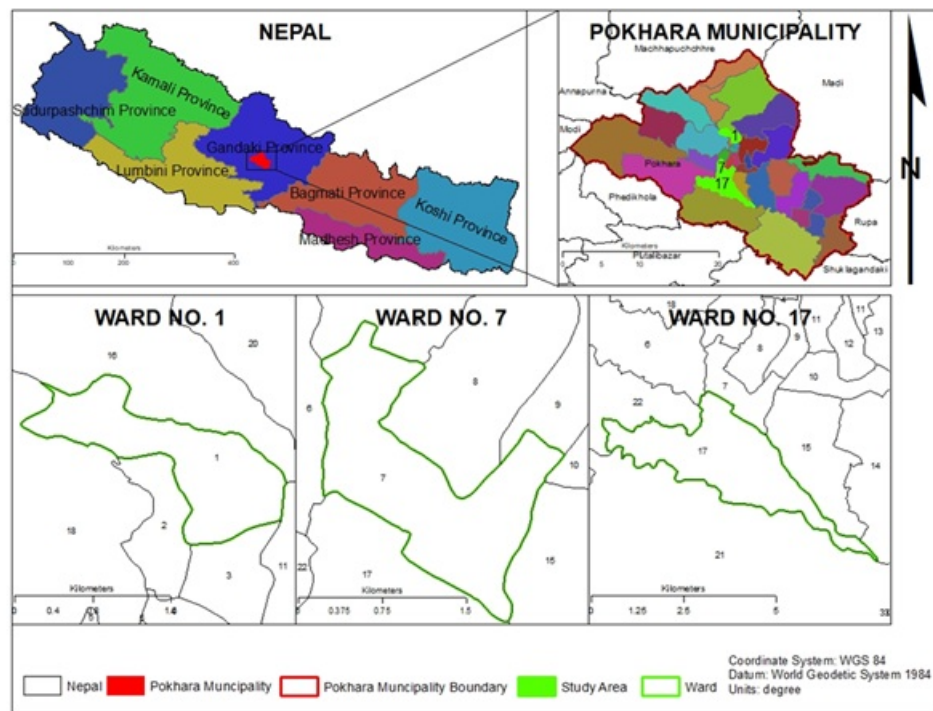


Fig. 1. Map showing the study areas within Pokhara Metropolitan City.

consider for this study. Finally, we picked up ward no. 7 for our study. The ward holds a population of 16,139 which lies somewhat in between the ward no. 1 and 17 regarding the population size and the area as well. In this study, ‘evacuation spaces’ refer specifically to publicly accessible open spaces—such as parks, playgrounds, sports grounds, and vacant lots—that are formally designated or informally recognized as critical assembly areas for the population in the immediate aftermath of a major earthquake.

2.3 Questionnaire Survey

We prepared a structured questionnaire list and used that to interview the local people of Pokhara Metropolitan City, particularly of the selected wards. We employed a mixed sampling approach, combining purposive and convenient sampling method was used during field survey. A lump sum 225 (75 respondents from each ward) were randomly selected for the purpose of this study. Those selected people included professionals to non-professionals from medical doctors, engineers, pharmacists, club members, retired civil servants, bankers, academicians, cadres of political parties, taxi drivers, house building labours, restaurant owners, lawyers, members of ‘women group’ (*aama samuha*) and policemen as well. We conducted the interview only after their consent. We selected the respondents regardless of their sex and locality with the assumption that they were all above 18.

2.4 Focus Group Discussion (FGD)

Similar to the questionnaire survey, we first prepared a set of semi-structured questionnaire to obtain the information at policy and planning level. Then we organized four

different focus group discussions, one in Pokhara Metropolitan City Office at New Road, Pokhara and the remaining three on each selected wards of the PMC. FGD targeted the staff of PMC from the relevant departments, elected chief of the wards and the staffs of the wards. The discussion focused on the current level of planning and preparedness for the potential earthquake hazards, challenges and other related issues that are prevalent in Pokhara.

2.5 Selection of Open Spaces

The survey department, ministry of land management, cooperatives and poverty alleviation in Pokhara provided the information on public open spaces. Then, survey was conducted to identify the open spaces in order to collect additional information such as status of access roads, availability of basic facilities such as electricity, drinking water and public toilets, and social infrastructures such as pharmacies, hospitals or clinics and police stations in and around the available open spaces. Remotely sensed data such as Google Maps and Open Street Maps were used to estimate the actual area of open space that would be available for potential relocation and the capacity of open space in terms of accommodating people. We considered 3.5 m² space per person including the circulation area, in continuation to the basic circulation features the ease of ingress, and utilization is of priority during the emergency period is of main concern. Similarly, addressing special needs of physically challenged people and safe movement and convenient access to all the locations and services within the facility are the basic points to be highlighted (UN-ISDR and UN-OCHA, 2008; Wright and Johnston, 2010). In addition, the study also considered potential or availability of social

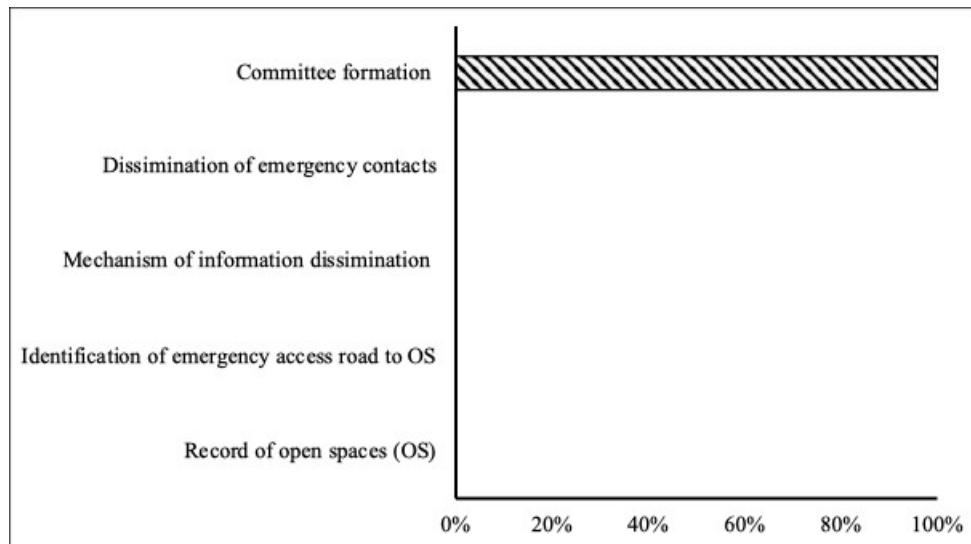


Fig. 2. Diagram showing the level of disaster preparedness by Pokhara Metropolitan City in terms of the response by the key personnel of the city. The results were based on the responses from the staff and elected members of PMC.

infrastructures for dual purpose i.e., integrated community facilities for multipurpose uses such as for earthquake and emergency shelter, and for relatively long-term resettlement of the evacuees of the earthquake due to the total collapse of the building (The Sphere Project, 2011).

2.6 Ranking of Open Spaces

We considered only public lands which are open and usable. Then the open spaces were categorized and ranked based on different indicators such as current or future land-use plan (if any), availability of the basic facilities such as electricity, water supply, nearness to critical facilities and environmental situation from public health point-of-view such as pollution level (Anhorn and Khazai, 2015). Availability of services or facilities such as hospitals, clinics, police station and social organizations within 500 m from the edge of the open space were considered.

Moreover, there should be a minimum time constrain to reach the evacuation sites in time at the time of an earthquake (Lambert et al., 2013; Ariccio et al., 2020; Xiao et al., 2022). Also, the road networks should be as such it will provide easy access to ambulance, fire brigade and other relief vehicles to the evacuation site so that there is an immediate response, as soon as a disaster strikes (Twigg, 2014; Alexander, 2015).

2.7 Data Analysis

Thiessen polygons were generated around each open space to demarcate zones of closest proximity. Each polygon defines an area where any location is closer in straight-line distance to that open space than to any other. This approach identifies the nearest open space in Euclidean terms but does not model actual road network access or travel time. The sample point used for the process was created by generating the central point using the tool “Feature to Point”. The ratio of area of open space to area of service was used to evaluate what population each of the area is capa-

ble of handling. To evaluate the facilities and services that could be within the emergency reachable distance from the open spaces, the location of facilities (Police station, Health centers and Hospitals, and Public Offices) were evaluated. Considering 500 m distance as the emergency reachable distance, the availability of the facilities within that distance and within the area of service of a particular open space were evaluated. However, availability of electricity, toilet/bathroom and drinking water facilities within the open space to qualify the area as better-quality area for emergency evacuation were considered. Those criteria are used in ranking the open spaces. A buffer of 500 m from the open space was created and clipped within the ward boundary. The locations of facilities available from the Open Street Map (OSM) were used to evaluate. Each of the open space were evaluated individually. We used ArcGIS version 10.2 (ESRI, 2013) to analyze remotely sensed data and develop maps.

3 Result and Discussion

3.1 Status of the Disaster Preparedness in Pokhara

3.1.1 Preparedness at the level of local government

This study found that Pokhara Metropolitan City as well as all the wards we focused had formed a “Disaster Management Committee” under the chairmanship of the elected chief of the ward. However, there were no preparedness actions undertaken in the field of disaster preparedness by the committee (Fig. 2). The officials and the political leaders of the wards could figure out names of some open spaces, however, there was no official records of open spaces neither any plan for the emergency rescue. According to the key persons of the PMC, the metropolitan city office has allocated two crores Nepali rupees (equivalent to US\$ 137,245) for the natural disaster and risk management. NRs 5 lakh (US\$ 3,431) could be available to each ward of the PMC to work in the field of ‘disaster risk management’. There was no mechanism of information dissemination to

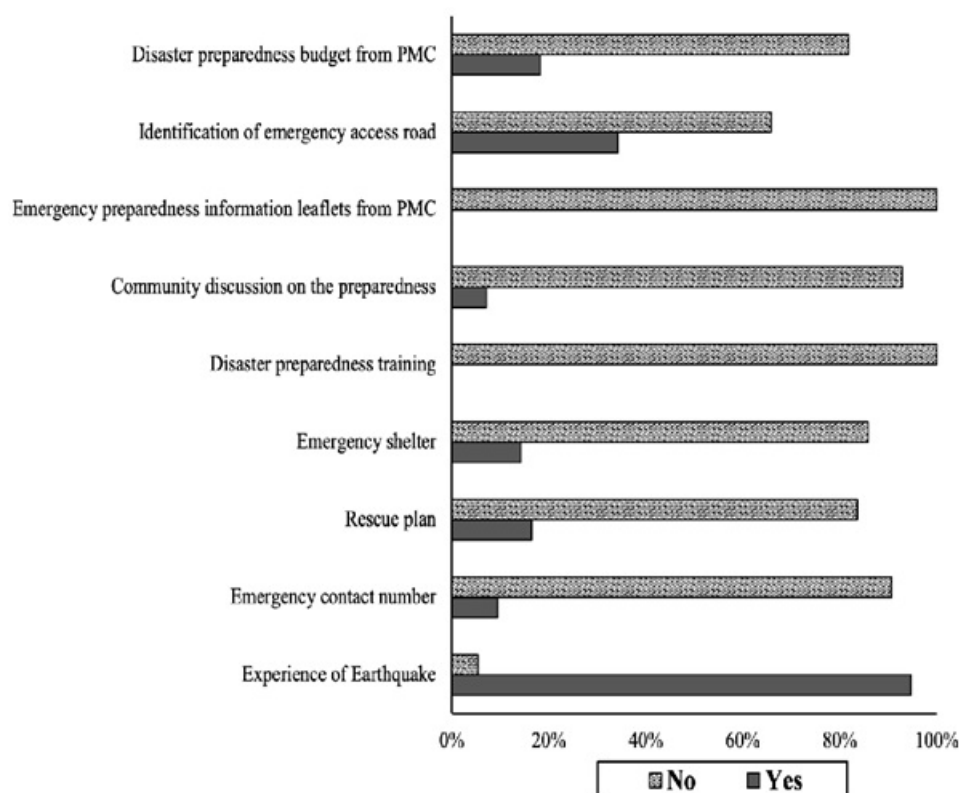


Fig. 3. Public response on disaster preparedness and cooperation from Pokhara Metropolitan City (PMC).

make the people of Pokhara well-informed about the risk of natural disaster like earthquake, preparedness and rescue procedures. PMC had neither prepared emergency rescue plan nor kept any record of open spaces and evacuation route to the open space.

3.1.2 Preparedness at the level of local public

Most of the people in Pokhara have experienced the earthquake in their life. Only 9% of the respondents were aware of the emergency contact number. According to them they would contact Nepal Police or dial 101 or 102 in case of dire need of help or rescue. None of the respondent had prepared any rescue plan in case of devastating earthquake. However, 16% of the respondents claimed that they had left some open space in their own land with the plan to use that space in case of earthquake. Only about 15% of the respondents (Fig. 3) explained that they have got a large tent to install and use as an emergency shelter. None of the respondents had ever attended any disaster preparedness training provided by any organization, neither they had any idea about the information leaflets regarding the disaster preparedness, evacuation and rescue plan or procedure. Only 7% of the people who responded to our interview informed us that they sometimes discuss in the community and among neighbourhoods or friends about the possible earthquake and how to be safe from that. Almost 1/3rd of the respondents were confident that the road next to their house/home are good and would be suitable enough to use as emergency access road. Rest of the respondents thought that the road that reaches to their home is narrow and would be completely blocked after a devastating earth-

quake. Furthermore, less than 1/5th of the respondents had some idea about the budget for disaster preparedness and rescue allocated by the local government.

The public response on disaster preparedness (Fig. 3) clearly indicates the poor planning and level of perceiving the possible risk due to earthquake. From policy making and implementing level i.e. the local government to the public who suffer from the disaster lack appropriate level of awareness and preparedness for the possible emergency situation.

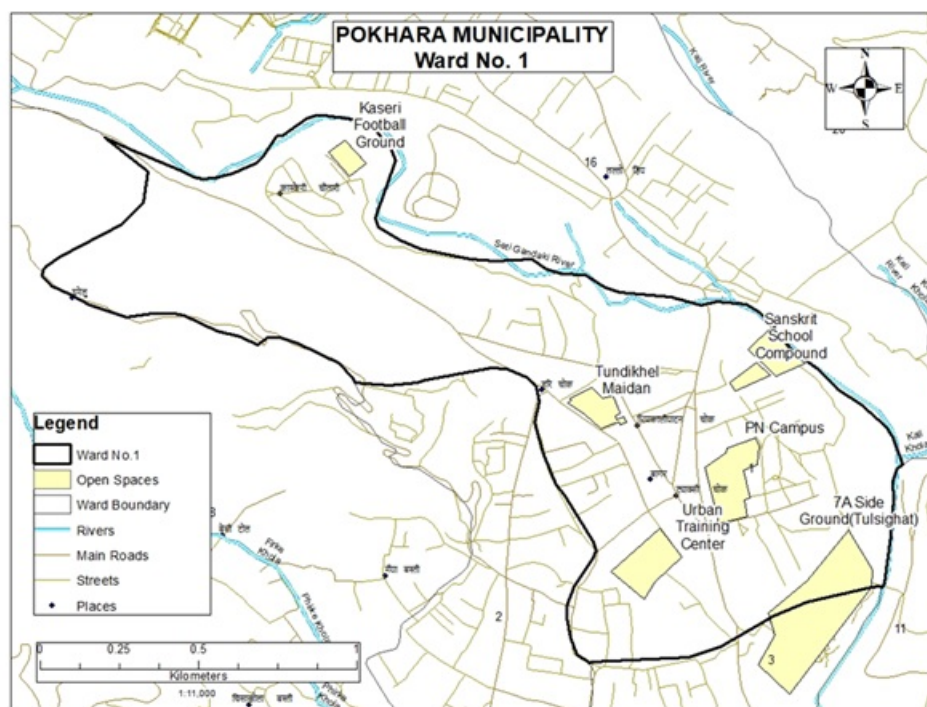
3.2 Open Spaces Available in Pokhara

During natural disasters like earthquakes, proximity to open spaces becomes critical for emergency evacuation. Parks, plazas, and fields serve as safe zones, enabling swift evacuation from buildings. Their accessibility can determine evacuation success, mitigating congestion and providing refuge until the threat subsides, highlighting the indispensable role of open spaces in urban resilience planning. In this regards, ward-wise distribution of open spaces in Pokhara is highly variable. Ward no. 1 which is only of the densely populated wards in Pokhara have about 15.67 ha of usable open space available. Open spaces in Prithvi Narayan Campus including the space in academic buildings, 7A side ground in Tulsighat, urban training center and Tundikhel maidan are some of the notable places with good access to roads and other necessary facilities (Table 1 & Fig. 4). Those areas are easily accessible by road networks.

There is a total of about 57ha of open and usable space available in ward no. 7 of PMC. Old airport in the area is

Table 1. Summary of the open spaces in Ward no. 1 of PMC with estimated capacity (3.5 m²/person). Area sourced from the Department of Land Management, Kaski.

SI.no.	Name of open Space	Sheet No.	Plot No.	Area (m ²)	Public Accessibility		Road Access		Landscape		Capacity
					All time	Not accessible	Yes	No	Plain	Slopy	
1	Tundikhel Maidan	093-0840-06	62	13448.94	P		P		P		3842
2	Prithvi Narayan Campus	093-0840-12,17	138, 198	25211.47	P		P		P		7203
3	7A side ground (Tulsighat)	093-0840-17	1	15000	P		P		P		4285
4	Urban Training Center	093-0840-17	98	20469.0	P		P		P		5848
5	Kaseri Football Ground	093-0799-13	1, 35	5616.0	P		P		P		1604
6	Sanskrit School Compound	093-0840-03	92	18234.0	P		P		P		5209
Total				97979.41							27991

**Fig. 4.** Map of ward no. 1 of PMC highlighting the open spaces and their distribution.

the largest open space that can alone accommodate more than 16,000 people in case of emergency evacuation (Table 2 & Fig. 5). Other important open spaces in terms of area in ward no. 7 include Masbar ground, Pushpalal memorial park and Tin Gaunle Thakali Samajghar.

Ward no. 17 which accommodates the highest population among the wards of Pokhara bear just about 8.4 ha of open public lands that can accommodate only about 24,000 people (Table 3) in case of emergency evacuation. Despite the fact that there are highest number of open spaces scattered in the ward no. 17 among the selected three wards of PMC, the ward has the least in amount of total area as open space available during emergency evacuation. Noticeable open spaces in terms of area include International Mountain Museum that can accommodate almost 10,000 people followed by Chhorepatan Tibetan football ground with a capacity of about 3500 people (Table 3 & Fig. 6).

3.3 Ranking of the Available Open Spaces

The best ranked open spaces for possible emergency evacuation in ward no. 1 include Prithvi Narayan Campus, Urban Training Center and Sanskrit School Compound.

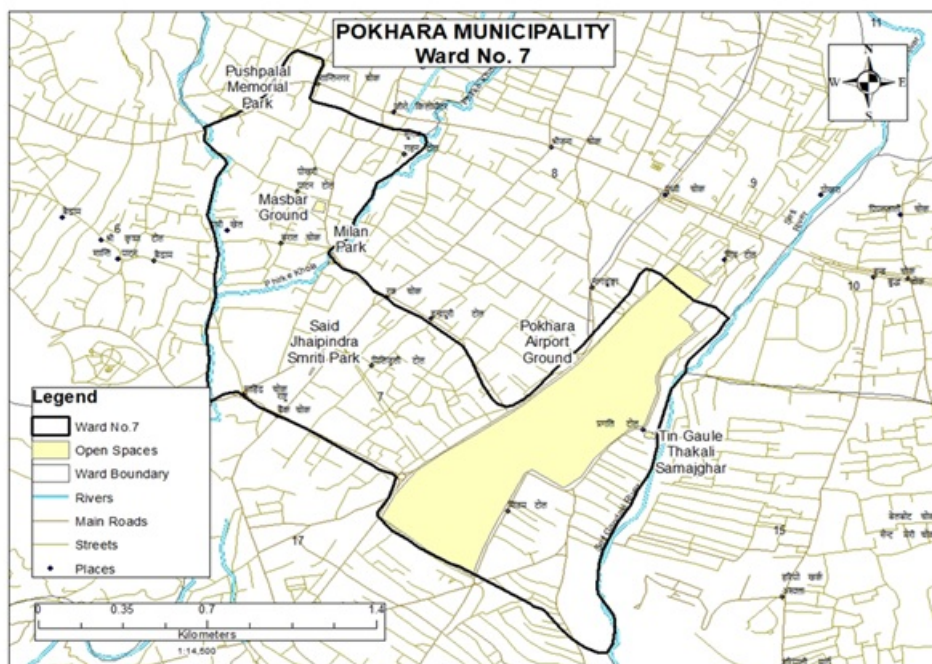
These areas are ranked in I category with all the facilities installed inside or within the range 500 m with good access to road. They can hold 7203, 5848 and 5209 people in case of emergency (Table 4). Tundikhel maidan with the capacity of 3842, 7A side ground at Tulsighat with the capacity of 4285 and Kaseri football ground with the people holding capacity of 1604 need the basic but necessary facilities installed within the area to make them prepare for the emergency evacuation.

There were three well-facilitated open spaces that could be available during emergency evacuation in PMC ward no. 7 include Pokhara airport ground with the highest capacity of people holding in the ward with the capacity of 160285. Other two well-facilitated open spaces are Pushpalal Memorial Park with the capacity of about 400 and Tingaunle Thakali Samajghar, 342 (Table 5). Masbar ground, Sahid Jhapindra Smriti Park and Milann Park lack the basic but necessary facilities which are to be developed or installed within the area so that those areas could be readily usable during the emergency situation.

Highest number of open spaces (patch numbers) were identified in ward no. 17 among the selected wards. Out

Table 2. Summary of the open spaces in Ward no. 7 of PMC capacity (3.5 m²/person). Area sourced from the Department of Land Management, Kaski.

Sl.no.	Name of open Space	Sheet No.	Plot No.	Area (m ²)	Public Accessibility		Road Access		Landscape		Capacity
					All time	Not accessible	Yes	No	Plain	Slopy	
1	Puspapal Memorial Park	093-0918-24	25	1390	P		P		P		397
2	Masbar Ground	093-0959-06	5	1829	P		P		P		522
3	Said Jhapindra Smirti Park	093-0959-16	21	310	P		P		P		88
4	Milan Park	093-0959-06	101	591	P		P		P		168
5	Tin Gaule Thakali Samajghar	093-0999-05	149	1200	P		P		P		342
6	Pokhara Airport ground	093-0999-04,05	5+	561000	P		P		P		160285
Total				566320							161802

**Fig. 5.** Map of ward no. 7 of PMC highlighting the open spaces and their distribution with major road systems.**Table 3.** Summary of the open spaces in Ward no. 17 of PMC with capacity (3.5 m²/person). Area sourced from the Department of Land Management, Kaski.

Sl.no.	Name of open Space	Sheet No.	Plot No.	Area (m ²)	Public Accessibility		Road Access		Landscape		Capacity
					All time	Not accessible	yes	no	plain	slopy	
1	Durga Mandir	093-0997-18	105, 106	1420.00	P		P		P		405
2	Chhorepatan tole sudhar area	093-0997-19	62	538.60	P		P		P		184
3	Devis fall park	093-0997-21	1	4310.00	P		P		P		1231
4	Chhorepatan Tibetan football ground	093-1037-04	74	12000 (32398)*	P		P		P		3428
5	Shaid memorial park	093-0998-24	1,2	7900	P		P		P		2257
6	Dam side park	093-0998-10	67	1197.00	P		P		P		342
7	Fewa dam park	093-0998-09	9	1500.00 (17979)*	P		P		P		428
8	Infront of Pardi school	093-0999-06,07	1,3	1530.00	P		P		P		437
9	Int. Mountaineering Museum	093-0999-23	32	34194.00	P		P		P		9769
10	Janaki basic play ground	093-1080-03	47	2704.00	P		P		P		772
11	Shahara Academy football ground	093-1081-09	7	7572.69	P		P		P		2163
12	Golf School Mustang chowk ground	093-0998-10	180	9237.00	P		P		P		2639
Total				84103.29							24055

*Figures in the parentheses indicate the total public land area.

of 12, only five open spaces had all the necessary facilities within or nearby the area. Those five open spaces could hold a total of just more than 14,000 people. The open space available in the compound of the International Mountaineering Museum could alone hold about 9,800 people followed by Golf School Mustang Chowk ground which could hold more than 2600 people. Most of the open spaces in the ward were smaller in size and were in need of basic facilities to be installed (Table 6).

3.4 The Area of Service

After the analysis of 'the area of service' by focusing the open spaces with usable area as revealed by the remotely sensed map in ArcGIS, we obtained the following Table 7. When we compared the area of open space that should have been available (Table 1, Table 2 & Table 3) with the actual area available (Table 7), the open space is shrinking in some places such as Tundikhel maidan in ward no. 1 and Milan Park in ward no. 7, may be because of the encroachment

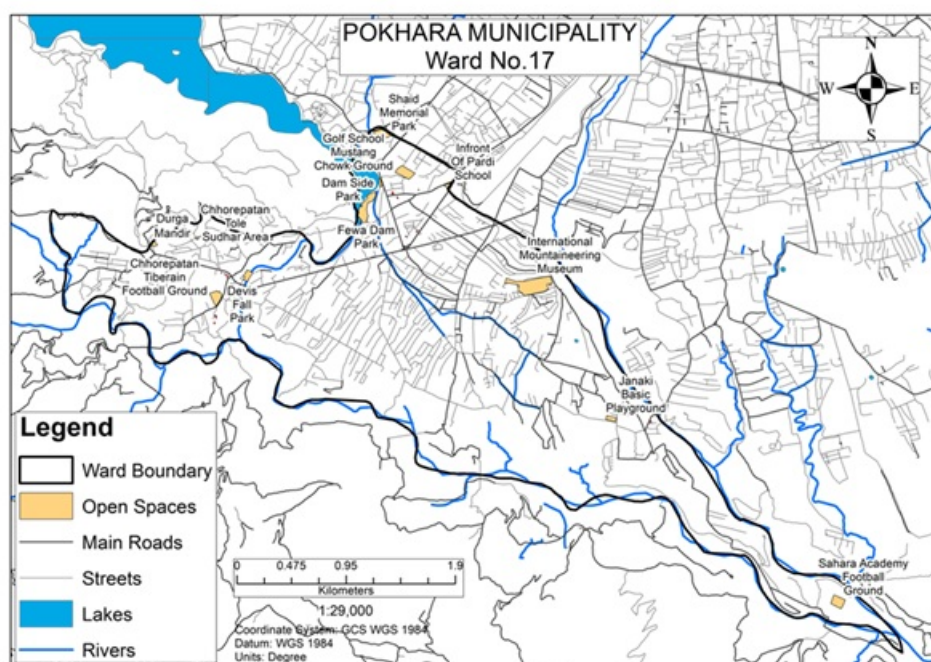


Fig. 6. Map of ward no. 17 of PMC highlighting the open spaces and their distribution with major road systems within the ward.

Table 4. The details of the ranking of available open spaces in ward no. 1 of PMC. ‘Capacity’ in the table refers to the number of persons that the open space can hold.

Sl no.	Name of open Space	Area (Sqm)	Capacity	Number of facilities						Rank
				W/S	Electricity	Toilet/ Bath	Social Organization	Health facilities	Security services	
1	Tundikhel Maidan	13448.94	3842	-	-	-	P	P	P	III
2	Prithvi Narayan Campus	25211.47	7203	P	P	P	P	P	P	I
3	7 A side ground (Tulsighat)	15000.00	4285	-	-	-	P	P	P	III
4	Urban Training Center	20469.00	5848	P	P	P	P	P	P	I
5	Kaseri Football Ground	5616.00	1604	-	-	-	P	P	P	III
6	Sanskrit School Compound	18234.00	5209	P	P	P	P	P	P	I

Table 5. The details of the ranking of available open spaces in ward no. 7 of PMC. ‘Capacity’ in the table refers to the number of persons that the open space can hold.

Sl. no.	Name of open Space	Area (Sqm)	Capacity	Number of facilities							Rank
				W/S	Electricity	Toilet/Bath	Social Organization	Health facilities	Security services		
1	Puspahal Memorial Park	1390	397	P	P	P	P	P	P	I	
2	Masbar Ground	1829	522	-	-	-	P	P	P	III	
3	Said Jhapindra Smirti Park	310	88	-	-	-	P	P	P	III	
4	Milan Park	591	168	-	-	-	P	P	P	III	
5	TinGaule Thakali Samajghar	1200	342	P	P	P	P	P	P	I	
6	Pokhara Airport ground	561000	160285	P	P	P	P	P	P	I	

Table 6. The details of the ranking of available open spaces in ward no. 17 of PMC. ‘Capacity’ in the table refers to the number of persons that the open space can hold.

Sl. no.	Name of open Space	Area (Sqm)	Capacity	Number of facilities						Rank
				W/S	Electricity	Toilet/Bath	Social Organization	Health facilities	Security services	
1	Durga Mandir	1420.0	405	P	P	P	P	P	P	I
2	Chhorepatan tole sudhar area	538.6	184	P	P	P	P	P	P	I
3	Devis fall park	4310	1231	P	P	P	P	P	P	I
4	Chhorepatan Tibetan football ground	12000	3428	-	-	-	P	P	P	III
5	Sahid memorial park	7900	2257	-	-	-	P	P	P	III
6	Dam side park	1197	342	-	-	-	P	P	P	III
7	Fewa dam park	1500	428	-	-	-	P	P	P	III
8	Infront of Pardi school	1530	437	-	-	-	P	P	P	III
9	Int. Mountaineering Museum	34194	9769	P	P	P	P	P	P	I
10	Janaki basic play ground	2704	772	-	-	-	P	P	P	III
11	Shahara Academy football ground	7572.7	2163	P	P	P	P	-	-	II
12	Golf School Mustang chowk ground	9237	2639	P	P	P	P	P	P	I

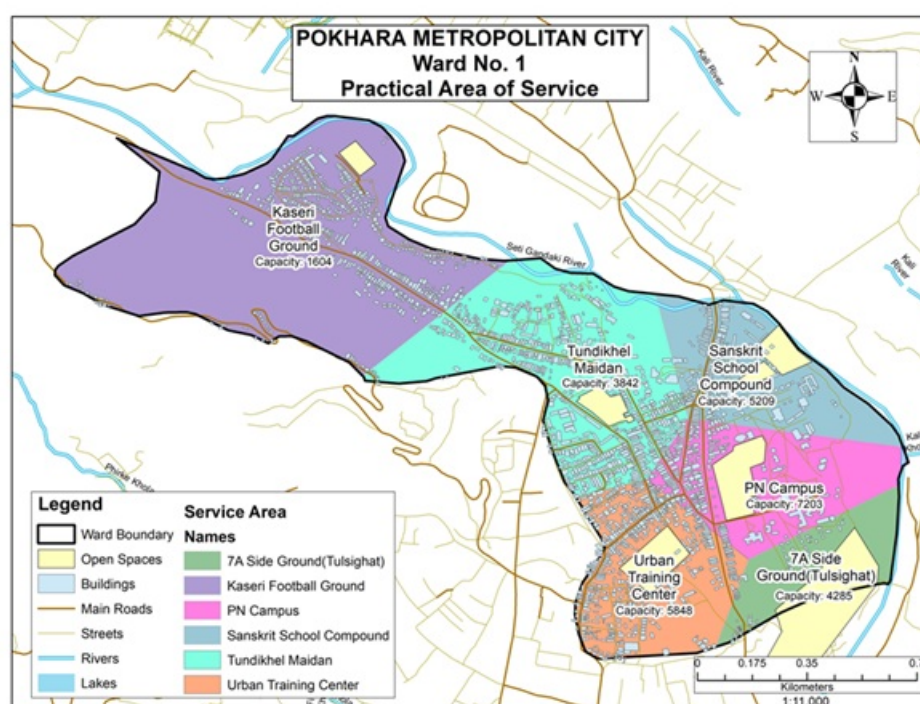
of the public lands or because of the already built infrastructures that occupied the open space such as in Prithvi Narayan Campus, Pokhara in ward no. 1.

Area of service for Kaseri football ground in ward no. 1 is found to be the largest in comparison to the total area

of open space available. It is because there is lack of public land which is usable in the north-western region of the ward. In addition to that, open space available in the south-eastern region of the ward i.e. 7A side ground at Tulsighat is significantly large in the map but the area of service is

Table 7. Area and service zones of open spaces in selected wards, PMC (Source: GIS analysis of recent remotely-sensed data).

Sl.no.	Ward No	Name of Open Space	Area of Open Space (m ²)	Area of Service (m ²)
1	1	Tundikhel Maidan	10604.9	337500
2		PN Campus	24287.3	194860
3		Kaseri Football Ground	5615.5	524650
4		Urban Training Center	20226.6	199635
5		Sanskrit School Compound	4258.79	177094
6		7A Side Ground (Tulsighat)	72790.9	112020
7	7	Milan Park	579.812	177199
8		Tin Gaule Thakali Samajghar	1040.29	312462
9		Pushpalal Memorial Park	1346.13	137708
10		Masbar Ground	1807.12	254357
11		Said Jhaipindra Smriti Park	311.293	439487
12		Pokhara Airport Ground	484740	655155
13	17	International Mountaineering Museum	32025.4	3395500
14		Sahara Academy Football Ground	7549.99	802932
15		Shaid Memorial Park	7812.61	73789
16		Devis Fall Park	3998.78	1546140
17		Chhorepatan Tole Sudhar Area	374.309	859675
18		Golf School Mustang Chowk Ground	9229.06	123189
19		Infront Of Pardi School	1490.09	315044
20		Fewa Dam Park	14454.4	669294
21		Dam Side Park	1151.18	117305
22		Chhorepatan Tibetain Football Ground	11998	684130
23		Janaki Basic Play Ground	2702	1981560
24		Durga Mandir	1417.5	576388

**Fig. 7.** Map of ward no. 1 of PMC: open spaces with service areas and estimated emergency evacuation capacity.

relatively small because more than half of the total area of the ground lies outside of the political boundary of the ward no. 1 (Fig. 7). Therefore, we excluded the area of the ground that did not lie within the ward. On the other hand, the nearest open space is easily accessible for each household in the ward and can be reached the nearest open space within 15 minutes on foot from the distant household within the ward boundary.

Regarding the service area in ward no. 7, old Pokhara airport and Tin Gaunle Thakali Samajghar can accommo-

date the largest population in the ward, and as such, the service area for those land is the largest. As in case of ward no. 1, north-western regions of ward no. 7 also lack appropriate number of open areas to use for emergency evacuation. As we can see in the Fig. 8, there are small patches of Pushpalal Memorial Park, Masbar Ground and Milan Park. Sahid Jhapindra Smriti Park is also small (also see Table 2).

All the open spaces in ward no. 7 are also easily accessible for each household in the ward. Based on the Fig. 8, it may take a maximum of about 15 minutes on foot from

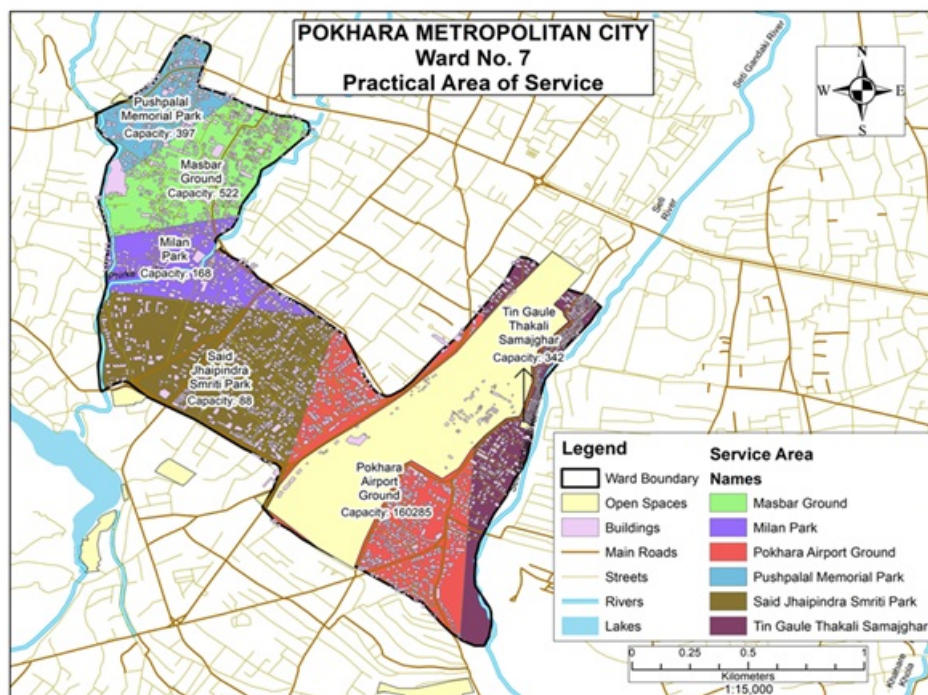


Fig. 8. Map of ward no. 7 of PMC: open spaces with service areas and estimated emergency evacuation capacity.

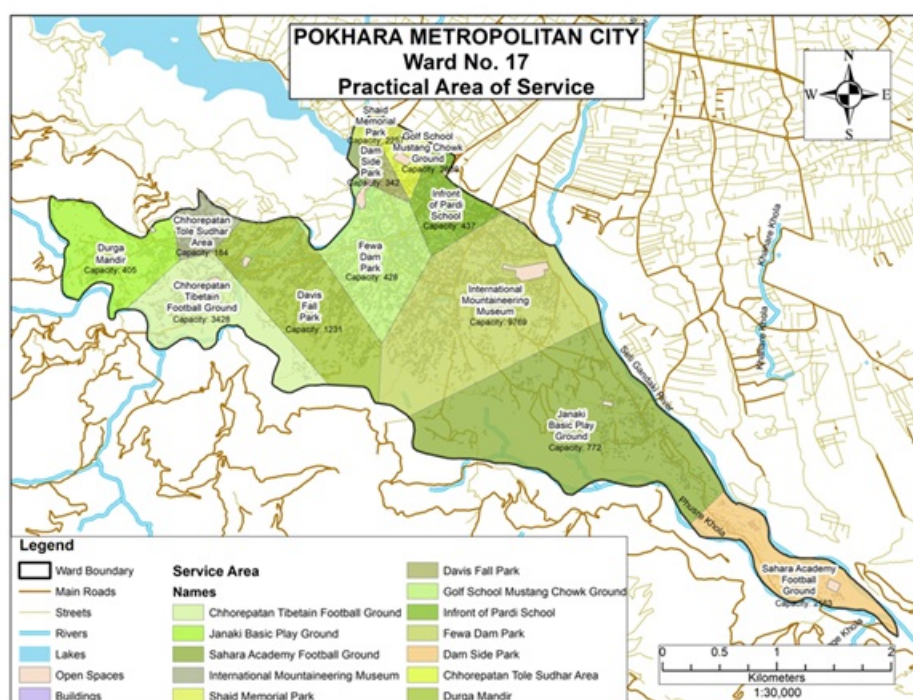


Fig. 9. PMC Map of ward no. 17 of PMC: open spaces with service areas and estimated emergency evacuation capacity.

the distant household within the ward boundary in each practical service area.

Ward no. 17, being the ward of homes with the highest population in PMC, there are limited number of small patches of open area in public lands are available. International mountaineering Museum is the only place with noticeable amount of open space in the ward (Fig. 9). Therefore, service area for the ward looks very large in comparison

to the patch of open space within the ward. If we compare the situation of the ward no. 17 in terms of open space available for emergency evacuation, the ward is the poorest among the three wards we selected for this study. Furthermore, based on the practical area of services (Fig. 9), 10 out of 12 available open spaces lie within a walking distance of a maximum of 15 minutes whereas the remaining two spaces—International Mountaineering Museum and the

Janaki Basic Play Ground—may take up to 20 minutes on foot from the farthest boundary.

It is important to note that the spatial findings on capacity and service gaps are specific to the three assessed wards, which were selected as representative pilot zones of dense, mixed-use neighborhoods. While the methodology establishes a scalable model for inventory and analysis, direct generalization to the entirety of Pokhara Metropolitan City is limited. A comprehensive city-wide assessment would require extending this analysis to distinct functional zones not covered here, such as commercial hubs (e.g., Lakeside), informal settlements, and critical infrastructure corridors. In these areas, risk profiles and evacuation dynamics would differ substantially. For example, in lakeside zones, the potential for secondary hazards like earthquake-induced seiche waves could critically compromise the safety of nearby open spaces—a vital consideration for future, risk-integrated planning that moves beyond the static capacity focus of this study. Furthermore, this study treats all buildings uniformly as potential sources of evacuees. In reality, buildings constructed or retrofitted to modern codes following the 2015 Gorkha earthquake would have a lower probability of collapse, potentially reducing immediate evacuation demand. Previous studies such as Pokharel et al. (2024) has mentioned that the open space available (3.3 m²/person) in Pokhara is significantly less than the World Health Organization's recommended standard of 9 m². Future, more granular studies should incorporate building-by-building seismic vulnerability assessments to enable risk-targeted evacuation planning and optimize the use of available open space.

4 Conclusion

Based on the information available and the results that we obtained, disaster preparedness and planning for emergency evacuation in Pokhara Metropolitan City is poor because there is no plan except developing a 'disaster management committee' from municipality level to the ward level and allocating some budget on the relevant topic. There are significant disparities in open space availability and holding capacities among the selected wards, with ward no. 17 having the lowest areas of open space followed by ward no. 1 and 7 relatively. Those wards have a total of 156,657.41 m², 566,320 m² and 84,103.29 m² areas available respectively as public areas of open spaces. Furthermore, ward no. 17 being the ward with the largest population size in PMC, can hold only about 24,000 people in the public open spaces, whereas the figure in terms of holding capacity is about 28,000 for ward no. 1 and 162,000 for ward no. 7. There are good road networks and most of the open spaces are within 15 minutes of walking distance from the distant boundary of each service area to the nearest open space. However, basic facilities such as public toilets and drinking water persist in many areas. Urgent action is imperative to manage open spaces effectively as part of PMC's disaster preparedness plan.

Conflict of interest statement

It is stated that the contents in the article are original and there is no conflict of interest with anybody.

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CRedit Statement

RB: Research Conceptualization, Data Interpretation and Manuscript Development, SJB: Data Collection, Management, Visualization and Draft Manuscript Preparation, SG: Supervision, Investigation and Draft Manuscript Editing KPP: GIS Data generation, Data Analysis, Validation and Writing-Reviewing and Editing.

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