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Research Article

Application of GIS in Analyzing Public Open Spaces and Their Adaptive Capacity for Risk Mitigation During and After Disaster Phases in Pokhara Metropolitan City, Nepal

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ABSTRACT

Public open spaces (POS) play a crucial role in urban environments, providing recreational benefits and serving as critical infrastructure for disaster risk reduction (DRR). This study focuses on the importance and adaptive capacity of POS in Pokhara Metropolitan City (PMC), a region prone to natural hazards like earthquakes, landslides, and flooding. Utilizing GIS technology, the study identifies and analyzes POS that can be optimally located and sufficiently equipped for effective disaster response. The research combines exploratory, descriptive, and analytical approaches, incorporating both qualitative and quantitative data from primary and secondary sources. A field survey identified 272 patches of POS, of which 162 were deemed suitable for disaster rehabilitation based on safety and accessibility criteria. The study reveals that PMC's POS per capita is significantly below the World Health Organization's recommended standard of 9 m², with only 3.3 m² available per person. The spatial distribution

and size of POS vary across the city's 33 wards, highlighting the need for strategic planning and increased investment in POS to enhance urban resilience. The findings underscore the necessity for stakeholders to manage and expand POS to protect life and property effectively during and after disasters, emphasizing the importance of integrating POS management into urban planning and disaster preparedness strategies.

Keywords: Adaptive capacity, disaster, mitigation, per capita, public open space, risk

BACKGROUND

Open spaces are essential for saving lives through coordinated humanitarian response in an event of a disaster (Subedi, 2019). Open space is a multi-functional landscape to be used both for recreational activities and for managing natural disasters (Islas and Alves 2016). POS offers in terms of handling disaster and mitigation of all losses during the fearful environment (Saxena, 2017). A key component of disaster preparedness strategies is identifying and providing appropriate areas for emergency shelters before disasters happen (Chien et al., 2002; Donohou, 2012; Tai et al., 2010). In urban areas, the availability of such spaces is often limited, and there is a growing need for risk-sensitive land use planning, which is frequently lacking (e.g., Global Communities, 2012). The Natural Disasters (Rescue Act, 2029 (with the Second Amendment) defines disasters as: And the term also refers to industrial accidents, explosions or accidents caused by toxic substances and any other kind of disaster (Nepal Red Cross Natural Disaster Relief Guide, 2055). The role of public open spaces in enhancing city resilience, particularly by encouraging adaptive response zones and serving as disaster evacuation areas (Mirza F. 2015). Strategic planning and design of spatial elements, along with their impact on the natural and built environment, are crucial for a city's ability to withstand and recover from disasters (Bosher et al., 2016). Public open space management is needed to reduce disaster risk mitigation and it is the necessity of a smart city (Tmalsina et al., 2024). Public open spaces have the ability to contribute at multiple levels within the city and can actively work to solve current and future problems by planning and designing (Jayakody et al., 2016).

Pokhara Metropolitan City (PMC), located in a region prone to natural hazards including seismic activities, landslides, and flooding, presents a unique case for the study of POS as critical infrastructure in disaster risk reduction (DRR). The city's topographical and climatic conditions heighten its vulnerability, emphasizing the need for well-planned disaster mitigation strategies Weichselgartner, 2001; Sharma & Joshi, 2016). GIS technology provides a powerful tool for analyzing spatial data, allowing for the identification of POS that are optimally located

and sufficiently equipped to function effectively in disaster scenarios (Goodchild, 2009).

A disaster is an accident which affects the normal course of life. People living in a disaster area have to face many difficulties in times of disaster. During this time, people are often deprived of basic necessities such as security, food, clothing, shelter, medicine, etc., so disaster situations arise around the affected area. Disasters disrupt the day-to-day operations of human beings and cause great loss of life and property. At the same time, the overall environment of the affected area becomes horrific. At disaster sites also deteriorate the human community's capability to cope with ruins. Therefore, a natural disaster that occurs anywhere can lead to a humanitarian grief. Disaster is also understood by various synonyms such as: disaster, crisis, calamity, catastrophe, great loss, etc. Urban area has normally dense populated area so in case of disaster, it is mandatory for all citizens to go to the safe place. Hading (1968) theory about tragedy of commons in public property. Relph's (1976) Place-making approach has been use and focused to extend and management of POS.

POS provides opportunities such as shelter for people affected by hazards. However, different typology of POS contributes to different opportunities from a small square to parks (Allan and Bryant, 2010). Public open space in the city uses on emergency and non-emergency conditions. It can be accommodated for multiple uses in a separate situation. So it is a multi-functional landscape to be used both for recreation activities and for managing natural disasters. Disasters originate in two ways: First, natural disasters which include earthquakes, landslides, geological catastrophes, climate-related snowfalls, glacial eruptions, droughts, hurricanes, cold waves, lightning, hail, etc. disasters are called natural disasters Similarly, the second anthropogenic cause like war, forest fire, epidemiology causes etc. Disaster is a compassionate state of crisis in human life. Many people face adversity at some point in their lives. Pokhara Metropolitan City is not free from the scourge of disaster without being beautiful. The need of the hour is to increase public awareness to mitigate and deal with disasters. The efficacy of GIS in disaster management has been well-documented, highlighting its capacity to collate and analyze data that guide decision-making before, during, and after disasters (Cutter et al., 2014).

Pokhara Metropolitan City (PMC), located in a region prone to natural hazards including seismic activities, landslides, and flooding, presents a unique case for the study of POS as critical infrastructure in disaster risk reduction (DRR). The importance of public open spaces (POS) in urban areas extends beyond their conventional roles in providing recreational and environmental benefits. The application of Geographic Information Systems (GIS) in analyzing

the capacity and strategic importance of POS during disasters offers a methodological advance in urban planning and disaster resilience. The relevance of GIS in urban planning is well-documented, with its capabilities extending to the simulation of disaster scenarios, assessment of evacuation routes, and optimization of resource allocation during emergencies (Cutter et al., 2014). In PMC, where public open spaces vary widely in size, location, and accessibility, GIS tools can provide invaluable insights into how these spaces can best be utilized during disasters. For instance, through spatial analysis, GIS can help determine which POS are most accessible to the majority of the population or are least likely to be affected by specific hazards like flooding or landslides.

Public open space is only one aspect in increasing complex urban environment, which play an important role within the urban context for its sustainability. Public open spaces provide significant welfares for the quality of life to urban inhabitants. On the other hand, it offers improved environmental conditions by reducing air and water pollution, filtering wind and noise, and enhancing the microclimate. It also supports psychological well-being, fosters social interaction and cohesion through encouraging outdoor activities, and contributes to economic growth. Additionally, it helps in effectively recovering from the impacts of natural and human-made hazards (Kelemenove et al., 2020). This capability is vital for devising effective strategies that enhance the resilience of urban infrastructure and communities (Goodchild, 2009).

Therefore, POS is essential part for temporary residence and shelter after disaster to rescue the aeffected population. But POS are the first evacuation place after disaster strikes in urban area. POS plays a crucial role as a site for rescue camps, medical facilities, and the distribution of essential supplies, making it vital for risk mitigation in urban areas. It offers significant opportunities for disaster risk reduction. This study aims to understand, analyze, and identify disaster management sites and evaluate the adaptive capacity of public open spaces. So, this paper tries to identify and mapping the suitable patches of POS and discusses it existing situation with it using potentiality capacity after disaster victim people. So study focused to identify the sites for somewhere to stay with safe from during and post disaster that need to be covered under this study. This paper also discusses on significant of public land in urban area as open space for such a disaster risk reduction.

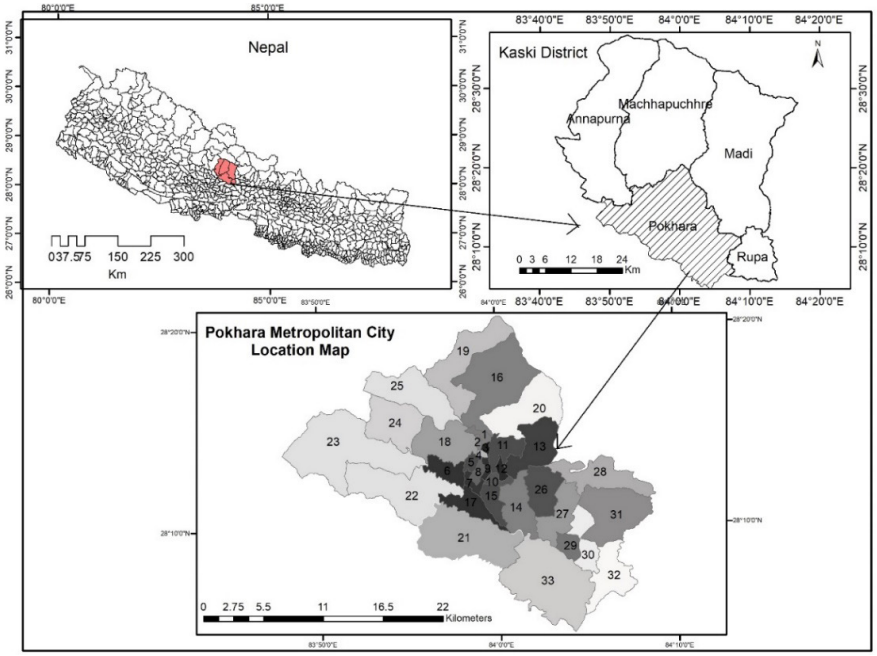
DATA AND METHODS

Rationale of Selection of the Study Area

Pokhara Metropolitan City is located in Gandaki Province and Kaski District. It is a naturally blessed city situated in the mid-hill valley of Nepal at the foot of Mount Fishtail and Mount Annapurna. Thus, every corner of PMC offers a natural viewpoint for the rapturous glimpses of the mountain scenery, enjoyed under the pleasant climatic conditions prevalent in the city. It is geographically the largest metropolitan city in Nepal and serves as the headquarters of both Kaski District and Gandaki Province. PMC is divided into 33 wards or small administrative units (Figure: 4) and extends from 28º 04' 46" to 28º 20' 28" north latitude and from 83º 47' 55" to 84º 07' 43" east longitude.

Figure 1

Location Map of Study Area



Sources: Topographical Maps (1998, 2017) Government of Nepal

The elevation ranges from 505 m (Kotre) to 1990 m (Armala northern side) and 2470 m (Panchase hill western side) above sea level. The metropolitan is protracted 33.8 km from north to south and 22.9 km from east to west. The total area of PMC is covered 464.24 km²,

i.e., 23.05 percent of the Kaski district and 0.31% of the country. This metropolitan has 81,456 households and a population of 413,934 (NSO, 2011). This valley is a slice of heaven at the base of snow-capped mountains and lush landscapes. The Seti River flows through the middle part of the valley, creating vulnerable sites due to floods, subsidence, landslides, etc. Given its geological prone areas and high monsoon rainfall, this metropolis essentially requires POS for vigilance against potential disasters. POS have the privilege of offering safe shelter and aid distribution to affected people during and after disasters. Therefore, the exploration of risk reduction and management suitable places as POS is a necessary task in high-density areas. Consequently, the concept of adaptive capacity for disaster risk mitigation through the study of public open space site and situation in PMC is considered an essential topic.

Research design

This study integrates exploratory, descriptive, and analytical research methods, utilizing both qualitative and quantitative data collected through various field study procedures. It incorporates primary and secondary sources of information, encompassing both qualitative and quantitative data types. The study employs multiple methods to generate spatial and attribute data, utilizing various tools and technologies. It specifically aims to produce vector data using the outlined methods. The field-based survey selected public open space (POS) patches that met criteria for risk reduction, with a focus on safety and road accessibility. Primary data was gathered from field observation surveys. The research design is illustrated in Figure 2.

Data Collection and Analysis

The study primarily relies on data obtained from field studies based on ward office information from Pokhara Metropolitan City. Following a reconnaissance survey of each ward, the characteristics of the patches are scrutinized, and potentially usable patches are selected as study areas. There are 272 patches of Public Open Spaces (POS), including aquatic areas, wetlands, river strips, cave areas, waterfalls, and forest-covered areas. For risk mitigation purposes, not all POS categories are suitable for gathering and recovery. For instance, areas such as water surfaces, caves, viewpoints, dense forests, sloped areas, river strips, dumping sites, and wetlands, which are not conducive to rehabilitation, are excluded from this study. Initially, a screening process is conducted to identify patches suitable for rescue based on their characteristics. The field observation method is then used to identify appropriate disaster rehabilitation sites. To determine the suitable number and locations of rehabilitation sites, a ward-level survey is conducted across the 33 wards of Pokhara Metropolitan, with the assistance

of local resource persons, resulting in the identification of 162 patches. GPS mapping is employed to create shapefiles for each patch using ArcGIS 10.3. Required information, such as the metropolitan ward division map and population size, is obtained from secondary sources, specifically the Survey Department of Nepal and the Central Bureau of Statistics (NSO).

The initial phase of data analysis involved categorizing the data collected from the Pokhara Metropolitan City (PMC) ward offices. In the subsequent phase, spatial and attribute data gathered from the field survey were imported using ArcGIS 10.3, and the spatial data were then expanded into vector form. The current population size and per capita POS were analyzed at the ward level using GIS. The location, shape, size, distribution, and attribute information of POS were depicted using maps, drawings, and tables.

RESULTS AND DISCUSSION

Spatial Configurations of POS

Disaster is unwanted even for human being as well as other biodiversity. Even in the urban area due to high density of population during and after disaster happened more people are affected. In general, POS are important in favour for mental and physical wellbeing. Although, POS also known as the disaster mitigation sites in urban area. The POS provide valuable opportunities for safe during and post disaster. Therefore, POS is an essential place in urban area for protect life and property during and post disaster.

Every single POS location is illustrated on the basis of a definitive reference with latitude, longitude and address of patches surrounding. However spatial arrangement of public open space resulted through its spatial character like spatial separation, size of patches, distribution patterns, etc. POS is a important part of urban land use which is differently distributed in all wards of study area. There are eight types of POS in PMC (Pokharel & Khanal, 2017). But ward wise distribution of POS is different. The locational patterns of POS are clustered in PMC. Some ward has more patches and some have few in number. So, its locational situation shows cluster in the pattern (Figure 3). The area of patches ranges from 0.026 hectares to 22.734 hectares. Disaster mitigation suitable POS and their covered area is illustrated in table 1.

Table 1

Suitable sites and POS covered area in Pokhara Metropolitan City

Categories of POS	Patches number and size			Total covered Area (Hectares)	Total area in Percent
	Tiny (< 1 Hectare)	Small (1-5 Hectare)	Large (> 5 Hectare)		
Park	46 (18.28)	9 (31.71)	3 (34.41)	84.4	49.63
Playground	18 (12.75)	4 (12.61)	1 (19.64)	45	26.46
Religious site	54 (21.39)	4 (8.75)	1 (6.07)	36.21	21.29
Distinct space	4 (1.78)	1(2.67)	0	4.45	2.62
Total	122 (54.2)	18 (55.74)	5 (60.12)	170.06	100.00

Source: Field observation, 2020

Note: Figure in parenthesis present covered area.

Table 1 indicate that the total risk mitigation suitable area is 170.06 hectares. Of this total, nearly half a percent (49.63) is covered by parks, while 26.46 percent is covered by playgrounds, 21.29 percent covers religious sites, and only 2.62 percent of the area is allocated as distinct space, which is used as an exhibition center and picnic spot in PMC.

The number of public open spaces varies across the 33 wards in PMC, ranging from only one to eleven patches of different sizes. The ward wise distribution pattern is shown in Figure 2.

Figure 2

Ward wise spatial location and distribution of public open spaces in PMC, 2024.

Figure 3

Ward wise number of patches and covered area

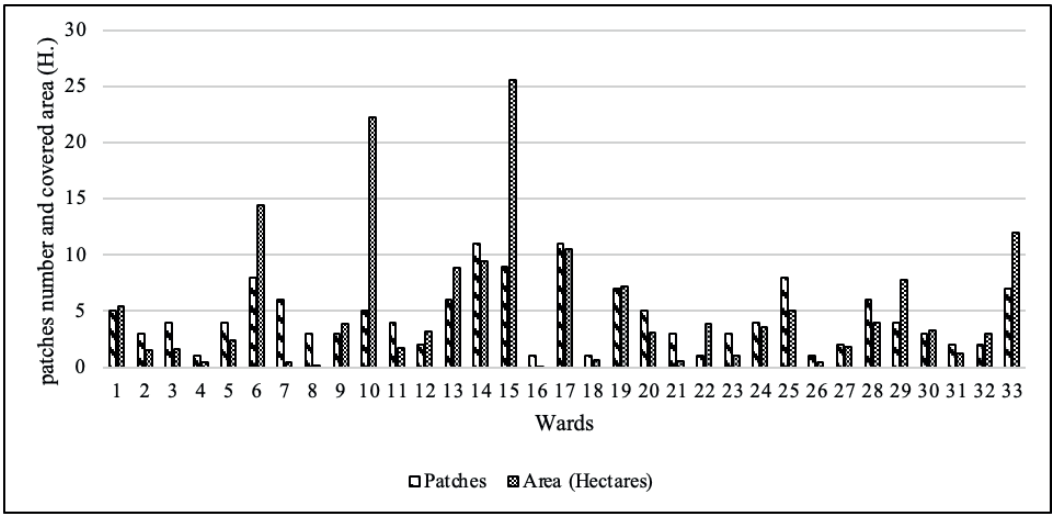


Figure 3 reveals the distribution pattern of risk reduction sites as POS, and Figure 4 presents the ward-wise number of patches and their covered areas.

Adaptive Capacity of POS

Public Open Spaces (POS) are crucial areas that offer safety during and after disaster events. These sites have attributes such as accessibility and infrastructure, enabling people to adapt to unpredictable disastrous situations. POS play a pivotal role in managing disasters and mitigating losses during such times (Saxena, 2017). Therefore, it is essential to thoroughly examine and understand the POS situation before the occurrence of potential disasters like earthquakes, floods, landslides, fires, cyclones, cloudbursts, and other anthropogenic disasters. POS are vital for rescue and recovery operations during and after disasters. It is reported that during earthquakes, people stay outdoors in open areas away from their homes. Thus, urban areas have managed appropriate POS to address the per capita open space needs. The WHO recommends that urban areas should provide 9 m² of public open space per person for various purposes (WHO, 2012). During disasters, people have limited time to reach a safe place for shelter. POS offer opportunities for gathering, shelter, and temporary refuge for those affected by hazards. For risk mitigation, appropriate POS are used based on the per capita ratio. Most parks, playgrounds, religious sites, and distinct spaces (e.g., exhibition centers, some picnic

spots) are suitable for risk management and collectively occupy only 170.06 hectares in PMC. Regarding accessibility for rescue, only 145 patches, ranging in size from 0.026 hectares to 22.734 hectares, have road access. The existing potential area of POS is about 3.3 square meters per urban dweller in the study area, which is less than half of the WHO's recommendation. However, the per capita distribution of POS varies by ward, as shown in Table 2 and Figure 4.

Table 2

Ward-wise Population and Per Capita Disaster Mitigation of POS

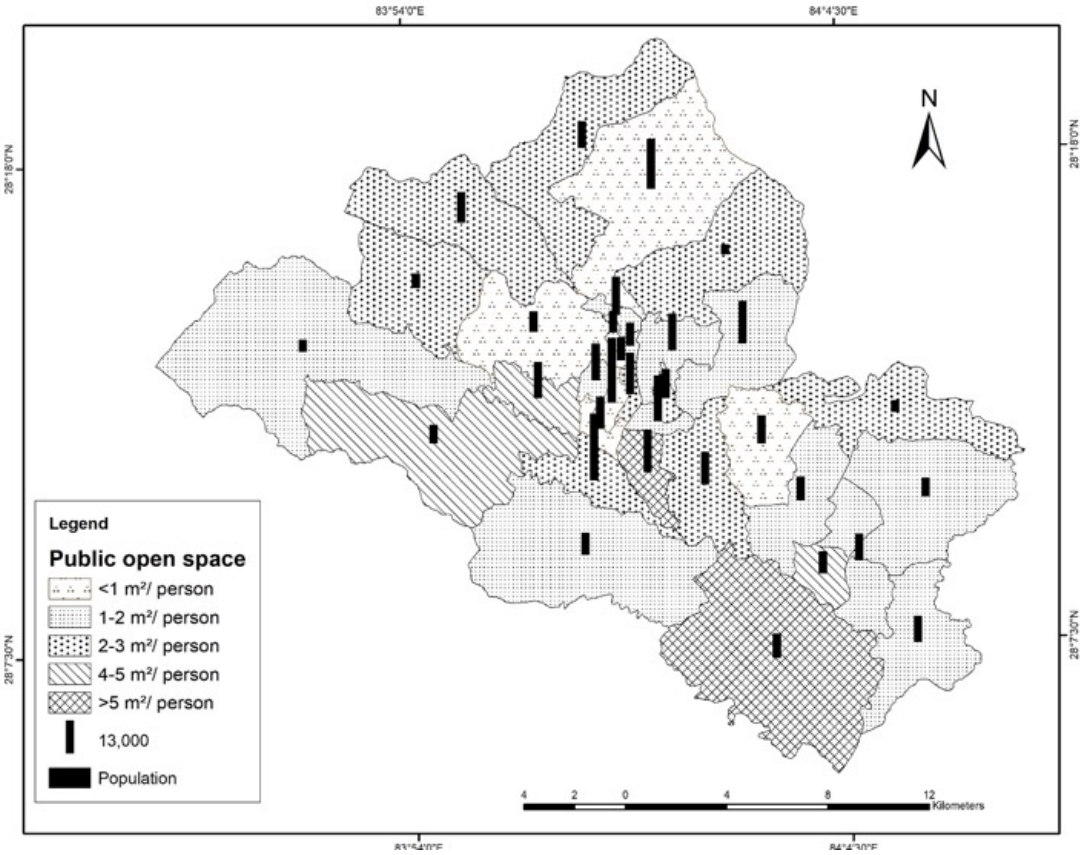
PMC Ward	Patches	Area (Hectares)	Population	POS area in Hectares/ per 1000 population	Per capita open space (m.²)
1	5	5.4656	13947	0.392	3.9
2	3	1.476	10100	0.146	1.5
3	4	1.6268	8284	0.196	2.0
4	1	0.4065	9152	0.044	0.4
5	4	2.3692	22325	0.106	1.1
6	8	14.4655	14455	1.001	10.0
7	6	0.4834	16139	0.030	0.3
8	3	0.2033	25439	0.008	0.1
9	3	3.8927	15981	0.244	2.4
10	5	22.2171	18435	1.205	12.1
11	4	1.7314	17594	0.098	1.0
12	2	3.1669	12710	0.249	2.5
13	6	8.865	22399	0.396	4.0
14	11	9.449	31561	0.299	3.0
15	9	25.5561	24406	1.047	10.5
16	1	0.0554	24465	0.002	0.0
17	11	10.5688	46005	0.230	2.3
18	1	0.6424	12945	0.050	0.5
19	7	7.2255	13855	0.522	5.2
20	5	3.1294	3936	0.795	8.0
21	3	0.5833	9070	0.064	0.6
22	1	3.8611	7596	0.508	5.1
23	3	1.0478	4276	0.245	2.5
24	4	3.5743	5950	0.601	6.0
25	8	5.048	17597	0.287	2.9
26	1	0.4688	16777	0.028	0.3
27	2	1.7966	16377	0.110	1.1
28	6	3.9693	4224	0.940	9.4
29	4	7.7728	16257	0.478	4.8

30	3	3.279	16192	0.203	2.0
31	2	1.2561	8702	0.144	1.4
32	2	3.022	14683	0.206	2.1
33	7	12.0357	11670	1.031	10.3
Total	145	170.711	513504	0.332	3.3

Source: Field study 2024 and NSO 2021.

Figure 4

Ward wise population and per capita disaster mitigation of POS



Source: Field study 2019 and NSO 2011.

Table 2 and Figure 4 show that the per capita public open space (POS) in PMC is significantly limited. Regarding disaster rehabilitation, the area of POS is insufficient. Among the 33 wards, only four (wards 6, 10, 15, and 33) meet the World Health Organization's (WHO) standards, while the remaining 29 wards fail to meet these requirements as well as disaster risk management criteria. Such resources must be readily available within a community for

effective risk mitigation. Therefore, stakeholders should pay more attention to increasing the area of POS in accordance with population density.

CONCLUSION

POSs are indispensable parts of the city for both wellbeing as well as for disaster mitigation. It is used not only for mental and physical well-being but also as a significant place for disaster relief. There is an urgent need to manage a minimum area because it provides essential services such as food, medicine, clothing, shelter, and overall relief to people affected by disasters.

These reasons make urban public open spaces inseparable parts of the city. Therefore, identifying existing features, provisions, and usage patterns of POS in the initial phases is essential. Field observations and GPS mapping data show that there is only 3.3 square meters of POS per capita, while the WHO recommends a minimum of 9 square meters for urban populations. PMC has less POS than WHO standards, indicating that the current situation for disaster reduction is inadequate. Twenty-nine wards failed to manage POS effectively for risk reduction. On one side, urban area are becoming more congested due to rapid population growth, and there is insufficient designated disaster mitigation area. Thus, the federal government, province, metropolitan authorities, and local residents must take action to protect life and property from potential disasters in PMC. There is a lack of sufficient POS due to the expansion of infrastructure and buildings in built-up areas.

Given the condition of open space in Pokhara is critically low due to high population density, land encroachment, and public area encroachment, measures should be taken to manage and increase its volume through the conversion of public land to public open space, land pooling practices, and significant investment in purchasing private land for expansion. The area of old Pokhara Airport, which is currently in operation but will be relocated in the near future, should remain open as it will be difficult to compensate otherwise. It is also necessary to protect open spaces without borders by installing fences or walls as soon as possible, connecting public places with road transport, and providing basic facilities in open spaces. Therefore, urban planners, policymakers, and stakeholders should manage the required and proper sites as public open spaces by employing a protective and suitable management plan in this metropolitan city.

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REFERENCES

Allan, P., & Bryant, M. (2010). *The critical role of open space in earthquake recovery: A case study*. Paper presented at the 2010 NZSEE Conference, Nueva Zelandia, 1-10.

Bosher, L., Von Meding, J., Johnson, C., Arefian, F. F., Chmutina, K., & Chang-Richards, Y. (2016). *Disasters and the built environment: Research roadmap summary* (1st ed., CIB Publication No. 410). CIB General Secretariat. https://www.cibworld.nl.

Chien, S., Chen, L., Chang, S., Chiu, G., & Chu, C. (2002). Development of an after earthquake disaster shelter evaluation model. *Journal of the Chinese Institute of Engineers, 25*(6), 591-596. https://doi.org/10.1080/02533839.2002.9670733.

Cutter, S. L., Ash, K. D., & Emrich, C. T. (2014). The geographies of community disaster resilience. *Global Environmental Change, 29*, 65-77.

Cutter, S. L., Ash, K. D., & Emrich, C. T. (2013). The geographies of community disaster resilience. *Global Environmental Change*, 29, 65-77.

Donohou, C. (2012). *Strategic planning for post-earthquake temporary housing: Best practices*. Edited by Hall, S., & Hapeman, K., Humanitarian Briefs Spanning Field Relief Aid Development.

Dhanabhakyam, M. & Sarath M. (2023). Psychological wellbeing: Asystematic literature review. *International Journal of Advanced Research in Science, Communication and Technology*, 603–607. https://doi.org/10.48175/IJARSCT-8345.

Global Communities. (2012). Shelter and settlements: Post-disaster response in urban environments. Retrieved August 8, 2013, from http://www.globalcommunities.org/node/37242.

Goodchild, M. F. (2009). Twenty years of progress: GIScience in 2010. *Journal of Spatial Information Science, 1*, 3-20.

Gnanasekaran, R., Ramya R., Yuvaraj, D., & Jamela, N. (2018). Production and purification of water from humid air by using activated carbon method. *International Journal of Engineering & Technology*, *7*(4.24), 688. https://doi.org/10.14419/ijet.v7i4.24.24561

Hardin, G. (1968). The tragedy of the commons science. *American Association for the Advancement of Science New Series*, 162(3859), 1243-1248.

Islas, P. V., & Alves, S. (2016). Open space and their attributes, uses and restorative qualities in an earthquake emergency scenario: The case of Concepcion, Chile. *Urban Forestry & Urban Greening, 10*, 56 & 67.

Jayakody, C., Amaratunga, D. & Haigh, R. (2016). The use of public open spaces for disaster resilient cities, 12th International Conference Paper of the international institute for infrastructure Resilience and reconstruction, university of Peradeniya, Kandy, Shri Lanka.

Kelemenova, T., Benedik, O., & Kolarikova I. (2020). Signal noise reduction and filtering. *Acta Mechatronica*, *5*(2), 29–34. https://doi.org/10.22306/am.v5i2.65

Manamdar, S., Josi J. Raj (2015). Management of public land for urban open space: In case of disaster risk reduction, FIG – ISPRS workshop, 2015: International workshop on role of land professionals and SDI in disaster risk reduction: In the context of post 2015 Nepal Earthquake. Kathmandu. https://www.fig.net/news/archive/news_2015/2015_08_comm2_7_nepal.asp

Mirza, F. (2015). Disaster mitigation approach of urban green structure concept in coastal settlement dimension. *Journal of Architecture and Built Environment, 42*(2), 51-58.

Nepal Red Cross (2055) Natural disaster relief guide. (Rescue Act, 2029).

National Statistics Office (NSO) (2078). Government of Nepal, Office of the Prime Minister and Council of Ministers, *National Statistics Office*. Kathmandu.

Relph, E. C. (1976). *Place and placelessness*. Pion Limited.

Pokharel, R. P. & Khanal, N. R. (2017). Open space: Typology and distribution in Pokhara Lekhnath Metropolitan city. *The Geographical journal of Nepal*, (11), 25-44.

Saxena, M. R. (2017). Role of open spaces in disaster management. Retrieved from https://www.researchgate.net/publication/312661449

Sharma, P., & Joshi, S. (2016). Urban growth and its impact on the vulnerability of Pokhara City, Nepal. *Land Use Policy*, 58, 25-38.

Subedi, Y. (2019). Disaster preparedness: A walk in the park. Retrieved from https://nepal.iom.int/ne/news/disaster-preparedness-walk-park

Tai, C. A., Lee, Y. L., & Lin, C. Y. (2010). Urban disaster prevention shelter location and evacuation behavior analysis. *Journal of Asian Architecture and Building Engineering,*

9(2), 215-220. https://doi.org/10.3130/jaabe.9.215

Timalsina, K. P., Subedi, B. P., & Sapkota, K. (2024). Contribution and compatibility of public open space in disaster management: Perception and experience from Kathmandu Metropolitan. *Geographical Journal of Nepal*, 90–117. https://doi.org/10.3126/gjn.v17i01.63940

Weichselgartner, J. (2001). Disaster mitigation: the concept of vulnerability revisited. *Disaster Prevention and Management: An International Journal*, *10*(2), 85–95. https://doi.org/10.1108/09653560110388609

World Health Organization (WHO) (2012). Health indicators of sustainable cities. In proceedings of the United Nations conference on sustainable development, Rio de Janeiro, Brazil.