The Geographical Journal of Nepal
Vol. 17: 90-117, 2024
DOI: https://doi.org/10.3126/gjn.v17i01.63940
Central Department of Geography,
Tribhuvan University, Kathmandu, Nepal

Contribution and compatibility of public open space in disaster management: Perception and experience from Kathmandu Metropolitan

Krishna Prasad Timalsina*, Bhim Prasad Subedi, Kanhaiya Sapkota

Central Department of Geography, Tribhuvan University, Kathmandu, Nepal.
*Corresponding email: krishnadhading@gmail.com

Received: 04 December , 2023; Accepted: 01 January, 2024; Published: March, 2024

Abstract

Despite the extensive literature on public open space (POS) in urban settings, its role in disaster risk reduction and management(DRRM) as perceived and experienced by its residents is limited. Taking a case from Kathmandu Metropolitan City (KMC), this paper analyzes the role and suitability of POS in DRRM. It focuses on: (a) how urban residents perceive and experience the linkages between POS and DRRM, (b) how they utilized the POS during disasters, and in what ways they were instrumental in helping disaster victims,and (c) to what extent the existing POSs are compatible for DRRM in dense urban areas. This study uses qualitative research methodology employing POS inventory taking, key informant interviews, in-depth interviews, and field observation as research instruments. The result of the study shows that people's perception on the use of POS during disasters was very positive and these spaces were intrinsically utilized during disasters in the metropolitan Kathmandu. However, their effectiveness and compatibility in DRRM were contingent upon contextual factors, the inherent nature and types of POS, and the extent of accessibility to them.

Keywords: public open space, disaster risk reduction, perception, experiences, Kathmandu

Introduction

Public Open Spaces (POS) are integral components of urban areas, serving as the foundation for a variety of public life activities. POS defined by Un-Habitat are spaces for public use, accessible and enjoyable by all for free and without a profit motive(UN-Habitat, 2018).The role of POS in improving disaster response and recovery has been

discussed widely in literature (Shrestha *et al.,* 2018; Koren & Rus, 2019; Davino *et al.,* 2021). In urban contexts, POSs are key components of disaster response as they are safe locations and offer spaces for the community that enable mutual coping among its members (Shrestha *et al.,* 2018). POS, encompassing various types of open areas, plays a vital role in the initial emergency phases, such as evacuation, as they provide pathways and gathering spots (Bernabei *et al.,* 2021). In times of crisis, emergency planners involved in disaster relief and mass care can significantly benefit from suitable shelter locations like POS within urban environments (Anhorn & Khazai, 2015).There is a growing acknowledgment of the role of public open spaces in enhancing the resilience and sustainability of cities worldwide (Koren & Rus, 2019).This suggests that POS holds significant importance in multiple aspects of DRRM, notably in facilitating rescue, relief, treatment, recovery, and temporary shelter for urban populations, especially in densely populated cities.

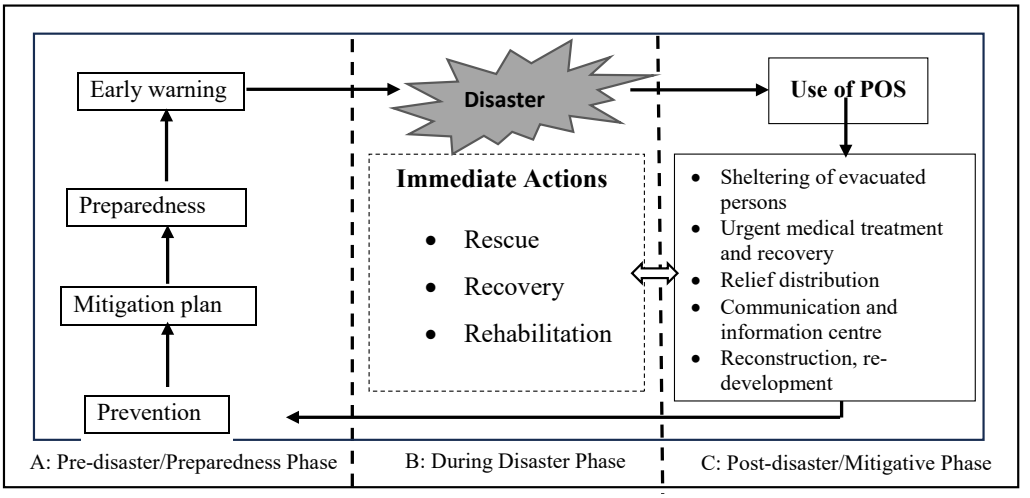
Different observations lead us to the insight that there is a close relationship between POS and DRRM in the urban context especially in those cities where there is a lack of sufficient open spaces for public use. Looking at the evidence of the importance of open spaces for DRRM, it reveals that open spaces are being used for disaster relief and recovery worldwide. After the 2010 earthquake that devastated Haiti, there were reports that hundreds of thousands of homeless people slept on the streets for many nights (French, 2017). Likewise, the Gorkha Earthquake in 2015 fled many people in the open spaces for many days under temporary tents or under the open sky. All of the Kathmandu Valley's 83 government-designated open spaces for use after the disaster were occupied (Shrestha *et al.,* 2018). In many cases, even after houses and buildings were deemed safe to return to, the fear prevented people sheltering outdoors from returning home (Allan *et al.,* 2013 cited in French, 2017). In such instances, it is obvious that open space has been referred to as vital in the aftermath of an earthquake. Conversely, the lack of large open space in the urban environment has been attributed to an increase in injury and death following an earthquake (Ainuddin & Routray, 2012). While examples in this paper primarily focus on earthquake-related disaster risk management,their significance extends to other types of disasters, including floods, fires, and landslides (Efroymson *et al.,* 2009; Pacheco Barzallo *et al.,* 2022).

The connection between POS and DRRM can be analyzed by focusing on how the disaster reduction cycle progresses through three different phases. In the pre-disaster phase, the emphasis lies on prevention, mitigation, preparedness, and early warning to foster resilient communities. During the disaster phase, immediate actions such as rescue, recovery, and rehabilitation activities are inevitable. The role of open spaces in disaster reduction becomes immediately apparent following the disaster, as POS contributes

in DRRM including sheltering of evacuated persons, urgent medical treatment and recovery, relief distribution, communication and information sharing, reconstruction, and re-development if sufficient POSs are available in the city. The relationship between POS and DRRM is elucidated in Figure 1.

Figure 1

Relationship between POS and DRRM, modified after USAID, 2021



POSs in urban settings serve not only as areas for greenery and recreation but also as essential components for building a resilient and safer urban community. With a sufficient allocation of public/open space for the city's population, these areas can be utilized for disaster risk rescue, relief, recovery, and shelter. Asian cities, confronted with challenges like high population density, the existence of slum areas, and insufficient infrastructure and services, are especially prone to disasters. The haphazard and rapid expansion of urban areas further compounds the vulnerability of these cities to disasters, creating disorderly environments that escalate the risk. Kathmandu is no exception to these challenges, standing out as a city highly sensitive to disaster risks and vulnerabilities (Bhattarai & Conway, 2010; USAID, 2021; Wisner, 2004).

In Kathmandu, displaced residents tend to spontaneously gather in public parks and open spaces during and after disasters, considering them as safer locations that serve as hubs for immediate needs like rescue, evacuation, emergency medical treatment, communication, shelter, and food distribution. Despite the acknowledgment of the inevitability of disasters in the urban context, the effective management of POS is crucial for meeting diverse needs in disaster prevention, response, and post-disaster

management, thereby contributing to community resilience. However, residents' perception on the role of POS in DRRM is limited. In densely populated urban areas like Kathmandu Metropolitan City (KMC), POS fulfills a dual purpose by enhancing urban life quality and serving as vital evacuation centers, fostering community cohesion, mutual support, and resilience. In this context, this paper analyzes the perception and experience of urban residents regarding the connections between POS and DRRM, exploring how these spaces are utilized during disasters and assessing their instrumental role. Furthermore, it evaluates the compatibility of existing POS for DRRM in dense urban areas.

Open space and DRRM: Conceptual approaches

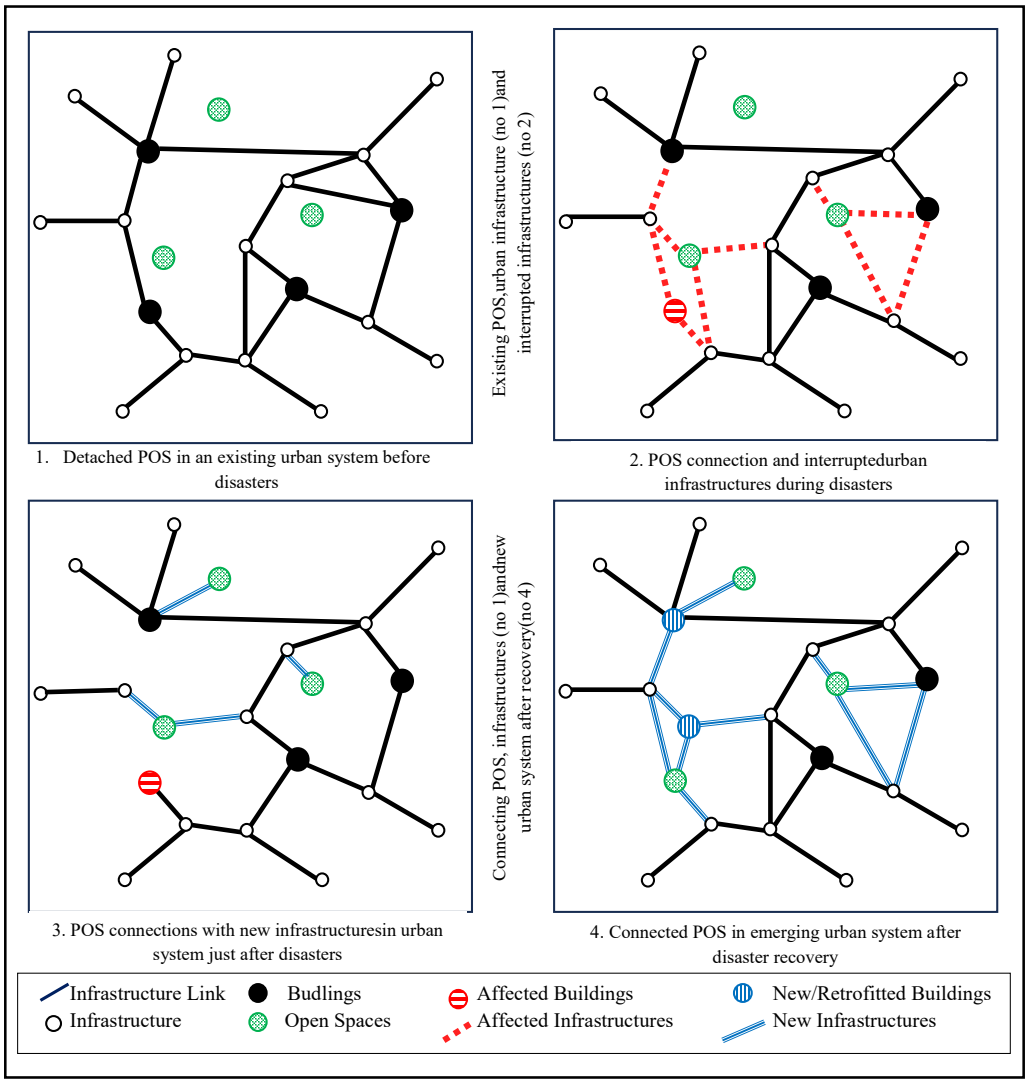
POSs are crucial for urban hazards, especially during earthquakes, serving as vital locations for recovery and mitigation (Akter *et al.,* 2022; Alawi *et al.,* 2023). POS plays an important role in enhancing urban disaster resilience, particularly in seismic-prone areas, by forming an integral part of the interdependent network system for the city (Koren & Rus, 2019). This concept delves into the multifaceted understanding and conceptualization of open spaces within the DRRM framework for a city system. It provides a comprehensive insight into the conceptual foundations of how open spaces contribute to disaster resilience and recovery within the city. During disasters in the city, the network of open spaces is activated to serve as safe zones for evacuation, community gatherings, and temporary shelters. To illustrate the relationship between POS and DRRM, a graphical model of city performance demonstrates the varying applications of open spaces before, during, and immediately after a disaster, and during the recovery process in the city system as presented in the figure (Figure 2).

The diagram illustrates the connections between POS and a city's infrastructure networks at different stages of disasters (no 1 to 4). It facilitates the analysis of how a disaster impacts a city, progresses through various stages of recovery, and how the city can enhance resilience post-risk recovery. When a disaster strikes, it disrupts existing city infrastructures and buildings, leading to scenarios that differ from the city's previous patterns. After a disaster, the city's network may undergo changes, including the development of new infrastructures, buildings, POS, and service provisions. Roads may be widened, networks expanded, accessibility to open spaces increased, safer sites developed, and construction practices altered based on lessons learned. People's perceptions may shift, and disasters could convey positive messages, transforming the city's mindset and functional system. The new POS network, with improved infrastructure and facilities, offers enhanced accessibility, increased infrastructure, and connectivity for the residents. Following effectively to prevailing rules and regulations

and shifting construction practices can elevate the city's resilience level. This stage of the city by this model reveals more resilience than before, enhancing increased access to POS and improved infrastructures.

Figure 2

POS and infrastructures networks model for DRRM in the city system



Source: Modified after Koren and Rus, 2019.

The diagram illustrates the connections between POS and a city's infrastructure networks at different stages of disasters (no 1 to 4). It facilitates the analysis of how a disaster impacts a city, progresses through various stages of recovery, and how the city can enhance resilience post-risk recovery. When a disaster strikes, it disrupts existing city infrastructures and buildings, leading to scenarios that differ from the city's previous patterns. After a disaster, the city's network may undergo changes, including the development of new infrastructures, buildings, POS, and service provisions. Roads may be widened, networks expanded, accessibility to open spaces increased, safer sites developed, and construction practices altered based on lessons learned. People's perceptions may shift, and disasters could convey positive messages, transforming the city's mindset and functional system. The new POS network, with improved infrastructure and facilities, offers enhanced accessibility, increased infrastructure, and connectivity for the residents. Following effectively prevailing rules and regulations and shifting construction practices can elevate the city's resilience level. This stage of the city by this model reveals more resilience than before, enhancing increased access to POSand improved infrastructures.

Study area, materials and methods

The urban morphological forms of KMC, shaped by its socio-cultural characteristics, exhibit two distinct social and spatial patterns. The city's core area, historically referred to as 'Old Kathmandu,' represents the core city area, characterized by compact settlements featuring historical POS, temple squares, courtyards, and narrow streets(MoPE, 1999). The outer areas comprise relatively newer settlements with mixed populations and diverse cultures. This study identifies and divides these two strata into 'Core Kathmandu (inner area)' and 'Outskirts (extended Kathmandu)(Figure 3). Core Kathmandu comprises 17 wards with 277 POSs, while the outskirts encompass 15 wards with 264 POSs.

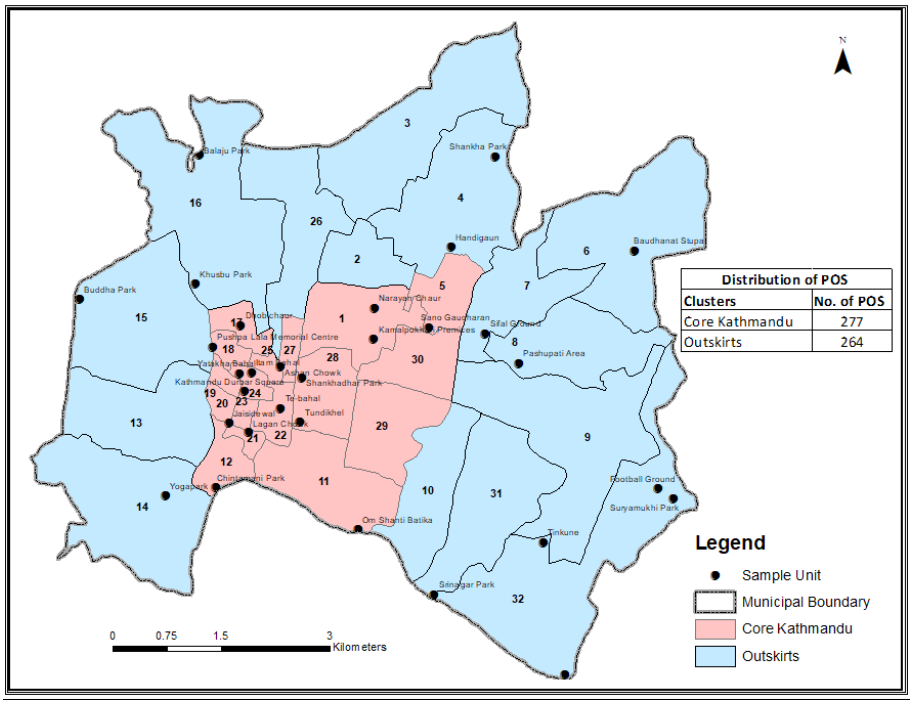
Methodologically,the present research encompassed various stages and methodologies, including POS inventory study, study site selection, informant identification, field observation and expert interviews[1]. The research materials and methods involved the following procedures.

In the initial stage of the study, the focus was on identifying various types, characteristics, and features of POS. This involved compiling a comprehensive inventory using data from diverse sources such as the Kathmandu Valley Development Authority (KVDA, 2015), International Organization for Migration (IOM, 2020),United Nation Development Programme(UNDP, 2020), Kathmandu Valley Mapping data and digital maps. The inventory study of POSs was finalized in different stages. The size of POS varies, ranging from 211 square meters to 537,484 square meters. These data were integrated

into a unified platform, facilitating the creation of maps and a detailed assessment of POS features, particularly their functional categories. To validate the inventory data, field verification was conducted through on-site visits, utilizing checklists to assess POS characteristics and functions in the context of DRRM compatibility. The inventory survey also included detailed observation of the sites, gathering information about the nature, functions, and visual activities within the POS. This observation, conducted over a month, was a crucial method to comprehend the behavior, patterns, and processes associated with POS.

Figure 3

Core Kathmandu and outskirts with distribution of sample unit in KMC



In the second stage of the study, potential sites for POS in KMC were identified by clustering core Kathmandu and outskirts. A total of 30 POS sites were purposefully chosen for in-depth investigation, with 12 from the core Kathmandu and 18 from the outskirts, aiming to represent various POS types based on a prior inventory study. Subsequently, a user opinion survey involving 354 participants was conducted at these selected POS sites to understand users' perceptions and experiences, especially regarding

implications for DRRM. The survey utilized mixed questionnaires administered through the COBO toolbox mobile application.

In the third stage of the study, in-depth interviews were carried out with a diverse group of participants, including visitors, residents, community group members, and individuals from POS management groups and these were distinct from those chosen for the user opinion survey. These interviews were conducted with participants' consent at scheduled times and dates. Some interviewees required multiple attempts, often exceeding two or three, to engage successfully. A total of 30 in-depth interviews were conducted at various sites in KMC. Additionally, interviews with key informants, such as urban experts and professionals, were conducted based on a predefined list. 24 key informants, including government officials, park management committee chairpersons, retired government officers, POS program experts, politicians, university academics, and representatives from Guthi Sansthan, were interviewed. Prior to these interviews, participants were contacted, schedules were confirmed, and interview locations were agreed upon. Alongside structured interviews, informal conversational interviews were spontaneously conducted during fieldwork in informal settings, addressing important aspects as they arose during different stages of fieldwork.

Public open space and urban disasters

If we take disaster severity, Kathmandu is at high risk of earthquakes followed by floods, fires, epidemics, landslides, etc. (UNISDR, 2015). High population density, the prevalence of poverty clusters, poor planning, social diversity, the poor capacity of communities to cope with disasters, lack of sufficient public open spaces, etc. are some of the reasons that lead to a high degree of disaster risks. In an informal interview, a respondent explains as saying:

> *'Kathmandu is experiencing an increase in disaster events. Many people from rural areas are moving to the city and settling along riverbanks, public spaces, and government land without considering disaster preparedness. The government's attempts to control nature, particularly by building high river embankments, have had negative consequences. Consequently, the area is flooded annually, resulting in substantial losses due to their interference with nature' (65-years-old lady, a local resident of Anamnagar).*

As Kathmandu is the most at-risk city in the world for a major earthquake, a study suggests that a magnitude 8.0 earthquake in the Kathmandu Valley would result in at least 100,000 deaths, 300,000 injured, and over 1 million persons displaced (MoHA, 2016).

The experiences of the 2015 earthquake have also prompted researchers, planners, and academicians to better prepare for the next disaster, to save human lives and minimize risks. In case of a disaster like an earthquake, human loss can be minimized through sufficient allocation of POS, making available access to POS, including other services and facilities in KMC. Open space implications in disaster risk preparedness and management in this concern are getting its pace and how it could be better used to make communities more resilient. As the picture (Figure 4a and 4b) reveals public occupancy to open spaces in KMC during the earthquake in 2015, it explains the situation of how people fled on the POS to save themselves from the earthquake shocks and aftershocks.

Figure 4a

Earthquake damage and open space occupancy, Basantapur Durbar Square

Figure 4b

Open space occupancy during the Earthquake, 2072 at Tundikhel area

Source: www.newsghana.com. and www.theatlantic.com accessed on 22 May, 2022.

In the figure,the first picture (3a) is of Basantapur Durbar Square, a historical public open space, where many historical and archaeological buildings collapsed in the Earthquake of 2015 and people gathered and stayed for a few days in the space under the open sky. After some days, they made a temporary shelter and stayed for many days in the space to save their life there. The second picture (3b) is of Tundikhel, a government-protected open space, where people spontaneously gathered after the Earthquake and stayed for many days in temporary shelters. Donors and authorities have also utilized such POS for rescue and recovery for sheltering.

Most of the POSs were fully occupied for sheltering and, therefore, contributed to DRRM intensively during the 2015 earthquake in Kathmandu. As the earthquake is an acute disaster that strikes suddenly and cannot be predicted, it requires a quick and effective response as well as planning for an effective coping strategy. To this, sufficient open spaces are inevitable in an urban area like KMC. Responses from intellectuals and local people on public open space and DRRM relations can be observed in some of the

interviewees' responses here. To elaborate on this, one of the respondents expressed his view by saying:

> *'There is a close relationship between public open spaces and disaster risk reduction as it provides a safer place for rescue, relief, recovery, and reconstruction. In the case of Kathmandu, there is no such large open space where reconstruction e.g.,the new settlement could be developed. However available open spaces should be protected, managed, and plan to utilize during disasters. The picture of Kathmandu during the earthquake and its aftershocks was terrible. As an Earthquake may occur at any time in Kathmandu, we need to protect the open spaces so that lives can be saved in the future' (A 65-year-old, Local Resident/Urban Expert/ Key Informant).*

Besides, other implications of POS and DRRM relations could be referred to as how a community and authorities during the disaster period would utilize the available POS at the settlement level. During a natural disaster like an earthquake, people immediately gather in the open spaces within the neighborhood areas. The POS in such a situation helps to get the correct figure of how many people are living and falling into the ruins in that neighbourhood during the earthquake simply by counting the families and number of inhabitants in the particular neighborhoods. The family members of the neighbourhood can figure out to estimate how many of them are trapped inside the collapsed structures. This is an important event during disasters as evacuators can effectively mobilize the rescue team so that many people can come to notice for rescue. Supporting this opinion an informant explains:

> *'Whether the earthquake in India, in Japan, or in Nepal, the use of open space helped to treat the injured people immediately at the spot and to find out how many people were trapped in the collapsed structures with the known person in the neighborhood level from those gathered in the open spaces at community/neighborhood level. It is overlooked but an important implication of public open space in highly dense built-up areas like Kathmandu' (A 54-year-old, Key Informants, Urban expert, Ministry of Urban Development).*

Disasters may leave positive impacts on the community after recovery if the community can lead it in the right direction. But it depends on how the government or local government could capitalize it recovering the disaster impacts to lead the community in the right direction. USAID has explained that after successful implementation of disaster risk recovery schemes at the community level may lead to a positive direction

changing the community to a better development rhythm than before. USAID (2021) explains;

> *'Urban risk reduction delivers many benefits in the long run. When successfully applied as part of sustainable urbanization, resilient cities help reduce poverty, provide for growth and employment, and deliver greater social equity, fresh business opportunities, more balanced ecosystems, better health, and improved education.'*

Therefore, the urban community can benefit from the disasters correcting them in their major problems of implementation of plans, and projects to make a resilient society for the future. But it always depends on the government authorities how they take it, respond to it, and accept it as an opportunity for development. If there is the will of authorities, a congested, overfilled city's evils can be transformed into a city transformation process of new development or change that is inevitably needed for the future. Implementation of urban regeneration, urban revitalization, and urban re-building could be implemented more easily. There are many cases where disaster-hit cities have been kept in situ as major conservation sites to show future generations and open attractive tourism sites. Sichuan of China is one that was hit by a devastating earthquake in 2008 with a huge loss now functioning as a popular tourism destination site (Tareen, 2023). Therefore, the relationships between the POS and DRRM can be traced through many dimensions of how they are contributing to urban society during the disasters, immediately after disasters, and recovery after the disasters.

Kathmandu witnessed the rise of POS after the disaster

In the aforementioned conceptual framework, we have briefly delved into the interconnected relationship between POS and DRRM within an urban setting. We have explored how the networks of POS and infrastructures play a pivotal role in contributing to DRRM across various stages of disasters. Following the 2015 earthquake, substantial evidence proves the claim that KMC has experienced the rise or increase in number of new POSs.The development and expansion of new POS were initiated or enhanced by KMC to address the evacuation of encroached land, expand river corridors, and conserve POS within KMC. After the 2015 earthquake, there is evidence supporting this argument that KMC has witnessed the emergence of new POSs for disaster risk reduction and other social implications in many ways (see Mishra, 2004; Jayakody & Amarayhunga, 2016; Saxena, 2016; Jayakody *et al.,* 2018 how people were rescued, and rehabilitated in the open spaces). The POSs serve as critical resources for urban populations during times of crisis, providing safety, shelter, and a sense of community support. Public perceptions regarding the community's awareness of preserving POS at

the community level have increased since the earthquake. This heightened awareness has generated a positive atmosphere for the recreation or establishment of POS within KMC, contributing to the city's POS provisions.

The emergence of POS along the riverbank, the expansion of road networks, enhanced connectivity via river corridors, the identification and preservation of public land, the demolition of buildings of the POS, and creation of open spaces, and the development of parks are among the noteworthy ongoing initiatives in KMC. Prominent POS in the Bagmati River Corridor, Bishnumati River Corridor, Dhobikhola River Corridor, and selected urban areas highlight the emergence of POS in KMC. These efforts to preserve public spaces have gained momentum following the 2015 earthquake. On one hand, authorities have come to recognize the significance of POS for disaster risk reduction, and on the other hand, these activities are gaining momentum due to the concurrent demand and proactive engagement of local governance. As a result, new POSs are now emerging at the community level within the city.

After the 2015 earthquake in Kathmandu, the noteworthy management of POS encompasses initiatives like Bagmati River Corridor Improvement, Manohara River Corridor Improvement, Bishnumati River Corridor Improvement, Dhobi Khola River Corridor Improvement, etc. These activities involve excavating and preserving rivers along with the associated public spaces on the riverbanks to enhance connectivity and connect with public activities. The conserved river corridors have been repurposed as public gardens, walking areas, cultural and religious spaces, recreational places, and other community services. Additionally, certain public lands with concrete structures have been demolished and repurposed into parks and recreational areas. Structures in public lands at Anamnagar (Jestha Nagarik Park), Balaju (Private Driving Training Center), Mahabaudha (in front of Bir Hospital) are some examples of structures that have been demolished to create open/green spaces. Reports indicate numerous instances of encroachment and construction in public open spaces in areas like Anamnagar, Devinagar, Bhimsengola, Baluwatar, Dallu, Bagmati and Bishnumati River corridors, Balaju, Samakhushi, Teku, Radhakrsihan Debsthan, Bansbari, etc. (Sapkota, 2080). The emergence of these public open spaces can be viewed as a response to the post-disaster realization of the importance of POS for DRRM and public use.

Moreover, the model could find application in the core urban areas of KMC for the implementation of urban redevelopment and regeneration plans. Impressions gathered from fieldwork indicate that compact structures, characterized by old buildings and narrow street connections, pose significant challenges in terms of DRRM. Addressing these issues can involve making the old building structures earthquake-resistant through

urban regeneration programs, such as house pooling. These programs have the potential to not only enhance the seismic resilience of the structures but also create public POS at the settlement level. This, in turn, facilitates easy access for residents through improved connectivity, fosters sociability, and supports various public activities. Urban regeneration initiatives by the KMC started with the Fiscal Year Budget of KMC 2015/16, focusing on Baidhya Chowk, Buddha Chowk, and Kilagal Chowk in the core Kathmandu. Such urban regeneration programmes can effectively be implemented in entire core areas of KMC for urban safety and the generation of POS.

Contribution of POS in DRRM: Perception and experience

In light of the preceding discussion regarding the relationship between POS and DRRM, it is evident that open spaces hold an important role in disaster response within the built environment. Open spaces serve as secure locations that offer essential shelter and support for communities during times of disaster, encompassing rescue, relief, recovery, and treatment efforts. The provision of such spaces in cities may vary, but medium-sized communal areas located within 200 meters from residential areas are typically preferred as immediate safe places (Shrestha *et al.,* 2018). When open spaces are available in close proximity to households, they instill a sense of psychological confidence in residents, as they perceive these areas as safer during calamities. However, the significance of POS in urban disaster risk reduction varies based on its patterns, forms, types, and distribution. Hence, it is imperative to investigate the role of public open spaces in DRRM within the KMC, considering both the core Kathmandu and the outskirts. These two distinct clusters exhibit different socio-cultural dynamics, with the

area dominated by the indigenous population and the outskirts characterized by migrant population dominance. This exploration should address key questions, including, do these public open spaces play a significant role in DRRM within the current urban landscape of KMC? How were these spaces utilized during the devastating earthquake that struck Nepal in 2015, resulting in a high number of fatalities and casualties? Moreover, how can these public open spaces contribute to mitigating other types of disasters, such as floods and inundations in Kathmandu? These critical issues will be examined within the core Kathmandu and outskirtsurban contexts of KMC.

Experiences and observations from core Kathmandu

Open spaces and DRRM relationships in the core urban area of KMC were analyzed through peoples' perceptions to know how they perceive and use it during disasters, immediately after disasters, and after recovery from the disasters. The perceptions are presented through individual, community, and institutional levels to know how public open spaces contributed during the 2015 Earthquake and how they perceived the POS

and DRRM relations. As the nature and functions of POSs in the core city differ from the outer one, the contribution to DRRM also differs accordingly. In the core areas, larger-scale POSs like Tundikhel, Ratnapark, Khullamanch were very important to rescue, recovery, and relief during the disasters. As people spontaneously gathered in these spaces, they made temporary shelters and stayed for many days. These spaces at that time were not only the 'home' of the homeless in Kathmandu but were 'home' for building owners and millionaires. It has been witnessed that during disasters, the people of the society can live together in unity without saying high-low, or rich-poor, and they show a sense of unity. One respondent talking about the scene after the earthquake in 2015 says:

> *'I remember that the Tundikhel area was fully occupied, people were gathering and stayed on the open ground for the first two days. After the third day, there were many temporary sheds prepared and people were living there for many days. Notably, during that time, not only were homeless individuals staying on the open ground, but even affluent individuals (Gharmalik or rich people) were observed in the temporary sheds, sharing the same space and shelter' (58-year-old, a local resident of Asan area).*

Observations from the densest areas where some sizeable open spaces are accounted as commons/neighborhoods. These commons are commonplace to surrounding households. These open spaces were mostly used for rescue, relief, treatment, and recovery during an earthquake in 2015. People immediately gathered in these spaces and activated for rescue, relief, and treatment of which injured people got immediate treatment. To present the scene and importance of public open spaces during the earthquake 2015, one respondent expresses as saying:

> *'During the 2015 earthquake, the Baha was fully occupied. People in the vicinity gathered promptly after the quake, and the area was extensively utilized for managing casualties and conducting rescue operations. Some of the casualties were quickly transported to hospitals for treatment. Additionally, arrangements were made to provide first aid to the injured, and some were accommodated in this location (48-year-old, a local Inhabitant of Yatakha Baha).*

Similarly, another respondent from another site of the core area further adds views on issue as follows:

> *'A month after the 2015 earthquake, nearly 25 families had taken residence in this area. Among them were both tenants and house owners whose*

> *buildings had collapsed either fully or partially due to the quake. During the earthquake period, people chose to stay in this open space for an extended period, considering it a safer alternative. The social unity during that time was noteworthy, as a surprisingly strong sense of community developed among all the inhabitants in this area'(44-year-old, a tenant resident, and respondent of Itum Bahal).*

Some of others have more bitter experiences of the earthquakes. The open spaces were not in their use during the 2015 earthquake. One of the respondents residing near Itumbal says:

> *'I lost my parents in the earthquake. My father attempted to reach the nearby Baha, just a 2-minute walk through a narrow Galli. Unfortunately, he didn't make it; a bunch of bricks fell on him along the way, resulting in his demise. Despite having open space (Itum Baha) near our home, my parents couldn't be saved due to the very narrow Galli connection. Consequently, I hold a different perspective on open spaces; they should be accessible with wider streets. Otherwise, the presence of open space becomes inconsequential for residents like me' (41-years-old, a local resident of Itum Bahal)*

The stories and perspectives shared reflect public attitudes, inter-household connections, accessibility challenges, and the unconscious psychology exhibited by individuals during disasters. They highlight spontaneous behaviors in the face of such crises. Some narratives express discontent with existing urban layouts and open space networks, citing instances where people lost their relatives while attempting to escape during the earthquake. The narrow streets (Galli) leading to open spaces posed challenges, resulting in the loss of loved ones. Additionally, some individuals lacked larger open spaces to seek refuge during disasters, forcing them to navigate the streets in search of safety. Another respondent adding to similar views expresses:

> *'There are three small Bahas/Bahis near my house, primarily designated for providing lighting to surrounding buildings. In reality, these spaces serve no practical purpose for us during disasters such as earthquakes or fires. If there were larger open spaces with proper accessibility to the community during emergencies, they would be more beneficial. As it stands, these small Bahas/Bahis in our community hold little meaning for us, and in times of disaster, we are left with no choice but to run randomly on the streets' (47-years-old, a local resident of Ashan Bazar).*

Authoritative and expert perspectives on the utilization of POS during disasters also shed light on the intriguing connection between POSs and DRRM in densely populated areas, such as the core areas of KMC. One of the informants expresses about this as saying:

> *'We need to enhance open spaces in cities like KMC, particularly in core areas. The city's initial urban planning incorporated a network of POSs that played a crucial role in DRRM for many years. Iconic core areas such as Dabali, Bahas/Bahis, Nani, Lachhci, Chowks, Mandala, Pukha, Stupa, Chaitya, Durbar Square, Tundikhel, and Hitti served as historical landmarks and vital public spaces, including for disaster response. Unfortunately, these areas are losing their identity, facing encroachment or being repurposed for parking, posing a growing threat to urban life' (68-years-old, key informant, urban expert and government representative).*

Expressing the restrictions on the use of POS in the core areas of KMC, an urban expert and representative of government institution speaks:

> *'I would assert that POSs have become restricted for public use after the advent of democracy. I recall that during my college days, we could freely enter Tundikhel, play, and engage in public life without any constraints. However, in the democratic era, the fences have grown taller, and access has been limited. This restriction on people's right to use POS in KMC seems incongruent with democratic principles. How can such constraints be justified in a democratic society? I mean to emphasize that public open spaces should be accessible to the public without restrictions (54- years old, key informants, Government Officer).*

The observations from the core urban areas through peoples' experiences reveal that public open spaces were useful for disaster risk reduction and management and extensively used during the earthquake in 2015. However, certain open spaces, hindered by limited accessibility through narrow streets (Gully), proved ineffective for DRRM. These spaces became hazardous, as people fleeing to these areas found themselves trapped on narrow streets, resulting in severe injuries or fatalities. This highlights the necessity for sizable open spaces with robust connectivity networks, especially in core urban areas where buildings lack adequate open spaces.

Authorities and experts emphasize the current urbanization process as unfavorable to open space development, leading to a reduction in available open spaces. Therefore, a strong effort is needed to improve housing spatial distribution and the transportation

network and increase accessibility to decrease urban disaster risk vulnerabilities in Kathmandu (Bhattarai & Conway, 2010). The prevailing patterns of urban expansion, existing POS provisions, and infrastructure development contribute to increased vulnerability in core urban areas. Therefore, redevelopment, regeneration, and the enhancement of connectivity and networks between settlements and POSs are crucial steps toward fostering resilient communities within the core urban areas of KMC.

Experiences and observations from urban outskirts

While the distribution of POS and per capita availability in the core and outskirts of KMC is nearly similar, public perception suggests that the outskirts are comparatively more conducive than the core areas. The fringe urban areas exhibit wider road connections, less compact urban forms, and reveal planned urban development initiatives across different hierarchical settlement levels. These areas boast better connectivity, improved accessibility, and, to some extent, newer settlements compared to the core urban areas. During the earthquake, open spaces in the outskirts were also extensively utilized for rescue, relief, recovery, and treatment. However, the usage and accessibility of POS in the outskirts differ based on the location and nature of the settlements. Settlements with good access to POS were perceived as safer by residents compared to those with limited or no access to public open spaces. To provide insight into respondents' views regarding their perceptions and behavior regarding POS and DRRM relations in their contexts, some of their experiences are outlined below.

One respondent puts his experience as:

> *'I remember that day, Baisakh 12, 2072 BS. I was seated, holding my three-year-old child on my lap, watching television. Suddenly, the sofa began shaking with a distinct noise. Without much thought, I immediately shouted loudly to my wife and son, who were working in the kitchen upstairs, to run outside. In a state of urgency, I also rushed outside to the open space. At that moment, my actions were more reactive than conscious, driven by the instinct to seek safety' (38-years-old, a resident of Pepsicola, Kathmandu).*

Another respondent put his views as:

> *'Throughout the earthquake, all of these open spaces were completely occupied, covered by Tirpals of various colors. People took refuge on the ground, leaving their homes for over 15 days during the seismic shocks and aftershocks. This open space became the temporary home for the*

community during that period' (40-years-old, local resident of Swayambhu area).

Similarly, another respondent expresses in this regard as:

'This open space holds significant importance during disaster periods. In the 2015 earthquake, people from the surrounding areas initially gathered here. They discussed, devised plans to rescue individuals trapped in collapsed buildings, and provided treatment and relief in this space' (37-years-old, a local resident of Balaju Area).

The perspectives on the utilization of POS during disasters, particularly the 2015 earthquake, convey that people recognize the value of these spaces in various ways. There is a realization of the crucial importance of maintaining open spaces for the community, serving as essential areas for rescue, recovery, relief, and treatment during disaster events, ultimately preserving public life. These open spaces not only function as areas for immediate response during disasters but also provide temporary shelter for those rendered homeless. Additionally, open spaces play a role in imparting psychological confidence in the community, encouraging their use during disasters. This sentiment is further supported by the responses of key informants, including medical experts and security personnel, highlighting the vital role of public open spaces during disasters in KMC.

One medical representative expresses his views as:

'I was present at the Civil Hospital on the 12th of Baisakh, 2072 BS. I recall that there was no available space to accommodate beds within the hospital buildings. Every bed was occupied, with two or three patients sharing a single bed. Ambulances continuously arrived, bringing in more injured individuals, resulting in large crowds gathering on the hospital premises. During that time, the entire hospital ground was filled with injured people. The doctors were faced with confusion, not knowing where to go and whom to attend to in the chaotic and panic-stricken situation'(47-years-old, medical representative and a local residentof Pepsicola area).

Security personnel who actively engaged during the crisis management in the 2015 Earthquake expresses:

> *'Managing crises was notably more feasible in areas with sufficient, well-sized open spaces. Rapid rescue and relief operations could be executed from such areas. In densely populated settlements, the flow of ambulances is hindered, potentially trapping injured individuals within collapsed structures. Our rescue teams face challenges in accessing and rescuing individuals in such cases. The bitter experiences from the 2015 earthquake highlight a higher injury and death rate in compact settlements compared to those with reasonable POS, where fewer people were injured, and the death rate was lower.' (53-years-old, security personnel of police post, residents of Pepsicola).*

Similarly, a government retired officer who worked for urban development institutions for many years expresses his views on the importance of POSs as:

> *'I believe that larger POSs play a significant role in DRRM as people can easily access these spaces for relief and temporary settlement. It is notable that the outer areas of KMC generally have better access to such open spaces. In the course of my Ph.D. research, I discovered that, despite various contributing factors, individuals residing in dispersed settlements are less prone to injuries, and the demise rate is comparatively lower, and vice versa. Consequently, during my tenure at the Department of Urban Development and Building Construction (DUDBC), I dedicated efforts to the implementation of building codes and the incorporation of POS in the planning of new urban areas' (54-years-old, key informant/ urban expert, government retiree officer).*

The statements above highlight the crucial role played by open spaces in fringe urban areas during the earthquake recovery in 2015. The recognition of the significance of these public open spaces extends not only to the residents of the community but also to experts actively involved in rescue and recovery operations. These experts acknowledge that these open spaces were extensively used for recovery, relief, treatment, and rehabilitation. Additionally, urban experts and government officials with substantial experience also affirm the value of public open spaces in disaster risk reduction and management.

Discussing the significance of POS in DRRM in Kathmandu, some examples highlight how blue space, represented by water bodies within urban areas, can contribute to

disaster risk reduction. A notable example is the Nebiko Biscuit Factory fire in the Balaju Industrial area, where traditional ponds in the city were insufficient during the fire. To control the fire, a Simrik Air helicopter flew to collect water from Rani Pokhari. This incident emphasizes the importance of water bodies like Rani Pokhari in disaster mitigation, as they can serve as crucial resources in emergencies, potentially saving lives in urban environments(My Republica, 2021).

However, the effectiveness of POS in DRRM in KMC varies based on the types and characteristics of the POS. Based on consultative feedback, community-managed POS are more widely utilized in disaster risk reduction and management (DRRM) compared to government-managed POS. Government-managed POS are often occupied by government institutions, limiting open access for the public use. The significant factor influencing this preference is the ease of spontaneous access to community-level POS as opposed to institutional POS. However, it is crucial to note that POS lacking proper connectivity and easy accessibility cannot effectively contribute to DRRM due to their limited usability. Therefore, the utilization of POS in DRRM is primarily determined not only by their size but also by factors such as connectivity, accessibility, openness, and ownership.

The main discussion above highlights how public open spaces contribute to disaster risk reduction and management. However, it is essential to recognize that the extent of economic losses and damage to buildings and infrastructure is contingent upon varying levels of exposure and vulnerability within each community, including the population and facilities. Additionally, factors such as the community's knowledge to cope with disasters, engagement in networks and associations focused on risk relief and recovery, and access to diverse assets contribute to the determination of the degree of losses and damages. It is evident that individuals with access to resources, good infrastructures, and sufficient assets are less likely to be vulnerable to disasters, while those with limited access to these resources are more likely to be vulnerable (Andrew & Keefe, 2014; Cutter *et al.,* 2000; Drakes & Tate, 2022; Fatemi *et al.,* 2017). Similarly, community networks, access to assets, and prevailing construction practices are other significant factors influencing the level of disaster damage and loss.

Openness and access compatibility of POSs in DRRM

The assessments and analyses from people's perspectives strongly indicate that public open spaces were extensively utilized in disaster risk reduction, particularly during the 2015 earthquakes, and will remain crucial for future disaster management. However, it's evident from the analysis that not all types of open spaces were or are equally important for DRRM. Given this empirical background, here is a need to explore the use

compatibility of POS for DRRM in KMC. The analysis is based on results obtained from the inventory survey, impressions from the users' survey, and key informant interviews conducted at different stages and various types of POS. The summary table (Table 1) below presents the results of the level of compatibility in the use of POS, considering the identified 493 POSs in KMC.

Table 1

Openness and access compatibility of public open spaces in KMC

Level of Compatibility in use	Core Kathmandu			Outskirts		
	Number of Open Space	Area (m^2)	Per capita POS(m^2)	Number of Open Space	Area (m^2)	Per capita POS (m^2)
Highly Compatible	49	714,805	0.27	135	2,749,106	0.24
Moderately Compatible	105	1,354,935	0.14	96	4,382,548	0.15
Modestly Compatible	64	686,053	0.28	33	1,546,046	0.43
Total/Average	277	2,755,793	14.14	264	8,677,700	13.0

Source: Field survey, 2022

The current scenario of compatibility for existing public open spaces in Kathmandu reveals that among the 493 POSs, 277 are situated in the core Kathmandu. Of these, 49 spaces, totaling 714,805 square meters, are highly compatible, 105 spaces with an area of 1,354,935 square meters are moderately compatible, and 64 are modestly compatible, covering 686,053 square meters. Similarly, of the 264 POSs in the outskirts, 135 are highly compatible, with 2,749,106 square meters, 96 are moderately compatible, encompassing 4,382,584 square meters, and 33 are modestly compatible, covering 1,546,046 square meters. Compatibility was evaluated through an analysis of inventory data, considering factors such as the availability of open areas, accessibility, location, size, and potential uses during disasters. Additionally, the verification of compatibility situations involved observation through visual impressions and insights derived from the user survey results.

When examining the results in relation to population per capita, it is revealed that there is 14.14 square meters of POS available per capita. Despite the average POS per capita population in KMC being approximately 7.9 m2 (inclusive of all types of POS), it falls below the WHO standard of 9m2 (UN-Habitat, 2018) and far behind as compared to per capita of Delhi (Shahfahad *et al.,* 2019).Breaking down compatibility per capita, highly compatible POS is only 0.27 square meters, moderately compatible POS is only 0.15

square meters per capita, and modestly compatible POS is 0.28 square meters per capita in the core areas of KMC. Similarly, in the outskirts, per capita availability is 13 square meters, with highly compatible POS at only 0.24 square meters, moderately compatible POS at only 0.14 square meters, and modestly compatible POS at 0.43 square meters.

POSs are broadly categorized based on size, hierarchy, public accessibility, ownership, function, management, and the percentage of openness area within them. However, their compatibility with DRRM is predominantly determined by the extent of openness area available within a specific POS and people's access to it. POS featuring fully open areas or open areas exceeding 75% of their total space are more suitable for DRRM. Additionally, POS accessible to the public at all times demonstrates high compatibility, providing continuous access during emergencies. In the context of KMC, community-managed POS at the neighborhood level, with unrestricted access for all community members, exhibits the highest compatibility. Some larger POS with unrestricted public access also score well in terms of compatibility. Conversely, institutional POS with access restrictions, even if well-connected by roads, are generally less compatible for DRRM. Therefore, the compatibility of POS for DRRM is primarily determined by access patterns and the availability of open space within them.

Public views from the respondents also suggest a deficiency in public open spaces for long-term rehabilitation in the valley at large, and specifically in KMC. One respondent expressing this adds;

> *'Adequate public open spaces in the valley are in short supply. Even government-preserved open spaces, such as Tundikhel, are diminishing in size. The bus park is going to betransformed into a commercial complex, and Sainik Manch is gradually being replaced with buildings. There are also reports that KMC is considering the construction of an international convention center at Bhrikutimandap, leading to the conversion of this open space into a covered area. Consequently, there will be very few large public open spaces remaining in KMC for effectively managing disaster-related emergencies' (68-years-old, key informant's interview, Ratnapark).*

The compatibility of POS also needs to be analyzed based on how these spaces have been accepted in the community and how they function in various social and cultural settings. In discussing the contexts of the core and outskirts of KMC, both clusters present nearly similar per capita POS. However, the compatibility of POS for DRRM in the core and outskirts of KMC differs due to distinct patterns, urban morphology, accessibility situations, density, and community perceptions in using POS during disasters. The

following are some community-level experiences that reflect the compatibility of POS in DRRM.One of the key informants expresses:

> *'The perceived lack of understanding regarding the significance of POS or the failure of responsible authorities to promote the positive impact of POS in human life, especially concerning DRRM, may contribute to the issue. Awareness of POS implications varies among different communities and is influenced by socio-cultural contexts. It appears that communities that are more vigilant tend to be better informed and actively advocate for the preservation of POS with greater effectiveness than others' (68-years-old, key informant/urban expert).*

One of the informants from the core urban areas revealing his experiences of how the POSs are/were compatible in DRRM says:

> *'The utility and suitability of open spaces during disasters largely depend on their accessibility to the population. The narrowness of the streets in this area creates an inherent sense of insecurity during disasters, as the streets themselves become hazardous. Consequently, residents are unable to access nearby open spaces as safe retreats. The confined streets discourage people from venturing into open spaces, even after a disaster has struck. Additionally, the narrow streets pose challenges for post-disaster rescue and relief efforts. The issue in these older settlements extends beyond the shortage of open spaces; it encompasses the limited access roads leading to these spaces' (45-years-old, local residents, Asan Bazar).*

Therefore, it can be concluded that not all POSs are aligned with DRRM, but some of them make significant contributions in this regard. Some people in KMC have been using POSs during disasters as a safe place, while others have not been utilizing them due to their incompatibility. The recent earthquakes, flooding, and inundations in KMC demonstrate to the important role that POSs have played in relief, rehabilitation, and recovery efforts during these disasters. However, the effective utility of these open spaces for DRRM is predominantly contingent upon their size, characteristics, and accessibility to people.

Conclusion

POSs play a significant role in DRRM in cities globally, including KMC. POSs are greatly valued for their contributions to rescue, rehabilitation, and recovery efforts during and after disasters, particularly earthquake disasters. They also play a crucial role

in identifying and aiding casualties and their family members who may be trapped or in need of assistance. The POSs serve as meeting points for evacuations, urgent treatment centers, and temporary shelters for those affected by calamities. POSs also facilitate efficient communication and coordination among emergency responders. Beyond their immediate roles in crisis response, they enhance a city's resilience by promoting community cohesion, raising awareness about disaster preparedness, and reducing the risk.

The role of POSs in DRRM is deeply influenced by the specific contexts in which they are situated. In KMC, distinct scenarios emerge regarding the impact of POSs on DRRM, particularly in the core and outskirts. In the densely populated urban core, characterized by high population density and narrow street networks, accessibility to POSs is often limited, despite a relatively equitable distribution of the POS. Conversely, in the outskirts with wider streets and improved connectivity, people can have easy access to POSs during disasters, even though the per capita POSs in these areas are lower. This suggests that the quantity and spatial distribution of POSs are less important than the community's ability to access them and their social and psychological confidence in utilizing these spaces during times of crisis. Strikingly, public perception of the utility of POSs during disasters is less favorable in the core areas when compared to the outskirts, despite the higher per capita presence of POSs in the core city.

The compatibility of POS in DRRM is determined by the extent of openness area available within a particular POS and public access to it. Community-managed POS at the neighborhood level, with unrestricted access for all community members, and the POS with unrestricted to people access have the highest compatibility. However, most of the institutional POS with access restrictions, even if well-connected by roads, are less compatible for DRRM. So, the compatibility of POS for DRRM in KMC is primarily tailored by access patterns and the availability of open space within them.

The evidence in KMC post-earthquake supports the emergence of new POSs. Initial efforts involve evacuating structures to create open spaces and developing river corridors for enhanced connectivity, aligning with the infrastructure network model. Notable city-level POSs have emerged by demolishing structures within existing POSs. Creating new POSs, improving connectivity, and redefining construction practices are crucial. Recognizing the multifaceted implications of POS in DRRM, as proposed by infrastructure network models, is essential for enhancing community resilience at both community and household levels.

Perception and experience suggest that POSs were inevitable during the disaster, particularly in the earthquake. This study, while focused on the case of KMC, holds

broader relevance for urban settings experiencing rapid urbanization and facing a decline in available POS. The implications drawn from this research extend beyond the confines of KMC, offering valuable insights applicable to urban contexts globally. The findings serve as a crucial resource for policymakers, empowering authorities and agencies to integrate the importance of POS into city planning and policy development within the realm of urban development. This emphasizes the significance of incorporating strategies that safeguard and enhance POSs, ensuring their inclusion in the blueprint of urban landscapes.

References

Ainuddin, S., & Routray, J. K. (2012). Earthquake hazards and community resilience in Baluchistan. *Natural Hazards*, *63*(2), 909–937. https://doi.org/10.1007/s11069-012-0201-x

Akter, S., Asma Khatun, M., Dev, T., Hossain, N., & Sarker, D. (2022). Potentiality assessment of community open space for disaster management purpose: A participatory approach to reduce disaster vulnerability on a community. *In:* Ghosh, C., & Kolathayar, S. (eds.), *A System Engineering Approach to Disaster Resilience Vol. 205*. Springer Nature Singapore, pp. 317–337. https://doi.org/10.1007/978-981-16-7397-9_23

Alawi, M., Chu, D., & Hammad, S. (2023). Resilience of public open spaces to earthquakes: A case study of Chongqing, China. *Sustainability*, *15*(2), 1092. https://doi.org/10.3390/su15021092

Andrew, M.K., & Keefe, J.M. (2014). Social vulnerability from a social ecology perspective: A cohort study of older adults from the National Population Health Survey of Canada. *BMC Geriatrics*, *14*(1), 90. https://doi.org/10.1186/1471-2318-14-90

Anhorn, J., & Khazai, B. (2015). Open space suitability analysis for emergency shelter after an earthquake. *Natural Hazards and Earth System Sciences*, *15*(4), 789–803. https://doi.org/10.5194/nhess-15-789-2015

Bernabei, L., Mochi, G., Bernardini, G., & Quagliarini, E. (2021). Seismic risk of open spaces in historic built environments: A matrix-based approach for emergency management and disaster response. *International Journal of Disaster Risk Reduction*, *65*, 1-15. https://doi.org/10.1016/j.ijdrr.2021.102552

Bhattarai, K., & Conway, D. (2010). Urban vulnerabilities in the Kathmandu Valley, Nepal: Visualizations of human/hazard interactions. *Journal of Geographic Information System*, *02*(02), 63–84. https://doi.org/10.4236/jgis.2010.22012

Cutter, S.L., Scott, M.S., & Mitchell, J.T. (2000). Revealing the vulnerability of people and places: A case study of Georgetown County. *Annals of the Association of American Geographers*, *90*, 713–737.

Davino, C., Gherghi, M., Sorana, S., & Vistocco, D. (2021). Measuring social vulnerability in an urban space through multivariate methods and models. *Social Indicators Research*, *157*(3), 1179–1201. https://doi.org/10.1007/s11205-021-02680-0

Drakes, O., & Tate, E. (2022). Social vulnerability in a multi-hazard context: A systematic review. *Environmental Research Letters*, *17*(3). https://doi.org/10.1088/1748-9326/ac5140

Efroymson, D., Thanh Ha, T.T.K., & Thu Ha, P. (2009). *Public spaces: How they humanize cities.* HealthBridge - WBB Trust.

Fatemi, F., Ardalan, A., Aguirre, B., Mansouri, N., & Mohammadfam, I. (2017). Social vulnerability indicators in disasters: Findings from a systematic review. *International Journal of Disaster Risk Reduction*, *22*, 219–227. https://doi.org/10.1016/j.ijdrr.2016.09.006

French, E.L. (2017). *Designing public open space to support seismic resilience: A systematic review* (Unpublished Master dissertation). The University of Guelph.

IOM. (2020). *Updated report on 83 open spaces identified for humanitarian purposes in Kathmandu Valley*. International Organization of Migration, Kathmandu, pp.1-158

Jayakody, R.R., & Amarayhunga, D. (2016). The use of public open spaces for disaster resilient cities. *E-Journal of Research Gate*, *2*(3), 118–128.

Jayakody, R.R.J.C., Amaratunga, D., & Haigh, R. (2018). Plan and design public open spaces incorporating disaster management strategies with sustainable development strategies: A literature synthesis. *MATEC Web of Conferences*, *229*, 1-6. https://doi.org/10.1051/matecconf/201822904001

Koren, D., & Rus, K. (2019). The potential of open space for enhancing urban seismic resilience: A literature review. *Sustainability*, *11*(21), 5942. https://doi.org/10.3390/su11215942

KVDA. (2015). *Atlas of open spaces in Kathmandu Valley*. Kathmandu Valley Development Authority, pp. 1-158.

MoPE, (1999). *Environmental planning and management of the Kathmandu Valley.* Ministry of Population and Environment, Government of Nepal, pp. 1-211.

Mishra, P. K. (2004). *The Kutch earthquake-2001: Recollections, lessons, and insights*. National Institute of Disaster Management, 1-258.

MoHA. (2016). *Nepal earthquake 2015: Post disaster recovery framework, 2016-2020*. Ministry of Home Affairs, pp. 1-102.

My Republica. (2021,August 07). *Massive fire breaks out at Balaju industrial area*. My Republic, Kathmandu.

Pacheco Barzallo, A., Fariña, J., & Álvarez De Andrés, E. (2022). Public open spaces: Enabling or impeding inclusive evacuation during disasters. *The Journal of Public Space, 7*(2), 79–92. https://doi.org/10.32891/jps.v7i2.1474

Sapkota, S. (2077 BS. Chaitra 11). Kathmanduma sayaun sarbajanik jagga Maphiyako Kabjama (in Nepali). Nagarik Daily.

Saxena, M. R. (2016). *Role of open spaces in disaster management.* https://www.researchgate.net/publication/312661449. Accessed: 20.06.2023

Shahfahad, Kumari, B., Tayyab, M., Hang, H.T., Khan, M.F., & Rahman, A. (2019). Assessment of public open spaces (POS) and landscape quality based on per capita POS index in Delhi, India. *SN Applied Sciences, 1*(4), 368. https://doi.org/10.1007/s42452-019-0372-0

Shrestha, S.R., Sliuzas, R., & Kuffer, M. (2018). Open spaces and risk perception in post-earthquake Kathmandu city. *Applied Geography*, *93*, 81–91. https://doi.org/10.1016/j.apgeog.2018.02.016

Tareen, H. (2023). The 2008 Sichuan earthquake and Its impacts on economy. *European Scientific Journal, ESJ*, *19*(13), 49. https://doi.org/10.19044/esj.2023.v19n13p49

UNDP. (2020). *Open space of Kathmandu, Lalitpur, Kirtipur and Bhaktapur*. United Nations Development Program, pp. 1-184.

UNISDR. (2015). *Disaster risk reduction and resilience in the 2030: Agenda for sustainable development: A reflection paper*. United Nations International Strategy for Disaster Reduction Practical Action, pp. 1-21.

USAID. (2021). *Disaster risk sensitive land use plan of Kathmandu Valley*. United States Agency for International Development, Nepal.

UN-Habitat. (2018). *Developing public space and land values in cities and neighborhoods. Discussion paper for a better urban future*. United Nations-Habitat, pp. 1-10.

Wisner, B. (Ed.). (2004). *At risk: Natural hazards, people's vulnerability, and disasters* (2nd ed). Routledge. www.newsghana.com. and www.theatlantic.com Accessed: 22.05.2022.