THE USE OF PUBLIC OPEN SPACES TO ENHANCE THE COASTAL URBAN CITIES' RESILIENCE TO TSUNAMIS

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ABSTRACT

Tsunami is a rapid-onset natural hazard that can be considered as one of the extremely destructive hazards. Depending on the location of the origin of Tsunami, there can be limited time available to evacuate people to safe places and to make appropriate response decisions in timely manner. Therefore, it is imperative to increase the inherent capacity of a city to respond this type of a natural hazard.

Planning and designing spatial elements are one of the directives to increase the inherent capacity of a city to resist, absorb, accommodate and recover from the effects of a Tsunami. Accordingly, this research paper emphasizes the importance of public open spaces as one of the key spatial elements of a city which can be used as a strategy to enhance the coastal urban cities' resilience to Tsunamis, as an agent of recovery, as a mode to provide essential life support, as a primary place to rescue, shelters and potential for adaptive response.

Moreover, this ongoing research study analyses the current literature on use of public open spaces for Tsunami resilience and also the current problems and issues associated with it. Finally, the analysis suggests set of recommendations to enhance the use of public open spaces to increase the coastal urban cities' resilience to Tsunamis.

Key words: Coastal Urban Cities, Disaster Resilience, Planning and Designing, Public Open Spaces, Tsunami Resilience

INTRODUCTION

The growth of world population and the increase of human migration towards the coastal urban cities, result rapid population growth in coastal urban cities. Therefore, these coastal urban cities will contain an increasingly large proportion of the world's human population (World Bank Group, 2016). Confirming this fact, population distribution studies indicate that half of the world's population lives within 60 km of the sea, and three-quarters of large cities are located on the coast (UNEP, 2015). However, this growing population in coastal urban cities, create significant challenges to both natural and built environments by polluting the coastal zone, putting more pressure on land and destabilizing the coastline by damaging mangroves, coral reefs, sea grass beds and sand dunes.

Further, the implications of climate change set all coastal locations at risk with the impacts of accelerated global sea-level rise, changes in storm frequency and other related coastal hazards (Neumann, Vafeidis, Zimmermann, & Nicholls, 2015). Moreover, the combined implication of the population growth in urban cities and the climate change, increase the exposure of coastal urban dwellers to natural coastal hazards such as coastal floods, storms, erosion, tsunamis, saltwater intrusion and subsidence.

Out of these coastal hazards, Tsunami is a rapid-onset coastal hazard that can be considered as ever-present threat to lives, infrastructure, and property along the coasts (Taubenböck et al., 2009). It is infrequent, but extremely destructive natural hazard. Historical records indicate that hundreds of thousands of people were killed by tsunamis worldwide (National Tsunami Hazard Mitigation Program, 2001). Further, Tsunami 2004 reminded the world to be more proactive by claiming nearly 275 000 lives and destroying billions of dollars' worth properties (Barber, 2005).

However, regardless of these threats of coastal hazards, rapid urbanization gathers more people towards coastal urban cities due to the internationalization of finance, service and products, growth of international ports and high-density developments near harbors. For instance, the estimations display that 489 cities within the Pacific states of Alaska, California, Hawaii, Oregon, and Washington are vulnerable to tsunamis and 900,000 people in these cities have the risk of being inundated by a 50-foot tsunami (National Tsunami Hazard Mitigation Program, 2001).

Therefore, it is an increasingly important, but critical task, to make coastal urban cities resilience to Tsunamis, especially with the challenges of urbanization. When making cities resilience to disasters, León and March (2014) state that urban planning and designing can play a vital role through its ability to integrate the multi-dimensional aspects affecting disaster risk reduction. Adding to this, UNISDR (2012) states that strategic planning and design of spatial elements and their influence on the natural and built environment are directives of city's capacity to absorb and recover from the effect of disasters.

While urban design and planning solutions play a vital role in creating resilient cities, public open spaces have become one of the key elements in spatial planning and designing which play an important role in urban cities. However, the use of public open spaces for disaster resilience has not been fully revealed yet to the research field (Hossain, 2014). Specifically, lack of consideration has been given to identify the role of Public open spaces to make cities resilience to Tsunamis. Accordingly, this research paper explores the potential use of public open spaces to make coastal urban cities resilience to Tsunamis and current problems associated with it, through the analysis of current literature.

RESEARCH METHOD

This paper presents the findings of an initial literature analysis based on a critical literature review and a synthesis which was conducted as part of an ongoing PhD research study. In order to ensure that the literature review is complete and comprehensive, the researcher has critically reviewed journal papers, book chapters, conference papers as well as local and international reports which discuss the current issues, problems and potentials in the subject area. At the same time, this literature review has been presented in different national and international audiences where the literature review has been critically examined and modified according to the feedback received. Accordingly, this paper presents current research need on planning designing public open spaces with a new focus on enhancing Tsunami resilience coastal urban cities.

MAKING COASTAL URBAN CITIES RESILIENCE TO TSUNAMIS

'Tsunami' is a series of long waves generated by a sudden displacement of a large volume of water (National Tsunami Hazard Mitigation Program, 2001). Tsunamis are activated mostly by submarine earthquakes, submarine volcanic eruptions, underwater landslides or slumps of large volumes of earth, meteor impacts, and even onshore slope failures that fall into the ocean or a bay. National Tsunami Hazard Mitigation Program (2001) and UNESCO (2015) state that submarine earthquakes are the most common causes for Tsunamis. Even though, Tsunami is a natural hazard, Tsunami events become a disaster when they harm people, damage properties and act beyond the ability of the communities to cope. Confirming this fact, Table 1 presents the overview of Tsunami disasters from 1980-2015.

Overview of Tsunami Disasters from 1980-2015	
No. of Events:	27
No. of People Killed:	250,471
No. of People Effected:	1,819,357
Economic Damage (US$ X1000) :	221,995,540

Table 28- Tsunami Disasters from 1980-2015, (EMDAT, 2016)

Further, table 2 describes the effect of Tsunamis on various countries which were caused by numerous tsunami events during the period of 1980 to 2015. Accordingly, it can be noted that, during the time period of 1980-2015, the most devastating tsunami event was recorded in 2004 which has taken the lives of more than 275,000 people and destroyed millions of dollars' worth of property (Prevention web UNISDR, 2008).

Year	Country	Total Deaths (No. of People)	Economic Damage (US$X1000)
2004	Indonesia	165,708	4,451,600
2004	Sri Lanka	35,399	1,316,500
2011	Japan	19,846	21,000,000
2004	India	16,389	1,022,800
2004	Thailand	8,345	No Data
1998	Papua New Guinea	2,182	No Data
2006	Indonesia	802	55,000
2010	Indonesia	530	No Data
2004	Somalia	298	100,000
2004	Maldives	102	470,100
2004	Malaysia	80	500,000

Table 29-Loss of human lives and economic loss by Tsunami events 1980-2015 (EMDAT, 2016)

Further, Asian Disaster Reduction Center (2011) has stated that North Pacific Coast Tsunami in Japan 2011 has killed more than 12,000 human lives while claiming 15,000 people missing. In addition to that, one of another devastating tsunami events was the Tsunami in 2010 in Chili. Accordingly, it can be noted that the destruction caused by three major tsunamis – Indian Ocean 2004, Chile 2010 and Japan 2011 have exposed the weaknesses of capability of communities to cope with these catastrophic events.

Moreover, Tsunamis cannot be confidentially predicted as they are generated by the movements on faults in the earth's crust. Therefore, depending on the location of the tsunami's origin, there can be limited time is available to evacuate people to places of safety and to make appropriate response decisions. Thus, to plan for such events, an extra effort needs to be taken by looking at each and every aspect of a city.

Further, as it was discussed before, the rapid coastal urbanization gather more people towards the coastal urban cities generating significant challenges to both natural and built environments. Hence, the vulnerabilities and impact are extremely high on urban coastal cities. Therefore, it is an imperative task to make coastal urban cities resilient to Tsunami hazards.

When making coastal urban cities resilience to Tsunamis, the focus can be given on various elements of a city including Public awareness on actions, Preparedness, built environment elements, Technological inputs, institutional capacity and ecological integrity, etc. Out of these elements, strategic planning and design of spatial elements and their influence on the natural and built environment are directives of city's capacity to absorb and recover from disasters (UNISDR, 2012). These spatial strategies can be focused on different spatial elements such as building structures, road networks, open spaces, forests and natural reserves. In this context, this particular study specifically focuses on Public open spaces as one of the key

spatial elements which can be significantly used to make coastal urban cities resilience to Tsunamis.

PUBLIC OPEN SPACES TO MAKE CITIES RESILIENCE TO TSUNAMIS

The current literature which discusses the potential use of public open spaces for disaster resilience reveal, that the public open spaces have a significant potential to be used in three main stages in disaster cycle; emergency response, recovery and mitigation.

Emergency Response and Recovery

In an event of a Tsunami, people may have very limited time to response including gathering to a safer place, sheltering and to distribute the necessary goods and services, etc. Therefore, community's ability to response and to make appropriate decision, timely manner will be highly determined by the arrangement of the spatial elements.

Accordingly, León and March (2014) emphasize the need of public open spaces with adequate location, capacity, and terrain qualities for Tsunami evacuation. They state that the most crucial two elements of Tsunami emergency are streets and Open spaces, because open spaces provide shelters for evacuees sometimes for hours to days depending on the extent of the tsunami warning or any resulting damage, while streets deliver the movement network for emergency services as well as for evacuees.

Further, Taubenböck et al. (2009), emphasize the need of identification of natural safe areas for emergency evacuation by overlapping the land use maps with tsunami hazard maps using remotely sensed data and these natural safe areas are defined as open spaces accessible by the street network and larger enough to accommodate the people in a rescue situation. Accordingly, open spaces which are accessible by the street network and have the capacity to accommodate people, are an asset for emergency evacuation in an event of a Tsunami. However, most of these literature which discuss the use of public open spaces for Tsunami resilience, do not discuss the practical implementation of this strategy to an urban context.

Allan and Brytan (2010) highlight that, recovery planners plan these open spaces, considering it as a part of the natural environment, but not as part of the built environment. They further identify that these strategies may end up with large quantities of unstructured open spaces which contradict with the strategies to achieve liveable, diverse and sustainable urban environments and also rather impractical with urban city form. Accordingly, it can be understood that to enhance use of public open spaces for emergency response and recovery, these Public open spaces need to be planned and designed to function well during both emergency and non-emergency times. Confirming this, Allan and Bryant (2010) discuss that the emergency management plans and recovery plans become more effective when it is aligned with everyday life of the city through urban planning and

designing strategies. Accordingly, when these emergency management plans and recovery plans are integrated into the day to day life, the city become more resilient to disasters.

This applies even more, when making urban cities resilience disasters. Tsunami is an infrequent event, therefore, provision of large quantities of open space for the only purpose of emergency management planning is not practical. It is even more difficult to apply to an urban city where the land scarcity is a major issue. Further, Allan and Bryant (2010) state that those places will not function well in an emergency if it is not well connected with the street network and in the long run those places will become neither physically prepared and will not be identified by the public in an emergency event. Accordingly, it can be understood, the necessity of planning and designing public open spaces to function well during both emergency and non-emergency times.

Further, León and March (2014) suggest, that Tsunami rescue open spaces need to be identified with an objective of providing safe assembly spaces, basic emergency services and utilities, such as first aids, fresh water, electricity, and communication. In supporting this, Allan and Bryant (2010) state that, different types of open spaces can be used for different functions in emergency response and recovery, providing simple to complex services such as gathering, sheltering, temporary inhabitation and so on. Accordingly, the need of these public open spaces may vary according to the type varying from small squares to parks and play grounds.

At the same time, Allan and Bryant (2010) highlight the use of Open Spaces network for disaster resilience through their study on the earthquake event of San Francisco. Further, they state that after a major earthquake, city's open space network have the potential to act as a 'second city' by providing simple to complex services. Consequently, this concept of open space network can be cross compared with the previously discussed need of having different types of public open spaces for Tsunami resilience. Accordingly, in order to enhance the use of Public open spaces to make coastal urban cities resilience Tsunamis, the concept of network of public open spaces can be used as a mode to facilitate different functions of Tsunami emergency response and recovery.

Mitigation

In addition to the use of public open spaces for emergency response and recovery, current literature point out the potential use of Public open spaces as a mitigation strategy.

To mitigate the risk of Tsunami, UNESCO (2015), propose that Tsunami mitigation strategies need to be formed using the land-use planning and regulation strategies. Further, they introduce a guideline presenting the necessity of setting up development setback line through the integration of Tsunami inundation modelling into land use planning. Further, National Tsunami Hazard Mitigation Program (2001), also emphasizes the use of

open spaces as an element to mitigate the Tsunami Risk. They introduce seven basic principles of planning and designing for Tsunami events. Out of these 7 principles, the second principle describes, that Tsunami hazard areas need to be allocated for open-space uses (National Tsunami Hazard Mitigation Program, 2001). However, most of these discussions, emphasize the need of acquiring Tsunami Hazard Areas for Open-Space Uses and confine the uses in conservation and preservation perspective.

Further, some of these arguments even suggest to use these open spaces for agriculture or scenic easement, but less consideration has been given on use of 'public open spaces'. Specially, in a coastal urban city where the land is a scarce resource, allocating open spaces only for the purpose of mitigation cannot be considered as the best practice. In this context, using preserved hazard areas for public open space uses of a city can be considered as a sustainable and practical solution. In supporting this view, Ardekani and Hosseini (2012), emphasize that development should be prevented in high-hazard areas wherever possible through land use regulations, nevertheless these preserved Tsunami hazard areas need to be used for open-space uses such as scenic amenity and recreational activities. However, this does not mean to promote an additional development in vulnerable areas, but it should be planned and designed to make the use of hazard-prone areas safer to the community and to get the highest and best use of the space in urban cities.

CONCLUSION

Above literature synthesis emphasizes that there is a significant potential of using Public open spaces to make coastal urban cities resilience to Tsunamis as a facilitator for emergency planning, as an agent of recovery and as an enabler for mitigation. However, most of the current studies identify the use of Public open spaces discretely in two places; 1) emergency management and recovery, 2) mitigation, but not as an interconnected system of a city. At the same time, as discussed before, the concept of public open spaces network can be potentially used for emergency response and recovery. Accordingly, amalgamating this strategy with mitigation strategy, a network of Public open spaces can be developed contributing to both emergency rescue, recovery and also to mitigation strategies. Development of this type of interconnected network of public open spaces can significantly contribute to create coastal urban cities resilience to Tsunamis.

In conclusion, this paper identifies current problems and issues, and suggest set of approaches which can be used to enhance the use of public open spaces to enhance the coastal urban cities' resilience to Tsunamis. Accordingly, these identified potentials, constrains and proposed strategies can be summarized as follows.

Potentials	Constrains	Proposed Strategies
• Emergency response and recovery – Gathering, Shelter, Distribution of goods and services	• Identification of open spaces without connecting everyday life of the cities	• Plan and design public open spaces to function well during both emergency and non-emergency times.
• The use of different typologies of Public open spaces for different functions of Tsunami resilience	• Result large quantities of unstructured open spaces contradicting to sustainable cites concept	• Develop an public Open Spaces Network contributing different functions of Tsunami resilience
• Tsunami hazard areas can be allocated for open-space uses	• Designation for the only purpose of conservation and preservation • Constrains in practical implementation to urban context	• Maximum utilization of Tsunami Hazard Prone areas for public open space uses rather than just keeping them for preservation and conservation
• Can significantly contribute to make coastal urban cities resilience to Tsunamis	• Identify the uses of Public Open spaces discretely without an interlink	• Development of Open Spaces Network which works as an interconnected system of the city

Figure 3- Summary of Discussion on current use of POS for Tsunami Resilience

Further, these initial findings will be critically evaluated at the next stage of the research where the researcher will incorporate the viewpoints of urban planners, coastal planners, disaster resilience experts and Tsunami effected communities on to these initial findings. Finally, the research findings will be used to develop a framework to plan and design public open spaces to enhance the coastal urban cities' resilience to Tsunamis.

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