INTERNATIONAL JOURNAL OF DISASTER RISK MANAGEMENT (IJDRM)

UDC: 614.8.069

ISSN (printed) 2620-2662
ISSN (online) 2620-2786

SCIENTIFIC-PROFESSIONAL SOCIETY FOR DISASTER RISK MANAGEMENT,
BELGRADE, THE REPUBLIC OF SERBIA

INTERNATIONAL JOURNAL OF DISASTER RISK MANAGEMENT (IJDRM)

Vol. 5 • № 1

Belgrade, 2023

PUBLISHER

Scientific-Professional Society for Disaster Risk Management
(https://upravljanje-rizicima.com/), Dimitrija Tucovića 121,
Belgrade, the Republic of Serbia with support International Institute for
Disaster Research, Belgrade.

E-mail: disaster.risk.management.serbia@gmail.com

Website - http://internationaljournalofdisasterriskmanagement.com/

EDITORIAL BOARD

Printed by
Neven, Belgrade

Ordering:
Scientific-Professional Society for Disaster Risk Management Belgrade
(https://upravljanje-rizicima.com/), Dimitrija Tucovića 121, Belgrade, Serbia

Fax/faks: +381 (0)1 425 77 94

E-mail: disaster.risk.management.serbia@gmail.com

PDF version of the journal

www.upravljanje-rizicima.com Published twice times a year

TABLE OF CONTENS

Santanu Baruah, Chandan Dey, Nandita Dutta, Manoj Kumar Phukan
Dima Hasao, Assam (India) Landslides' 2022: A Lesson Learnt 1

Mohammed M. A. El Mougher, Sabah A. M. Abu Sharekh, Mr. Ramzy F. Abu Ali, Ayed A. M. Zuhud
Risk Management of Gas Stations that Urban Expansion Crept into in the Gaza Strip 13

Faicel Tout
Flood policy in Algeria 27

Bojan Janković, Aleksandar Sakač, Igor Iričanin
Students' perception of police readiness to respond to disasters caused by a COVID-19 pandemic 39

Mst. Rajani Akter, Tuhin Roy, Rina Aktar
Challenges of Women in Post-disaster Health Management: A Study in Khulna District 51

Vladimir M. Cvetković, Saša Romanić, Hatidža Beriša
Religion Influence on Disaster Risk Reduction: A case study of Serbia 66

Ayesha Iftikhar, Jawed Iqbal
Factors Responsible for Urban Flooding in Karachi:A Case Study Of Dha 81

DOI: https://doi.org/10.18485/ijdrm.2023.5.1.1

Research article

DIMA HASAO, ASSAM (INDIA) LANDSLIDES' 2022: A LESSON LEARNT

Santanu Baruah[1,2*], Chandan Dey[1,2], Nandita Dutta[3], Manoj Kumar Phukan[1]

[1] CSIR-North East Institute of Science & Techanology, Jorhat - 785006, Assam, India; manojphukan06@gmail.com (M.P.)

[2] Academy of Scientific and Innovative Research (AcSIR), Ghaziabad - 201002, India; s.chandandey@gmail.com;

[3] Assam State Disaster Management Authority (ASDMA), Guwahati - 781005, Assam, India; nanditadutta7@gmail.com

* Correspondence: santanub27@gmail.com

Received: 7 May 2023; Accepted: 1 June 2023; Published: 30 June 2023

Abstract: During the monsoon season of 2022, the Dima Hasao district of Assam faced a series of landslides across multiple locations, resulting in significant damage to property and newly developed communication infrastructure. These landslides were caused by a combination of natural and anthropogenic factors. The region being host to one of the world's wettest monsoon belts and under tremendous tectonic stress with sedimentary geological formation is highly susceptible to landslides. In addition to these natural factors, the construction of communication infrastructure and roadways may have contributed to destabilizing the slopes and increasing the risk of landslides. Excavation activities for the expansion of highways and the conversion of railway tracks to broad-gauge may have altered the natural slope dynamics, exacerbating the severity of the landslides. This paper explores the causes and consequences of the landslides from an environmental determinism and possibilism perspective. It argues for the optimization of the neo-determinism fine line by identifying remedial countermeasures to prevent or minimize the impact of future landslides in the area. Effective communication and collaboration among the government, non-governmental organizations, community leaders, and the public are essential for reducing the risk of natural disasters and promoting sustainable development in landslide-prone regions. The identified countermeasures have practical implications for disaster management and planning in similar regions globally.

Keywords: Dima Hasao Landslides; Resilience; Neo-Determinism; NE India; Community awareness.

1. Introduction

Landslides, a major natural hazard, are triggered by the movement of a mass of rock, debris, or earth down a slope (Cruden, 1991). Intense rainfall, cloudburst, earthquake, storm waves, rapid stream erosion or other such stimuli, which increase or decrease shear stress in slope-forming materials, are typically responsible for landslides (Yao, Tham, & Dai, 2008). Human activities, predominantly in the form of deforestation or slope excavation for constructing roads and buildings etc., have become important landslide triggers as development expand into unstable hillslope areas (Li, Wang, & Mao, 2020).

Assam, a north-eastern (NE) state of India, is prone to different kinds of natural hazards. Flood, landslides, earthquakes are the common examples of such calamities that the people of Assam have witnessed since long (Singh, 2005). The geological settings & tectonic environment of the state are very complex that may contribute to some of the natural disasters (Baruah et al., 2021; Mitchell, 1993). From the geotechnical point of view, the state of Assam, especially whole Northeast India falls in seismic zone-V (Kayal, 2008). Assam is located in the path of tropical cyclones that affect the Bay of Bengal region, leading to heavy rainfall and floods. The state is also situated in one of the world's wettest monsoon belts, which makes it susceptible to flooding and landslides during the monsoon season.

In this paper, we attempt to highlight the probable triggers for the landslides and identified a few necessary and important remedial countermeasures to avoid of minimize the impact of future landslides. The vulnerability of Assam to natural disasters underscores the importance of having a robust disaster management system in place. The authorities ought to necessary measures to prevent disasters, including developing early warning systems, implementing infrastructure development plans, and conducting regular risk assessments. The authorities must also work closely with communities to develop community-based disaster management strategies that take into account the unique needs and vulnerabilities of different groups, including indigenous communities.

The region being host to one of the world's wettest monsoon belts and under tremendous tectonic stress with sedimentary geological formation is highly susceptible to landslides and exhibit the traits of environmental determinism. And at the same time, widespread developmental activities involving extensive slope excavation and deforestation indicate possibilism action. The large-scale mass wasting disaster is a combined result of both these actions and a case for optimizing the neo-determinism fine line is suggested.

2. Incident

The monsoon season of 2022 brought unprecedented rainfall to the Northeast region of India, particularly in the state of Assam. Cyclone Asani further intensified the rainfall, leading to catastrophic floods and landslides. The unrelenting rain poured down in two major episodes in May and June, each lasting over a week and including frequent torrential sessions, resulting in significant damage to the infrastructure and people's livelihoods. The Dima Hasao district of Assam was among the hardest-hit areas. A series of landslides occurred at multiple locations, triggered by a phase of continuous rain with frequent torrential outpour, directly affected 12 villages. The landslides killed at least three people and displacing nearly 57,000 residents from the district, according to the Assam State Disaster Management Authority (TWC, 2022). The magnitude of the devastation caused by the landslides and flooding was immense, with over 200 homes destroyed and 10321.44 hectares of cultivated land swamped in flooding (TWC, 2022).

The photographs shown in Figure 1A, B, and C captured the scale of devastation, with entire villages submerged in water and massive landslides burying homes and farmlands. The government, along with various non-governmental organizations and disaster relief agencies, worked tirelessly to provide emergency aid and assistance to those affected by the disaster.

3. Aftermath and Causes

Dima Hasao is a spectacular hilly district under the Assam state of India and also known as the "Mini Switzerland of Northeast India". The district is famous for scenic beauty, heritage railway tracks, mountains, ancient monuments, clouds and rains. To rejoice the spectacle, a vista dome train to Haflong from Guwahati was also launched recently. By virtue of its geographical location, it is considered as the fulcrum between the Brahmaputra and Barak valleys. Jatinga, a small village located near Haflong, is a famous tourist attraction for the mysterious phenomenon of birds committing suicide during the end of monsoon. Several development projects have been implemented in the region and a few are still in the progress. However, the catastrophic landslides, which transpired suddenly, caused heavy damage to all the major development projects (Talukdar, 2022). These projects were supposed to benefit the people living in the region, but they were instead victims of the disaster. The district was cut off from the rest of the state for several days, with multiple segments of roads collapsed, railway tracks washed away, and a few important bridges drifted away (Talukdar, 2022). Many remote villages remained cut off completely as there were no means of contacting the people because of landslides coupled with electricity and internet outage. Most of the areas under the brunt were along slopes concomitant with anthropogenic activities and establishments, most of which are communication infrastructures. It is the worst such disaster according to the witnessing populace and a number of cause and reasons are speculated, ranging between different parcels and facets of natural and anthropogenic circumstances.

Tectonically, the umbrella effect of the complex geodynamic configuration of NE India (Dey et al., 2021) is also ubiquitous in the Dima Hasao district which host segments of the Kopili Fault, Dauki Fault and the Naga Thrust (Fig 2A). All the three lineaments are seismically very active and play an intrinsic role in characterizing the tectonic configuration of NE India. The region is part of the foreland basin of the Indo-Burma Subduction Zone. Consequently, the district is hit by at least 13 earthquakes since 1950 (ISC, 2022), with the magnitude (M_b) range of 3 to 6. (Fig. 2A). Geologically, the region comprises of tertiary and quaternary sedimentary rocks, mainly sandstone, belonging to Barail, Surma, Tipam and Dihing Group. The sedimentary formation of Dima Hasao region under the influence of tectonic manifestation coupled with high intensity of rain is extremely prone to mudflow and landslides.

With respect to the recent landslides, the region along the recently constructed/renovated communication network between Maibong and Ditokcherra of Dima Hasao was the worst affected (Fig. 2B). Several cases of landslides sweeping away highways were reported from this transect (Fig 1B).

Fig 1A: Specimen photographs capturing devastation caused by rain and landslides at the New Haflong railway station (Source: ASDMA).

Fig 1B: Specimen photographs of eroded section of highway along the Maibong and Ditokcherra stretch (Sources ASDMA).

Fig 1C: Specimen photographs of eroded section of railway line along the Maibong and Ditokcherra stretch (Sources: ASDMA).

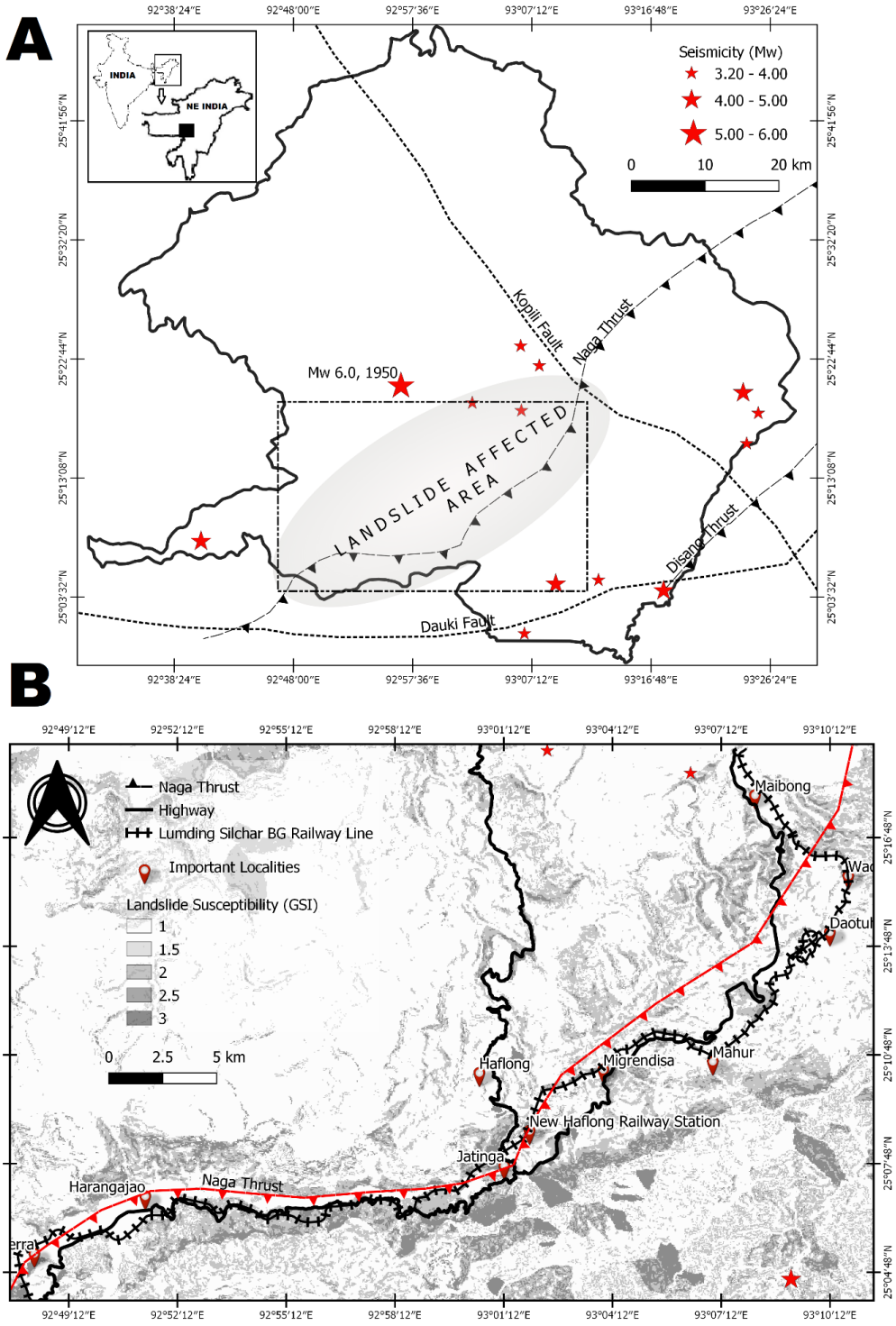

Fig 2: A. Map showing the Dima Hasao district of Assam along with the major tectonic features and seismicity (ISC, 2022). The oval shaded area is severely affected by the episode of landslides and the dotted rectangle represents the area shown in map B. Inset map in top left corner showing the study area from the perspective of India and NE India. **B.** Map showing the highway and railway communication network along with the Naga Thrust and locations of severe devastations. Landslide susceptibility (GSI) is also shown with 3 and 1 indicating extremely high and low susceptibility, respectively.

Subgrade foundation of railway track was washed away at multiple locations due to landslide (Fig 1C). At Daotuhaja, several meters of rails fastened to sleepers laid hanging on the

air as the subgrade underneath was eroded (Fig 1C). The New Haflong Railway Station was dumped under debris and the nature of mud flow was so intense that a train was derailed (Fig 1A). Several road and railway tunnels along the transect were blocked by mud debris. The highway, part of east west corridor of India, and the railway, connecting important NE states of India, along the said stretch lie very close to the Naga Thrust. The Jatinga and the Mahur river, flowing near parallel with the Naga Thrust, was responsible for mudflow and floods along with the landslides. The communication network between Maibong and Ditokcherra, as shown in Fig 2B, occur along patches of high landslide susceptibility. About 15 km stretch of near parallel highway and railway line from Jatinga to Harangajao consistently run through high landslide susceptible zones. The same stretch also lies very close and follows the trend of the Naga Thrust. Besides, the railway line from Jatinga to Migrendisa and Harangajao to Bandarkhal run very close following the trend of the Naga Thrust. Therefore, it is observed that the pattern and distribution of severe landslide localities follow a close trend with respect to the Naga Thrust.

The Naga Thrust, characterized by the Indo-Burma Subduction Zone, is a major crustal dislocation zone and marked by very high rate of erosional activities (Gupta, 2006). The landslide and mass wasting potential is also evident from clustering of high landslide susceptibility zones (GSI, 2022) along the thrust. Both the railway and highway connectivity through the region was recently overhauled, with the two-lane highway receiving an expansion of four lane and the meter gauge railway track converted to broad-gauge.

4. Countermeasures

The causes of the series of landslides in the Dima Hasao district could be attributed to a combination of natural and anthropogenic factors. It is apparent that a combination of natural and human-induced factors have played a role in the series of landslides that have caused significant damage and disruption in the district. Studying both the natural and anthropogenic scenarios, the following countermeasures are identified for holistic application towards avoiding or minimizing the impact of future landslides:

I. Landslide Hazard Mapping and Zonation

Landslide hazard mapping and zonation can be a helpful tool to identify high-risk areas for landslides. The identification of these areas could help to inform land-use planning and disaster risk reduction measures. Landslides are more likely to occur on slopes greater than 30 degrees and in areas with high rainfall intensity (Dai, Lee, & Wang, 2003). Studies have shown that combining geospatial techniques with field-based observations and inculcation of neural network models can improve the accuracy of landslide hazard mapping (Aditian, Kubota, & Shinohara, 2018). The mapping process typically involve collection of different types of data, including topographic, geological, and rainfall data. The data should then be analyzed using various techniques, such as the Analytical Hierarchy Process (AHP), to identify and rank the different landslide hazard factors (Pourghasemi, Pradhan, & Gokceoglu, 2012). The landslide hazard maps can identify the areas that are most susceptible to landslides, helping local authorities and emergency responders to develop appropriate measures for disaster risk reduction. The maps produced can be used for land-use planning and decision-making by local authorities and developers. Moreover, updating and refining landslide hazard maps regularly is essential to account for changes in the landscape, such as new land-use practices or climate-induced changes, which may affect the stability of slopes (Huabin, Gangjun, Weiya, & Gonghui, 2005).

II. Slope Stabilization

Slope stabilization is a crucial countermeasure to reduce landslide risk. One way to stabilize slopes is by using vegetation. Plant roots can help to bind soil particles together, thus reducing the chances of soil erosion and landslides. A study conducted in the hills of Uttarakhand found that slope stabilization through soil-specific holistic vegetation can significantly reduce landslide risk (Vasistha, Rawat, & Soni, 2011). Engineering interventions towards slope stabilization include retaining walls, soil nailing, rock bolting, and shotcrete. For example, soil nailing involves the insertion of steel reinforcement bars into the ground, which are then grouted with concrete to create a stable slope. Similarly, rock bolting involves the use of steel bolts to anchor rocks to the ground, thereby reducing the chances of rockfall. These techniques have been successfully implemented in various landslide-prone regions around the world, including in India (Pradhan & Siddique, 2020). Controlled blasting can be used to remove loose soil and rocks from slopes, reducing the risk of landslides. However, it should be carried out under expert supervision to avoid any adverse effects on the slope stability.

III. Drainage System

Drainage systems play a crucial role in mitigating the risk of landslides as they help to control the excess water that can trigger slope failures. Surface water can saturate the soil, making it more prone to erosion and landslides. Therefore, proper drainage systems should be developed to remove surface water from slopes. In a study conducted in Nepal, it was found that poor drainage was a significant cause of landslides (Ghimire, 2011). In Dima Hasao, it is essential to develop a drainage system that can handle heavy rainfall and prevent the accumulation of water on steep slopes. The construction of surface drains, culverts, and catchment basins can help in the effective management of water on the slopes. In addition, it is crucial to ensure that the drainage systems are properly maintained and cleaned regularly to ensure their optimal functioning.

IV. Early Warning System

Early warning systems (EWS) play a crucial role in mitigating the damage caused by landslides by providing timely alerts to communities at risk. Research has shown that effective early warning systems can significantly reduce the impact of landslides and save lives (Guzzetti, Peruccacci, Rossi, & Stark, 2008). The early warning system for landslides is typically based on rainfall thresholds, which are established based on the geological and climatic conditions of a particular region. In Dima Hasao, the development of an effective early warning system is crucial due to the high susceptibility of the region to landslides. The system should incorporate the use of modern technologies such as sensors, remote sensing, and communication systems to provide timely alerts to the affected communities and authorities. The integration of indigenous knowledge and community participation in the development and implementation of the early warning system can also enhance its effectiveness and sustainability (Alessa et al., 2016).

V. Building Codes and Regulations

Building codes and regulations play a crucial role in reducing the risk of landslides in hilly regions like Dima Hasao. The codes and regulations ensure that buildings are designed and constructed in a manner that can withstand the forces of nature, including landslides. Proper building codes and regulations also prevent the construction of buildings in vulnerable areas, such as steep slopes and unstable terrains, which can increase the risk of landslides. A study conducted by the United Nations Development Programme suggests that enforcing

building codes and regulations can significantly reduce the risk of landslides in hilly regions like Northeast India (ADRC 2015). In a study conducted in the Himalayas, it was found that the implementation of building codes and regulations reduced landslide risk significantly (Vaidya et al., 2019).

5. Community Awareness and Preparedness

Community awareness and preparedness play a crucial role in mitigating the impact of landslides. The community members living in landslide-prone areas should be informed about the risk of landslides and how to respond to such situations. This information can be disseminated through various channels such as community meetings, awareness campaigns, and the use of social media platforms. The community should also be educated on the importance of complying with building codes and regulations to ensure that their homes and infrastructure are constructed in a manner that reduces the risk of landslides. Moreover, community members can play a significant role in monitoring and reporting potential landslide hazards. They should be encouraged to report any signs of instability, such as cracks in the ground or tilting of trees, to the authorities. This early warning can allow authorities to take appropriate action before a landslide occurs. The success of community awareness and preparedness efforts depends on the involvement of various stakeholders, including the government, non-governmental organizations, and community leaders. These stakeholders should work together to design and implement effective programs that address the unique needs of each community. By working together, we can create a culture of safety and resilience that helps to reduce the impact of landslides on communities.

Besides, the unique topography and natural beauty of Dima Hasao have made it a preferred location for tourism in the recent days. Consequently, there is a rapid increase in population growth and urbanization which has put pressure on the environment. Existing regulations may not be enough, as inappropriate and non-contextual urban development are observed in the district, highlighting the need for better implementation of building codes and provisions. Inculcation of building codes and provisions are necessary to mitigate the impact of landslides. Building codes should be updated to include provisions that address the risks associated with landslides. For example, homes and infrastructure should be built on stable ground and reinforced to withstand potential landslides. The community should also be educated on the importance of complying with building codes and regulations to ensure that their homes and infrastructure are constructed in a manner that reduces the risk of landslides.

6. Conclusion

A variety of perspectives prevail which debates phenomena involving natural disasters, such as landslide, from the subjugator purview of nature and/or human. The concept of 'environmental determinism' upholds the influence of nature over human and its activities and treats human subordinate to nature, and the concept of 'environmental possibilism' regard human as a geographic agent who modifies the environment according to needs such that the nature eventually gets humanised and starts bearing the imprints of human endeavour (Lewthwaite, 1966). The 'neo-determinism' idea dwells between the determinism and possibilism concepts and dismisses the situation and condition for both absolute necessity and absolute freedom (Lewthwaite, 1966).

The Dima Hasao situation presents a classical scenario for optimizing the neo-determinism fine line for co-existence between determinism bearings produced by the tectonic and geographic dispensation and the possibilism approach to develop and tame the harsh topography of the region. The neo-determinism fine line can be attained by considering all the parameters influencing the determinism force of nature. All the counter measures identified in this paper attempts to address the core parameters towards adopting the neo-determinism approach.

The developmental initiatives are essential for progressive upliftment of a society. However, adequate measures should be adopted collectively to constrain the ill determinism bearings of the nature as a result of such actions. The Dima Hasao tragedy has taught a lesson and should be considered as a case study for evaluating the additional local parameters and devising site specific scientific and engineering solutions. There needs to be a complete safety and environmental review of all development projects for a region like NE which is seismically very active. It is essential that this disastrous course should be reversed without delay. Otherwise, similar disasters are bound to happen in the future.

Declarations

Availability of data and materials: The data used in this study can be directly accessible by sending a request to the Director, CSIR-North East Institute of Science and Technology, Jorhat-6, Assam, India at director@neist.res.in.

Competing interests: The authors declare that they have no competing interests

Funding: No funding received from any sources for this work.

Authors' contributions: All authors contributed to the study conception and design. Material preparation and analysis were performed by S.B. and C.D. Data collection are performed by N.D. and M.K.P. The figures are prepared by C.D. The MS is written by C.D. and S.B. All authors commented and checked the manuscript for any mistakes. All authors read and approved the final manuscript before submission.

Acknowledgements: We thank Dr. G. Narahari Sastry, Director, CSIR-North East Institute of Science and Technology (CSIR-NEIST), Jorhat, Assam, India for his kind support and guidance in carrying out this work.

References

Aditian, A., Kubota, T., & Shinohara, Y. (2018). Comparison of GIS-based landslide susceptibility models using frequency ratio, logistic regression, and artificial neural network in a tertiary region of Ambon, Indonesia. *Geomorphology*, *318*, 101–111.

Alessa, L., Kliskey, A., Gamble, J., Fidel, M., Beaujean, G., & Gosz, J. (2016). The role of Indigenous science and local knowledge in integrated observing systems: moving toward adaptive capacity indices and early warning systems. *Sustainability Science*, *11*, 91–102.

Baruah, S., Sharma, A., Dey, C., Saikia, S., Boruah, G. K., Eluyemi, A. A., … Sailo, S. (2021). Correlation between crustal anisotropy and seismogenic stress field beneath Shillong–Mikir Plateau and its vicinity in North East India. *Geomatics, Natural Hazards and Risk*, *12*(1), 2070–2086.

Center, A. D. R. (2015). Sendai framework for disaster risk reduction 2015–2030. *United Nations Office for Disaster Risk Reduction: Geneva, Switzerland*.

Cruden, D. M. (1991). A simple definition of a landslide. *Bulletin of the International Association of Engineering Geology-Bulletin de l'Association Internationale de Géologie de l'Ingénieur*, *43*(1), 27–29.

Dai, F. C., Lee, C. F., & Wang, S. J. (2003). Characterization of rainfall-induced landslides. *International Journal of Remote Sensing*, *24*(23), 4817–4834.

Dey, C., Baruah, S., Choudhury, B. K., Chetia, T., Saikia, S., Sharma, A., & Phukan, M. K. (2021). Living with Earthquakes: Educating masses through earthquake awareness: North East (NE) India perspective. *Annals of Geophysics*, *64*(3).

Ghimire, M. (2011). Landslide occurrence and its relation with terrain factors in the Siwalik Hills, Nepal: case study of susceptibility assessment in three basins. *Natural Hazards*, *56*(1), 299–320.

GSI. (2022). *National Landslide Susceptibility Mapping, Assam Susceptibility*.

Gupta, I. D. (2006). Delineation of probable seismic sources in India and neighbourhood by a comprehensive analysis of seismotectonic characteristics of the region. *Soil Dynamics and Earthquake Engineering*, *26*(8), 766–790.

Guzzetti, F., Peruccacci, S., Rossi, M., & Stark, C. P. (2008). The rainfall intensity–duration control of shallow landslides and debris flows: an update. *Landslides*, *5*, 3–17.

Huabin, W., Gangjun, L., Weiya, X., & Gonghui, W. (2005). GIS-based landslide hazard assessment: an overview. *Progress in Physical Geography*, *29*(4), 548–567.

ISC. (2022). International Seismological Centre 2022, On-line Bulletin. https://doi.org/https://doi.org/10.31905/D808B830

Kayal, J. R. (2008). *Microearthquake seismology and seismotectonics of South Asia*. Springer Science & Business Media.

Lewthwaite, G. R. (1966). Environmentalism and determinism: A search for clarification. *Annals of the Association of American Geographers*, *56*(1), 1–23.

Li, Y., Wang, X., & Mao, H. (2020). Influence of human activity on landslide susceptibility development in the Three Gorges area. *Natural Hazards*, *104*(3), 2115–2151.

Mitchell, A. H. G. (1993). Cretaceous–Cenozoic tectonic events in the western Myanmar (Burma)–Assam region. *Journal of the Geological Society*, *150*(6), 1089–1102.

Pourghasemi, H. R., Pradhan, B., & Gokceoglu, C. (2012). Application of fuzzy logic and analytical hierarchy process (AHP) to landslide susceptibility mapping at Haraz watershed, Iran. *Natural Hazards*, *63*, 965–996.

Pradhan, S. P., & Siddique, T. (2020). Stability assessment of landslide-prone road cut rock slopes in Himalayan terrain: a finite element method based approach. *Journal of Rock Mechanics and Geotechnical Engineering*, *12*(1), 59–73.

Singh, T. (2005). Impact of earthquake disasters on new urbanization pattern in north eastern region of India. *Journal of Environmental Systems*, *32*(1).

Talukdar, S. (2022). Dima Hasao Tragedy: Climate Change, Policy Faults and Govt Apathy to Blame. *Newsclick*. Retrieved from https://www.newsclick.in/dima-hasao-tragedy-climate-change-policy-fault-govt-apathy-blame

TWC. (2022). Northeast India Braces for Very Heavy to Extremely Heavy Rainfall from May 16-20; Assam, Meghalaya, Arunachal on Alert. *The Weather Channel*. Retrieved from https://weather.com/en-IN/india/news/news/2022-05-16-very-heavy-rains-to-seize-assam-meghalaya-arunachal-and-sikkim

Vaidya, R. A., Shrestha, M. S., Nasab, N., Gurung, D. R., Kozo, N., Pradhan, N. S., & Wasson, R. J. (2019). Disaster risk reduction and building resilience in the Hindu Kush Himalaya.

The Hindu Kush Himalaya Assessment: Mountains, Climate Change, Sustainability and People, 389–419.

Vasistha, H. B., Rawat, A., & Soni, P. (2011). Hazards mitigation through application of bio-engineering measures in landslide areas. *Disaster and Development*, *5*, 37–52.

Yao, X., Tham, L. G., & Dai, F. C. (2008). Landslide susceptibility mapping based on support vector machine: a case study on natural slopes of Hong Kong, China. *Geomorphology*, *101*(4), 572–582.

DOI:https://doi.org/10.18485/ijdrm.2023.5.1.2

Research article

RISK MANAGEMENT OF GAS STATIONS THAT URBAN EXPANSION CREPT INTO IN THE GAZA STRIP.

Dr. Eng Mohammed M. A. El Mougher [1*], Dr. Sabah A. M. Abu Sharekh[2], Mr. Ramzy F. Abu Ali[3], Dr. Eng. Ayed A. M. Zuhud

[1] Palestine University, Program of Crisis and Disaster Management- IUG, Palestine, Director, Security and Safety Management, General Directorate of Palestinian Civil Defence, Gaza.

[2] Al-Batana University, Researcher in Crisis and Disaster Management, Ministry of Education of Gaza.

[3] Researcher in Crisis and Disaster Management IUG- Palestine

[4] Cairo University, Lecturer in Faculty of Engineering Palestine University.

* Correspondence: arch.moh.elmougher@gmail.com

Received: 8 May 2023; Accepted: 5 June 2023; Published: 30 June 2023

Abstract: The study aimed to understand and analyze the risks of indiscriminate urbanization around gas stations, the mechanisms for mitigating risks that affect buildings, and the most important risks affecting the surrounding area. The study followed a descriptive and analytical approach using chemical analysis software (ALOHA) to achieve the study objectives. The study found various risks and problems that threaten the community's safety and security in the Gaza Strip, and the presence of multiple factors that affect the safety system, especially the isolation of tanks that are exposed to the risk of ignition or explosion. It also concluded that the radius of the leakage, ignition, or explosion risks varies depending on the tank size, weather conditions, and the surrounding building density. The study recommended to narrow the gap between science and practical application in the field of safety and security, and also to work on correcting the conditions of gas stations to cohere with the protection of the internal front from accidents and risks of hazardous, flammable, or explosive chemicals.

Keywords: LPG Stations, Facility Correction, Risk Management, Chemical Analysis, Urbanization.

1. General framework

1.1 Introduction

The science of Risk management is considered one of the modern sciences that government institutions and international bodies are interested in; through developing guidelines, regulations, and legislation that strengthen the safety system, prevent risks, and reduce their effects. The United Nations has shown a keen interest in establishing scientific evidence that enhances the resilience of cities to withstand greater risks through urban planning, which sequentially improves infrastructure resilience and the sustainability of human activities, and that urban agglomerations must bear the risks and their resulting threats, analyze them, and develop control mechanisms and policies to reduce their level (UNDRR, 2017).

The Gaza Strip is characterized by its small area of 365 km^2, with more than 2.25 million inhabitants, making it the most densely populated area in the world. It is bordered to the east and north by the occupied Palestinian territories, to the south by the Arab Republic of Egypt, and to the west by the Mediterranean Sea (Awad, 2020). The Gaza Strip suffers from risks that threatens the urban environment and human gatherings due to the Israeli blockade of Palestinian society. The challenges of urban development related to the scarcity of land are the biggest threat to stability and balance, followed by encroachments on land uses by citizens (El-Mougher, 2016), which resulted in problems impacting the distribution of hazardous crafts and facilities, thus increasing the rates of risks that threaten the environment of the Gaza Strip.

The gas stations scattered throughout the Gaza Strip pose a threat due to various factors and associated problems, especially given the political, social, and economic vulnerabilities that make the Gaza Strip a place where expired gas tanks are assembled. Additionally, there is a prohibition on the entry of new and modern tanks to the Gaza Strip, along with a decline in both public safety indicators and the provision of preventive measures.

1.2 Study Problem

Land scarcity and high population density in the Gaza Strip represent a clear challenge, especially in the light of the indiscriminate urbanization that has increased the risks stemming from economic, social, and political vulnerability and the consequent increase in the level of hazard associated with the presence of gas stations in overcrowded residential areas. Based on the nature of the researchers' work and their direct observation of the regulatory violations of the safety distances between gas stations and residential facilities or the safety distances between fuel and gas stations, the following main question arose:

What are the risk management mechanisms for gas stations affected by urban expansion?

The following questions have been raised:

- What are the risks associated with gas stations?
- What are the risks of urbanization on gas stations?
- How to control the risks of urbanization around gas stations?

1.3 Objectives of the study:

The study aimed to understand and analyze the risks of indiscriminate urbanization around gas stations, the mechanisms for mitigating risks that affect buildings, and the most important risks affecting the surrounding area. Hence, the following objectives were derived:

– Identify the risks of liquefied household gas-filling stations.

- Analyze the risks of urbanization around gas-filling stations.
- Assessing the risk control of urbanization around LPG filling stations and mechanisms to minimize the proximity of residential buildings to them.

1.4 Importance of the study:

- The study contributes to solutions development to existing and accumulated problems at gas stations.
- Assists decision-makers in taking necessary measures to mitigate risks.
- Enhances the researchers' skill in dealing with risks associated with hazardous facilities, which reflects on improving their performance.

1.5 Study Methodology:

The researchers used the descriptive approach to describe the gas stations, their quantity, and the problems they face. They also used the analytical approach by using chemical beam programs to analyze potential accidents, and the constructive approach to develop mechanisms and a design model to mitigate the risks of gas stations deployed in residential areas.

1.6 Study Boundaries:

1.6.1 Spatial Boundaries: *Gaza's 365 km² area, which is characterized by high population and urban density.*

1.6.2 Objective Boundaries: *gas stations, hazardous chemicals, regulations and legislation, chemical analysis programs.*

1.6.3 Time Boundaries: *The time period extends from 2020 to date.*

1.7 Previous studies:

1.7.1 (El-Mougher, 2019) study, titled: Indicators for Risk Assessment and Management in Industrial Enterprises in Gaza Strip.

The study aimed to reach standards and indicators for risk management in industrial enterprises and to link problem-solving with risk management in industrial enterprises, depending on risk assessment and management indicators. The study used the descriptive and analytical approach to local standards for risk assessment and management. It found weak reliance on clear indicators in risk assessment and management, a lack of employers' interest in risk assessment and analysis, a lack of methodological evidence adopted to analyze and assess risks in enterprises that put them at risk and a weak response. The study recommended activating scientific research in the field of risk management, raising the level of training and sensitization of workers on the importance of safety and risk prevention, preparing an annual risk assessment for enterprises, and dividing risk management procedures into an exploratory assessment of risks, remedial measures that enhance risk prevention, and corrective measures that correct the risks in industrial enterprises.

1.7.2 (Beheshti, Dehghan, Hajizadeh, Jafari, and Koohpaei, 2018) study, titled: Modelling the Consequences of Explosion, Fire and Gas Leakage in Domestic Cylinders Containing LPG.

The study aimed to model the effects of LPG leakage from domestic cylindrical containers. It used the descriptive and analytical approach to describe the factors affecting LPG leakage in cylinders of the following volumes (26, 60, 78, and 107 liters). The ALOHA program was used to analyze leakage pathways and events resulting from ignition and explosion. The study found that a leaking cylinder of the studied volumes had a gas concentration of 33,000 ppm in a radius of up to 11 meters around the cylinder, which poses a risk of death and a direct threat to people's lives. Meanwhile, the gas concentration at a distance of 11-16 meters was about 21,000 ppm, which is equivalent to a low explosive level, leading to the combustion and explosion of the gas vapor cloud, which poses a threat to people in a radius of 15 meters. The study recommended that accident response plans should be based on a chemical analysis of leakage risks and work to reduce the adverse effects of the spread of gas vapor clouds or hazardous substances to protect people.

1.7.3 (Bariha, Mishra, & Srivastava, 2016), titled: Fire and explosion hazard analysis during surface transport of liquefied petroleum gas (LPG): A case study of LPG truck tanker accident in Kannur, Kerala, India.

The study aimed to simulate a collision accident between a truck tanker and a barrier that caused a crack in the bottom pipe, resulting in gas leakage for 20 minutes, forming a large vapor cloud in Kannur, Kerala state, India. The study used the descriptive and analytical approach to describe the scope of impact, ignition and explosion risks resulting from the vapor cloud, using the PHAST program and case study methodology for the actual incident that occurred and caused severe damage. The study concluded that the leakage resulted in a fireball and a boiling liquid expanding vapor explosion (BLEVE) in the tank, which caused a fire followed by an explosion, and the incident resulted in fatalities, injuries, as well as ignition of trees, houses, vehicles, and surrounding stores. The results of the analysis, modeling, and simulation of the fireball, jet flame radiation, and overpressure leading to the explosion were consistent, and an area with a radius of approximately 200 meters was severely affected, which is consistent with the actual loss of lives and property verified from ground data.

1.7.4 Commentary on the previous studies:

The previous studies have focused on examining the risks associated with domestic gas containers with a capacity of up to 107 liters, studying indicators of industrial enterprise risk assessment, and holding risk assessments using computerized programs of a roadway gas tank with a leakage followed by ignition and then an explosion. However, the current study works on developing mechanisms to deal with gas stations scattered in urban agglomerations and how to reduce the risks and damages which affect the urban environment. This study is characterized by providing a set of solutions to minimize risks at gas stations scattered among the population, given the multiple factors affecting urban change and land use in the Gaza Strip. Therefore, it can cover a research gap.

2. Theoretical framework

A hazard is a phenomenon, substance, or condition which is capable of damaging the infrastructure, services, community, property, natural environment, or surrounding environment; (UNESCO 2016) Sources of risk vary between human activity or dangerous conditions that can cause severe loss of life or health impacts that harm property, interrupt livelihoods

or disrupt social and economic services and environmental damage (LPG Bottling Plant & BPCL Kappalur, 2017). The risks are the combination of the likelihood of occurrence and the effects of such occurrence with the potential to adversely affect activities, production objectives and work in the enterprise (Zhao et. al., 2017).

2.1 Risk Management:

Risk management is characterized by integrated processes that contribute to the development and improvement of the ability of institutions, departments, organizations, companies, factories, or enterprises to understand risk, its dimensions, the most important sources of risk, and the assessment of those risks, their resulting actions, levels of impact and expected damage to the surrounding environment, as well as assessing human, property and working environment vulnerability to damage affecting work streams and procedures to establish comprehensible mechanisms for managing and controlling their sources and limiting their impact on their surroundings.

2.1.1 Risk management methodology

To implement the practical methodology to start identifying the risks that threaten the enterprise, institution, or project, is done through a range of executive processes: (General Department of Planning and Development, 2020)

- Adopting practical tools used to identify risks.
- Adapting the tools to the environment, conditions and variables affecting the emergence and expansion of risks.
- Collecting information and data according to the approved tools, analyzing the information and identifying the risks.
- Building expected scenarios according to:
    - The worst-case scenario that can stop the normal activity.
    - The best-case scenario that aligns with risk avoidance.
    - The realistic scenario that chimes with the ability of hazard sources to influence the community's life cycle.
- Choosing the best alternative in the proposed scenarios, especially to mitigate the expected damages.
- Developing risk control and management plans, and assign tasks and responsibilities to stakeholders.
- Integrating risk response or mitigation plans with civil defence plans.

2.2 Liquefied petroleum gas (LPG)

LPG is a mixture of propane and butane with a quantity of hydrogen sulfide added to give a distinctive smell. It is classified as flammable gas and lies in category II by NFPA, UN, and the Globally Harmonized System for Hazardous Materials (GHS). LPG is a pressurized gas that goes through cooling processes to be transformed into a liquid state within containers. When LPG is released from its containers, it spreads in low-lying areas because it is heavier than air, which makes it hazardous when ignited and can affect people and property.

2.2.1 Hazardous Properties of LPG

2.2.1.1 The boiling point for LPG: is - 161.48 to - 0.5 °C. The boiling point is defined as the temperature at which the substance changes from liquid to gaseous state during each part of the liquid.

2.2.1.2 The flash point of LPG is - 104 to - 60 °C, where the flash point is defined as the lowest temperature at which LPG can form a flammable mixture with air in the presence of a source of ignition.

2.2.1.3 Lower ignition or explosion limit: It forms a risk of explosion or ignition at a minimum mixing rate of 1.8% with atmospheric.

2.2.1.4 The upper limit of ignition or explosion: It constitutes a risk of explosion or ignition at a maximum mixing rate of 9.5% with atmospheric air for the occurrence of ignition or explosion. If the percent exceeds this limit, then the mixture of gas and air is very rich in gas and the amount of oxygen in the air is insufficient for the occurrence of ignition or explosion.

2.2.1.5 Self-ignition temperature: LPG ignites at pressure (1.013) Bar and at temperatures (287-537 °C).

2.3 The explosion chemistry of LPG: (Wasel, 2010)

2.3.1 Propane:

$$C_3H_8\ (g) + 5\ O_2(g) \xrightarrow{\text{flame}} 3CO_2 + 4\ H_2O + E$$
$$44\ \text{gram} + 160\ \text{gram}$$

- (1)liter of propane gas needs (5) liter oxygen for explosion.
- Oxygen gas represents 20% of atmospheric air = one fifth of atmospheric air.
- (1) liters of propane gas need (5 * 5 = 25) liters of atmospheric air in pressure (1) bar for explosion.

2.3.2 البيوتان

2.3.2 Butane

$$2C_4H_{10}\ (g) + 13\ O_2(g) \xrightarrow{\text{flame}} 8CO_2 + 10\ H_2O + E$$
$$58\ \text{gram} + 230\ \text{gram}$$

- (2) liters of butane gas need (13) liters of oxygen for the explosion to occur.
- Oxygen gas represents 20% of atmospheric air = one fifth of atmospheric air.
- (2) liters of butane gas need (13 * 5 = 65) liters of atmospheric air in pressure (1) bar for explosion.

3. Practical framework and study tools:

To achieve the study's objectives, researchers followed a descriptive and analytical approach and a case study methodology for applying clear mechanisms to reduce the risk of LPG stations to urban agglomerations in the Gaza Strip, where the study analyzed the content of reports and made chemical analysis through chemical package programs.

3.1 The Reality of Gas Stations in the Gaza Strip:

Successive Governments in the Gaza Strip have worked to regulate the issuance of licenses for gas stations in the Gaza Strip since the establishment of the Palestinian Authority until the present time. Due to urban expansion, the vulnerable state of society, high land prices, and the decline in the application of local authorities' regulations due to economic and social vulnerabilities, all of which have led to many violations of the system for establishing gas stations issued by the Central Committee for Buildings and Urban Planning in 2006 and the regulations for safety conditions, protection, fire prevention, firefighting equipment and alarms specification that must be available in gas-filling stations, transport and distribution vehicles, and storage locations for liquefied petroleum gas cylinders issued in 2000 as one of the explanatory regulations of Civil Defence Law No. (3) of 1998 have emerged.

To achieve the objectives of the study, researchers analyzed the reports of the Central Committee for Buildings and Urban Planning as well as those of the Committee for Correction of Hazardous Facilities and Crafts. These reports indicated that competent government committees conducted field visits to gas stations and took decisions to either close the stations or halt operations.

The Central Committee for Buildings and Urban Planning established a system that outlines the regulatory requirements for gas stations in the Gaza Strip. However, this system did not consider the maximum limit for gas stations' capacity, daily operational capacity, or storage capacity that considers the relationship with the supplying entities, the closure of border crossings, and their impact on administrative and societal components. Moreover, the application of the system did not enforce citizens to refrain from expanding urbanization around gas stations, leading to an increase in hazards that affect urban and architectural development. Currently, the number of gas stations in the Gaza Strip is (51), distributed as follows: (5) gas stations in Rafah, one of which was closed for violating safety requirements; (7) gas stations in Khan Younis, one of which experienced a fire followed by an explosion and remains closed to this day; (14) gas stations in middle Governorate, one of which was moved for violating requirements; (16) gas stations in Gaza Governorate, one of which was closed due to the high urban density surrounding it; and (9) gas stations in the northern governorate, of which two were ordered to be moved for violating regulatory requirements.

Additionally, there are many gas stations that have construction permits but have not been completed due to the economic conditions experienced by the local community and the difficulty in providing the necessary extensions for installations and tanks, which impedes the establishment and development of gas stations to overcome the deterioration of equipment and tools.

3.1.2 Station violations to the system or regulation of safety and fire prevention requirements:

As a result of the multiple violations, and through field visits conducted by the researchers, they classified the violations as follows: (Committee for Correction of Hazardous Facilities and Crafts, 2021)

- **Regulatory problems:** These are related to the specific dimensions of the station, its location, or land-use requirements, and it violates the 2006 gas-filling system in the Gaza Strip, thus the station needs to change its location according to the system.
- **Urban Safety Problems:** These are related to violations of the dimensions and distances specified by the Civil Defence regulations, which require a distance of 100 meters between fuel and gas stations. These problems require a review of the corrective measures of these stations.

- **Tank-related Problems:** They are concerned with the nature of gas containers, and with modifying and welding them without proper heat treatment. All the international codes require the removal of tanks that have been modified from service and convert their use as fuel tanks. Moreover, these tanks have exceeded their expected lifespan, which is estimated at 20-25 years according to the specifications of each country, especially since the occupation prevents the entry of new tanks while allowing the entry of terminated tanks, or ones with rust and corrosion. In addition, to the lack of ability to conduct periodic technical inspections.
- **Problems related to the specifications of pumps and pipelines:** the occupation tightened its suffocating siege on the Gaza Strip, which contributed to the failure to provide pumps that comply with international standards and specifications. This has consequently led to the use of filling and discharge pumps that violate regulations and standards, as well as gas pipelines that extend from tanks to the filling points that do not conform to Palestinian standards and specifications, thereby using water pipelines that are not designed to withstand gas pressure or maintain their liquid state.
- **Problems related to the stored quantities:** it has been noticed that most of the stations violate the storage categories and maximum capacity specified for them according to the station construction system. There are stations whose capacity is classified as 50 tons, but they are storing quantities that exceed 100 tons, and there is a case of a station that has reached a capacity of more than 500 tons.
- **Problems related to the application of safety and protection measures:** a significant portion of fuel and gas stations lack the minimum safety and protection components required for the stations, whether in terms of cooling and covering tanks or the provision of fire and gas sensors, and other crucial measures to reduce risks at the stations.

3.1.3 Potential risks in gas stations:

In light of the above and based on the analysis of the report's content, the researchers have identified a range of significant risks associated with the hazardous material used in gas stations. These risks can lead to potential accidents according to their sequence scenarios, as shown in Figure (1). These risks can cause loss of life, assets, or property, in addition to occupational illnesses for workers.

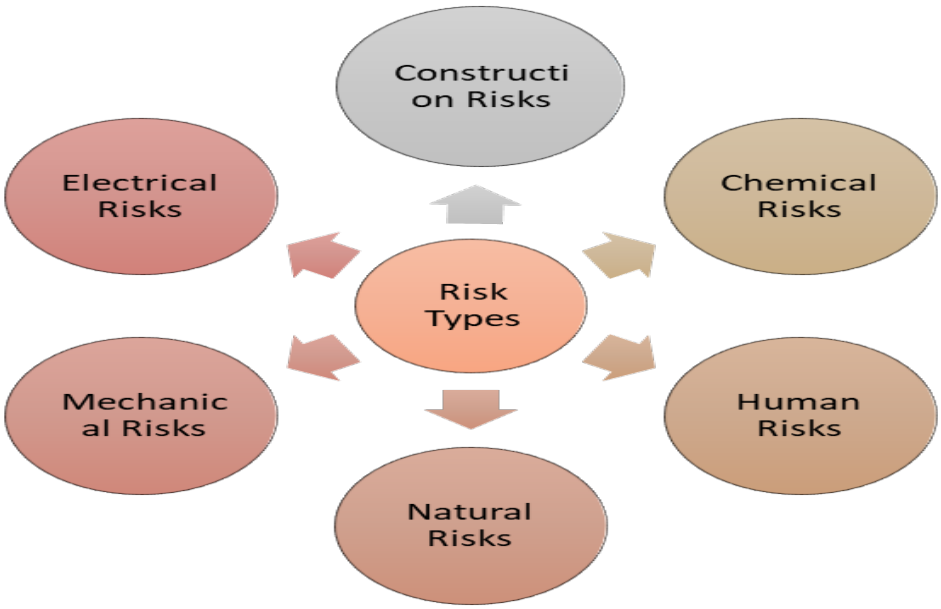

Figure (1): Potential risks at Gaz Station

3.2 Chemical Risk Analysis:

To achieve the study's objectives, chemical package programs were used to analyze potential risks according to scenarios of potential accident sequences, which are as follows:

3.2.1 Risk of gas leakage from 100-ton tank without fire

– **The areas where the gas is spread.** when a hazardous chemical (gas) leaks due to a malfunction in the tank, such as a faulty valve or a direct impact causing a large hole, or due to severe earthquakes or sudden soil collapse without explosion, the gas spreads in the surrounding areas as shown in Figure (2).

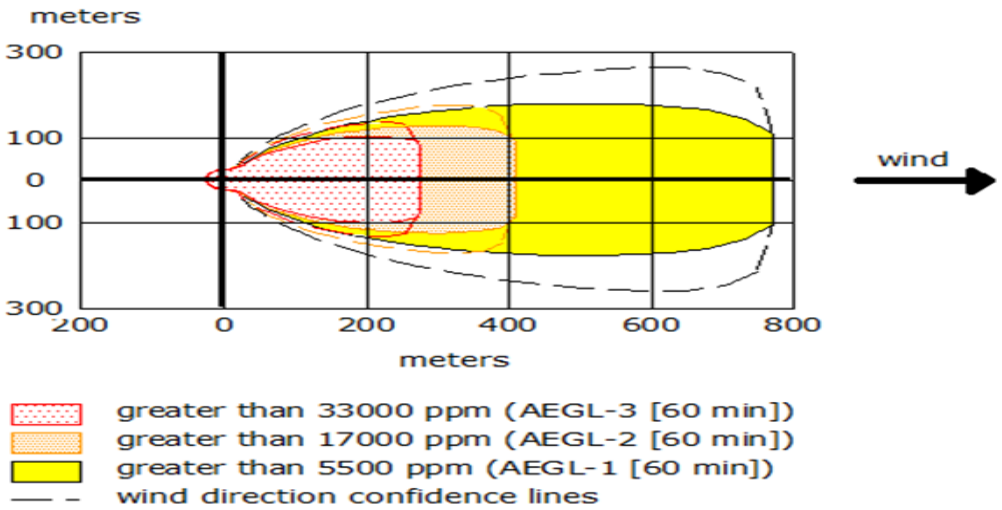

Figure (2) : Gaz spreading in the surroundings

Figure (2) shows that: the red threat zone, which poses a threat to human life, extends up to a distance of 275 meters, while the orange threat zone, where the people's abilities are impaired, is approximately 409 meters away. Whereas the yellow threat zone, in which the gas is barely felt and extends to around 772 meters downwind.

– **The Flammable areas:** In case of gas leakage and its subsequent ignition, in the red and orange threat areas combined together, there would be complete destruction of buildings, while the yellow threat area would be filled with toxic gases and fumes. Figure (3) shows the flammable areas.

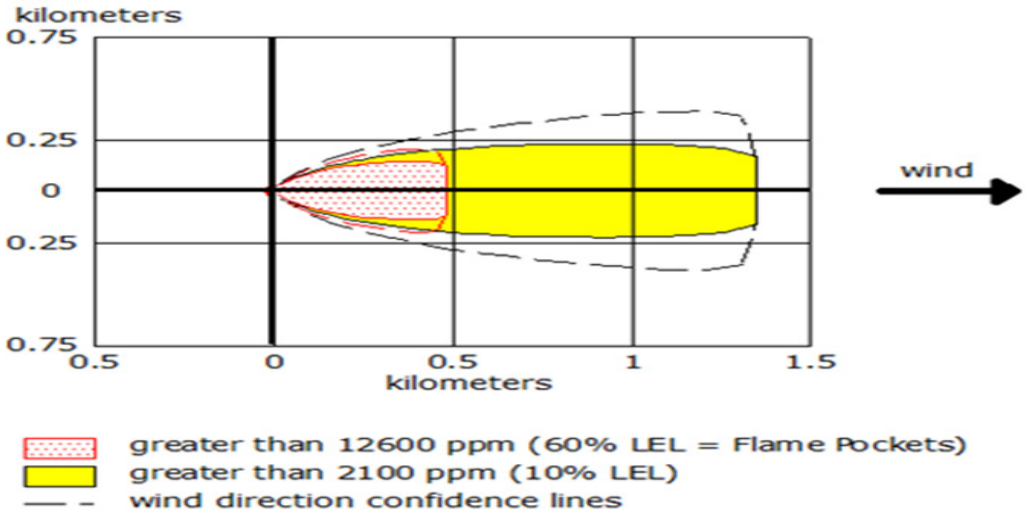

Figure (3) : Flammable areas due to Gaz spreading

Figure (3) shows that: the red and orange threat zones extend up to a distance of 486 meters, while the yellow threat zone, where building windows can be shattered, reaches a distance of approximately 1.4 kilometers. It is noteworthy that the area where buildings get damaged is very large.

– **Blast areas of vapor cloud:** the following figure shows the blast areas of the vapor cloud where the red threat zone is defined by a high impact level and accompanied by destruction of buildings. Figure (4) shows the blast areas of the vapor cloud.

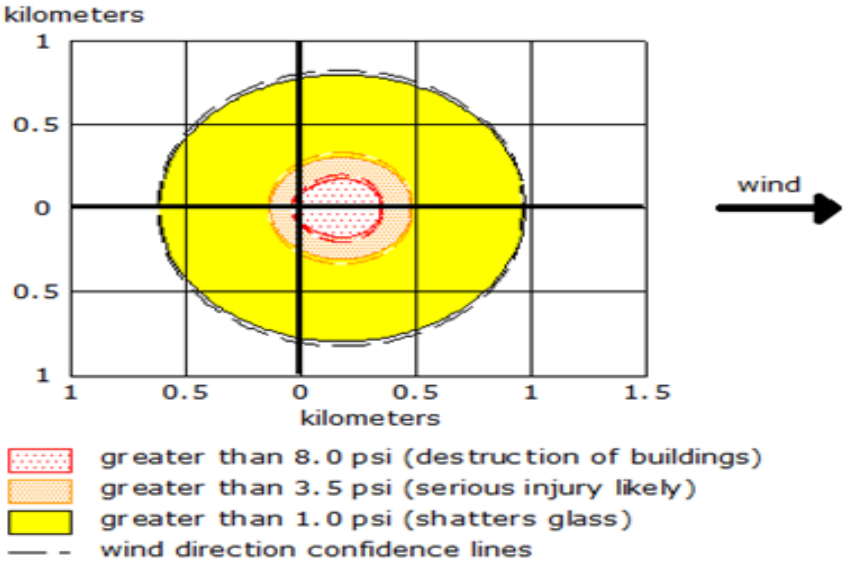

Figure (4):The threat zone of Gaz cloud blast

Figure (4) shows that: the red threat zone is estimated to extend about 356 meters in all directions, and the orange threat zone, which would likely cause serious injury, is predicted to extend to a distance of 488 meters. The yellow threat zone, where glass gets shattered, is estimated to extend up to 979 meters away.

3.2.2 Gas leakage risk from 100-ton tank accompanied by a jet fire

– In case of leakage of gas from the tank accompanied by a jet fire, the areas affected by thermal radiation resulting from the gas combustion are shown in figure (5).

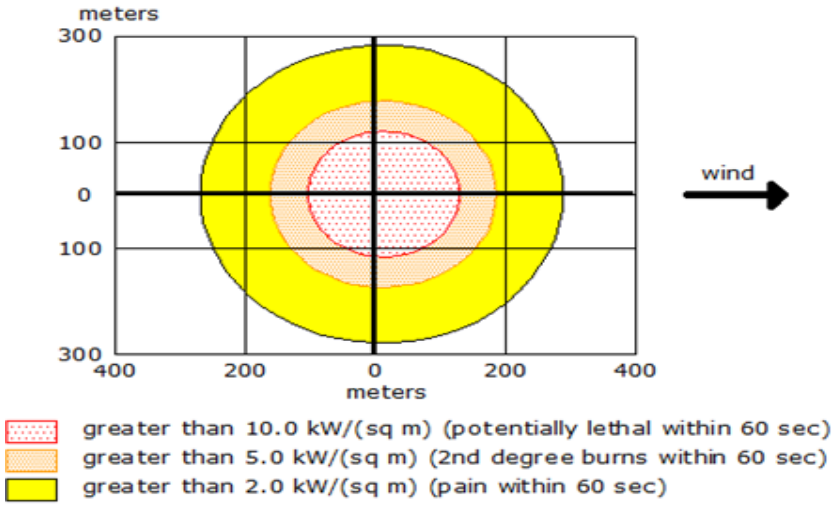

Figure (5):Gaz leakage spreadings

Figure (5) shows that: The red threat zone, where there is a high risk of death for individuals exposed to thermal radiation within 60 seconds, is estimated to extend up to 160 meters. The orange threat zone, where there is a moderate risk of second-degree burns for individuals exposed to thermal radiation within 60 seconds, is estimated to extend up to 190 meters. The yellow threat zone, where individuals may experience pain due to exposure to thermal radiation within 60 seconds, is estimated to extend up to 240 meters.

3.2.3 Risk of 100-ton gas tank explosion in the form of a fireball, (BLEVE).

– **The tank explodes and chemical burns in the form of a fireball.** Figure (6) shows the tank explosion and the gas burning in the form of a fireball, releasing thermal radiation that affects a wide area.

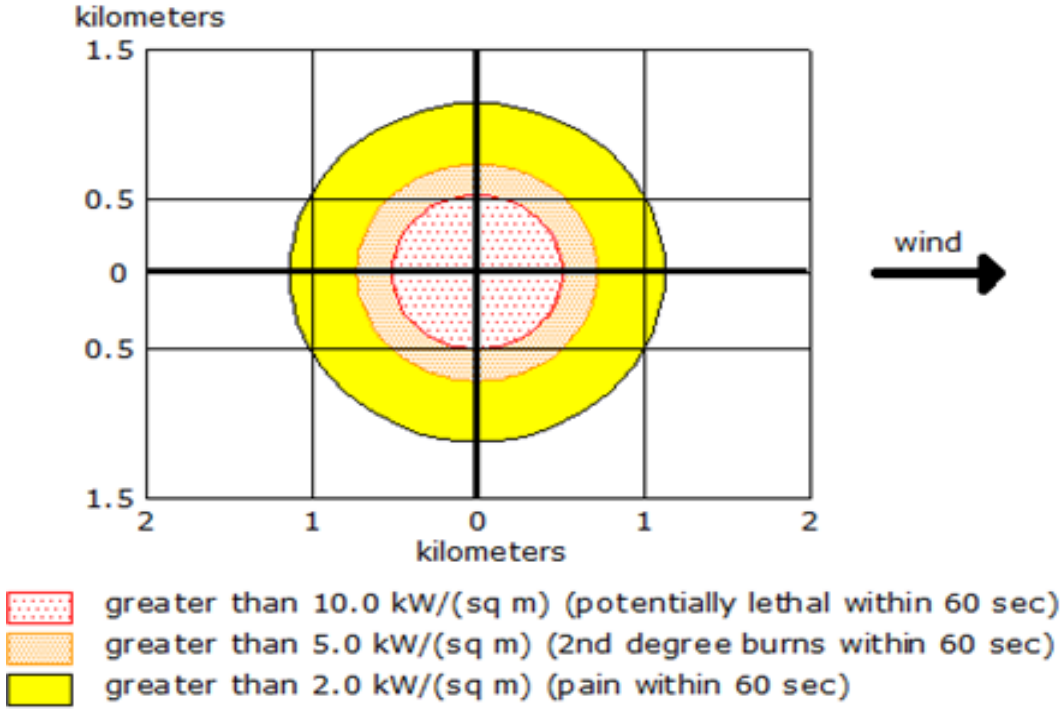

Figure (6) : Vessel Gaz explosions

Figure (6) shows that: the red threat zone extends up to 513 meters, the orange threat zone reaches up to 724 meters, and the yellow threat zone extends up to 1.1 kilometers.

4. Discussion of results, treatment idea, and risk management to reduce the risks

Due to the fact that ignition or explosion factors require oxidation and reduction, and thus a reaction between oxygen and the combustible material, researchers believe that the first step in treatment is to provide an oxygen-free environment in the surrounding area of the tank. In case of leakage, appropriate measures should be taken to prevent gas from spreading and leaking, or a suitable spatial environment should be designed to withstand the vibrational pressure resulting from the gas vacuum explosion. This can be achieved through the following steps:

4.1 Placing gas tanks in reinforced concrete chambers underground, and covering them with sand, as shown in figure (7).

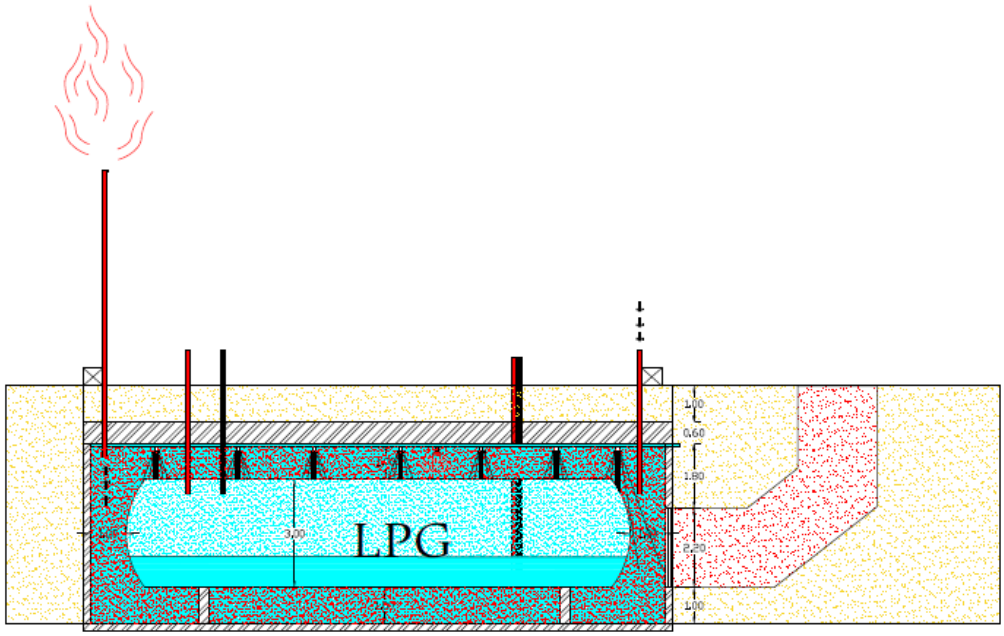

Figure (7) : LPG Vessel under ground room

Figure 7 shows that:

- The Room volume = 400 m^3, the tank volume = 98 m^3, the pressure in the tank ≈ 25 bar.
- To calculate the vacuum volume required to convert the diffused gas pressure to (1) bar = 25 * 98 = 2450 m^3.
- The required volume for homogenizing LPG gas with atmospheric oxygen = 2450 * 25 = 61250 m^3.
- Any leaked liquid gas inside the concrete pool is disposed of by pumping in air and suctioning the liquid gas and igniting it in the open air. Water is also used through water sprinklers and immersion systems to dissolve the gas in water and prevent its ignition.

4.2 Operational risk reduction:

Operational risks are the most prominent cause in the records of accidents associated with gas stations, including poor electrical extensions -which are one of the main causes of fires-, poor mechanical extensions or inability to perform periodic inspections of extensions and tanks. It is vital to continuously adhere to the Palestinian regulations, specifications and standards which require periodic inspection of gas extensions every six months and gas tanks every two years at most. Additionally, pressure relief and automatic sprinkler systems, early fire alarm systems, and flame detection sensors must be installed. Leakages can be detected through sensors connected to an alarm system, which can activate water immersion systems that push gas upwards to prevent accidents.

5. Conclusion

Based on the analysis of the findings, the researchers reached the following conclusions:

- There are several factors that contribute to enhancing the security and safety system, particularly isolating tanks that are at risk of ignition and explosion through concrete rooms.
- Ignition, explosion and leakage factors vary according to different weather conditions.
- Negligence plays a prominent role in expanding the cycle of risks, leading to recurring accidents.
- There is an urgent need to update the legal system in the field of safety, prevention and regulatory requirements for gas stations.
- The weakness of the regulatory system and the diversity of problems related to the regulatory requirements.

Recommendations

- The Safety Data Sheets (SDS) for imported chemicals should be attached to their containers, to identify their components and methods of handling during storage, transport, disposal, and prevention and safety measures.
- The need for a comprehensive system for Hazardous Materials management among the relevant ministries; that addresses Hazardous Materials from their point of entry into the Gaza Strip until their disposal.
- The need to narrow the gap between science and practical application in the security and safety field.
- The need to correct the conditions of gas stations, to cohere with the protection of the internal front from accidents and risks of hazardous, flammable, or explosive chemicals.

References

Awad, Ola (31 December 2020): The situation of Palestinians at the end of 2020, Central Center for Palestinian Statistics, Ramallah.

Bariha, Nilambar; Mishra, Indra Mani; Srivastava, Vimal Chandra (2016): Fire and explosion hazard analysis during surface transport of liquefied petroleum gas (LPG): A case study of LPG truck tanker accident in Kannur, Kerala, India. Journal of Loss Prevention in the Process Industries. Volume 40. Netherlands.

Beheshti, Mohammad Hosein; Dehghan, Somayeh Farhang ; Hajizadeh, Roohalah; Jafari, Sayed Mohammad; Koohpaei, Alireza (2018): Modelling the Consequences of Explosion, Fire and Gas Leakage in Domestic Cylinders Containing LPG, Medical and Health Sciences Research, Vol 8, Special Issue 1, United Kingdom.

Committee for Correction of Hazardous Facilities and Crafts (2021): Report of a workshop on the mechanisms for correcting the conditions of gas stations spread among the population, Gaza Centre for Human Development, internal report, Gaza.

Directorate General of Planning and Development (2020): A methodological guide for assessing internal front risk management, Palestinian Ministry of Interior, Gaza.

LPG Bottling Plant, BPCL Kappalur (2017): Risk analysis study report, Risk Chem Engineering Bharat Petroleum Corporation Ltd, Madurai.

El-Mougher, Mohammed (2016): Environmental Protection Plan in the Gaza Strip, unpublished doctoral thesis, Al-Azhar Al-Sharif University, Egypt.

El-Mougher, Mohammad (2019): Indicators of Risk Assessment and Management in Industrial Facilities in Gaza Strip, Journal of Engineering Sciences and Information Technology, vol. 2, No. 2, Arab Journal of Science and Research Publishing, Gaza.

United Nations Office for Disaster Risk Reduction (2017): Empowering Cities to Resilience Guide to Local Government Leadership, United Nations, Geneva.

UNESCO (2016): Disaster Risk Management for World Heritage, United Nations UNESCO.

Wasel, Mohamed Majdi (2010): Principles of Engineering Chemistry, Malib Publishing, Egypt, p. 163.

Zhao, Jingjing; Li, Wei; Bai, Chongliang (2017): Risk Evaluation for Fire and Explosion Accidents in the Storage Tank Farm of the Refinery, A publication of The Italian Association of Chemical Engineering Online, Chemical engineering transactions vol. 62, China.

DOI:https://doi.org/10.18485/ijdrm.2023.5.1.3

Research article

FLOOD POLICY IN ALGERIA

Faicel Tout[1*]

[1] Institute of Urban Techniques Management, cities and health Laboratory, University of Constantine 3, The New city Ali Mendjeli.B.P. 'B' 72, 25000 Constantine. Algeria.

* Correspondence: faicel@univ-constantine3.dz

Received: 7 May 2023; Accepted: 1 June 2023; Published: 30 June 2023

Abstract: Through this research, we try to identify the policy of prevention and management of disasters related to the risk of flooding in Algeria, especially by knowing the degree of integration and interest of the State in this risk, and by examining the completeness of legislation and regulation, their complementarity or not, their realistic effects, and the extent of effective control over the phenomenon, and from there, the research focused on various legislation related to land use, insurance, institutional organization, legislation on water evacuation, dam safety, construction techniques for protection, infrastructure, public hygiene, environmental protection, organization of emergency response, first aid, warning systems, information methods, control and maintenance, attempts to raise awareness and rehabilitation. And the construction laws and the knowledge of their real weight. The research has shown late interest in this aspect, as it has clarified some of the problems that prevent finding practical ways to protect cities, such as the lack of plans indicating areas at risk of flooding, the lack of real programming of these plans, the lack of control of irregular urban expansion, the lack of separation and detail in the general guidelines for cities and rural areas in the field, and the lack of control of the tasks assigned to the Local authorities in this aspect in the legal texts, especially with regard to the municipality, the absence of private institutions for insurance for this type of risk and the absence of specialized teams for disaster relief. The research also indicates some means that allow better protection of the risk, such as the possibility of relying on historical plans as a temporary and conditional measure for areas that have been exposed to floods in order to pass the prevention policy on the ground and try to exploit remote sensing techniques and develop modelling methods to achieve real predictions and simulations of areas at risk.

Keywords: Flood Risk, disaster Management, legislation, prevention, regulation, Algeria

1. Introduction

Many countries in the world are affected by disasters resulting from natural hazards (Miceli et al., 2008), of which floods are one of the most important and frequent (Perrone et al., 2020). Many countries have tried to develop different policies and procedures to deal with The hazard, including structural measures related to the protection of facilities such as the construction of dams and water drainage systems, and non-structural measures such as early warning (Yang & Liu, 2020) and the dissemination of awareness. the risk of flooding can greatly affect the course of development and may cause results that cannot be easily recovered. In terms of large cities with demographic weight and economic importance, Algeria is considered one of the countries frequently exposed to the risk of flooding (Bourenane et al., 2019). Like other countries, it has sought ways to adapt and cope with this danger. It is trying to master laws and regulations to better control this danger and manage the disasters that may result from it.

Most of the opinion is that Algeria has discussed the issue of floods only after the disasters that Algerian cities have witnessed at the beginning of the new millennium, such as the floods of Bab El Oued, and according to this, the assumption that many cities that have experienced housing growth, especially after independence, are threatened by this danger is acceptable, and this even after the publication of texts that attempt to organize the reconstruction process that have not addressed the actual means of prevention and management of disasters and have not clearly detailed the methods of prevention and management.

This poses a major problem related to the enactment of planning and reconstruction laws without really caring about this danger. In an attempt to remedy the situation, the legislator enacted the law on prevention and management of disasters and amended the law on planning and reconstruction, which came after the earthquake of Boumerdes in 2003 (Harkat, 2021). After nearly 4 decades of independence, a period in which residential growth increased and a significant increase in the proportion of urbanization and irregular housing which was associated with safety problems during this period, and from then on, the presence of many buildings in risky areas is very likely due to the direct relationship between the lack of control of urban growth and the increase of flood disasters (Olcina & Sauri, 2016).

2. Methodology

Based on the research of legislative and regulatory texts related to flood risk and related to prevention, which can be considered synonymous with protection (Liao et al., 2019) and texts related to disaster management and the texts that are derived from them, as well as the search for relevant texts issued by foreign countries, as well as on the basis of previous research in this area and The subjectwhich is generally related to the management of risks and natural disasters, we try to highlight the strengths and weaknesses of the national strategy followed in this area, and answer some of the questions related to the reason for the recurrence of the phenomenon and the extent of the real willingness shown by stakeholders to take charge of this danger, led by local authorities .and from this, the pivotal attention is to understand why despite the interest of Algeria in the aspects that interfere with the management of risk in general,, at the regional and local level, decades ago, it comes back to the fact that the current situation of dealing with natural hazards, especially in terms of preventing the risk of flooding, can not be described at the level required or necessary, because the repeated incidents of floods do not even exclude the new cities , which is supposed to be based on the concept of resilience in its two components related to prevention or post-disaster management, and

does not even exclude the cities that are located in areas that do not experience significant values of precipitation, not even rural areas in different regions. Discovering the real reasons behind this will require research on many topics, but through this research, we will try to understand the state policy towards the subject, and from there the research will try to read and evaluate the texts especially related to land use planning, insurance, institutional organization, legislation on water drainage, dam safety, construction techniques for protection, infrastructure, environmental protection, hygiene, monitoring and maintenance, organization of emergency response and relief, warning systems and information methods, attempts to raise awareness, rehabilitation, building codes, examining whether they are adequate or not, and verifying the assumption that the legislative and regulatory framework is integrated and that it is only a question of activation and implementation.

3. Results and Discussions

Legislation and regulation related to spatial planning:

The basic law that defines the tools of local planning, which is Law 90-29 related to planning and reconstruction, did not address the side of natural hazards with regard to preparing the master plan for development and urbanization or the land occupation plan, and the amendment that includes that did not come until fourteen years later within Law 04-05 which includes the amendment to the previous law and despite the issuance of this amendment, until today, the concern of the local planning tools PDAU and POS does not concern the danger in the required manner; because The easements that are set for the valleys are still subject to the discretion of the directorates and general engineering offices, which are not actually empowered to rule on this issue(Harkat, 2021).

The regulations also stipulated, according to Executive Decree 15-19, which includes the procedures for preparing and handing over construction contracts, which cancels the provisions of Executive Decree 176-91, that the building certificate explains the building rights and the agreements made regarding plots of land, including natural hazards that may affect the site Concerned and plots of land at risk of flooding.

Likewise, the prevention of major risks and the protection of the population has been taken care of by Law 06-06, which includes the directive law for the city, which is among its objectives.

The legislator has also stipulated that the plan of new cities must include measures to prevent major hazards. This is indicated by Executive Decree No. 11-76, which defines the conditions and procedures for the development, preparation and approval of the plan for new cities

And with regard to regional planning, it was stated within Law 02-10, which includes the approval of the national plan for planning the Territory, that within the strategy set in order to prevent major risks, risks must be identified and foreseen, and technical capabilities for control and anticipation must be developed, as well as ensuring information and sensitization and providing training to mobilize competencies And the actors in the policy of prevention and management, but this law concerned the various dangers in general and focused more clearly on seismic risks, and the risk of floods has not been taken care of as much, and the law related to the state 12-07 also did not clarify the responsibilities of the state in this context Rather, he only indicated that within the powers of the State People's Assembly in the framework of agriculture and irrigation, it must initiate work to prevent flood risks and other natural disasters. Likewise, Municipal Law 10-11 did not refer to the role of the municipality in the work of protecting cities or rural areas.

Despite the interest of previous laws for the prevention of flood risk, it can be said that the real concern for flood risk was contained in laws 04-20, the law 05-12 and executive decree 09-399. as the Provisions for flood prevention in law 04-20 on prevention One of the major hazards and disaster management in the context of sustainable development is that the general plan that defines the provisions to reduce susceptibility to injury and prevent its consequences must include a national map of sensitivity to floods that defines the areas likely to be exposed to floods and what can be blamed for this law is that it has not indicated the period of updating the prevention plans and the possibility of revision or not.

And among the objectives of Law 12-05 was to control floods by controlling the course of surface waters in order to protect property and people in urban areas or other areas exposed to floods, and it indicated the possibility of developing mechanisms to anticipate floods and measures for warning and intervention in relation to the areas located Below the water barriers and adjacent to the valleys, which is what came within Executive Decree 09-399, which is considered an implementation of what was stated in Article 53 of Law 05-12, as it was concerned with the mechanisms of anticipating floods, specifically to protect the sites below the water barriers and dams and the areas adjacent to the valleys, and perhaps This special interest is due to the ability and possibility of accurate identification of the areas at risk, since the studies related to this type of flood are based on realistic or estimated values with a small percentage of error for the volumes of water within the water barrier under study, and from that, identifying the areas located in the danger area, which can Affected by the flood wave as a result of the scenario of cracking the water barrier, its results will be practical, realistic and acceptable even to the public.

Development of prevention techniques:

This is what came within the principles and rules for the prevention and management of major dangers, which were included in Law 20-04, where it was stressed the need to follow up on technical developments for the prevention of major dangers and the development of forecasting and weather forecasting systems and technical monitoring of protection facilities in anticipation of any deterioration in their condition which may constitute Danger, and the executive texts contained in Decree 17-333, which defines the rules for the exploitation and maintenance of surface water barriers, indicated the need to take into account some technical operations that aim to ensure a safe condition for the dam, as well as the possibility of its cracking, deterioration, or the possibility of it producing floods as a result of being affected by seismic activity. Or flooding it with water as a result of rockslides or soil erosion, in addition to what was determined by Decree 09-399, which specifies the mechanisms for anticipating floods in relation to this framework, and in general, these rules and measures call for the protection and the prevention of property, people and environment whenever the need arises. And the use of the best techniques in terms of preventive work.

Effective institutions in the prevention and management of flood risks:

Accurate assessment of a risk of this kind and complexity requires data related to prevention and the formation of data banks, which have been assigned to the National Delegate for Major Risks, it represents one of the pillars of the prevention policy, and In this context, it is also entrusted with promoting the media to protect those involved and the population. It also contributes to the development of knowledge and techniques in this field. From this, it is an important support for controlling this danger. Its president is also tasked with preparing an annual report that includes an evaluation of the knowledge and preventive measures embodied and various suggestions that aim to reduce risks.

The National Agency for Water Resources whose legal nature has been transformed to become industrial and commercial in accordance with Executive Decree 148-19, was previously called the National Institute of Water Resources. It is mandated within the framework of the state's development policy to carry out hydrological and hydrogeological studies, explorations and analyses related to water harvesting studies, soil studies and data collection related to water resources.

The National Bureau of Meteorology is also a public institution of an industrial and commercial nature, as stated in Executive Decree No. 98-258, which, in addition to being tasked with acquiring meteorological data and preserving and exploiting the archive of data related to that, is also tasked with monitoring climate changes, monitoring weather developments, broadcasting warnings to the public and Exploited.

The Fund for Natural Disasters and Major Technological Risks established by Decree 90-402 is one of the means that has been established in order to support reconstruction and recovery after trauma. Some of its expenses are represented in compensating disaster victims, financing prevention studies and rescue expenses.

Hygiene:

One of the most important areas related to the management of the risk of floods, especially in urban areas, is the field of waste management, as preserving waterways and drainage channels in an unpolluted condition and allowing the smooth flow of water is important to preserve natural environments and to prevent valleys from deviating from their paths and clogging channels and Flooding the adjacent areas, and this is more related to mud, dead waste, building materials, and waste resulting from demolition and construction works, although the law made it clear that the municipality is the one who takes care of everything related to household waste starting from its collection, and this was included in Law 90-08 and Law 11- 10 He also clarified that the waste resulting from construction and demolition works is the responsibility of its producers, which is what was included in Law 19-01 and the prohibition of placing building materials on the roads according to Law 15-08 that relates to the leveling of buildings, but what is not yet clear is the responsibility for purifying the valleys and Watercourses and protection facilities such as small dams and basins collecting and dividing water, which regulate the process of rainwater drainage, and which currently can be said that the process of cleaning it is subject to political volunteering and the few initiatives of civil societies.

Sewage:

In the interest of the state on the quality of the water that is thrown into the natural spaces, and because many cities adopt a joint drainage system for rainwater and sewage water, it required individuals and industrial establishments to take various measures that allow reducing pollutants to the lowest level, and water filtration plants were adopted in accordance with Reducing the effects of human activity in a way that does not affect the biological diversity of the discharge environment and the protection of groundwater and natural landscapes, and it is one of the controls that have been approved on the connection to public networks for wastewater discharge, and in this aspect, one of the factors that prevent this is the absence of actual control, so currently it is not Contribute as necessary to prevent connection to public networks, which is a phenomenon that spreads widely in chaotic neighborhoods where the lowest standards of connection are not adopted, such as ensuring the appropriate slope for water drainage, and this may constitute a great danger to public health in the event of flooding. Appropriate flow values are still absent in many cities, as the phenomena of blockage due to waste and dust are frequent phenomena.

Information, early warning and communication:

Among the rights that individuals have is the right to be acquainted with the state of the environment and the measures directed to protect it, which is stated in Law 03-10 as a right to environmental information. The individual also has the right to know the danger that threatens him and his property and the means of prevention. As well as preventive information, and the principle of participation within Law 20-04 included this right and includes the right to be informed of the expected risks, ways of prevention, and arrangements related to taking care of the effects of disasters. What can be referred to in this regard is the problem of preparing and distributing this information, despite its importance in minimizing losses. (Shih et al., 2019) especially with regard to local warnings for isolated areas, as these areas do not have an actual technical support that allows for the wide spread of information and to receive sufficient attention, and the absence of media and warnings may contribute to the spread of misinformation and Spreading fear and panic, which could contribute to the aggravation of the situation (Torpan et al., 2021), and all actors are invited to invest in this aspect in a way that allows the public and the private and guarantees sufficient time to make decisions related to personal protection for lives and properties.

The legislator was also interested in coordinating communication and consultation between the various sectors and actors, and although this is necessary in preparing prevention plans, it becomes more important when it comes to managing disasters and crises, especially organizing field interventions. And in order to ensure a national strategy for communication related to managing natural and technological hazards, a national strategy was established. A committee, according to Executive Decree No. 04-181, is called the Liaison Committee and is tasked with controlling media material related to prevention and management related to dangers, as well as ensuring responsible delivery of information and raising awareness, etc., which ensures the practical and safe employment of the media in the management of dangers and disasters.

Organizing emergency interventions and first aid:

It came in Executive Decree No. 59 -19, which determines the modalities for preparing and managing rescue plans, which cancels the provisions of Decree 231-85, which defines the conditions for organizing interventions and first aid and their implementation when disasters occur, as well as the modalities for that. that Rescue organization schemes are prepared based on knowledge of the history of risks and their maps, as well as based on an analytical summary of risks. These foundations remove one of the obstacles facing the efforts to protect cities, as this decree gives historical maps their value and opens the door for them to be valued, and perhaps they can be considered an ideal means of compensation for maps Resulting from modelling processes and especially related to torrents resulting from exceptional rains that result in direct floods because the actual problem and complexity related to determining the extent of the areas at risk based on the probability values of expected rain raise doubts about the realism of the studies, which may lead in the end to the lack of serious consideration of the studies. However, the adoption of historical maps that reflect the areas flooded as a result of floods is in itself a challenge. This is not related to updating these maps and preparing them for employment based on geographical reference. Rather, the problem is related to access to them, which is something that all ancient colonies may share. In which the colonizer takes possession of all property and seizes it, even documents and maps related to the floods.

And for Algerian cities, the flood maps starting from the sixties may be eligible for approval for the establishment of protection projects or the approval of relief and aid measures, provided that it takes into consideration the various interventions that occurred in the field, especially those that include the construction of dams or the diversion of valleys or Exploit-

ing it or making modifications to it, and this should not be related to major projects that are made for long periods, as they require taking into account many other factors, such as climate change, the impact of vegetation cover, and the change of soil properties, especially about permeability.

Insurance and rehabilitation:

Insurance plays an important role in mitigating the effects of disasters and recovering from them (Koks et al., 2015). Ordinance 95-07 related to insurance included the possibility of insuring against the risks of hail, storm, ice and floods according to the conditions stipulated in the insurance contract, and it was not mandatory Natural disaster insurance until the issuance of Ordinance 03-12 related to compulsory insurance for natural disasters and compensation for victims, and it was approved by Law 03-16. The order also indicated that determining the prices applied to take care of the effects of natural disasters, guarantee limits and exemptions are related to With the development of the level of risk, which is also linked to the area of exposure and the vulnerability of the building, but on the other hand, the technical difficulties facing the process of identifying these two others could constitute an obstacle for insurance companies in controlling premiums or contributions, and imposing unified premiums on large areas would not be acceptable from In general (Koks et al., 2015), which may reflect negatively on attempts to direct individuals towards this type of insurance and accept these financial burdens.

Building awareness:

Without a doubt, building preventive awareness involves many factors (Raikes et al., 2019), especially awareness of natural hazards, as they represent unexpected dangers. Hence, the first stage in mobilizing efforts to support prevention is to build awareness, and the media can be used more effectively. And it can have a pivotal role in that after that one of the proposals that encourage society to invest in protecting themselves can be applied, and this is accompanied by a broader scope for accepting their views (Smith et al., 2016) Also, resorting to the application of the deterrent texts contained in the various laws that are related may affect positively the policy of protecting the city from these dangers will have a significant impact in managing these risks.

4. Recommendations

The basis for passing the national policy to take care of the risk of flooding from papers to the field is to develop flood plans that will contribute to reducing losses (Khalaj et al., 2021) and based on which construction can be prevented in areas exposed to a high level of danger (Erdlenbruch et al., 2009). Despite the difficulty of defining the areas exposed to flooding accurately, relying on geographic information systems may acceptably allow this. The development of these maps is a very important element of prevention, as it constitutes the cornerstone for other procedures related to managing the risk. Care must also be given to prevention in the first place, since the burdens that It will be borne by the public and private sectors in the event of disasters, and will exceed many times the costs of prevention. It would have been more appropriate for the authorities to draw up maps of the areas that were previously affected, acquire them, and use them to prevent construction accordingly, which did not happen. It is also possible to develop a digital platform to be updated that identifies the areas at risk of flooding. Depending on the amount of rain recorded or expected, and it can attach with a warning system.

Even with these legislations, there is a gap between the legislation and the actual possibility of the application first as a result of the current knowledge in the field of prevention from the risk of floods and torrential rains and the various problems facing the preparation of prevention schemes. Also, the current laws do not control the required form in all stages of management and do not address other types of floods From this, the application of new and effective flood risk management standards will require a response from the legislation and may call for changes to the current legislation and regulation (Nikolić Popadić, 2021).

The laws of local authorities must specify their responsibility and increase their powers in preventing major dangers before referring to their role in managing disasters. The sector of managing natural hazards in the urban centre is among the sectors that do not receive sufficient attention in the state and municipality and the interest of local officials who are supposed to have a greater awareness of the local situation and relevant experience (Becker et al., 2014) where generally comes as a secondary interest and The practical side of it is usually absent within the work plans, and the controls for cleaning waterways, waste, mud, and trees must be clear within the waste management law. Prevention, protection, and management measures must also be defined for rural areas, and better control of agricultural activity because of its impact on increasing the risks associated with floods Even in the neighbouring urban areas (Howe & White, 2010) and the need to include environmental protection within the various prevention schemes and the protection of floodplains because of their value in supporting biodiversity from the risk of floods by studying the quality of water that is thrown into natural estuaries and the controls of surface water infiltration into Groundwater, Laws related to agriculture should also clarify the ways to protect agricultural areas.

The national network of monitoring devices affiliated with both the National Agency for Water Resources and the National Bureau of Meteorology needs to be renewed and the traditional ones should be replaced with automatic ones, to avoid technical errors related to obtaining data or errors related to saving data values, and they also need to be strengthened and intensified in particular In areas that express different natural characteristics, especially about topographical basins with a wide area, large urban mass, high population density, economic value, and complex topography, and give access to climatic data, especially those related to the maximum daily rainfall, should be allowed, even if limited or monitored and also give access to the various historical documents and plans in scientific research, as those data are being the basis for building any study related to floods.

It is also necessary to involve citizens at various levels, starting from planning to supporting implementation, monitoring and maintenance, and this will not be done except by clarifying the level of danger, as the lack of vision that embodies the danger makes the initiative that is concerned with risk prevention weak and does not receive listening ears. It is also supposed to encourage interest in water economy and a culture of storage And the use of rainwater and the transition from considering it as a risk to considering it as a resource, especially for arid and semi-arid areas, for local groups or for private individuals who have the right to dispose of real estate, and clarifying the legal ways for that, as the current laws do not take into account the aspect of rainwater valuation

The planning and construction laws must include general directives for protection or minimum standards for protection from the danger of flooding in particular, which is what needs the diligence of researchers. It must also refer to ways of prevention and facilitate the work of rescue teams at the level of the city, neighborhood and residence. also, current laws do not deal with the procedures related to the current buildings located within the risk areas or the procedures related to the built-up areas. From here, it can be said that the current plans are not duly consistent with the prevention standards, and they require urgent intervention, and it must also put special provisions to put an end to soil impermeability and find methods

to increase its permeability. Such as increasing the per capita share of green spaces, as well as the construction of roads must include conditions for protection from flooding and surface runoff, which could pose a danger to individuals or property.

Even with taking measures to prevent danger, the emergence of disasters must be taken into account, and there is a need to prepare and form specialized intervention teams from the various relief and rescue groups affiliated to the Ministry of the Interior or the Ministry of National Defense and provide them with the necessary means and update their equipment, and it must also ensure the possibility of applying plans prepared in advance and Ensure the safety of the means and facilities necessary to implement these plans in the event of disasters

The insurance sector should not only relate to compensation and rehabilitation assistance but should also intervene in the factors of the prevention industry. To set well-considered contributions and premiums, insurance institutions should invest in scientific and technical aspects. The authorities can also encourage the establishment of special institutions for insurance against this type of risk. These institutions can also contribute to financing protection projects.

5. Conclusions

Managing the flood risk cannot depend on political volunteering. Resilience towards this risk requires integrated elements in prevention, management and rehabilitation. These are the elements on which the national policy must be built to take care of the flood risk. Although the state has made an important journey in that, the associated legal system It still has not found the ideal formula for controlling this danger. It can also be said that the current initiatives are concerned with managing the disaster more than it does with prevention, which is supposed to come in the first place. Although the state has monitored some organization to take care of this aspect, there is a problem of activation, and from this One of the most important needs of the risk management reality is to support the legislative and regulatory texts to better control the various types of floods and overcome the difficulties in developing plans for areas at risk of floods and local intervention plans in order to pass the policy of prevention, management and rehabilitation to the field.

References

Bourenane, H., Bouhadad, Y., & Guettouche, M. S. (2019). Flood hazard mapping in urban area using the hydrogeomorphological approach: case study of the Boumerzoug and Rhumel alluvial plains (Constantine city, NE Algeria). Journal of African Earth Sciences, 160(December 2018), 103602. https://doi.org/10.1016/j.jafrearsci.2019.103602

Erdlenbruch, K., Thoyer, S., Grelot, F., Kast, R., & Enjolras, G. (2009). Risk-sharing policies in the context of the French Flood Prevention Action Programmes. Journal of Environmental Management, 91(2), 363–369. https://doi.org/10.1016/j.jenvman.2009.09.002

Executive Decree No. 04-181 of June 24, 2004 Ministry of Post and Information and Communication Technologies Official Gazette No. 41 of June 27, 2004 p. 24 establishing the Liaison Committee associated with major natural and technological hazards.

Executive Decree No. 09-399 of November 29, 2009 Official Gazette No. 71 of December 02, 2009, p. 3 Defines flood forecasting mechanisms.

Executive Decree No. 11-76 signed on February 16, 2011, Ministry of Urban Development and Environment, Official Gazette No. 11 of February 20, 2011, page 10 specifying the conditions and modalities for developing, preparing and approving the new city development plan.

Executive Decree No. 15-19 of January 25, 2015, Official Gazette No. 7 of February 12, 2015, page 4 specifying the procedures for preparing and delivering construction contracts.

Executive Decree No. 17-333 of November 15, 2017 Official Gazette No. 68 of November 28, 2017 p. 15 sets the rules for the exploitation and maintenance of surface water barriers.

Executive Decree No. 19-148 of April 29, 2019 Official Gazette No. 30 of May 08, 2019 p. 15 amending the organic law of the National Agency for Water Resources.

Executive Decree No. 91-175 of May 28, 1991 Official Gazette No. 26 of June 01, 1991, page 953 Determines the general rules for planning, development and construction.

Executive Decree No. 91-176 of May 28, 1991 Official Gazette No. 26 of June 01, 1991, p. 962 determines the procedures for preparing and handing over the construction certificate, partition permit, partition certificate, building permit, conformity certificate, and demolition permit.

Executive Decree No. 98-258 of August 25, 1998 Official Gazette No. 63 of August 26, 1998, page 9 includes the transformation of the National Office of Meteorology into a public institution of an industrial and commercial nature.

Harkat, N. (2021). Urban vulnerability of Algerian Cities to flood Risk, case study Batna city (in French). University of Constantine3 -Salah Boubnider-.

Howe, J., & White, I. (2010). Flooding , Pollution And Agriculture. International Journal of Environmental Studies, October 2014, 19–27. https://doi.org/10.1080/00207230304746

Khalaj, M. R., Noor, H., & Dastranj, A. (2021). Investigation and simulation of flood inundation hazard in urban areas in Iran. Geoenvironmental Disasters, 8(1), 1–13. https://doi.org/10.1186/s40677-021-00191-1

Koks, E. E., Jongman, B., Husby, T. G., & Botzen, W. J. W. (2015). Combining hazard, exposure and social vulnerability to provide lessons for flood risk management. Environmental Science and Policy, 47, 42–52. https://doi.org/10.1016/j.envsci.2014.10.013

Law No. 01-19 passed on December 12, 2001, Ministry of Urban Planning and Environment, Official Gazette No. 77 of December 15, 2001, page 9, relating to waste management, control and removal.

Law No. 03-10 passed on July 19, 2003 Official Gazette No. 43 of July 20, 2003 p. 6 related to the protection of the environment within the framework of sustainable development.

Law No. 03-16 of October 25, 2003, Official Gazette No. 64 of October 26, 2003, page 5 approving Ordinance No. 03-12 of Jumada II 27, 1424 corresponding to August 26, 2003 relating to compulsory insurance for natural disasters and compensation for victims .

Law No. 04-05 passed on August 14, 2004, Ministry of Housing and Urbanization, Official Gazette No. 51 of August 15, 2004, page 4 amending and supplementing Law No. 29-90 of Jumada I 14, 1411, corresponding to December 1, 1990, relating to planning and development.

Law No. 04-20 passed on December 25, 2004, Ministry of the Interior and Local Authorities, Official Gazette No. 84 of December 29, 2004, page 13 relating to the prevention of major dangers and the management of disasters within the framework of sustainable development.

Law No. 05-12 of August 4, 2005, Official Gazette No. 60 of September 4, 2005, p. 3, related to water.

Law No. 06-06 passed on February 20, 2006, Ministry of Urban Development and Environment, Official Gazette No. 15 of March 12, 2006, page 16 containing the directive law of the city.

Law No. 08-15 passed on July 20, 2008, Ministry of Housing and Urbanization, Official Gazette No. 44 dated August 03, 2008, page 19 sets out the rules for matching buildings and completing their completion.

Law No. 10-02 passed on June 29, 2010 Official Gazette No. 61 of October 21, 2010, page 3 includes the approval of the National Plan for Territory Development.

Law No. 10-11 passed on June 22, 2011 Official Gazette No. 37 of July 03, 2011, p. 4 relating to the municipality.

Law No. 12-07 passed on February 21, 2012 Official Gazette No. 12 of February 29, 2012 p. 5 relating to the mandate.

Law No. 90-08 passed on April 7, 1990, Ministry of the Interior, Official Gazette No. 15 of April 11, 1990, page 488, relating to the municipality.

Law No. 90-29 passed on December 01, 1990, Ministry of Equipment, Official Gazette No. 52 dated December 02, 1990, page 1652, related to planning and reconstruction.

Liao, K. H., Chan, J. K. H., & Huang, Y. L. (2019). Environmental justice and flood prevention: The moral cost of floodwater redistribution. Landscape and Urban Planning, 189(September 2018), 36–45. https://doi.org/10.1016/j.landurbplan.2019.04.012

Miceli, R., Sotgiu, I., & Settanni, M. (2008). Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy. Journal of Environmental Psychology, 28(2), 164–173. https://doi.org/10.1016/j.jenvp.2007.10.006

Nikolić Popadić, S. (2021). Flood prevention in Serbia and legal challenges in obtaining the land for flood risk management. Environmental Science and Policy, 116(March 2020), 213–219. https://doi.org/10.1016/j.envsci.2020.11.007

Olcina, J., & Sauri, D. (2016). Flood policy in Spain: a review for the period 1983-2013. Disaster Prevention and Management, 25(1), 41–58. https://doi.org/http://dx.doi.org/10.1108/DPM-05-2015-0108

Ordinance No. 03-12 of August 26, 2003 of the Ministry of Finance, Official Gazette No. 52 of August 27, 2003, page 22, relating to compulsory insurance against natural disasters and compensation for victims.

Ordinance No. 75-25 signed on April 29, 1975 Ministry of Transport Official Gazette No. 36 dated May 06, 1975, page 486 includes the establishment of the National Meteorological Office.

Ordinance No. 95-07 of January 25, 1995 Official Gazette No. 13 of March 08, 1995, p. 3 relating to insurances.

Perrone, A., Inam, A., Adamowski, J., & Sole, A. (2020). A participatory system dynamics modeling approach to facilitate collaborative fl ood risk management : A case study in the Bradano River. 580(May 2019). https://doi.org/10.1016/j.jhydrol.2019.124354

Raikes, J., Smith, T. F., Jacobson, C., & Baldwin, C. (2019). Pre-disaster planning and preparedness for floods and droughts: A systematic review Jonathan. International Journal of Disaster Risk Reduction, 38(May), 101207. https://doi.org/10.1016/j.ijdrr.2019.101207

Shih, S. S., Kuo, P. H., & Lai, J. S. (2019). A nonstructural flood prevention measure for mitigating urban inundation impacts along with river flooding effects. Journal of Environmental Management, 251(September), 109553. https://doi.org/10.1016/j.jenvman.2019.109553

Smith, A., Porter, J. J., & Upham, P. (2016). "We cannot let this happen again": reversing UK flood policy in response to the Somerset Levels floods, 2014. Journal of Environmental Planning and Management. https://doi.org/http://dx.doi.org/10.1080/09640568.2016.1157458

Torpan, S., Hansson, S., Rhinard, M., Kazemekaityte, A., Jukarainen, P., Meyer, S. F., Schieffelers, A., Lovasz, G., & Orru, K. (2021). Handling false information in emergency management: A cross-national comparative study of European practices. International Journal of Disaster Risk Reduction, 57. https://doi.org/10.1016/j.ijdrr.2021.102151

Yang, T. H., & Liu, W. C. (2020). A general overview of the risk-reduction strategies for floods and droughts. Sustainability (Switzerland), 12(7), 1–20. https://doi.org/10.3390/su12072687Alcayna, T., Bollettino, V., Dy, P., & Vinck, P. (2016). Resilience and disaster trends in the Philippines: opportunities for national and local capacity building. PLoS currents, 8.

DOI:https://doi.org/10.18485/ijdrm.2023.5.1.4

Research article

STUDENTS' PERCEPTION OF POLICE READINESS TO RESPOND TO DISASTERS CAUSED BY A COVID-19 PANDEMIC

Bojan Janković[1], Aleksandar Sakač[1], Igor Iričanin[2]

University of Criminal Investigation and Police Studies, 196 Cara Dušana Street, 11080 Belgrade-Zemun, Serbia;

2 Ministry of Interior of the Republic of Serbia, Belgrade.

Correspondence: *bojan.jankovic@kpu.edu.rs*

Received: 5 March 2023; Accepted: 1 June 2023; Published: 30 June 2023

Abstract: The COVID-19 pandemic has pointed out the need to examine the role of the police in emergencies caused by various infectious diseases as much as possible. The aim of the study is to determine the perception of students of the University of Criminal Investigation and Police Studies, who are studying to become police officers, about the actions of the police in confronting the COVID-19 pandemic, i.e. the readiness of police officers to respond in the current as well as in the future pandemics. The research used a modified survey questionnaire from the previous research. The survey was anonymous. All respondents voluntarily agreed to participate in the research conducted from May to June 2022. The research data were collected from 105 students of the University of Criminal Investigation and Police Studies. According to the respondents, the police officers did well in the new circumstances given the lack of protective equipment and insufficient training for such situations. It was assessed that the police are one of the key entities in opposing the COVID-19 pandemic. Research findings can help police organizations plan their work during infectious disease pandemics. Above all, in the planning of the procurement of protective equipment, in education of future police officers by introducing new topics in training related to the work of the police in infectious disease pandemics, such as improving communication with citizens, and its implementation in online format. The findings of the study can be an incentive to other researchers as a basis for further research in the field of police work in emergencies because there are few of them in the scientific literature, and those related to police work in a pandemic are almost non-existent.

Keywords: students, perception, police, disaster, pandemic, COVID-19

1. Introduction

Although we are gradually beginning to forget consequences of the COVID-19 on society, the announcements of scientists have informed us we should not relax, both because of the COVID-19 itself, and because of future infectious disease pandemics. We have to emphasize that the police were one of the important subjects in helping the population to overcome this pandemic during the last two years (Janković, 2021; Janković & Cvetković, 2020; Kekić & Milenković, 2020). Members of the police were often exposed to infection of the said disease, and were under enormous stress during the pandemic (De Camargo, 2021; Li, Cheung, Sun, Cheung, & Zhu, 2021). During the first month of the COVID-19 pandemic, around 2.34% of police officers of the Ministry of Interior of the Republic of Serbia were infected or in quarantine (Janković & Cvetković, 2020). During the same period, in New York, there were around 4% of police officers infected and one out of six police officers was in in quarantine (Ashby, 2020), while in Detroit, almost 1/3 of employees were in quarantine (Hansen & Lory, 2020). The number of deaths among police officers from COVID-19 during 2020 in the US accounted for 62% of all deaths of the aforementioned population (Violanti, Fekedulegn, McCanlies, & Andrew, 2022).

Members of the police are normally exposed to great stress during engagement in emergencies (Adams & Anderson, 2019; McCanlies, Gu, Andrew, & Violanti, 2018; Domingo & Ormila, 2022; El-Mougher, 2022; Odero & Mahiri, 2022; El-Mougher & Jarour, 2022). Stress arises because of situations in which police officers encounter a large number of the dead and injured persons, severe destruction, and the like. However, there could be a more important factor due to which the police officers are under considerable stress, the fact they are not prepared to respond in emergencies, especially those caused by infectious diseases, i.e. they have not received adequate training, in contrast to the regular police tasks for which they are trained (Cvetković, Pavlović & Janković, 2021; Janković & Cvetković, 2020). There is a question how ready the police are to react in such situations. Previous experiences have shown that the police are insufficiently prepared for the challenges associated with large-scale disasters, such as floods, earthquakes, and the like (Janković, 2021). At this point, questions that arise are what role members of the police played and whether they successfully performed their tasks during the COVID-19 pandemic. The professional and scientific public could give the assessment of their role, but sometimes it is important, especially in situations where there is still the lack of scientific research as well as complete information, to hear from the public that can contribute to solving such problems as the current one (Sergey & Gennadiy, 2022; Shibru et al., 2022; Dukiya & Benjamine 2021; Adamović et al, 2021).

Literature review

Until recently, there were not many studies in the literature related to the role and work of the police in emergencies. The small number of existing studies did not deal with emergencies caused by epidemics or pandemics of infectious diseases, but those caused by hurricanes (Deflem & Sutphin, 2009; McCanlies et al., 2018; Rojek & Smith, 2007; Varano & Schafer, 2012), floods (Milojković et al., 2015; Milojković, Stevanović, Milojević, Vučković, & Janković, 2014; Mitrović & Vučković, 2016) and terrorist acts (Mendonça, Webb, Butts, & Brooks, 2014; Mladjan & Cvetković, 2012; Sommera, Njåb, & Lussandc, 2017; Sukabdi, 2016; Varano & Schafer, 2012). Until the COVID-19 pandemic, there were few studies related to the police response to emergencies caused by infectious diseases. Thus, at the beginning of the 20th century, a number of studies related to police actions during influenza pandemics, which represented a great challenge for the police (Brito, Luna, & Sanberg, 2009; Luna, Brito, & Sanberg,

2007). Areas where police forces may encounter problems during infectious disease pandemics have been identified, and in this regard, police units must be prepared in three main areas: the police unit preparation (maintaining operational continuity – continuing work in new circumstances), protection of police officers (education about disease transmission, use of protective equipment, vaccination, treatment) and community protection (maintenance of public order). The adequate police planning is crucial for a successful response in such situations (Cvetković & Janković, 2020; Janković, 2021).

With the outbreak of COVID-19 in 2020, much more research has been conducted on this topic in all areas of the society. This also applies to policing in the newly created circumstances. One of the first such papers (Janković & Cvetković, 2020) examined the perception of citizens about the police behaviour at the beginning of the pandemic. The research showed that the police played an important role in the fight against the COVID-19 pandemic and that citizens had confidence in the police, but also that police officers had not been sufficiently trained to work in such emergencies. Janković (2021) reached similar conclusions, with the fact that the research did not refer exclusively to the actions of the police during COVID-19, but to all pandemics of infectious diseases, both existing and the future one. Furthermore, the study conducted in Israel (Perry, Jonathan-Zamir, & Factor, 2022) has indicated that the police had strong support from citizens in the initial phase of the COVID-19 pandemic (April 2020). However, the same survey showed that the longer the pandemic lasted (December 2020), the less support the police got from citizens. At the beginning of the COVID-19 pandemic, the study indicated changes in telephone calls made to the police compared to the pre-pandemic period (Ashby, 2020). Namely, the number of calls to the police, contrary to previous expectations, dropped significantly during the first few weeks. While there was a decrease in the number of calls related to traffic accidents, on the other hand, there was an increase in the number of calls related to the discovery of dead bodies, because there was an increase in mortality due to the outbreak and spread of COVID-19. Changes in police actions were noted in field actions while dealing with certain types of crime. Thus, in Sweden, during the first 10 weeks of the pandemic, there was a decrease in the general crime rate as well as in certain types of crime such as assaults, pickpocketing, burglaries, while drug-related crime remained at the same level (Gerell, Kardell, & Kindgren, 2020). Similar results were observed in Los Angeles (Stickle & Felson, 2020) where the overall crime rate decreased by about 15%, particularly in robbery (−24%), shoplifting (−14%), theft (−21%) and bodily injuries (−11%). However, burglary, domestic violence, vehicle theft and homicide remained statically unchanged. All the changes in policing had a negative impact on the psychological health of police officers (De Camargo, 2021; Li et al., 2021).

Several studies indicated changes in police work made during the COVID-19 pandemic (Gaub, Cohen, & Davis, 2021; Janković, 2021; Janković & Cvetković, 2020; Kekić & Milenković, 2020). Now, with the semblance of normality, we have to decide which modifications and innovations should be retained, adopted and implemented in further work (Gaub et al., 2021). Researchers have identified four areas of adaptation to policing during the pandemic: 1) safety measures, 2) roster and posting changes, 3) impacts on training, and 4) innovation and planning (Gaub et al., 2021). Safety measures refer to wearing protective masks, gloves, keeping a certain distance from citizens, etc. (Janković & Cvetković, 2020). Another measure of adjustment in policing was related to roster and posting changes. There, it was primarily related to the drastically reduced mutual contact between police officers that was carried out through different shift work. Moreover, the redistribution pertained to the previous type of duties that the police officers performed, that is, they began to perform new, non-standard police duties. For example, the police were in charge of searching for the contacts of infected persons, so that such persons could be put into self-isolation, the suppression of the illegal

sale of medical equipment and consumer goods was intensified; they regulated queues in front of shops, prohibited gatherings of people, etc. Regarding the impact on training, recent research suggests that police educational institutions have experienced a number of impacts related to the COVID-19 pandemic. This means that different police educational institutions have responded differently not only to the challenges of the pandemic, but also to their willingness to embrace more online and alternative strategies for curriculum delivery (Davies & Al Sharefeen, 2022; White, Schafer, & Kyle, 2021).

Method

In order to assess students' perception of the role of the police in the emergency caused by the COVID-19 pandemic, a modified survey questionnaire from an earlier study conducted by Janković and Cvetković (2020) was used for the research. A structured questionnaire developed by using close-ended, multiple-choice questions, and 5-point Likert scale questions (1 for strongly disagree to 5 for strongly agree) was used in the study. Within the first part of the questionnaire, there were questions concerning demographic and socio-economic characteristics of respondents, while the second part contained questions about the role of the police in the COVID-19 pandemic. The survey was anonymous. All respondents voluntarily agreed to participate in the research conducted at the University of Criminal Investigation and Police Studies in Belgrade. Data for the research were collected from 105 students of the University of Criminal Investigation and Police Studies. The research was conducted from May to June 2022.

In this study, the demographic characteristics of respondents were calculated using descriptive statistics. To examine the relationship between assessment of the role of the police in an emergency due to the COVID-19 pandemic and dichotomous independent variables, an independent samples T-test was used. The analysis of variance (one-way ANOVA) was used to examine the relation of different groups of independent variables and variables on the student's perception of the police. All tests were two-tailed, with a significance level of $p < 0.05$. Statistical analysis was performed using SPSS Statistic 26.0.

Socio-economic and demographic characteristics

Bearing in mind the complexity of conducting the research in the state of emergency conditions, the survey respondents, 59 % women and 41 % men, were not representative of the gendered stratification of the country that registers 51.3 % of women and 48.7 % of men (Janković & Cvetković, 2020). The average age of respondents was 20.04 years of age, and the respondents who were 20 (42; 40 %) and 19 (36; 34.3 %) years of age were the most represented. Most of the respondents were first-year students (51.4%), then second-year (37.1%) and third-year students (11,4%). Most of respondents attend the academic studies of criminalistics (87.6%), while a smaller number of respondents attend the academic studies of information technology (12.4). Only one respondent had specific education in the field of emergencies. About a quarter of respondents have a family member employed in the police. A small number of respondents (32.4%) were vaccinated against the corona virus. On the other hand, 61% of respondents were not infected with the corona virus (Table 1.).

Table 1 Basic socio-economic and demographic information of respondents (n = 105).

Variable	Category	Frequency (%)	
Gender	Male	62	(59.0)
	Female	43	(41.0)
Age	19	36	(34.3)
	20	42	(40.0)
	21	16	(15.2)
	22	9	(8.6)
	23	2	(1.9)
Year of studies	First	54	(51.4)
	Second	39	(37.1)
	Third	12	(11.4)
Type of studies	Undergraduate Academic Studies of Criminalistics	92	(87.6)
	Undergraduate Academic Studies of Information Technology	13	(12.4)
Education on emergencies	Yes	1	(1.0)
	No	104	(99.0)
Family member in the police	Yes	27	(25.7)
	No	78	(74.3)
Vaccinated	Yes	71	(67.6)
	No	34	(32.4)
COVID-19 contamination	Yes, once	34	(32.4)
	Yes, more than once	10	(9.5)
	No	61	(58,1)

Results

The obtained results indicate that 61.9% of respondents believe that police officers of the Ministry of Interior wore protective face masks in contact with citizens during the COVID-19 pandemic (X=3.54), and at the very beginning, 71.4% of respondents believe (X=3.89). Contrary to such high percentages related to wearing masks, there were different responses in case of wearing protective gloves. Only 16.2% (X=2.03) of the respondents stated that police officers wore protective gloves during the pandemic, while 23.8% (X=2.28) of the respondents believe they wore them at the very beginning. In addition, 40% of respondents stated that police officers had all the necessary personal protective equipment during the pandemic, and 25.7% (X=3.08) were not sure if police officers had the specified equipment.

When it comes to preventive measures, 44.7% (X=3.15) of respondents state that police officers kept the distance of 1.5-2 m when contacting citizens during the pandemic, while 56.2% (X=3.48) of respondents believe it was done at the beginning. In contrast, 46.6% of respondents state that police officers are generally well trained to respond to the COVID-19 pandemic (X=3.30). In addition, about 56.2% of respondents point out that during the pandemic, police officers should have spent more time talking to people about their daily problems (X=3.45). The largest number of positive responses from the respondents (73.3%) of all the questions asked, stated that during the pandemic, police officers should have spent more time talking to citizens to inform them and clarify the measures the state was taking to combat the disease (X =3.92). A large percentage (71.4%) of the respondents had a positive assessment of policing during the pandemic. A large number of respondents (66.6%) believe that police officers, after health workers, have the most important role in the society in combating the corona virus (X=3.79) (Table 2).

Table 2 Results of a descriptive analysis of students' perception about police (n = 105)

	Mean	Std. Deviation	Yes (%)	Not Sure (%)	No (%)
Police officers wore masks during the pandemic	3.54	1.225	61.9	16.2	21.9
Police officers wore masks at the beginning of the pandemic	3.89	1.203	71.4	12.4	16.2
Police officers wore gloves during the pandemic	2.03	1.220	16.2	9.5	74.3
Police officers wore gloves at the beginning of the pandemic	2.28	1.431	23.8	13.3	62.9
Police officers have all the equipment against COVID19	3.08	1.246	40	25.7	34.3
Police officers kept distance during the pandemic	3.15	1.343	44.7	21.9	33.3
Police officers kept distance at the beginning of the pandemic	3.48	1.256	56.2	21	22.9
Police officers are generally well trained for the COVID19 pandemic	3.30	1.119	46.6	26.7	26.9
More talks with citizens about everyday problems	3.45	1.263	56.2	21.9	21.9
More talks with citizens to inform them about measures	3.92	1.107	73.3	16.2	10.5
Police officers performed their job well during COVID19	3.94	1.073	71.4	20.0	8.6
After health workers, police officers have the most important role in combating COVID19	3.79	1.174	66.6	18.1	15.2

T-test of independent samples was used to examine the relationship between the assessment of the role of the police in an emergency due to the COVID-19 pandemic and dichotomous independent variables. Using the mentioned test, a preliminary check of all dichotomous independent variables was performed. The only statistically significant correlation was between gender and the assessment of whether it was necessary to talk more with citizens about everyday problems during the pandemic (male - M = 3.18, SD = 1.39; female - M = 3.84, SD = 0.95; t (103) = - 2.90, p = 0.005). The results indicate that female respondents believed that during the COVID-19 pandemic, police officers should have paid more attention to talking with citizens about their everyday problems.

One-factor analysis of variance (ANOVA) was used to examine the relationship between the assessment of the role of the police in an emergency due to the COVID-19 pandemic and continuous variables. Preliminary analyses established a connection between only one continuous dependent variable (assessment of whether police officers wore masks to a sufficient extent during the COVID-19 pandemic) and one independent variable with four groups of respondents (1. respondents who had no contact with police officers, 2. who had contact only once, 3. who had contact twice and 4. who had contact with police officers several times during the COVID-19 pandemic). A one-factor analysis of variance was used to examine whether the respondent's contact with police officers during the COVID-19 pandemic had an impact on the assessment of whether police officers wore masks sufficiently during the said pandemic. The aim was to examine whether this assessment have been distinguished depending on whether they had contact with the police officers. The homogeneity of variances test was used to examine the equality of variances in the results for each of the four groups. Considering the results of Levene's test, the assumption of homogeneity of variance was not violated. According to the presented results, there is a statistically significant difference between the mean values of the mentioned groups (F = 4.55 p = 0.005). Post hoc comparisons using Tukey's HSD show that the recorded mean value of whether police officers wore masks sufficiently during the pandemic was statistically significant (p = 0.05) and different from each other in subjects who did not have contact with police officers (M = 3.28, SD = 1.24) and respondents who had contact with police officers more than once (M = 3.94, SD = 1.09)

during the COVID-19 pandemic. Judging by the results obtained, the assessment of whether police officers sufficiently wore masks during the COVID-19 pandemic is highest among respondents who had several contact with police officers during the mentioned pandemic.

Discussion

While presenting the basic socio-demographic data, it was observed that only 1/3 of the respondents were vaccinated. This information indicates that young people do not trust vaccines. Indirectly, it can be concluded that they do not have enough confidence in the state authorities that distribute vaccines. Young people definitely have stronger immunity, however, during the pandemic, a large number of young people died from the mentioned disease.

Regarding preventive measures [wearing masks (M = 3.89, 3.54), gloves (M = 2.28, 2.03) and keeping distance (M = 3.48, 3.15)], it is obvious that members of the police took the mentioned measures more intensively at the beginning of the pandemic. Although there was less protective equipment at the beginning of the pandemic than later, the measures were applied less and less as the time went on. Several things contributed to this. Primarily it was the mental fatigue, because this pandemic had been going on for more than two years, without its end in sight. Another reason was the availability of vaccines, medicines, and medical facilities, so police officers became more relaxed. The obtained results are different from the similar research conducted by Janković and Cvetković (2020) and are rather less favourable than the aforementioned research. Respondents in the research conducted by Janković and Cvetković rated police officers taking preventive measures better [wearing masks (M = 4.25), gloves (M = 4.01) and keeping a distance (M = 3.25)]. We have to emphasize that the research was conducted after the first month of the pandemic, when citizens were most afraid of infection, which could have influenced citizens' perception.

Additional statistical analysis revealed a statistically significant correlation between gender and the assessment of whether it was necessary to talk more with citizens about everyday problems during the pandemic (male - M = 3.18, female - M = 3.84). The results indicate that female respondents believed that during the COVID-19 pandemic, police officers should have paid more attention to talking to citizens about everyday problems. The explanation lies in the very nature of the female population, which is normally more sensitive than men are, therefore this trait influenced the obtained results.

The second statistical significance was determined for the variable – contact of respondents with police officers during the COVID-19 pandemic, and the variable – respondents' assessment of whether police officers wore masks sufficiently during the pandemic. The obtained results indicate that the assessment of whether police officers wore masks sufficiently is highest among respondents who had more contact with police officers during the pandemic, and is significantly lower among respondents who had no contact with police officers. Respondents who had contact with police officers had more insight into how they perform their duties and whether they use personal protective equipment, including protective masks.

In relation to the previous research conducted by Janković and Cvetković (2020), respondents in the current survey believe to a lesser extent that police officers have all the necessary equipment (3.08:3.95). In contrast, respondents believe largely than in the mentioned survey that police officers are trained to react in the COVID-19 pandemic (3.30:2.81) and that police officers should spend more time explaining the measures taken by the police during the COVID-19 pandemic (3.92:3.09).

Regarding the respondents' trust in the police during the COVID-19 pandemic, the results indicated that it was slightly lower than in the previous survey (3.94:4.33) (Janković & Cvetković, 2020). The explanation can be found in the different timing of the research, as the previous research was conducted at the beginning of the pandemic, while the current research was conducted after two years, during the apparent calm of the situation. Fear among citizens at the beginning of the pandemic was great. It was greater than today. At that time, citizens could only turn to the state, and indirectly to the police as the state representative. As the danger partially passed, citizens' trust in the police declined. The obtained results are consistent with the research conducted in Israel (Perry et al., 2022) in which it was shown that the police had strong support from citizens in the initial phase of the COVID-19 pandemic (April 2020), while later, as the pandemic lasted longer, this support has fallen (December 2020).

Similar to the previous research (Janković & Cvetković, 2020) respondents believe that police officers, after medical workers, have the most important role in combating the COVID-19 pandemic.

Conclusion

The COVID-19 pandemic was and remained a new challenge for police organizations. Therefore, they had to change the way they operate and adapt it to the new circumstances. According to the respondents, the police officers, given the lack of protective equipment and insufficient training for such situations, coped well in the new circumstances. It was assessed that the police are one of the key entities in opposing the COVID-19 pandemic. Research findings can help police organizations plan their work in possible future pandemics of infectious diseases. First, in planning the procurement of additional protective equipment and keeping it in stock, and not to procure it afterwards, such as happened in case of this pandemic. Moreover, training programs should be changed in police education; new topics related to policing in pandemics of infectious diseases should be introduced in training. Police education must be adapted to work in epidemics, primarily to be prepared for online training as much as possible. It was observed that respondents believe that police officers should talk more with citizens about their everyday needs and provide more information about the measures they undertake. Therefore, in police training, more time should be devoted to the topic of communication, both in everyday conditions, and especially in emergencies, because when there is great fear among the citizens, the police is the first they turn to for information and help.

The limitation of this research is that it was conducted on only 105 students of the University of Criminal Investigation and Police Studies in Belgrade, aged between 19 and 23. The future research should be conducted with a larger number of respondents of different ages from the general population. However, the findings of this research can help us understand the state and improvement of policing in emergencies caused by pandemics of infectious diseases and be an incentive to other researchers as a basis for further study of this topic. There are very few such studies in the scientific literature, and those related to the work of the police during the pandemic are almost non-existent.

References

Adamović, M., Milojević, S., Nikolovski, S., & Knežević, S. (2021). Pharmacy response to natural disasters. *International Journal of Disaster Risk Management*, *3*(2), 25-30.

Adams, T. M., & Anderson, L. R. (2019). *Policing in Natural Disasters: Stress, Resilience, and the Challenges of Emergency Management*. Philadelphia: Temple University Press.

Ashby, M. P. J. (2020). Changes in Police Calls for Service During the Early Months of the 2020 Coronavirus Pandemic. *Policing: A Journal of Policy and Practice, 14*(4), 1054-1072. doi:10.1093/police/paaa037

Brito, C. S., Luna, A. M., & Sanberg, E. L. (2009). *Benchmarks for developing a law enforcement pandemic flu plan*. Washington, D.C: Police Executive Research Forum.

Cvetković Vladimir, M., Pavlović, S., & Janković, B. (2021). Private security prepardness for disasters caused by fire. *NBP – Journal of Criminalistics and Law*, 26(1), 35–59. doi:10.5937/nabepo26-29443

Cvetković, V. M., & Janković, B. (2020). Private security preparedness for disasters caused by natural and anthropogenic hazards. *International Journal of Disaster Risk Management, 2*(1), 23-33. doi:10.18485/ijdrm.2020.2.1.3

Davies, A., & Al Sharefeen, R. (2022). Educating Future Police Professionals Amid Covid-19 a UAE Perspective. *Policing: A Journal of Policy and Practice, 16*(2), 282-295. doi:10.1093/police/paac009

De Camargo, C. (2021). 'It's tough shit, basically, that you're all gonna get it': UK virus testing and police officer anxieties of contracting COVID-19. *Policing and Society, 32*(1), 35-51. doi:10.1080/10439463.2021.1883609

Deflem, M., & Sutphin, S. (2009). Policing Katrina: managing law enforcement in New Orleans. *Policing: A Journal of Policy and Practice, 3*(1), 41-49. doi:10.1093/police/pan071

Domingo Dela Cruz, R., & Ormilla, R. C. G. (2022). Disaster Risk Reduction Management Implementation in the Public Elementary Schools of the Department of Education, Philippines. *International Journal of Disaster Risk Management*, *4*(2), 1-15. https://doi.org/10.18485/ijdrm.2022.4.2.1

Dukiya, J. J., & Benjamine, O. (2021). Building resilience through local and international partnerships, Nigeria experiences. *International Journal of Disaster Risk Management*, *3*(2), 11-24.

El-Mougher, M. M. (2022). Level of coordination between the humanitarian and governmental organizations in Gaza Strip and its impact on the humanitarian interventions to the Internally Displaced People (IDPs) following May escalation 2021. *International Journal of Disaster Risk Management*, *4*(2), 15-45. https://doi.org/10.18485/ijdrm.2022.4.2.2

El-Mougher, M. M., & Jarour, M. (2022). International experiences in sheltering the Syrian refugees in Germany and Turkey. *International Journal of Disaster Risk Management*, *4*(1), 1-15.

Gaub, J. E., Koen, M. C., & Davis, S. (2021). Transitioning from pandemic to normalcy: what police departments can learn from the rank-and-file. *Policing: An International Journal, 45*(1), 91-105. doi:10.1108/pijpsm-09-2021-0127

Gerell, M., Kardell, J., & Kindgren, J. (2020). Minor covid-19 association with crime in Sweden. *Crime science, 9*(1), 1-9. doi:10.1186/s40163-020-00128-3

Hansen, J. A., & Lory, G. L. (2020). Rural Victimization and Policing during the COVID-19 Pandemic. *American Journal of Criminal Justice, 45*(4), 731-742. doi:10.1007/s12103-020-09554-0

Janković, B. (2021). The Role of the Police in Disasters Caused by Pandemic Infectious Diseases. *International Journal of Disaster Risk Management, 3*(1), 41-48. doi:10.18485/ijdrm.2021.3.1.4

Janković, B., & Cvetković, V. M. (2020). Public perception of police behaviors in the disaster COVID-19 – the Case of Serbia. *Policing: An International Journal, 43*(6), 979-992. doi:10.1108/PIJPSM-05-2020-0072

Kekić, D., & Milenković, M. (2020). Role of the Serbin police in maintaining security in the conditions of the epidemic of infectious diseases. In S. Jaćimovski (Ed.), *Archibald Reiss Days, 2020* (pp. 281-290): University of Criminal Investigation and Police Studies.

Li, J. C. M., Cheung, C.-k., Sun, I. Y., Cheung, Y.-k., & Zhu, S. (2021). Work–Family Conflicts, Stress, and Turnover Intention Among Hong Kong Police Officers Amid the COVID-19 Pandemic. *Police Quarterly*. doi:10.1177/10986111211034777

Luna, A. M., Brito, C. S., & Sanberg, E. A. (2007). *Police Planning for an Influenza Pandemic: Case Studies and Recommendations from the Field*. Washington, DC: Police Executive Research Forum.

McCanlies, E. C., Gu, J. K., Andrew, M. E., & Violanti, J. M. (2018). The effect of social support, gratitude, resilience and satisfaction with life on depressive symptoms among police officers following Hurricane Katrina. *Int J Soc Psychiatry, 64*(1), 63-72. doi:10.1177/0020764017746197

Mendonça, D., Webb, G., Butts, C., & Brooks, J. (2014). Cognitive Correlates of Improvised Behaviour in Disaster Response: the Cases of the Murrah Building and the World Trade Center. *Journal of Contingencies and Crisis Management, 22*(4), 185-195. doi:10.1111/1468-5973.12057

Milojković, B., Milojević, S., Vučković, G., Janković, B., Gligorijević, M., & Jokić, N. (2015). Certain aspects of provoding use of police units in actions of protection and rescuing in case of natural disasters. In *Archibald Reiss Days* (pp. 407-422). Belgrade: The Academy of Criminalistic and Police Studies, Belgrade.

Milojković, B., Stevanović, O., Milojević, S., Vučković, G., & Janković, B. (2014). Neka iskustva iz angažovanja studenata i zaposlenih na Kriminalisitčko-policijskoj akademiji u akcijama zaštite i spasavanja od poplava 2014. godine [Some experiences from engaging students and employees at the Criminal Police Academy in the actions of protection and rescue from floods in 2014]. In *Elementarne nepogode i vanredne situacije* (pp. 255-271). Beograd: Institut za uporedno pravo i Kriminalističko-policijska akademija.

Mitrović, B., & Vučković, G. (2016). Bazična osposobljenost policajaca Ministarstva unutrašnjih poslova Republike Srbije u plivanju kao osnovnoj motoričkoj veštini neophodnoj u akcijama zaštite i spasavanja od poplava [Basic swimming competence of police officers of the Ministry of interior of Serbia as a basic motor skill required in flood protection and rescue operations]. *NBP – Journal of Criminalistics and Law, 21*(3), 61-77. doi:10.5937/nabepo21-13018

Mladjan, D., & Cvetković, V. (2012). Police deployment in emergencies caused by the abuse of weapons of mass destruction. In *Archibald Reiss Days* (pp. 533-545). Belgrade: Academy of Criminalistic and Police Studies.

Odero, N. A., & Mahiri, I. (2022). The Complacency of Flood Victims, Socio Economic Factors, and Effects and Vulnerabilities of Floods in Lower Kano Plains, Kisumu County, Kenya. *International Journal of Disaster Risk Management*, *4*(2), 59-77. https://doi.org/10.18485/ijdrm.2022.4.2.4

Perry, G., Jonathan-Zamir, T., & Factor, R. (2022). The long-term effects of policing the COVID-19 pandemic: Public attitudes toward the police in the 'new normal'. *Policing: A Journal of Policy and Practice, 16*(1), 167-187. doi:10.1093/police/paab070

Rojek, J., & Smith, M. R. (2007). Law Enforcement Lessons Learned from Hurricane Katrina. *Review of Policy Research, 24*(6), 589-608.

Sergey, K., & Gennadiy, N. (2022). Methodology for the risk monitoring of geological hazards for buildings and structures. *International Journal of Disaster Risk Management*, *4*(1), 41-49.

Shibru, M., Operea, A., Omondi, P., & Gichaba, M. (2022). Impact of 2016-2017 drought on household livestock assets and food security: the case of pastoralists and agro-pastoralists in Borana zone, southern Ethiopia. *International Journal of Disaster Risk Management*, *4*(1), 49-69.

Sommera, M., Njåb, O., & Lussandc, K. (2017). Police officers' learning in relation to emergency management: A case study. *International Journal of Disaster Risk Reduction, 21*, 70–84. doi:10.1016/j.ijdrr.2016.11.003

Stickle, B., & Felson, M. (2020). Crime Rates in a Pandemic: the Largest Criminological Experiment in History. *American Journal of Criminal Justice, 45*(4), 525-536. doi:10.1007/s12103-020-09546-0

Sukabdi, Z. A. (2016). Building community resilience: strategic role of police with bombing victims. *Police Practice and Research, 17*(2), 160-170. doi:10.1080/15614263.2015.1128162

Varano, S. P., & Schafer, J. A. (2012). Policing Disasters: The Role of Police in the Pre-Disaster Planning and Post-Disaster Responses. In M. Deflem (Ed.), *Disasters, Hazards and Law (Sociology of Crime, Law and Deviance)* (Vol. 17, pp. 83-112). Bingley: Emerald Group Publishing Limited.

Violanti, J. M., Fekedulegn, D., McCanlies, E., & Andrew, M. E. (2022). Proportionate mortality and national rate of death from COVID-19 among US law enforcement officers: 2020. *Policing: An International Journal*. doi:10.1108/pijpsm-02-2022-0022

White, D. R., Schafer, J., & Kyle, M. (2021). The impact of COVID-19 on police training academies. *Policing: An International Journal, 45*(1), 9-22. doi:10.1108/pijpsm-06-2021-0078.

DOI:https://doi.org/10.18485/ijdrm.2023.5.1.5

Research article

CHALLENGES OF WOMEN IN POST-DISASTER HEALTH MANAGEMENT: A STUDY IN KHULNA DISTRICT

Mst. Rajani Akter [1], Tuhin Roy[2], Rina Aktar[3]

[1] Social Science School, Khulna University, Khulna 9208, Bangladesh

* Correspondence: rina13@ku.ac.bd

Received: 4 May 2023; Accepted: 7 June 2023; Published: 30 June 2023

Abstract: Health management in post-disaster phase needs more attention than any other phase because this includes mitigation and recovery which is challenging for people especially women. Women play an active traditional gender roles in family with a lot of responsibilities; in post-disaster period they faced more challenges in management of health. Quantitative methods were used to assess the challenges of women in post-disaster health management, this study was carried out on Dacope Upazila (North Kamarkhola village) of Khulna District. Following simple random sampling procedure by using interview schedule, 199 participants were selected from 412 population. Both descriptive as well as inferential statistics were applied in this study, statistical tests such as Pearson's chi-square, correlation and regression had been done to test the hypotheses. Findings show that socioeconomic position like employment status of women (p<0.024), types of houses (p<0.000), monthly income (p<0.001), monthly savings (p<0.001), monthly household income (p<0.000) and household savings (p<0.019) occupation (p<0.019) and head of the household had (p<0.058) a significant relationship with the challenges of women in post-disaster health management. Monthly income and physical health problem were also correlated with the challenges. In OLS regression test it was found that health (physical and mental) and family size had great positive impact on challenges of women. The study also found that, women of North Kamarkhola village were unable to get medical facilities and maintain proper menstrual hygiene immediately after disaster. Violence against women was also a little bit increased in post-disaster period which generated challenges.

Keywords: Post disaster, health, challenges, problems, women etc.

1. Introduction

Geographically Bangladesh is situated in an active disaster zone, the people of Bangladesh always face frequent attack of different kinds of natural disaster like flood, cyclone, tsunami, earthquake, heat wave, river erosion, excessive rainfall etc. Both male and female are affected by disaster, but the women, older people and children are more vulnerable for these natural phenomena. From some significant catastrophic events of the decade it have been seen that the women of the subcontinent don't have enough knowledge about management of disaster issues and women faced severe vulnerability than men (Gokhale, 2008). Statistical data show that in 2003 by European heat wave the rate of death of older women was higher than older men, the tsunami of 2004 also caused higher death rate of women than that of men (Rahman, 2013). In Bangladesh during the disaster of 1991 and 2007 the death rate of women was more than men (Rahman, 2013). From 1797 to 2009, approximately 65 different cyclone occurred in Bangladesh which caused 53 percent of all cyclone related death and around 80 or 90 percent loss globally (Paul, 2010). Women in family play a vital role in disaster management but the contribution of them is always neglected by our larger society; the contribution of women had been seen as valueless.

Disaster can be defined as sudden accident or a natural affliction that causes great damage of life or Property. From sociological view point, disaster can be defined as a severe and unexpected condition which disrupt social structure (Blaikie et al, 2005). In this study the concept of health management indicates the role or effort of women in managing health care issues which may include medical supplies, treatment and emergency preparedness. This mainly concern the sudden activity to manage health issue after disaster. Challenge mainly used for understanding the health issues of women which is difficult for them after disaster, like nutritional issues, safe drinking water, medical support, sanitation facilities, personal hygiene Issues, homelessness, violence etc.

The role of women in family is more likely caretaker of the children and older people, they properly didn't able to run with bearing children and long hair, extra cloth makes their life miserable during disaster emergency (Chew & Ramdas, 2005). Pregnant women during and after disaster faced more problems than other women, lack of safe place for delivery, sanitary issues and environment produced the chance of infection as well as mortality (Van den Akker, de Vroome, Mwagomba, Ford, & van Roosmalen, 2011). The mortality rate during and after disaster is higher in south Asian countries. Lack of access to information technology and as a lower income country, the people of Bangladesh are able to see the destructive image of disaster, especially women are less powerful and marginal than others in our society.

Severe health problems (both mental and physical) take place after disaster and affects women and children most. In Bangladesh the policy and program about disaster management are not equal for male and female (Climate Change Cell, 2009). During disaster period different kinds of sexual and reproductive hygiene problem spread out and it also increased the prevalence of sexual harassment and domestic violence (Rahman, 2013). Sexually transmitted diseases (STD) and PTSD come out in post disaster as a result of sexual and psychological violence which have a great effects on women wellbeing as well as their family (Xiong et al., 2008). Women reproductive health issues are significant during the period of disaster which caused mortality and morbidity which also may result in infertility, stillbirth, early pregnancy loss, disabilities and serious injury(Cordero, 1993). Diarrhea, cholera, fever, skin diseases and snake bites are most common problems among the people of Bangladesh which caused by disaster (Mondal, Rashid, Rahman, & Amin, 2018). Sanitation problem in post disaster period is a serious problem for women which also responsible for health problem of their own as well as the environment damages. Food insecurity is one of the most concerning

issues after disaster which partly depended on female member of the family, lack of nutritional requirement also interrupts breast feeding of the child. Post disaster period including migration and different kinds of water contaminated and other diseases also create mental illness (Cordero, 1993).

Factors like socioeconomic, demographic, stressful life events, loss of wealth and property had significant relationship with events in recovery phase, coping mechanism and support after disaster (Freedy & Simpson Jr, 2007). This model of risk factor helps to identify the factors affecting mental and physical health problem in post-disaster period, which also emphasizes the factors that women are more emotional than men so they experienced more mental health issues in post-disaster period which produced from post-disaster recovery stressful events. This model also explains, how much importance the socioeconomic condition has in case of health problem and management.

Women during flood and other disasters unable to maintain their menstrual hygienic, most of the time they have to wash their used cloth by dirty water and they are bound to use those cloths repeatedly (Rashid & Halder, 1998). The vulnerability and challenges of women from disaster are more severe in developing and poor countries like Bangladesh, where women are less powerful and don't have any control over their own livelihood; the position of women in decision making of family issues also restricted by our society and the position of poor women are worse than that. In developing countries, a lot of challenges for women come out when they become homeless and unable to go outside without vail or permission of male person; women are even unable to get primary treatment and sanitation facilities after disaster because of the superstation. Limited study had been conducted regarding these issues in this area, so this study was designed to access the various health problems faced by women as well as to investigate the challenges of women regarding management of health issues in post-disaster period in Dacope Upazila of Khulna District.

2. Materials and methods

Observing the quantitative research design, this study is explanatory in nature as well as the study was carried out on women respondents who were chosen purposively in Kamarkhola union under Dacope Upazila of Khulna District. Area of Kamarkhola Union consists of total 6839 women, among them 412 women lived in North Kamarkhola village which was purposively selected as the area of the study, because disasters would frequently attack and create vulnerable situation for women in this area. To achieve the study objectives, some specifications were made to identify the respondents, the data were collected from i) married or widow women who lived in Kamarkhola Union (North Kamarkhola village) of Dacope Upazila at least 3 years ii) belonged to the age group of 18 to 60 years. The interview schedule containing both open and closed questions in English as well as designed for data collection. According to the aforecited a criterion by census was conducted by the research, 199 women respondents were identified from study area selected through simple random sampling. A sample size of 199 was determined regarding a confidence level of 95 and confidence interval 5.

The formula for calculating sample size was:

$$SS = SS = \frac{z^2 x\, p(1-p)}{c^2} \qquad ss_i = \frac{ss}{1+\frac{ss-1}{pop}}$$

Here, SS = Sample size, SSi = sample size according to the population, Z = Z value (e.g., 1.96 for 95% confidence level), P = percentage picking a choice, expressed as decimal (*i.e.*,0.5 used for sample size needed), C= confidence interval (*e.g., 0.5 used for sample size needed*)

Formula 1: The first formula had been used to define the sample size

$$SS=\frac{(1.96)^2\times o.5\ (1-0.5)}{(0.0500)^2}$$
$$=\frac{3.842\times 0.5\times 0.5}{0.00250000}$$
$$=\frac{0.9604}{0.002500}$$
$$\mathbf{= 384.16}$$

Formula 2: The first formula had been used for correction for finite Population

$$SS_i=\frac{\text{ss}}{1+\frac{\text{ss}-1}{\text{pop}}}$$
$$=\frac{384.16}{1+\frac{384.16-1}{412}}=\frac{384.16}{1+\frac{384.16}{412}}$$
$$=\frac{384.16}{1+0.933}=\frac{384.16}{1.933}$$
$$= 198.7 = \mathbf{199}$$

Due to pandemic situation, the researcher had to compel collecting data in different times (1st March to 31th March, 2021 and 1st September- 5th September, 2021).

Table 1: Time Schedule of Field work

Field Work	Duration	Number of Women
Census	February 5th – 10th February, 2020	412
Pre-test	20th October - 22th October, 2020	50
Data Collection	1st March- 31st March, 2021 1st September- 5th September, 2021	199

Measurement of the Variable

Table 2: Measurement of the Variable

Serial No	Variable	Measurement	Range
	Physical Health Problem in post-disaster period (Fever, Injuries, Aches and Pains, Diarrhea or Cholera, Skin Diseases)	Scale (5-point Likert scale); {1 (N = Never), 2 (R= Rarely), 3 (S = Sometimes), 4 (O= Often) to 5 (A =Always)}	5 to 11 = Low 12 to 18 = Medium 19 to 25 = High
	Mental Health Problem (Sleep Disturbance, Eating Disturbance, Depression, stress, Anxiety, Paranoid)		4 to 9 = Low 10 to 15 = Medium 16 to 20 = High
	Challenges of post-disaster health management (Medical Support/ first aid, safe drinking water, Sanitation Facilities, Personal Hygiene and Gynecological Issues, victim of violence)		5 to 14 = Low o 25 = High

Form their findings the hypotheses were: i) relationship between loss of wealth/property and psychological impact on women during post disaster period ii) loss of shelter during post disaster period is associated with mental impact on women iii) poor socio-economic condition is associated with producing challenges iv) and relation between access of pure drinking water and prevalence of diseases in post disaster period. Personal and socio-economic background of the respondent were analyzed through descriptive statistics (frequency distribu-

tion) and different statistical tests like Pearson's Chi-square, correlation and OLS regression model were utilized to measure the relationship of different variables.

4. Results

Personal Information of the Respondent

Table no. *3* represents the personal information of *199* women of north Kamarkhola village of Dacope Upazilla who had faced different kinds of disaster in their lifetime. Table shows that the majority of the respondents belonged to the age group of *34* to *47* years and the average age of the respondents was around *39* years old with standard deviation *9.79*. Most of the respondents around *62* percent were the followers of Hinduism and rest of them (*38.7%*) were the followers of Islam. *45.7* percent of them were able to reach primary education which was the highest number around *28* percent of the respondents completed secondary level education and even only *1* percent of them were able to reach tertiary level of education; the average educational qualification was *5.45* class with standard deviation *3.67*. Approximately *90* percent of the respondents were married and only *9.5* percent of them were widow.*84.4* percent from the total respondent were unemployed and rest *15.6* percent were employed. Most of them were housewives (*84.4%*); *7* percent of them were day laborer, *2.5* percent were tailor, *3* percent of them were job holder and rest *3* percent were involved in family-based business. As most of the respondents were housewives, they *(84.4%)* didn't have any income, only *1* percent of the respondent had higher income comparing with others; other *11.1* percent had lower income which was between BDT *5000* to BDT *8000* and *3.5* percent of them had middle range income, the average income of the earned respondents was BDT *7580.65* with *2705.23* standard deviation. The average monthly expenditure of the respondents was BDT *2563.11*. Moreover, *92* percent of the respondents had no savings and only *8* percent had savings around BDT *500* to BDT *1000* where standard deviation was *201.56*.

Table 3: Personal Information of the Respondent

Variable Name	Frequency (%)	Mean (SD)
Age		
20-33	61 (30.7)	
34-47	89 (44.7)	38.97 (9.79)
48-60	49 (24.6)	
Religion		
Islam	77 (38.7)	
Sanatan	122 (61.3)	
Year of Schooling		
Illiterate	39 (19.6)	
Primary Level	91 (45.7)	
Secondary Level	55 (27.6)	5.45 (3.67)
Higher Secondary	12 (6.0)	
Tertiary Level	02 (01)	
Marital Status		
Married	180 (90.5)	
Widow	19 (9.5)	
Employment Status		
Unemployed	168 (84.4)	
Employed	31 (15.6)	

Occupation of the Respondent		
Housewife	168 (84.4)	
Tailor	5 (2.5)	
Day labor	14 (7.0)	
Job holder	6 (3.0)	
Business	6 (3.0)	
Monthly Income of the Respondent		
No income	168 (84.4)	7580.65 (2705.23)
5000-8000	22 (11.1)	
9000-12000	7 (3.5)	
13000-15000	2 (1)	
Monthly Expenditure of the Respondent		
No expenses	96(48.2)	2563.11 (3244.90)
≤2000	74 (37.2)	
2001-8000	21 (10.6)	
8001-15000	8 (4)	
Monthly Savings of the Respondent		
No savings	183 (92)	906.25 (201.56)
Have savings	16 (8)	

Household survey, 2020-2021

Household Information of the Respondent

Table number *4* is about the household information of the respondent. *53.8* percent of the respondents lived in nuclear family which were more than half of the total respondents and most of the family (*63.8%*) had 5 or more than 5 family members; average family member was *5.18*. Maximum heads of the household were husband and only *3.5* percent respondents were the head of their own household. *60.3* percent household were regulated by single income. The average total monthly income of the respondent's house was BDT *15080.40*; besides this the average expenditure of those household were BDT *14859.30* with Standard deviation of *5519.28*. Most of the household had no savings which was around *83* percent and average savings for each family was BDT *942.86*. Around *51* percent of the households had semi-pakka house and around *73* percent of the respondents had traditional sanitation facilities. Most of the respondents (*33.2%*) used to drink water from pond which was given by the government and NGOs. Besides, *27.6* percent respondents used to drink rain water by preserving it for years. The main source of power for most of the household (*81.9%*) was electricity. All of the respondents would response positively to the questions of damage of the house and property during disaster like flood, water logging or cyclone. Around *46.7* percent of the respondents had to face much damage in post-disaster period and only *10* percent of them were the sufferers of less damage in case of property and house.

Table 4: Household Information of the Respondent

Variable Name	Frequency (%)	Mean (SD)
Types of Family by Nature		
Nuclear	107 (53.8)	
Extended	92 (46.2)	
Family Size		
≤4	72 (36.2)	5.18 (1.532)
5≥	127 (63.8)	
Head of the Household		
Husband	141 (70.9)	
Self	7 (3.5)	
Others	51 (25.6)	
Types of Family by Income		
Single earned	120 (60.3)	
Dual Earned	79 (39.7)	
Monthly Household Income		
5000-12000	89 (37.7)	
13000-20000	116 (58.3)	15080.40 (5477.56)
21000≥	14 (7.0)	
Monthly Household Expenditure		
5000-12000	71 (35.7)	14859.30 (5519.28)
13000-20000	116 (58.3)	
2100≥	12(6.0)	
Monthly Savings of the Household		
No savings	164 (82.4)	942.86 (161.40)
Have savings	35 (17.6)	
Types of Houses		
Kathcha	86 (43.2)	
Semi-pakka	101 (50.8)	
Pakka	12 (6.0)	
Types of sanitation		
Traditional	145 (72.9)	
Modern	54 (27.1)	
Sources of Drinking Water		
Pond	66 (33.2)	
Deep Tubewell	36 (18.1)	
Rain Water	55 (27.6)	
Others	42 (21.1)	
Sources of Power		
Solar	32 (16.1)	
Electricity	163 (81.9)	
Others	4 (2.0)	
Information about loss of house and property		
Yes	199 (100)	
No	0 (0)	
Level of Damage by Disaster		
Less Damage	20 (10.1)	
Medium Damage	86 (43.2)	
Much Damage	93 (46.7)	

Household survey, 2020-2021

Health Problems and Challenges in Post-disaster Period

This section is about the post-disaster effects on health and challenges of women in managing the situation which was measured by scale value. According to the collected data it was seen that large proportion of the respondents (around *65* percent) experienced medium level of physical health problems in post disaster period including fever, diarrhea, skin disease, aches and pain. Only *2* percent of the respondents had to face low physical health problems and other *32.2* percent had to face higher problems. Disasters had strongly affected on psychological health. *50.8* percent respondents had to face higher mental health problem, besides, *47.2* percent faced medium mental health problem and only *2* percent faced lower problem in post-disaster period. In this section lower response indicate higher level of challenges and higher response indicates comparatively lower challenges. Moreover, 94 percent respondents had to serious challenges of post-disaster and didn't get any facility to face those challenges. They mainly had to face the problem of getting first aid, availability of drinking water, sanitation facilities etc.

Table 5: Health Problems and Challenges in Post-disaster Period

Physical Health Problem in Post-disaster Period		
Low (5-11)	4 (2.0)	
Medium (12-18)	131 (64.8)	16.60 & 2.79
High (19-25)	64 (32.2)	
Mental Health Problem in Post-disaster Period		
Low (4-9)	4 (2.0)	
Medium (10-15)	94 (47.2)	15.22 & 2.83
High (16-20)	101 (50.8)	
Facilities to Face Challenges of Women in Post-disaster period		
Low (5-14)	187 (94.0)	11.05 & 2.09
High (15-25)	12 (6.0)	

Household survey, 2020-2021

Physical Health Problems in Post-disaster Period and Its Covariates (Chi-square test)

Pearson's Chi Square test had been done to show the association between socio-economic variables and physical health problem. Table shows that, marital status (fisher's exact test=12.132, $p<0.002$), types of family (fisher's exact test=16.311, $p<0.000$), sources of drinking water (fisher's exact test=31.881, $p<0.000$) and mental health problem (fisher's exact test=31.948, $p<0.000$) were highly significant with the physical health problem which was experienced by women in post-disaster period.

Table 6: Physical Health Problems in Post-disaster Period and its Covariates

Independent Variables	Physical Health Problems in Post-disaster Period			Test Statistics$_{(df)}$	P value
	Low (5-11)	Medium (12-18)	High (19-25)		
Marital Status of the Respondents					
Married	2 (1.1)	115 (63.9)	63 (35.0)	12.132^{b} $_{(2)}$	0.002**
Widow	2 (10.5)	16 (84.2)	1 (5.3)		
Types of Family by Nature					
Nuclear	2 (1.9)	85 (79.4)	20 (18.7)	16.311^{b} $_{(2)}$	0.000**
Extended	2 (2.2)	46(50)	44 (47.8)		
Sources of Drinking Water					
Pound	0 (0)	31 (47)	35 (53)	31.881^{b} $_{(6)}$	0.000**
Deep Tube-well	0 (0)	24 (66.7)	12 (33.4)		
Rain Water	0 (0)	42 (76.4)	13 (23.6)		
Others	4 (9.5)	34 (81)	4 (9.5)		
Mental Health Problem in Post-disaster Period					
Low	0 (0)	4 (100)	0 (0)	31.948^{b} $_{(4)}$	0.000**
Medium	4 (4.3)	76 (80.9)	14 (14.9)		
High	0 (0)	51 (50.5)	50 (49.5)		

^{b} Fisher's exact test reported (expected cell less than 5)

$^{**}p\leq0.01$, $^{*}p\leq0.05$

Mental Health Problems in Post-disaster Period and its Covariates (Chi-square test)

Table number 7 is about the mental health problem of women in post-disaster period and its covariate. Pearson's Chi Square test had been done to elaborate the association between variables. It is found that, types of family (nature) (fisher's exact test=8.009, p<0.010), head of the household (fisher's exact test=11.309, p<0.017), types of family (income) (fisher's exact test=10.677, p<0.003), year of schooling (fisher's exact test=34.938, p<0.000), and physical health problem (fisher's exact test=31.948, p<0.000), faced by women in post-disaster period had a higher level of significance with the mental health problem of the respondents.

Table 7: Mental Health Problems in Post-disaster Period and its Covariates

Independent Variables	Mental Health Problems in Post-disaster Period			Test Statistics$_{(df)}$	P value
	Low (4-9)	Medium (10-15)	High (16-20)		
Types of Family by Nature					
Nuclear	4 (3.7)	42 (39.3)	61 (57)	8.009^{b} $_{(2)}$	0.010**
Extended	0 (0)	52 (56.5)	40 (43.5)		
Head of the Household					
Husband	4 (2.8)	58 (41.1)	79 (56)	11.309^{b} $_{(4)}$	0.017**
Self	0 (0)	2 (28.6)	5 (71.4)		
Others	0 (0)	34 (66.7)	17 (33.3)		
Types of Family by Income					
Single Earned	4 (3.3)	46 (38.3)	70 (58.3)	10.677^{b} $_{(2)}$	0.003**
Dual Earned	0 (0)	48 (60.8)	31 (39.2)		
Year of Schooling of the Respondents					

Illiterate	0 (0)	12 (30.8)	27 (69.2)		
Primary Level	0 (0)	40 (44)	51 (56)		
Secondary Level	0 (0)	34 (61.8)	21 (38.2)	$34.938^{b}_{(8)}$	0.000^{**}
Higher Secondary	4 (33.3)	6 (50)	2 (16.7)		
Tertiary Level	0 (0)	2 (100)	0 (0)		
Physical Health Problem in Post-disaster Period					
Low	0 (0)	4 (100)	0 (0)		
Medium	4 (3.1)	76 (58)	51(38.9)	$31.948^{b}_{(4)}$	0.000^{**}
High	0 (0)	14 (21.9)	50 (78.1)		

[b] Fisher's exact test reported (expected cell less than 5)

$^{**}p \leq 0.01$, $^{*}p \leq 0.05$

Challenges of Women in Post-disaster Health Management and Its Covariates (Chi-square test)

A Pearson's Chi Square test for independence with α= .05 had been done to exhibit the relation between different variables and challenges of women in post-disaster period which showed that employment status of women (fisher's exact test= 4667, $p<0.024$) was significant with challenges of women. Another result shows the significant connection between occupation and challenges (fisher's exact test=10.928, $p<0.019$). According to the independence test head of the household was also significant with the challenges faced by women in Dacope Upazila (fisher's exact test= 10.928, $p<0.058$). Challenges of women were highly significant with types of houses (fisher's exact test= 16.023, $p<0.000$), table illustrates that the monthly income (fisher's exact test= 16.201, $p<0.001$) and monthly savings (fisher's exact test= 14.990, $p<0.001$) of the respondent were also significant with challenges. Side by side, monthly household income (fisher's exact test=19.994, $p<0.000$) and household savings (fisher's exact test=7.029, $p<0.019$) were significant with the challenges. Moreover, both physical (fisher's exact test=6.352, $p<0.044$) and mental (fisher's exact test=6.483, $p<0.043$) health problems of the respondent were also significant with the challenges.

Table 8: Challenges of Women in Post-disaster Health Management and Its Covariates (Chi-square test)

Independent Variables	Challenges of Women		Test Statistics$_{(df)}$	P value
	Low (5-14)	High (15-25)		
Employment Status of the Respondents				
Unemployed	161 (95.8)	7 (4.2)	$4.667^{b}_{(1)}$	0.024^{*}
Employed	26 (83.9)	5 (16.1)		
Occupation of the Respondents				
Housewife	161 (95.8)	7 (4.2)		
Tailor	4 (80)	1 (20)		
Day Labor	13 (92.9)	1 (7.1)	$10.928^{b}_{(4)}$	0.019^{*}
Job Holder	5 (83.3)	1 (16.7)		
Business	4 (66.7)	2 (33.3)		
Head of the Household				
Husband	133 (94.3)	8 (5.7)		
Self	5 (71.4)	2 (28.6)	$10.928^{b}_{(2)}$	0.058^{*}
Others	49 (96.1)	2 (3.9)		
Types of houses				

Kathcha	76 (88.4)	10 (11.6)		
Semi-pakka	101 (100)	0 (0)	$16.023^{b}{}_{(2)}$	0.000^{**}
Pakka	10 (83.3)	2 (16.7)		
Monthly Income of the Respondent				
No income	161 (95.8)	7 (4.2)		
5000-8000	21 (95.5)	1 (4.5)	$16.201^{b}{}_{(3)}$	0.001^{**}
9000-12000	3 (42.9)	4 (57.1)		
13000-15000	2 (100)	0 (0)		
Monthly Savings of the Respondents				
No savings	176 (96.2)	7 (3.8)	$14.990^{b}{}_{(1)}$	0.001^{**}
Have savings	11 (68.8)	5 (31.3)		
Total Income of the Household (monthly)				
5000-12000	59 (85.5)	10 (14.5)		
13000-20000	116 (100)	0 (0)	$19.994^{b}{}_{(2)}$	0.000^{**}
21000≥	12 (85.7)	2 (14.3)		
Monthly Household Savings				
No Savings	158 (96.3)	6 (3.7)	$7.029^{b}{}_{(1)}$	0.008^{*}
Have Savings	29 (82.9)	6 (17.1)		
Physical Health problems				
Low	4 (100)	0 (0)		
Medium	127 (96.9)	4 (3.1)	$6.352^{b}{}_{(2)}$	0.044^{*}
High	56 (87.5)	8 (12.5)		
Mental Health Problems				
Low	4 (100)	0 (0)		
Medium	84 (89.4)	10 (10.6)	$6.483^{b}{}_{(2)}$	0.043^{*}
High	99 (98)	2 (2)		

[b] Fisher's exact test reported (expected cell less than 5)

$^{**}p \leq 0.01$, $^{*}p \leq 0.05$

Bivariate Correlation

Table number 9 illustrates the direction and strength of relationship between challenges of women in post-disaster health management and its covariates. Monthly income (r=.153*) and physical health problem (r=.150**) had lower positive correlation with challenges faced by the respondents. Surprisingly it is found that, year of schooling, family size and mental health problem had no significant relationship with the challenges.

Table 9: Challenges of Women in Post-disaster Health Management and its Covariates (Correlation).

Variables	1	2	3	4	5	6
1. Challenges						
2. Year of Schooling	.100					
3. Monthly Income	$.153^{*}$	$.189^{**}$				
4. Family Size	.122	-.084	-.104			
5. Physical Health Problems	$.250^{**}$	-.078	.068	-.085		
6. Mental Health Problems	-.114	$-.402^{**}$	-.008	-.007	$.389^{**}$	

*p≤0.05, **p≤0.01

Low= ≤ .29, Moderate= .30-.49, High= ≥ .50

Ordinary Least Square Regression

Table 10 displays the ordinary least square regression predicting Challenges of Women in Post-disaster Health Management where independent variables were some variables and the value of R^2 = .152 which implies in this study that mentioned variables clarified the challenges of women 15 percent. Among the factors, physical health problem (β=.339**), mental health problem (β=.218**), and family size (β=.145*) positively impacted on the challenges of women in post-disaster health management. On the other hand, age of the participants and year of schooling had no impact on challenges of women in post-disaster health management.

Table 10: OLS Predicting Challenges of Women in Post-disaster Health Management

Independent Variable	Dependent Variable: *Challenges of Women*
	β (S.E.[a])
R^2	**.152**
(Constant)	6.746 (1.432)
Factors	
Age	.136 (.017)
Year of Schooling	.129 (.050)
Family Size	.145* (.091)
Physical Health Problem	.339** (.055)
Mental Health Problem	.218** (.059)

[a] Standard Error
$^{*}p\leq0.05$, $^{**}p\leq0.01$

5. Discussion

According to the collected data it was seen that large proportion of the respondents (around *65* percent) experienced medium level of physical health problems in post disaster period including fever, diarrhea, skin disease, aches and pain. Only *2* percent of the respondent's had to face low physical health problems and other *32.2* percent had to face higher problems. On the contrary, Mondal et al. (2018) found that physical health problems in post-disaster period like cholera, diarrhea, fever, skin diseases had strong correlation with drinking water. *50.8* percent respondents had to face higher mental health problem, besides, *47.2* percent faced medium mental health problem and only *2* percent faced lower problem in post-disaster period. Another study of (Schwartz, Liu, Lieberman-Cribbin, & Taioli 2017) tried to find out the mental effect of disaster as a result from Hurricane Sandy at New York which takes place in 2012. Moreover, 94 percent respondents had to serious challenges of post-disaster and didn't get any facility to face those challenges. On the other hand, another study found that, women took more challenge and responsibility than men during and after disaster, researcher found that the reason of women vulnerability is poverty and traditional gender role in family (Reyes & Lu 2016).

In this study it also found a significant association between those physical health problems and sources of drinking water (fisher's exact test=31.881, p<0.000). In this study also found that year of schooling (p<0.000), classification of family by income (p<0.003) and mental health problem (p<0.000) were highly associated with mental health problem (Schwartz, Liu, Lieberman-Cribbin & Taioli ,2017) also found a positive association between loss of wealth and property with mental health effects of disaster in post-disaster period. In the contrary,

Bell and Folkerth (2016) had found a strong correlation between mental illness from disaster and domestic violence which was also seen from qualitative part of this research paper.

Apart from socioeconomic condition and other facilities create challenges for women in post disaster period, the study was mainly designed to know the challenges of women in post-disaster period. Mondal et al. (2018) showed that married women faced more challenges than other but unfortunately there was no significant relationship between marital status and challenges in this study; one the other hand, physical health problems had higher level of significance with marital status (p<0.002) of women. Reyes & Lu (2017) identified that vulnerability and challenges mostly depend on socio-economic background of the people. There were also a significant association which had been found between health (physical p<0.044, & mental p<0.043) problem and challenges. Result from correlation, it was found that monthly income (r=.153*) and physical health problem (r=.150**) had lower positive relation with challenges of women but year of schooling, family size and mental health problem had no significant relationship with the challenges.

However, according to the study of Rashid & Halder (1998) and Mondal et. al (2018), women during flood and other disasters didn't have access to medical facilities, menstrual hygiene as well as sanitation which makes post-disaster phase more challenging for them. In this study it was found that, most of the women in Dacope Upazila didn't get access to use proper sanitation and medical facilities. Just after disasters they were unable to get essentialities like drinking water, first aids and menstrual equipment which compelled them to live in the unhygienic situation. Most of the women in North Kamarkhola village at post-disaster period reused old cloths as menstrual equipment which even they didn't wash properly. Rahman (2013) and Sohrabizadeh et al. (2017) found that women experienced more violence and domestic roles in post-disaster period because of their loss of wealth and economic insecurity. In this study it was also found that post-disaster phase brought a lot of pressure on women by increasing their work (reconstruction) which was crying need for their recovery.

Conclusion

The findings suggested that many socio-economic statues such as employment, income as well as savings (both personal and household), and house type were the main factors to face the challenges of women in post-disaster period. Both physical health problem and mental health problems contributed a lot to impact on the challenges of women. Proper medical facilities were absent in post-disaster period, so women had to face in their physical problems. Besides, pure drinking water was not available in post-disaster period and this was more responsible to make the situation worse for the women. So, government of Bangladesh should give more focus to the women of this area so that they can be able to maintain a standard of living with proper health and medical facilities. Present government of Bangladesh, has already taken a program to ensure health facilities of women and children and established 13,000 community clinics around the country, many women are still unaware of the facilities. Awareness programs should be increased by governments as well as NGOs. NGOs should come forward to ensuring awareness of proper health management in post-disaster period. Finally, more research is expected to identify the challenges faced by women in post-disaster period and then the authority will take the steps to the welfare of health management among the women in Bangladesh.

References

Bell, S. A., & Folkerth, L. A. (2016). Women's Mental Health and Intimate Partner Violence Following Natural Disaster: A Scoping Review, *Prehospital and disaster medicine, 31(6), 648-657*, Doi: 10.1017/S1049023X16000911.

Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (2005). At Risk: Natural Hazards, People's vulnerability and Disasters, USA and Canada: Routledge, London and New York ISBN: 1134887086.

Chew, L., & Ramdas, N. (2005). Caught in the Storm: The Impact of Natural Disasters on Women Caught in the storm: The impact of natural disaster on women, San Francisco, USA. The Global Fund for Women. Retrived 11.12.2019, fromhttps://www.globalfundforwomen.org/wpcontent/uploads/2006/11/disasterre port.pdf.

Climate Change Cell. (2009). Climate Change, Gender and Vulnerable Group in Bangladesh, Ministry of Environment and Forests, Department of Environment. Dhaka: Climate Change Cell. Retrieved 12 11, 2019, from http://www.climatechangecell-bd.org

Cordero, J. F. (1993). The Epidemiology of Disasters and Adverse Reproductive Outcomes: Lessons Learned, *Environmental Health Perspectives, 101(suppl 2), 131-136*, doi: 10.1289/ehp.93101s2131.

Freedy, J. R., & Simpson Jr, W. M. (2007). Disaster-related physical and mental health: A role for the family physician, *American family physician, 75(6), 841-846.*

Gokhale, V. (2008). Role of Women in Disaster Management: An Analytical Study with Reference to Indian Society, Paper presented at the 14th World Conference on Earthquake Engineering Chaina, Retrived 11.12.2009, from https://www.iitk.ac.in/nicee/wcee/article/14_10-0049.PDF.

Mondal, M., Rashid, M. A., Rahman, S., & Amin, M. N. (2018). Challenges and Coping Strategies of Married Women in Post Disaster Situation: A Study on Khulna District, *Advances in Sciences and Humanities, 4 (3), 37-44*, Doi: 10.11648/j.ash.20180403.11.

Paul, B. K. (2010). Human Injuries Caused by Bangladesh's Cyclone Sidr: An Empirical Study, *Natural hazards, 54(2), 483-495*, Doi: 10. 1007/s11069-009-9480-2.

Rahman, M. S. (2013). Climate Change, Disaster and Gender Vulnerability: A study on Two Divisions of Bangladesh, *American Journal of Human Ecology, 2(2), 72-82*, Doi: 10.11634/216796221302315.

Rashid, S., & Halder, S. (1998). Floods of 1998 and BRAC–A case study on three slums in the Dhanmandi area of Dhaka city, Unpublished report, Dhaka.

Reyes, D. D., & Lu, J. L. (2016). Gender Dimension in Disaster Situations: A case study of Flood Prone Women in Malabon City, Metro Manila, *International Journal of Disaster Risk Reduction, 15, 162-168,* Doi: 10.1016/j.ijdrr.2015.11.001.

Reyes, D. D., & Lu, J. L. (2017). Gender Dimensions and Women's Vulnerability in Disaster Situations: A case study of Flood Prone Areas Impacting Women in Malabon City, Metro Manila, *Journal of International Women's Studies,18(4), 69-88,* http://vc.bridgew.edu/jiws/vol18/iss4/6.

Schwartz, R. M., Liu, B., Lieberman-Cribbin, W., & Taioli, E. (2017). Displacement and Mental Health After Natural Disasters, *The Lancet Planetary Health, 1(8), e314*, Doi: 10.1016/S2542-5196(17)30138-9.

Sohrabizadeh, S., Jahangiri, K., Jazani, R. K., Babaie, J., Moradian, M. J., & Rastegarfar, B. (2017). Women's challenges and capabilities in disasters: A case report of the twin earthquakes of Eastern Azerbaijan, Iran. PLo Scurrents, 9.doi:10.1371.

Sohrabizadeh, S., Tourani, P., Sogand, & Khankeh, H. R. (2016). Women and Health Consequences of Natural Disasters: Challenge or Opportunity? Women & health, 56(8), 977-993, Doi: 10.1080/03630242.2016.1176101 54.

Van den Akker, T., de Vroome, S., Mwagomba, B., Ford, N., & van Roosmalen, J. (2011). Peripartum Infections and Associated Maternal Mortality in Rural Malawi, *Obstetrics & Gynecology, 118(2), 266-272*, Doi: 10.1097/AOG.0b013e3182254d03.

Van Kamp, I., Van der Velden, P. G., Stellato, R. K., Roorda, J., Van Loon, J., Kleber, R. J., Lebret, E. (2005). Physical and Mental Health Shortly After a Disaster: First Results from the Enschede Firework Disaster Study, *The European Journal of Public Health, 16(3), 252-258*, Doi: 10.1093/eurpub/cki188.

Xiong, X., Harville, E. W., Buekens, P., Mattison, D. R., Elkind-Hirsch, K., & Pridjian, G. (2008). Exposure to Hurricane Katrina, Post-Traumatic Stress Disorder and Birth Outcomes, *The American journal of the medical sciences, 336(2), 111-115*, Doi: 10.1097/MAJ.0b013e318180f21c.

Yzermans, J., Donker, G., & Vasterman, P. (2004). The Impact of Disasters: Long Term Effects on Health Public Health in Europe (pp. 317-341), Berlin, Heidelberg: Springer, Doi: 10.1007/978-3-642-18826-8_2.

DOI:https://doi.org/10.18485/ijdrm.2023.5.1.6

Research article

RELIGION INFLUENCE ON DISASTER RISK REDUCTION: A CASE STUDY OF SERBIA

Vladimir M. Cvetković,[1,2,3,*], Saša Romanić[2,3], Hatidža Beriša[4]

[1] Faculty of Security Studies, University of Belgrade, Gospodara Vučića 50, 11040 Belgrade, Serbia

[2] International Institute for Disaster Research, Dimitrija Tucovića 121, 11056 Belgrade, Serbia;

[3] Scientific-Professional Society for Disaster Risk Management, Dimitrija Tucovića 121, 11056 Belgrade, Serbia; (S.R) - sasharoma77@yahoo.com;

[4] School of National Defense, University of Defense, Veljka Lukića Kurjaka 33, Belgrade; hatidza.berisa@mod.gov.rs

* Correspondence: vmc@fb.bg.ac.rs

Received: 1 May 2023; Accepted: 20 June 2023; Published: 30 June 2023

Abstract: Human perception of nature and God have always been inextricably linked. In order to understand nature and its inherent processes, including various natural hazards, the reasons for their origin were often attributed to God's will, suffering for sin and the similar. Fear of material and human losses prompted a man to pray and offer sacrifices/gifts and other rituals to appease the "wrath of the gods". The progress of civilization and technology has not alleviated the destruction and trauma that natural disasters inflict on all aspects of social life. A major obstacle to this is the exponential population growth in vulnerable areas. The frequency of natural disasters and the fatalistic attitudes that limit the effective fight against them have motivated religious communities and individuals to cooperate with international and international organizations and institutions to reduce the risk of local disasters. Believers thus receive the necessary psychological and financial assistance and support from religious communities during all phases of disaster management. Therefore, the subject of this paper is a comprehensive examination relationship between the degree of religiosity of the population and how this connection impacts the policy of reducing disaster risk. The aim of the research is to scientifically describe the nature of the relationship between the degree of religiosity of citizens and different segments of disaster risk reduction.

Keywords: disasters, influence, risk reduction, religion, Serbia**.**

1. Introduction

The impossibility of preventing and predicting natural hazards (Sergey, 2021; Dukiya & Benjamine, 2021; Adamović et al., 2021) caused continuous anxiety and fear among people. Nature, for the man of that time, represented something great and inexplicable for the man of that time the myth of Noah's Ark, ancient human communities felt powerless before its destructive effects (Korstanje, 2019). One example is the Aboriginal culture, in which disasters have been attributed to gods and deities since time immemorial, and all events in nature are perceived as punishments and revenge for their sins, i.e. violated moral codes (Korstanje, 2019). Such examples can also be found in Slavic mythology – Perun punishes with thunderbolts, while in Greece, Poseidon reprimands with waves (Dragnea, 2013). By offering sacrifices and gifts, a man tried to appease the wrath of the gods and satisfy their will (Harl, 1990).

Religion is a set of human norms and values based on faith in something more than human authority – faith in an order that transcends human authority (Harari, 2019). To unite vast expanses, religion must follow a comprehensive order that transcends human authority and extends belief to all men. Therefore, it must be comprehensive and missionary in order to unite the vast expanses. Islam and Buddhism are two examples of such religions. Ancient religions were limited to a small geographical area and were exclusive. These religions, in addition to money, make a key contribution to the unification of humanity (Harari, 2019).

In different religions, similar deities exist in parallel, as well as similar behaviors of people. Thus, Slavs celebrate God Perun – God of thunder, sky and atmosphere; Greeks Poseidon – God of the sea; Scandinavians – God of the sea Aegir; Polynesians - Earthquake God Mafuia (Adeney-Risakotta, 2009). The testimonies of survivors of disasters and various prophecies are recorded in epics, fairy tales and holy books; for example, the Biliblia describes various disasters over time, from solar eclipses and the Great Flood to hail and storms. In addition to the Bible, the phenomenon of the Flood is also mentioned in the Epic of Gilgamesh, the Indian Mahabharata and the Greek Deucalion (Hossieni, 2018). The fear of water and floods, which today are one of the most frequent and devastating natural disasters, originates from myths and legends. With the development of human society, there have been changes in the perception of the world and the environment. Thus, people begin to see specific patterns and cycles in nature, seasons, create calendars, etc. The desire for survival necessarily led to adapting to nature, following cycles and changes.

Natural hazards are primarily the result of the action of natural forces, but an increasing share in their generation nowadays is also attributed to the human factor (Sherry & Curtis, 2017; Domingo & Ormila, 2022; El-Mougher, 2022; Dukiya & Adelete, 2022; Odero & Mahiri, 2022; Podder et al., 2022). Through inadequate management of natural resources, continuous and increasingly serious pollution of air, soil and water, man contributes to the occurrence of various disasters, from landslides to nuclear disasters, climate and relief changes. Despite this, deity-enhanced explanations of natural hazards are still present to some extent around the world (Kulatunga, 2010). For example, there is a noticeable tendency in Christianity to describe actual and potential victims in theistic terms, even when they are familiar with alternative scientific achievements and explanations; "Theodicy" is a term that describes an attempt to reconcile God's love, justice and omnipotence with human sacrifice and suffering (Chester, 2005).

Disaster risk perception is a multidimensional concept for understanding which information on how to interpret disaster misunderstanding conditions is imperative (Stumpf et al., 2017). For example, the very decision to evacuate in the response phase to a natural disaster is primarily determined by risk perception (Kinateder et al., 2015). The factors that participate in the process of forming risk perception are numerous. The social community to which an

individual belongs, including its cultural framework, is undoubtedly one of them (Schmidt, 2004). Thus, people's perceptions of natural, spiritual and social phenomena are socially constructed categories. Social perception is important because it helps people understand and interact with the physical and social world (Bempah & Øyhus, 2017). The psychological connection between religions and disasters is manifested in the adaptation or tolerance of negative events in religious persons, in three ways (Bentzen, 2019): maintaining closeness to God, nurturing a sense of meaning and purpose in life; participation in various religious adjustment activities, committing minor sins, participating in the work of church groups; searching for reasons for certain events, tragedies that are God's work, God's punishment, etc.

1.1. Literary review

During the past few years, the role of religion in disaster management has attracted the attention of researchers (Gianisa & Le De, 2018), although research on this topic in domestic literature is still scarce. The relationship between human behavior and perception has long been documented (Bempah & Øyhus, 2017), and the belief system of individuals is one of the dominant factors that influence the way of interpreting and responding to disaster risks (Sherry & Curtis, 2017). These socio-cognitive patterns are of particular importance for the phase of prevention and preparedness, because they can shed light on certain behaviors of the population and their attitude towards disaster risks. However, there is no consensus in the literature as to the nature of this effect. For example, one discourse emphasizes the positive role of religion in disaster conditions and after it (Sun & Han, 2018), while others indicate that religion can generate a low perception of disaster risk (Sachdeva, 2017) and fatalistic attitudes in the face of such events (Gianisa & Le De, 2018).

According to one theory, new generations of young people are more educated than previous generations, which reduces their commitment to religion and its practice (Arias-Vazquez, 2012). However, Schwadel (2015) emphasizes that the negative effect of education on the scale of religiosity should be taken with a grain of salt, bearing in mind that there is significant variation among nations, and that this effect is most pronounced in nations that are relatively religious. Therefore, when mitigating the effect of education on the level of religiosity, it is vital to know the national context. On the other hand, in the literature we come across theories that claim that young people become more religious with the passage of years in life, especially when they have children (Bengtson, Silverstein, Putney, & Harris, 2015; Gallagher, 2007). When it comes to young people, the most important predictors of religiosity appear to be church attendance during high school by peers and ethnicity. Also, the role of gender, place of residence, religious education and church attendance during childhood, mother's religiosity and mother's attitude towards religious education during childhood, as the primary religious role model in childhood, is not negligible (Gunnoe & Moore, 2002).

Gianisa and Le De (2018) indicate that religious customs and beliefs influence the connection of people in the local community and lead to successful coping with disasters. The role of religious communities is particularly prominent in eliminating gaps in response and recovery, especially when external intervention is inadequate or insufficient (Gianisa & Le De, 2018). Through religion, people get support, collective thinking and response to specific dangers are formed. In most countries, there are multiple religions and religious communities. All of them show both similar and their own specific behavior. Spiritual beliefs positively affect health, increasing optimism and reducing depression, substance use and abuse, suicide, and risky behavior (Weber & Pargament, 2014; Abdel-Khalek & Lester, 2007). The benefits of religion on mental health are also reflected in encouraging forgiveness, gratitude and compassion, a sense of belonging and easier coping with stressful events. In addition, the results

of the study conducted by McFarland (2010) are significant, indicating that men derive more mental health benefits from religious engagement than women, as well as that men who are highly religiously engaged have significantly better mental health. from other men.

Starting from the previously elaborated, the aim of this paper is a scientific description of the influence of various aspects of religion on the effectiveness of disaster risk reduction policy, as well as the way in which religious beliefs, motives and fatalistic attitudes shape the perception of the risk of natural disasters. In this way, it contributes to existing debates about the nature of the role of religious elements in the practice of disaster response and recovery.

2. Materials and Methods

The goal of the research is a scientific description of the nature of the relationship between the degree of religiosity of citizens in the area of Belgrade and different segments of disaster risk reduction, including their readiness to respond, providing assistance to others and the state, support for the involvement of religious institutions in disaster management processes, and predictors of disaster risk perception in the domain of religion. The explicative goal of the research involves elucidating the ways in which religious factors shape awareness of the risks of natural disasters. The paper is based on a general hypothesis according to which there is an influence of the perception of religiosity on attitudes about reducing the risk of disasters, that is, preparedness and resilience. Specific hypotheses arise from the general hypothesis: there is an influence of religiosity on attitudes about preparedness for disasters; there is an influence of religiosity on citizens' attitudes about resilience to disasters; there is an influence of religiosity on undertaking disaster risk reduction measures.

2.1. Basic Characteristics of Respondents

The sample included a total of 250 respondents in the area of Belgrade. In accordance with the proportional representation of the sexes in the Republic of Serbia, the sample consisted mostly of female respondents (62.8%), while members of the male population represented 37.2% in the sample. In relation to the age of the respondents, it was determined that the largest number of respondents belonged to the age group of up to 50 (32.8%) and up to 30 years of age (33.2%). Then, 63 respondents (25.2%) included in the sample are up to 40 years old (25.2%), while 22 respondents (8.8%) are in the over 50-year-old category. When it comes to the level of education, it was determined that the smallest number of respondents (3.2%) have completed doctoral studies, while, on the contrary, the largest number of respondents have secondary education (40%). Then, 40 respondents (16%) stated that they had completed higher education, 60 respondents (24%) had completed basic academic studies, while 42 respondents (16.8%) reported completed master's academic studies. Furthermore, it was determined that the largest number of respondents included in the sample achieved an excellent (48.4%) and a very good average (42%) during their secondary education. In addition, 4 respondents (1.6%) achieved a sufficient average, while 20 respondents (8%) pointed out that they achieved a good general average during secondary education. Regarding the current marital status of the respondents, the results indicate that 64 respondents (25.6%) are not in an emotional relationship, 48 respondents (19.2%) are in a relationship, 20 respondents (8%) are engaged, 106 respondents (42.4 %) is married, 8 respondents (3.2%) are divorced, while 4 respondents (1.6%) belong to the widow/widow category. When asked about their current employment status, 198 respondents (79.2%) indicated that they were employed, while 52 respondents (20.8%) were unemployed. The answers to the question about the amount of

average monthly income that respondents earn indicate that 5.6% earn incomes up to 25,000 dinars, 20.8% up to 50,000 dinars, 74 respondents (29.6%) up to 75,000 dinars, while the incomes of 29.6% reach over 90,000 dinars on a monthly basis. Also, 14.4% pointed out that they have no personal monthly income.

2.3. Questionnaire Design

In order to create the questionnaire, questions from previous research (Merli, 2012; Ha, 2012; Aten et al., 2019; Feener & Daly, 2016; Adiyoso & Kanegae, 2013) on the impact of religiosity on disaster risk reduction were used. After detailed analyses, starting from the operational definition of disaster risk reduction, individual questions and adaptations to the designed research were adapted. The survey questionnaire consists of 30 questions, which include questions about the basic demographic and socio-economic characteristics of the respondents, as well as a special part related to the subject of the research. Before starting the research, a pilot study was conducted with the aim of determining their comprehensibility to all annexed persons of different socioeconomic characteristics.

2.4. Analyses

The data obtained in the survey were entered into the statistical program SPSS (Statistical package for social sciences). After that, a data check was performed in order to eliminate possible errors when entering the answer. The collected data were analyzed using descriptive statistics, and the frequency and percentage were determined. In the next step, the obtained data were crossed, i.e., the demographic characteristics of the respondents with the perception of risk, e.g., the connection between the level of education of the respondents and the preparedness for earthquakes. T-test and One-way ANOVA were used to examine the relationship between the variables and the earthquake risk perception. All tests were two-tailed, with a significance level of $p<0.05$. Statistical analysis was performed using SPSS Statistic 17.0 (IBM SPSS Statistics, New York, United States).

3. Results

Contrary to the ideological views that prevailed in the past, according to which disasters were understood exclusively as the work of God, the findings of modern research indicate an increase in public awareness regarding the contribution of the human factor, as vital, to the occurrence of natural disasters. Accordingly, respondents were asked to what extent they agree with the statement that the human factor contributes to the occurrence of disasters and their frequency. The findings indicate that the largest number of respondents largely (40.8%) and absolutely (28.4%) agree with the mentioned statement. Also, 2.4% disagree to an absolute extent, 7.6% strongly disagree, while 20.8% believe that the human factor moderately contributes to the occurrence of natural disasters and their frequency.

When asked, "What feeling does the news of a disaster that hit a certain area cause in you?", the largest number of respondents stated sadness (66.4%), followed by fear (23.6%). In addition, 2.4% pointed out that in the mentioned circumstances they feel anger, 1.6% indifference, 0.8% helplessness, 0.8% concern - if the disaster happened in the immediate vicinity of our country, 1.2% empathy, while 0.8% emphasized that such news makes them want to provide the necessary help. When it comes to the intensity of the fear of disasters that the respondents experience, the findings indicate that 11.6% do not feel fear at all, 30%

do not feel fear to a great extent, 32.4% feel fear to an average degree, 15.6% in feels fear to a great extent, while the smallest number, 10.4%, points out that they are absolutely afraid of potential disasters.

When asked whether natural disasters can be prevented, 58.8% gave an affirmative answer, while 24.4% of respondents believe that it is not possible. As the perception of the risk of disasters plays a significant role in different phases of risk reduction, especially in the phase of preparedness for natural disasters, the respondents were asked the question to what extent the religious beliefs of individuals determine the perception of the risk of natural disasters. They expressed their views on a Likert scale from 1 to 5 (1 - do not determine to an absolute extent; 5 - determine to an absolute extent). According to the findings, 20.8% of respondents believe that religious beliefs absolutely do not determine the awareness of the risk perception of natural disasters, while 18.8% believe that they do not determine it to a large extent. In contrast, 43.6% point out that religious beliefs moderately determine the perception of risk, 13.6% determine it to a large extent, while 3.2% believe that the religious beliefs held by individuals absolutely determine their perception of disaster risk. To the question, "Can religious stories and myths inhibit action in disaster conditions?", 42.8% gave an affirmative answer, while 48.4% believe that religious stories, by themselves, do not have the power to inhibit action in disasters.

The largest number of respondents included in the sample largely (38.8%) and absolutely (29%) agree with the statement that people turn to God only in difficult moments of life. Also, 22.8% moderately agree with the mentioned statement. Conversely, 5.2% point out that they absolutely disagree, while 10 respondents (4%) strongly disagree with the statement that people turn to God only in difficult moments of life. To the question, "Do religious attributes represent a resource that can motivate preparatory actions and improve the psychological resistance of individuals and society to natural disasters?", the largest number of respondents (65.6%) answered in the affirmative. In contrast, 86 respondents (34.4%) believe that religious attributes do not represent a significant resource in the examined context. In relation to the statement that believers help the population threatened by the consequences of natural disasters to a greater extent than the rest of the population, the largest number of respondents (52.8%) disagree, while 97 respondents (38.8%) believe that the mentioned statement faithfully reflects reality.

On a Likert scale from 1 to 5 (1 – absolutely disagree; 5 – absolutely agree), respondents then rated the extent to which they agree with the statement that disasters bring out the best in all people. According to the findings, 7.6% absolutely disagree with the mentioned position, 14% disagree to a greater extent, 29.6% agree to a moderate extent, 32% agree to a greater extent, while 16.8% absolutely agrees with the statement that disasters draw the best out of people.

Extremist attitudes of individuals and society have often shaped their preventive activities, preparatory actions, as well as the response to disasters caused by natural hazards (such as disobeying evacuation orders, etc.). Accordingly, respondents were asked to what extent they agree with the view that only true believers will be protected from the effects of disasters. More than half of respondents included in the sample (52.4%) absolutely disagree with the mentioned position, 16.4% strongly disagree, 22.4% moderately agree, 6.4% strongly agree agree, 2.4% of respondents absolutely believe that only true believers will be protected from the impact of disasters. Starting from the radical attitude that dominated in the past, according to which natural disasters were understood as God's work, that is, the way in which he communicates with mankind and punishes his sins, the respondents were asked to what extent they agree with this opinion. According to the findings, the largest number of respondents (40%) absolutely disagree, 49 respondents (19.6%) strongly disagree, 48 respond-

ents (19.2%) moderately agree, 29 respondents (11 .6%) agree to a greater extent, while 24 respondents (9.6%) expressed absolute agreement with the notion that the causes of natural disasters lie in the will of God.

This was followed by an assessment of respondents' attitudes on a Likert scale on the question of whether humanity's adequate care for nature would not cause the suffering we are witnessing today. The largest number of respondents in an absolute measure 43.2%, to a greater extent 32.8%, as well as in an average measure 18.4% agree with the mentioned position. In addition, 8 respondents 3.2% strongly disagree, while 6 respondents 2.4% absolutely disagree with the statement that adequate care for nature would prevent the suffering we are witnessing today. The assessment of respondents' views on the extent to which joint efforts between disaster managers and religious leaders would improve preparedness, response and recovery from natural disasters revealed the following: 8.8% believe that joint efforts between the aforementioned actors would absolutely not improve the various phases of management in natural disasters, 14% believe that they would not improve to a large extent, 39.6% that they would improve to a medium extent, 20% that they would improve the situation to a large extent, while 17.6% pointed out that joint efforts between managers in disasters and religious leaders absolutely improved preparedness, response and recovery from natural disasters.

Finally, on a Likert scale from 1 to 5, the question of the importance of including religious institutions in the disaster risk reduction program was evaluated in order to build a more resilient community. According to the findings, 12.8% believe that the inclusion of religious institutions is absolutely not important, 12.4% that it is not important to a large extent, 34.4% rated the importance of inclusion with a medium score on the scale, 24% attributed more importance to the inclusion of religious institutions institution, while 24% believe that the inclusion of religious institutions in the risk reduction program can absolutely contribute to building a more resilient community.

The results of the T-test show that there is a statistically significant association between gender and variables related to the degree of own fear ($p = 0.000$); claims that the human factor contributes to the occurrence ($p = 0.001$); religious beliefs determine attitudes ($p = 0.011$); disasters bring out the best in people ($p = 0.001$); true believers protected from disasters ($p = 0.010$); inclusion of religious institutions in risk reduction programs ($p = 0.016$). Further analyzes show that women rate their level of fear of men to a greater extent than men. In addition, to a greater extent, they believe that the human factor contributes to a greater extent to the occurrence of disasters and that it is not God's work; then, they emphasize to a greater extent that religious beliefs determine the perception of risk; they bring out the best in people; point out that true believers will be protected from disasters; point out that there is a greater importance of including religious institutions in disaster risk reduction programs (Table 1).

Table 1. T-test results between gender and observed variables on the influence of religion on disaster risk reduction.

	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
The intensity of one's own religiosity	−0.900	0.369	−0.137	0.152
Susceptibility of the territory of the Serbia to disasters	−1.76	0.079	−0.199	0.113
Preparedness of the population of the Republic of Serbia for natural disasters	0.684	0.494	0.081	0.118
The degree of own fear of natural disasters	−6.02	0.000**	−0.845	0.140
The human factor contributes to the occurrence of natural disasters and their frequency	−3.38	0.001*	−0.432	0.128
Religious beliefs determine the perception of risk from natural disasters	2.54	0.011*	−0.350	0.137

Relying on God's protection (assistance from higher powers) in disaster conditions	−1.79	0.073	−0.325	0.181
People turn to God only in difficult moments of life	0.493	0.623	0.068	0.139
Disasters bring out the best in all people	−3.24	0.001*	−0.477	0.147
True believers will be protected from the effects of disasters	−2.60	0.010*	-0.372	0.143
Natural disasters are God's work, message and way of punishing the sins committed by mankind	−0.098	0.922	−0.017	0.177
The importance of including religious institutions in the disaster risk reduction program in order to build a more resilient community	−2.42	0.016*	−0.385	0.159

The research results show that there is a statistically significant correlation between age and the following variables: the claim that people turn to God only in difficult moments; disasters bring out the best in people; that natural disasters are the work of God. Namely, further analyzes show that with increasing age, support for the position that people turn to God, only in difficult moments, decreases. Then, it was found that with increasing age, support for the view that disasters bring out the best emotions in people also increases. In the end, it was determined that the support for the position that disasters are the work of God increases with age (Table 2).

Table 2. Results of Pearson's correlation between age and selected variables. Source: edited by the author.

		Age
The intensity of one's own religiosity	Pearson Correlation	−0.008
	Sig. (2-tailed)	0.904
	N	248
Susceptibility of the territory of the Serbia to disasters	Pearson Correlation	0.002
	Sig. (2-tailed)	0.969
	N	248
Does the human factor contribute to the occurrence of natural disasters and their frequency?	Pearson Correlation	−0.013
	Sig. (2-tailed)	0.838
	N	248
Do religious beliefs determine risk perception (awareness) from natural disasters?	Pearson Correlation	0.056
	Sig. (2-tailed)	0.379
	N	248
Relying on God's protection (help from higher powers) in disaster conditions?	Pearson Correlation	−0.077
	Sig. (2-tailed)	0.229
	N	248
People turn to God only in difficult moments of life?	Pearson Correlation	−0.170**
	Sig. (2-tailed)	0.007
	N	248
Disasters bring out the best in people	Pearson Correlation	0.130*
	Sig. (2-tailed)	0.041
	N	248
True believers will be protected from the effects of disasters?	Pearson Correlation	−0.071
	Sig. (2-tailed)	0.263
	N	248
Natural disasters are God's work, a message and a way of punishing the sins committed by the human race?	Pearson Correlation	−0.208**
	Sig. (2-tailed)	0.001
	N	248

*** 0.01; * 0.05*

The results of the ANOVA analysis show that there is a statistically significant association between education and the following observed variables: intensity of religiosity (p = 0.000); perception of the susceptibility of the territory to disasters (p = 0.000); preparedness of the population for natural disasters (p = 0.000); reliance on God's protection in natural disasters (p = 0.000); people turn to God only in difficult moments (p = 0.000); disasters bring out the best emotions in people (p = 0.000); true believers will be protected (p = 0.000); disasters are God's messages (p = 0.000). Further analyzes show that respondents with a high school diploma mostly emphasize that they are religious, that people rely on God's protection in the face of disasters and that they turn to God only in difficult moments. Respondents with a university degree mostly emphasize that the territory of the RS is subject to the effects of disasters and that disasters are God's messages, but on the other hand, they least emphasize that the Republic of Serbia is prepared for disasters. Respondents with completed primary school point out that disasters bring out the best emotions in people, and that only true believers will be protected from disasters. In addition, it was determined that there is a statistically significant relationship between marital status and the following observed variables: religious beliefs determine risk perception; relying on God's protection; disasters bring out the best emotions in people; disasters are God's messages. Further analyzes show that the respondents with a higher education degree mostly point out that religious beliefs determine the perception of risk. On the other hand, respondents with a high school diploma mostly emphasize that in disasters, people rely on God's protection, that disasters bring out the best emotions from people, and that disasters are God's message.

4. Discussion

Regarding the relationship between fatalistic attitudes and reaction to disasters, we find evidence in the literature that mystical stories and fatalistic beliefs have a negative impact on the perception of disasters (they encourage people to take more risks and not take protective measures) (Kouabenan, 1998). In our research, the results are divided. While 42.% of the respondents believe that religious stories and myths can inhibit an adequate response in the face of disasters, 48.4% disagree with that view. On the other hand, the majority of respondents (52.4%) of our study reject fatalistic beliefs, e.g. that only true believers will be protected from the effects of disasters, as well as the understanding that the causes of natural disasters rest solely in the will and wrath of God. Nevertheless, respondents to the greatest extent (43.6%) emphasized the importance of religious beliefs in shaping the perception of disaster risk. Aksa, Utaya, Bachri and Handoyo (2020) found that higher levels of fatalistic attitudes cause lower risk perceptions of natural disasters, and that fatalism can lead to a lack of disaster preparedness.

When it comes to improving the preparedness of the population by integrating the efforts of disaster managers and religious leaders, the largest percentage of respondents pointed out that they would moderately improve risk reduction practices. In contrast, Sheikhi et al. (2021) found that religious communities have a key role and contribution to disaster mitigation. The claim that people turn to God only in difficult moments of life was evaluated positively in our research. Similarly, a study conducted by Bentzen et al. (2019) indicates that people resort to religion to a greater extent when overcoming major challenges and problems, such as illness, death of a family member, and various threats to life. In addition, the respondents of our study to the greatest extent believe that religious attributes represent a resource that can motivate preparatory actions and improve the psychological resistance of individuals and society to natural disasters.

Regarding the relationship between fatalistic attitudes and reactions to disasters, there is evidence in the literature that mystical stories and fatalistic beliefs have a negative impact on the perception of disasters, that is, they encourage people to take more risks and not take protective measures (Kouabenan, 1998). In our research, the results are divided. While 42% of respondents believe that religious stories and myths can inhibit an adequate response in disaster conditions, 48.4% disagree with that view. On the other hand, the majority of respondents (52.4%) of our study reject fatalistic beliefs, e.g. that only true believers will be protected from the effects of disasters, as well as the understanding that the causes of natural disasters rest solely in the will and wrath of God. Nevertheless, the respondents emphasized to the greatest extent the importance of religious beliefs in shaping the perception of the risk of disasters. Aksa et al. (2020) found that higher levels of fatalistic attitudes cause lower risk perceptions of natural disasters, and that fatalism can lead to a lack of disaster preparedness.

When it comes to improving the preparedness of the population by integrating the efforts of disaster managers and religious leaders, the largest percentage of respondents pointed out that they would moderately improve risk reduction practices. In contrast, Sheikhi et al. (2021) found that religious communities have a key role and contribution to disaster mitigation. The claim that people turn to God only in difficult moments of life was evaluated positively in our research. Similarly, in one of the studies (Bentzen, 2019) it was found that people resort to religion to a greater extent when overcoming major challenges and problems, such as illness, death of a family member and various threats to life. In addition, the respondents of our study to the greatest extent believe that religious attributes represent a resource that can motivate preparatory actions and improve the psychological resistance of individuals and society to natural disasters. Further analyzes revealed the existence of a statistically significant relationship between gender and the following observed variables: degree of own fear; claims that the human factor contributes to the occurrence of disasters; of the view that religious beliefs determine perception; disasters bring out the best in people; true believers are protected from disasters; the importance of including religious institutions in risk reduction programs. When it comes to the gender gap, it was found that women rate their level of fear to a greater extent than men. Such results are consistent with a large number of other empirical studies devoted to the gender issue of disaster risk perception (Cvetković, Öcal, & Ivanov, 2019; Cvetković & Sandić, 2016; Khan, Rana, & Nawaz, 2020). In addition to the explanations that rest in the social roles of women, the availability of more modest resources in the household compared to men (due to which the fear of losing them is greater) and greater physical vulnerability (Holgersson, Sahovic, Saveman, & Björnstig, 2016; Ho et al., 2008), it is important to point out a certain reluctance of men brought up in our culture to openly express weaknesses, such as fear.

In addition, women to a greater extent believe that the human factor contributes to the occurrence of disasters to a greater extent, and that it is not God's work; then, they emphasize to a greater extent that religious beliefs determine the perception of risk; they bring out the best in people; point out that true believers will be protected from disasters; point out that there is a greater importance of including religious institutions in disaster risk reduction programs. Here, it is important to state the implications of the study (Sohrabizadeh, Jahangiri, & Khani Jazani, 2018), which unequivocally indicate that women are more influenced by religion than men and that it is necessary to encourage their role in strengthening the positive effects of religiosity.

The research results also showed that there is a statistically significant correlation between age and the following variables: the claim that people turn to God only in difficult moments; disasters bring out the best in people; that natural disasters are the work of God. Namely, further analyzes show that with increasing age, support for the position that people turn to God,

only in difficult moments, decreases. Then, it was found that with increasing age, support for the view that disasters bring out the best emotions in people also increases. In the end, it was established that with the growth of years, the support for the position that disasters are God's work also increases. The existence of differences in attitudes towards disasters among different age groups is also found by other research (Nakao, Kawasaki, & Ohnishi, 2019).

In the end, a statistically significant connection between marital status and the following observed variables was determined: religious beliefs determine risk perception; relying on God's protection; disasters bring out the best emotions in people; disasters are God's messages. Further analyzes show that the respondents with a higher education degree mostly point out that religious beliefs determine the perception of risk. On the other hand, respondents with a high school diploma mostly emphasize that in disasters, people rely on God's protection, that disasters bring out the best emotions from people, and that disasters are God's message. These results are not surprising, given that educational attainment is one of the most significant predictors of disaster risk perception (Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015).

3. Conclusions

The discourse on the constructive as well as the harmful influence of religious beliefs is equally represented in the literature. Despite differing views on the nature of that influence, all agree that religious beliefs govern interpretations of natural hazards in many cultures and societies. During and after natural disasters, people need psychological support and comfort provided by religious institutions. Religious attributes can encourage a positive psychological response and, thus, improve the resilience of an entire society to natural disasters. When facing a disaster, people can seek spiritual support from God, and at the same time rely on resources and support in the social community to which they belong and participate in various group therapies for healing and alleviating the psychological consequences.

Therefore, religious institutions contribute especially in the recovery phase, by providing appropriate material and psychological support to the population in the affected areas. The content of the message that religious authorities send to the public in such conditions can be of critical importance, and disaster risk communication must integrate contemporary knowledge about the relationship between religion and risk reduction. Fatalistic beliefs are a special challenge for solving and reducing which it is necessary to engage and unite the efforts of the government, educational institutions, media and religious leaders. This requires effective cooperation, communication and coordination at all levels. Although the potential of religious institutions in various stages of disaster management is evident, their role is still largely overshadowed in the literature and in practice.

In addition to the capacity and state of the competent services, the prevention and mitigation of the consequences of disasters largely depend on the perception of the community. Human consciousness, therefore, emerges as a valuable resource in management efforts, particularly in the process of planning and designing programs, strategies, and response plans. It is shaped both by individual factors, such as age, gender, education, disaster experience, marital status, risk perception and income, and by social factors, such as religious identity. Along with the rejection of ideological understandings about the nature of disasters as the work of God comes a change in the perception of control and responsibility. The then helplessness in the face of an insurmountable fate is replaced by the awareness of the possibility of controlling the consequences, that is, mitigating and minimizing the damage when a natural disaster occurs. In this way, a necessary precondition was created to improve the preparedness of the population, and then the response and recovery from the disaster.

This study opens up new research questions, including examining the various religious factors and dimensions that influence risk perception, preparedness, response, and recovery after a natural disaster. The implications of the research are critical for decision-makers in the Republic of Serbia, who are facing increasing demands to respect people's attitudes and beliefs that influence their behavior in disaster conditions. In combination with other mechanisms, they can be used to create appropriate strategies at the national level and programs adapted to different categories of the population. In future research, it would be important to investigate the coping strategies in response to disasters and traumatic events used by non-religious individuals versus those used by religious ones. The limitations of the research are reflected in the fact that a larger territorial area and a larger number of inhabitants of the Republic of Serbia were not covered.

Acknowledgments: The authors express their gratitude to the anonymous reviewers for their comments, and the Scientific-Professional Society for Disaster Risk Management (http://upravljanje-rizicima.com/) and International Institute for Disaster Research in Belgrade, Serbia for their scientific support.

Funding: This research was funded by the Scientific-Professional Society for Disaster Risk Management, Belgrade, Serbia (http://upravljanje-rizicima.com/) and International Institute for Disaster Research.

Conflicts of Interest: The authors declare no conflict of interest.

References

Abdel-Khalek, A. M., & Lester, D. (2007). Religiosity, health, and psychopathology in two cultures: Kuwait and USA. *Mental Health, Religion and Culture*, *10*(5), 537-550.

Adamović, M., Milojević, S., Nikolovski, S., & Knežević, S. (2021). Pharmacy response to natural disasters. *International Journal of Disaster Risk Management*, *3*(2), 25-30.

Adeney-Risakotta, B. (2009). Is there a meaning in natural disasters? Constructions of culture, religion and science. *Exchange*, *38*(3), 226-243.

Adiyoso, W., & Kanegae, H. (2013). The preliminary study of the role of Islamic teaching in the disaster risk reduction (a qualitative case study of Banda Aceh, Indonesia). *Procedia Environmental Sciences*, 17, 918-927.

Aksa, F. I., Utaya, S., Bachri, S., & Handoyo, B. (2020). The role of knowledge and fatalism in college students related to the earthquake-risk perception. *Jàmbá: Journal of Disaster Risk Studies*, *12*(1), 1-6.

Arias-Vazquez, F. J. (2012). A note on the effect of education on religiosity. *Economics Letters*, *117*(3), 895-897.

Aten, J. D., Smith, W. R., Davis, E. B., Van Tongeren, D. R., Hook, J. N., Davis, D. E., & Hill, P. C. (2019). The psychological study of religion and spirituality in a disaster context: A systematic review. Psychological Trauma: Theory, Research, Practice, and Policy, 11(6), 597.

Bempah, S. A., & Øyhus, A. O. (2017). The role of social perception in disaster risk reduction: Beliefs, perception, and attitudes regarding flood disasters in communities along the Volta River, Ghana. *International journal of disaster risk reduction*, *23*, 104-108.

Bengtson, V. L., Silverstein, M., Putney, N. M., & Harris, S. C. (2015). Does religiousness increase with age? Age changes and generational differences over 35 years. *Journal for the scientific study of religion*, *54*(2), 363-379.

Bentzen, J. S. (2019). Why are some societies more religious than others?. In *Advances in the Economics of Religion* (pp. 265-281). Palgrave Macmillan, Cham.

Chester, D. K. (2005). Theology and disaster studies: The need for dialogue. *Journal of volcanology and geothermal research*, *146*(4), 319-328.

Cvetković, V. M., Öcal, A., & Ivanov, A. (2019). Young adults' fear of disasters: A case study of residents from Turkey, Serbia and Macedonia. *International Journal of Disaster Risk Reduction*, *35*, 101095.

Cvetković, V. M., Roder, G., Öcal, A., Tarolli, P., & Dragićević, S. (2018). The role of gender in preparedness and response behaviors towards flood risk in Serbia. *International journal of environmental research and public health*, *15*(12), 2761.

Cvetković, V., & Sandić, M. (2016). The fear of natural disaster caused by flood. *Ecologica*, *23*(82), 203-211.

Domingo Dela Cruz, R., & Ormilla, R. C. G. (2022). Disaster Risk Reduction Management Implementation in the Public Elementary Schools of the Department of Education, Philippines. *International Journal of Disaster Risk Management*, *4*(2), 1-15.

Domingo Dela Cruz, R., & Ormilla, R. C. G. (2022). Disaster Risk Reduction Management Implementation in the Public Elementary Schools of the Department of Education, Philippines. *International Journal of Disaster Risk Management*, *4*(2), 1-15.

Dragnea, M. (2013). Slavic and Greek-Roman Mythology, Comparative Mythology. *Romanian Cultural History Review Supplement of Brukenthal. Acta Musei*, *20*.

Dukiya, J. J., & Adelete, B. (2022). Remote Sensing and GIS Assessment of Domestic Fuel Energy Supply: A Threat to Global DRR Crusade in South-western Nigeria. *International Journal of Disaster Risk Management*, *4*(2), 45-59.

Dukiya, J. J., & Benjamine, O. (2021). Building resilience through local and international partnerships, Nigeria experiences. *International Journal of Disaster Risk Management*, *3*(2), 11-24.

El-Mougher, M. M. (2022). Level of coordination between the humanitarian and governmental organizations in Gaza Strip and its impact on the humanitarian interventions to the Internally Displaced People (IDPs) following May escalation 2021. *International Journal of Disaster Risk Management*, *4*(2), 15-45.

Feener, R. M., & Daly, P. (2016). Religion and Reconstruction in the Wake of Disaster. *Asian ethnology*, *75*(1), 191.

Gallagher, S. K. (2007). Children as religious resources: The role of children in the social reformation of class, culture, and religious identity. *Journal for the Scientific Study of Religion*, *46*(2), 169-183.

Gianisa, A., & Le De, L. (2018). The role of religious beliefs and practices in disaster: The case study of 2009 earthquake in Padang city, Indonesia. *Disaster Prevention and Management*.

Gunnoe, M. L., & Moore, K. A. (2002). Predictors of religiosity among youth aged 17–22: A longitudinal study of the National Survey of Children. *Journal for the scientific study of religion*, *41*(4), 613-622.

Ha, K. M. (2015). The role of religious beliefs and institutions in disaster management: A case study. *Religions*, *6*(4), 1314-1329.

Harari, Y. N. (2014). *Sapiens: A brief history of humankind*. Random House.

Harl, K. W. (1990). Sacrifice and pagan belief in fifth-and sixth-century Byzantium. *Past & Present*, (128), 7-27.

Holgersson, A., Sahovic, D., Saveman, B.-I., & Björnstig, U. (2016). Factors influencing responders' perceptions of preparedness for terrorism. Disaster Prevention and Management.

Hossieni, H. (2018). Great floods from primary scientific hypothesis to myths. *European Journal of Science and Theology*, *14*(6), 41-46.

Hussaini, A. (2020). Environmental Planning for Disaster Risk Reduction at Kaduna International Airport, Kaduna Nigeria. International Journal of Disaster Risk Management, 2(1), 35-49.

Khan, A. A., Rana, I. A., & Nawaz, A. (2020). Gender-based approach for assessing risk perception in a multi-hazard environment: a study of high schools of Gilgit, Pakistan. *International journal of disaster risk reduction*, *44*, 101427.

Kinateder, M. T., Kuligowski, E. D., Reneke, P. A., & Peacock, R. D. (2015). Risk perception in fire evacuation behavior revisited: definitions, related concepts, and empirical evidence. Fire science reviews, 4(1), 1-26.

Korstanje, M. E. (2019). Disasters in the Society of Fear. In *Terrorism, Technology and Apocalyptic Futures* (pp. 123-141). Palgrave Macmillan, Cham.

Kouabenan, D. R. (1998). Beliefs and the perception of risks and accidents. *Risk Analysis*, *18*(3), 243-252.

Kulatunga, U. (2010). Impact of culture towards disaster risk reduction. *International Journal of Strategic Property Management*, *14*(4), 304-313.

Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C. Y., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature climate change*, *5*(11), 1014-1020.

Mano, R. M., Kirshcenbaum, A., & Rapaport, C. (2019). Earthquake preparedness: A Social Media Fit perspective to accessing and disseminating earthquake information. *International Journal of Disaster Risk Management*, *1*(2), 19-31.

McFarland, M. J. (2010). Religion and mental health among older adults: Do the effects of religious involvement vary by gender?. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *65*(5), 621-630.

Merli, C. (2012). Religion and disaster in anthropological research. Critical risk research. Wiley, London.

Nakao, R., Kawasaki, R., & Ohnishi, M. (2019). Disaster preparedness of hillside residential area in Nagasaki city, Japan: evaluations regarding experiences related to a fire. Journal of rural medicine, 14(1), 95-102.

Odero, N. A., & Mahiri, I. (2022). The Complacency of Flood Victims, Socio Economic Factors, and Effects and Vulnerabilities of Floods in Lower Kano Plains, Kisumu County, Kenya. *International Journal of Disaster Risk Management*, *4*(2), 59-77.

Podder, M., Hasan, M. K., & Islam, M. J. (2022). Seismic Vulnerability Assessment of Existing Buildings by Rapid Visual Screening Method: A Study on Ward 27 in Dhaka South City Corporation. *International Journal of Disaster Risk Management*, *4*(2), 77-91.

Sachdeva, S. (2017). The influence of sacred beliefs in environmental risk perception and attitudes. *Environment and Behavior*, *49*(5), 583-600.

Schmidt, M. (2004). Investigating risk perception: a short introduction. Loss of agro-biodiversity in Vavilov centers, with a special focus of genetically modified organisms (GMOs), edited by: Schmidt, M., Ph. D. Thesis, Vienna.

Schwadel, P. (2015). Explaining crossnational variation in the effect of higher education on religiosity. *Journal for the Scientific Study of Religion*, *54*(2), 402-418.

Sergey, K. (2021). Methodology for Building Automated Systems for Monitoring Engineering (Load-Bearing) Structures, and Natural Hazards to Ensure Comprehensive Safety of Buildings and Constructions. *International Journal of Disaster Risk Management*, *3*(2), 1-10.

Sheikhi, R. A., Seyedin, H., Qanizadeh, G., & Jahangiri, K. (2021). Role of religious institutions in disaster risk management: a systematic review. *Disaster medicine and public health preparedness*, *15*(2), 239-254.

Sherry, J., & Curtis, A. (2017). At the intersection of disaster risk and religion: Interpretations and responses to the threat of Tsho Rolpa glacial lake. *Environmental Hazards*, *16*(4), 314-329.

Sohrabizadeh, S., Jahangiri, K., & Khani Jazani, R. (2018). Religiosity, gender, and natural disasters: a qualitative study of disaster-stricken regions in Iran. Journal of religion and health, 57(3), 807-820.

Stumpf, K., Knuth, D., Kietzmann, D., & Schmidt, S. (2017). Adoption of fire prevention measures–Predictors in a representative German sample. Safety science, 94, 94-102.

Sun, Y., & Han, Z. (2018). Climate change risk perception in Taiwan: Correlation with individual and societal factors. *International journal of environmental research and public health*, *15*(1), 91.

Weber, S. R., & Pargament, K. I. (2014). The role of religion and spirituality in mental health. Current opinion in psychiatry, 27(5), 358-363.

DOI:https://doi.org/10.18485/ijdrm.2023.5.1.7

Research article

FACTORS RESPONSIBLE FOR URBAN FLOODING IN KARACHI: A CASE STUDY OF DHA

Ayesha Iftikhar[1], Jawed Iqbal[1]

[1] National University of Sciences and Technology, Rislpur Campus, Pakistan

*Correspondence: ayeshakhan3359@gmail.com

Abstract: Flood has become an immense phenomenon in Pakistan. On August 2020 DHA Karachi was badly affected by urban flooding. This study discusses that poorly maintained drainage networks are the factors that caused urban flooding in DHA. This study aims to discover the factor that led to the urban flooding in DHA and what damages are caused. Methodology greatly includes questionnaires. GIS has been used for carrying out mapping of DHA surface drainage networks. The data collected from the questionnaires showed that poor drainage network was the main cause of urban flooding in DHA and phase 6 was mostly damaged as a lot of land encroachment has been done in this phase. Streets were mostly damaged as stagnant water caused crackers in them thus causing power outrage and difficulty in evacuation. This study may provide a guideline to disaster planning, management, and development authorities.

Keywords: Urban flooding; DHA; GIS; Drainage networks; land encroachment.

1. Introduction

When a place is inundated by the water that normally remains dry there occur a flood. When excessive rainfall occurs the drainage system capacity gets reduced and extreme runoff is created that mostly happens in urban cities (Adetunji, 2013). Severe floods have some of the worst natural catastrophes, according on ecological conditions. Because of their brutal effects, floods have a huge influence on human existence. Humans residing in the area are unable to effectively foresee the severe occurrence of Flood Risk due to the harsh external conditions (H.L Cloke, 2009).

Society inability to deal with the flood event because of reduced coping capacities thus makes it vulnerable to the extreme events and creates social unrest (Di Baldassarre, 2013). It is gaining more attention as population growth has caused people to live in urban places (Nasiri, 2004). It has been deduced that urbanization and climate change will soon increase the magnitude and frequency of the flood events (IPCC, 2014).

One of the vast spread and severe challenge is urban flooding. There are different factors like urbanization, climate change, drainage networks and population growth that are the cause of urban floods which not only make the intensity of the floods devastating but also caused an increase in its frequency leading to loss of lives, property and critical facilities as the time passes.

Countries like Europe, Africa, Asia and USA has been greatly affected by the urban floods in the past few years. The occurrence of floods in more in most and least developed nations. Lack of proper development planning, mismanagement of drainage networks and illegal dumping of waste are the causes of urban flood in developing nations while extreme rainfall, climatic variation, flash flood and storm surge triggers urban flood in developed nations.

In Pakistan about 72% of the people are living in slum areas. Since there is poorly developed infrastructure that is not resilient to floods it intensifies the urban flooding. As there is no proper development planning the protective structures fails when climatic variation occur leading to flood in these areas. Different studies have shown that Pakistan has become a subject to Floods from the past few years. Pakistan faced extreme flooding in 2010 that caused loss of life and property.

Karachi which is an economic hub is one of the cities of Pakistan that is facing urban flooding. In monsoon season the city is flooded by rain water causing extreme damage and disruption in daily activities. For climate change adaptation and systemic development planning in order to reduce the damage caused by flooding flood forecasting and vulnerability assessment is of key importance. In order to make Pakistan especially Karachi city flood resilient it is important to know the physical, socio-economic and environmental factors, flood plain and prone areas as well as vulnerability level in the city. The environmental and socio-economic factors both together make an area vulnerable to urban floods. These factors are different at different places.

Extreme rainfall leads to flooding. Anthropogenic activities also trigger flooding. These include illegal settlement along river or drainage network, mismanagement of dumping of waste, deforestation, urbanization, land degradation and poor development planning (Danumah, 2016). For safe and secure living it is important to mitigate the urban flood and it is done by proper checking of rainfall records, flood forecasting, flood prone area mapping as well as predicting and mitigating flood risks.

On 25 August 2020 Karachi City experienced unprecedented urban flooding as a result of the rain for a solo day, at 345 mm (13.58 in) which not only surpassed the historical 298.4 mm (11.75 in) recorded in 1984 but also caused massive and catastrophic inundations in the major portion of the city, that resulted in the streets to look like rivers causing extreme damage as well as also resulted in washing away of the people, houses and automobiles. Because of this at different places landslide phenomena were also seen that again caused trouble and damage to thousands of people by drowning them or causing them to suffer from electrocution as well as causing destruction of property and vehicles.

DHA Karachi being no exception. Since the city began maintaining weather reports in 1931, it is the most terrible rainfall Karachi has ever experienced. A total of 760 mm (29.92 in) of rainwater was reported during the week starting from August 28, 2020. Officials used sailboats to rescue individuals stuck in the streets around the city during the floods. Many issues arose for the estimated 15 million people of the metropolis, including downed power lines, out-of-service mobile phone towers, and significant fuel shortages due to the city's high reliance on alternate generating units. Flooding happens when water collects in areas that are not ordinarily inundated, as is widely known. They commonly arise in urban areas as a result of extreme rainfall, which causes an excess of runoff that exceeds the capacity of drainage systems, or when an extreme event occurs in a susceptible physical and socio-economic surroundings, outstripping society's capacity to control or remain viable as a result of the outcomes. The disposal of waste especially the solid ones and encroachment on natural drainage patterns by the katchiabadis residents are one of the reasons for extreme flooding in Karachi city.

2. Method

2.1. Methodology

This research applies thematic analysis method to assess factors that caused urban flooding in DHA Karachi with constraints of sparse data. Also, the purpose of analyzing flood factors is not only to spatially locate flood hazard but to be able to quantitatively or qualitatively deduce significance of the risks (Smith, 2003). As a result, all the risks related to a country, region, or a city need to be taken into account for risk assessment of spatial nature (Greiving, 2006).

1.2. Data collection from DHA

There are two types of studies namely quantitative and qualitative. A rigorous, objective, and formal approach is adopted to collect measurable data in quantitative research while viewpoints, behaviors, and experiences of people are studied in qualitative research. This is quantitative research that aims at discovering the causes that resulted in DHA flooding with the help of GIS.

The methodology that is adapted to carry out this study includes primary data. In primary data, questionnaire will be developed to collect data from DHA and thematic analysis would be used. The basic data related to DHA flooding was collected with the help of a standardized questionnaire that was distributed among the residents living in all eight phases of DHA.

1.3. Targeted population and Sample size

DHA Karachi has a total population of about 661,000, whereas the total targeted population is 1000 in all 8 phases for example phase 1 has 125, phase 2 has 75, phase 3 has 140, phase 4 has 100, phase 5 has 125, phase 6 has 175, phase 7 has 150 and phase 8 has 110. Stratified random sampling also known as proportionate random sampling is used to complete the sampling process. It is a probability sampling approach that distributes the entire population into strata also termed homogeneous groups (Qualtrics, 2021). This sampling method focuses on the demographic make-up of the population for collecting the population sample. Since each stratum is randomly chosen there is no biasedness in the process thus this approach is fair for the participants.

In 1976 a sample size computation technique was developed by a statistician named Taro Yamane to calculate the given population sample size. The formula applied for calculating the sample size of this research is devised by (Yamane, 2016).

$n = N/ 1+N (e)^2$

Where n= Size of the sample

N= Size of the targeted population

e = Margin of the error acceptable or measures of precision is 0.05

$n = 1000/ 1+1000 (0.05)^2$

$n = 1000/ 1+1000 (0.0025)$

$n = 1000/ 1+ 2.5$

$n = 1000/ 3.5$

$n = 285.7$

$n= 286$

The above result suggests that 286 people were sampled from an overall population of 1000, which is a good sample size.

Table 1. Sample Size

DHA Phases	Target Population	Sample Size
1	125	125/1000*100 = 12.5% of 286 = 36
2	75	75/1000*100 = 7.5% of 286 = 21
3	140	140/1000*100 = 14% of 286 = 40
4	100	100/1000*100 = 10% of 286 = 29
5	125	125/1000*100 = 12.5% of 286 = 36
6	175	175/1000*100 = 17.5% of 286 = 50
7	150	150/1000*100 = 15% of 286 = 43
8	110	110/1000*100 = 11% of 286 = 31
Total	**1000**	286

Determination of sample size is critical in that research that uses primary data for collecting responses through a questionnaire. By using the Taro Yamane technique sample size is calculated as shown in the table mentioned above. To develop the sample this technique adopted a stratified random sampling that is proportionally representative of the population.

2. Result

2.1. Analysis

In this chapter, the method adopted to obtain the result included primary data that was obtained with the help of questionnaire and the data obtained is analyzed, processed, and interpreted with the help of GIS in the form of maps.

The thematic analysis was applied to the questionnaire to collect data. The pie charts were used to tell the different percentages of the respondent's answers and the table showed the response of the DHA authority. This research is carried out by handing out and opened ended questionnaire to DHA authority and 1000 closed ended questionnaires to the residents of DHA Karachi of which 714 were not properly answered while 286 were free from any error. These 286 questionnaires were then used for displaying, analyzing, and interpreting the data. The questionnaire was divided into two parts the first part includes the general introduction of the respondents while the second part includes the question related to the urban flooding in DHA Karachi. There were a total of 23 questions of which 5 were related to personal information while 18 were related to the damages, issues, and problems being faced by the respondents. The respondents included 42.5% females and 57.5% males. The analysis of questions is done using pie charts in which percentages show the different responses given by the respondents. These questions are given below:

1. What was the targeted population in each DHA phase?

The targeted population was taken from all the eight phases of DHA. Out of 100%, about 12% of responses come from Phase 1, 7% from Phase 2, 14% from Phase 3, 10% from Phase 4, 13% from Phase 5, 18% from Phase 6, 15% from Phase 7 and 11% from Phase 8. From the pie

chart, it could be seen that the highest number of responses were from Phase 6 and 7 while the least responses came from Phase 2.

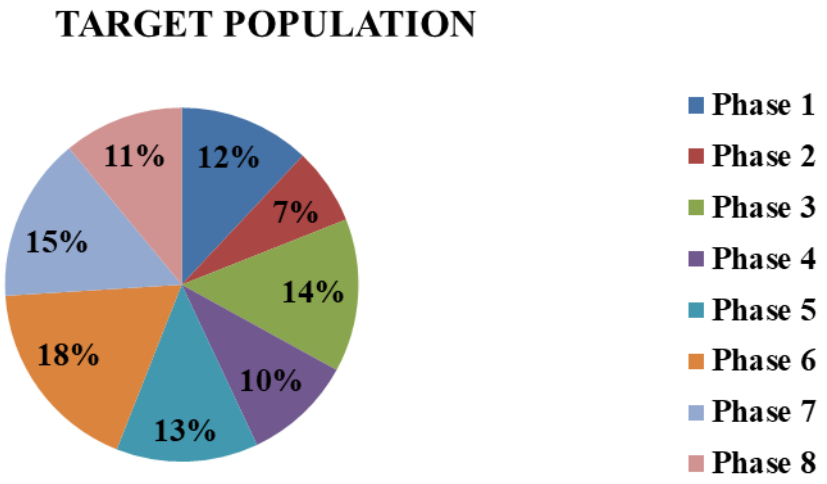

Figure 1. Target population

2. How many responses were received from each Phase?

12% of the response was received from Phase1 and 2, 9% of the response was received from phase 3, 14% from phase 4, 6% from phase 5, 29% from phase 6, 12% from phase 7, and 6% from phase 8.

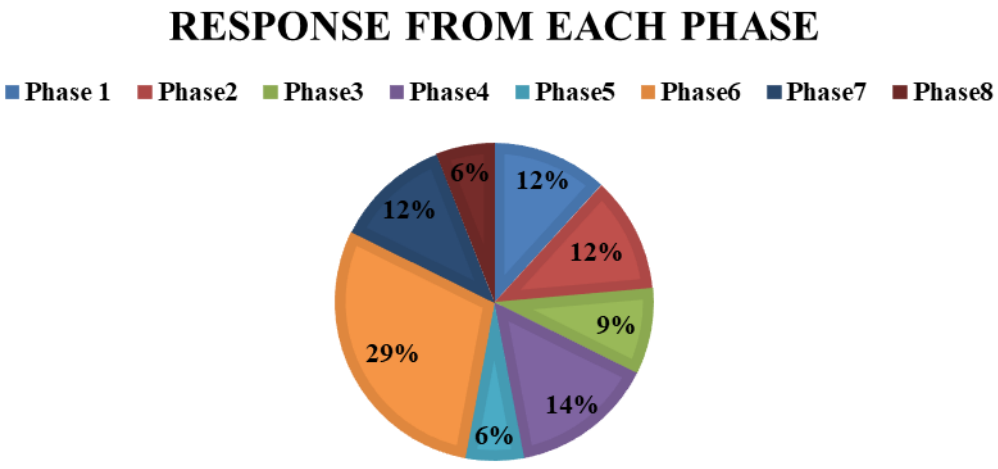

Figure 2. Response from each Phase

3. **In your opinion what is the cause of urban flooding in Karachi?**

Four opinions were given and according to 79% of the respondents, the urban flooding was because of the poor drainage and sewerage system. 14% of the respondents think it is because of climate change. 5% of respondents think it is due to urbanization while 2% of the respondents said it is because of population growth.

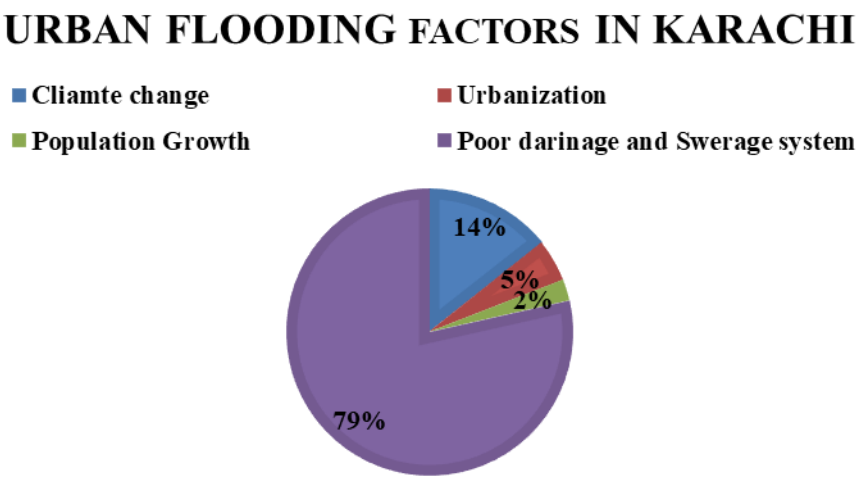

Figure 3. Urban Flooding Factors

4. What are the factors that caused urban flooding in DHA Karachi?

From the pie chart, it could be seen that 55% of the respondent's weak drainage and sewerage system is the cause that led to urban flooding in DHA while 38% say it was because of the lack of development planning. According to 5% of the respondents, it was due to poor governance while 2% believed a reduced infiltration rate was the cause of urban flooding.

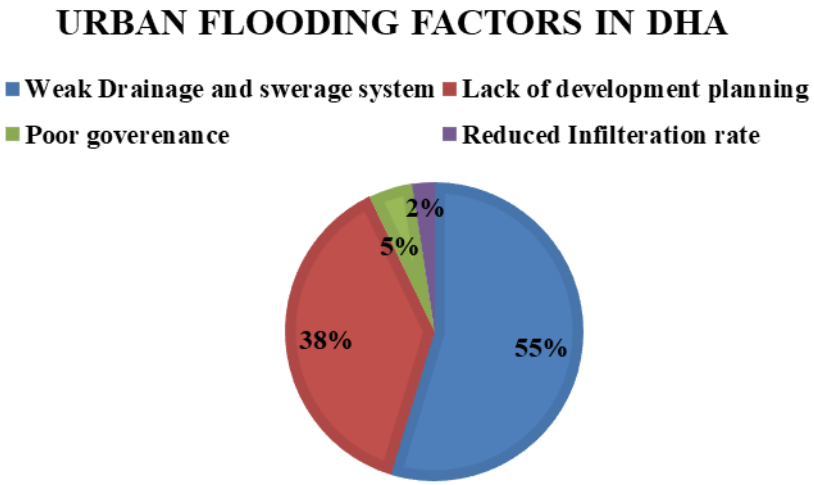

Figure 4. Factors in DHA

5. Was your house damaged due to urban flooding (material damage)?

19% of the respondent's houses were not damaged by the floods, 60% of respondents' houses were slightly damaged, and 16% of respondents said their house was half damaged while 5% said their house was completely damaged.

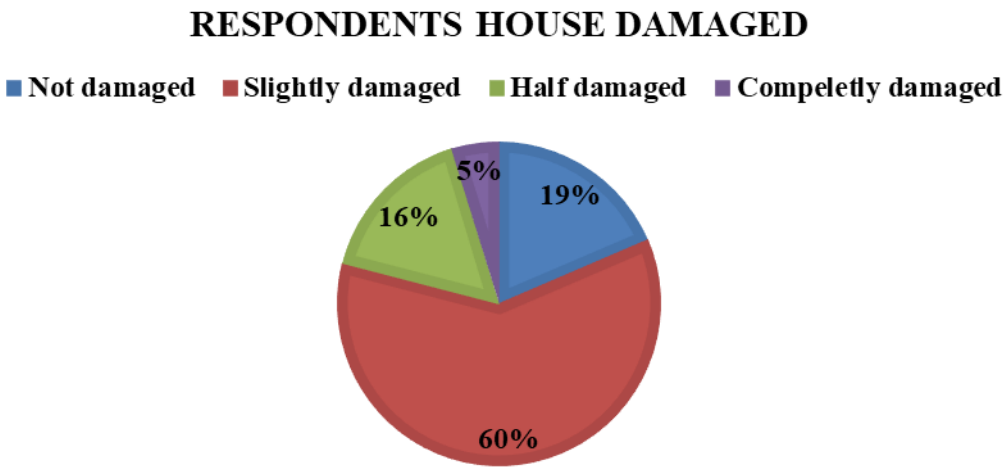

Figure 5. Respondent's House damage

6. What do you think was mostly damaged by flooding?

Because of urban flooding infrastructure as well as critical facilities had been damaged. The greatest damage was posed to the roads and about 49% of the roads and streets were affected by the flooding. 9% of schools and shopping markets were damaged and mostly the ground floor was damaged. 5% of the hospitals and 28% of houses were damaged.

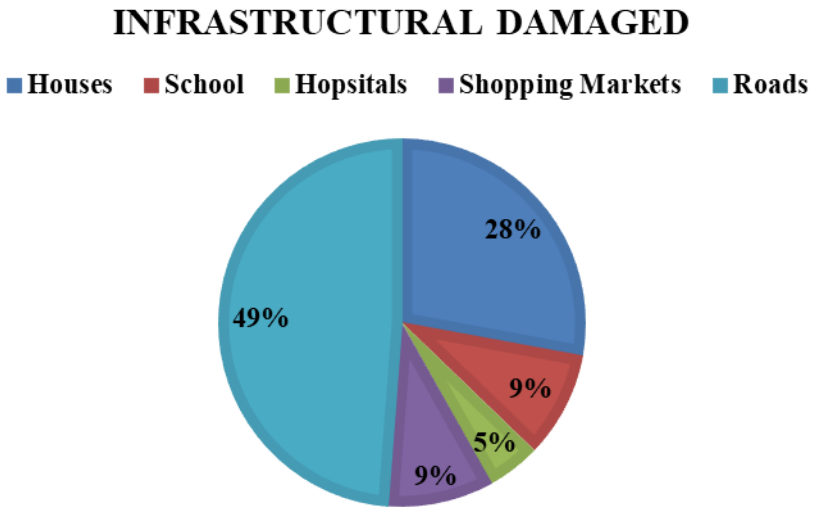

Figure 6. Infrastructural Damage

7. **How many people in your area lost their lives?**

21% of respondents said there was no loss of life in their area, 14% said between 1-5 people lost their lives in their area. 9% said between 5-10 people lost their lives while 56% said the loss of life in their area was more than 10.

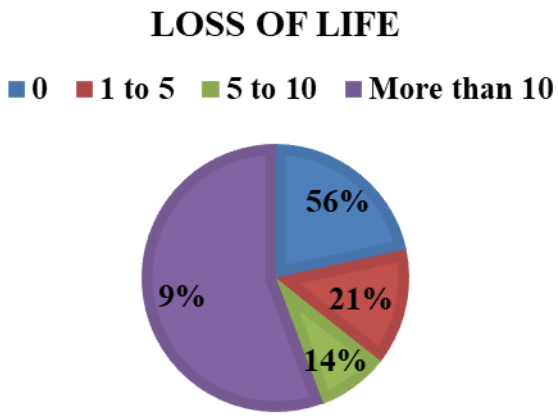

Figure 7. Loss of Life

8. **Who rescued you?**

When it was asked who rescued them about 5% said the Provincial government rescued them, 44% said they were rescued through Army, 21% were rescued by DHA and 30% were self-rescued.

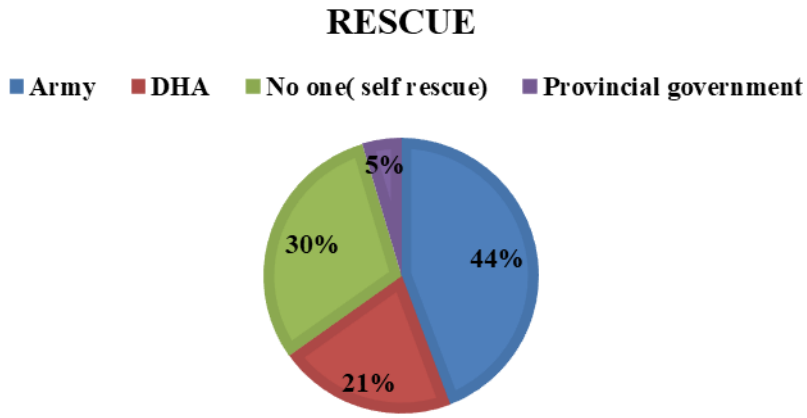

Figure 8. Rescue

9. How much time was taken to rescue you?

When it was asked how much time was taken to rescue them about 20% said they were rescued in less than 5 hours, 12% were rescued in 5 hours, 5% said one day was taken for their rescue while 63% said more than 1 day was taken to rescue them.

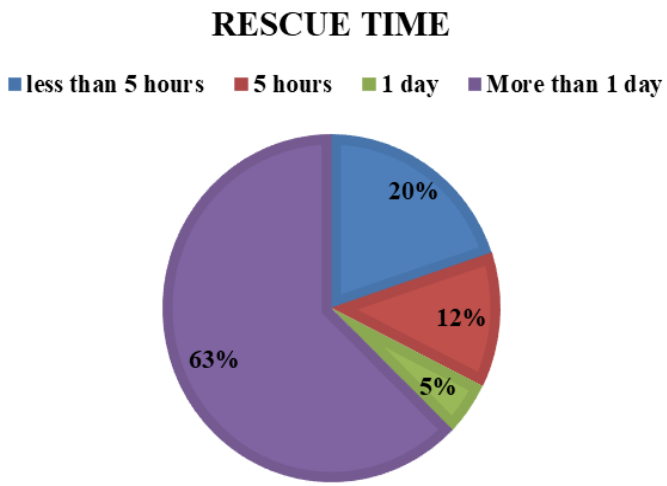

Figure 9. Rescue time

10. **What methods were adopted for your rescue?**

The rescue process was carried out through different means. From the pie chart, it could be seen that the maximum number of respondents who were rescued through other means is 52% which mostly includes self-rescue. 22% of the respondents were rescued by vans, 21% by boat and 5% by helicopter.

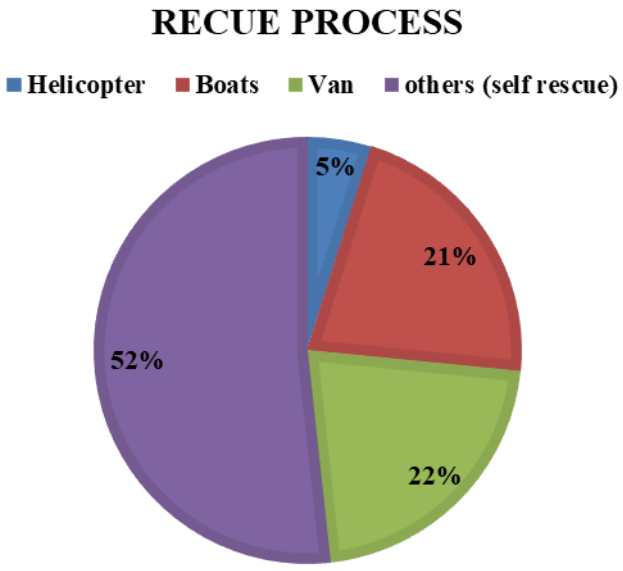

Figure 10. Rescue process

11. What were the major problems faced by you?

The main problem that was faced by the respondents was power outrage and about 44% of them faced this problem. 39% faced were not timely rescued, 12% did not have anything to eat while 5% did not face any problem at the time of urban flooding in DHA.

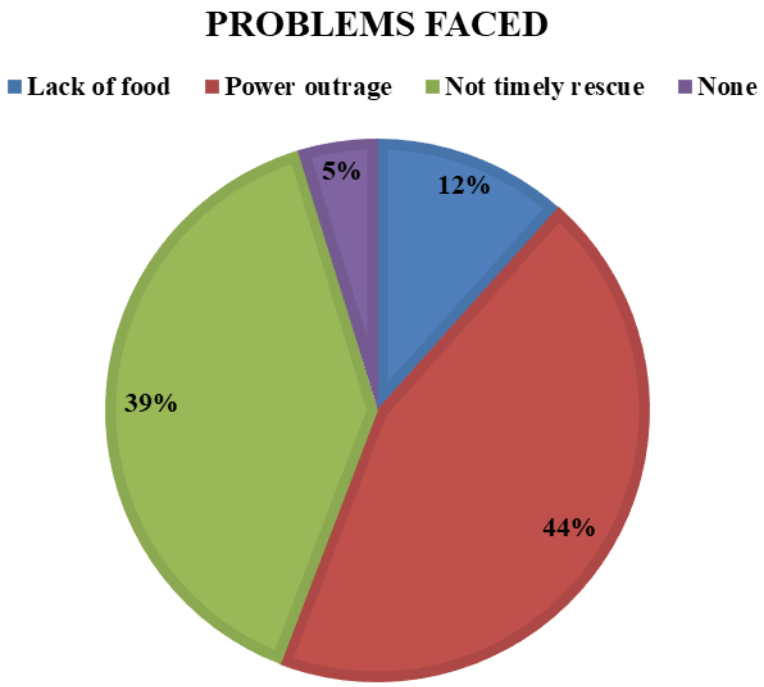

Figure 11. Problem Faced

12. How many houses in your area were damaged (material damage)?

About 5% of the respondents said there was no damage to the houses in their area. About 31% said between 1 to 5 houses were damaged in their area. According to 38%, the damaged houses in their area were 5 to 10 while 26% said the damaged houses were more than 10% in their area.

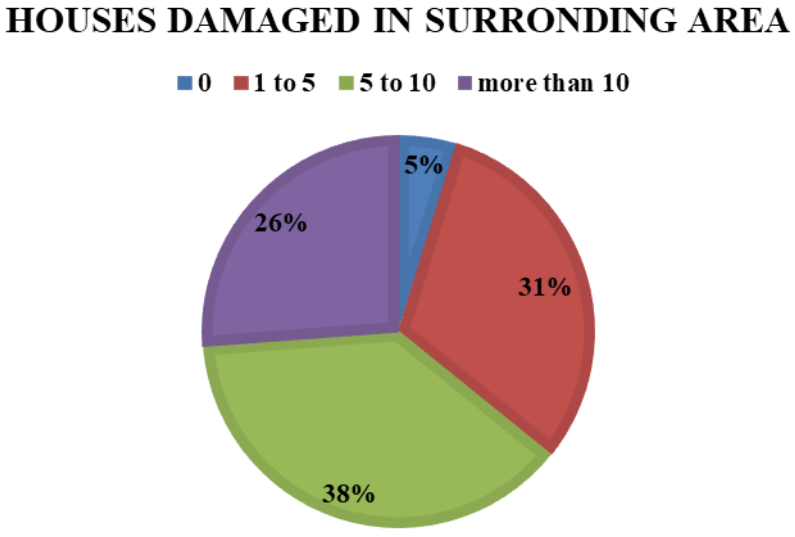

Figure 12. House damaged in surrounding of DHA

13. **Was there any stagnant water in your street?**

As a result of urban flooding, the streets were flooded with rainwater. About 83% of the respondents show stagnant water in their streets while for 17% there was no stagnant water.

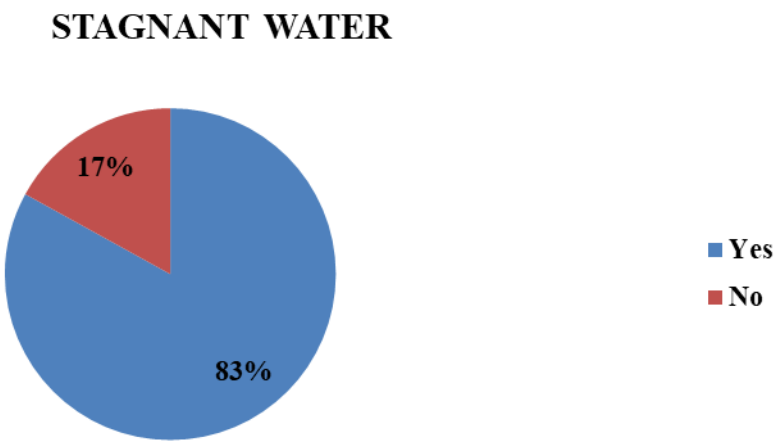

Figure 13. Stagnant Water

14. How much time was taken to remove that stagnant water?

Since eighty-three percent of the streets were covered with stagnant water and the time taken to remove this water was different in every phase. 7% of the respondents said it was removed in one day whereas 29% said two days were taken for the removal of stagnant water while 63% said the time taken to remove the stagnant water from their streets was three days.

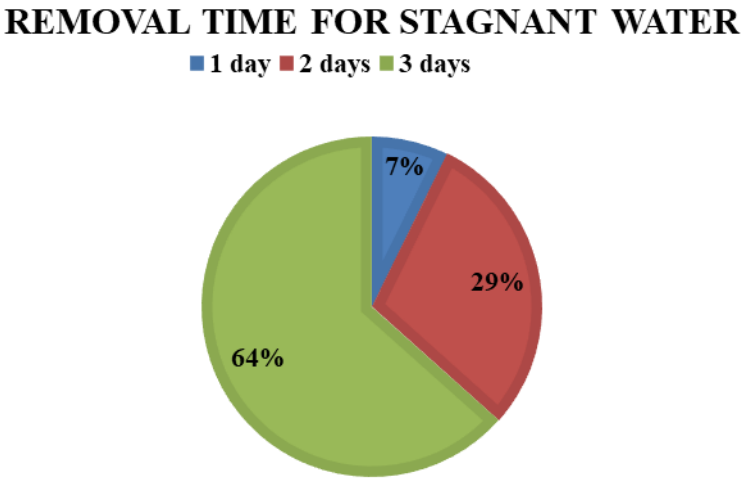

Figure 14. Removal time for stagnant water

15. Does any school in your area was damaged?

69% of respondents said the schools located in their area were damaged because of flooding while 31% said no school located in their area was damaged.

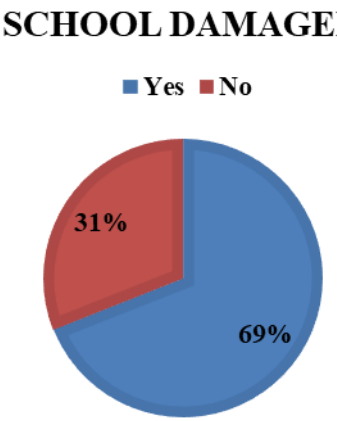

Figure 15. School Damaged

16. **Does any hospital in your area been damaged?**

About 12% of answers from the respondents showed that hospitals were affected by the flooding while 88% of responses showed there were no damaged hospitals.

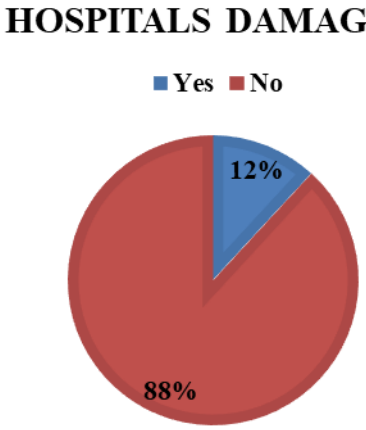

Figure 16. Hospital damaged

17. Was there any help from DHA?

When it was asked the respondents that DHA help them during the time of crisis only 34% said yes while 66% said there was no help from the DHA.

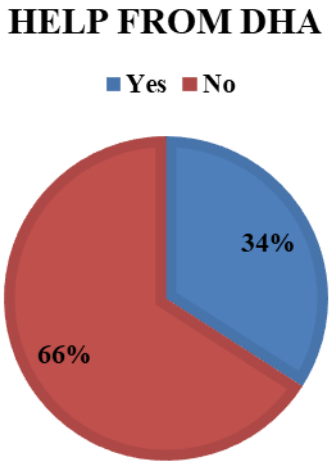

Figure 17. Help from DHA

18. **Do any mitigation measures are adopted by DHA to avoid urban flooding in the future?**

61% of the respondents think that there are no mitigation measures that DHA has adopted to avoid future urban flooding and while according to 39% DHA had worked on flood mitigation measures to avoid flooding in the future.

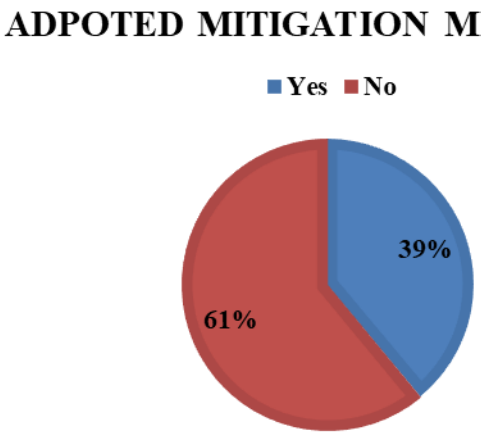

Figure 18. Adopted Mitigation measures

19. Are you satisfied with the work of DHA?

Respondents were asked about their satisfaction level regarding working with DHA. Everyone had different points of view 39% of them were highly unsatisfied, 7% were satisfied, 14% were just satisfied, 20% were neutral as well as 20% were unsatisfied with their work.

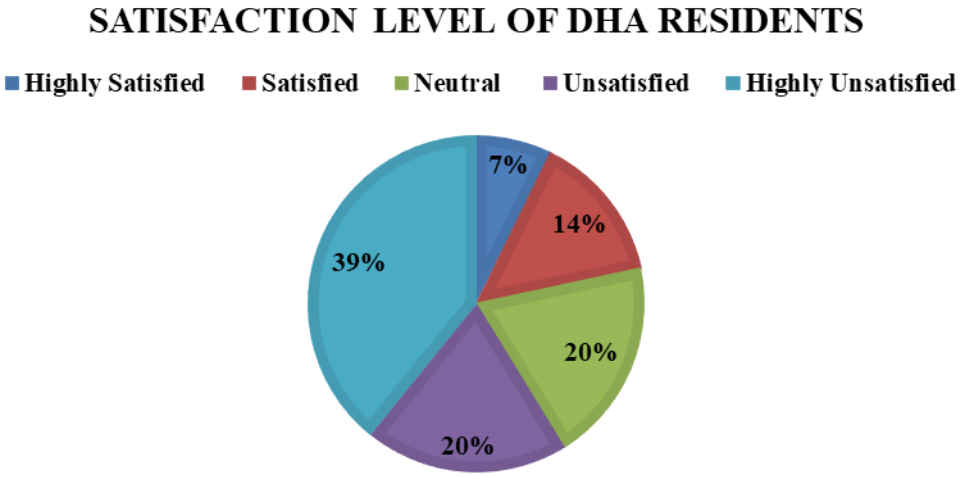

Figure 19. Satisfaction level of DHA Residents

Table 2. Questionnaire filled by DHA Authority

Q. No.	Questions	Answer	
1	What is the estimated population of residents in DHA Karachi?	6,61000	
2	What is the estimated number of houses in DHA Karachi?	31,833	
3	What is the estimated number of houses in each Phase?	Residential	
		Phase-I	1091
		Phase-II & II Ext	1832
		Phase-IV	2787
		Phase-V&V Ext	5546
		Phase-VI	6964
		Phase-VII & VII Ext	3877
		Phase-VIII	5020
		Phase-VIII (E-8)	25
		27142	
		Commercial	
		Phase-I	51
		Phase-II & II Ext	1060
		Phase-IV	224
		Phase-V&V Ext	1156
		Phase-VI	1338
		Phase-VII & VII Ext	529
		Phase-VIII	330
		Phase-VIII (E-8)	3
		4691	
4	What is the total number of schools, roads, hospitals, public offices and shopping centers in DHA Karachi?	School	35
		Hospital	5
		Public Buildings	
		Police Station	4
		Telephone Exchange	3
		Post Office	3
		Graveyard	8
5	How many houses were damaged in each Phase?	Nil but many houses faced material loss.	
6	How many people lost their lives?	Mr Faizan S/o Ghulam Muhammad (Age about 18x yrs) died on spot due to elec shock at 4th Tariq street near Masjid Zubair, Ph-VII, (Extension).	
7	Which Phase had the largest number of damages in terms of houses and individuals?	Phase-IV, Phase Vl, Phase-VlI and Phase Vlll. Map showing details is attached at Annexes.	
8	Total number of damaged schools, roads hospitals, public offices and shopping centers in DHA Karachi?	Map showing affected area attached in annexes.	

9	Who rescued the people and through which means?	Army called on to Relief Op during Rain Emergency 2020.
10	How much time was taken to rescue the people?	S&V Dte responded instantly to rescue people form houses, roads, basements and commercial markets by utilizing available equipment/ vehicles. However, worst areas were:- a. Kh-e-Badban b. Kh-e-Bahria c. Old Sunset Blvd d. Kh-e-Hilal e. Kh-e-Shujaat f. Kh-e-Shahbaz to 26 street g. Rahat Commercial h. Nishat Commercial i. Shahbaz Commercial j. Bukhari Commercial k. Kh-e-Amir Khusro l. Kh-e-Tariq m. Kh-e-Qasim to Kh-e-Ittehad
11	How much time was taken to clear the debris and stagnant water?	Approx 1x week was consumed to clear debris and stagnant water completely.
12	What methods were adopted for the removal of stagnant water?	Lifting of water form pounded area through the employment of bowsers and pumps.
13	What were the major problems faced by the residents as well as the rescuing authority?	Problem faced by residents of affected area: - a. Power loss due to shut down. b. Gas sup discontinued where pumps exposed to rainwater. c. Communication stalled. d. Road under poundage. e. School closed. f. Sewerage choked.
14	What was the reason that led to the urban flooding in DH Karachi?	Causes of Flooding a. Drains are choked not properly cleaned. b. Sewerages are connected to drains causing lowering the capacity of drainage system. c. Dumping of sewage in drains. d. Maintenance became the issue due to inaccessible drains. e. Phase-II of const of SWD halted.
15	What measures are adopted by the DHA to avoid urban flooding in future?	**Rain Emergency work Measure to avoid urban flooding** a. Hydrological study to ascertain causes of flooding. b. Hiring of consultant M/s Zeerukfol vetting of already executed works and planning, design & supervision of left over storm water drainage network and linking sewage from Mehmoodabad drain to TP-4 in DHA. c. CA for execution of left over drain with NCL. d. Formulated rain emergency scheme for DHA Karachi.

3. Discussion

At the eastern border of Karachi city, DHA is situated on the Karachi-Hyderabad highway. DHA is divided into 8 phases that are distributed into 17 sectors which are further branched into subsectors namely A, B, C, D, etc having a population of about seventy thousand. Each phase has its park and commercial area. There are six major lanes and streets in DHA. Phase 4, 5, 6, 7, 8 has normal lanes and streets, Phase 4 has commercial and gizri lanes and streets, Phase 5 has zamzama streets, Phase 1 and 2 has north, south, central as well as sunset lane and streets. A few features of the area are:

- Surrounded by the Arabian Sea including its Creeks on three sides.
- The elevation is at mean sea level with numerous areas being lower than mean sea level
- A major portion of land use is on reclaimed land from the sea.
- Malir Nadi is the main natural water channel that flows from North to South on the Eastern Side of DHA Karachi and subsequently falls into the Creek.

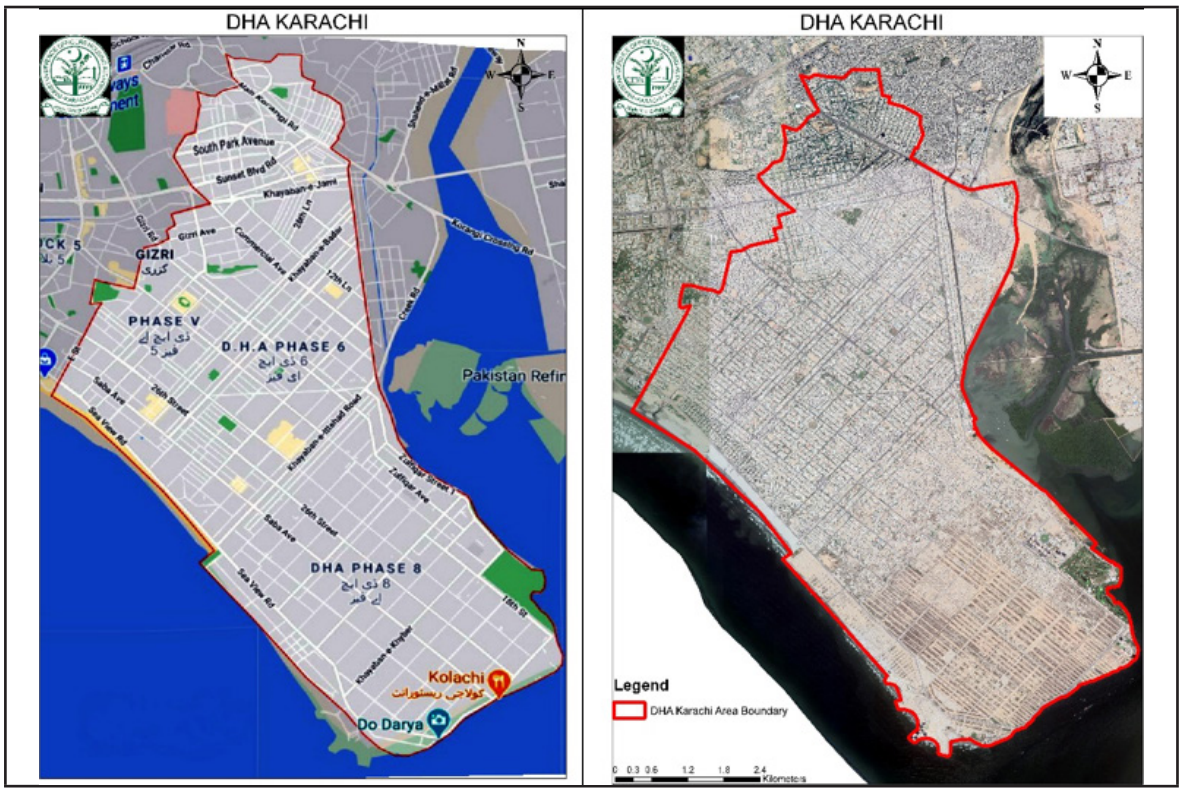

Figure 20. Location Map of DHA Karachi

Flooding happens when water collects in areas that are not ordinarily inundated, as is widely known. Urban flooding occurs in DHA as a result of heavy rain, which causes an accumulation of water that exceeds the capacity of drainage systems, resulting in a susceptible physical and socioeconomic environment that exceeds DHA's ability to regulate or withstand the repercussions.

The red outline in the figure shows the boundary of the DHA Karachi. From the analysis, it is concluded that DHA has been built on the flood plain area and the reason why it was flooded with monsoon rainwater was that many houses were built (land encroachment) on the commercial car parking area. Along with this the drainage system is not properly developed and maintained by the authority due to stormwater inundating the whole society. The drainage system capacity is lesser than the dumping of solid and liquid waste into it by

the residents. Most of the damage was observed in phases 5,6,7 and 8. Streets were mostly cracked due to the standing water and those houses that were single units faced structural as well as material loss. Most of the residents self-rescued either by evacuating or moving to the roof of their houses. To avoid future urban flooding, a proper development planning process needs to be developed for DHA in those areas that have the highest risk of inundation should be made residential free as well as a comprehensive design for stormwater drains and flood water training works should also be provided to ensure safety and sustainability. The system will also accelerate and improve analyses for future land-use planning and ensure timely decision-making.

3.1. The factor that causes urban flooding in DHA Karachi

The image of the DHA Karachi taken from the Google earth map has been shown below:

Figure 21. DHA Google Earth Image

The figure 22 shows the generalized surface drainage pattern of DHA Karachi with likely accumulated areas. With the help of GIS (DEM), this drainage map has been created that shows the flow of incoming water from the surrounding areas of Karachi into DHA. The flow pattern of the internal water and its accumulation in different areas of DHA had also been seen. The accumulated areas are represented by the red dots. The areas where these dots are bigger are the areas that are mostly inundated like phases 5 and 6 while those areas that have small dots are the least accumulated areas like phases 1,2 and 3. The blue arrows indicate the flow pattern and direction of stormwater from the drainage network that is spread throughout the DHA.

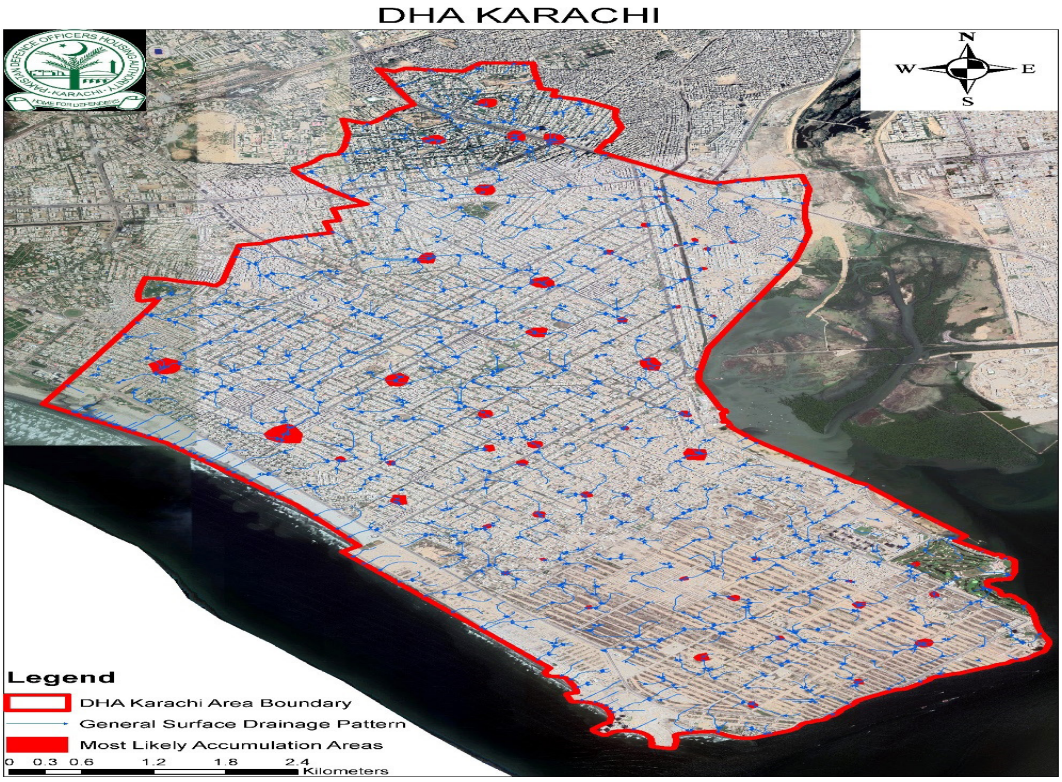

Figure 22. Generalized Surface Drainage Pattern DHA Karachi with Likely Accumulation Areas

To remove the stagnant water from the accumulated areas borehole tests were performed. The different location that was best for conducting this test is shown in the figure below. The profile of the soil, as well as groundwater regimes, was first identified through this test. And then the stagnant water was removed. To stop the dumping of sewerage waste into the drainage of phase 6 proper place should be given for its disposal without creating any environmental hazards. Also, the structural design of the drainage and sewerage system needs to be updated to avoid urban flooding in the future.

3.2. Limitation and Recommendation

For flood hazards and vulnerability of Karachi city and DHA's following recommendations, are devised that will be beneficial in future studies:

- For flood hazard mapping of DHA there should be an online detailed digital geological map of the area that should be easily accessible. Since most of the people also die because of electrocution during flooding caused by monsoon heavy rainfall there should be the availability and usage of an electric transmission vector map. For any new housing society, it should be kept in mind what impact does it cause on the storm-water drains as well as on the overall drainage and sewerage system in Karachi city as well as these societies should also be recognized by the authorities in term of drainage system expansion and for that DHA Karachi should be used as a baseline study to avoid the impacts and effects that DHA has faced as a result of monsoon rainfall. Survey and questionnaire should be used for awareness of the public about flood hazards as well as for flood preparedness in terms of resilience to flooding.

4. Implication

With the help of DHA Authority Rain Emergency 2020 Plan figure 23 has been devised that shows the overall damage posted to different areas in DHA. This plan could be used while devising flood mitigation measures, also if bore hole test figure 24 are conducted in the affected areas removal of stagnant water could be removed faster.

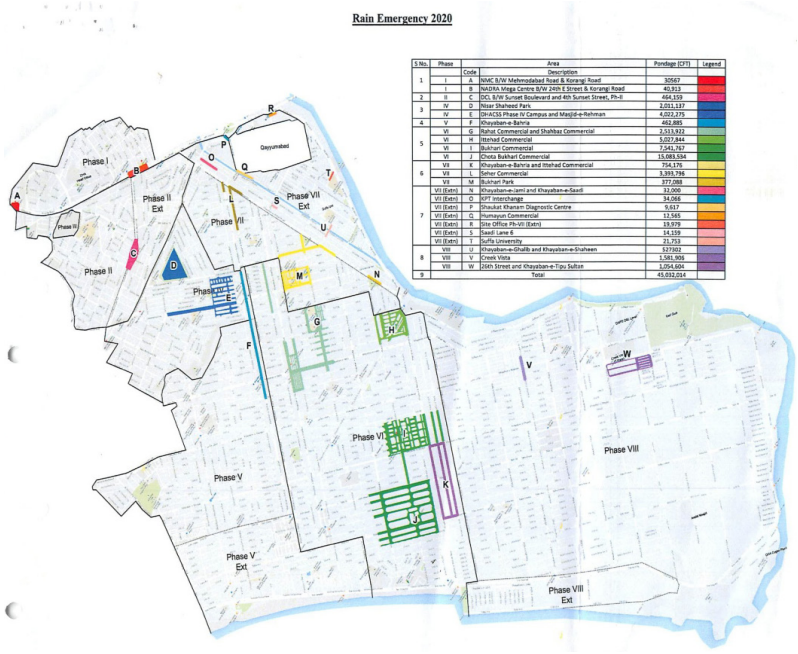

Figure 23. Rain Emergency 2020

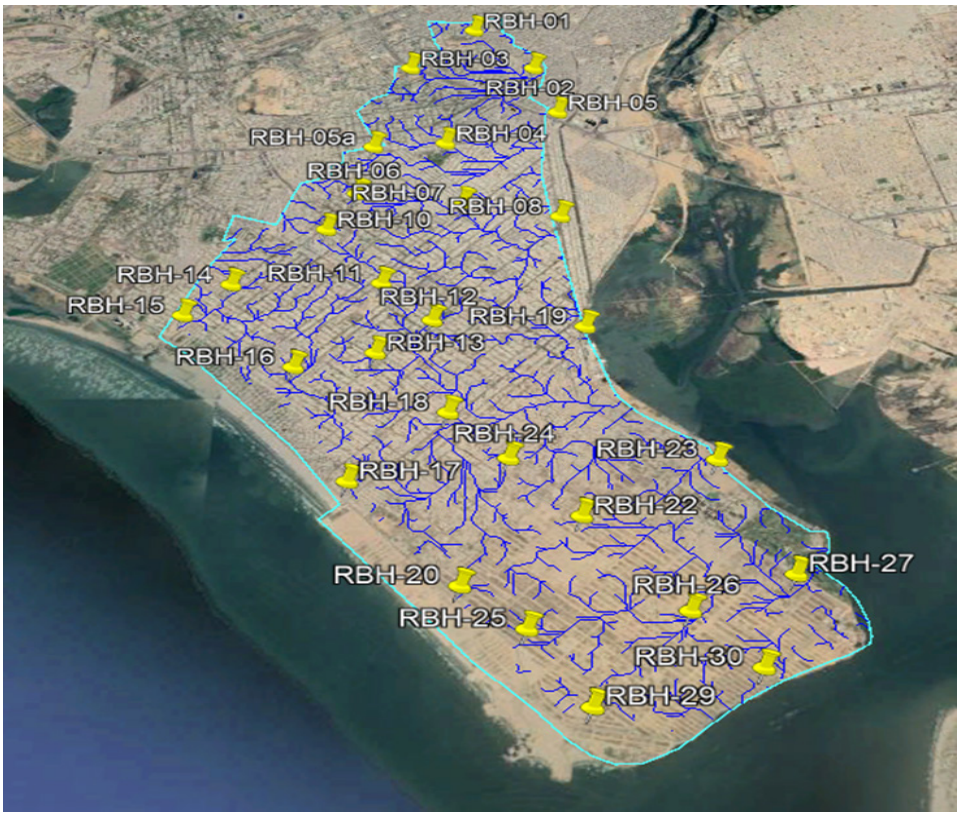

Figure 24. Identified Most Likely Locations for Borehole Tests

5. Conclusion

As a result of heavy and extreme monsoon, rainfall and storm surge Karachi city had to face the problem of urban flooding that not only results in the loss of lives but also disrupts city life. As a result of heavy and extreme monsoon rainfall and storm surge Karachi city had to face the problem of urban flooding that not only results in the loss of lives but also disrupts city life. In August 2020 DHA area of Karachi city was badly affected by monsoon rainfall resulting in massive damage and destruction. Two questionnaires were developed in order to find the cause of urban flooding in DHA and how much damage it has posed to the society. One questionnaire was distributed among the residents of DHA while second was sent to the DHA Authority. After collection of responses they were crossed checked and it was found that poor drainage and sewerage system was the main factor that led to urban flooding. And streets, roads and all transportation routes were mostly damaged.

7. Author contributions

The corresponding author Ayesha Iftikhar contribution includes: Analysis, Methodology, Software, Writing – original draft, Writing – review and editing. The second author Dr. Jawed Iqbal contribution includes: Investigation, Supervision, Visualization.

8. Funding

There was no funding for this research.

9. Acknowledgments

In the end we would like to thanks DHA authority who helped us in gathering data.

10. Conflicts of interest

"The authors declare no conflict of interest."

11. References

Adetunji, M.; Oyeleye, O. Evaluation of the causes and effects of flood in Apete, Ido Local Ahmed I., R. Rudra. B. Gharabaghi, J. Dai, M. Peacock, and M. Widaatalla. 2013.

Danumah, J. H., Saley, M. B., Odai, S. N., Thiel, M., & Akpa, L. Y. (2016). Remote Sensing Based Analysis of the Latest Development and Structure of Abidjan District, Cote d'Ivoire. *Geoinfor. Geostat. Overview*, *5*.

Di Baldassarre, et al. (2013) 'Socio-hydrology : conceptualising human-flood interactions'.

Greiving, S., Fleischhauer, M., &Lückenkötter, J. (2006). A methodology for an integrated risk assessment of spatially relevant hazards. Journal of environmental planning and management, 49(1), 1-19.

H.LCloke,F.Pappenberger "Ensemble flood forecasting: A review" Elsevier Journel of Hydrology, vol. 375, pp.613- 626,September 2009.

IPCC. 2014. Summaryforpolicymakers, in Climate Change 2014: Impacts, Adaptation, and-Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth AssessmentReport of the Intergovernmental Panel on Climate Change, edited by Field, C.B.,V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O.Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, andL.L. White. Cambridge, 1-32. The United Kingdom and New York, NY, USA: Cambridge UniversityPress.

Nasiri, H.; Shahmohammadi-kalalagh, S. Flood vulnerability index as a knowledge base for

Nath, S. K. (2004). Seismic hazard mapping and microzonation in the Sikkim Himalaya through GIS integration of site effects and strong ground motion attributes. Natural Hazards, 31(2), 319-342.

Qin, H. P., Li, Z. X., & Fu, G. (2013). The effects of low impact development on urban flooding under different rainfall characteristics. Journal of environmental management, 129, 577-585. Qualtrics, 2021. How to use stratified random sampling in 2022.

Smith, K. (2003). Environmental hazards: assessing risk and reducing disaster. Routledge.

Snead, R. E. (1967). RECENT MORPHOLOGICAL CHANGES ALONG THE

Socioeconomic evaluation of Swat river watershed project. Forest education division, Pakistan Forest Institute.

Yamane, T., 2016. How to calculate a Reliable Sample size using Taro Yamane Method.

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

504
614.8.069

International Journal of Disaster Risk Management/Editor-in-Chief Vladimir M. Cvetković. - Vol. 1, no. 1 (2019) - Beograd: Scientific-Professional Society for Disaster Risk Management, 2019 - (Belgrade: Neven). - 24 cm

*Semi-annually.
ISSN 2620-2662 = International Journal of Disaster Risk Management
COBISS.SR-ID 275206924