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Research article

FLOOD VULNERABILITY ASSESSMENT BY FLOOD VULNERABILITY INDEX (FVI) METHOD: A STUDY ON SIRAJGANJ SADAR UPAZILA

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Abstract: Flood is one of the most common and extreme hazards in Bangladesh because of its geographical location. Sirajganj is a district with the highest flood propensity in Bangladesh. The study aims to evaluate the vulnerability in the ten Unions of Sirajganj Sadar upazila to the flood hazard. Different forms of vulnerability evaluation approaches differ in their method. The Flood Vulnerability Index (FVI) method has been implemented in this research to determine flood vulnerability in order to classify which areas of the study are the most vulnerable to flooding. For the study of flood vulnerability, three indicators (i.e. exposure, sensitivity and resilience, etc) are selected in four dimensions (social, financial, environmental and physical). The FVI calculation determines the flood vulnerability index scores for each union. Following the analysis of FVI, in Sirajganj Sadar Upazila Mechhra union is marked as being highly vulnerable. Since this union is very poor in adaptability, coping capacity and resilience; exposure and susceptibility are greater. The other syndicates are highly exposed to floods. Finally, the zoning map for flood risk was developed on the basis of vulnerability index ratings.

Keywords: Vulnerability; Flood Vulnerability Index; Exposure; Susceptibility; Resilience

1. Introduction

Bangladesh is one of the world's biggest rivers with a dense network of Ganges, Brahmaputra with Meghna distributors, and over 230 main rivers and tributaries. The basin Ganges, Brahmaputra and Meghna occupies a net total area of roughly 1.76 x 106 square kilometers spanning Bangladesh, Bhutan, China, India and Nepal. Just 7% of this vast catchment area is in Bangladesh. The country's monthly yearly precipitation ranges from 1500 to 5000 mm with an average of 2300 mm. Bangladesh is particularly vulnerable to flood dangers due to its geographical location, land characteristics, the multitude of rivers and the mountain climate. The floods are annual, with the worst floods happening in July and August. A few days now, the earth has been flooded, inhabitants have been displaced on a wide scale and economic disruption and ecological impacts have been immense. Global warming such as climate change, demographic and economic development and urbanization is exacerbating floods. As a consequence, floods routinely affect life and livelihoods (Bhattacharya et al, 2013).

In Bangladesh, flooding is by far the most frequent and dangerous threat. During the monsoon season, the volume of water flowing into Bangladesh from upstream exceeds the rivers' capacity. Each year, over 26,000 km^2 (roughly 18 percent of the country) of Bangladesh is flooded, killing over 5,000 people and damaging over seven million homes due to melt water from the Himalayas. Floods have wreaked havoc on Bangladesh throughout its history, especially in 1966, 1987, 1988, and 1998. (Disaster Management in Bangladesh, 2003).

Sirajganj is one of Bangladesh's worst-affected districts due to flooding. Since so much of Sirajganj district is located along the Jamuna River, it is regularly flooded and eroded. Because of the comparatively low lying areas and deltas, as well as the presence of a large river called Brahmaputra, the ten unions of this Upazila are the most vulnerable to flooding (Bhuyian, 2014). In this report, the Flood Vulnerability Index (FVI) approach is used to assess flood hazard vulnerability in order to determine which areas in Sirajganj Sadar Upazila are the most vulnerable to flooding (FVI).

2. Literature review

In contrast to other methods, the indicator-based approach offers a more detailed image of overall flood vulnerability in each region. In flood risk management, vulnerability is the most important factor to consider. One of the most important goals of flood vulnerability assessment is to establish a direct link between theoretical flood vulnerability conceptions and the day-to-day administrative process. Since a variety of methods to assessing vulnerability have been adopted, authorities must choose the most suitable technique. Curve method, catastrophe loos data method, computer simulation methods, and indicator based methods are the four most commonly used evaluation methods (Nasiri et al., 2016).

The report, titled "Flood vulnerability index as a knowledge base for flood risk assessment in urban areas," focused on the flood vulnerability index as a knowledge base for flood risk assessment in urban areas. There is a need to develop flood risk management strategies due to the magnitude of the effects of flooding. The assessment of flood risk at the urban scale is one of the most critical aspects of flood management. Many studies have been conducted on flood danger, including flood vulnerability assessments, because understanding vulnerability is important not only for the survival of communities that are vulnerable to extreme flooding, but also for their adaptation to climate change. Developing a Flood Vulnerability Index is one strategy for achieving this aim (FVI). The Vulnerability Index will assess which areas are the most vulnerable to flooding and should be taken into account during potential

redevelopments. That is, FVI establishes a connection between theoretical flood vulnerability expectations and the day-to-day flood management process. This research is largely focused on the flood risk literature (Nasiri, 2013).

The study "Community Vulnerability Assessment Tool Methodology" developed the Community Vulnerability Assessment Tool (CVAT), a danger and vulnerability assessment methodology that aids emergency managers and planners in their efforts to minimize hazard vulnerabilities through hazard mitigation, systematic landuse, and development planning. The model takes into account a variety of threats, such as storm surge, wind, and tornadoes, and provides a methodology for identifying and prioritizing them. The model also defines sensitive facilities (e.g., police, fire, hospitals, shelters, services, and so on) and calculates their vulnerability to physical and operational hazards. A small number of inputs are used in a social vulnerability study, but the analysis is not exhaustive (Flax et al., 2002).

This paper, titled "Reducing the Complexity of the Flood Vulnerability Index," examines the findings of an examination conducted to select the most important indicators in order to create a frugal use of the FVI. This approach is applicable at three different spatial scales (river basin, sub-catchment, and urban) and to the various components of flood vulnerability (social, economic, environmental, and physical), just as it was with the original methodology. Improvements to the FVI methodology were made by assessing the indicators' importance and studying the key indicators needed to effectively represent the reality of the fluvial floods. This was accomplished by the use of statistical methods (a derivative and a correlation method) as well as expert expertise (via a questionnaire). Finally, both of these approaches were combined to define the most important indicators and simplify the FVI equations. After its complexity is reduced, the FVI can be more easily used as a tool for flood risk reduction, decision-making enhancement, and education (Balica & Wright, 2010).

The article "Social Impacts and Flood Vulnerability in Bangladesh and Nepal" looked at flood vulnerability, impacts, and coping strategies in Bangladesh and Nepal, with the goal of proposing a long-term mitigation strategy. According to historical data, floods in Bangladesh and Nepal have increased in frequency, severity, and length since 1970, causing significant human suffering, disruptions in normal life and activity, infrastructure, crop and agricultural destruction, and severe economic impacts. Both countries' disaster management bureaus have already organized numerous trainings, conferences, and seminars to disseminate scientific information and disaster preparedness practices to disaster managers and increase public awareness. Apart from modern flood control methods, the people of these countries have lived with flooding for centuries, depending on traditional/indigenous knowledge and other local adaptation practices. It is critical that indigenous, traditional, and conventional traditions be incorporated into national and regional policy, and this should be accomplished through a participatory process involving policymakers and relevant stakeholders (Dewan, 2015).

The article "Community Responses to Flood Early Warning System: Case Study in Kaijuri Union, Bangladesh" examined community-based flood early warning system responses. Early alert is a vital aspect of reducing disaster risk. There have been significant advances in medium-range and seasonal forecasting in recent decades. This paper outlines an integrated framework for medium-range flood forecasting that is focused on the needs of agricultural users in order to minimize flood impacts on the farming community. Danger and vulnerability evaluations were carried out by group consultation as part of the methodology. Based on farmers' needs for early warning, the study included creating a flood risk map and response options to flood risk probabilistic forecasts. The ability to use probabilistic forecasts for organizational decision-making is demonstrated in this report. Focus group meetings, informal interviews, and surveys were used to determine the predicted lead-time requirements,

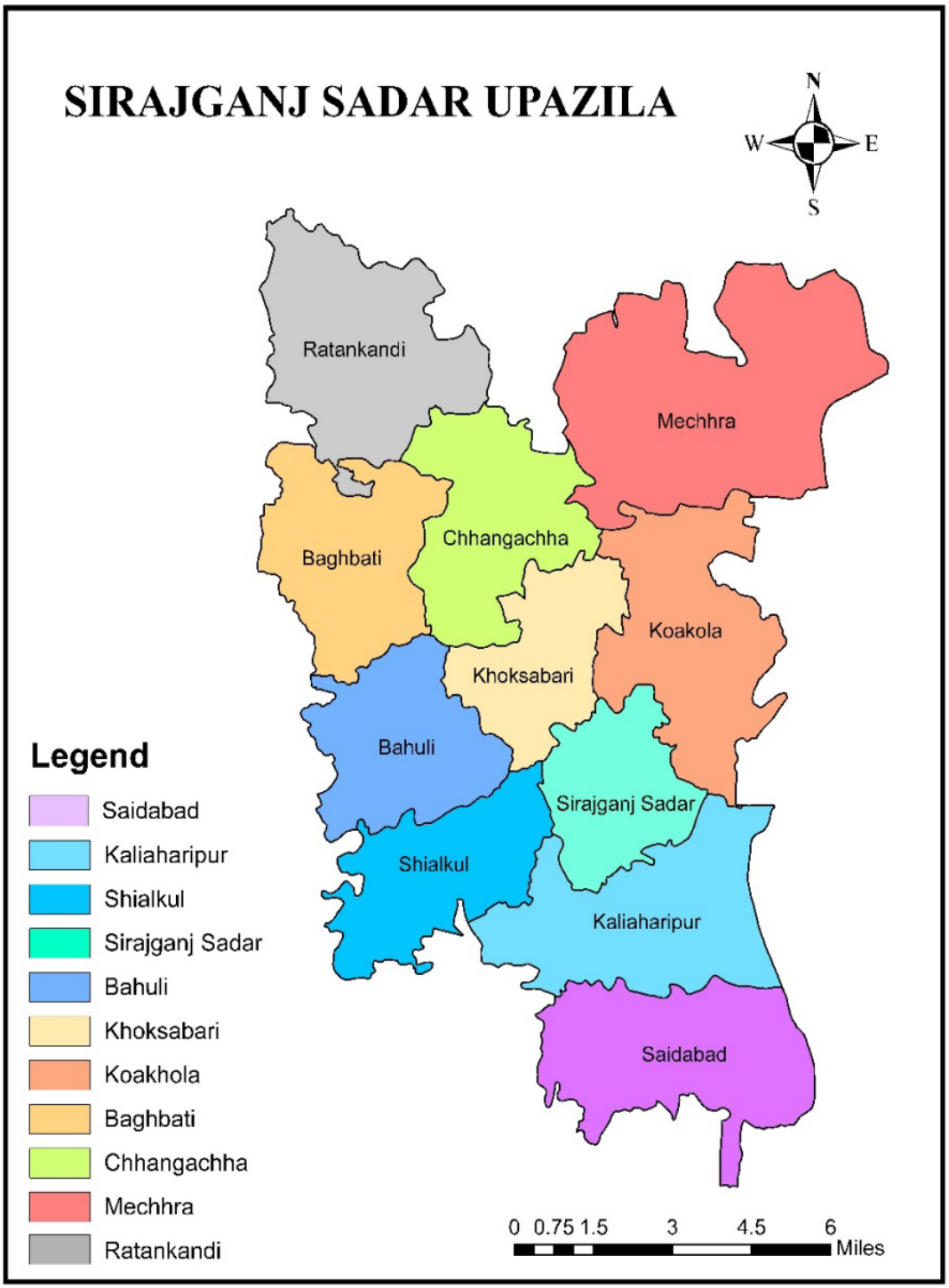
impacts, and management options for crops and livestock. The findings included flood risk mapping focused on the study area's communities' exposure to flooding, as well as early warning impacts before and after flood events (Fakhruddin et al., 2015).

The research "Flood hazards and vulnerability assessment in a Riverine Flood Prone Region: a case study" aims in a remote sensing and geographic information system to evaluate the danger and vulnerabilities of riverine floods in a flood-prone area (GIS). Flood frequency analyzes are carried out for the purpose of assessing flood risk and vulnerability to various levels. The vulnerability feature is developed for settlement and fisheries vulnerability maps. Depth harm relationship has been established for the development of the vulnerability feature. In order to generate a Raster-based vulnerability chart, vulnerability functions of settlement and fishing are utilized. The flux frequency analysis demonstrates the best fitting distribution for flood frequency analysis in the study area of Pearson form III distribution. In the 100-year return cycle, floods represent 48, 35, 53 and 38 respectively, respectively, for the total agricultural, settlement, and fishery areas. Vulnerability has been observed in settlement areas that are scaled down to low, very low, moderate, high and very high. The vulnerable fishery areas of 18, 19, 9, 3 and 4 percent in 100 years of water supply are poor, extremely low, moderate, high and very high. The research findings may be useful for a potential flood mitigation strategy in the field of study (Bhuiyan, 2014).

3. Research materials and methods

3.1 Study Area Profile

Sirajganj Sadar Upazila (Sirajganj district) area 320.15 sq. km, located in between 24°22' and 24°37' north latitudes and in between 89°36' and 89°47' east longitudes. The study area is unions of Sirajganj Sadar Upazila which is one of the worst flood affected region of Bangladesh. It was surrounded by a network of rivers namely Jamuna. Sirajganj Sadar Upazila located at the right side of Jamuna River. Every year this Upazila flooded in monsoon rainfall period from July to September. All union of this Upazila are vulnerable to flood. Flood vulnerability analysis is important for understanding which unions are more vulnerable and which unions are less vulnerable to flood. Every year flood occurs in this Upazila and is very vulnerable to flood because of its geographic location and Jamuna River. That's why Sirajganj Sadar Upazila is selected as the study area.



(Source: Author, 2019)

Figure 1. Study Area (Sirajganj Sadar Upazila)

Sirajganj Sadar Upazila consists of ten unions namely Baghbati, Bahuli, Kalia Haripur, Kaoakola, Khoksabari, Mechhra, Ratankandi, Saidabad, Shialkul, Chhangachha. Basic Information about these ten unions is shown in table1.

Table 1. Union Wise Distribution in Sirajganj Sadar Upazila

Union Name	Population	Population Density	Population Growth Rate (%)	Literacy Rate (%)	Child mortality Rate	Disable People
Baghbati	53015	1994	1.77	41.9	4.6	1.4
Bahuli	39403	1661	1.14	39.1	4.6	1.2
Kalia Haripur	50400	1786	1.37	44.0	4.6	2.5
Kaoakola	17713	541	1.35	31.1	4.6	1.0
Khoksabari	302705	1549	0.69	44.8	4.6	2.1
Mechhra	24766	486	1.59	35.4	4.6	1.8
Ratankandi	48916	1467	0.33	40.7	4.6	1.5
Saidabad	47610	1328	2.08	40.7	4.6	4.6
Shialkul	45965	1882	1.88	45.1	4.6	1.1
Chhangachha	381709	1406	1.09	43.9	4.6	1.9

(Source: Field survey, 2019)

3.2 Flood Vulnerability Index (FVI)

Because of the increased flood hazard, better approaches must be established to help decision-making in flood risk management. The Flood Vulnerability Index (FVI) is a tool focused on indicators. The FVI has been thoroughly evaluated with regard to all components of a flood disaster that are most likely to be affected: social, economic, environmental and physical. The FVI tests the vulnerability level for each factor (exposure, susceptibility and resilience). Vulnerability itself is known to be a combination of exposure, susceptibility and resilience:

Vulnerability = (Exposure × Susceptibility)/ Resilience (Balica and Wright, 2010).

This study's evolved approach aims to assess flood vulnerability in three ways: (1) visibility, (2) susceptibility, and (3) resilience. These variables are defined as follows by (Pouya et al., 2017): People, property, structures, and other elements that are present in hazard zones and are thus exposed to potential losses have been described as exposure. Flooding can have an effect on humans and physical objects, which is known as exposure. The values that are present at the place where floods occur can be understood. Exposure is a term that is used to describe the process Goods, facilities, cultural heritage, agricultural lands, and people can all be included among these values. The elements revealed within the framework that affect the probabilities of being harmed in a flooding situation are referred to as susceptibility. General population, social ties, and institutional growth data are among the susceptibility measures. The ability of a system, population, or society exposed to hazards to withstand, absorb, and recover from the effects of a hazard is known as resilience. Political, administrative, environmental, and social organizational evaluations are all used to assess resilience.

Flood vulnerability is an important factor to consider when assessing flood risk and assessing damage. Many methods for assessing flood susceptibility have been developed by researchers. It's difficult to quantify flood vulnerability because it depends on a variety of factors including social, economic, environmental, physical, and even political factors. The selection of indicators is the first step in any indicator-based vulnerability assessment. There are three types of vulnerability assessment methods: vulnerability index systems, vulnerability curve methods, and disaster loss data (Nasiri, 2013). The vulnerability index system has been used to assess flood vulnerability in Sirajganj Sadar Upazila among these methods. Since this Upazila is heavily populated, it is prone to flooding. Exposure, susceptibility, and resilience are three factors having impacts on calculation of vulnerability. The FVI has been evaluated holistically, taking into account all dimensions that are most likely to be impacted by a flood disaster in Sirajganj Sadar Upazila: social, economic, environmental, and physical. The FVI framework used in this study evaluates the degree of vulnerability for each indicator (exposure, susceptibility, and resilience) across four dimensions and multiple spatial scales.

Table 2 illustrates the appropriate indicators under four factors but it is an important matter that selection of vulnerability indicators is directly relevant to that study context.

Table 2. FVI system components

Dimensions	**Indicators**					
	Exposure	**Acronym**	**Susceptibility**	**Acronym**	**Resilience**	**Acronym**
Social	Population Growth	P_G	Child Mortality	C_M	Educational status (Literacy Rate)	E_S
	Population Density	P_D			Awareness & Preparedness	A/P
	Disable People	D_P			Institutional Arrangement	I_A
					Training Program	T_P
					Indigenous Practices	I_P
					Warning System	W_S
Economic	Household Assets	H_A	Unemployment	U_M	Economic Diversification	E_D
	Agricultural Dependency	A_D			Flood Insurance	F_I
	Income Source	I_S				
Environ-mental	Land Use	L_U	River bank Erosion	R_E	Embankment	E
	Monsoon Rainfall	M_R			Water Body	W_B
Physical	Closeness to River	C_R	Geographic Location	G_L	Communication System	C_S
	Housing Pattern	H_P			Access to Utility & Service facility	A_{US}
					Flood Shelter	F_S

(Prepared by: Author, 2019)

The general formula for FVI is calculated by classifying the component in three groups of indicators: exposure (E), susceptibility (S) and resilience (R)-

$$FVI = \frac{E*S}{R} \quad \text{..... (i)}$$

With regard to indicators this equation is become to following ones (Balica, 2012) -

$$FVI_{social} = \frac{P_G*P_D*D_P*C_M}{E_S+\frac{A}{P}+I_A+T_P+I_P+W_S} \quad \text{..... (ii)}$$

$$FVI_{Economic} = \frac{H_A*A_D*I_S*U_M}{E_D+F_I} \quad \text{..... (iii)}$$

$$FVI_{Environmental} = \frac{L_U*M_R*R_E}{E+W_B} \quad \text{..... (iv)}$$

$$FVI_{Physical} = \frac{C_R*H_P*G_L}{C_S+A_{US}+F_S} \quad \text{..... (v)}$$

$$FVI_{union} = FVI_{social} + FVI_{Economic} + FVI_{Environmental} + FVI_{Physical} \quad \text{..... (vi)}$$

Total FVI of each urban area is the sum of these four indicators based FVI (Eq. ii-vi). This index value indicates extent of vulnerability as follows in below table.

Table 3. Flood vulnerability interpretation (Balica, 2012)

Index value	Description
<0.01	Very small vulnerability to floods
0.01-0.25	Small vulnerability to floods
0.25-0.50	Vulnerable to floods
0.50-0.75	High vulnerability to floods
0.75-1.00	Very high vulnerability to floods

4. Flood vulnerability analysis:

flood vulnerability assessment is analyzed for ten unions (Baghbati, Bahuli, Kalia Haripur, Kaoakola, Khoksabari, Mechhra, Ratankandi, Saidabad, Shialkul, Chhangachha) of Sirajganj Sadar Upazila under Sirajganj district for identifying which unions are more vulnerable and which are low vulnerable to flood by considering social, physical, economic and environmental dimension with such components under three indicators. The current situation and some important data about each indicator of ten unions under Sirajganj Sadar Upazila are observed field field survey, Key Informant Interview (KII), Focus Group Discussion (FGD) and questionnaire survey. A questionnaire has been devised with four main dimensions, concerning the degree of significance of each indicator and the vulnerability components. It has been completed by local people of each union. Some data has been collected from Sirajganj Sadar Upazila office and Bangladesh Water Development Board. The respondents have evaluated the indicator's influence on flood vulnerability in general. Some people are gathered together from similar background to discuss about flood. According to their opinion some classes have been created and weighted each components of each indicators under four dimensions on a scale 5 to 1, where 5 indicates very high vulnerable and 1 very low vulnerable. Then these weights are normalized. Normalized value is 0.01-1. Table 4 shows category, weight, and normalized value. The formula of normalization is:

$$X' = \frac{X-Min}{Max-Min}$$ Where, X' is normalized value.

Table 4. Category and Weight and Normalization Value

Category	Weight	Normalized value
Very low vulnerable	1	0
Low vulnerable	2	0.25
Moderate vulnerable	3	0.50
High vulnerable	4	0.75
Very high vulnerable	5	1

(Prepared by: Authors, 2019)

One normalized value has been found for every component. The Flood Vulnerability Index for each dimension (social, economic, environment, physical) is calculated for ten unions using formulas (Eq. ii-v) with these normalized values.

Social vulnerability: The social dimension includes indicators that describe the context, capacity, skills, knowledge, values, beliefs and behavior of individuals, households, organizations and communities at various geographic scales. Social indicators are typically used to assess current conditions or achievements of social goals related to human health, housing, education levels, recreational opportunities and social equity issues (Balica & Wright, 2010). The indicators for social vulnerability to flood for Sirajganj Sadar Upazila have been chosen as a determinant of vulnerability. For flood vulnerability index, ten components have been chosen, which cover three indicators under social dimension of flood vulnerability and give an overview of the situation. Among ten components, three components indicate exposure, one component indicates susceptibility and six indicate resilience to flood. The components of exposure are Population growth rate(P_G), Population Density *(P_D)*, Disable People(D_P); component of susceptibility is Child Mortality (C_M) and components of resilience are Educational Status (Literacy Rate) (E_S), Awareness & Preparedness *(A/P)*, Institutional Arrangement (I_A), Training Program (T_P), Indigenous Practice (I_P), Warning System (W_S). Table 5 shows that the value of Flood Vulnerability Index (FVI) of every union for social dimension. According to the table, Saidabad union is more socially vulnerable among ten unions.

Economic Vulnerability: The income and prosperity of the study area are depicted in the economic dimension. These metrics would provide information about the capacity to generate and deliver flood-prone goods and services. Developing countries, for example, are characterized by low per capita income, a shortage of human resources, a lack of investment and finance, and weak infrastructure. Developed countries, on the other hand, are characterized by substantial investments in prevention and countermeasures, long life expectancy, flood insurance, and urban planning, among other things. If economic growth accelerates, the risk of flooding will likely increase as well (Balica & Wright, 2010). As a determinant of vulnerability, the indicators for economic vulnerability to flood for Sirajganj Sadar Upazila have been chosen. Six components have been chosen for the flood vulnerability index, which cover three indices under the economical dimension of flood vulnerability and provide an overview of the situation. Three of the six elements are exposure, one is susceptibility, and the other two are flood resilience. The components of exposure are Household Assets (H_A) Agricultural Dependency (A_D), Income Source(I_S); component of susceptibility is Unemployment Rate (U_M) and components of resilience are Economic Diversification(E_D), Flood Insurance(F_I). Table shows that the value of Flood Vulnerability Index (FVI) of every union for economic dimension. According to the table, Bahuli union is more economically vulnerable than ten unions.

Environmental Vulnerability: The environmental aspect involves indicators that relate to the environmental damage caused by floods or intrusion caused by human beings that could increase the vulnerability of certain areas. Activities such as farming, urban growth and forestry have been shown to generate greater vulnerability to flooding which can lead to more pollution (Balica & Wright, 2010). As a factor determining the vulnerability, environmental indicators for Sirajganj Sadar Upazila have been chosen. Five components have been chosen to cover three social measures of the vulnerability of the flood and provide an overview of the situation for the flood vulnerability index. Two components include exposure, one is vulnerability and two are flood resistance.The components of exposure are Land use (L_U), Monsoon Rainfall (M_R); component of susceptibility is Riverbank Erosion (R_E) and components of resilience are Embankment *(E),* Water Body (W_B). Table 5 shows that the value of Flood Vulnerability Index (FVI) of every union for environmental dimension. According to the table, Mechhra union is more environmentally vulnerable among ten unions.

Physical Vulnerability: The physical dimension contains how the physical conditions (natural or human-made) can influence the vulnerability of a particular region to floods. The indicators for physical vulnerability to flood for Sirajganj Sadar Upazila have been chosen as a determinant of vulnerability. For flood vulnerability index, six components have been chosen, which cover three indicators under social dimension of flood vulnerability and give an overview of the situation. Among six components, two components are exposure, one component is susceptibility and three are resilience to flood. The components of exposure are Closeness to River (C_R), Housing Pattern(H_P); component of susceptibility is Geographic Location (G_L) and components of resilience are Communication System(C_S), Flood Shelter (F_S). Table 5 shows that the value of Flood Vulnerability Index (FVI) of every union for physical dimension. According to the table, Mechhra union is the most physically vulnerable one to flood among ten unions.

The total Flood Vulnerability Index is calculated for each union using Formula (Eq. vi). Table 5 shows total Flood Vulnerability Index (FVI) for every unions where the highest index value is 1.00 at Mechhra union.

Table 5. Union wise Flood Vulnerability Index (FVI)

Dimension Union	Social	Economic	Environmental	Physical	Total
Baghbati	0.07	0.16	0.30	0.08	**0.61**
Bahuli	0.03	0.23	0.30	0.06	**0.62**
Kalia Haripur	0.09	0.04	0.13	0.23	**0.49**
Kaoakola	0.01	0.05	0.25	0.24	**0.55**
Khoksabari	0.03	0.2	0.30	0.06	**0.41**
Mechhra	0.01	0.14	0.60	0.25	**1.00**
Ratankandi	0.02	0.08	0.45	0.08	**0.63**
Saidabad	0.15	0.01	0.06	0.23	**0.45**
Shialkul	0.07	0.06	0.30	0.11	**0.54**
Chhangachha	0.03	0.04	0.30	0.15	**0.52**

(Prepared by: Authors, 2019)

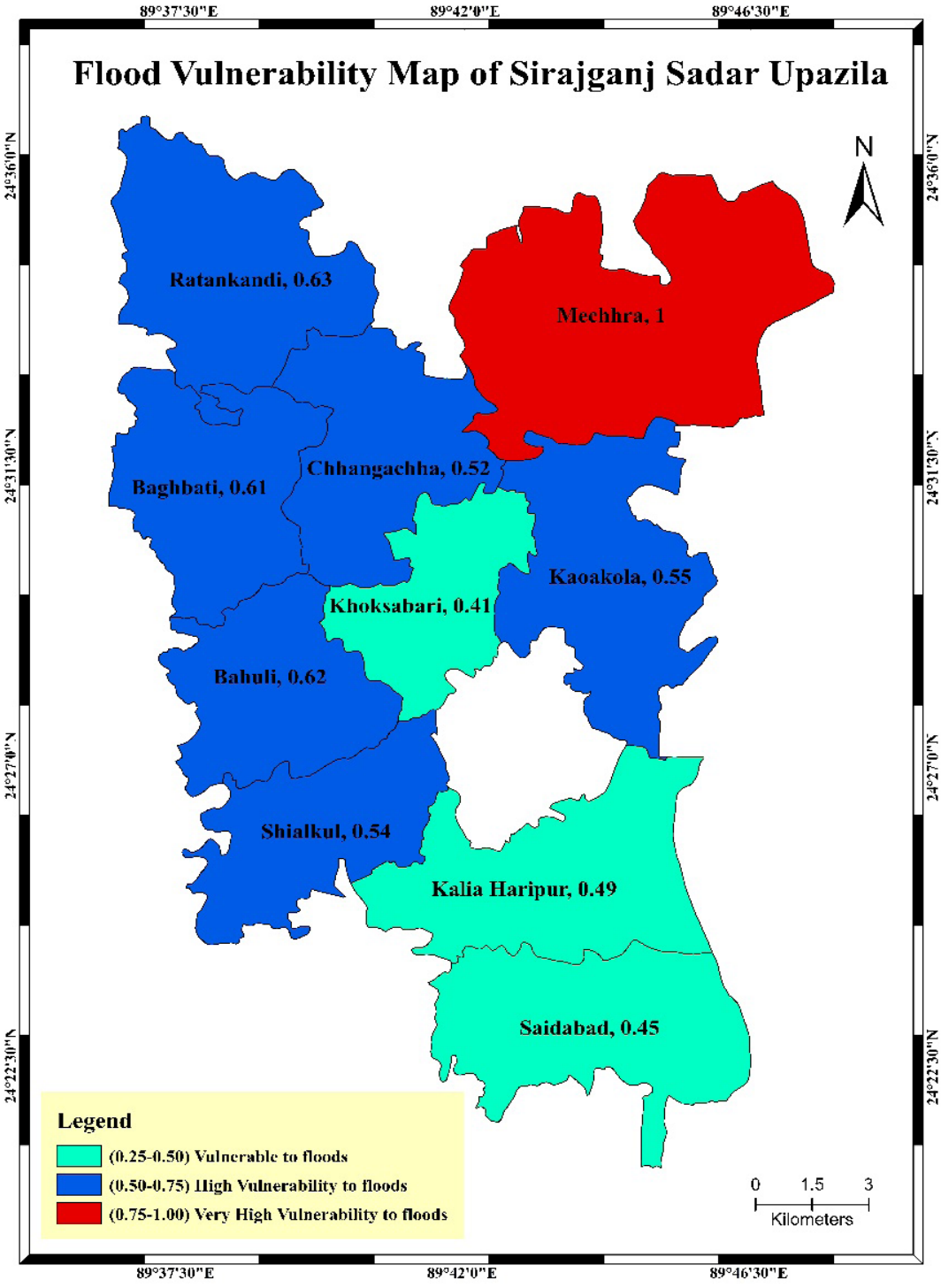
Table 6 shows union wise Flood Vulnerability Interpretation where six unions are high vulnerable to flood which index value range is 0.50-0.75. The most noticeable aspect of the table 6, Mechhra union is very high vulnerable to flood.

Table 6. Union wise Flood Vulnerability Interpretation

Index value	Description	Unions
<0.01	Very small vulnerability to floods	--------
0.01-0.25	Small vulnerability to floods	--------
0.25-0.50	Vulnerable to floods	Khoksabari (0.41)
		Saidabad (0.45)
		Kalia Haripur (0.49)
0.50-0.75	High vulnerability to floods	Chhangachha (0.52)
		Shialkul (0.54)
		Kaoakola (0.55)
		Baghbati (0.61)
		Bahuli (0.62)
		Ratankandi (0.63)
0.75-1.00	Very high vulnerability to floods	Mechra (1.00)

(Prepared by: Author, 2019)

The FVI for environmental and physical dimension of Mechhra union is extending or reaching upward more than other unions. Because of its geographical location, this union is more environmentally and physically vulnerable. It has been observed from field survey, Mechhra union is located at middle in the river and it is a "Char Area". This union is very high vulnerable for its low resilience and lack of indigenous coping capacity. Final result has been shown in Figure 2. From the map, it is clearly understood that, Mechhra union is in very high vulnerable zone; Baghbati, Bahili, Ratankandi, Shialkul, Kaoakola, Chhangachha unions are in high vulnerable zone; Khoksabari, Saidabad, Kalia Haripur unions are in vulnerable zone.



(Prepared by: Author, 2019)

Figure 2. Flood Vulnerability Map of Sirajganj Sadar Upazila

5. Conclusion

sirajganj district is one of Bangladesh's flood-prone regions. This study introduces a method of indexing, which is applied to determine flood vulnerability and focuses on Sirajganj Sadar Upazila flood susceptible unions. This research also offers a summary of the Flood Vulnerability Index (FVI) framework assessment methods for flood vulnerability. The whole

FVI concept is that the area (Sirajganj Sadar Upazila) is affected by a four dimensional flood risk (social, economic, environmental and physical). This research covers a thorough review and understanding of flood vulnerability measures, i.e. exposure, sensitivity and resilience. The finding of the study is the comparative vulnerability analysis among the ten unions of the upazila. This result will be helpful to design any kind of flood risk management measures for Sirajganj Sadar Upazila.

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Research article

DISASTER MANAGEMENT IN TURKEY: A SPATIAL APPROACH

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Abstract: Disasters cause losses on people and residential areas, cause interruption of normal life and decision-making mechanism, collapse communication and communication even for a short time, and damage infrastructure and superstructure investments. In the traditional disaster management design, the regulations created by the legislation and rules issued are directed to each unit in the country at the same time. Administrative authorities must coordinate the emergency recovery process as a requirement of these protocols. In modern disaster management approaches, disasters are associated with spatially; the distribution, severity, type, and population affected by disasters are all considered. Starting with the spatial distribution of such disasters in Turkey, disaster management can be structured from space to center. The Turkish disaster management mechanism has issued recommendations as a consequence of this study.

Keywords: spatial approach, disaster, disaster management, earthquake, Turkey.

1. Introduction

All phases of disaster response, recovery, recovery, mitigation, and disaster preparedness that happen after one disaster event and continue until the next disaster (Coppola, 2011: 10) are included in the disaster management process (Fig 1). The main objectives of the response phase are to provide emergency aid and assistance, reduce the risk of secondary damage, and allow rescue operations as easy as possible. "Provide immediate assistance during the early recovery phase required to restore critical life support services to minimal operating levels, and continue to provide support until society returns to normal," according to the recovery plan (Petak, 1985). Mitigation is an opportunity to lessen the potential effects of disasters when they occur. Behaviours of preparedness for potential disasters are also included in preparedness.



Figure 1. *Disaster management process*

Comprehensive, progressive, risk-driven, integrated, collaborative, coordinated, flexible, and professional disaster management can be structured (Çakın, 2007). Priorities, hazards, risk analysis, impact analysis, alert, and forecasting are all critical factors to consider in risk-driven disaster management. On the other hand, integrated disaster management focuses on bringing together all levels of management (central administration and local municipalities), social units, the private sector, NGOs, and individuals.

An uncoordinated emergency and crisis management system can be much less effective than a coordinated disaster / risk management perspective in handling disasters and emergencies. The interruption or prevention of normal life, as well as the unpredictable and uncontrollable nature of disaster risks, are the main factors that increase the severity of disasters (Kapucu, 2013: Coppola, 2011). The works done before and after a catastrophe is referred to as disaster management. Since a disaster just lasts a short time, the work that can be performed during it is a repetition of exercises that have already been practiced and implemented.

Crises, threats, and tragic incidents draw the public's and media's attention rapidly because they impact large groups of people directly or indirectly. Following such events, public policies in a part of the whole of the can alter (Alexander, 2005). These adjustments differ depending on the countries' governance understanding and disaster characteristics; often a centralized structure is more beneficial, and other times it is more beneficial to interfere locally in disaster areas (Yavaş & Yavuz, 2015).

Since public organizations and local municipalities lack the capacity, resources, and experience required for disaster management on their own, collaboration between public institutions, the private sector, and non-governmental organizations is required for the effective completion of the disaster management process's tasks. Major disasters have shown the importance of collaboration among all organizations and NGOs involved in disaster management for successful disaster management.

In disaster management around the world, a transformation from post-disaster wounding policies to pre-disaster preparedness and mitigation stages has been observed since the 1980s (Balamir, 2007: 32). The United Nations prepared the Hyogo Declaration for the years 2005-2015 and the Sendai Declarations for the years 2015-2030 with the aim of identifying disaster risks, preventing disasters before they happen, and preparing individuals and organizations for disasters (Macit, 2019; Pearson & Pelling, 2015). Since no perfect crisis management mechanism exists in all countries, governments are forced to pursue solutions that will improve their ability to deal with crises.

1. The current disaster management system in Turkey

Turkey has been adhering to the Disaster Emergency Response Services Regulation (AADMHY) in terms of disaster preparedness and damage prevention since 2013. As a result, the Turkish Republic Ministry of Interior's Crisis and Emergency Management Presidency (AFAD) takes disaster-prevention measures (Şahin, 2019). As can be deduced from this concept, Turkey's disaster management center operates as a single-source service (Table 1). Taking decisions as the centre of the whole country in disaster management may lead to the emergence of wrong practices in the disaster area, to react slowly, and the local response of the decisions taken to be irrational. Especially when it is considered that not all cities have the same level of regular structuring, the disconnection between decision-makers and the application area increases (Yavaş & Yavuz, 2015). Leaving decision-making power solely in the hands of local authorities and making emergency management decisions on the spur of the moment can, however, result in a misreading of the big picture. Today, an integrated disaster management system is used to identify the hazards and threats ahead of time, to take steps to avoid or mitigate losses that could occur prior to the disaster, to ensure successful intervention and coordination, and to carry out post-disaster recovery works in a timely and efficient manner (AFAD, 2021).

Table 1. *The Turkish disaster management system's major milestones (Kuterdem, 2010; Seymen&Akın, no date).*

Period	Properties	Annotations
-– 1923	Before Republican	Rules for settlements in Istanbul
1923 - 1944		Response, Post Disaster Aids and 1930 Municipality Law
1944 –1958		Partially Disaster Reduction, First EQ Zonning Map, First Building Code
1959 - 1999		Ministry of Reconstruction and Settlement, Civil Defence Law
1999 - 2009	Awakenning	
2009 – 2013	Organisation	Establishing Disaster and Emergency Management Presidency (AFAD)
2013 - 2018	Re- organisation	Regulation on Disaster and Emergency Response Services
2018 -	Re- organisation	AFAD was connected to the Turkish Republic Ministry of Interior's.

In Turkey, local governments are generally expected to carry out disaster preparedness as a legal requirement (Öcal, 2007). The Turkish crisis management system is structured in a hierarchical order. In the centralized management approach, legislation is the official basis for responding to disasters. Following Turkey's extreme disasters, the majority of disaster-related legislation was created. The Marmara Earthquake in Turkey in 1999, for example, caused concern, and the UN initiated risk management strategies, preparing the groundwork for a shift in Turkey's disaster management system. These provisions include the type of response to potential disasters, as well as the food supply, clothing, health services, and temporary shelter during and after the disaster (Ganapati, 2008).

2. Natural disaster risks and spatial approach to Turkey' disaster management

Turkey is one of the few countries in the world that has been hit by many catastrophic events. Natural disasters, terrorist attacks, and migration caused by insecurity in neighboring countries are among the country's most common disasters. Due to its mathematical and specific location, Turkey has been seen in a wide variety of disasters, with the geological structure and climate playing a big role. A number of factors affect the severity of disasters that have arisen in the historical process of socioeconomic, cultural, and philosophical contexts. Individual and social inequalities in Turkey and its neighbors have the potential to have much further consequences. Turkey should establish a disaster management system to determine the relationship between all of the components mentioned above.

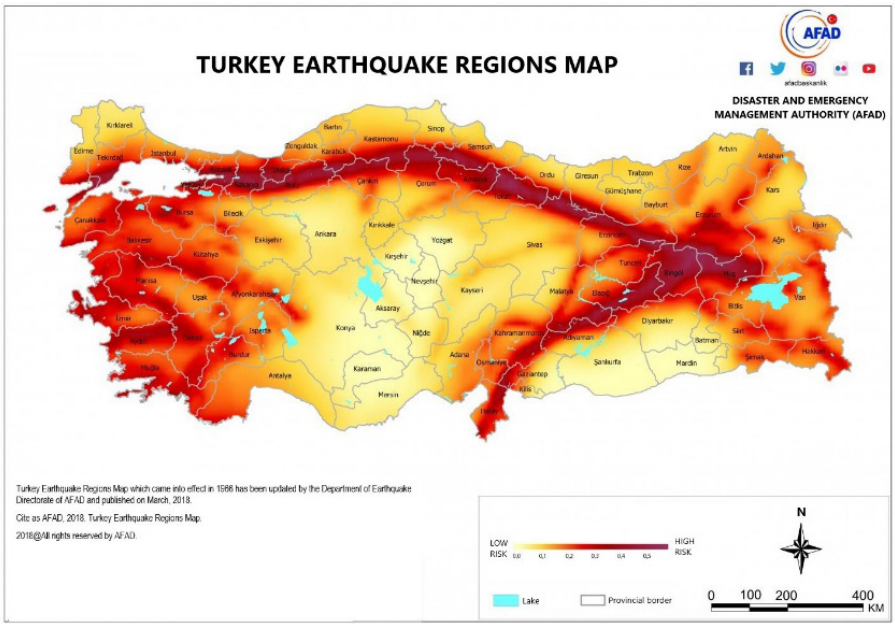


Figure 2. *Turkey seismic regions (AFAD, 2018).*

Because of its geographical location, Turkey is continuously threatened by natural disasters. Our country has experienced disasters such as earthquakes, landslides, floods, avalanches, drought, wildfires, extreme winter conditions, and storms. The landslide is the most common type of disaster in Turkey (32,7 %). Besides that, since Turkey is a geologically young country, earthquakes are common (6,8%). In Turkey, floods are a major natural disaster (12,2 %). Avalanche is another form of disaster that occurs in our country (3,8 %), and can happen in Turkey, especially in the eastern part of the country. Occasionally, many natural disasters occur at the same time. Other natural hazards, such as severe weather conditions (1,7%), are also seen in Turkey [AFAD, 2021]. Turkey is located on one of the world's most important fault zones. These fault lines can be found in three major areas: the North Anatolia Fault Zone (NAFZ), the South East Anatolia Fault Zone (SEAFZ), and the West Anatolia Fault Zone (Figure 2). Extreme and deadly earthquakes are produced by these fault generations.

In the 5472 settlements in Turkey (provincial, district centers, towns, municipalities, and villages), 15.3 % of the landslides are observed. 43.5 % of landslide-prone settlements are less than 20 kilometers from faults or fault areas (Figure 3). In other words, the faults/fault zones provided a suitable area for the production of landslides (Gökçe, Özden & Demir, 2008).

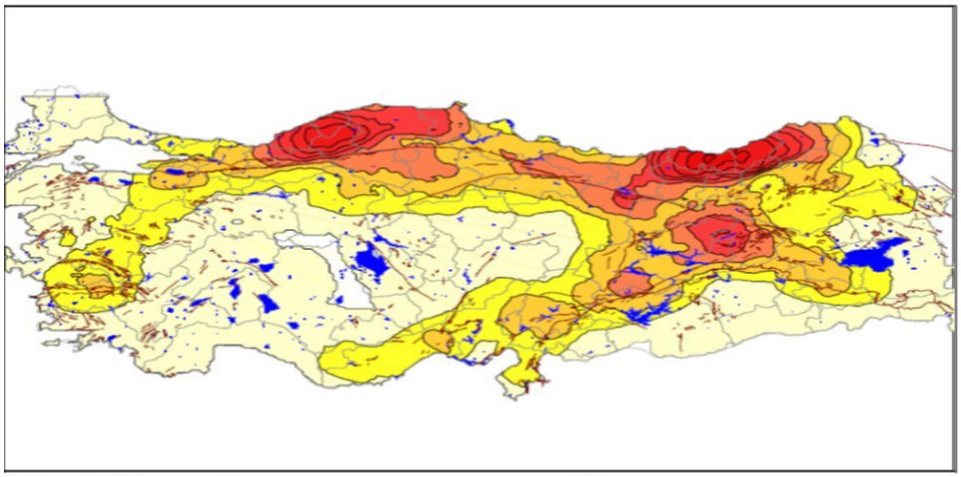


Figure 3. *Lanslides and active faults in Turkey (Gökçe, Özden, Demir, 2008)*

Turkey also has three different climates: Mediterranean, Continental, and Black Sea climates (similar to the Oceanic climate type). The majority of the country, especially the central and eastern Anatolia regions, has a continental temperate climate, while the Aegean, Mediterranean, and Southeastern Anatolia regions have subtropical dry summer climate characteristics, according to the Köppen-Trewartha climate classification. While the Black Sea coast has a subtropical humid climate; some provinces in Trakia and the Inner Aegean have a marine temperate climate (Fig. 4). In the provinces of Iğdır, Konya-Ereğli, Urfa-Ceylanpınar, and Çorum/Osmancık, semi-arid steppe climates can be observed. According to the Köppen-Trewartha Climate Classification, 47,22 of our country has a Continental Climate (Dc), 30.95 % Subtropical Dry Summer Climate (Mediterranean climate - Cs), 11.51 % Temperate Maritime (Do), 7.94 % Subtropical Humid Climate (Cf), and 2.38 % Semi-Arid-Step Climate (BF). Turkey is also confronted by major world air masses (Siberia HP, Asor HP, Island LP, and Basra LP). Within a year in Turkey, you can experience four separate seasons (Öcal, 2019).

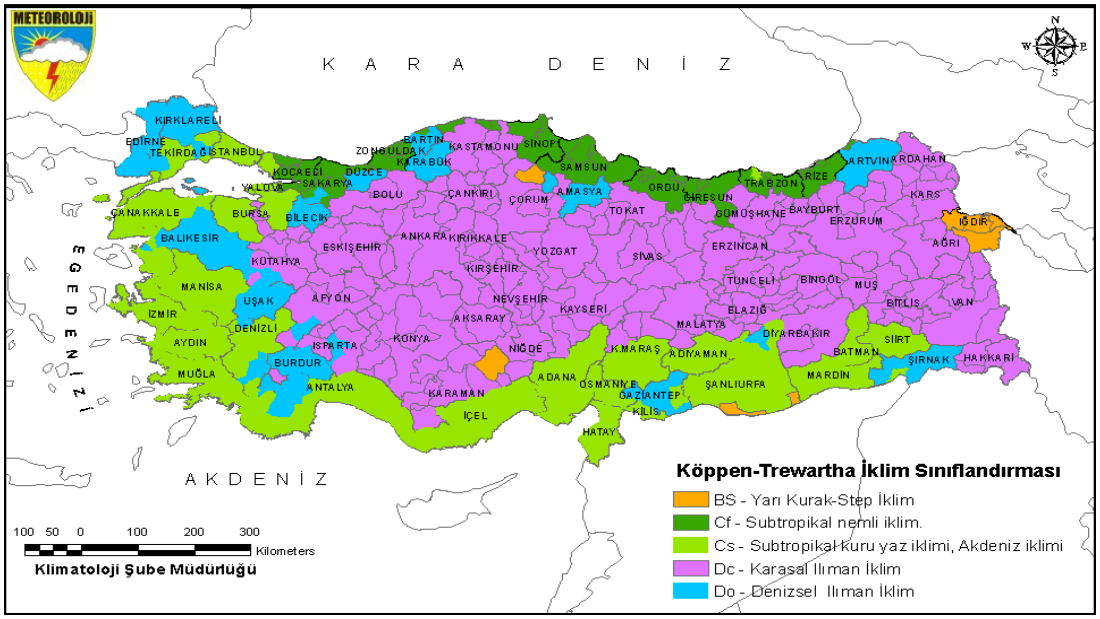


Figure 4. *Koppen-Trewartha climate classification of Turkey (MGM, 2018)*

While Turkey has a wide range of climatic and geological features, earthquakes are the most destructive types of disasters in the country. For many years, earthquakes have been regarded as an interference in crisis management, and changes were made accordingly. As a result of this situation, the Turkish Crisis Management System was not flexible enough to deal with all potential crises.

An uniform disaster management system would be useful if Turkey ignored the broad geographic features and differentiation factors that cause disasters. For example, the Erzincan earthquake of 1939 (MS: 7.9) killed 32968 people, and the earthquake of 1992 killed 653 people (MS: 6.8). Karaman, on the other hand, has never been exposed to a severe earthquake. For another example, landslides are most prevalent in the provinces of Trabzon and Rize. These cities, on the other hand, are seismically secure. Erzurum and Sivas are popular for their floods, and Erzurum is a seismically risky place from these regions.

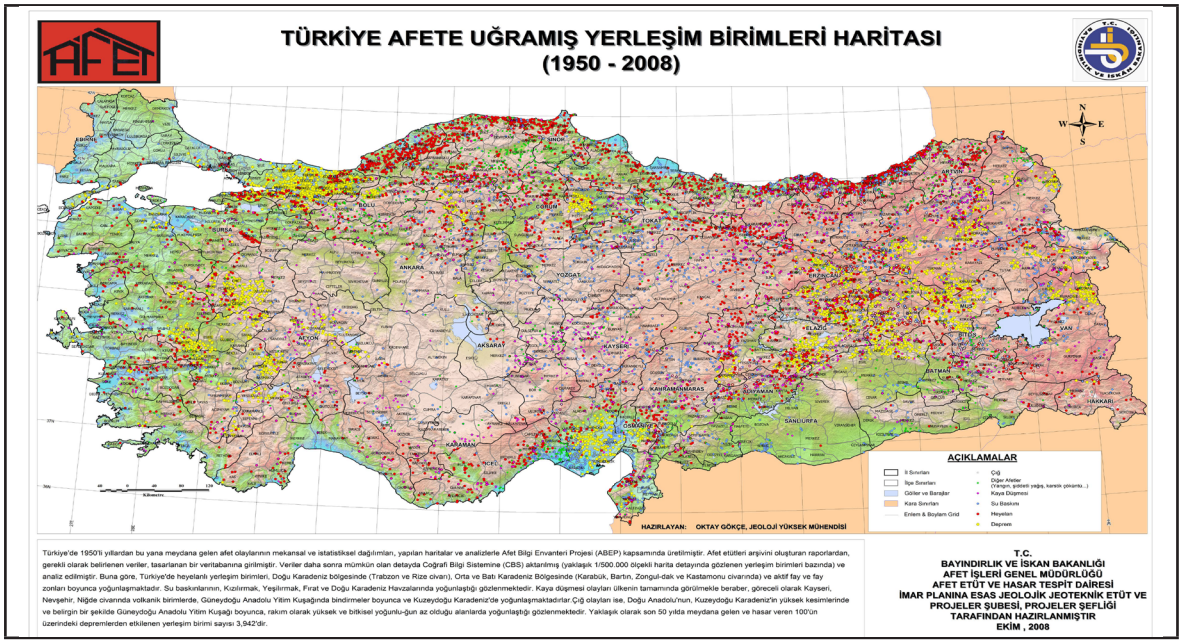


Figure 5. *The map of settlements in Turkey suffered disaster between 1950 and 2008. (Gokce et al., 2008)*

Each administrative unit in Turkey should be dealt with as an effective disaster management system in terms of the level of risk (Fig. 5). It is necessary to determine the most common types and severity of disasters in the relevant location, as well as the factors that increase disaster severity spatially. If this is implemented, it is obvious that certain disaster-causing incidents can be controlled in a way that benefits the community ahead of time (Koç, Petrow, & Thieken, 2020). Settlements should be considered not only in terms of geographical location, but also in terms of economic and social influences. With the assistance of certain computer programs and artificial intelligence technologies, the collected data can be analyzed, and spatial risk/danger situations can be reported. The technical assessments and analyses that will be conducted can provide policymakers with critical information.

3. Conclusion / Discussion

The framework of crisis management can be adapted to the type, severity, spatial, and changing patterns of potential crises. Officers are periodically appointed to the heads of pro-

vincial and district units in Turkey. This situation may sometimes result in the risky area not being properly recognized. Even if ideal laws and plans are made in the administrative center, disaster management would be difficult to achieve the desired success unless a spatial disaster arrangement is made for potential disasters. In the case of Turkey, emergency management and the implementation of such procedures have not achieved the desired results in the last 100 years of experience. According to Balamir (2007; Aydner and Özgür, 2014) the model designed from location to center in disaster management would be beneficial in minimizing disaster risks, whereas the command-control model would be more effective in disaster response.

In this context, disaster risk and intensity maps for the location should be prepared. These supplies will help disaster relief efforts in other countries that have experienced similar disasters (Fujita / Shaw, 2019). Besides that, stakeholder engagement is critical for evaluating risks and to ensure social participation in global issues of disaster management (Guo & Kapucu, 2019). Perić & Cvetković, 2019).

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INDICATORS OF RISK ASSESSMENT AND MANAGEMENT IN INFRASTRUCTURE PROJECTS IN PALESTINE

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Abstract: This study aims to identify the risks which face the work environment in infrastructure projects in order to reduce them and protect human and material resources also it aims to identify indicators used in the assessment, management and prevention of risks in infrastructure projects

Therefore, the study had adopted the analytical descriptive approach, which describes the phenomenon and analyse action taken and adopted in risk management and risk management approach. Infrastructure projects, there's a lack of clear application models in the governmental institutions to implement a national approach for risk management, in addition to the poor knowledge related to risk management sciences. Consequently, the study recommended to adapt comprehensive programme to qualify society and companies in the field of risk management and protection, and following the national risk management approach in infrastructure projects.

Keywords: Indicators, Assessment, Infrastructure, Projects, Palestine

1. Introduction

The Gaza Strip suffers from stopping of urban development because of the siege imposed on it since 2007, and depletion of material resources, environment, and diathesis infrastructure for all aspects of Palestinian development, especially after the continuation of military operations since 2006, notably attacking power station, and bridges between the Gaza and Middle Governorates, which had an impact on the environment and infrastructure of the national sectors of Palestine. As a result, The Qatar Committee for the Reconstruction of Gaza announced many projects to develop infrastructure, which is related to roads and transportation sectors, the environment, water and sanitation sector, and the social housing sector.

Thus, 1 billion $ grant was allocated by the Emir of Qatar Sheikh Hamad bin Khalifa, in addition to the grants allocated by Qatar State for the development of infrastructure which was attacked during the repeated military actions on the Gaza Strip. (El-Shaikh Ali, 2018). The risk management science is concerned with previous evaluation studies that study risk assessments and analyse their multiple impacts on different sectors. It is also concerned with the expected risks that may occur during the preparation of infrastructure projects due to its special dealings with machinery, equipment and the risks of dealing with the soil and slips expected to occur during excavations. Additionally, it concerned with the risks of materials used in projects such as hazardous chemicals which affect the human resources involved in the implementation of infrastructure projects. (Hamza, Shaimaa 2014). The planning process for Infrastructure contributes to build social, service and economic systems. Also it contributes to the achievement of comprehensive development of economic. Infrastructure development affects the recovery of the economy in various fields such as the energy sector, the water sector, the environment and sanitation sector, the transport and communications sector, the gas sector and the construction sector. Infrastructure development processes also require the development of human resources, the development of economic resources, the development of social and health services and basic services that meet the needs of the community. (Riyadh Economic Forum 2007). Hence, this research aims to identify the risks related to the work environment in infrastructure projects to reduce risks and protect human and material resources. Additionally it aims to identify indicators used in the assessment, management and prevention of risks in the infrastructure projects. The study focused on Palestine but the research procedure described in the paper may be applied to any country.

2. Research problem

By reviewing the meetings minuets and reports of the National Committee of Occupational Safety and Health in Palestine, the annual reports issued by the general department of inspection and work protection at Palestinian ministry of labour and the annual reports issued by Civil Defence, researcher found that there are a set of regulations and laws relating to the provision of a safe working environment but they are and have a lack in identifying clear indicators for the assessment and management risks of the work environment in infrastructure projects, Therefore, finding these indicators will provide a clear assessment that contributes to achieve the following:

a) Developing human capacity in the field of effective planning and preparation for infrastructure projects.

b) Contribute to the reduction of the work environment risks and enhance protection of workers and material resources.

c) Improve emergency response and recovery levels with minimal human and material losses.

Therefore, the research problem can be elaborated on the following main question: Can indicators of risk assessment and management in infrastructure projects contribute to the development of a safe working environment?

3. Objectives

The study aims to:

- Identifying the risks related to the work environment in infrastructure projects.
- Identifying a set of indicators that can be dropped on infrastructure projects to reduce the risks of work and preserve the human and material resources, which can contribute to improving the levels of supervision of the work environment of infrastructure projects.

4. Importance of the study:

- Provide proposed models for the analysis and assessment of infrastructure risks projects in work environment to be used to examine the feasibility of projects implemented by infrastructure institutions.
- To develop the scientific system which researchers can rely on when we link between the indicators related to the evaluation of infrastructure risks in Palestine.

5. Research Approach

The study adopted a deductive approach that describes the criteria and requirements for risk management in infrastructure projects based on data collection from:

- The meetings minuets of the National Committee for Occupational Safety and Health.
- The annual reports issued by the general department of inspection and work protection.
- The annual reports issued by Civil defence
- Interview with experts.
- Visiting many projects.

It helps to describe and analyse the problem to reach the results of the study objectives, as well as the policy, criteria and indicators approach, that affect the risk study. The study was performed in 2018 and was limited to the infrastructure projects in Palestine

5.1. Literature Review

The literature search included standard methods (i.e. database search, including Science Direct, Google Scholar and TRIS) and the research team's extensive domestic and international contacts to find pertinent data and citations on the topic that have not been formally published. The literature search included journals, conference papers and books.

5.1.1. Previous study

Several previous studies have been conducted in Palestine close to this field, one of these studies is (Mughir, Muhammad, 2018) which was entitled by Indicators of Risk Assessment and Management in Industrial institutions in the Gaza Strip which aims to identify a set of indicators that can be applied to industrial institutions in occupational safety and health field. Another study is (Obaidi, Amal, 2013) which was entitled by The role of Project Risk

Management in Ensuring the Success of its Achievement - the institution of road works and the transport of goods and fuel –Albbsa as a case study .It aims to understand the risks facing the projects and to identify the most important elements that support the effectiveness of the techniques are used to address the risks.

5.1.2. Definitions and concepts

Indicators: The tools defined by the institutions to measure and evaluate their achievements of objectives and vision in order to measure their plans progress. These indicators go through a set of levels according to the institution objectives, such as indicators that relate to operational activities, tactical objectives and the strategic objectives. (National Commission for Academic Evaluation and Accreditation (2013).

Evaluation: It is a management process to measure the conformity between the completed work and the institutions plan. It is determining where we stand now. The judgment of activities, events, programs and projects performed through the methodology established by the organization to measure the judgment on its outputs within the measurement models imposed by the organization.

Risk management: the level of capacity of institutions, organizations, companies, managers and employees to comprehensively understand and identify risks that are expected to cause disasters related to each sector. This entails reducing the vulnerability of damage on persons, property and the working environment by the guidelines, instructions, laws and regulations governing their management assessing the expected impact of risk. The process is carried out in several planned steps (United Nations (2015).

Danger: The problems, threats and events negatively affect the life cycle of the organization and impede the achievement of the strategic objectives. It causes a threat to both human life and environment. As well as it threated the public health, natural resources, industrial and aesthetic environment (Directorate of Policies and Studies (2016).

Risks: Threats that contribute to stopping the sustainability of the work of any project, program or plan and resulting in negative or positive impacts on the environment surrounding the sources of risk. The geographical impact varies according to the quality of the expected hazard. (Modulator, 2018).

Infrastructure: All requirements and services that operate the community, project or public utilities and facilities that contribute to the growth of the national economy (Fulmer, J, 2009). Such as transport, water, sanitation, energy and gas resources electricity, communications, roads, projects for buildings, official institutions, railways, and sports fields.

5.2. The Current Status of Infrastructure Projects in Palestine

Infrastructure developments in Palestine emerged after the arrival of the Palestinian National Authority at the end of 1994, when these projects were ineffectively managed and directed, especially in projects financed by international institutions where funding was mortgaged with financier policies. The occupation forces in geopolitical areas, as well as military operations and the targeting of facilities, buildings, natural and human resources since 2001, have contributed to increase significant changes in the Palestinian infrastructure. The occupation contributed also in the destruction of the f Palestinian agriculture and industrial infrastructure. It attacked housing projects and road projects and energy. In addition, it depleted the water resources, sand and natural reserves throughout the occupation of the Gaza Strip, it destructed the airport and government buildings (Esposito, Michelle, 2009). In

2006, the indicators of destroyed infrastructure have been increased, as bridges, roads and the power plant in the Gaza Strip has been attacked. The prevalence of risk in infrastructure projects has increased as a result of the tight siege on the Gaza Strip. The environmental risks was spread due to the inability to operate many vital projects such as energy, water and sanitation. The infrastructure of all Palestinian sectors has been affected by many risks resulting from the three military attacks in 2008, 2012 and 2014, which included attacking all human, natural and industrial resources in the Gaza Strip such as electricity lines, communications networks, sewage and water, economic, social, agricultural land, fishing boats, religious and health institutions and hospitals. The rubble of the destroyed buildings spread throughout the Gaza Strip, and the waste resulting from military operations, including parts that did not explode (Modulator, 2016). so the level of challenges which faces the infrastructure in the Gaza Strip is very high as mentioned below:

- Military operations
- The siege imposed on the Gaza Strip.
- Linking project financing to external agendas from international organizations and institutions.
- The lack of interest in infrastructure projects by the state and donors, and this emerged after the military attacks on Gaza in 2014.
- The lack of real guidance for development priorities is due to the lack of clarity of the Palestinian borders.
- The depletion of natural and environmental resources in the Palestinian territories.
- Heavy pressure on infrastructure projects in light of the weak operating budgets. This has affected the direction of wastewater and sewage to the sea, increasing the marine pollution of the Gaza Strip.
- Lack of indicators to identify and assess the risks of infrastructure projects in the Gaza Strip.

5.3. Factors Affecting increasing of Risk Levels for Infrastructure in the Palestinian Territory

1. **Military operations:** The occupation destroys vital and socially sensitive facilities, resulting in huge amounts of rubble and rubble for destroyed and damaged buildings, which have a negative impact on the environment, occupational safety and health. These amounts need to remove to landfills. The occupation attacks of all available energy resources and the deforestation of agricultural land led to a high percentage of environmental pollution of water, air and soil and the high level of risk on the groundwater (Palestinian Council of Ministers, 2014).
2. **Financing Risks:** These risks are related to the nature of access to finance for infrastructure projects, especially since the Palestinian Territory is one of the most difficult areas to forecast the needs. The forecasting and planning of the infrastructure projects relate to the pre-security approvals for these projects, especially the energy, communications, water and sanitation projects and the local environment (El-Shaikh Ali and Ihab, 2018).
3. **Selection of infrastructure locations:** The signed agreements between the Palestinian National Authority and the occupation require prior security approvals for all sites chosen for the construction of the infrastructure. For example, the location of Gaza International Airport and some vital projects related to services in the border areas.

4. **Human Risks:** These are all risks that can harm human staff from mismanagement of equipment, machinery, poor knowledge of the nature of the material they deal with, human injuries and accidents resulting in death risks, occupational diseases affecting employees and all human behaviours associated with the work environment (Modulator, 2018).
5. **Risks of war debris:** According to international reports, the military attack in 2014 resulted in approximately 7000 unexploded ordnance, in addition to the objects that exploded and left negative effects on the infrastructure, the environment, the lives of citizens and the safety of workers (Al-Mughir, 2017).
6. **Environmental risks:** As a result of the siege imposed on the Gaza Strip, wastewater pumped into the sea, which negatively affects the environment. Infrastructure projects and its waste disposal have affected the natural environment and its resources. All of the above, in addition to the use of hazardous and chemical materials without attention to environmental standards set by the United Nations Environment Program, as well as local standards to deal with all hazardous materials in the Gaza Strip contributed to the multiplicity of sources of danger to the environment surrounding the human, increased environmental pollution, and the spread of noise and pollution of water, air and soil (Al-Mughir, 2018).
7. **Operational risk:** Operational risks relate to the nature of the operation of employees and regulations that determine the rights and duties of employees, compensation requirements, working hours, hazard pay allowances, all aspects of the operational aspects of infrastructure projects, and the distribution of tasks, competencies and job descriptions for occupational safety and health supervisors, road safety inspectors, Personal safety equipment for workers in hazardous areas and insurance systems and protection of workers in dangerous areas such as tunnels, bridges and high places (ILO, 2017).

5.4. Risk assessment and management methodology:

There are multiple methodologies for risk management and reduction of their effects according to the variables determined by the institution for the management of the stages of risk and the implementation of the prevention strategy and methods of dealing with them.

The methodologies are multiple but agree in five the elements: the identification of risks, analysis, evaluate, control and follow-up and periodic control (Deep and Shelali, 2008).

Figure 1 shows the stages of risk assessment and management.



Figure 1. *Stages of risk assessment and management.*

5.4.1. Risk identification:

The methodologies for identifying and classifying risks vary from place to place, from country to country, and from institution to institution, according to their nature. There are a set of methodologies that identify risks as financial, administrative and organizational risks. Table 1 illustrates the proposed model for identifying risks.

Table1. *Proposed model to identifying Risk*

	Type of Risk	Military operations	Financing Risks	Location Selection	Human Risks	Risks of war debris	Environmental risks	Operational risk
1	Nature of danger							
2	Threat (human/material)							
3	Internal/external							
4	Risk							
5	Classification							
	Original and target supplier							

5.4.2. Risk analysis:

This stage concerns with analysing the prevalence of risk and their effects, threats to be imposed and its sources, knowing the assets expected to be the target of these risks ,determination of the expected action to damage the project assets, amount of resources expected to be lost, the levels of injury caused by the core work in the project and the impact on the surrounding environment such as landslides and geological changes during the implementation of construction work (Latifa and Abdali, 2012).

5.4.3. Risk assessment

The ability to determine the portability of the occurrence of the hazard and its transform to a real risk that threat the implementation of the project, and causes delay in its timetable

Therefore, Risk Assessments of incidents are carried out through evaluation models organized by institutions according to risk prevalence indicators. Models are also interested in identifying risk levels (extreme, large, medium or low) to identify how to control all risks in the work sites. (Atef, et al., 2008).

At this stage, the risk is assessed according to a clear methodology as shown in table (2), which illustrates the proposed model Risk assessment indicators and probability of occurrence and the impact, while figure (2) explains the factors influencing the evaluation process.

Table 2. *Risk assessment indicators and probability of occurrence and impact*

Evaluation Matrix	Intensity				
Probability	Not noticeable (1)	Low (2)	Average (3)	Intense	Very intense
Very weak (1)	1	2	3	4	5
Poor (2)	2	4	6	8	10
Average (3)	3	6	9	12	15
Large (4)	4	8	12	16	20
Very large (5)	5	10	15	20	25

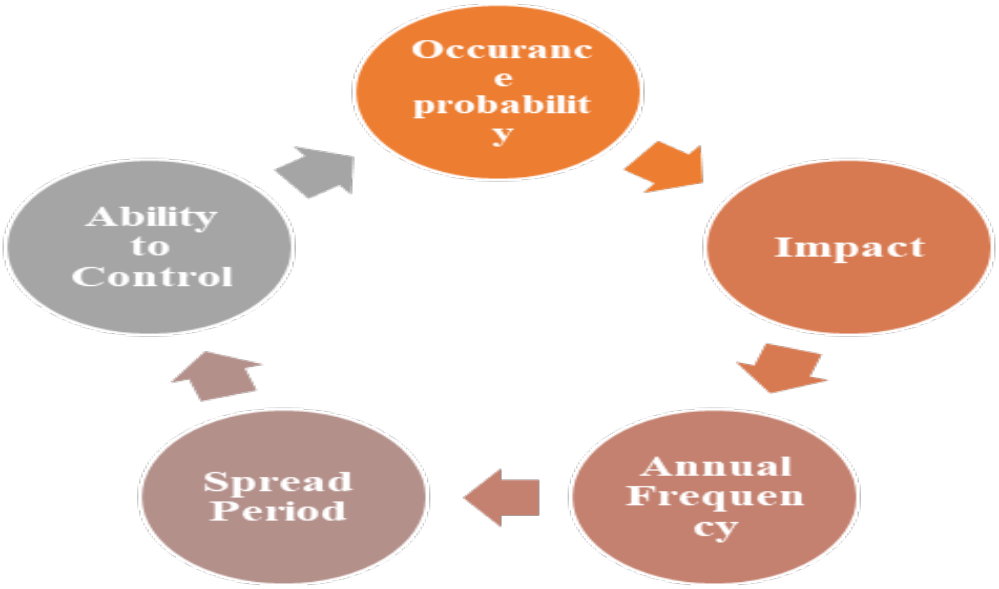


Figure 2. *Factors influencing the evaluation*

5.4.4. Risk control

The procedures used to control the threats, and measure the acceptability of the risks so that they do not have adverse effects that lead to stopping the work. Additionally, identify processes that do not require high costs, determine how to convert step paths so that the project itinerary cannot be opposed. Reducing the risk need to commitment to standards that contribute to the provision of a safe working conditions and avoiding the risk by eliminating the sources of danger and avoid them before, during or after the occurrence. The extent of control and success is determined by verifying and continues inspection on risk sources and implement to measures that reduce the risk (Latifa and Abdali, 2012). Table 3. illustrates the degrees and mechanisms of risk control.

Table2. *Degrees and mechanisms of risk control*

Degree	Type	Description
25-15	Very high risk	Very high. It can cause the stopping work in workplace under the current time. It may occur loss of life, injury, material loss and total disruption of work.
12-8	High risk	High and unacceptable, need to change activity and urgent process, human injuries and high material losses that could threaten to stop work
6-4	Medium risk	Acceptable and must be managed so that they remain at their lowest level and need to be adjusted in procedures, the rate of human injuries is low and does not affect work. May be material losses lead to stopping work for few times.
3-1	A simple risk	Acceptable without the need for further action. The loss of human life is negligible, as well as minor material losses that do not affect the work or the temporary suspension.

5.4.5. Monitoring and periodic monitoring

Direct monitoring of all changes in development plans and strategic policies related to risk management and control. These activities have contributed to the actual change of the negative coefficient impact due to the nature of the danger on the surrounding environment. Monitoring processes also include safety plans to monitor changes in risk sources, and implement all preventative actions that contribute to prevention and reduction in future (Atef, et al., 2008). For further explanation of the mechanisms for monitoring risk management evaluation and analysis, see Table 4, which outlines the integrated analysis matrix for control process of risk management.

Table 4. *Integrated analysis matrix for control process of the risk management.*

	Type of Risk	**Risk status**	**Risk reason**	**Risk effect**	**Level of intensity**	**Protection requirements**	**Probability of Risk**	**Control the risk**	**Checking the control**
1	Risk 1	Human error	Dereliction	Stopping work	Extend outside the factory	Awareness and education	Happened before	Can be avoided	Partially controlled

5.5. Priorities of protection management and reducing risks in infrastructure projects

The protection from risks is the most important priority for development in infrastructure field. The planning and preparation of infrastructure projects requires examining all society stress and its resources and how to sustain and protect them. The priorities in four stages:

5.5.1. Understanding Risks

At this stage, all risks that are expected to disrupt the operation of infrastructure projects should be understood. Risk understanding begins with understanding the threats of social and economic structure as well as understanding of operational risks that are exposed to workers, and all the risks that affect the elements of infrastructure(Water, electricity, sanitation, land use distribution, roads and transport, economic structure, social, cultural and health infrastructure, administrative and legal structure).

All of this contributes to a thorough understanding of everything that affects local infrastructure (Hamza and Shamma, 2014). Understanding risk includes:

- **Risk identification:** identify the risks and their distribution according to sectors that interfere in the implementation of infrastructure projects by using the tables identified by the researchers.
- **Risk analysis:** identify the recurrence of risks to the infrastructure, the surrounding environment and the level of injuries during the implementation of infrastructure projects and rates of material and human losses.
- **Risk assessment:** determine the degree of impact and probability of ooccurrence and repetition to identify the amount of damage in existing resources and their implications for prolonging the life span of project implementation periods.

5.5.2. Strengthening disaster risk management

This is a priority to strengthen local and human capacities in how to effectively manage risk operations through operational plans as following:

- **Risk control:** ability to control risk sources through: risk distribution to reduce their impact (in the case of multiple intervention), or risk pooling (which require high levels of protection and cash flow), or risk exchange through the exchange of assets of high value with a low value, or through maintain and freeze the risk through the insurance of the project.
- **Risk monitoring:** monitoring of the risk through the "risk monitoring plan" which identify the preventive policies set by the state in the infrastructure projects, and follow up the safety system of workers and external site and follow-up procedures for medical periodic checking of workers.
- **Identification of top policies:** should be a clear and available to all employees and administrative levels, and identify possible strategic alternatives to control risks before expansion, and then choose the optimal strategic alternative, according to the current situation and future variables, which contributes to the development of risk management plans.
- **Identification of risk management mechanisms :** identifying activities that would help to transfer risk to other areas or to avoid activities that could contribute to risk occurrence, or to undertake activities that reduce risks through programs identified by organizations which implement infrastructure projects or accept risks that cannot affect the final output of the project or impede the work.

5.5.3. Invest in risk reduction:

Effective institutions should form partnerships with relevant national and local actors that require them to promote a participatory approach to investment development in disaster risk reduction. It can be implemented through:

- **Strengthening the capacities of the human community:** through the rehabilitation of human resources and their ability to understand field changes in the workplace that increase the level of risk affecting the implementation of the infrastructure project.
- Enhancing human capabilities and relying on informed human staff at all risk minimizes unnecessary operational costs and limits the disruption of normal activities.
- **Strengthening physical capacities and infrastructure:** the development of material resources and the provision of financial inputs contribute to the minimizing of risks. The strengthening of the material resources within the work site from monitoring all the executive works leads to the spread of the safety plan. The above requires agencies responsible for the implementation of projects to involve the Ministry of Labor in the prevention of risks and arrange workshops within the site in accordance with the International Labor Organization standards and the regulations of engineering work.
- **Determine the geographic range of each incoming hazard:** during the planning process and the preparation of infrastructure designs, the consultant is required to determine the effective geographic range of each future hazard during the implementation of the infrastructure projects. These reports shall be approved by the General Directorate of Civil Defence, inspection and work protection in the Ministry of Labor.
- **Identify risk requirements and needs:** during planning operations there is imperative safety plan within the work site include: distribution of all raw materials and hazardous in the workshops, generator and machinery, identify all requirements for

safe handling of risks resulting from the use of equipment , machines and urgent intervention to prevent hazards from falling through the team dealing with accidents associated with the relevant authorities and trained in the field.

5.5.4. Enhanced readiness to address and respond to disasters

Planning, needs, development and development processes require us to consider all risks and involve the risk plan within the development plan, as well as to improve the readiness of the infrastructure to sustain its readiness to meet the expected risks of turning to real accidents and disasters. This is done by:

- **Risk Preparedness:** through good preparation based on identifying needs and expected results and where we want to get with the lowest possible cost.
- Effective planning to address risks: the efficiency of planning contributes to higher output quality as well as reducing cost related risk management.
- **Distribution of tasks and roles to institutions:** By defining the network of powers of all operating companies, design offices, advisory bodies, project sponsors and those who will benefit from the project.
- **Training and Community Rehabilitation:** Training of all human resources contributes to a clear understanding of the risks that are expected to occur. Thus, the training and qualification of the team should be designed based on direct observation in the first period of the project, and the creation of potenial risks to know how to deal with them.
- **Identify the difference of confrontation and effective communication:** The formation of a team to intervene directly to deal with any incident within the work site until the presence of the competent authorities and deal with those incidents. They must have direct communication equipment with government agencies that document accidents and arrange all transactions with insurance companies and other government institutions.
- **Forming volunteer teams:** in the event of the spread of accidents outside the work environment and can affect the human resources and physical presence in the workplace, especially the work related to major projects, coordination with the youth organizations to provide services to evacuate the workers from the place.
- **The existence of an incident communication system:** in the multiplicity of infrastructure projects, it is necessary to develop horizontal and vertical communication system with all levels which contribute in protecting the working human resource. Additionally, the type of communication with the government agencies concerned with emergency response operations in the event of multiple accidents and their impact is greater than the capacity of the executing company.
- **Accident Response:** The time factor is one of the most important factors affecting incident response. Thus, accident response processes are related to the qualification of the staff and the specialized teams working within the infrastructure projects site,s as well as to the emergency response government institutions.
- **Early recovery mechanisms:** in case of the spread of risks within the work site and change the parameters of infrastructure and available financial resources, it requires government agencies to support small businesses to re-regularize the work as outlined in the national policy agenda on sustainable development and within the sixth national priority (Palestinian National Policy Agenda 2017-2020).

- **Better Reconstruction:** frequent incidents contribute to the reconstruction of work sites to provide a safe, decent and fair working environment that takes into account all the standards of occupational safety and health, environmental protection and the development of material and human resources.

5.6. Integrated risk management methodology in infrastructure projects:

There are many available risk management methodologies which manage risks in an integrated manner, which require government agencies to build a national risk management system in all areas. Also, the methodology must be linked to pre-detection of risks, and identify all remedial actions associated with human behaviour in dealing with risks as well as the implementation of remedial activities for infrastructural projects that are at risk and preventative activities that contribute to comprehensive protection. The above is done through the following:

5.6.1. Prediction of risks and crises

Effective organizations need to predict all risks expected to occur prior to the implementation of infrastructure projects. This requires a study of all the vulnerabilities and threats faced by the previous infrastructure projects within the local geographical areas as mentioned below:

- **Infrastructure readiness to natural hazards:** the first process that needs to be addressed is the preparedness of flood infrastructure. In this context, and researchers -based on their work experience in many emergency committees and local bodies- had found that the establishment of infrastructure does not take into account the requirements of comprehensive rehabilitation of all the risks expected due to high rainfall. Infrastructure that does not tolerate rainfall in unusual weather hours.
- **Infrastructure readiness for industrial and human risks**: it relates to the provision of infrastructure for risk response operations, as providing emergency vehicle traffic routes, the ability of the infrastructure to withstand the vibration resulting from the military actions by the occupation forces, in addition to the impact of the attacks on the destruction of many Palestinian infrastructure facilities.

5.6.2. Planning and dealing strategies:

- **Defining the future vision:** imagine what level and position we can reach in the process of defining the vision, all the expected variables are examined in relation to financial resources and natural resources. In addition to the pressure on road networks and conflicts in land use and the requirements of regulation and rehabilitation of existing infrastructure.
- **Understanding Risks:** This phase begins with urban planning levels during the preparation of the master plan, as well as in national and local development plans. It examines all the risks that are expected to occur and their impact on the infrastructure in the Gaza Strip and in the geographical scope of each local authority.
- **Prioritization:** This is done by prioritizing the handling of infrastructure projects according to the actual needs of the community, in order to achieve less operational costs for the urban development surrounding the local communityas well as providing basic infrastructure requirements to contribute to governance and good governance.

- **Turning Priorities into Strategic Goals:** Strategic objectives are being set to protect the human and material resources available at the sites of infrastructure projects, and turning all goals into tactical and operational objectives. So, risk management programs and projects are designed to contribute to the rational management of resources and reduce threats that would affect infrastructure.

Table 5: shows the data to be collected during the assessment and control of infrastructure development projects that have been built on an integrated data approach that can assist in the effective development planning of the infrastructure.

Table 5. *Proposed model for all integrated data on the infrastructure project*

Project name		Owner	
Donor		Consultant	
The project site		The project area	
Infrastructure project types		Number of employees	
Data sheet material used in the project	Liquid	Solid	Gas
Expected risks		Probability of occurrence	
External threats to the project		Frequency range	
Type of natural hazards		Origin of danger	
Expected Timing		Expected impact on the project	
Control level		Control procedures	
Monitoring	Ongoing	each activity	Specific
Availability of monitoring devices		Protective and safety devices are available	
Provide protection requirements for employees		Existing of safety supervisor	
Priorities of Project risk management		Sub-Sector of the infrastructure Project Sector	
Organization for addressing the risk	Project management	External experts and specialists	Government agencies

- **Table 6**: Priorities for dealing with risks

Table 6. Priorities for dealing with risks

	Priority	**Risk Indicator**	**Evaluation**			
			Yes	**Ratio**	**No**	**Legal action**
1	Understanding Risks	Risk identification				
2		Risk analysis				
3		Risk assessment				

4	Strengthening disaster risk management	Risk control				
5		Risk monitoring				
6		Identify mechanisms to deal with risk				
7		Identify top policies				
8	Investing in disaster risk reduction	Strengthening the capacities of human societies				
9		Strengthening physical capacities &infrastructure				
10		Determine the geographic range of each incoming risk				
11		Identify requirements and needs to address risks				
12	Strengthen disaster preparedness and response	Prepare to face the risks				
13		Effective risk management planning				
14		Distribute tasks and roles to institutions				
15		Training &community rehabilitation				
16		Identify the difference of confrontation &effective communication				
17		Forming volunteer teams				
18		The existence of an incident communication system				
19		The extent of incident response				
20		Early recovery mechanisms				
21		Reconstruction in best form				

- T**able 7 :** shows evaluation indicators of prevention and safety measures in infrastructure projects

Table 7. Evaluation indicators of prevention and safety measures in infrastructure projects

Item	Evaluation of field safety procedures				Notes
	Excellent	Good	Average	Weak	
Road signs in the way					
Converts traffic paths to other routes					
Place evacuation plan.					
Long barriers					

Lighting					
Use the phosphoric reflector					
Traffic lights					
Buffer zones					
Warning tapes					
Personal safety equipment					
Isolation of raw materials					
Supervisory management of all hazardous works					
The existence of a management plan for the movement of workers and equipment					
A work permit is available					
Site Security Plan					
Work site entries and exits can be controlled					
Risk is determined in advance					
The risk tree is updated according to the environment variables.					
Scaffolding and stairs are available					
There is a plan for waste management and safe disposal					
There are clear work models for project safety management					
Pre-training of staff to deal with risks					

6. Conclusion and Recommendations

6.1. Conclusion

- National indicators of development in the field of infrastructure are unclear due to the lack of risk assessment, management and prioritization according to the global development methodologies.
- There is a lack of studies linking risk management and assessment in infrastructure projects.
- The cultural awareness among employees, existing of risk indicators, virtual training and creation of a hazardous environment within the workplaces can contribute effectively in managing risks in infrastructure field**.**
- The National Occupational Safety and Health Committee is working in enhancing the role of occupational safety and health, and integrate it into project plans to minimize losses in human resources, facilities and equipment.
- Training and community awareness of workers in infrastructure projects can play an effective role in reducing the incidence of accidents.

- There are no documented and approved models from the National Occupational Safety and Health Committee concerned with risk analysis and assessment in the field of infrastructure.
- Lack of community awareness of risk management science in all working sectors.
- There are no clear indicators from government agencies to assess risks in the areas of infrastructure.
- Consulting companies and contracting companies can control risks if they understand risks and prioritize intervention and thus avoid them.
- There is an inverse relationship between the risk and the high rates of prevention and protection procedures employed in the workplace, which in turn reflects positively on the accident rate.
- Risk assessments, investment in risk and good preparedness to avoid risk occurrence can contribute to reducing operational costs and remedial requirements.
- Lack of interest by employers in relying on a clear methodology for risk assessment and analysis.

6.2. Recommendations

- It is highly recommended to direct scientific research to provide evaluation criteria and indicators that correspond to local variables in Palestine.
- Adopting the indicators included in the priority table proposed in this study by the competent authorities in the assessment and management of risks in the field of infrastructure.
- Work to increase the level of training and awareness of workers to the requirements of prevention and protection against hazards in the work environment.
- Prepare an annual risk assessment for the existing infrastructure projects and projects under implementation.
- Adopt the proposed table number 1 in prioritizing risk management.
- Adopt Proposed Table 7 in the assessment of occupational safety and health measures within the workplaces of infrastructure projects.
- Prepare an analysis of the network of risk-related relationships in the work environment and strategies for dealing with them.
- Organization quadratic planning which includes the safety plan, risk prevention, security plan, risk control, safe evacuation plan for workers, material resources and critical assets, emergency plan and the sustainability of a safe and decent working environment.
- Identify appropriate preventive activities to deal with each risk and integrate it into local and national development plans and within specific periods for each action, with the importance of monitoring of all actions and activities.
- Consulting, engineering and infrastructure companies should pay attention to training and enhance their capacity in the field of effective risk control.
- The adoption of national references for the assessment and management of risks according to the nature of the work of each sector.

- Strengthen clear national strategies and policies in national development for infrastructure issues and projects, in order to increase their preparedness for crisis and disaster risks in Palestine.

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Research article

THE ROLE OF THE POLICE IN DISASTERS CAUSED BY PANDEMIC INFECTIOUS DISEASES

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Abstract: So far, the police have played and are playing a very important role in the fight against pandemics in the current situation. Recent events have indicated the need to pay as much attention to the role of the police in emergencies caused by pandemics (epidemics) of infectious diseases, because it is noticeable that, in the previous period, either in practice or in scientific circles, not enough attention was paid to this segment of police work. The author's wish was to provide an answer to the question whether and in what way the police coped with the natural disaster caused by the pandemic of the infectious disease COVID-19. The answer would be that the police did not cope during the COVID-19 pandemic. The paper provides guidelines that would help police organizations cope with possible future natural disasters caused by a pandemic of infectious diseases in a better way.

Keywords: police, disaster, pandemic, COVID-19

Introduction

Police operations represent a line of police actions and activities that encompass activities done by different organizational parts of the police towards achieving the set goal on the territory of a certain state or its part, all in cooperation with the police from different countries (Milojević & Janković, 2014). Police operations are various, depending on the state of security in which these operations are undertaken. In relation to the state of security, police operations are divided into peace operations, wartime operations, operations in the state of emergency and emergency situation operations (Milojević & Janković, 2014).

While it is obvious which operations are carried out in war or in peace, it is often unclear to the public what is meant by a state of emergency and the emergency situation. Summarized, the distinction between a state of emergency and the emergency situation could be defined based on the degree of danger and the severity of the threat. In an emergency situation, the danger and threat are less severe than in a state of emergency. The danger that leads to a state of emergency is so great and serious that it endangers the very survival of the state. Some authors therefore state that a state of emergency can be declared "in the case of large-scale civil riots in which violence threatens the survival of the state or its citizens" (Lončar,

Radivojević, Radošević, & Mirković, 2019). The state of emergency, therefore, endangers the constitutional order itself and is a constitutional category, while the legal treatment of emergency situations in the Republic of Serbia is regulated by the Law on Disaster Risk Reduction and Emergency Management (The Law on Disaster Risk Reduction and Emergency Management, 2018). Here the emergency situation is defined as "a situation arising from a declaration by the competent authority when risks and threats or consequences for the population, environment and material and cultural goods are of such scope and intensity that their occurrence or consequences cannot be prevented or eliminated by regular actions of bodies and services, which is why it is necessary to use special measures, forces and means with an intensified regime of work for their mitigation and elimination". The danger that requires the declaration of an emergency situation arises from natural disasters, technical and technological accidents, pandemics of infectious diseases, in a word, according to the legal terminology – from disasters (Lončar et al., 2019). The difference drawn in this way is not entirely precise, reliable and strict, since the circumstances that lead to emergency situations can also lead to a state of emergency. In other words, due to the appropriate danger, emergency situations can grow into a state of emergency. Such an example was in Serbia in 2020, during the COVID-19 pandemic, when the level of risk of coronavirus was estimated to be extremely high. On March 16, the state leadership decided to declare a state of emergency, which allowed the use of a wider range and intensity of emergency measures in an emergency situation due to the pandemic (Cvetković et al., 2020) and enabled wider police engagement.

Previous experiences have shown that the police are poorly prepared for challenges related to large-scale disasters, such as floods, earthquakes and the like (Cvetković, 2014, 2016; Goyal, 2019; Janković & Cvetković, 2020; Sheptycki, 2020; Varano & Schafer, 2012). Also, in the previous period it has been pointed out that, in the field of emergency planning, the police and other segments of the community are insufficiently trained, without experience and technological infrastructure to be able to respond to disasters effectively (Brito, Luna, & Sanberg, 2009; Luna, Brito, & Sanberg, 2007; Varano & Schafer, 2012). A review of the scientific literature examining the place and role of the police in natural disasters reveals four categories of issues raised in this context, relations between the police and the community, mental health of police officers in disasters, organizational challenges within police organizations and inter-agency cooperation (Laufs & Waseem, 2020).

The COVID-19 pandemic is the "first global police event" that represented the cause for researchers and scientists to apply existing theories and empirical research in emergencies (Sheptycki, 2020). With this paper, the author wants to join this group of researchers in order to answer whether and in what way the police coped with the natural disaster caused by the pandemic of the COVID-19 infectious disease. In addition, the author wants to present general guidelines that police organizations should adhere to in all pandemics in order to cope with such specific situations successfully.

Police operations during the pandemic of the COVID-19 infectious disease

The first broader police engagement to combat infectious diseases was during the Spanish flu pandemic, from 1918 to 1920, as it was the deadliest disease in human history. It is estimated that 50 million people died from the disease worldwide. One of the tasks of the Chicago police was to arrest any citizen who coughed or sneezed in public (Luna et al., 2007). On the other hand, the police also faced internal challenges; therefore, 500 police officers in Philadelphia did not come to work for fear of becoming infected (Luna et al., 2007).

There have been many epidemics of various infectious diseases in the history of the Republic of Serbia starting from the plague and cholera epidemics in the Middle Ages, to the outbreak of smallpox, swine flu and the COVID 19 pandemic. In 1972 in the Republic of Serbia, during the smallpox (Variola Vera) epidemics, the police were broadly engaged in securing quarantine (Kekić & Milenković, 2020). There were as many as eight quarantines in Belgrade in which patients were accommodated, four of which were in hospitals, while four were housed in adapted civilian facilities – hotels and motels (Kekić & Milenković, 2020).

The last pandemic of the viral disease COVID 2019, which started in China, did not bypass the Republic of Serbia. The first case was registered in Serbia on March 6, 2020, and like most of the following, it occurred when infected citizens of Serbia returned to their homeland in large numbers from countries that had already been affected by the pandemic. Global pandemic panic has resulted in a dramatic increase in border control (Sheptycki, 2020). Due to the large influx of Serbian citizens at the border crossings, nearly 400,000 during the first month, there was no time for classic checks (Djordjevic, 2020). Each member of the border police did passenger profiling individually, *ad hoc*, based on the previous experience, interviews and vehicle and luggage checks (Janković & Cvetković, 2020). The citizens of Serbia who came from the countries affected by the pandemic, were imposed a measure of self-isolation for 28 days, based on the decision of the sanitary inspector, delivered at the border crossing (Cvetković et al., 2020). After arriving in Serbia, police officers checked their quarantine by phone several times a day in the beginning, which was a huge job, because at certain times there were between 70,000 and 100,000 citizens in self-isolation (Janković & Cvetković, 2020). If the citizen did not answer the phone calls, the police patrols, upon arriving at the home address, determined whether the particular person was at the residential address. Checks were performed in such a way that they were carried out at different time intervals, so that persons would not know the exact time of the control (Đorđević, 2020). The third method of control, especially of Serbian citizens who came from abroad, was to monitor their movements based on foreign mobile phone numbers (not wiretapping). If the citizens were not found, a search was announced for them, and after they were found, criminal charges were filed against them for the criminal offense "Failure to comply with health regulations during the epidemic" (Turanjanin & Radulović, 2020).

Apart from citizens who came from abroad, citizens with a residence in Serbia were also controlled, because in one period they were also subject to restrictions and prohibitions on the movement of persons, the control of which members of the police were in charge (Djordjevic, 2020). The first type of permanent restriction of movement referred to elderly citizens over 65 years of age. The second restriction of movement was valid for all citizens, regardless of age, every day from 5:00 PM, until the next morning until 5:00 AM. According to the MOI of the Republic of Serbia, 4% to 5% of Serbian citizens violated the ban on movement during curfew, or 25 every 100,000 citizens did not respect the measure of restricting the movement of citizens (Janković & Cvetković, 2020).

In the Republic of Serbia, while at work during the first month of the pandemic, 17 police officers were diagnosed with COVID-19, and about 800 of them were in self-isolation due to virus symptoms or suspicious contacts with infected people, which was 2.34 % of all police officers (Janković & Cvetković, 2020). As there was a danger of the disease spreading among police officers, 10% of them were sent on forced annual leave. This was done in order to save a number of police officers as a reserve in case of a possible larger number of infected police officers. In Detroit, 1,000 were quarantined out of about 2,800 employees (Hansen & Lory, 2020). In New York, in the first month of the COVID-19 pandemic, 1,500 police officers (about 4%) were infected, and one in six police officers was quarantined (Ashby, 2020).

Guidelines for police procedures during pandemics (epidemics) of infectious diseases

Similar to critical incidents caused by a man or natural events such as floods or earthquakes, viral pandemics (epidemics) also affect the police work (Jennings & Perez, 2020). Most critical incidents occur only in a limited geographical area and do not last very long, allowing other unaffected emergency services to assist the community in the most severe incidents (Brito et al., 2009). The pandemic, on the other hand, affects several regions at the same time and can continue over a longer period of time, creating challenges locally, nationally, and even globally (Jennings & Perez, 2020).

In every legal system, in the conditions of pandemics (epidemics), the authorities face situations in which they have to make choices, but are in doubt what measures to take, and all that affects the work of the police (Kekić & Milenković, 2020). During pandemics, priority tasks can be divided into five main categories: implementation of quarantine or the complete lockdown; finding alternatives to arresting and detaining criminal suspects; support and assistance to health professionals; dealing with new forms of crime, such as the sale of counterfeit medical and protective equipment; and providing police information on social networks and their monitoring in order to provide timely information and prevent the occurrence of various forms of social unrest (Kekić & Milenković, 2020).

Within these categories of tasks, among the priority ones in the initial stages are the implementation of quarantine or complete blockade and assistance to health workers. Within these categories, specific tasks are performed, such as enforcing public health orders to quarantine or restrict travel, securing the perimeter of infected areas, securing health facilities, mass control (crowding), investigating cases of infection, protecting national stocks of vaccines and drugs, etc. Because of the increased engagement in certain tasks, it is sometimes necessary for certain police officers and other police employees to be transferred to perform other tasks. This also happened in the Serbian police, during the COVID-19 pandemic, where employees in the administrative affairs did telephone checks to see if particular citizens were in their apartments during the quarantine (Janković & Cvetković, 2020). A similar procedure was followed in New York, where about 700 police officers were redirected from other duties so that the police could respond to calls from citizens because of violation of social distancing regulations (Ashby, 2020).

Police officers have also performed other tasks in order to counter the pandemic of the virus, primarily seeking the contacts of infected persons in order to shelter such persons in self-isolation. Special telephone numbers and e-mail addresses have been opened for obtaining information; the suppression of the illegal sale of medical equipment and consumer goods has been intensified; the police are regulating the queues in front of shops, banning gatherings of several people, etc. (Janković & Cvetković, 2020).

Police tasks change significantly during the pandemic compared to the daily ones that are carried out before it. Police actions must adapt to the new situation, because there is a change in crime rates (Hansen & Lory, 2020; Stickle & Felson, 2020), types of crimes (Hansen & Lory, 2020; Stickle & Felson, 2020), phone calls from citizens (Ashby, 2020; Hansen & Lory, 2020), etc. During the pandemic, citizens call on the police not only to deal with serious crimes or serious threats to public safety, but also because of a wide range of tasks for maintaining public order, from disputes between neighbors, minor traffic accidents, to providing non-police information (Sukhwani, Gyamfi , Zhang, AlHinai, & Shaw, 2019). In the United States, the total number of calls to the police decreased during the pandemic (Ashby, 2020). However, the range of crime-related calls during the first three weeks of the quarantine was different, as calls related to physical attacks decreased while calls for burglaries increased (Ashby, 2020).

In New York, for example, in the first month of the pandemic, there was an increase in telephone calls to the police due to domestic violence, so in March 2020 there were 1753 phone calls compared to1522 phone calls in March 2019 (Hansen & Lory, 2020). There has been a decrease in the number of calls related to traffic accidents since the announcement of quarantine measures (Ashby, 2020). However, in the later weeks of quarantine, there was an increase in the number of calls related to traffic accidents, which can be explained by the "quarantine fatigue", i.e. citizens became nervous after being closed in their homes for several weeks (Ashby, 2020). The research in Sweden (Stickle & Felson, 2020) indicated that during the first five weeks after government restrictions began, there was an 8.8% drop in the reported crime. Specifically, in the case of burglaries, that decrease was 23%; in the case of car theft, it was as much as 61%. However, there was an increase in the number of drug-related crimes. All of the above indicates that police organizations should be flexible in planning the response to changes in the frequency of calls and changes in the rates of certain types of crime. A detailed understanding of changes in calls to the police will make it possible for police leaders to establish evidence-based plans to ensure adequate responses in the future. Thus, each police organization should analyze the calls made to it during the COVID-19 pandemic in order to make adequate plans for future pandemics of various diseases.

Since the police are at the forefront in the fight against the pandemic and implementation of measures to respond to it, they are at a higher risk of exposure to the infection at the same time. Therefore, it is very important to protect police officers from possible infection, without diminishing the effect of police activity. Consequently, personal protective equipment has become essential for police officers to reduce these health risks. Police officers who are in direct contact with citizens are required to wear protective equipment, such as disposable gloves, disposable coats or overalls, protective masks (markings N95[1] or higher), eye protection such as goggles or visors for single use (Luna et al., 2007). It is recommended that if a police officer comes into contact with a person during an arrest, uses coercive means, or takes any other official action, his or her equipment should be cleaned and disinfected before reuse (Jennings & Perez, 2020). In addition to protective equipment, it is necessary to vaccinate the entire staff employed in the police organization in accordance with the recommendations of public health institutions.

In addition to the danger of infection caused by a close contact, the problem of intentional contamination of police officers has also been highlighted in recent times. In March 2020, the FBI warned local police agencies that extremist groups, such as neo-nationalists and similar organizations, encouraged their members to deliberately spread the virus to police officers by spraying body fluids on police officers on the streets (Jennings & Perez, 2020). At the same time, police officers also reported incidents of intentional spitting and coughing by people who claimed to have been positive for the virus (Jennings & Perez, 2020).

Police officers cannot carry out all preventive measures, i.e. they cannot perform their duties without direct personal contact with citizens. However, the volume of individual non-priority jobs may be reduced. Therefore, the basic functions of the police unit carried out in emergencies should be recognized. They can be classified into three categories: those that must be continued during an emergency, those that can be suspended but should be resumed as soon as possible after the incident, and those that may be suspended until the return to normal conditions (Luna et al., 2007). For example, one of those that can be suspended until the return to normal conditions is the termination of counter services, their transition to work online from home, as well as other administrative tasks and all meetings in the police, both internal and external with the local community (Janković & Cvetković, 2020).

1 Multilayered mask (4 protective layers) offering 95% of protection from toxic particles 2 to 5 micrometer big. Certified as FFP2 or N 95 protective mask.

To reduce the likelihood of exposure of all police officers to the virus at once, some police organizations made a 50/50 plan, dividing employees in half and keeping the two groups completely separate from each other (Jennings & Perez, 2020). One of the possible measures is the suspension of all ceremonies, trainings and all activities that are not necessary at a given moment (Janković & Cvetković, 2020). The police station premises should be ventilated and disinfected more often, and a smaller number of citizens wearing protective masks should be allowed to enter them. (Luna et al., 2007).

A prerequisite for successful counteracting an infectious disease pandemic is adequate police planning (Cvetković & Janković, 2020). The threat of a pandemic of infectious diseases is not new, but it has recently been recognized as a real danger for which police organizations must be prepared. Many police organizations around the world, including the police in the Republic of Serbia, have created emergency response plans in case of the loss of infrastructure, communications and information technology (Hansen & Lory, 2020; Janković & Cvetković, 2020). However, many of them have yet to consider the loss of human resources and the effects of such a loss on police units and the community during a pandemic (Luna et al., 2007). The need for planning is critical because a pandemic can spread through a population in days and weeks, and in contrast, it can take months to develop pandemic plans.

The police must be involved in *external planning*, and must make their own plans (*internal planning*) to respond to a pandemic (Luna et al., 2007). Police organizations must provide an integrated response to a pandemic through partnerships with other emergency services (Al-ramlawi, El-Mougher, & Al-Agha, 2020; Hansen & Lory, 2020; Jennings & Perez, 2020; Varano & Schafer, 2012). While public health institutions have already formulated plans for a pandemic, the description of the role of the police in these plans is often generalized by statements that the police will "assist and support other state bodies and local services wherever possible" (Luna et al., 2007).

When emergency public health operational plans are activated, the police should activate their internal plans. The moment of activation of the plan may be different. It may be when the World Health Organization declares a pandemic of a certain infectious disease or when the Ministry of Health declares an epidemic of a contagious disease on the territory of the Republic of Serbia (Brito et al., 2009).

When planning, it must be taken into account that due to the pandemic and the infection of police officers, there may be a reduction in the workforce. Plans are prepared for the possibility that from 10% to as many as 80% of police unit employees may be lost or unable to work (Luna et al., 2007). On the other hand, contrary to the absence of employees, those who remain at work may become seriously tired trying to compensate for the loss of other staff, and this should be taken into account when planning.

Conclusion

During the pandemics, police officers played a significant role in providing public services and maintaining order. So far, the police have played, and are playing a very important role in the fight against the pandemic. Recent events have indicated the need to pay as much attention to the role of the police in emergencies caused by pandemics (epidemics) of infectious diseases, because it is noticeable that in the previous period, either in practice or in scientific circles, not enough attention was paid to the fact how much the police were able to help the society in overcoming one of the most difficult periods in human history.

One of the main lessons that police organizations have learned in recent years is that mistakes that occur during work cannot be hidden. However, to reduce their number, it is necessary to undertake adequate planning in order to minimize the probability that police officers would make a mistake. However, police organizations must move away from the traditional police mentality to define every possible incident and event clearly and in detail, because the very nature of emergencies often defies clear prediction and articulation. Therefore, police officers need to be given a clear operational framework, but even then, they need discretion and flexibility to make plans and approaches based on situational needs in relation to the given circumstances. Even within a particular category of emergencies, there are elements that differ, so that two different pandemics may require very different police responses. Therefore, it is necessary for police managers to complete special training, which would relate to police planning in specific situations, because it turned out that police organizations in the previous period did not have plans how to act in such situations. In addition to managers, each police officer should complete additional training aimed at responding to emergencies caused by pandemics of infectious diseases, because it is obvious that in the previous period they were not adequately prepared to react in the right way. Such training should be included in programs of educational institutions in charge of police education.

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