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Hazard Assessment of Iran Provinces based on the Health Ministry Tool in 2019

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Abstract

Background: Iran is a disaster-prone country, which is subjected to various hazards, such as floods, earthquakes, fire, and traffic accidents.

Objectives: This study aimed to determine the priority and risk of various hazards threatening the public in different provinces of Iran in 2019.

Methods: This cross-sectional study was carried out from March to September 2019 using data related to 31 provinces of Iran. The assessment was conducted using hazard assessment tools presented by the Iranian Ministry of Health. A total of 70 natural, man-made, and complex hazards were analyzed in this study. The data were collected by holding sessions and conducting individual and group interviews with the officials of provincial Red Crescent Societies as well as reviewing the databases of the Red Crescent Society and the Disaster Management Organization. The participants consisted of operation analysis experts.

Results: In terms of the frequency of occurrence, earthquake (12: 38.7%), traffic accidents (7: 22.6%), and flood (6: 19.4%) obtained the highest priority in different provinces in descending order. Furthermore, regarding the total scores of hazards in all provinces, flood (78.6), earthquake (75.3), traffic accidents (71.9), drought (60.1), and building collapse (58.1) had the highest priority in descending order.

Conclusion: Given the extreme vulnerability of Iran to various disasters, authorities should develop strategic plans to reduce the risks associated with high-priority disasters. In addition, crisis and disaster management policymakers must develop separate detailed disaster response plans for each hazard in order to increase the preparedness at organizational and community levels. Public training can also raise awareness among the public and help people cope better with various hazards.

Keywords: Disaster, Hazard, Iran, Prioritization, Public training, Risk

1. Background

Natural disasters directly affect public health and result in injuries and deaths. They also increase physical and mental illnesses, disrupt social networks, and destroy physical territories and personal properties (1). Natural disasters (e.g., storms, floods, earthquakes, fire, drought, terrorist attack, volcanic eruption, and chemical disasters) and diseases may affect people in almost all countries. These disasters may start quickly or gradually. In any case, they have adverse effects on people, society, and the economy (2). Natural disasters are inevitable hazards that result in injuries, deaths, or destruction of buildings. About 771,911 people died and 1,917,557 were affected by disasters worldwide between 2006 and 2015 (3).

With a population of about 80 million people, Iran is exposed to a wide range of natural and man-made hazards, such as earthquakes, drought, and traffic accidents (4, 5). Among about 300 most populated cities of Iran, approximately, 77% of them are built on faults and seismic zones and 50% are prone to floods (6). Furthermore, almost every 10 years, thousands of people are affected by large earthquakes with magnitudes greater than 7 Richter in Iran. In addition, people in some cities are exposed to storms and/or tidal waves. Therefore, these disasters lead to the death of about 5,000 people and loss of more than 100 billion Tomans each year (7). In total, 31 out of 40 known disasters occur in Iran (8). According to a report in 2016, Iran was ranked among the top 10 disaster-prone countries in the world. In the last 4 decades, about 109,000 Iranians have lost their lives due to disasters (9, 10). However, the frequency, severity, and outcome of disasters in Iran have increased in recent years (10).

Crises and disasters affect communities in many ways, including damage to humans, environment, and infrastructure. However, the vulnerability can be

reduced through management measures, such as national and local capacity building, proper planning, and suitable training (11). Health centers, public societies, and relief organizations may be affected by crises and disasters, and therefore, are unable to help the survivors which per se can lead to secondary crises (12). Iran is a disaster-prone country, which is subject to various disasters, such as floods, earthquakes, fire, and traffic accidents.

2. Objectives

This study aimed to determine the priority and risk of various disasters threatening the general public in different provinces of Iran in 2019. Moreover, it was attempted to assess the need for developing public training programs.

3. Methods

This cross-sectional study was conducted from March to September 2019 using data related to 31 provinces of Iran. Hazard scores were calculated using a book entitled "Risk Assessment National Tools and Specialized Medical Surge Capacity Indicators in Disasters" written in 2014 for the Iranian Ministry of Health and Medical Education (13). A total of 70 natural, man-made, and complex hazards were analyzed in this study. The validity of the method has been confirmed by several Iranian crises and disaster experts and health managers. The risk scores were calculated using four indicators of the return period, intensity, vulnerability, and probability.

3.1. Return period

It refers to the recurrence intervals of a hazard in a geographical area. Hazards are classified into five levels based on their return periods (Table 1). A hazard, which has occurred repeatedly over the past 100 years, is placed in the fifth level. A return period obtains a coefficient of 2. As shown in Table 1, hazards are classified into five levels based on their return period.

3.2. Intensity

Hazard intensity is defined according to the number of people who died or were injured due to a hazard. The intensity of a hazard that has occurred frequently in an area is determined according to the number of people who died or were injured in the worst-case scenario. Hazard intensity has a coefficient of 5. As can be seen in Table 2, hazards are classified into five levels based on their intensity.

3.3. Vulnerability

Vulnerability refers to the characteristics of a community that make it susceptible to the adverse effects of a hazard. Hazard vulnerability has a coefficient of 5. Hazards are classified into five levels based on the vulnerability of communities to their effects (Table 3).

Table 1. Hazard classification based on return periods

Level	Return period	Definition
1	Very low	The hazard has not been recorded over the past 100 years.
2	Low	The hazard has occurred once over the past 100 years.
3	Medium	The hazard has occurred 2-3 times over the past 100 years.
4	High	The hazard has occurred 3-5 times over the past 100 years.
5	Very high	The hazard has occurred more than 5 times over the past 100 years.

Table 2. Hazard classification based on the intensity levels

Level	Intensity	Definition
1	Zero	The hazard has not affected the health of the public.
2	Low	Dead: 1-2 individuals Injured: 1-5 individuals
3	Medium	Dead: 3-5 individuals Injured: 6-9 individuals
4	High	Dead: 6-9 individuals Injured: 10-99 individuals
5	Very high	Dead: ≥10 individuals Injured: ≥100 individuals

Note: The fulfillment of one condition is sufficient, *i.e.*, the intensity is determined based only on the number of injured cases or the number of deaths. The larger figure is taken into account. A hazard, which has killed 5 people and injured 100 individuals, is placed in the fifth level.

Table 3. Hazard classification based on vulnerability

Level	Vulnerability	Definition
1	Very low	Less than 20% of the population at risk may be physically, financially, or functionally affected.
2	Low	20%-40% of the population at risk may be physically, financially, or functionally affected.
3	Medium	40%-60% of the population at risk may be physically, financially, or functionally affected.
4	High	60%-80% of the population at risk may be physically, financially, or functionally affected.
5	Very high	80%-100% of the population at risk may be physically, financially, or functionally affected.

Table 4. Hazard classification based on probability

Level	Probability	Definition
1	Zero	The hazard never occurs in the desired area.
2	Low	The hazard may occur once over the next 75-100 years.
3	Medium	The hazard may occur once over the next 35-75 years.
4	High	The hazard may occur once over the next 5-35 years.
5	Very high	The hazard may occur once over the next 5 years.

3.4. Probability

Probability refers to the likelihood of the occurrence of a hazard at a specified time interval in the future. It is predicted through scientific observations or based on previous experiences and changes in the features of a geographical area. Probability has a coefficient of 7. According to Table 4, hazards are classified into five levels based on their probability.

The coefficients of the return period (2), intensity (5), vulnerability (5) and probability (7) are constant. The final risk score (score range: 19-95) is calculated through the summation of the scores of these four indicators.

To calculate the risk level in each province, the score of each hazard in that province is multiplied by its population ratio. Subsequently, all hazard scores are summed and listed in descending order.

The data were collected by holding sessions and conducting individual and group interviews with the officials of provincial Red Crescent Societies and reviewing the databases of the Red Crescent Society and the Disaster Management Organization.

The participants consisted of operation analysis experts. Other data were collected from regional disaster management organizations, Iran Meteorological Organization, Geophysics Institute of the University of Tehran, provincial Red Crescent Societies, provincial fire departments, and local trustees. Finally, the data were analyzed in Excel 2016.

4. Results

Table 5 presents the priority and total risk scores of 11 frequent hazards in 31 provinces. Flood, earthquake, traffic accidents, and drought were generally the top priorities.

The frequency distribution of hazards with the highest priority in different provinces is shown in Figure 1. Earthquake, traffic accidents, and flood obtained the highest priority in descending order.

Table 6 tabulates the priority of 22 hazards based on the total hazard scores in all provinces.

Table 5. Priority and total risk scores of 11 frequent hazards

Hazard		Earthquake	Flood	Landslide	Rock-fall, subsidenc, quicksand	Storm	Tornado	Sandstorm	Dust	Forest and rangeland fire	Drought	Terrorism
East Azerbaijan	Priority	2	6	20		13			7		14	
	Score	90	73	35		68			73		67	
West Azerbaijan	Priority	7	4	12		14				13		
	Score	49	55	33		28				29		
Ardabil	Priority	13	1	23	14	20	19	44	15	7	17	32
	Score	60	75	53	60	55	56	19	60	70	57	46
Esfahan	Priority	39	9	26	20	19	41	21	17	31	25	33
	Score	40	90	63	65	70	19	65	70	56	64	51
Alborz	Priority	2	7	24	5	19				18		
	Score	80	69	53	70	60				61		
Ilam	Priority	9	7	10					3	5		
	Score	53	63	46					75	65		
Bushehr	Priority	1	2	22	23	16	20	24	14	25	13	26
	Score	95	95	19	19	61	35	19	83	19	85	19
Tehran	Priority	4	1	23	24	19	38	20	21	26	28	14
	Score	88	95	65	61	66	19	66	66	58	56	73
Chaharmahal and Bakhtiari	Priority	4	3	5	6	13	19	23	16	10	32	37
	Score	83	83	78	78	59	52	40	55	70	33	26
North Khorasan	Priority	1	3	11	8	12	29	33	23	9	30	31
	Score	83	75	37	42	36	17	19	28	42	19	19
Razavi Khorasan	Priority	7	4	12		14				13		
	Score	49	55	33		28				29		
South Khorasan	Priority	1	8	44	25	10	12	11	4	43	13	24
	Score	95	85	26	40	75	75	75	95	26	69	47
Khuzestan	Priority	3	1	32	17	28	29	30	2	25	42	8
	Score	80	90	41	65	50	50	50	90	60	21	75
Zanjan	Priority	4	5	8	10	25	38	43	27	6	35	39
	Score	80	80	73	75	54	26	19	49	80	30	24
Semnan	Priority	6	11	12	14	22	32	33	23	8		34
	Score	80	68	63	60	54	26	26	54	75		26
Sistan and Baluchestan	Priority	1	4	28	31	9	43	11	2	19	40	3
	Score	90	85	52	47	80	28	75	90	63	31	90
Fars	Priority	1	5	14	15	38	39	41	8	7	42	24
	Score	95	90	73	73	26	26	19	76	80	19	52
Qom	Priority	18	17	35	16	34	45	37	38	39	7	8
	Score	33	38	19	40	19	19	19	19	19	63	58
Qazvin	Priority	9	4			6				7		
	Score	60	75			71				63		

Table 5. Continued

Kurdistan	Priority	1	8	13	15	23	19	20	9	6	26	31
	Score	95	80	73	60	45	45	45	80	85	35	28
Kerman	Priority	1	3	44	14	21	24	13	10	5	20	23
	Score	95	90	19	73	51	46	73	78	85	55	50
Kermanshah	Priority	1	13	17	26	27	35	36	14	9	42	8
	Score	95	80	75	70	70	49	49	80	85	45	85
Kohgiluyeh and Boyer-Ahmad	Priority	11	1	15	12	30	31	32	16	23	9	33
	Score	80	95	75	80	19	19	19	75	67	89	19
Golestan	Priority	1	4	12	32	31		47	39			
	Score	95	90	80	55	55		19	19			
Gilan	Priority	3	1	9		14		43	34	13	27	31
	Score	95	95	74		63		19	23	65	33	26
Lorestan	Priority	1	5	9	23	13			4	8		
	Score	19	12	10	37	5			13	10		
Mazandaran	Priority	4	1	5	6	8	39	40	33	10	44	41
	Score	90	95	90	90	85	26	26	33	80	19	26
Markazi	Priority	1	2	4	17	16			6			
	Score	78	78	77	65	71			76			
Hormozgan	Priority	6	4		15	12			14	9		
	Score	74	77		44	62			47	70		
Hamedan	Priority	1	3	19	15	38	31	39	11	8	10	26
	Score	85	80	53	60	19	19	19	65	70	68	40
Yazd	Priority		7					3	5			
	Score		75					90	85			

The frequency distribution of hazards with the highest priority in different provinces is shown in Figure 1. Earthquake, traffic accidents, and flood obtained the highest priority in descending order.

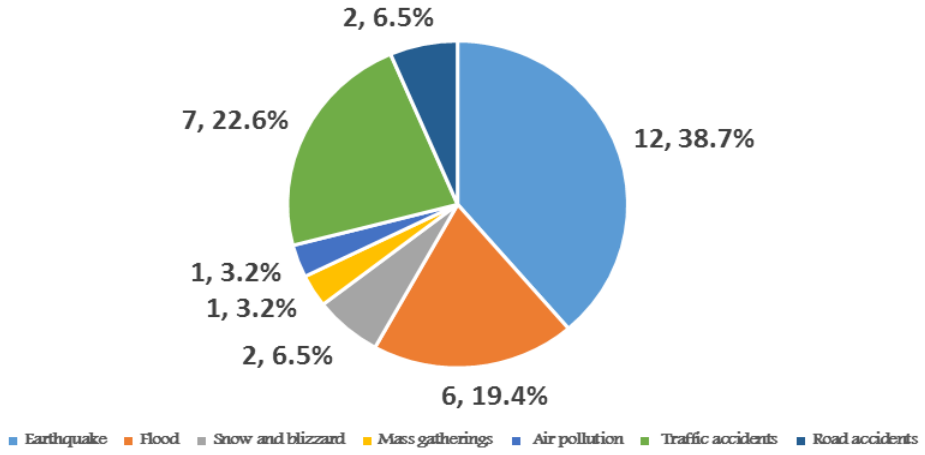

Figure 1. Frequency distribution of hazards with the highest priority in different provinces

Table 6. Priority of hazards based on total hazard scores

Priority	Hazard	Total score	Priority	Hazard	Total score
1	Flood	78.6	**12**	Dust	48.2
2	Earthquake	75.3	**13**	Storm	48.0
3	Traffic accidents	71.9	**14**	Air pollution	47.1
4	Drought	60.1	**15**	Rock-fall, subsidence, quicksand	46.1
5	Building collapse	58.1	**16**	Extremely high temperature	43.9
6	Snow and blizzard	57.9	**17**	Railroad accidents	42.6
7	Industrial hazards	56.7	**18**	Explosions and explosives	42.4
8	Building (structure) fire	56.3	**19**	Aviation accidents	39.4
9	Forest and rangeland fire	53.8	**20**	Avalanche	38.5
10	Landslide	50.5	**21**	Beach accidents	38.4
11	Sandstorm	50.4	**22**	Epidemic diseases	37.4

5. Discussion

This study aimed to analyze and prioritize various hazards in different provinces of Iran. Based on the results, earthquakes, traffic accidents, floods, and drought obtained the highest scores and priority; moreover, they showed occurrences in almost all provinces. Similar to this finding, the United Nations refers to drought as the most devastating natural disaster (14). In addition, 62% of the US lands were affected by a continental drought between 2011 and 2012. This drought exceeded 99% for drought size and affected about 150 million people (15).

According to a study conducted by Ardalan et al.

(2013), damage to health facilities is the most important earthquake-related hazard in Iran. They also argued that structural damages account for 53.8% of all damages. This result is in line with the finding of the present study. Earthquake is a major cause of death among the health personnel and the most important cause of structural and non-structural damage to primary health centers (4). The seasonal flood was the fifth most important hazard with a mean score of 45.96 (score range: 19-79). According to the 2015 World Disasters Report, the flood was among the most frequently reported disasters worldwide between 2005 and 2014. During this period, 1751 floods occurred throughout the world, which killed 59,092 people, injured 866,417 others, and imposed a significant burden of 342,836 million USD on the global economy (The 2015 World Disasters Report). In Thailand, the worst flood disaster in at least five decades occurred in 2011 with 1085 deaths and an economic loss of about 45.7 billion USD. This was the fourth costliest natural disaster in recent history (16).

Hospital Safety Index is among the most common tools used by researchers for assessing the disaster risk in hospitals. It can also be used to assess the risks threatening the communities. In Iran, researchers have drawn hazard maps to assess the vulnerability of Kerman and Tehran provinces to natural hazards. The effectiveness of risk assessment depends on organizational commitment and inter-organizational collaboration at high levels (17).

In total, 119 natural disasters were recorded in 25 provinces of Iran (11.9 events per year) between 2001 and 2011. The disasters threatened the lives and safety of many health staff who worked in primary health care centers in the affected cities. These events led to the physical damage or functional failure in 1401 health centers, injury or illness of 644 people, and death of 127 health staff. The most adverse effects of the disasters were observed in the health centers of Kerman, Sistan and Baluchestan, and Lorestan (18). More than 100 hospitals and 650 health centers were affected by natural disasters worldwide between 1990 and 2010; moreover, patients and staff were evacuated from many hospitals due to their unsafe conditions (19).

Risk analysis is a stable approach; therefore, relevant analyses and assessments should be performed at short intervals. In addition, low-priority hazards should also be taken into consideration when developing risk-reduction plans. Disaster risk assessment can help disaster decision-makers allocate adequate resources and budgets to relevant programs. Regarding the limitations of this study, there was no comprehensive database of information about disasters, which occurred in the last decade in Iran. In addition, despite the long return period of some disasters, the researchers only used available news archives and some local sources of information to examine past events.

With this background in mind, further studies are recommended to analyze various hazards on an annual basis, use different risk analysis approaches, get highly-qualified experts involved in the analysis process, promote resilience to various hazards, and take necessary measures to reduce the risks and increase relevant capacities.

6. Conclusion

Given the extreme vulnerability of Iran to various disasters, authorities should develop strategic plans to reduce the risks associated with high-priority disasters. The results demonstrate the need for a comprehensive general and specialized training program to prepare people for floods, earthquakes, and road accidents. In addition, crisis and disaster management policymakers must develop separate detailed disaster response plans for each hazard in order to increase the preparedness at organizational and community levels. Public training can also raise awareness among the public and help people better cope with various hazards.

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Footnotes

Authors' Contribution: Ahmad Soltani, Farshid Alaedini, Navvab Shamspour, and Milad Ahmadi Marzaleh were responsible for the study conception and design. Ahmad Soltani, Farshid Alaedini, Navvab Shamspour, and Milad Ahmadi Marzaleh supervised the whole thesis. Ahmad Soltani, Farshid Alaedini, Navvab Shamspour, and Milad Ahmadi Marzaleh prepared the first draft of the manuscript. Ahmad Soltani, Farshid Alaedini, Navvab Shamspour, and Milad Ahmadi Marzaleh performed the analysis of the results and supervised the study. All authors have read and approved the final manuscript.
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