Study and Application of Flood Control Risk Trend Analysis Model

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KEY WORDS: FPSR; Natural disasters risk trend analysis model framework; Flood control risk trend analysis model; AHP

ABSTRACT:

In order to analyze the comprehensive risks of natural disasters quantitatively and improve the accuracy of natural disaster management and control, this paper expands the F indicator, Forecast, which is about real-time monitoring and early warning data of natural disasters, and forms the flood control risk trend analysis model framework based on PSR. The framework is named FPSR, i.e. Forecast-Pressure-State-Response, composed of static data and dynamic data. By establishing the four-level index system of flood control risk trend analysis in Fangshan District of Beijing, screening factors, and using analytic hierarchy process, AHP, and experts scoring to determine the weights of each factor, it constructs the flood control risk trend analysis model, FCRTAM. At last, using the real-time monitoring and early warning data of natural disasters in Beijing and the information such as disaster-causing factors, historical natural disasters, major hidden dangers, disaster-bearing bodies, disaster reduction resources (capacities), etc., from National Natural Disaster Comprehensive Risk Census in Fangshan, it analyzes the flood control situation of each town in Fangshan. The results show that the results flood control risk index calculated according to FCRTAM is basically consistent with the actual flood control situation of the towns in Fangshan, and can provide theoretical basis for flood control comprehensive risk trend analysis and the decision-making of disaster prevention and reduction in Fangshan District, which has high use value.

1. INTRODUCTION

Due to its complex geographical environment, there break out various natural disasters in Beijing, especially floods, hail disasters and forest fires, and so on. The natural disasters have caused great threats and losses to the safety of people's lives and property. It is helpful for management natural disaster risk to objectively understand natural disaster risk and accurately grasp the hidden danger and evolution direction of natural disaster. However, natural disaster is characterized by lots of outbreak points and wide influence area and unpredictability, it is difficult to control natural disaster risk with limited manpower. Quantifying the risk of natural disaster, mastering urban risk, and identifying natural disaster risk levels and preparing countermeasures ensure the pertinence and efficiency of the implementation of natural disaster risk response(Xie, 2021). So, scholars at home and abroad have adopted a variety of methods to assess natural disaster risk.

For the risk assessment of rain and flood disasters, Crichton(Crichton, 2011) proposed the flood risk triangle model, and Aleksandra(Aleksandra, 2011) used 26 indicators to assess the vulnerability of flood risk in Manchester, UK. Benito(Benito, 2004) and Nott(Nott, 2004) assessed urban flood risk by using historical disasters data. By using historical data, Guo

Tao(Guo, 1991) and Xu Yueqing(Xu, 2001) analyzed the risk of urban flood. Wang Qianwen(Wang, 2021) studied the risk effect of rainstorm and flood disaster based on the system of "3 relationships-2 characteristics-20 indicators". Du Juan(Du,2006) established a prediction model based on flood-related indicators to evaluate the loss of urban flood disasters. Zhou Yi(Zhou, 2021) assessed mountain torrents in Shidu Town of Beijing. For the risk assessment of typhoon disaster, Hong Yifeng(Hong, 2014) studied the tropical cyclone disaster risk in eastern Zhejiang based on AHP and weighted comprehensive evaluation method. Zhang Yongheng(Zhang, 2009) studied typhoon disasters in Zhejiang Province by constructing typhoon comprehensive evaluation index and disaster level index. Ma Qingyun(Ma, 2008) analyzed and evaluated typhoon disaster level based on weighted average method. Huang Chunzhi(Huang, 2018) constructed and quantitatively analyzed typhoon disasters in Fujian province based on AHP and fuzzy comprehensive evaluation method. For the risk assessment of urban rainstorm disaster, Zhang Yuhua(Zhang, 2019) proposed a fuzzy comprehensive index evaluation system of urban rainstorm based on fuzzy mathematics. Fu Hongen(Fu, 2021) predicted the risk of rainstorm and flood disaster in Shenzhen based on GA-SVR-C. Li Zihua(Li, 2012), Liu Yao(Liu, 2014) and Li Tao(Li, 2016) studied the risk zoning and defense of lightning disaster in City based on GIS and natural disaster risk assessment method. Jin Juliang(Jin, 1998) used cloud model to analyze the temporal and spatial distribution characteristics of drought in Anhui Province.

These researches attempt to quantitatively analyze the single disasters such as rainstorm, typhoon, lightning, landslide, geohazard and drought, and so on. But these are few people or no people to study on the comprehensive risk assessment of natural disasters and the development trend of natural disasters. In view of Beijing's comprehensive risk survey of natural disasters carried out from 2020 to 2022, this paper combines the real-time monitoring and early warning and results of natural disasters survey to comprehensively analyze the flood control trend in Beijing(Song, 2022a), especially the flood control risk at the town, to support urban flood prevention and mitigation in Beijing.

2. FLOOD CONTROL RISK TREND ANALYSIS MODEL

2.1 Flood Control Risk Trend Analysis Framework(FPSR)

In disaster risk assessment, PSR (pressure state response) model and analytic hierarchy process (AHP) are widely used. Wicaksono(Wicaksono, 2020), Mandal(Mandal, 2018) and Kayastha(Kayastha, 2013) used the Analytic Hierarchy Process, AHP, to create the landslide susceptibility map, and Dikshit(Dikshit, 2020) evaluated the landslide risk caused by rainfall according to the expert scoring method to determine the weight. Xiang Xiqiong(Xiang, 2005) established a regional landslide geohazard risk evaluation method. Sun Qiang(Sun, 2018) analyzed the landslide risk in Longxi Basin based on GIS and AHP. Shen Huaifei(Shen, 2021) analyzed the landslide susceptibility in Gansu Province based on AHP and information method. These methods have achieved good results in disaster risk assessment, but the evaluation indicators of PSR are mostly based on the existing static historical data, which reflect the historical or current situation and can not show the future situation. In order to comprehensively analyze the urban flood control risk trend, this paper adds F, Forecast, about natural disasters real-time monitoring and warning based on PSR and constructs the flood control risk trend analysis model framework, which is FPSR, Forecast-Pressure-State-Response, see Figure 1, composed of static data and dynamic data(Song , 2022a). The dynamic data is F, and the static data contains Pressure, P, State, S, and Response, R. In FPSR, P is composed of information such as disaster-causing factors, historical natural disasters and major safety risks, and S is about hazard-affected bodies, and R is about disaster mitigation resources (capacities).

2.2 Flood Control Risk Index

The Flood Control Risk Trend Analysis Model, FCRTAM, based on FPSR is composed of four-level indicators, whose standard principles for selecting indicators are scientific and accessible, universal and regional, dynamic and static, etc. The first-level indicator of FCRTAM is Flood Control Risk Index, FCRI. The 2nd-level indicators of FCRTAM consist of F, P, S and R, etc. The 3rd-level indicators and the 4th-level indicators are selected from the real-time monitoring and early warning data of natural disasters and the results of Fangshan comprehensive risk survey of natural disasters(Song, 2021b), including flooding disaster, rainstorm disaster, earthquake, geohazards, such as landslide, mudslide, collapse, and major safety risks, hazard-affected bodies, disaster mitigation resources (capacities). FCRI is as follows:

$$FCRI = w_{F2}x_{F2} + w_{P2}x_{P2} + w_{S2}x_{S2} + w_{R2}x_{R2} \quad (1)$$

$$w_{F2} + w_{P2} + w_{S2} + w_{R2} = 1 \quad (2)$$

In formula, x_{F2},x_{P2},x_{S2},x_{R2} and w_{F2},w_{P2},w_{S2},w_{R2} are the values and weights of 2nd-level of F, P, S, and R. Their values' and weights' ranges are from 0 to 1. The values of the 2nd-level F,P,S and R are combined by 3rd-level indicators' values and its weights, and the 3rd-level indicators' values are combined by the 4th-level indicators' values and its weights, as follows.

$$x_2 = \sum_{i=1}^{n}(w_i)_3(x_i)_3 = \sum_{i=1}^{n}(w_i)_3\left(\sum_{j=1}^{m}(w_j)_4(x_j)_4\right) \quad (3)$$

$$\sum_{i=1}^{n}(w_i)_3 = 1 \quad (4)$$

$$\sum_{j=1}^{m}(w_j)_4 = 1 \quad (5)$$

In formula (3)-(5), the subscripts of 2, 3 and 4 mean the indicators' levels, which are 2nd-level, 3rd-level and 4th-level respectively. $(w_i)_3$, $(x_i)_3$, $(w_j)_4$ and $(x_j)_4$ mean the weights of 3rd-level indicators, the values of 3rd-level indicators, the weights of 4th-level indicators and the values of4th-level indicators, whose values' range is 0~1.

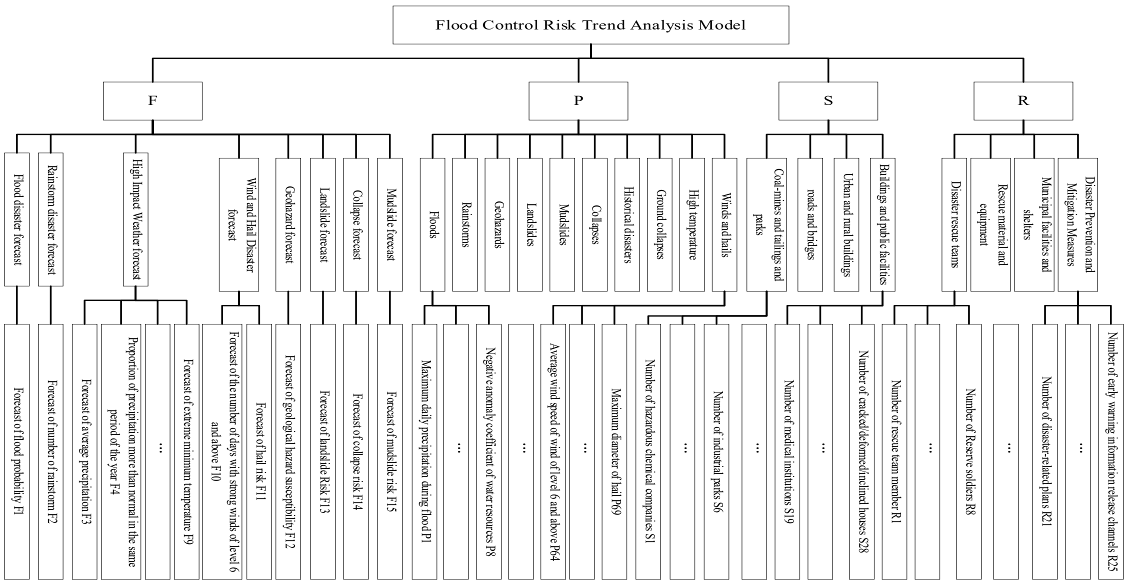

Figure 1. Indicators of FCRPM

2.3 Weights Settings

The key of FCRTAM is to determine the indicators of each level and their weights. The method is as followings. After selecting and determining the indicators of each level, the judgment matrix of indicators is constructed by Saaty Scaling Law(Saaty, 1980), then the weights of indicators of each level are calculated by AHP. The steps are: (1) Select targeted and reasonable indicators to construct a hierarchical model. (2) Construct the judgment matrix of indicators for each level by comparing indicators in pairs. (3)Calculate the maximum eigenvalue λ_{max} and eigenvector of the judgment matrix $V = \{v_1, v_2, \cdots, v_i, \cdots, v_n\}$. (4) Check the Consistency of judgment matrix. (5) If the consistency of the matrix is not satisfied, repeat step (2). If the consistency is satisfied, the eigenvector corresponding to the maximum eigenvalue is the weight of the indicator.

The process of checking consistency of judgment matrix is as follows. According to the maximum eigenvalue λ_{max}, calculate the matrix consistency index $CI = (\lambda_{max} - n)/(n-1)$(n is the order of the matrix). Compare CI with the random consistency index RI of the same order and get the ratio $CR = CI/RI$. RI can be treated as a constant with some matrix. If CR<0.1, it indicates that the judgment matrix satisfies the consistency.

Considering that FCRTAM is mainly to reflect the impact of natural disasters on urban security, and analyze various natural disasters trend situation, when setting the indicators' weights of FCRTAM, the P indicator's weight of natural disasters is the largest, the F indicator's weight is the second, and the S and R indicators are the third and the fourth. So, in order to highlight F and P indicators, the order of 2nd-level indicators' weights is: $w_P > w_F > w_S > w_R$. Table. 1 shows the weights of 2nd-level, 3rd-level and 4th-level indicators of F.

Table 1. F indicator's weights of FCRPM

N	2nd-level	2nd-	3rd-level	3rd-	4th-level indicators	4th-	Directi
1	F	0.2822	Flood disaster	0.26	Forecast of flood probability F1	1	+
2			Rainstorm	0.2198	Forecast of number of rainstorm F2	1	+
3			High Impact Weather forecast	0.1609	Forecast of average precipitation F3	0.3197	+
4					proportion of precipitation more than	0.2117	+
5					Forecast of precipitation days F5	0.1744	+
6					Forecast of average temperature F6	0.1015	+
7					Forecast of extreme Maximum	0.0836	+
8					Forecast of temperature higher than	0.0689	+
9					Forecast of extreme minimum	0.0401	+
1			Wind and Hail Disaster	0.0962	Forecast of the number of days with	0.6	+
1					Forecast of hail risk F11	0.4	+
1			Geohazard	0.0983	Forecast of geohazard susceptibility	1	+
1			Landslide	0.0644	Forecast of landslide Risk F13	1	+
1			Collapse	0.0544	Forecast of collapse risk F14	1	+
1			Mudslide	0.046	Forecast of mudslide risk F15	1	+

In the table, "+" in indicator directionality means the larger the indicator value is, and the higher the flood control risk is. And "-" means the larger the indicator value is, the lower the risk is.

2.4 Data Processing

When calculating FCRI, the four-level indicators' values should be normalized firstly. For discrete values, such as possibility of a flooding forecasting, whose values are high valued (0.6,1.0], medium high valued (0.4,0.6], medium low valued (0.2,0.4], and low valued [0,0.2], and mudslides grade, whose values are extra-large valued (0.5,1.0], large valued (0.3,0.5], medium valued (0.2,0.3], and small valued [0,0.2], it gets the biggest value when it is normalized. For example, if possibility of a flooding forecasting is high, then its value gets 1.0 between 0.6 and 1.0. For continuous values, it is normalized by the following formula.

$$x' = \begin{cases} 0 & , \quad x < x_{min} \\ \dfrac{x - x_{min}}{x_{max} - x_{min}}, & x_{min} \le x \le x_{max} \\ 1 & , \quad x < x_{max} \end{cases} \tag{6}$$

In formula (6), x, x_{min} and x_{max} mean the current value, the minimum value, and the maximum value respectively. And if the indicator's directionality is "+", $x' = x'$. If it is "-", $x' = -x'$.

2.5 Classification Of Risk Grades

According to the historical data and historical trend analysis data of Fangshan Natural Disaster Survey, and comparing between the results of FCRI many times and the actual values, the relationship between FCRI value and risk grade is determined. Table 2 shows the flooding risk grades of each town in Fangshan District with the FCRI((Song, 2022a).

Table 2. Flood control risk grades in Fangshan District

Risk	Low-	Medium-	High-risk	Very
FCRI	[0,0.20]	(0.20,0.25]	(0.25,0.30]	(0.30,1]

3. Validation analysis

3.1 Overview Of The Study Area

The total area of Fangshan District in Beijing is 2,019 square kilometers, with 28 towns. Its annual average temperature is 10.8°-11.7°C, and Its annual average precipitation is 602.8-645.3mm. The meteorological disasters often occur in Fangshan, including drought, rainstorm, gale, hail and temperature anomaly. Each area of Plain's, hill's and mountain's in Fangshan is one-third. There are six types of geohazards in Fangshan, including collapse, landslide, mudslide, unstable slope, ground collapse and ground subsidence.

3.2 Results Analysis And Verification

3.2.1 FCRTAM Validation

In 2020, Fangshan District was completed the natural disaster comprehensive risk survey((Song, 2021b), and the disaster information of the Twhole district was got. So, in the FCRTAM, the values of the 4th-level indicators' values of P, S and R are got from the results of the pilot project of the Fangshan census in 2020, and the values of F are from the monitoring and early warning data from Beijing Meteorological Service, Beijing Water Authority, Beijing Municipal Commission of Planning and Natural Resources, and so on. The results of FCRI and various indicators values of each town in Fangshan District in July 2021 show in Table **4**. And the monitoring and early warning data are as followings.

Table 3. 4th-level F indicators' values of each town in Fangshan District in July 2021

4th-level F	Liangxiang	Zhoukoudian	Liulihe	Yancun	Doudian	Shilou	Changyang	Hebei	Changgou	Dashiwo	Zhangfang	Shidu	Qinglonghu	Hancunhe	Xiayunling	Nanjiao	Fozizhuang	Daanshan	Shijiaying	Puwa	Chengguan	Xinzhen	Xiangyang	Dongfeng	Yingfeng	Xingcheng	Xilu	Gongchen
Forecast of flood probability F1	0.6	0.5	0.9	0.5	0.8	0.5	0.9	0.9	0.7	0.7	0.7	0.9	0.8	0.6	0.6	0.8	0.8	0.8	0.7	0.6	0.5	0.6	0.6	0.5	0.9	0.5	0.9	0.6
Forecast of number of rainstorm F2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	0
Forecast of average precipitation F3	189	194	188	191	194	189	194	192	192	195	190	186	190	190	190	188	191	190	195	188	194	192	188	186	193	194	193	189
proportion of precipitation more than normal in the same period of the year F4	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Forecast of precipitation days F5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Forecast of average temperature F6	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Forecast of extreme Maximum Temperature F7	34	33	34	34	34	34	34	33	34	33	34	33	33	33	33	33	33	33	33	33	34	34	34	34	34	34	34	34
Forecast of temperature higher than average temperature F8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forecast of extreme minimum temperature F9	18	17	18	18	18	18	18	17	18	17	18	17	17	17	17	17	17	17	17	17	18	18	18	18	18	18	18	18
Forecast of the number of days with strong winds of level 6 and above F10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forecast of hail risk F11	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1
Forecast of geohazard susceptibility F12	0.2	0.5	0.3	0.2	0.3	0.3	0.2	0.8	0.4	0.8	0.3	0.8	0.8	0.9	0.5	0.8	0.8	0.6	0.9	0.5	0.3	0.2	0.5	0.4	0.5	0.6	0.3	0.3
Forecast of landslide Risk F13	0.2	0.7	0.5	0.5	0.4	0.4	0.4	0.6	0.3	0.6	0.2	0.8	0.8	0.5	0.6	0.5	0.5	0.7	0.8	0.8	0.3	0.4	0.2	0.6	0.5	0.3	0.6	0.3
Forecast of collapse risk F14	0.3	0.9	0.2	0.5	0.4	0.5	0.3	0.7	0.4	0.7	0.2	0.6	0.8	0.5	0.5	0.9	0.7	0.6	0.9	0.9	0.6	0.4	0.3	0.6	0.4	0.2	0.6	0.6
Forecast of mudslide risk F15	0.5	0.7	0.4	0.2	0.6	0.2	0.2	0.5	0.6	0.6	0.2	0.5	0.9	0.5	0.9	0.9	0.6	0.9	0.8	0.8	0.3	0.3	0.3	0.2	0.3	0.4	0.5	0.6

Table 4. FCRI and various indicators values of each town in Fangshan District in July 2021 (%)

No	Town	FCRI value	2nd-level F value	2nd-level P value	2nd-level S value	2nd-level R value
1	Liangxiang	22.648	10.555	13.167	0.177	1.251
2	Zhoukoudian	23.999	12.183	14.17	0.282	2.636
3	Liulihe	21.787	11.814	12.852	0.183	3.062
4	Yancun	22.306	12.081	12.735	0.58	3.09
5	Doudian	24.207	12.151	14.312	0.627	2.883
6	Shilou	20.183	9.575	12.764	0.459	2.615
7	Changyang	19.395	8.986	12.418	0.765	2.774
8	Hebei	25.5	13.617	13.736	0.616	2.469
9	Changgou	22.288	10.408	13.378	0.431	1.929
10	Dashiwo	26.381	14.879	13.825	0.521	2.844
11	Zhangfang	23.644	12.355	13.57	0.569	2.85
12	Shidu	25.082	13.582	14.026	0.799	3.325
13	QinglongHu	26.192	14.914	13.265	0.59	2.577
14	Hancunhe	25.724	13.652	14.401	0.565	2.894
15	Xiayunling	27.897	13.153	17.077	0.887	3.22
16	Nanjiao	25.268	13.312	14.097	0.165	2.306
17	Fozizhuang	28.152	15.448	15.077	0.398	2.771
18	Daanshan	26.417	12.255	15.939	0.575	2.352
19	Shijiaying	24.292	11.472	14.942	0.569	2.691
20	Puwa	26.626	13.877	14.884	0.2	2.335
21	Chengguan	19.129	10.678	12.361	0.563	4.473
22	Xinzhen	24.225	13.288	11.803	0.32	1.186
23	Xiangyang	16.974	9.017	11.803	0.158	4.004
24	Dongfeng	23.575	12.28	11.776	0.253	0.734
25	Yingfeng	18.635	9.218	11.744	0.227	2.554

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26	Xingcheng	23.415	11.893	11.834	0.987	1.299
27	Xilu	21.069	11.156	11.647	0.623	2.357
28	Gongchen	21.587	11.939	11.958	0.854	3.164

For Fangshan District in July 2021, Beijing Meteorological Service estimates that the average temperature of the whole city in July is about 26℃, higher than the same period of the year,25.5℃, and close to the same period of the last decade, 26.0℃. The total precipitation in most areas is 180~200mm, which is 1-2% more than that in the same period of the year,164mm, and close to the same period of the last decade, 201.3mm. Beijing Water Authority estimates that it will be more rainfall in the main flood season in Beijing. In comprehensive consideration of the flood disaster for many years in Beijing, the risk of flood disaster caused by heavy rainfall in July is high. It is necessary to pay attention to urban waterlogging, floods in mountains, floods in small and medium-sized rivers. And Beijing Municipal Commission of Planning and Natural Resources estimates that July will be the peak period of geohazards in Beijing, and the number of geohazards caused by rainfall will increase significantly. It is necessary to pay attention to the prevention of rain-induced collapse, landslide, debris flow, and ground collapse disasters, especially along the traffic line, scenic spots, front and back of houses, debris flow ditches, and goaf. And according to the values, the 4th-level F indicators' values are in Table **3**. According to the rule of FCRI, the flood control risk grade of each town in Fangshan in July 2021 is shown in Figure 2. In Figure 2, there are 10 high-risk towns, which are mainly in mountainous areas, including Z Hebei, Dashiwo, Shidu, Qinglonghu, Hancunhe, Xiayunling, Nanjiao,Fozizhuang, Daanshan and Puwa.

Table 5. Statistics on the actual number and proportion of disasters in July 2021

Risk Grad	Number of disasters			Proportion of disasters		
	Geo	Waterlo	S	Geo	Waterlo	Su
High	5	23	2	62.5	46.94%	49.
Medi	3	19	2	37.5	38.78%	38.
Low-	0	7	7	0	14.28%	12.

In July 2021, the actual weather and disasters in Fangshan District are as follows. It rains for 22 days in July, i.e. 4 days of heavy rain, 3 days of moderate rain, 14 days of thunderstorms, and 1 day of light rain. There

There are 14 meddium-risk towns, which are in city center, including Liangxiang, Zhoukoudian, Liulihe, Yancun, Doudian, Shilou, Changgou, Zhangfang, Shijiaying, Xinzhen, Dongfeng, Xingcheng, Xilu and Gongchen, and so on. There are 4 low-risk towns, including Changyang, Chengguan, Xiangyang and Yingfeng.

According to the results, it shows that the high-risk areas are mainly the towns with large pressure P indicators, such as rainstorms, floods, debris flows and collapses, including Daanshan, Dashiwo, Fozizhuang, Hancunhe, Nanjiao, Puwa, Qinglonghu, Xiayunling, and the towns with large F indicators values, such as flood, high-impact weather and geohazards, including Hebei and Shidu. The low-risk towns are mainly with high S and R indicators' values, including Changyang, Chengguan and Xiangyang.

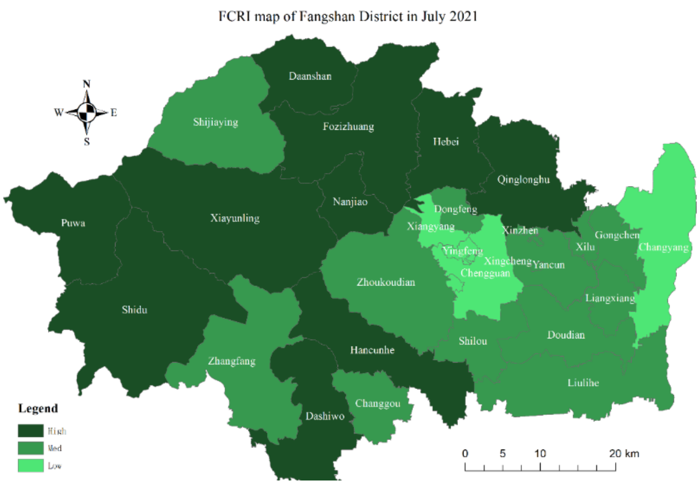

Figure 2. FCRI map of Fangshan District in July 2021

3.2.2 Data Validation And Analysis

are 8 geohazards and 49 waterlogging points, 12 of them are newly added. 5 geohazards are in high-risk regions, 3 in medium-risk region. The proportion of geohazard points in high-risk area and medium-risk area are 62.5% and 37.5% respectively. And 23 waterlogging points are in high-risk regions, 19 in medium-risk regions, and 7 in low-risk regions, whose proportions are 46.94%, 38.78% and 14.28% respectively. 28 geohazards and waterlogging points are in high-risk regions simultaneously, 22 in medium risk regions and 7 in low-risk areas, whose proportions are 49.12%, 38.60% and 12.28% respectively, seen in Table **5**. By analyzing the actual weather and the number of waterlogging points and geohazards in each town in Fangshan districts in July 2021, the risk grade in each town divided by the number of disasters is basically consistent with the result of the flood control risk situation analysis model.

The verification shows that the FRIC results of FCRTAM based on FPSR are basically consistent with the actual situation. When verifying the model, the validity of the model needs to be further verified to support the promotion and application of the model to the whole city, because only the information about geohazards and waterlogging points can be collected, while the loss caused by disasters cannot be collected.

4. CONCLUSIONS

By studying the research on the analysis and evaluation of natural disaster risk situation at home and abroad, this paper adds the F indicator, Forecast, which is about real-time monitoring and early warning data of natural disasters, and innovatively puts forward the flood control risk trend analysis model framework, named FPSR, i.e. Forecast-Pressure-State-Response, which is composed of static data and dynamic data and integrates real-time monitoring and early warning of natural disasters, natural disasters, major hidden dangers, disaster bearing body, disaster reduction resources (capacity), and so on. According to the importance of flood control risk trend analysis factors, it establishes the indicator's system for flood control risk trend analysis in Fangshan District of Beijing, selects the indicators and its weights in each level by combining AHP and expert scoring, and builds the flood control risk situation analysis model based on FPSR. Finally, the pre-processed real-time monitoring and early warning data of natural disasters in Beijing and the experimental nation risk survey results of Fangshan are imported into the flood control risk trend analysis model to calculate the FRCI of each town of Fangshan District. The FCRI values are the comprehensive flood control risk trend in Fangshan, which can provide reference for analysis and disaster prevention and mitigation decision-making.

5. ACKNOWLEDGMENTS

This study was supported by the National Key R&D Porgram of China(2021YFD13000500); the project of Zhanjiang Science and Technology Bureau (2021A05040).

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