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Article

Evaluation of Flood Mitigation Physical Examination in Zhengzhou City from the Perspective of Resistance

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Abstract: In recent years, the study of urban flood resistance has included the perspectives of spatial environment and multiple elements of urban space, which break through the limitation of only focusing on engineering measures in traditional disaster prevention. The article constructs a flood prevention and mitigation index system under the perspective of resistance based on the basic work of urban physical examination and ignoring the variability of population size affected by floods in different regions. It also takes 6 districts and 6 counties under the jurisdiction of Zhengzhou City as the research object, combines the relevant data of 12 cities, uses the entropy weight method and the coefficient of variation method to determine the index weights comprehensively and introduces the barrier degree diagnosis model. This article carries out urban flood control and disaster reduction special physical examination, considers resistance obstacle factors and promotes strategy analysis and research. The results show that from the perspective of spatial distribution, the flood control and flood mitigation resistance of Zhengzhou City is in a "differential" distribution state and the high resistance areas are Erqi District, Jinshui District and Gongyi City. In general, the resistance index in the southwest region was higher than that in the northeast region and there was a significant difference between urban areas and counties, showing a medium-high and medium-low resistance status. From the results of the study, to improve the level of resistance to flood mitigation in each city, it is necessary to focus on the main obstacle factors that hinder the development of the city and to fundamentally improve the level of resistance to create a more livable and healthier city according to local conditions.

Keywords: city special physical examination; flood mitigation; environmental resistance; system resistance; barrier factors

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1. Introduction

Currently, in the context of global warming and rapid urbanization, various disasters are occurring frequently. Among them, flooding is at the top of the list. According to the United Nations Office for Disaster Risk Reduction, floods have accounted for 43% of natural disasters in the past 20 years, affecting more than 200 million people and causing economic losses of about USD 65.6 billion [1]. More than 60% of China's land area and more than 90% of its population are threatened by floods to varying degrees [2], making it one of the countries with frequent flood disasters and the most severe losses [3]. Since July 2021, many parts of the world have been threatened by extreme rainfall. Germany, as a country with complete drainage facilities, sustained heavy rainfall that has also caused flooding in the western and southwestern regions [4]. From 17–23 July, many parts of Henan Province, China, suffered from a continuous heavy rainfall process, with daily rainfall exceeding historical rainfall extremes at several national meteorological observation stations [5]. In recent years, the economic losses caused by flood disasters have soared and the data changes after 2012 are more significant, which is twice the previous growth [6]. Thus, it can be seen that sudden rainstorm disasters have complexity and chain effects and have become one of the main factors limiting socioeconomic development.

However, from the city's perspective, sudden rainstorms are only the causative factor for the rapid outbreak of urban risks, while the failure of the city to conduct timely medical examinations and identify problems in the city during the development process is the root cause of the degree of harm that affects public safety events [7], and human security is at the heart of all public safety. Urban physical examination evaluation is accompanied by the development of urban planning evaluation theory [8], which originated from the evaluation of planning implementation. Before the urban physical examination evaluation was put forward, there was corresponding evaluation work in the past urban master planning, land use planning and other planning. The evaluation of the urban master plan contains the objectives of the plan outline, the implementation of mandatory elements and the operation and implementation of the plan [9]. The assessment of the overall land use plan focused on the ecological land use situation, the land use layout and the implementation of major projects [10]; however, all are mainly focused on planning and implementation assessments [11], with more comprehensive assessments and fewer specific assessments [12]. However, the urban health check assessment in the new era mainly relies on the urban spatial basic information platform and places more emphasis on being people-oriented, comprehensive and integrated, as well as green development and other planning concepts, which are more scientific and specific than the assessment contents of the traditional planning system. In 2019, 11 cities, including Shenyang, Nanjing and Guangzhou, were included in the first batch of urban physical examination pilot cities, with assessments focusing on 36 indicators in 8 dimensions, including ecological livability, urban characteristics, convenient transportation, living comfort, diversity and inclusion, security and resilience, urban vitality and resident satisfaction. Since then, the assessment content has been optimized by the proposal of the Evaluation Protocol for Urban Physical Examination of Territorial Spatial Planning, which contains six dimensions: security, innovation, coordination, green, openness and sharing [13]. The current urban health check indicator system mainly takes these six dimensions as a reference and the indicators are considered more comprehensively. This will solve the problem of varying assessment criteria across cities at the level of technical standards [14]. However, due to the different challenges faced by each city and the factors affecting the overall development, it is necessary to take precise measures and establish an assessment system for specialized medical examinations.

Relatively speaking, flood prevention and control is a great challenge for Zhengzhou City at present. Therefore, this paper focuses on a special physical examination and assessment of flood control in Zhengzhou City. According to the existing scholars, the research on flood control from the perspective of disaster resistance is mainly divided into engineering and nonengineering measures. Engineering measures include flood protection raises, sluice gates and construction-type projects such as flood storage areas and river channels and enhance flood resistance by improving flood protection standards [15–17], which can be well accomplished to intercept and divert flood waters. However, its drawback is its inability to cope with the secondary and derivative hazards to the city arising from overtopping floods. According to the research results of a large number of flood disasters, when disasters occur, there will be an interruption of road networks in urban areas, insufficient service coverage of public service facilities and a lagging response of emergency systems [18]. Therefore, with the idea of flood control through traditional engineering measures alone, it has become difficult to cope with large-scale and long-duration floods [19]. The urban lifeline system is the main disaster-bearing body of urban public security incidents [20] and the responsiveness of the emergency service system and the ability of the affected population groups to help themselves are becoming increasingly important in response to disasters [21]. The severity of damage caused by natural disasters to the human economy and society is mainly determined by the resistance of the disaster-bearing body. The study of disaster resistance is the basis for the study of the vulnerability of disaster-bearing bodies and therefore, the study of the resistance of the population groups themselves affected by flood hazards can draw on studies of vulnerability. Currently, in the vulnerability assessment of urban lifeline systems, scholars mainly focus on predisaster prevention, postdisaster recovery, physical damage and functional loss and study before, during and after the disaster [22]. The main research methods are based on empirical analysis, simulation methods, economics, indicator system construction and complex network methods [23]. Among them, empirical-based analysis refers to the combination of historical data, experimental data and expert experience to assess the cascade failure propagation and correlation relationships between different facilities, including regression analysis [24,25], data envelopment analysis [26], etc. The simulation method refers to the integration of multiple lifeline subsystems and then analyzes the characteristics of the whole system, including the agent simulation method [27,28], the system dynamics model [29], etc. Methods based on economics are divided into two categories: the input–output method [30,31] and the computable general equilibrium theory [32]. The complex network approach, which is based on the impact of perturbations on network metrics for infrastructure assessment, is the most used method, usually using the network topology complementary method [33] and the network flow method [34], among others. The construction of the index system is to evaluate the risk of infrastructure by selecting indicators and using mathematical models, including the comprehensive index method [35], analytic hierarchy process [36], principal component analysis [23], an expert scoring method [37], entropy weight method [38,39], fuzzy comprehensive evaluation method [40] and other methods. From the above overview, it can be understood that, for one thing, in terms of categorizing assessment scales, more research has been performed on single infrastructures of lifeline systems and less on interconnected whole lifeline systems. The emergency response capacity of the city's service system and the self-help awareness of its inhabitants are greatly weakened, especially in the context of the general trend towards higher and higher levels of infrastructure development and greater interconnectedness. Secondly, in the study of the correlation of lifeline systems, most of them focus on the functional relationship between infrastructures, while there are few studies on the smoothness of the spatial flow of residents between different infrastructures under special circumstances. Therefore, it is necessary to improve the response ability of the service system and the self-help ability of the residents.

To address the abovementioned research deficiencies, the study takes resistance as a perspective, constructs an index system based on two dimensions of environmental resistance and system resistance from spatial correlation and conducts a special medical examination and assessment from the perspective of urban flooding resistance. It can deepen the urban physical examination evaluation system and help the precise implementation of urban development planning. This assessment uses a combination of two objective methods, the entropy weight method and the coefficient of variation method, to analyze the urban resistance index more objectively. In particular, a barrier degree model is introduced, which can infer the main barrier factors affecting each area, which can provide ideas for the future direction of each area's focus. At the level of public safety in cities, the ability to cope with floods can be improved to some extent.

2. Study Area Overview and Data Sources

2.1. Study Area

Zhengzhou City, located in the north-central part of Henan Province, where the middle and lower reaches of the Yellow River divide, is the core city of the Central Plains City Cluster and the important distribution center for materials in the central region [41]. In terms of administrative division, Zhengzhou City has six districts, five county-level cities and one county. In terms of transportation location, Zhengzhou is an important comprehensive transportation hub in China and has formed a three-dimensional transportation system consisting of highways, railroads and airlines [42]. The city has a relatively complex topography, with high topography in the west and low topography in the east and flat topography overall. It is a temperate continental monsoon climate with four distinct seasons, with less rain in spring and winter and more rain in summer and autumn, mostly concentrated in July–September. The overall rainfall is low and spatially and temporally unevenly distributed and it is said that there are „nine droughts in ten years", but local floods occur almost every year [43]. The water system has two major water systems, the Yellow River and the Huai River, and the urban area is mainly penetrated by the Jalu River system, a tributary of the Huai River, which covers a large area, accounting for 73% of the city's rivers and 27% of the Yellow River, with a total of 124 rivers of various sizes in Zhengzhou, and which serves as a drainage channel for the city [34] (Figure 1).

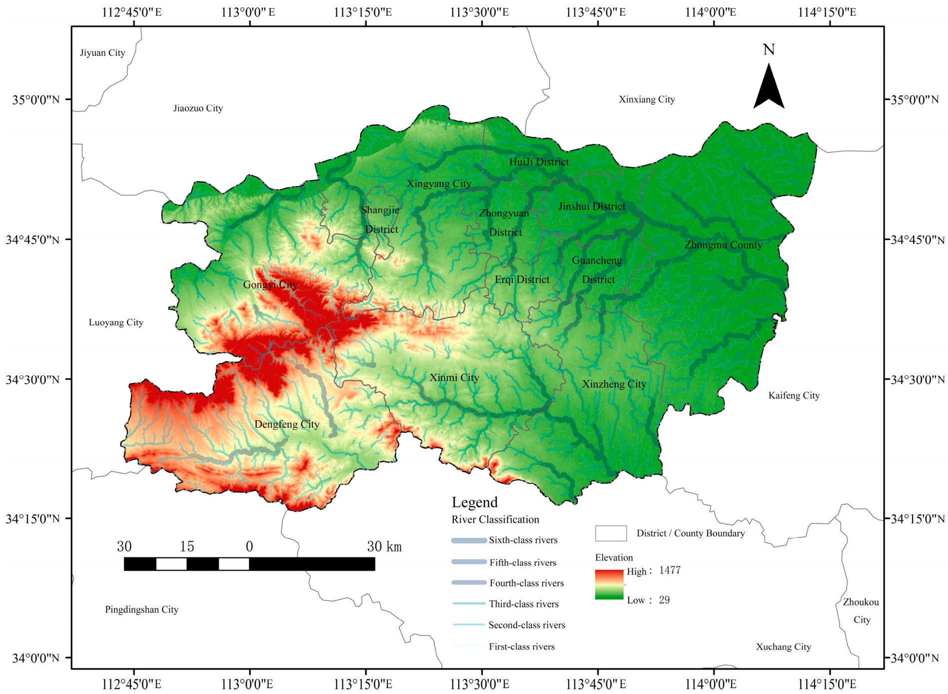

Figure 1. Overview of the study area.

2.2. Data Sources

The research data used in this paper are divided into statistical and spatial data. The specific sources are as follows: statistics derived mainly by computational derivation; the spatial data were derived from ArcGIS 10.8 as the operating software platform, through a series of processes such as projection transformation, resampling and projection to a unified coordinate system [44] (Table 1).

Table 1. Data types and sources.

Data Type	Data Source	Data Description
Altimetric Data	Geographical spatial data cloud	The grid resolution is 30 m.
Land Use Type Data	The third land space survey	2020 data
Rainfall	Zhengzhou Water Conservancy Bureau	2020 Water Resources Bulletin
Traffic and Road Data	National Basic Geographic Information Center	2020 vector data
Administrative Boundary of Space	Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences	Administrative boundary data of cities and counties in China
Socioeconomic Data	Zhengzhou City county people's government website; "Zhengzhou Statistical Yearbook-2021"; "2020 National Economic and Social Development Bulletin"	2020 data

3. Materials and Methods

3.1. Construction of Physical Examination Index System

3.1.1. Indicator Selection

This paper is based on the "Urban Physical Examination and Assessment Protocol for Territorial Spatial Planning" as the basis for indicator selection, the "United Nations Sustainable Development Goals (2030)" as the construction target and the existing research results as well as the study area profile "The General Office of the State Council on strengthening the implementation of urban waterlogging control" (State Office [2021] No. 11). Taking the concept of a "resistance perspective" as the entry point, we construct a special assessment index system for urban flood prevention and mitigation. The construction of the flood mitigation index system is carried out using two-dimensional layers of environmental resistance and system resistance. The reason is the severe urban flooding caused by the extraordinarily heavy rainfall in Zhengzhou on 20 July 2021, whose 1-h rainfall reached 201.9 mm, one third of the average multiyear rainfall value in Zhengzhou, exceeding the extreme value of hourly rainfall on land in China (198.5 mm, Linzhuang, Henan, 5 August 1975). In terms of the design return period for flood control, even if the planning area is designed according to the flood control standard of 200 years, Zhengzhou City can withstand 102.8 mm of rainfall in 1 h, but it is still impossible to withstand heavy rainfall, so it can be seen that the city's flood control standard can hardly withstand a sudden attack of heavy rainfall. Therefore, considering the two-dimensional layers of environmental resistance and system resistance, two categories are selected, which are the assessment of environmental construction that may trigger disasters before the occurrence of disasters and the assessment of urban lifeline system perfection during and after the occurrence of disasters, and the characteristic index system of flood prevention and mitigation is established under the safety and resistance dimension.

3.1.2. Construction of Index System

This indicator system is mainly divided into three levels of indicators: 1 primary indicator; 2 secondary indicators, which are environmental resistance and system resistance, and 6 tertiary indicators, as shown in Table 2. They reflect the surface condition (C11, C12, C13, C14), hydro climate (C21, C22, C23), transportation capacity (C31, C32), medical rescue capacity (C41, C42, C43), material security capacity (C51, C52, C53, C54) and communication security capacity (C61).

Table 2. Physical examination index system.

Goal Layer	Dimensional Layer	Criterion Layer	Indicator Layer	Positive and Negative Indicators	Index Calculation Explanation
A Flood Mitigation Resistance Physical Examination	B1 Environmental Resistance	C1 Surface Conditions	C11 Percentage of forest cover (%)	+	Forest area/Total land area
			C12 Vegetation coverage index (%)	+	Vegetation coverage area/Land area × 100%
			C13 The proportion of impervious area (%)	−	Impervious area/Total land area
			C14 Years of surface runoff depth (mm)	−	Average annual runoff depth
		C2 Hydro Climatic Conditions	C21 Year average air temperature (°C)	+	The arithmetic mean of daily average temperature of each day throughout the year
			C22 Water network density index (%)	−	Water area/Total area
			C23 Average annual rainfall (mm)	−	Total annual rainfall/Years

Table 2. *Cont.*

Goal Layer	Dimensional Layer	Criterion Layer	Indicator Layer	Positive and Negative Indicators	Index Calculation Explanation
A Flood Mitigation Resistance Physical Examination	B2 System Resistance	C3 Transportation Capacity	C31 Rescue road density (km/km^2)	+	Total length/Total area of railway, highway, national highway, county highway and urban road
			C32 Evacuation road density (km/km^2)	+	Total length/Total area of national roads, county roads and urban roads
		C4 Medical Rescue Capability	C41 Medical station density (per square kilometer)	+	Number of medical stations/Area
			C42 Number of beds per capita in medical institutions (A/ten thousand people)	+	Number of beds in health care institutions at the end of the year/Number of permanent residents at the end of the year × 1000
			C43 Ratio of ambulance personnel (%)	+	Number of ambulance personnel/Regional population
		C5 Material Security Capacity	C51 Proportion of social security expenditure (%)	+	Social security expenditure/General public budget expenditure
			C52 Disposable income (CNY/person)	+	Refers to the income that residents can use freely.
			C53 Per capita output of grain (kg/person)	+	Total grain output/Resident population
			C54 Per capita water resources (kg/person)	+	Total water resources/Resident population
		C6 Communication Security Capability	C61 Mobile communication equipment coverage percentage (%)	+	Number of mobile phone users/Resident population

Note: The selection of the index system ignores the difference in the size of the population affected by floods.

3.2. Calculation of Index Weights

3.2.1. Data Normalization Processing

In the construction of the physical examination index system, comprehensive indicators will be used for evaluation and the nature of different indicators varies. To eliminate the differences in magnitude and order of magnitude between the indicators and to ensure the scientific nature of the physical examination results, the original data are usually normalized, as shown in Table 3. The method used to standardize the data in this paper is the extreme difference method, as follows.

Calculation of positive indicators

$$Z_{ij} = \frac{x_{ij} - min\{x_{ij}\}}{max\{x_{ij}\} - min\{x_{ij}\}} \tag{1}$$

Calculation of negative indicators

$$Z_{ij} = \frac{max\{x_{ij}\} - x_{ij}}{max\{x_{ij}\} - min\{x_{ij}\}} \tag{2}$$

where x_{ij} is the original value of i evaluation unit on the jth indicator, $\max\{x_{ij}\}$ denotes the maximum value of the jth indicator and $\min\{x_{ij}\}$ denotes the minimum value of the jth indicator. Z_{ij} is the value after normalization of the data.

Table 3. Standardized value of physical examination index for flood control and disaster reduction in Zhengzhou.

Indicator	Nature	Zhong Yuan District	Erqi District	Guan Cheng District	Jin Shui District	Shang Jie District	Hui Ji District	Zhong Mu County	Gong Yi City	Xing Yang City	Xinmi City	Xin Zheng City	Deng Feng City
C11	+	0.10	0.26	0.41	0.00	0.46	0.34	0.36	0.90	0.52	0.83	0.31	1.00
C12	+	0.06	0.28	0.11	0.00	0.34	0.29	0.81	0.93	0.67	0.83	0.63	1.00
C13	–	0.00	0.33	0.08	0.66	0.31	0.65	0.91	0.96	0.91	0.82	0.73	1.00
C14	–	0.26	0.26	0.26	0.26	0.41	0.26	0.35	0.77	0.00	0.66	0.47	1.00
C21	+	0.17	0.22	0.06	0.39	0.00	0.06	0.06	1.00	0.39	0.11	0.06	0.22
C22	–	0.89	0.94	0.91	0.61	0.96	0.00	0.46	0.82	0.61	1.00	0.94	0.95
C23	–	0.38	0.38	0.38	0.38	0.92	0.38	0.71	0.78	1.00	0.88	0.00	0.78
C31	+	0.70	0.74	0.92	1.00	0.43	0.39	0.05	0.03	0.07	0.06	0.18	0.00
C32	+	0.73	0.75	0.88	1.00	0.47	0.41	0.09	0.07	0.16	0.17	0.20	0.00
C41	+	0.75	1.00	0.55	0.85	0.31	0.11	0.00	0.10	0.04	0.01	0.11	0.00
C42	+	0.39	1.00	0.26	0.89	0.21	0.00	0.19	0.19	0.14	0.26	0.17	0.32
C43	+	0.42	1.00	0.33	0.91	0.18	0.00	0.14	0.17	0.10	0.14	0.11	0.17
C51	+	0.83	1.00	0.40	0.31	0.74	0.57	0.00	0.72	0.56	0.90	0.11	0.79
C52	+	0.62	0.73	0.72	1.00	0.78	0.42	0.00	0.28	0.17	0.16	0.22	0.03
C53	+	0.00	0.001	0.01	0.002	0.03	0.03	0.73	0.51	1.00	0.71	0.58	0.74
C54	+	0.05	0.04	0.07	0.00	0.09	0.15	1.00	0.57	0.85	0.61	0.26	0.69
C61	+	0.63	0.68	1.00	0.76	0.002	0.52	0.00	0.64	0.37	0.54	0.12	0.25

Notes: "+" indicates a positive indicator, the larger its value the stronger its effect on the system; "-" indicates a negative indicator, the larger its value the weaker its effect on the system.

3.2.2. Methods of Weight Assignment

(1) Entropy Method

The entropy method is a method to determine the weight by the index entropy, which is a measure of uncertainty and is an objective assignment method. The smaller the entropy value of an indicator, the greater its degree of variation; conversely, the larger the entropy value of an indicator, the smaller the degree of variation. The calculation steps are as follows.

First, the data are standardized using the range method.

Secondly, calculate the entropy value N_j of the ith indicator

$$N_j = -k\sum_{i=1}^{n} M_{ij} \times lnM_{ij} \tag{3}$$

where N_j denotes the information entropy value, $k = \frac{1}{lnn}$, $M_{ij} = \frac{Z_{ij}}{\sum_{i=1}^{n} Z_{ij}}$, M_{ij} denotes the weight of the jth indicator value in the i-th year.

Calculation of the weight value W_j

$$W_j = \frac{q_j}{\sum_{i=1}^{n} q_j} \tag{4}$$

where W_j denotes the jth indicator weight value, $q_j = 1 - N_j$ and q_j denotes the coefficient of variation.

(2) Variation Coefficient Method

The coefficient of variation, also known as the coefficient of dispersion, is a statistical measure of the degree of variation of each indicator, reflecting the degree of dispersion on the unit mean [45]. It is an objective weighting method and the weight of each indicator is obtained by normalizing the coefficient of variation of each indicator. The calculation method is as follows.

Derive the standard deviation γ

$$\gamma = \sqrt{\frac{\Sigma_{i=0}^{n}\left(x_{ij} - x_j\right)^2}{n-1}} \tag{5}$$

where x_{ij} denotes the jth indicator value in year i; x_j denotes the mean value of the indicator.

Get the average value β

$$\beta = \frac{\Sigma_{j=n}^{n} x_{ij}}{n-1} \tag{6}$$

Find the coefficient of variation

$$C \times V = \frac{r}{\beta} \tag{7}$$

Find the coefficient of variation coefficient weights W_i

$$W_i = \frac{H_i}{\Sigma_{i=1}^{m} H_i} \tag{8}$$

Among them, W_i represents the weight value of the coefficient of variation and H_i represents the coefficient of variation.

In this paper, two objective evaluation methods are selected to synthetically examine the emergency response capability of Zhengzhou City to floods. The entropy weight method is a comprehensive evaluation system, which can independently reflect the impact of the evaluation system on the results [39]. The coefficient of variation of the coefficient of variation method is a dimensionless quantity that eliminates the effects of measurement scale and magnitude. The combination of the two methods was averaged to make the obtained weights more scientific.

The data in Table 3 were brought into Formula (4) and Formula (8) to derive the weight values W_j and W_i for the two methods, respectively, and the combined weight W was obtained by calculating the average value, as shown in Table 4.

Table 4. Table of weights of indicators for the Flood Mitigation Health Checkup.

Goal Layer	Dimensional Layer	Portfolio Weights	Guideline Layer	Portfolio Weights	Indicator Layer	Indicator Weights		W
						W_i	W_j	
A Flood Mitigation Resistance Physical Examination	B1 Environmental Resistance	0.37	C1 Surface Conditions	0.16	C11	0.05	0.04	0.042
					C12	0.05	0.05	0.048
					C13	0.04	0.03	0.036
					C14	0.05	0.03	0.039
			C2 Hydro Climatic Conditions	0.20	C21	0.08	0.08	0.084
					C22	0.08	0.09	0.087
					C23	0.04	0.03	0.031
	B2 System Resistance	0.63	C3 Transportation Capacity	0.13	C31	0.07	0.08	0.072
					C32	0.06	0.06	0.057
			C4 Medical Rescue Capability	0.22	C41	0.08	0.10	0.089
					C42	0.06	0.05	0.057
					C43	0.07	0.07	0.070
			C5 Material Security Capacity	0.24	C51	0.04	0.03	0.033
					C52	0.05	0.05	0.052
					C53	0.07	0.10	0.087
					C54	0.07	0.07	0.070
			C6 Communication Security Capability	0.05	C61	0.05	0.04	0.046

Notes: Where, W_i denotes the coefficient of variation weight value, W_j denotes the entropy weight method weight value and W denotes the comprehensive weight value.

3.3. Integrated Urban Resistance Assessment Model

The integrated urban resistance assessment index, R_ synthesis, is the product of the combined weight, W, of each indicator and the value of each indicator data after normalization. Based on the values of the resistance indices of each system layer, a weighted average was obtained to derive a comprehensive urban resistance model [46]. The specific steps are as follows.

$$R_{integration} = R_A + R_B \tag{9}$$

where R_A denotes the environmental indicator factor and R_B denotes the system indicator factor.

3.4. Obstacle Degree Diagnosis Model

Based on the comprehensive evaluation of the counties and districts under the jurisdiction of Zhengzhou City, the barrier degrees of each evaluation index in the comprehensive index were identified to discover the barrier factors affecting the improvement of urban resistance [47] and to provide directions for the later development of the city in the following steps.

Calculate the degree of influence of the indicator layer on urban resistance

$$D_{ij} = M_i \times W_{ij} \tag{10}$$

Calculate the index deviation degree

$$X_{ij} = 1 - x'_{ij} \tag{11}$$

Calculate the obstacle degree

$$R_j = \frac{D_{ij} \times x_{ij}}{\sum_{i=1}^{m} D_{ij} \times x_{ij}} \tag{12}$$

Analyze the obstacle degree of each criterion layer to the overall decision goal

$$r_j = \sum_{j=1}^{n} R_j \tag{13}$$

4. Results and Analysis

4.1. Urban Flood Mitigation Resistance Analysis

By constructing the index system of physical examination for flood control and disaster reduction from the perspective of resistance, the comprehensive resistance index of 17 index elements in 2 categories of evaluation in 12 cities, counties and districts of Zhengzhou City was obtained by using the coefficient of variation method and entropy method. Using Equation (9), the environmental factors and system factors are taken into account, and the Arc GIS 10.8 natural interruption point grading method (Jenks) is used to summarize and calculate the environmental resistance index, system resistance index and comprehensive resistance index of each city and county under the jurisdiction of Zhengzhou City.

4.1.1. Environmental Resistance Analysis

According to the analysis in Figure 2 and Table 5, among the environmental resistance indicators, the resistance of Gongyi City and Dengfeng City is relatively high. In terms of land use, Dengfeng City and Gongyi City have about 20% of impervious area, compared to 77% in the Central Plains, a difference of more than 50% between the ratios. The annual afforestation area in the two cities is as high as 2409 and 3593 hectares, respectively, compared to 7 hectares in the Central District, a difference of more than a thousand times. In terms of hydroclimate, the temperature difference between urban areas and the counties and cities under the jurisdiction of Zhengzhou City is small, with an annual average temperature of around 14.5 °C. The rainfall in the urban area differs by roughly 40 mm to that in the county and city, while the rainfall in Xinzheng City is 661 mm, in contrast to other regions. The water network density index is higher in the Huiji District, Zhongmu County and Xingyang City. Overall, the environmental quality of the six counties and cities is higher compared to urban areas. From the spatial scope, the ecological quality of Zhengzhou City becomes better from east to west and the environmental resistance increases step by step.

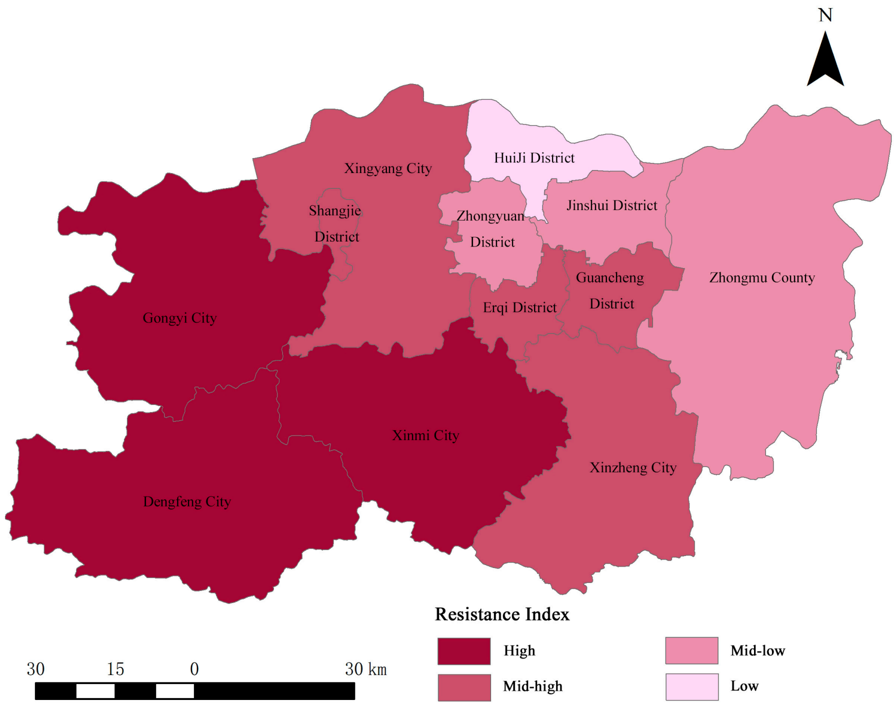

Figure 2. Environmental resistance distribution map.

Table 5. Environmental resistance index distribution table.

Environmental Resistance	Index Interval	Area
High Resistance	0.09–0.12	Gongyi City, Dengfeng City, Xinmi City
Mid-high Resistance	0.07–0.09	Xinzheng City, Shangjie District, Erqi District, Xingyang City, Guancheng District
Mid-low Resistance	0.02–0.07	Zhongyuan District, Zhongmu County, Jinshui District,
Low Resistance	0.01–0.02	Huiji District

4.1.2. System Resistance Analysis

According to the analysis in Figure 3 and Table 6, among the system resistance indicators, Erqi District and Jinshui District have the highest resistance. In terms of transportation, the highest density of rescue and evacuation roads in Jinshui District is over 10 km/km^2, while the lowest is 1.4 km/km^2 in Dengfeng City, a difference of 7 times, due to the early development of Jinshui District, which has multidimensional three-dimensional traffic and a significant road network density. In terms of medical security, Erqi District has the most complete medical facilities, with a density of 3.5 medical stations.km^2 and 21 beds per 10,000 people, due to the relatively good medical resources in the Erqi District area, such as the First Affiliated Hospital of Zheng University having more than 10,000 beds, which shows the degree of perfection of medical resources. The density of medical stations in Dengfeng City and Zhongmu County, where medical resources are relatively poor, is 0.35 km^2 and the number of medical beds per capita is also low, at 5 and 7 beds per

10,000 people, respectively, which is nearly a 3 times difference from that of Erqi District and Jinshui District. In terms of material security, Jinshui District has the highest per capita disposable income, which is 1.4 times higher than that of Dengfeng City. The highest social security expenditure ratio is in Erqi District and Dengfeng City and the lowest is in Guancheng District, which are 10 times different from each other. In terms of communication security, the difference between urban areas and 6 counties and cities is not significant, while Xinzheng City and Zhongmu County are relatively low. In general, the urban area has higher system resistance than the six counties and cities and the urban lifeline system is better; from the perspective of spatial scope, the system resistance of Jinshui District and Erqi District is the highest, that is, "the middle is the highest, the southwest is higher and the northeast is the lowest".

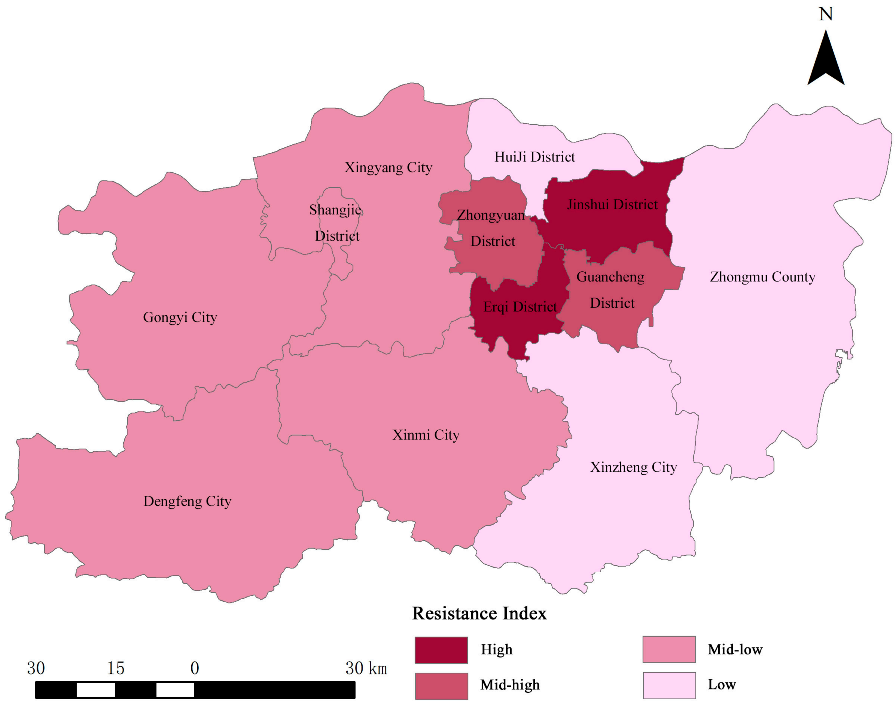

Figure 3. System resistance distribution diagram.

Table 6. System resistance index distribution table.

System Resistance	Index Interval	Area
High resistance	0.31–0.42	Erqi District, Jinshui District
Mid-high resistance	0.22–0.31	Guancheng District, Zhongyuan District
Mid-low resistance	0.16–0.22	Xingyang City, Xinmi City, Shangjie District, Gongyi City, Dengfeng City
Low resistance	0.14–0.16	Zhongmu County, Xinzheng City, Huiji District

4.1.3. Comprehensive Resistance Analysis

According to the above analysis, in terms of the main influencing factors, combining Figure 4 and Table 7, it can be seen that the dimension that has a greater impact on the overall resistance is the system resistance. The system resistance, material security and medical security capacity have larger weights of 0.24 and 0.22, respectively, indicating that the same indicator varies widely across regions and has the greatest impact on system resistance. The Jinshui and Erqi districts are more prominent in terms of medical and material security and the region also has the highest resistance index. At the spatial level, the cities with higher levels of resistance in Zhengzhou are the Erqi District, Jinshui District and Gongyi City and the lowest level of resistance is in the Huiji District. According to the data and graphical analysis, regions with high comprehensive resistance have superior transportation, medical, material and economic levels compared to other cities and can have better coping and recovery capabilities when flooding occurs. In general, the spatial differences in the resistance indices of the districts and counties under the jurisdiction of Zhengzhou City are large and the distribution of resistance levels is uneven, with "the Resistance index in the southwest being higher than that in the northeast".

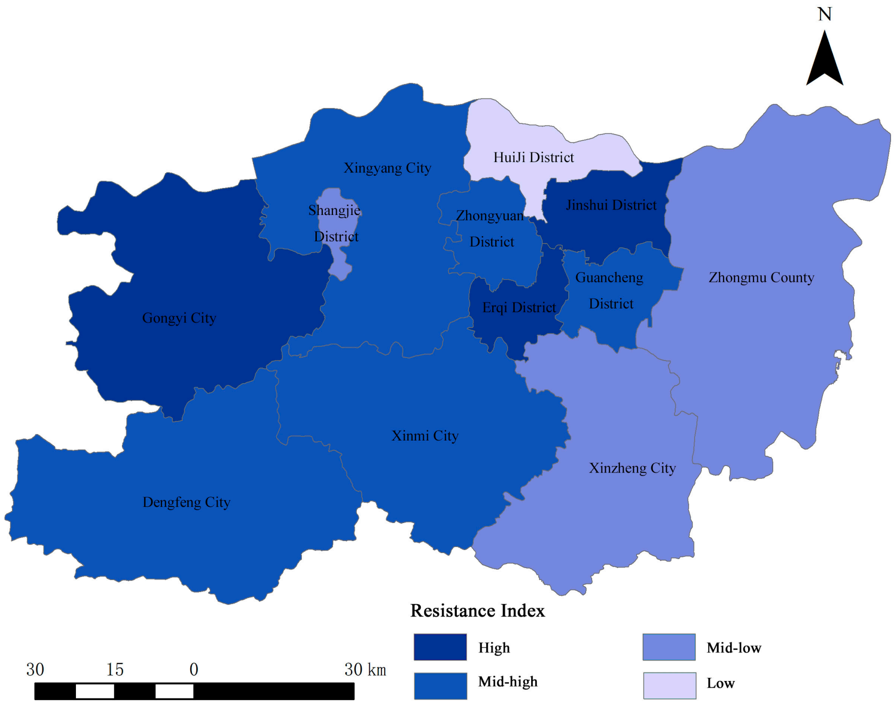

Figure 4. Comprehensive resistance distribution map.

Table 7. Comprehensive resistance index distribution table.

Comprehensive Resistance	Index Interval	Area
High resistance	0.47–0.58	Erqi District, Jinshui District, Gongyi City
Mid-high resistance	0.36–0.47	Dengfeng City, Xinmi City, Guancheng District, Xingyang City, Zhongyuan District
Mid-low resistance	0.22–0.36	Shangjie District, Zhongmu County, Xinzheng City,
Low resistance	0.00–0.22	Huiji District

4.2. Barrier Degree Diagnosis and Improvement Path Analysis

Based on the physical examination of flood control resistance in Zhengzhou City, to find out the main factors affecting the resistance of various regions in Zhengzhou City, this paper introduces the obstacle degree diagnosis model. Based on Equations (10)–(13), Table 8 was calculated. According to the table shown, it can be seen that there are significant differences in the barriers affecting the resistance of different regions. The details are as follows.

Table 8. Major barrier factors affecting the resistance of regional flood mitigation.

Region	First Obstacle Factor		Second Obstacle Factor		Third Obstacle Factor		Fourth Obstacle Factor		Fifth Obstacle Factor	
	Factor	Obstacle Degree	Factor	Obstacle Degree	Factor	Obstacle Degree	Factor	Obstacle Degree	Factor	Obstacle Degree
Zhongyuan District	C5	0.31	C1	0.25	C4	0.18	C2	0.17	C3	0.07
Erqi District	C5	0.40	C1	0.27	C2	0.21	C3	0.08	C6	0.04
Guancheng District	C5	0.33	C4	0.24	C1	0.22	C2	0.19	C3	0.02
Jinshui District	C5	0.40	C1	0.28	C2	0.23	C4	0.06	C6	0.03
Shangjie District	C4	0.27	C5	0.26	C1	0.15	C2	0.14	C3	0.11
Huiji District	C4	0.27	C5	0.24	C2	0.23	C1	0.13	C3	0.10
zhongmu County	C4	0.30	C2	0.20	C3	0.18	C5	0.16	C1	0.09
Gongyi City	C4	0.39	C3	0.25	C5	0.24	C2	0.05	C6	0.04
Xingyang City	C4	0.35	C3	0.20	C2	0.15	C1	0.13	C5	0.12
Xinmi City	C4	0.36	C3	0.21	C5	0.18	C2	0.14	C1	0.06
Xinzheng City	C4	0.28	C5	0.23	C2	0.17	C3	0.15	C1	0.11
Dengfeng City	C4	0.35	C3	0.24	C5	0.19	C2	0.14	C6	0.07

4.2.1. Analysis of Obstacle Factors and Promotion in High Resistance Index Area

The high-resistance index areas are the Erqi District, Jinshui District and Gongyi City. For the Erqi District and Jinshui District, the main obstacle factor is the material security aspect C5, which has the highest per capita disposable income, but the per capita food production and per capita water resources are low and usually attention needs to be paid to the need for material reserves to cope with the impact of unexpected disasters. The second obstacle factor is land use C1, high imperviousness and low vegetation coverage in both areas, the area needs to be well planned for green space construction to create a more green and livable living environment. The third obstacle is the climate and hydrological factors C2, the region's building density and population density are high and the city's heat capacity will gradually rise, resulting in the "heat island effect", an easy cause of heavy rainfall in the flood season, attention should be paid to sponge city construction, more use of permeable tiles to build parking lots, construction of roof gardens, etc. For Gongyi City, the main obstacle factors are medical rescue capacity C4 and transportation capacity C3, which are weak compared to the urban area. The degree of transportation connection between the region and the urban area should be strengthened and medical facilities should be emphasized to cope with the threat of sudden disasters and to build a more livable city.

4.2.2. Analysis of Obstacle Factors and Promotion in Mid-High Resistance Index Area

The middle and high resistance areas are Dengfeng City, Xinmi City, Guanchenghuizi District, Xingyang City and Zhongyuan District. For the Dengfeng, Xinmi and Xingyang cities, the obstructive factors that hinder the development of urban resistance are mainly distributed in system resistance. The main obstacle factors for all three municipalities are medical rescue capacity C4 and transportation capacity C3, indicating that the resistance of a region cannot be separated from the perfection of transportation and the construction of medical facilities. The counties and cities should strengthen the infrastructure and municipal facilities. Another higher obstacle factor is material security capacity C5, which should strengthen the development of regional secondary and tertiary industries to attract more enterprises and talents to promote the economic development of the region. For the Guancheng Huizu District and Zhongyuan District, which are cities with relatively high resistance in urban areas, the main obstacle factor for their development is the material security capacity C5; the two regions have a large area for development and construction and low food production, and attention should be paid to the sowing of crops and the reserve of materials. The second obstacle factor in the Central Plains is land use C1, which has the highest proportion of built-up area. The increase in the impervious area will lead to a weakening in the city's ability to store water bodies and make it prone to inadequate drainage, and the construction of drainage facilities and ecological environment should be strengthened. In the face of the main factors hindering urban development, management should be strengthened in time to make up for the shortcomings.

4.2.3. Analysis of Regional Obstacle Factors and Improvement of Mid-Low Resistance and Low Resistance Index

The medium- and low-resistance cities are Shangjie District, Zhongmu County and Xinzheng City. For Shangjie District, the main obstacle factors for urban development are medical security capacity C4 and material security capacity C5. Since the Shangjie District was transferred to Zhengzhou City in 2020, its socioeconomic development is relatively slow compared to other urban areas, with a significant difference in medical development compared to urban areas and per capita grain production is also relatively low. The correlation between the region and urban development should be strengthened while emphasizing the development of agricultural industries. For Zhongmu County and Xinzheng City, the first obstacle factor is the medical security capacity C4. The number of medical stations and the number of beds should be increased appropriately to reduce problems such as the distance to see a doctor and the difficulty of seeing a doctor. The other obstacle factors in Zhongmu County are hydro-climatic C2 and transportation capacity C3. The reason is that the county has a high density of water networks and a small specific drop of rivers, which is very prone to internal flooding, and engineering measures such as river management and levee construction should be strengthened as well as the accessibility of transportation roads. The second obstacle factor in Xinzheng is the material security capacity C5, mainly due to the low amount of water resources per capita and the construction of water diversion projects should be strengthened. For the low-resistance city Huiji District, the main obstacle factors affecting its development are medical security capacity C4 and material security capacity C5. Huiji District has fewer overall medical resources, low per capita food production and weak economic strength, and the city's emergency management is supported by strong economic strength, the region needs to invest more in medical and transportation facilities and other construction, promote the development of the linkage between the three industries, enhance economic strength and strengthen the city's resistance and resistance to disasters.

5. Discussion

One of the main contributions of this study is to propose a characteristic flood control special physical examination evaluation based on the basic work of urban physical examination. However, in previous studies, urban physical examination is often comprehensively evaluated in multiple dimensions [48,49], lacking accurate identification and quantitative analysis of the "short board" of the city [12]. This is conducive to enriching the evaluation results of urban physical examination, transforming them into accurate and efficient implementation and has certain guiding application value for future flood control research. Another contribution is that the paper did not only use the weighted average of two objective methods to find the resistance index of each area of the city, which is different compared to the previous methods of subjective [50,51] and fuzzy evaluation [52,53] that were mostly used in the construction of the index system, which can effectively avoid the subjectivity in the evaluation process. Moreover, the barrier degree model was introduced to analyze the main barrier factors to the development of each area, which can identify and clarify the factors that have a major impact on the evaluation results and provide certain ideas for the scientific formulation of the future development path of the city compared to the evaluation of flood risks using hydrological models [54,55] and hydrodynamic models [56,57].

Urban flood control physical examination also has practical significance for urban disaster prevention and management. The special physical examination and evaluation of urban waterlogging risk is an important means of urban governance under the dimension of safety resilience. It can examine the savings and infiltration capacity of the built environment, the defects of urban spatial layout and the redundancy of infrastructure. Accurately identifying the defects in urban disaster prevention can provide new ideas for improving urban flood resistance. Measuring the resilience of cities to flooding helps to formulate flood control policies and helps decision-makers to identify priorities for improving the resilience of cities to flooding.

The innovations of this study are, for one thing, the construction of a special characteristic medical examination index system for urban flood control that can identify urban safety problems more precisely. Secondly, the concept of resistance is integrated into the nonengineering measures of flood risk prevention and control, and the obstacle degree model is used to evaluate the factors of the environment and urban lifeline system to resist flood to find out the key factors restricting urban development. Thirdly, most scholars focus on the functional correlation of a single infrastructure network [58,59]. However, this paper can analyze and evaluate the related facilities of the system from the perspective of spatial correlation, which is more comprehensive.

Flood risk is a dynamic process. The extreme rainstorm in Zhengzhou City on 20 July 2021 led to severe inundation, river flooding, landslides, subway back-ups and other multidisaster complications that caused significant casualties and property damage [60]. Landslides mostly occur in the western mountainous areas. Due to the weak infrastructure construction in the countryside, flood control facilities have difficulty resisting the erosion of sudden floods due to old age, poor transportation conditions and lack of medical facilities, which can easily cause people to be trapped or even casualties. This is closely related to the low system resistance of the county and city, and the poor lifeline system of the city is prone to delayed rescue. Subway backflow occurs in the main urban area and the low environmental resistance of the urban area is greatly related to the impervious area of the main urban area of Zhengzhou City, which is 73%, the ground on the rainwater infiltration adjustment ability is weakened, easily forms a confluence, the formation of backflow phenomenon. According to the results of this paper, the system resistance of urban areas is high and the urban lifeline system is more perfect in case of sudden disasters, and the emergency system can play an effect but the natural environment has weak storage and absorption capacity of water bodies and is not able to play a coordinating role in flood control and drainage of the city. This is consistent with the findings of this paper. Therefore, the results of the physical examination assessment of urban flood resistance in this study are considered reasonable.

However, this study has several drawbacks. For one, since there are fewer studies on special physical examinations for urban physical examinations, there is a lack of a standard evaluation system as a reference and, therefore, the chosen method and the construction of the index system may not be scientific enough. Second, the index system requires a large amount of data support and is time-sensitive, mainly focusing on static analysis of historical data and resistance assessment of the predisaster system, and the intrinsic correlation and extensiveness among the indicators may be insufficient, which is the limitation of the study. In the future, the index system should be expanded in conjunction with the development direction and economic level of cities to make it more objective, accurate and scientific in responding to the level of urban flooding resistance. According to local conditions, special flood prevention and special medical examination indexes should be established.

6. Conclusions

The flood control special physical examination provides new ideas and governance paths for urban flood disaster prevention and control. In this study, a flood control and disaster reduction index system from the perspective of resistance was established. A total of 17 indicators were selected from the 2 dimensions of environmental resistance and system resistance. The entropy weight method, coefficient of variation method and obstacle degree model were used to analyze the resistance index of each area of Zhengzhou City and calculate the main obstacle factors of each area. From the above study, we conclude that the comprehensive resistance in the southwestern part of the study area is relatively higher than that in the northeastern part, with a "graded" distribution and obvious spatial differentiation. Relatively speaking, the overall system resistance of urban areas is higher than that of counties and cities, while the environmental resistance is lower than that of counties and cities, which is closely related to the development direction and economic level of cities. Similarly, with the rapid increase in the level of socioeconomic development, there are commonalities in urban and rural development in different regions, such as the large gap between urban areas and counties and cities, the lack of mobility of various factors and the weak sharing capacity of infrastructure. Overall, the main constraints on the safety of urban areas in the face of sudden disasters are the natural environment and the saving capacity of the land, while the main factors affecting the safety of counties and cities are the robustness and redundancy of the infrastructure. Therefore, in the promotion of rapid urbanization, how to keep the built environment fully adaptable under extreme disasters and the infrastructure robust and redundant in function, fully identify potential risk elements in urban flood control and scientifically check and assess disaster risks will be an important guarantee for achieving sustainable regional development and one of the important tasks of future flood control.

Overall, the stronger the disaster resistance, the better the ability to cope in the event of an unexpected disaster and the smaller the disaster loss will be. Therefore, in response to the above medical examination assessment, future practical measures should have the following aspects.

6.1. Adhere to the Harmonious Coexistence of Man and Nature and Promote the Low-Impact Development Model

Comprehensive consideration of regional natural environmental conditions and urban spatial layout; give full play to geographical advantages; strengthen the rivers, lakes and other water bodies to regulate storage and diversion functions and improve the urban flood control and drainage system; strengthen the construction of sponge cities and increase urban elasticity; strengthen environmental management and ecological restoration; promote the construction of ecological infrastructure; comprehensively improve the level of ecological protection; and continuously improve the ability of the whole society to manage disaster risks.

6.2. Improve Flood Mitigation Awareness and Enhance Emergency Preparedness

Take the initiative to learn flood control knowledge and enhance flood control awareness; actively participate in community disaster preparedness drills to develop self-rescue capabilities and improve the public's ability to handle emergencies; strengthen publicity and education to convey flood prevention knowledge and skills to the public through television and radio; multiparty participation and comprehensive measures to improve flood disaster prevention awareness and response capabilities for all.

6.3. Focus on the Combination of Engineering and Nonengineering Measures to Reduce Disaster Losses

Appropriate increase in flood protection standards for urban infrastructure; enhance the robustness and redundancy of infrastructure to coordinate with the scale of population development and the rate of socioeconomic development and to guarantee the systemic nature and integrity of urban construction; strengthen the propaganda of disaster prevention concepts and raise the awareness of the whole society in terms of disaster prevention and mitigation so that the whole society can face disasters squarely and be prepared to deal with them; establish and improve the government-led, socially engaged disaster risk management mechanism; use systematic thinking and an integrated approach to manage urban flooding.

6.4. Deepen the Flow of Factors between Urban Areas and Counties and Promote the Common Construction and Sharing of Infrastructure

Dealing with the relationship between urban areas and counties and cities, give full play to the radiation-driven role of urban areas and promoting infrastructure interconnection; actively explore infrastructure integration collaboration mechanisms, revitalizing and renovating old facilities; set up a disaster fund to increase funding for urban disaster prevention and construction; provide financial support to make up for the shortcomings of county and city infrastructure; and promote the integrated development of urban and rural areas.

6.5. Improve the Urban Lifeline System and Improve Disaster Management Risk Ability

Adhere to the concept of people-oriented, life-centered, coordinated construction of safe and high-quality urban lifeline system engineering; comprehensively sort out the information data and operational status of infrastructure in each region and improve the infrastructure configuration; develop and improve the city's lifeline monitoring system to achieve timely risk perception; establish an early monitoring and warning system for early and efficient disposal response to improve the city's safety operation guarantee; comprehensively enhance the ability to prevent risks and continuously improve the level of urban security.

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References

1. Lu, S.; Huang, J.; Wu, J. Knowledge domain and development trend of urban flood vulnerability research: A bibliometric analysis. *Water* **2023**, *15*, 1865. [CrossRef]
2. Jing, W.; Na, L.; Yanyan, W.; Shan, W. Study on flood affected population and economic risk assessment and zoning method. *China Water Resour.* **2023**, *74*, 16–19.
3. Jiguo, Z.; Huimin, W. Risk assessment model for regional flood disaster based on the principle of information diffusion. *J. Water Resour. Water Eng.* **2010**, *21*, 37–39.
4. Bosseler, B.; Salomon, M.; Schlüter, M.; Rubinato, M. Living with urban flooding: A continuous learning process for local municipalities and lessons learnt from the 2021 events in Germany. *Water* **2021**, *13*, 2769. [CrossRef]
5. Yang, L.; Jie, J. A brief analysis of Zhengzhou "7.20" heavy rainstorm and improvement of the urban meteorological disaster emergency response and disposal mechanism. *China Flood Drought Manag.* **2023**, *33*, 61–65.
6. Yi, W.; Xiaomei, Z.; Ningfang, Z.; Zhengguang, H.; Jiaying, L.; Yang, L.; Ying, W. Evolution characteristics of global meteorological and hydrological disasters from 1990 to 2019. *Trans. Atmos. Sci.* **2021**, *44*, 496–506.
7. Li, S.; Wanlu, L.; Zhongqi, Z. A study on urban physical examination assessment index system from the perspective of resilient cities. *Beijing Plan. Rev.* **2020**, *34*, 128–132.
8. Hongling, Q. Urban physical examination: Institutional innovation in the evaluation and implementation of urban master planning. *Urban Rural Dev.* **2019**, *64*, 12–15.

9. Min, Z.; Xuchen, Z. Explorations on the evolution process and effective operation of city examination assessment: A perspective of public policy process. *City Plan. Rev.* **2022**, *46*, 65–74.
10. Zhuandi, S. Problems and countermeasures of Jingning county land use planning implementation evaluation. *Rural Technol.* **2021**, *12*, 100–101.
11. Yanran, S.; Lin, Z.; Yu, F.; Yixiang, M.; Biqi, K.; Haotian, X. An exploration of the method and practice of assessing the current status in territorial spatial and protection-a case study of Jingdezhen city, Jiangxi province. *Urban Plan. Forum* **2020**, *64*, 35–42.
12. Xianfeng, J.; Changbo, W.; Yue, L.; Zhiming, H.; Xiaobo, H.; Xianfeng, P.; Renfei, Y. Thinking and practice of urban special examination oriented to the implementation of targeted policy measures. *Geospat. Inf.* **2023**, *21*, 15–20.
13. Lu, W.; Yingying, C.; Minshou, X. Doing a good medical examination and assessment to scientifically help modernize urban governance—An example of urban medical examination and assessment of Zhengzhou City's 2020 territorial spatial planning. *Resour. Guide* **2021**, *51*, 22–23.
14. Haijun, B.; Xiaoyi, Z.; Mingli, J.; Ming, Z. Study on the city evaluation index system oriented to territorial space safety from the perspective of resilience. *China Land Sci.* **2022**, *36*, 21–30.
15. Liang, Y.; Yue, L.; Xiaofei, Y. Analysis and design of urban flood control project scheme. *Tech. Superv. Water Resour.* **2023**, *31*, 191–194.
16. Junling, Z. Analysis of design flood in yiganqi flood control project of Yerqiang river basin. *Tech. Superv. Water Resour.* **2023**, *31*, 22–24.
17. Liu, Z.; Xiong, Y.; Xu, J. Flood simulation and flood risk reduction strategy in irrigated areas. *Water* **2023**, *15*, 192. [CrossRef]
18. Ruqiong, Q.; Junming, F.; Shaokun, P.; Yu, X.; Xiaozui, W. Study on the flood disaster spatio-temporal variation prediction method. *Geospat. Inf.* **2019**, *17*, 24–28.
19. Yanjuan, L.; Wen, L. Research on the project planning of "prospering water resources and moistening lincang" under the new situation. *Tech. Superv. Water Resour.* **2022**, *30*, 79–82.
20. Daoming, L. Urban lifeline and public safety. *Anhui Archit.* **2016**, *23*, 96–97.
21. Yanping, L.; Jixin, H. Review on infrastructure resilience assessment and future direction. *J. Catastrophology* **2021**, *36*, 153–159.
22. Weidong, Y.; Chunlei, D. A review of urban infrastructure resilience research. *Constr. Technol.* **2022**, *51*, 1–5.
23. Xiaoran, L.; Wei, W.; Aili, L. Research on the time-space features of macro vulnerability to lifeline system of Beijing-Tianjin-Hebei areas. *Math. Pract. Theory* **2018**, *48*, 9–20.
24. Cheng, Y.; Yuan, Z.; Li, Y.; Fan, J.; Suo, M.; Wang, Y. The influence of different climate and terrain factors on vegetation dynamics in the Lancang river basin. *Water* **2023**, *15*, 19. [CrossRef]
25. Li, L.; Xin, L.; Jingmin, Z. Impacts of traffic and land use on the environment in Tianjin based on regression analysis. *J. Hebei Univ. Technol.* **2017**, *9*, 53–57.
26. Pingping, X.; Jing, Z.; Chunxiao, L.; Senyuan, L.; Linfeng, L. Efficiency analysis of primary medical and health resources allocation based on data envelopment analysis. *Mod. Prev. Med.* **2023**, *50*, 1075–1079.
27. Lunyan, W.; Xiaodong, Z.; Huimin, L.; Chan, Z.; Lelin, L. Research on emergency installation of mobile flood control system based on multi-agent simulation. *Yellow River* **2018**, *40*, 38–43.
28. He, H.; Yida, F.; Siquan, Y.; Wenbo, L.; Xiaotian, G.; Wenze, L.; Hailei, W. A multi-agent based theoretical model for dynamic flood disaster risk assessment. *Geogr. Res.* **2015**, *34*, 1875–1886.
29. Reyes-Silva, J.D.; Novoa, D.; Helm, B.; Krebs, P. An evaluation framework for urban pluvial flooding based on open-access data. *Water* **2023**, *15*, 46. [CrossRef]
30. Xiaojin, L.; Qiaoli, W.; Xinyu, B. Measurement of production factors of various transportation modes based on input-output method. *J. Transp. Eng.* **2023**, *23*, 78–84.
31. Jiyuan, W.; Zhang, C.; Shaobo, L. An empirical analysis of the promotion of China's economy by the infrastructure investment of the ''one belt and one road": From the perspective of multi-sectoral input-output. *J. Jiangxi Univ. Financ. Econ.* **2016**, *18*, 11–19.
32. Han, L. Research on the mechanism of economic impact of land factors based on spatial general equilibrium theory. *Stat. Decis.* **2019**, *35*, 41–45.
33. Lu, Q.C. Modeling network resilience of rail transit under operational incidents. *Transp. Res. Part A Policy Pract.* **2018**, *117*, 227–237. [CrossRef]
34. Changjun, L. Simulation analysis of urban flooding risk and defense measures in zhengzhou city. *Disaster Reduct. China* **2022**, *32*, 34–37.
35. Dong, Y.; Zhu, Y. Exploring the coupling coordination of green transformation of industry and novel infrastructure in the context of low-carbon economy. *Sustainability* **2023**, *15*, 4872. [CrossRef]
36. Weiwei, N. Research on the evaluation method of urban transportation facilities. *TranspoWorld* **2019**, *26*, 10–11.
37. Changgen, X.; Jiale, L. Improving expert scoring method for complex environmental risk assessment. *Constr. Saf.* **2022**, *37*, 73–75.
38. Shuo, S.; Duan, F. Evaluation of infrastructure resilience of Yangtze river delta urban agglomeration based on topsis entropy weight method. *China Real Estate* **2020**, *41*, 31–35.
39. Zhen, Z.; Yichen, Z.; Jiquan, Z.; Qiuling, L.; Jiahao, Y.; Chenyu, D. Urban resilience assessment based on entropy weight method and topsis model-take Changchun city as an example. *J. Catastrophology* **2023**, *38*, 213–219.

40. Xingfa, L.; Xuelu, L. Assessment on comprehensive benefits of land remediation based on analytical hierarchy process and fuzzy synthetic evaluation—A case study of land remediation project of Quichuan, Huachi county in Qingyang city of Gansu province. *J. Anhui Agric. Sci.* **2017**, *45*, 197–200.
41. Jian, F.; Xiaotao, G.; Mingye, Q. Overall solution for urban flood control and drainage under extreme rainfall and flood-taking zhengzhou as an example. *China Water Resour.* **2022**, *73*, 39–42.
42. Zhao, B.; Wang, K. Study on the optimization of Zhengzhou City's administrative division in the context of national central city construction. *China Anc. City* **2020**, *34*, 41–45.
43. Yuexiu, W.; Caihong, H.; Shengqi, J. Study on storm flood and flood risk zoning in Zhengzhou city. *Pearl River* **2018**, *39*, 17–23.
44. Zhanfu, L.; Rong, Z.; Xueyan, Z.; Jingjing, L.; Jiaming, W. Evaluation and influencing factors of rural territorial space security in loess hilly region: A case of Lintao county. *Arid. Land Geogr.* **2023**, *46*, 127–138.
45. Pengcheng, X.; Fei, Z.; Yahui, S. Research on social risk assessment of infrastructure investment in countries along "the belt and road". *J. Ind. Technol. Econ.* **2022**, *41*, 3–11.
46. Shuoliang, J.; Xiansheng, C. Urban resilience assessment and barrier factor analysis under flooding scenarios. *Stat. Decis.* **2022**, *38*, 63–67.
47. Jin, G.; Jianlan, R.; Qing, Y.; Yu, Z. Evaluation and influencing factors of ecological civilization construction in Shandong province-based on projection pursuit model and obstacle model. *East China Econ. Manag.* **2018**, *32*, 19–26.
48. Wu, J.; Wang, X.; Chen, Y.; Jingshu, L. The difficulties of megacities' city health examination and the practice in Shanghai. *Urban Plan. Forum* **2022**, *4*, 270.
49. Zhao, Z.; Duan, L.; Wu, J. Method study on management calculation and evaluation analysis of urban physical examination indicator. *Urban Geotech. Investig. Surv.* **2023**, *195*, 40–44.
50. Nguyen, N.M.; Bahramloo, R.; Sadeghian, J.; Sepehri, M.; Nazaripouya, H.; Nguyen Dinh, V.; Ghahramani, A.; Talebi, A.; Elkhrachy, I.; Pande, C.B.; et al. Ranking sub-watersheds for flood hazard mapping: A multi-criteria decision-making approach. *Water* **2023**, *15*, 2128. [CrossRef]
51. Hassan, Z.; Kamarudzaman, A.N. Development of flood hazard index (fhi) of the Kelantan river catchment using geographic information system (gis) based analytical hierarchy process (ahp). *Pertanika J. Sci. Technol.* **2023**, *31*, 203–215. [CrossRef]
52. Ning, Y.; Haijun, L.; Jia, Y. Construction of urban public security and disaster assessment system based on resilient city theory. *Sci. Technol. Inf.* **2023**, *21*, 118–121.
53. Su, Q.; Chang, H.S.; Pai, S.E. A comparative study of the resilience of urban and rural areas under climate change. *Int. J. Environ. Res. Public Health* **2022**, *19*, 8911. [CrossRef]
54. Hu, H.; Li, J.; Wu, S. Simulation evaluation of a current limiting scheme in an urban rail transit network. *Sustainability* **2023**, *15*, 375. [CrossRef]
55. Glick, R.; Jeong, J.; Srinivasan, R.; Arnold, J.G.; Her, Y. Adaptation of swat watershed model for stormwater management in urban catchments: Case study in Austin, Texas. *Water* **2023**, *15*, 1770. [CrossRef]
56. Wu, J.; Hu, P.; Zhao, Z.; Lin, Y.T.; He, Z. A gpu-accelerated and lts-based 2d hydrodynamic model for the simulation of rainfall-runoff processes. *J. Hydrol.* **2023**, *623*, 129735. [CrossRef]
57. Tufano, R.; Guerriero, L.; Annibali Corona, M.; Cianflone, G.; Di Martire, D.; Ietto, F.; Calcaterra, D. Multiscenario flood hazard assessment using probabilistic runoff hydrograph estimation and 2d hydrodynamic modelling. *Nat. Hazards* **2023**, *116*, 1029–1051. [CrossRef]
58. Lu, Q.C.; Zhang, L.; Xu, P.C.; Cui, X.; Li, J. Modeling network vulnerability of urban rail transit under cascading failures: A coupled map lattices approach. *Reliab. Eng. Syst. Saf.* **2022**, *221*, 108320. [CrossRef]
59. Lin, J.; Xiao, W.; Xiaotian, L. Research on the supply level of medical facilities in Wuhan central area. *Mod. Urban Res.* **2020**, *35*, 42–52.
60. Dawei, T.; Yang, L.; Fuxin, S.; Xiaoguang, L. Analysis of flood control and disaster reduction in zhengzhou city and discussion on countermeasures. *Water Resour. Plan. Des.* **2022**, *35*, 4–8.