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"Gheorghe Asachi" Technical University of Iasi, Romania

ENVIRONMENTAL RISK ASSESSMENT METHOD USING SPATIAL POINT SOURCE ACCUMULATION TECHNIQUE

Tianxin Li[1,2], Anni Zou[1*], Xing Chen Zhou[1,2], Lirontso Monaheng[1]

[1]*School of Energy and Environmental Engineering, University of Science and Technology Beijing*
[2]*Beijing Key Laboratory of Resource-oriented Treatment of Industrial Pollutants, Beijing, People's Republic of China*

Abstract

In this study, we discuss a risk assessment method for spatial point source accumulation that is suitable for regional comprehensive prevention and control of environmental risks. The distribution types of spatial risk sources and other related data are collected and analyzed by adopting Fengtai District, Beijing as an example. On the basis of the spatial analysis algorithm, the environmental risk of region is comprehensively assessed from the perspective of risk-inducing factors, risk substances, and environmental sensitivity. The characterization methods of five types of environmental risk sources, namely, chemical substances, air pollutants, water pollutants, hazardous wastes, and accumulation, are proposed. The point-to-surface continuity of spatial expression is realized using spatial analysis technology of geographic information system. A model of environmental sensitivity of receptors is constructed considering social complexity and sensitivity. The relative comprehensive expression of risk value in space is realized using an overlay of layers and through spatial analysis algorithm. The comprehensive cumulative risk degree and type of spatial environment in assessment areas are obtained, and the risk control zoning is conducted accordingly. Eight levels of risk control zones are proposed as a basis of the follow-up of management departments to conduct risk control. In addition, the way identifies high risk areas, where monitoring and detailed analysis is required. This study provides a reference for similar research and evaluation work.

Keywords: ArcGIS spatial analysis technique, environmental risk, risk control zoning, spatial point source accumulation technique

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1. Introduction

As a result of the rapid development of industrialization, environmental accidents occur frequently in some parts of China. Environmental risk is defined as an event caused by natural causes or human activities. These events can lead to the damage of the natural environment, human health, and ecosystem by reducing environmental quality and ecological function and services. Environmental risk focuses on the probability (possibility) of an occurrence of the event (Lin, 2013). Driven by various environmental events, China's environmental risk management system has been improved continuously, and the overall level of environmental risks in China has improved (Bi et al., 2017; Zhang, 2018). China's environmental risk status and development trends shift from a single risk to a complex environmental risk and from a local environmental risk to regional and even global environmental risk changes (Lu et al., 2012).

To comply with this change, research on environmental risk obtains increasing attention, and the methods are different but they improve environmental management. For some fields, such as mathematical knowledge, solution-focused risk assessment has been reflected in the environmental risk management system (Grech et al., 2017; Goldstein, 2018; Lian, 2016; Robu et al., 2007). Sebestyén et al. (2017) proposed scientific recommendations on environmental risk assessment for drug residues by analyzing the current regulations and regulatory in human medicinal products and

*Author to whom all correspondence should be addressed: e-mail: 634562934@qq.com; Phone: +8618811327005

veterinary drugs in Europe. We reviewed the methods of risk quantification and assessment mentioned in Romania's national research project in line with European research priorities, and conducted a comprehensive study of the behavior of persistent pollutants and the risks associated with their presence in the environment by Gavrilescu (2010). Mou (2011) discussed the environmental risk during dangerous goods transportation through system analysis methods and focused on the spread and hazard of pollutants. On the basis of environmental factors, transportation accident rates, and the degree of impact on the environment, an index called *Fanal* is used to analyze environmental risks during the transport of dangerous goods.

For quantitative calculation and analysis of environmental risks, regional environmental risks largely depend on the layout and structural problems of industrial and regional development. The development of regional environmental risk assessment and risk zoning can provide a scientific basis for formulating macro-environmental risk management strategies and guide the optimization and adjustment of industrial structure and layout. It is, regional environmental risk assessment, therefore, an important approach to prevent and reduce regional environmental risks (Bi et al., 2006; Panahandeh et al., 2018). In comparison with the environmental risk of a single construction project, regional environmental risk has the characteristics of multisource, multichannel, and multisensitive objectives and risk accumulation. To reflect the differences in regional environmental risks, some researchers have proposed to establish a risk classification model using geographic information system (GIS) technology. These researchers have studied the environmental risks in a region by focusing on the risk of hazardous chemicals but obtained limited attention to other risks (Buffat et al., 2017; Xu, 2017; Mahapatra et al., 2018; Minolfi et al., 2018; Yu and Che, 2019).

Some researchers have constructed comprehensive assessment and regionalization methods for regional environmental risks (Minolfi et al., 2018; Wang and Chen, 2015). These researchers have mainly considered social sensitivities associated with population rather than the type and function of land use when they studied the risks of environmentally sensitive receptors. The present study refers to the methods in existing guidelines for environmental risk assessment in China and uses Fengtai District, Beijing a study area to carry out the assessment. It constructs a method for identifying and evaluating regional environmental risk sources (several different types) and environmental sensitive receptors.

This method takes into account the types and functions of land use. Thus, the present study quantifies and classifies the risk of assessment units. Environmental risk management and control measures suitable for regional development characteristics are suggested, and reference for similar research and assessment work is provided.

2. Materials and method

2.1 Study area

Fig. 1 depicts the entire region of Fengtai District, Beijing the main research area of this study. Based on the grid results of all enterprises and institutions in Fengtai District, this study identifies the spatial location of all risk points and classifies risk types systematically. The large area of risk source is the focus of prevention and control.

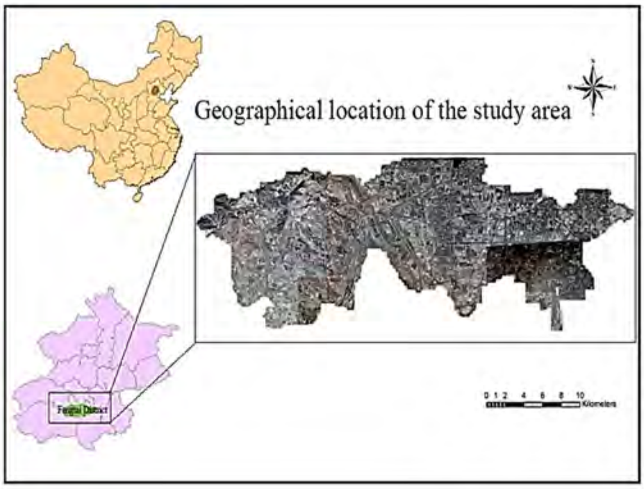

Fig. 1. Geographical location of the study area

The large risk area focuses on subsequent prevention and control and is the first base map for environmental risk prevention and control after landing. In accordance with the coordinates of risk sources, the spatial distribution of risk sources in Fengtai District, Beijing is expressed using the GIS software, as illustrated in Fig. 2.

In the spatial distribution of risk sources, as demonstrated in Fig. 2, 152 environmental risk sources are identified through a data query in this assessment. The central and eastern regions are relatively concentrated. In terms of quantity distribution, the risk problem of accumulation occurs in these zones in theory. Among these risk sources, the sources of atmospheric emission risks are widely distributed, with 65 sources mainly concentrated in Central and Eastern Fengtai District. The hazardous wastes have 38 sources, which are distributed in the central area.

In addition, sewage discharge has 28 sources that are mainly distributed in South and East Fengtai District and 20 chemical risk sources that are mainly distributed in South and East Fengtai District. A cumulative pollution source is located in South Fengtai District. The proportions of sources of atmospheric emission, hazardous waste, sewage discharge chemical risk, and cumulative pollution to total pollution risks are 42.76%, 25.00%, 18.42%, 13.16%, and 0.66%, respectively. Evidently, the pollution source with a high pollution risk in Fengtai District includes atmospheric emissions.

2.2. Environmental risk assessment

2.2.1 Identification and hazard characterization methods of risk source

On the basis of the analysis of the risk source, the ArcGIS spatial analysis technology is used to rasterize the environmental risk index to be represented by the pixel value in the raster layer（Fig. 3). In the present study, the regional vector files in Beijing are divided into fishing nets using the feature processing tools of ArcGIS data management tools. The vector files with 1952 regular grid areas of 1 km × 1 km are generated by clipping and transforming the Beijing area as the boundaries of the scope. Among them, the total area of Fengtai District is 305.52 km^2, and 53 grid areas cover the Fengtai area.

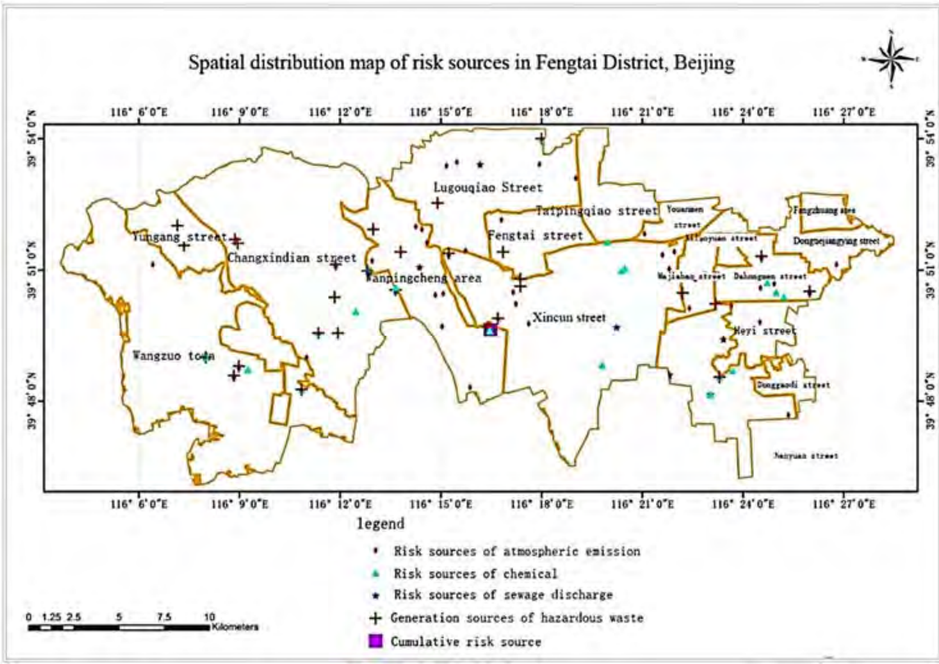

Fig. 2. Spatial distribution of risk sources

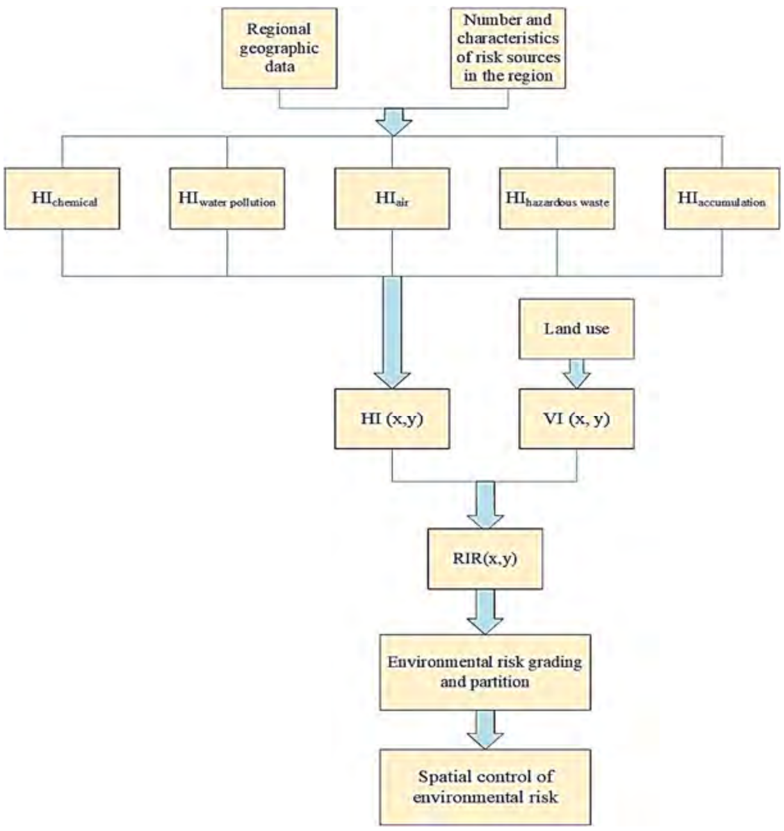

Fig. 3. Methodological route of indicators

In Fengtai District, the actual data are limited by the number of monitoring points and do not have spatial continuity. The existing point data of quality must be spatialized to enable spatial simulation results to coincide with actual data. The characteristics of the spatial analysis indicate that the eigenvalues are likely similar when the points in the spatial position are close; the probability of similar eigenvalues is minimal when the distance is far. This finding is the most basic theoretical hypothesis of spatial interpolation technique (Ma et al., 2008). In the present study, spatial expression frequently used to convert measurement data from discrete points into continuous data surfaces for comparison with the distribution patterns of other spatial phenomena to achieve spatial continuity of simulated data. For example, IDW (inverse distance weighted) spatial analog interpolation is a method weighted by the distance between the interpolation and the sample points. On the basis of the similarity principle, a known value of the sample is used to predict other values of any position in the area, and the evaluation results of spatial continuity are obtained (Duan et al., 2018). The hazard characterizations are distinct from different types of hazard sources. The characterization methods of hazard sources are presented as follows:

2.2.1.1. Method of chemical source

Eq. (1) is used to calculate the hazard for chemical sources.

$$\mathrm{HI}_{\mathrm{chemical}}=\mathrm{Q} \tag{1}$$

where $\mathrm{HI}_{\mathrm{chemical}}$ and Q represent chemical source hazards and quantitative characterization of the nature and quantity of chemicals present in the chemical source, correspondingly. The *Identification of Major Hazardous Sources of Hazardous Chemicals* (GB 18218-2009) is used to compute the nature and quantity of the risk substances by comparing the maximum total amount and critical value of the risk substances in the enterprise boundary and characterize the nature and quantity of the chemicals as (Eq. 2):

$$Q = q_1 / Q_1 + q_2 / Q_2 + q_3 / Q_3 + \ldots + q_n / Q_n \tag{2}$$

where $q_1 \ldots q_n$ is the maximum amount of storage or use in each risk substance of chemical source, and $Q_1 \ldots Q_n$ is the critical amount of each risk substance.

2.2.1.2 Method of water pollution sources

The hazards of water pollution sources are related to the volume of emission, characteristics, and direction of discharged substances. Eq. (3) is used to calculate the hazards of water pollution sources.

$$HI_{water\ pollution} = lgQ_{water} * C_{water} * P_{water} * E \tag{3}$$

where $HI_{water\ pollution}$ is the risk of water pollution discharge source; Q_{water} is the annual quantity of wastewater effluent (t); C_{water} is the discharge type characteristics of water pollutants; P_{water} is the emission concentration of water pollutants; E is the direction of discharge; $E = 5$ for a river, and $E = 1$ for a sewage plant.

If the characteristic pollutants emitted by the emission source were the first type of pollutants in the *Integrated Wastewater Discharge Standard* (GB8978-2002), then C_{water}= 2* for the first pollutants; C_{water}=1 for the second type of pollutants (Eq. 4).

$$P_{water} = c_1 / C_1 + c_2 / C_2 + c_3 / C_3 + \ldots + c_n / C_n \tag{4}$$

where c1–cn is the average concentration of each characteristic pollutant, and C1-Cn is the emission standard stipulated by the *Integrated Wastewater Discharge Standard* (GB8978-2002) corresponding to each characteristic pollutant.

2.2.1.3 Method of air pollution sources

The risk of gas pollution source is related to the emission and its characteristics and is calculated using Eq. (5).

$$HI_{air} = lgQ_{air} * C_{air} * P_{air} \tag{5}$$

where HI_{air} is the danger of air pollution sources, Q_{air} is the annual emission of air pollution sources (10,000 m^3/a), C_{air} is the emission category characteristics of air pollution sources, and P_{air} is the emission concentration characterization value of air pollutants.

If the characteristic pollutants emitted by the emission source are heavy metals and organic pollutants specified in the *Comprehensive Emission Standards for Air Pollutants* (GB16297-1996), then the number of heavy metals and organic pollutants is $C_{air}=2*$. Otherwise, $C_{air}=1$. The algorithm of P_{air} is expressed as given by Eq. (6).

$$P_{air} = c_1 / C_1 + c_2 / C_2 + c_3 / C_3 + \ldots + c_n / C_n \tag{6}$$

where $c_1 \ldots c_n$ is the average emission concentration of each emission source. $C_1 \ldots C_n$ is the emission standard stipulated in the *Integrated Emission Standard of Air Pollutants* (GB16297-1996) corresponding to each characteristic pollutant.

2.2.1.4 Method for hazardous waste source

The calculation of hazardous waste source is related to the amount of hazardous waste generated and the disposal methods of the enterprise (Eq. 7).

$$HI_{hazardous\ waste} = lg \sum (Ti * Q_{hazardous\ waste}) \tag{7}$$

where $HI_{hazardous\ waste}$ is the risk of hazardous waste source, $Q_{hazardous\ waste}$ is the annual production of different hazardous wastes (kg), and Ti is the treatment method of a certain type of hazardous waste.

In accordance with the various disposal

methods of hazardous waste, the values are presented as follows: entrusting qualified units to dispose of hazardous wastes (incineration, landfill, or comprehensive utilization), T=1.5; temporarily storing in the plant area, T=2; entrusting units without qualified units to dispose of hazardous waste, T=5; direct discharge, T=8.

2.2.1.5. Representation method of the cumulative hazard of risk sources

The cumulative hazard of risk sources is first related to the nature and quantity of cumulative risk substances. Eq. (8) is used to calculate

$$HI_{accumulation} = lgQ_{accumulation} \tag{8}$$

where $HI_{accumulation}$ is the risk of cumulative hazard source, and $Q_{accumulation}$ is the maximum design reserves of cumulative substances in the enterprise.

The degree of danger at a certain point (sensitive point) is related to its spatial distance from dangerous sources, and the cumulative risk index (*HI* [x, y]) at a point in space is calculated using Eq. (9):

$$HI(x,y) = \sum_{i=0}^{151} (\mathrm{HI}_i / D_i) \tag{9}$$

where I = 0, 1, ... , 151 (this study investigated and identified 152 environmental risk sources) is the source number of the risk, and D_i is the distance from the surrounding risk source to the point; 0<D<=10000 m (in accordance with the *Guidelines for Risk Assessment of Enterprise Environmental Risks*).

2.2.2. Environmental sensitivity assessment

The sensitivity of a plot to environmental risks largely depends on the type and function of the land. Therefore, the plan identifies seven types of land use, namely, farmland, grassland, woodland, transportation facilities, residential areas, drinking water sources, and nature reserves. In accordance with the type of land use, risk receptors are divided into four categories, and then the sensitivity is determined by a risk receptor; the sensitive index value is provided. The specific criteria are listed in Table 1.

The spatial distribution of environmental sensitivity index in Fengtai District, Beijing was analyzed by overlapping layers with the support of GIS software after gridding the spatial distribution of environmental sensitivity index (Fig. 4). The overlay analysis in GIS is suitable for considering multiple types of risk sources. It is an operation of superimposing two or more layers of map elements to produce a new feature layer. Therefore, the new elements are generated by dividing or merging the original elements that combine the attributes of the former layer (Buffat et al., 2017).

Table 1. Standard of environmental risk sensitivity

Susceptibility	***Risk receptor***	***Sensitivity index***
Low	Farmland, grassland, and woodland	1
Medium	Transportation facilities	2
Medium and High	Residence Community	3
High	Drinking water source and nature reserve	4

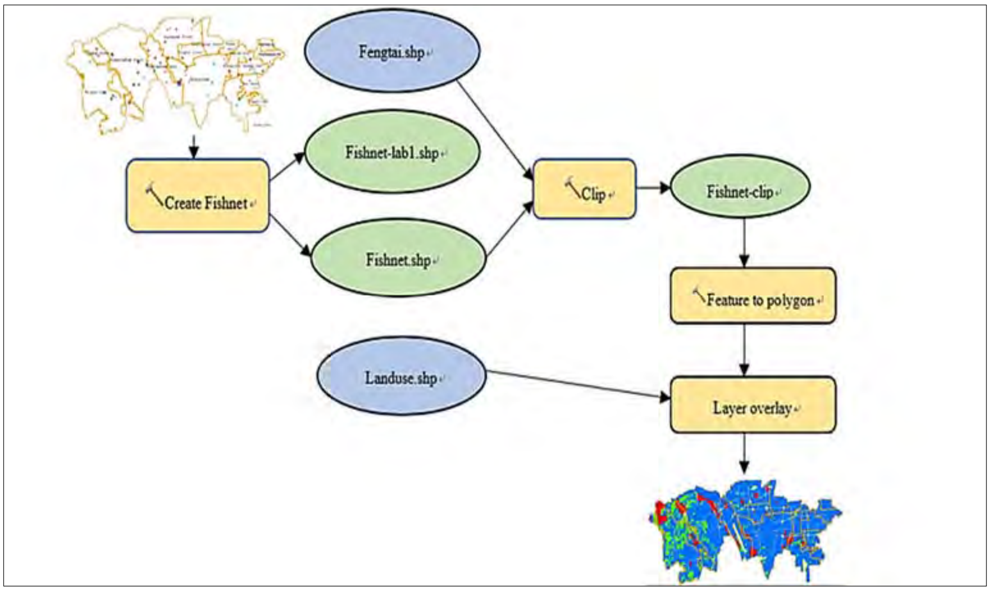

Fig. 4. Technological process of a risk-sensitive value

2.2.3. Method of environmental risk value

The risk expression proposed by the United Nations suggests that risk is a comprehensive measure of the likelihood of a hazard and the severity of the hazard that is as expressed by Eq. (10).

$$R = V * H \quad (10)$$

where H indicates the probability and intensity of the target's exposure to the risks, and V is the probability that the risks caused damage to the victim.

We refer to the DRI (disaster risk index) system and related literature on natural disaster risk, and we can obtain the environmental risks, including three elements, namely, environmental sensitivity, risk-causing factors, and vulnerability of environment, based on the assessment ideas presented (Li et al., 2010). Each aspect of the risk is indispensable, and the risk value can be expressed as follows (Eqs. 11-12)

$$RIR = V * HI * S \quad (11)$$

where RIR is the risk index; V, HI, and S are the environmental sensitivity, risk-causing factors, and environmental vulnerability, respectively.

$$RIR\left(x, y\right) = VI\left(x, y\right) * HI\left(x, y\right) \quad (12)$$

where VI (x, y) is the sensitive index of the point, and HI (x, y) is the risk index of the point.

2.3. Environmental risk zoning and classification

Environmental risk zoning is a sorting process of the relative size between regions and subregions and is the main means of regional environmental risk management. The results of the zoning can provide a scientific basis for the development of risk management strategies and adequate information for activities within regions.

Therefore, from the perspective of the degree of the impact of the risk sources, the environmental risk is divided into four levels. Moreover, from the viewpoint of regional management and control, identifying the type and characteristics of the environmental risk source is divided into eight levels. The specific levels are presented in Table 2. These levels can result in environmental risk degree classification. Risk management and control zoning of Fengtai District are performed with the support of GIS software.

3. Results and discussion

3.1. Result of regional risk analysis

The spatial hazard distribution of the entire region is obtained from the point representation to the surface simulation using 20 chemical risk sources, 28 water pollution sources, 65 atmospheric pollution sources, and 38 dangerous goods sources, in accordance with the evaluation and characterization methods demonstrated in Fig. 5.

In Fig. 5, the spatial analysis method of IDW interpolation is used to present the environmental risk index from point to surface to be continuous in space. In addition, when the color is deep, the environmental hazard is large. The environmental risk index of Fengtai District, Beijing mainly spreads out at different centers in the southwest and southeast (when the risk is high, the radius of the circle is large), and the area, where the circular areas intersect, is more dangerous than before. These findings represent a dangerous accumulation. From the spatial distribution, the most northeastern region and remote areas of Fengtai District are less affected by the high-risk areas. The risk of all samples is involved in the estimation of other unknown points because IDW interpolation is a spatial analysis of the entire region, thereby obtaining increasingly global and accurate simulation results. In summary, the environmental risk index of Fengtai District, Beijing has a trend of high in the east and low in the west.

The environmental risk of the chemical source and hazardous waste is high, but this finding does not indicate that the risk value of the air and the sewage pollution source are small. The type, size, and treatment of emissions are related. Thus, most studies on environmental risk assessment have focused on chemical risk and dangerous goods sources. Therefore, the relevant departments can be instructed to consider the risk of chemical and dangerous sources mainly in accordance with the situation when assessing the environmental risks of the regions.

3.2 Result of environmental risk sensitivity assessment

The distribution of environmental sensitivity of different plots in the entire region is obtained in accordance with Method 2.2 (Fig. 4) and the vector map of the status of land use in Fengtai District, and the receptor sensitivity is identified as follows:

Table 2. Environmental risk grading and partition table

Graded by risk source (four levels)	*Partition in accordance with risk source characteristics (eight levels)*
Low risk area	Low risk control area
Medium risk zone	Medium risk control area for chemicals
Medium–high risk zone	Medium risk control area for hazardous waste
High risk zone	Medium risk control area for the atmosphere
-	Medium–high risk control area for the atmosphere
-	Medium risk control area for sewage
-	Medium–high risk control area for sewage
-	High risk control area for sewage

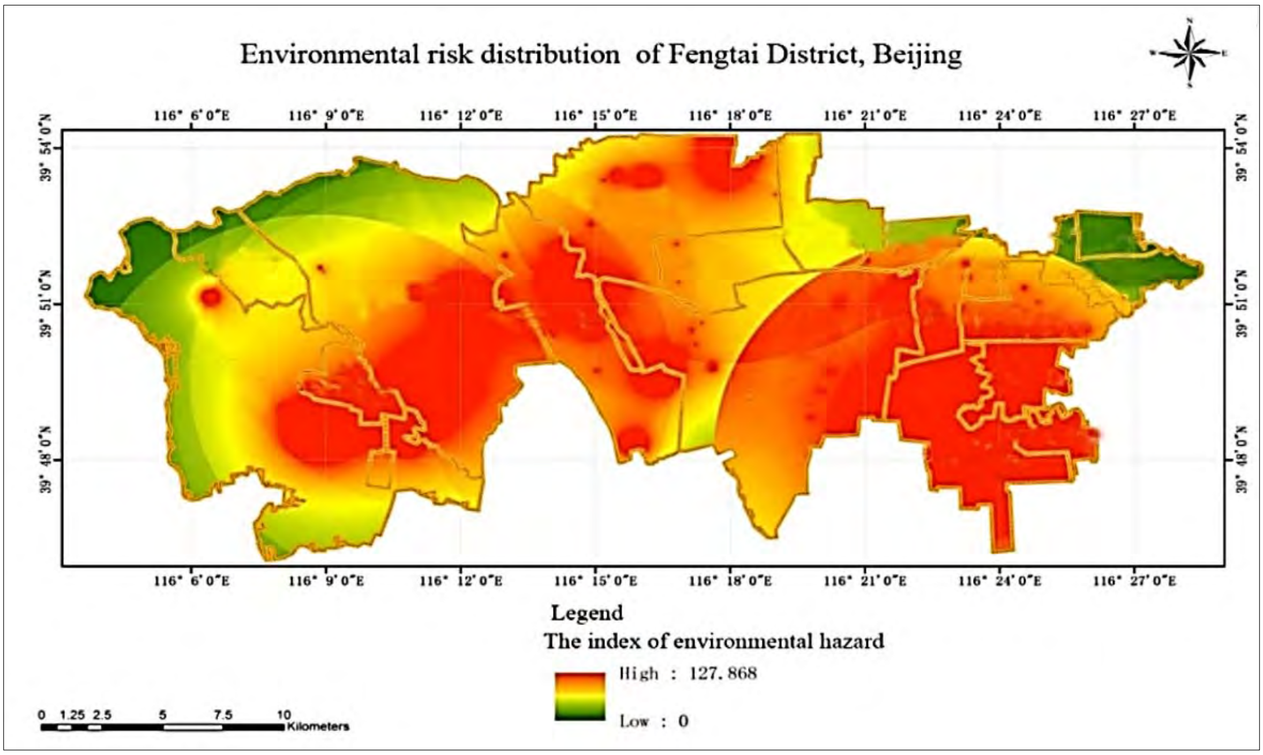

Fig. 5. Hazard distribution of risk source in Fengtai District, Beijing

Fig. 6 exhibits that the sensitivity values of environmental risk in Fengtai District are distributed in spatial blocks, which are divided into four grades. The index of environmental risk can be expressed in the form of pixels in the entire zone by overlaying the grid (1 km × 1 km) map layers based on the current vector map of land use, and the distribution trend and law of sensitivity values can be clearly plotted on a map. The map shows that most sensitive areas are living environments of people, whereas few sensitive areas include protected zones or protected areas of natural vegetation and are mostly concentrated in Western Fengtai District. Therefore, Fengtai District is impressible as an urban environmental system.

Therefore, when assessing the environmental risks generated by a single project, the residential area, surrounding nature reserves, and water sources, including distance, downwind, and other relevant factors, must be fully considered.

3.3 Result of environmental risk value

The characterization of environmental risk value must take into account the external risk sources and the internal acceptors of the environment. The chemical substances, water pollution sources, air pollution sources, and hazardous wastes and the cumulative situation of a single risk source at the same point are considered, as exhibited in Fig. 3. The spatial distribution of risk value is realized from calculating the risk value of samples to simulating any point (x, y). The distribution of the intrinsic receptor sensitivity values is obtained on the basis of the analysis of the current land use in the study area and the technique illustrated in Fig. 4. These layers are superimposed by the algorithm of Eq. (12). The distribution of environmental risk value is obtained as follows.

Fig. 7 demonstrated that the distribution of environmental risk values in Fengtai District, Beijing is spatial continuously, and the areas with high risk values are round distribution and radiation diffusion. The southeastern corner and the southwestern section of Fengtai District are the centers of the circles, and they diffuse outward with different radii. The regional environmental risk value of the intersection in zones of diffusion exogenous is also high, thereby reflecting the accumulation of small risks. The diffusion zone in the southeastern corner has the largest radius, thereby indicating that the risk value is high, and the area of environmental impact is large. In general, the environmental risk value in Fengtai District tends to be high in the east and low in the west and high in the center and low in the boundary; the situation is slightly better in the north than in the south. The method of layer overlay can visually show the distribution of the environmental risk value in a map with extensive considerations and high accuracy.

Fig. 7 illustrates that an environmental risk value is consistent with the hazard distribution of risk source. This method unifies the hazard value of the risk source itself and the sensitivity of the environment itself into an environmental risk value, as plotted on the graph. This method is different from the previous research methods of some researchers (Wang and Chen, 2015) but can reflect the distribution of environmental risk value.

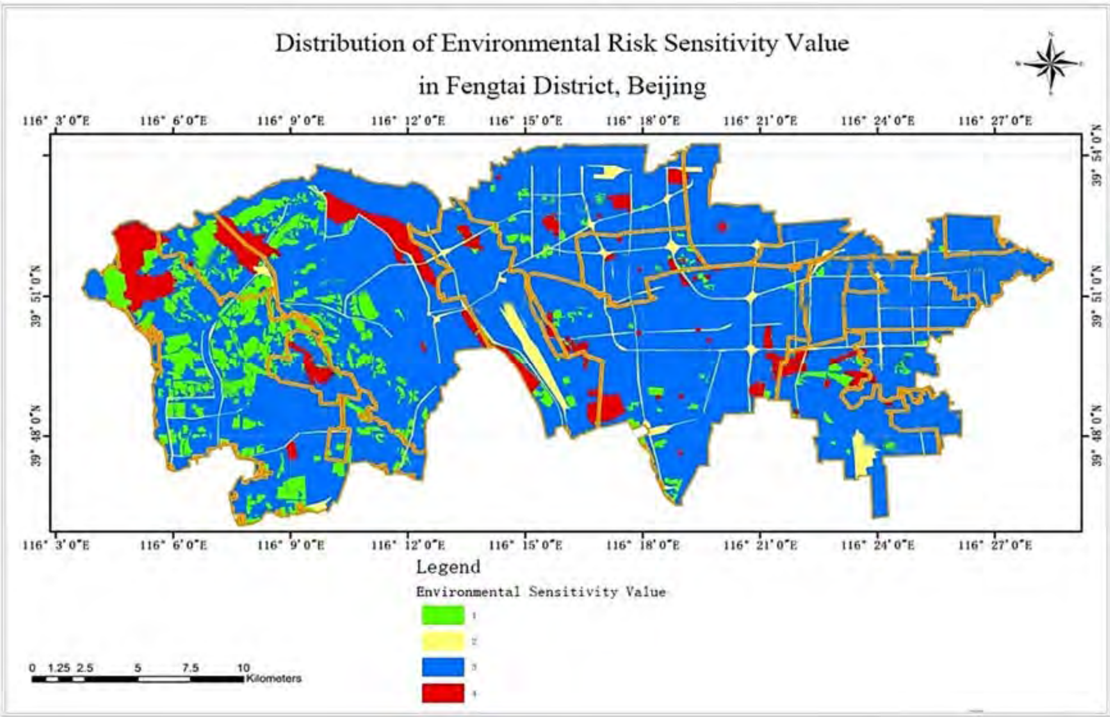

Fig. 6. Distribution of Environmental Risk Sensitivity Value in Fengtai District, Beijing

3.4 Result of risk classification

In accordance with the spatial distribution of the environmental risk values, combined with Method 2.3 of risk zoning pairs, the environmental risk zoning map can be obtained, as depicted in Fig. 8. The environmental risk is divided into four colors using the Layer Properties function of GIS based on the distribution of environmental risk value that represents different levels and risk areas, thereby causing the zoning to become increasingly intuitive and clear. Fig. 8 shows that the high risk areas have the continuity of outward diffusion with various radius circles in space, and the range of risk source radiation for diverse pollution types is different. The high risk areas are mainly distributed on both sides of Fengtai District, and the large areas are located in the southeastern corner. The medium risk region is distributed in a large range, and the low risk areas are scattered in an irregular fragment at the edge of Fengtai District that is mainly concentrated in the western region. Therefore, in the future, we will focus on pollution prevention and control in high risk areas, such as Southeast Fengtai District.

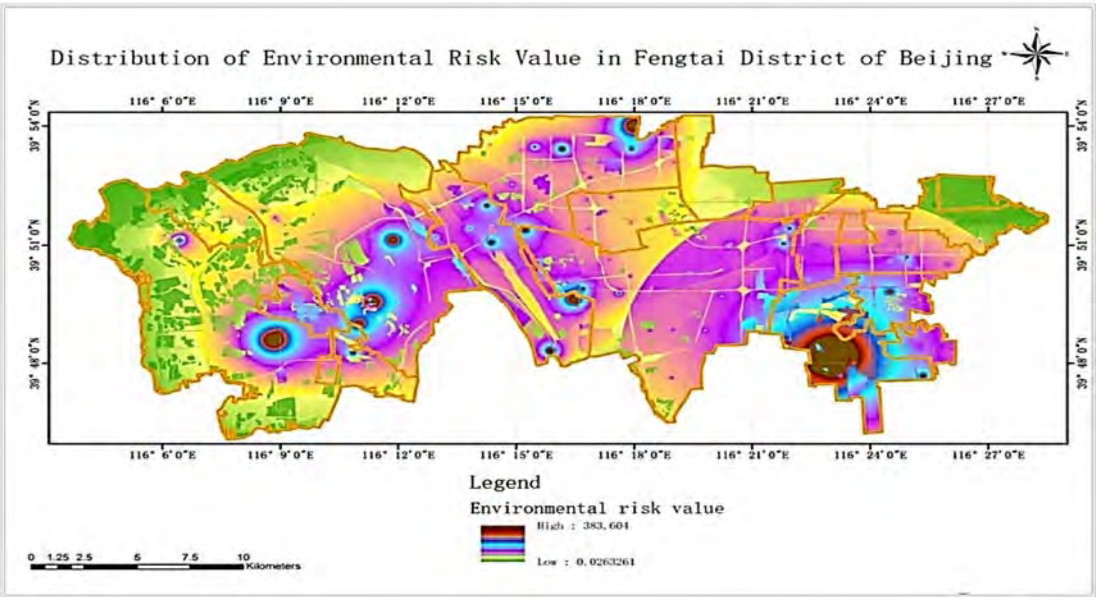

Fig. 7. Distribution of Environmental Risk Value in Fengtai District, Beijing

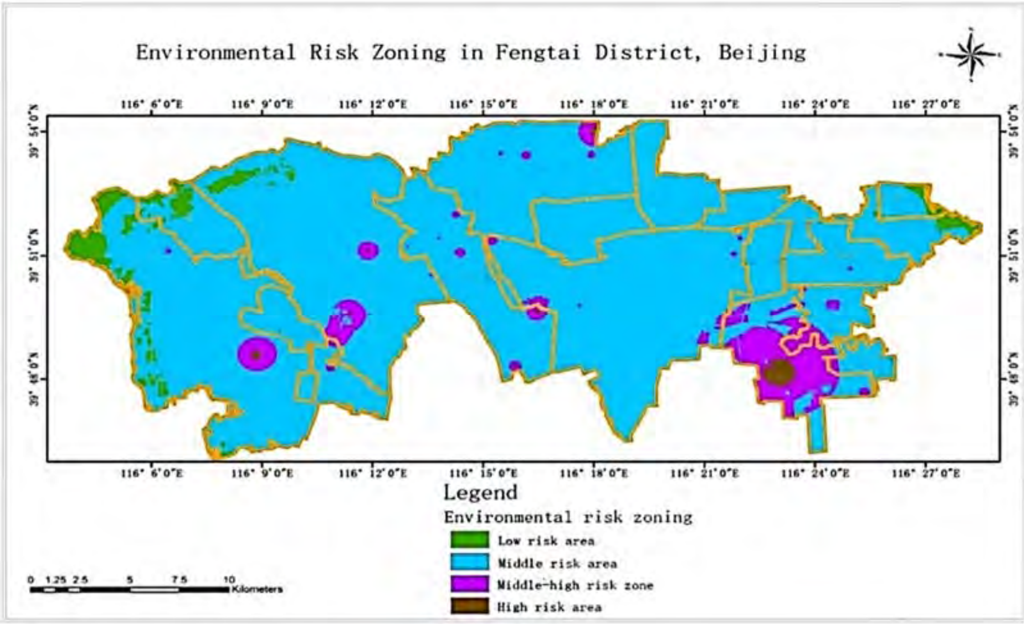

Fig. 8. Environmental risk zoning in Fengtai District, Beijing

Regardless of the division of district administration or street, environmental risk can be directly divided into four levels of environmental risk areas through the division of environmental risk value (Ge and Shang, 2018). This method can be realized using ArcGIS, and it is a solution for environmental risk zoning.

3.5 Spatial control of environmental risk

Fengtai District can be divided into blocks to control the environmental risk combined with the risk assessment in different characterizations of 3.1-3.4, as illustrated in Fig. 9.

From the viewpoint of regional management and control and on the basis of the environmental risk value, environmental risk management and control level is divided into eight levels using the Layer Properties function of GIS. The environmental risk control scheme (Fig. 9) is obtained after combining different colors with recognition to the type of pollution sources. Fig. 9. shows that the control areas do not only have block distribution in space but also circulars or intersecting distribution. Furthermore, the distribution rule is consistent with the characteristics of point distribution and diffusion law of different types of risk sources. For example, the southeast corner of Fengtai District has high risk value and sensitivity. Then, the types of pollution sources are identified; thus, it is a sewage high risk control zone. The distribution of environmental risk value indicates that the areas with a high environmental risk value are typically discharge points of sewage source.

In Fig. 9, the entire area is divided into 42 blocks. Different blocks indicate corresponding suggestions. For areas of low risk control, establishing and improving risk routines and regulations are proposed. For zones of risk control in chemicals and in hazardous wastes, the preparation of chemical emergency and online monitoring of the risk sources are planned. Setting strict emergency and supervision can reduce the occurrence of environmental events. For control zones of medium and medium-high risk in the atmosphere, the measures aim to control the total amount of smoke dust and nitrogen oxides while implementing online monitoring. For the medium and medium–high risk control areas in the sewage, online monitoring pollution while controlling the total volume of ammonia nitrogen, petroleum pollutants, and phosphorus in different blocks is recommended. For the high risk control zones of sewage, developing plans for risk emergency in sewage can avoid increased environmental losses. A control scheme similar to that corresponding to the block is increasingly operable. When dividing the area of environmental risk management, considering the subarea of streets can facilitate the supervision of managers to a certain extent and provide favorable decisions.

In comparison with the environmental risk assessment method of a single pollution source, this technique considers the point source accumulation. It does not only cover the single risk of chemical, atmospheric, sewage, and hazardous waste sources but also reflect the cumulative risks. In addition, the receptor sensitivity of the region in combination with the current land use situation is considered. Finally, the distribution of environmental risk can provide reasonable suggestions for future prevention and control of a region.

4. Conclusions

In the study, we have established a process of identifying and evaluating regional environmental risk sources (several different types) and environmental sensitive receptors, which consider the types and functions of land use.

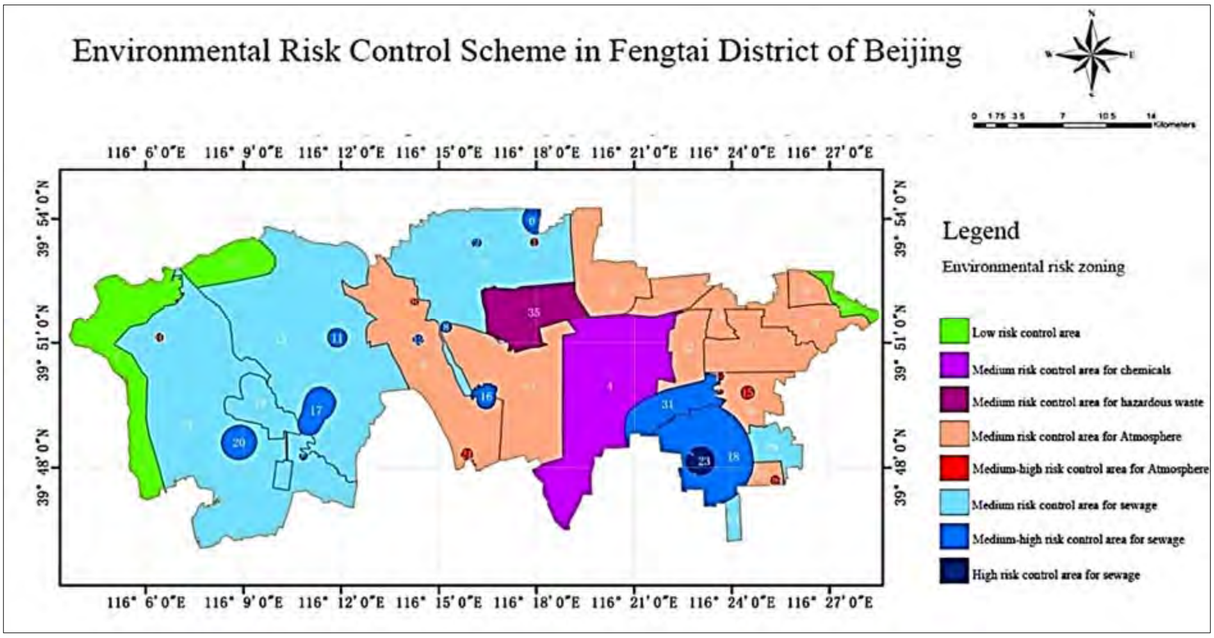

Fig. 9. Environmental Risk Control Scheme in Fengtai District, Beijing

On the basis of the analysis of risk sources, the environmental hazard index is rasterized, as reflected in the form of a pixel value in the raster layer, by integrating the data of different pollution sources and situations in the entire region through Arcgis spatial analysis.

In this study, risk index is combined with sensitivity scientifically by analyzing the risk degree and sensitivity model of different types of pollution. Therefore, the trend and regularity of regional environmental risk can be reflected on a map. In accordance with the distribution of environmental risk, suggestions on the construction of regional environmental risk prevention and control system are proposed from the regional perspective.

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