Construction of soil environment information management platform based on ArcGIS

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Abstract. With the development of industry and agriculture, the problem of soil environmental pollution is gradually exposed. Strengthening soil environmental management is an effective way to prevent and control pollution. Through consulting data and on-the-spot investigation, to identify and analyze the types of soil pollution in a certain area. To grasp the situation of soil pollution in this area preliminarily, and identify the degree of soil pollution and characteristic pollutants of soil risk sources through investigation of key pollution enterprises. At the same time, the technological process of chemical plant and coking plant as well as the discharge of the Three Wastes are analyzed. To find out the main pollution factors of the region and make an accurate evaluation of the pollution situation, use ArcGIS to analyze, basic framework of the construction of soil environment information management platform, provide the framework foundation for the construction of the platform, put forward reasonable suggestions for the regional soil restoration work, and provide scientific guidance for the prevention and control of soil pollution and the use of agricultural land in the region.

1. Pollution status
In recent years, China's industry, agriculture and cities have achieved better and faster development. At the same time, the development also brings about environmental problems. The heavy metals released by human beings are accumulated in the soil through various ways, which makes the soil environmental quality decline, thus affecting the quality and safety of plants and human health. Therefore, the research on the source, content, spatial distribution, soil environmental quality and risk assessment of soil pollutants has attracted more and more attention of the society and experts. In order to better manage the change of soil environment at home and abroad, corresponding soil information systems have been established [1].

Since the 1960s, more and more attention has been paid to the establishment and application of soil information system in the world. Many developed countries have successively established their own soil information system, while the development of developing countries in this area is relatively backward. The database structure established in each country is "customized" according to the professional field of system application and the characteristics of each region. China's soil information system (SIS) is relatively weak in foundation and backward in development, so soil scientists in China are facing more difficult tasks. The selected area of this study: Area A is an important fruit and vegetable production base and livestock breeding area, and also a national high-quality wheat production base. Therefore, the quality of soil environment directly affects the safety of agricultural products, and then affects the health of the people. On the other hand, the industrial base of area A is also very advantageous, mainly coal chemical industry and coking industry. This paper mainly investigates the soil pollution of the land used by three key industries enterprises, so as to obtain the
basic soil pollution of area A. In order to provide reference for the control and remediation of soil pollutants in the whole region, a small-scale soil information management platform was established by using GIS and other technical means from the perspective of enterprise pollution in the region.

1.1. Investigation on the risk sources of soil pollution near the chemical plant
The chemical plant, one of the research objects, is located in an industrial area, which mainly produces high-tech products such as veterinary antibiotics, organic trace element amino acid chelates, enramycin premixes, salinamycin premixes and so on. Antibiotics are produced by actinomycetes, bacteria, fungi and other microorganisms or chemically synthesized substances with the same or similar structure that can kill or inhibit pathogenic microorganisms. Since Alexander Fleming discovered penicillin in 1929, the use of antibiotics has become more and more popular. In particular, veterinary antibiotics are the most widely used and the largest amount of antibiotics, which account for more than 70% of the total amount of veterinary drugs. Microelement amino acid chelate is the third generation of microelement additive. Enramycin premixer is a kind of peptide antibiotic premixer. Its effective component is enramycin.

There are acid and alkali in the workshop of antibiotic extraction, which threaten the soil environment. Trace element additives will bring heavy metal pollution. In the preparation of enramycin premix, there will be some hazardous solid wastes such as antibiotic residue, which will bring biological pollution to the soil. Therefore, the soil characteristic pollutants of the risk source are inorganic acid and alkali, heavy metals and hazardous solid wastes.

1.2. Investigation on risk sources of soil pollution near coking plant
Another research object mainly produces coke, coal tar, crude benzene, gas and other chemical products. Meanwhile, there are 100,000 square meters nursery stock and flower cultivation base and Bioengineering Research Institute in the garden area. Polycyclic aromatic hydrocarbons (PAHs), aromatic organic compounds and hydrogen sulfide will be produced in the production process of coke and coal tar. There are certain risks in crude benzene production, and leakage may occur. The harm of gas production to soil is not significant. Therefore, the soil characteristic pollutants of the enterprise are mainly polycyclic aromatic hydrocarbons and aromatic organic compounds.

Based on the above analysis, the types of soil pollution in this area can be roughly divided into two types, namely inorganic pollution and organic pollution. Inorganic pollution mainly refers to heavy metal pollution. Many heavy metals, such as lead, arsenic and cadmium, are produced in chemical production. Organic pollution refers to the polycyclic aromatic hydrocarbons and aromatic organic compounds produced in the production process of chemical plants and coking plants.

2. Evaluation method
In view of the above conclusions, the evaluation methods selected in this study are mainly for the pollution evaluation methods of heavy metals, polycyclic aromatic hydrocarbons and aromatic organics.

2.1. Pollution assessment method of heavy metal elements
2.1.1. Single factor index method. Single factor index method is a method to evaluate the pollution status of crops or soil and the harm degree of pollutants. Generally, the measured value of heavy metal content is divided by the background value of soil. The smaller the pollution index is, the lighter the pollution degree of the element is given to the environment [3]. The calculation formula is as follows:

$$ P_i = \frac{C_i}{S_i} $$

(1)

P_i represents the single factor pollution index of the sampling point; C_i represents the test value of
heavy metals (mg / kg); $S_i$ represents the background value of heavy metals in the area (mg / kg). The classification standard of this method is shown in Table 1.

| Classification | $P_i$ | Pollution degree | Classification | $P_i$ | Pollution degree |
|----------------|------|-----------------|----------------|------|-----------------|
| 1              | $P_i<1$ | Alert           | 3              | $2<P_i<3$ | Moderate        |
| 2              | $1<P_i<2$ | Light          | 4              | $3<P_i$ | Severe          |

2.1.2 Nemero comprehensive pollution index method. When there are many kinds of heavy metal elements in the soil to produce pollution, in order to fully understand the real situation of soil pollution, the Nemero index can not only highlight the impact of heavy metal elements that contribute a lot to the pollution, but also evaluate the pollution level of different heavy metal elements to the soil environment as a whole. The calculation formula of Nemero comprehensive pollution index is as follows:

$$P_n = \sqrt{\frac{(P_i)^2 + (P_{i,\text{max}})^2}{2}}$$ (2)

In the formula, $P_n$ represents the Nemero pollution index of the mining area; $P_i$ represents the single factor pollution index of the sampling point; $P_{i,\text{max}}$ represents the largest Nemero pollution index of the sampling point. The classification standard of Nemero pollution index is shown in Table 2. From the factors that need to be referenced in the calculation process of Nemero's formula, this pollution index method can comprehensively reflect the pollution degree of pollutants in the soil environment by emphasizing the impact of high concentration pollutants on the soil environment quality [4].

| Classification | $P_n$ | Pollution degree | Pollution level | Classification | $P_n$ | Pollution degree | Pollution level |
|----------------|------|-----------------|-----------------|----------------|------|-----------------|-----------------|
| 1              | $P_n<0.7$ | Safe           | Clean           | 4              | $2<P_n<3$ | Moderate        | Obvious         |
| 2              | $0.7<P_n<1$ | Alert         | Still clean     | 5              | $3<P_n$ | Severe          | Serious         |
| 3              | $1<P_n<2$ | Light          | General         |                |       |                 |                 |

2.2 pollution assessment methods for toxic organic compounds
Polycyclic aromatic hydrocarbons (PAHs) have three effects of carcinogenesis, The environmental harmfulness of toxic organic pollutants depends on the toxicity and exposure level of organic toxicants. Figure 1 shows a general procedure for environmental risk assessment of organic toxicants.
3. Build information platform

3.1. Create soil information database
Download and load the location of the above-mentioned enterprises into ArcGIS 10.2 through the map, get a vector map of area a, and create a simple table database[5]. The created table is shown in Table 3 below.

| The number of Risk source | Latitude/° | Longitude/° | Altitude/m |
|---------------------------|------------|-------------|------------|
| 1                         | 36.084     | 111.405     | 470.333    |
| 2                         | 36.058     | 111.685     | 590.551    |
| 3                         | 36.160     | 111.480     | 479.868    |
| 4                         | 36.151     | 111.493     | 460.334    |
| 5                         | 36.021     | 111.460     | 448.136    |

3.2. Analysis of platform structure module
According to the analysis of platform requirements, the platform can be divided into five functional modules: data input module, data management module, soil pollution evaluation module, data query module and result output module. The structure diagram of system function module is shown in Figure 2.
After the above operation process, a small-scale soil information management platform is established. This small-scale soil environment information management platform includes the list of soil risk source enterprises, the specific geographical location of enterprises, the products produced and the soil characteristic pollutants produced. After the subsequent sampling and monitoring steps, the database of monitoring items and monitoring results can be added to the platform to enrich the platform data and better facilitate management[6]. The attributes of each risk source can be queried, updated and applied through the attribute table in this small platform. Update the data of the risk source by adding the data in the attribute table.

4. Conclusions and recommendations
The construction of soil information management platform in area A is a large project. First of all, we need to input the information and monitoring data to the database through the database module. In order to prevent data disorder and loss in the database, it is necessary to manage it scientifically and maintain the whole system in real time. In order to manage soil pollution scientifically, the platform needs evaluation and analysis module. The design of evaluation module can refer to single factor pollution index evaluation method, Nemero comprehensive index evaluation method and address accumulation index method. Through the evaluation of the platform, the pollution status of pollution factors can be accurately obtained, so as to provide scientific basis for pollution control. In order to make full use of the platform, all attributes can be queried in real time, which requires the establishment of data query module. After the periodic statistics of the pollution situation, the corresponding spatial pollution changes in each time period can be intuitively obtained. It can not only output spatial data, but also print out the corresponding map, making the result more intuitive.

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