ISSN: 2688-9323

Analysis of Assessment Methods of Heavy Metal Pollution in Soil

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Abstract

At present, soil heavy metal pollution is becoming more and more serious due to various kinds of pollution. In this paper, the present soil heavy metal pollution is serious, and heavy metal pollution is not only harmful to the ecological environment, but more importantly to human health. The common assessment methods of soil heavy metal pollution were summarized, and their advantages and disadvantages and applicability were analyzed.

Keywords

Soil; Heavy Metals; Pollution; Evaluation Method; Analysis.

1. Introduction

Soil pollution has become a very serious environmental problem in China. Among them, heavy metal pollution has been widely concerned because it is not naturally degraded, easy to accumulate and toxic to organisms [1]. At present, there are many evaluation methods for soil heavy metal pollution, and each method has different results. This paper intends to analyze the evaluation methods of soil heavy metal pollution in order to provide reference for evaluation of soil heavy metal pollution.

2. Evaluation Method and Standard of Soil Heavy Metal Pollution

2.1. Single Factor Pollution Index Method

Single factor pollution index method is the most commonly used evaluation method [2]. The background value or standard limit value of a pollutant in soil is used as an evaluation index to measure the cumulative pollution degree of pollutants [3-4]. The specific calculation method is as follows:

$$P_i = \frac{C_i}{S_i} \quad (1)$$

Type,$P_i$is the heavy metal pollution index in soil;C_i is the measured value of heavy metals in soil (mg/kg); S_i is the standard value of heavy metals in soil (mg/kg) [5]. The evaluation criteria are: $P_i < 1$ is no pollution; $1 \leq P_i < 2$ is minor pollution; $2 \leq P_i < 3$ moderate pollution; $P_i \geq 3$ is severe pollution [5,6].

2.2. Potential Ecological Hazard Index Method

Potential ecological hazard index method has been widely used in water area ecological risk analysis and soil ecological hazard analysis. The specific calculation method is as follows:

$$E_i = T_i \frac{C_i}{S_i} \quad (2)$$

Type, $E_i$is potential ecological damage index;$T_i$is the toxicity response coefficient of heavy metals, the value is 2 [7]; C_i is the measured value of heavy metals in soil (mg/kg);S_i is the standard value of heavy metals in soil (mg/kg) [5]. The evaluation criteria are:$E_i < 40$ is slight

ISSN: 2688-9323

hazard; $40 \leq E_i < 80$ is medium hazard; $80 \leq E_i < 160$ is strong harm; $160 \leq E_i < 320$ is a very strong hazard; $E_i \geq 320$ is extremely harmful [7].

2.3. Ground Accumulation Index Method

Ground accumulation index method is widely used in the evaluation of heavy metal pollution in sediments and soil [8], the specific calculation method is as follows:

$$I_{geo} = \log_2 \frac{C_i}{KB_i} \tag{3}$$

Type, I_{geo} is accumulate pollution index; C_i is the measured concentration of heavy metal i in soil; K is the coefficient representing the changes of background values affected by rock geology and sedimentary characteristics (general K=1.5). B_i is the geochemical background value of heavy metal i in soil. The evaluation criteria are: $I_{geo} \leq 0$ is no pollution, $0 < I_{geo} \leq 1$ is no - moderate pollution, $1 < I_{geo} \leq 2$ is moderate pollution, $2 < I_{geo}$ 3 is moderate - strong pollution, $3 < I_{geo} \leq 4$ is strong pollution, $4 < I_{geo} \leq 5$ is strong - extremely strong pollution, $5 < I_{geo}$ is extremely strong pollution.

2.4. Model Exponential Method

Model exponential method includes fuzzy mathematics method and grey clustering method.

Fuzzy mathematics is an effective method to solve the fuzzy boundary problem of soil heavy metal pollution levels [9], later has been widely applied in environmental studies. Based on the measured values and the pollution of heavy metal element classification indexes, the ambiguity between the determined by first calculate the relative membership degree of single heavy metal elements in pollution belongs to grade level, and then calculated and determined by the weight of each element in the overall pollution of heavy metals share, finally the fuzzy matrix composite operation, it is concluded that pollution levels [10].

Grey clustering method is developed on the basis of fuzzy mathematics, but compared with its weight treatment, it is more objective and reasonable. This method constructs the whitening function, introduces the correction coefficient, determines the weight of pollutants, and finally calculates the clustering coefficient for evaluation. Specific models and evaluation procedures can be referred to relevant studies [11].

3. Analysis of Heavy Metal Pollution Assessment Methods in Soil

3.1. Single Factor Pollution Index Method

The single factor pollution index method can reflect the pollution degree of each evaluation factor, and facilitate the comparative analysis of each pollution factor, so as to quickly judge the main pollution factors of soil environment. It is mainly used for the evaluation of specific area polluted by single factor. Advantages: This method has clear objectives and is easy to operate, but in practice, the soil environment of a certain region is often the result of the joint action of multiple factors [12].

3.2. Potential Ecological Hazard Index Method

The potential ecological hazard index method comprehensively considers the heavy metal content, biological toxicity differences of various elements and their addition effects, and the determination of weight and heavy metal toxicity response coefficient in the calculation process is subjective. Advantages: It can not only reflect the potential impact of various heavy metals on the ecological environment, but also reflect the different contribution rate of each heavy metal to it.

ISSN: 2688-9323

3.3. Ground Accumulation Index Method

In addition to anthropogenic pollution factors and environmental geochemical background values, the geocumulative pollution index method also takes into account changes in background values that may be caused by natural diagenesis [13]. Disadvantages: this method ignores the different pollution capacity and bioavailability of various metals as well as the geographical and spatial differences, so it is unable to carry out the comparative analysis of inter-element and inter-regional soil heavy metal pollution degree.

3.4. Model Exponential Method

The specific model and evaluation procedure of fuzzy mathematics method, in the application process of fuzzy mathematics method, the determination of the weight of each index is the key link; The weight of grey clustering method is usually calculated by the weight method of excessive concentration, ignoring the biological toxicity of pollutants. Finally, the clustering coefficient was classified according to the maximum value, and the correlation between the clustering coefficient and the clustering coefficient of the lower level is ignored.

4. Conclusion

Single factor pollution index method, potential ecological harm index method and ground accumulation index method are relatively simple and easy to master, but they ignore the complexity, gradual change and ambiguity of soil heavy metal pollution, and cannot be comprehensively and objectively evaluated. However, the model index method comprehensively considers the grayness of soil system and the fuzziness of quality change, making up for the deficiency of the general index method. However, the evaluation process is complicated, the operation is complex, and the weight determination is subjective. Therefore, the selection of evaluation methods of soil heavy metal pollution should be combined with the specific selection of evaluation focus.

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