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# Soil Heavy Metal Pollution in the soil of Railway Traffic: a Mini-review

**Chen Jiasheng[1], Li Tingting[2], Wang Lin[1,2]***

*[1] Miami College of Henan University, Kaifeng, 475002, China*
*[2] School of Environment and Planning, Henan University, Kaifeng, 475002, China*
**Corresponding Author*

***ABSTRACT.*** *The problem of heavy metal pollution is a hot issue widely at home and abroad, and the heavy metal residues in food is also getting more and more attention. In recent years, with the continuous development of China's economy, railway transportation has also developed into one of the main land transportation modes. The dense railway network communicates with the north and the south, making it convenient for people to travel and transport goods. But while creating convenience, environmental problems brought about by the operation of the railway have gradually attracted people's attention. One of the main environmental problems brought about by railway transportation is the heavy metal pollution of the soil along the railway, and it has great ecological potential risks. This paper discusses the sources of heavy metals in the soil along both sides of the railway in China using the existing literature, summarizes the impacts and potential ecological risks, and provides suggestions for remediation of heavy metal pollution in soil.*

***KEYWORDS:*** *soil beside the railway traffic, heavy metals, pollution remediation*

## 1. Introduction

As the base of biological survival and development, soil conservation has been paid close attention to as the space on which human beings depend for survival. The soil system is the basic structural unit of the biosphere, which is polluted by heavy metals and may also have serious effects on the atmosphere and water environment, and ultimately endangers human health through circulation and food chain enrichment. Therefore, it is of great significance to carry out the research and detection of heavy metals in soil on both sides of the railway.

As one of the main modes of land transportation in China, railway transportation has been widely used. In recent years, the study on the environmental impact of China's road traffic has been gradually deepened, but the research on the environmental pollution caused by railway sits is scarce. Compared to road transport, rail transport releases less dust to the environment and no tire wear[1-2], while

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friction between wheels and rails, vehicle maintenance and improper disposal during the transport of certain substances can result in heavy metal contamination in the soil[3-8]. We will analyze the harmful and influence of heavy metals in the soil on both sides of the railway line, and provide a theoretical basis for the railway construction, and the rational use of land on both sides of the railway.

## 2. The heavy metal contamination of soil in China

Soil heavy metals are mainly referred to the relative density of 50 or more than metal elements such as Cd, Cr, Ni, Cu, Zn, Pb, etc. In general, soil heavy metal pollution is referred to the heavy metal content of soil due to human activities caused soil heavy metal content in the soil is significantly higher than the original content, and caused ecological quality deterioration phenomenon[9].

Heavy metal elements in soil are mainly natural sources and artificial interference input two ways[10]. Among natural factors, the soil-forming mother matter and soil-forming process have a great influence on the soil heavy metal contents[11]. Among all kinds of man-made factors, heavy metal pollution is caused mainly by industrial, agricultural and transportation sources. Zhu et al[12] investigated the heavy metal content of soil in the top-polluted irrigation area of Xinxiang City, Henan Province, and found that the contents of Cd, Ni, Zn and Cu in the soil were seriously exceeded. Song et al[13] analysed of 138 typical regional soil pollution cases, showing that the probability of heavy metal pollution in China's cultivated soil was 16.67%, the proportion of China's cultivated soil contaminated by heavy metals accounted for about 1/6 of the total amount of cultivated land, of which heavy metal pollution of cultivated land in Liaoning and Shanxi might be particularly serious. Liu et al[14] researched the current situation and causes of soil heavy metal pollution in Suzhou agricultural products, found that there were serious heavy metal pollution in the soil of Suzhou agricultural products, farmland soil pollution area reached 1000 $km^2$.

The threat of heavy metal pollution is that it can not be degraded by microorganisms, in the surface environment has cumulative[15], can be absorbed by crops, resulting in metabolic disorders, affecting growth and development or distortion mutation. So through the food chain, heavy metals easily pose a serious threat to plants, animals and human bodies, the ecological environment and human health. Cadmium is one of the more common heavy metal pollutants in soil, is a non-essential element of human body, animal and plant, but it is very important for metallurgy, plastics, electronics and other industries. It can seriously harm plant and human health, and has the characteristics of long-term, hidden and irreversible[16]. Liu et al[17] studied that when the soil contains 0.43 mg/kg soluble cadmium, the rice yield was reduced by 10%, and when the content reaches 8.1 mg/kg, the rice yield decreased, and stakes reached 25%. The "pain disease" that occurred in Japan in the 1960s was caused by the consumption of rice containing cadmium in the local population[18]. Cui et al[19] researched cadmium in the soil-plant-human system migration accumulation could cause damage to bones, liver, kidneys, immune system, and induce a variety of cancers.

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In recent years, heavy metal pollution incidents in China are frequent, such as in 2005, Guangdong, Beijiang, and Yuguan section of the cadmium serious exceeding the standard event. In 2006, Xiangjiang, Hunan, Zhuzhou section of cadmium pollution accident. In 2009, Fengxiang County of Shaanxi Province, hundreds of children blood lead exceeded the standard. In 2011, Yunnan Qujing chromium pollution incident was happened[20].

In general, soil heavy metal pollution is harmful to the environment as well as to human production and life[21-26]. Therefore, we need to understand and find solutions to the sources of heavy metal pollution that can cause soil heavy metal pollution.

## 3. Impact of railway traffic on soil heavy metal pollution

### *3.1. The link between railway traffic and heavy metal pollution in soil*

The distribution characteristics of railway land is "belt" due to railway land with the railway in all aspects. They are layout mainly, cross-provincial, city, cross-border, crisscrossing, occupy a wide area, covers a wide range of types, both rural and urban, across the provincial boundaries, city boundaries, county boundaries without restrictions[27]. As one of the sources of heavy metal pollution, the friction between the wheels and the tracks, the maintenance of vehicles and the improper disposal of certain substances in the transport process will cause heavy metal pollution in the soil[28]. According to “the National Bulletin of soil pollution survey” published in China in 2014, the 1,578 soil sites on both sides of the 267 trunk roads were surveyed, 20.3% were over-standard, with the main pollutants being lead, zinc, arsenic and polycyclic aromatic hydrocarbons, generally concentrated within 150 meters of the road[29]. Cai et al[30] studied the distribution law and pollution characteristics of farmland soil on both sides of a characteristic section of Shanghai-Kunming expressway and Gui-Huang high-speed, and the comprehensive potential risk index, the results showed the transition from intensity risk to moderate risk in the range of 10-15m on the side of the road. Road traffic and railway traffic have a strong commonality, so these data can also reflect the soil heavy metal pollution on both sides of the railway. In the study, Guo et al[31] pointed out that the heavy metal content in the soil on both sides of the highway was greatly influenced by traffic flow, terrain, climate and meteorological factors, which would also greatly affect the heavy metal content of the soil on both sides of the railway. Lu et al[32] studied the distribution of heavy metals in the Qinghai-Tibet railway construction section and the soil on both sides of the construction section, and the results showed that the soil heavy metal content on both sides of the railway built in the operation section was obviously regularly distributed, and the mercury and lead content were significantly higher than in the construction section, indicating that railway traffic had an important influence on the soil heavy metal content on both sides of the railway. Ma et al[7] studied the South Side Railway of the Zhengzhou-Putian section of the Bohai Railway, and found that the impact of heavy metal pollution on both sides of the railway traffic was more than ten times

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greater than that of road traffic. Mei et al[33] studied a section of coal transport railway in a mining area of Huaibei, and compared the heavy metal content next to the coal transport railway with the first-level natural background value of China's soil quality environmental standard (GB-15618-1995) [34]and the soil background value of Anhui Province, and the results showed that the first-level natural background value of cu and Cd elements were more than twice the background value of Anhui Province.

### *3.2. Potential ecological hazards of heavy metal pollution in soil along the railway lines*

Since the wide range of railway sand, the variety of land types, so the railway traffic is more likely to cause pollution to the soil along the way, and pollution is cumulative long-term and is a potential ecological hazard.

Heavy metal pollution elements in the soil along the railway mainly include Ni, Cd, Pb, Cu, Zn and Cr[35], according to the characteristics of heavy metals and environmental behavior, Hakanson proposed a potential ecological hazard index method from the sedimentary point of view to evaluate heavy metal pollution in soil[36]. As one of the advanced methods of heavy metal pollution research in soil in the world[37], the potential ecological index method can not only reflect the effects of various pollutants in a particular environment, but also reflect the combined effects of various pollutants, and divide the potential hazard level by quantitative method, which is one of the most widely used methods in the research of the project[38]. Wang et al[39] by using artificial neural network method studied six different railway lines in Japan, and found that the ecological risk level of the six lines was high, and their comprehensive cancer risk index exceeded 5.0 x 10-5, and the soil heavy metals along the railway line had a more serious risk of cancer.

### *3.3. Treatment of soil heavy metal pollution along railway lines*

Because of the potential, irreversibility and long-term characteristics of soil heavy metal pollution, the prevention and control of heavy metal pollution in soil should be based on the basis of prevention and control. At present, some work has been carried out in the field of soil heavy metal pollution remediation, which is not particularly lacking in soil heavy metal pollution remediation along the railway line, but we can get inspiration from other soil types of heavy metal pollution control research. For example, the soil heavy metal pollution control on both sides of the highway can use the method of agricultural control methods. The contaminated areas on both sides of the road can be planted many trees, flowers, grass or cash crops such as castor, or ornamental trees etc. Not only can beautify the environment, in arid areas can also play a role in wind and sand. In the clean sand, while purifying the soil, cash crops such as castor can also be used as a raw material for soap, increasing the income of local farmers[40]. Chen et al[41] have discovered the world's first arsenic-rich plant in mainland China, the weeds, and developed a complete set of plant restoration techniques. Wu et al made a major breakthrough in

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the joint plant-chemical restoration of heavy metal-contaminated farmland soil by using Cd and Zn's ultra-rich plants, lime, calcium phosphate and waste calcium carbonate[42-44]. Due to railway traffic has the characteristics of covering a wide area, ribbon distribution, a certain range of high safety alert, for the soil heavy metal pollution prevention and control of other methods such as engineering control methods, biological control methods, chemical control methods and so on, should go through a large number of researches.

## 4. Conclusion

By analyzing the published literatures, we conclude that: (1) Railway traffic is an important source of heavy metal pollution in soil along the railway, and its pollution impact range is much larger than that of road traffic; (2) China's railway has a wide distribution range, rich land types, and railway traffic. The resulting heavy metal pollution will have an adverse impact on people's production and life and the surrounding ecological environment; (3) At present, there is little research on heavy metal pollution in soil along the railway, and there is also a lack of domestic research on the treatment of heavy metal pollution in soil along the railway ; (4) From the treatment of heavy metals in the soil along the highway, we can get some suggestions on the treatment of heavy metals in the soil along the railway.

Therefore, we should carry out more investigation and discussion on the maximum impact range and distribution of heavy metals in soil along railway traffic, and carry out research on the treatment methods of heavy metal pollution in soil along railway lines in the future, which will play an important role in the remediation, planning, soil remediation and protection of the surrounding environment of the railway.

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