Study on Impacts of Mining Development in Wanjiang City Belt on Urban and Rural Environment

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Abstract: This paper made a general introduction to the industrial and agricultural production, population and physical geography in the Wanjiang City Belt (hereinafter referred to as the Belt) and analyzed the regularity of ore formation, the distribution and characteristics of mineral resources and the status of mining development in the Belt. Besides, it studied the impact of mining development on urban and rural environment of the region, namely damage to soil resources, surface landscape and groundwater, geological disasters, hazards of mine waste water and residues and other types of plant-related pollution. It also put forward specific countermeasures for environmental problems arising from mining development in the Belt from the perspectives of rule by law & management and technology & economy. In addition, it introduced soil pollution in urban and rural areas of the region and ideas and methods for soil environmental governance, taking the Tongling region for example.

1. Introduction
The Plan of Industrial Transfer Demonstration Zone in the Wanjiang City Belt (hereinafter referred to as the Plan) was approved by the State Council on January 12, 2010. The zone includes eight prefecture-level cities including Hefei, Wuhu, Ma'anshan, Anqing, Chuzhou, Chizhou, Tongling, Xuancheng and Liu'an, with a soil area of 76,000 km² accounting for over half of the soil in the whole province. The statistical population in the zone reached 31.0489 million at the end of 2015, accounting for 44.68% of the total population of the province. Its total output value reached RMB 1.4948 trillion in the same year, accounting for 67.93% of that of the province. The GDP of the Belt increased at an average rate of up to 21.59% from 2005 to 2015. It is one of the regions with the fastest development in Anhui Province [1].

2. Agricultural production and land use in the region
The Wanjiang City Belt, located in the middle and lower reaches of the Yangtze River (MLYR) plain, has been a land of plenty with developed water system and fertile soil since ancient times. According to the Plan, there are six prioritized pillar industries in the industrial transfer demonstration zone, namely textile industry, equipment manufacturing industry, high-tech industry, raw material industry, modern service industry and modern agriculture.

Agriculture makes up a large proportion in the industry of the Belt according to the existing data. The planting areas of jute, ambary, rice, wheat, beans, cotton, aquaculture and low-mountain economic crops in Anhui are mostly concentrated here. The economic value of the agricultural industry is quite significant. Agricultural and forestry land use: The agricultural land in the Belt covers a total area of
4,427,924.82 hectares, including cultivated land, woodland and grassland, accounting for 70.86% of the total soil area of the Belt. Construction land: The construction land in the Belt covers an area of 1,043,423.55 hectares, including town, village and mine land and land for transportation and water conservancy, accounting for 16.7% of the total area of the Belt.

Anhui Province has formed production, processing and supply bases for rice, rape, cotton, vegetables and tea which are mainly concentrated in the industrial transfer demonstration zone. It is one of the key provinces in collective forest areas in South China, with a large proportion of forestry. It has a forestry land area of 4,431,800 hectares, a forest area of 3,804,200 hectares and a forest coverage rate of 26.53%. Chizhou and Xuancheng have a higher forest coverage rate, more than 50%. The forest coverage rates of Tongling, Anqing and Lu'an all exceed 30% [2].

Current situation of planting and forestry development in Wanjiang city belt

| Areas   | Rice    | Grain  | Cotton | Rapeseed | Vegetables | Garden fruit | Tea   |
|---------|---------|--------|--------|----------|------------|--------------|-------|
| Hefei   | 3213412 | 3129855| 35520  | 176915   | 1595130    | 142444       | 1240  |
| Wuhu    | 1420216 | 1359250| 54445  | 142694   | 1191605    | 38214        | 2434  |
| Ma'anshan| 1070448 | 1038383| 16654  | 94832    | 647211     | 21558        | 335   |
| Tongling| 160991  | 156036 | 5385   | 20475    | 102467     | 4566         | 95    |
| Anqing  | 2675744 | 2583194| 102069 | 262922   | 1446507    | 29206        | 8710  |
| Chizhou | 694496  | 677869 | 31152  | 85303    | 335384     | 6178         | 5772  |
| Chuzhou | 4404865 | 4248255| 10148  | 109630   | 1331467    | 67374        | 474   |
| Xuancheng| 1378312 | 1309990| 13815  | 97345    | 701455     | 38290        | 26463 |
| Lu'an   | 4758980 | 4648084| 16380  | 124266   | 1302363    | 47514        | 16444 |

Data source: revised according to the statistical yearbook of Anhui Province in 2013

3. Distribution and development status of mineral resources in the region

3.1. Regularity of ore formation in the region
The metallogenic belt in the middle and lower reaches of the Yangtze River is an important one in eastern China, spanning Hubei, Jiangxi, Anhui and Jiangsu successively, with a total area of about 10.8×104 km2. The complete metallogenic belt is distributed in the southwest-northeast direction and can be further divided into three southern, northern and middle sub-bands. The middle sub-band located in the Wanjiang City Belt is the main part of the metallogenic belt in the middle and lower reaches of the Yangtze River, which concentrates the main copper, iron, pyrite, gold, silver, lead and zinc deposits in the region [3]. See Fig.1.
3.2. Distribution of mineral resources in Anhui Province and cities along the Wanjiang City Belt

Anhui is rich in mineral reserves with a wide range and the reserves can be roughly classified into non-ferrous metal, energy, ferrous metal and precious metal minerals, minerals of rare and dispersed elements, minerals for metallurgical auxiliary raw materials, non-metallic minerals for chemical raw materials and minerals for building materials. Among them, ferrous metal minerals mostly occur in Ma'anshan, Lujiang and Chizhou, etc.; most non-ferrous metal minerals occur in Anqing, Tongling and Chizhou, etc. and most precious metal minerals in Tongling, Wuhu, Huangshan and other areas; minerals of rare and dispersed elements mostly occur in Anqing, Tongling, Hefei, Huangshan and other areas [4]. See Table 2 for details of the classification and distribution of mineral resources in Anhui.

| Serial number | Mineral Category                                      | Main Distribution Area                                      |
|---------------|------------------------------------------------------|-------------------------------------------------------------|
| 1             | Energy Minerals Resources                            | Surrounding areas of Huainan, Huaibei, Suzhou and Hefei      |
| 2             | Ferrous Metal Resources                              | Ma'anshan, Lujiang, Lu'an, Chizhou, Xuancheng, Qianshan, Huangshan |
| 3             | Nonferrous-metallic Mineral Resources                | Lu'an, Hefei, Tongling, Chizhou                              |
| 4             | Precious-metallic Mineral Resources                  | Hefei, Tongling, Wuhu, Huangshan                            |
| 5             | Rare Metals and Disperse Element Mineral Resources   | Qianshan, Tongling, Hefei, Huangshan                        |
| 6             | Metallurgical Auxiliary Material Resources           | Hefei, Lu'an, Chizhou, Chuzhou, Xuancheng, Suzhou            |
| 7             | Nonmetallic Mineral Resources for Chemical Raw Materials | Chuzhou, Xuancheng, Hefei, Wuhu, Tongling                 |
| 8             | Nonmetallic Mineral Resources for Building Materials | Anqing, Xuancheng, Chuzhou, Hefei, Chizhou, Maanshan, Tongling |

Note: it is revised according to the annual report of mineral resources of Anhui Province (2013) issued by the Department of land and resources of Anhui Province
3.3. Overview of mineral development in the region

According to Table 2, a large number of metal smelting and processing enterprises have emerged near the Yangtze River, such as Ma’anshan Iron and Steel Co., Ltd., Hefei Iron and Steel Co., Ltd., Tongling Nonferrous Metals Group Co., Ltd., Wuhu Iron and Steel Plant, Hefei Aluminum Plant, Wuhu Smelting Plant and other key enterprises. They have made great contributions to the economic and social development of the region by great development therein. Ma’anshan, also known as the Steel City, and Tongling, also known as Copper Capital, are cities built for mining. Mining development plays an extremely important role in the region and occupies an important position in the mining field of Anhui Province [5] [6]. Table 3 shows the mineral development in cities along the Wanjiang City Belt

| Areas           | Area for mining/ hm² | Area for Administrative Region / hm² | distribution ratio /% |
|-----------------|----------------------|--------------------------------------|-----------------------|
| Anhui Province  | 16787                | 14014119                             | 1.2                   |
| Chizhou         | 173                  | 839872                               | 0.21                  |
| Tongling        | 620                  | 105844                               | 5.85                  |
| Chuzhou         | 710                  | 1351733                              | 0.53                  |
| Ma’anshan       | 1234                 | 406452                               | 3.04                  |
| Hefei           | 1571                 | 1142968                              | 1.37                  |
| Wuhu            | 1630                 | 602605                               | 2.71                  |
| Xuancheng       | 1636                 | 1231255                              | 1.33                  |
| Anqing          | 1687                 | 1540212                              | 1.1                   |
| Lu’an           | 1771                 | 1839917                              | 0.96                  |

Note: according to Anhui Provincial Department of land and resources "Anhui Province mineral resources reserves evaluation data (2013)" revised

4. Impact of mining development on urban and rural environment of the region

Mining development has made an outstanding contribution to the economic development of the region, but it also has a great adverse impact on the ecological environment of the region, mainly as follows:

4.1. Damage to soil resources

Mining and smelting mineral resources will inevitably produce non-reusable slag and waste soil. A large number of farmland, forest land and construction land will be occupied for the arrangement of such waste. The mining process will also destroy geological strata and mountain structure, inducing disasters such as ground collapse and debris flow. All these will damage soil resources to varying degrees.

4.2. Geological disasters

Mining development often induces urban and rural geological disasters such as landslides, mudslides and collapses.

4.3. Damage to groundwater

The breaking of balance of local aquifers caused by the drainage of groundwater in mining areas
during mining activities will lead to the decline of the local groundwater level and make the groundwater near mining areas dry up gradually, resulting in the insufficient irrigation of the farmland and even affecting the normal domestic water of nearby villagers.

4.4. Hazards of mine waste water and residues
A large amount of waste water will be produced in the process of mineral dressing in many non-ferrous metal mines. The mining field itself will have a large amount of waste water generated. However, such waste water and materials produced will generally be discharged into nearby natural water bodies without thorough purification or only with simple and incomplete purification, causing great damage to the downstream rural and urban water and soil environment.

4.5. Plants related to mining development also produce other types of pollution to a certain extent.
For example, smelting plants, iron and steel plants and metal processing plants will also produce a large amount of waste water, sewage, waste gas and waste residues, etc., which will damage the urban and rural environment in the region to a certain extent [7] [8].

5. Specific countermeasures for environmental problems in mining development in the Wanjiang City Belt

5.1. Legal and management measures

5.1.1. To manage mines according to law and protect the mine environment
Relevant laws and regulations are the most fundamental basis. Therefore, it is necessary to improve the legal system, strengthen the management of responsibility for the environment and promote the protection of mine resources and environment [9].

5.1.2. Improvement of the law enforcement capacity and efforts of environmental protection in the mining industry
The current environmental protection of mines in Anhui Province needs to be further strengthened. Many areas are faced with problems such as incomplete corresponding management organizations in grass-roots governments, lack of professional managers and scientific facilities and weak environmental awareness of many people. Therefore, it is necessary to strengthen law enforcement comprehensively and punish environmental violations severely.

5.1.3. Enhancement of overall management
The environmental protection of mines covers a wide range including mineral extraction, soil utilization, ecological environment construction and environmental protection. Moreover, there are many management departments involved in protection-related activities. For example, forestry departments should ensure that the forest environment is not damaged and water conservancy departments should make sure that soil erosion is within the controllable range. The management conducted by so many functional departments at the same time will inevitably lead to management chaos. Therefore, it is necessary for the government to set up a powerful coordinating body with the main leader as the head of the body, formulate a responsibility system and implement a strict accountability system so that the work can be coordinated well [10].

5.1.4. Strengthening social supervision and doing well in mass monitoring and prevention of geological disasters
Mining development often induces geological disasters. What government departments should do is to enhance people's awareness of prevention and control of geological disasters, for example, by publishing relevant scientific knowledge in public authoritative media, putting up posters in communities and public places with large flow of people and carrying out relevant publicity through
radio, television or internet, and pay special attention to the publicity in the vast rural areas, starting from the grass-roots level, so as to ensure that the grass-roots people can master the basic knowledge of prevention and work specifications and reduce the loss of property and life caused by geological disasters [11].

5.2. Technical and economic measures

5.2.1. Adoption of new technology and process
Governments should promote technological innovation in mining vigorously, encourage the application of new technologies and equipment to actual production, promote new technologies and reform new processes actively during mining, mineral dressing, smelting and the processing of mineral products, strengthen support for technical research related to environmental governance and remediation and encourage the use of new equipment and technologies in environmental remediation to improve the overall efficiency of environmental governance.

5.2.2. Enhancement of the construction of scientific and technological teams and technological innovation in the environmental protection of mines
The construction of geological science and technology teams in China has made great progress in recent decades, but the related infrastructure construction is to be strengthened. The monitoring of natural geological disasters such as landslides, land subsidence and ground fissures is still not accurate and clear enough. It is necessary to improve the theoretical research of prevention and control of geological disasters.

5.2.3. Diversified financing for environmental restoration and governance of mines
Governments should strengthen the support for environmental restoration and governance of mines, for example, determine whether the governance funds should be paid by the state or the responsible person based on the causes of geological disasters and whether the funds paid by the state should be paid by the local government or the central government, and make relevant budgets in advance.

5.2.4. Implementation of project management system for environmental restoration and governance of mines
It is necessary to carry out environmental protection, restoration and governance projects of mines and implement the market access system and hierarchical management system for related projects. The Municipal Bureau of Land and Resources should strengthen the supervision and management of environmental remediation and governance projects within the city. Relevant functional departments of various counties and districts should enhance the supervision and management of projects within their respective jurisdictions.

6. Main practice of Tongling City in environmental governance of mines

6.1. Overview of mining development and soil environmental problems in the Tongling region
Tongling is one of the areas with the strongest mining development in the Wanjiang City Belt. It is a key area of heavy metal pollution prevention and control in Anhui Province, with serious pollution of heavy metal and acid mine waste water. It has always been the focus of experts, scholars and relevant government departments. Some scholars have studied and analyzed the recycling and reuse of non-ferrous metal mineral waste, and sampled and analyzed the waste water produced by acid mines. It has been found that the metal deposit waste is highly acidic due to the thermal weathering condition and low-PH leaching environment in the Tongling region, and the main heavy metal pollution elements are Cu, Cd, Hg, Pb, Zn and Cr, etc. among which Cd is the most toxic element. Tailings waste in the Tongling region has become the main source of heavy metal pollution in surface water in the region.
6.2. Ideas and specific measures for soil environmental governance in the Tongling region

Tongling City has always attached importance to environmental problems caused by mining development and made positive achievements in the research and governance over the years. The environmental quality of Tongling has been continuously improved. Main measures for the prevention and control of soil pollution in the city are as follows:

6.2.1. In-depth and detailed investigation on soil environmental quality

Tongling extracts all the soil test data related to agriculture and land available and focuses on investigating contaminated land and suspected contaminated land, thereby formulating a detailed soil investigation plan.

6.2.2. Improvement of efforts to set up a soil environmental quality monitoring network

Existing soil environmental monitoring points are subject to unified planning and integrated optimization. Monitoring points and frequency and monitoring items of characteristic pollutants are increased based on the prevention and control of heavy metal pollution and the construction of “shopping basket” bases.

6.2.3. Enhancement of the protection of unpolluted soil

The land use should be planned strictly for the site selection of enterprises that may cause soil pollution. It is strictly forbidden to establish industrial enterprises containing non-ferrous metal smelting and chemical engineering that will cause soil pollution in residential areas, medical institutions, schools and nursing institutions for the aged, etc. Existing enterprises that cause serious pollution to the soil should be relocated orderly or closed according to law.

6.2.4. Enhancement of the comprehensive prevention and control of pollution sources

The comprehensive management of mines and tailings ponds should be accelerated. The green mine construction and long-term management should be boosted. Protective measures must be taken in mining, mineral dressing, transportation and other activities to prevent waste gas, waste water and tailings from polluting the soil environment.

Tongling should accelerate the management of the geological environment of mines, complete the restoration and governance of geological environment and ecological damage in abandoned mining areas such as the former Tongguanshan Copper Mine and completely solve the problems such as acid water seepage and sand leakage in Taoyuan Pyrite Mine in Yian District and the abandoned copper mine of Non-ferrous Metals Group in Jingbian, Qianpu Village, Congyang County.

It should also strengthen the disposal of industrial solid waste, administer the stacking places of tailings and industrial by-products comprehensively, ensure the effective operation of relevant facilities for preventing scattering, loss and leakage, and formulate targeted implementation plans.

6.2.5. Enhancement of the law enforcement for soil environment

Tongling should implement laws, regulations and standards strictly, for example, strengthen the enforcement of laws, regulations and standards related to the prevention and control of soil pollution and the enforcement and inspection of laws, regulations and departmental rules on the management of soil environment in polluted land, agricultural land and industrial and mining land.

6.2.6. Enhancement of target responsibility assessment

Tongling should clarify the primary responsibility of the government, set up a leading group for the prevention and control of soil pollution with the mayor as the leader and main principals of the people's government at county and district levels and relevant departments of the city as members so as to promote its work in soil pollution prevention and control, assess the implementation by governments at all levels strictly and reward and punish relevant personnel according to the assessment results.
7. Conclusion

7.1 Wanjiang City belt is the key development area of Anhui Province
According to the statistics at the end of 2015, the population of the region reached 31.0489 million, accounting for 44.68% of the total population of the province, and the GDP of the same year reached 1494.8 billion yuan, accounting for 67.93% of the GDP of the province. In recent ten years, the average growth rate of GDP of Wanjiang City belt has reached 21.59%, which is the fastest growing area in Anhui Province.

7.2 the development of mineral resources and the processing of mineral products make a great contribution to the local economy
The area is rich in mineral reserves, mainly including non-ferrous metal minerals, energy minerals, ferrous metal minerals, precious metal minerals, rare dispersed element minerals, non-metallic minerals of chemical raw materials and non-metallic minerals of building materials. A large number of mining, smelting and processing enterprises have emerged in the area. Such as Ma'anshan Iron and steel company, Tongling Nonferrous Metals Group Company and other backbone enterprises. These enterprises have made great efforts to develop and process in the region and have made great contributions to the economic and social development of the region.

7.3 the development and processing of mining industry have many negative effects on the environment of the region
There are mainly damage to soil resources, geological disasters, groundwater damage, mine wastewater and waste residue hazards.

7.4 specific measures to solve the environmental problems of mining development in Wanjiang City Belt
The first is to strengthen legislation, improve the relevant system and regulations, at the same time, improve law enforcement and severely punish environmental violations.

The second is to strengthen the overall management. There are many aspects of mine environmental protection. The government should set up a strong overall organization, with the main leaders as the head of the organization, formulate a responsibility system, and implement a strict accountability system. Only in this way can it be possible to coordinate this work well.

The third is to encourage the application of new technologies and new equipment in actual production, and actively promote new technologies in the process of mining, beneficiation, smelting and mineral products processing.

Fourth, it is necessary to raise diversified funds for mine environment restoration and treatment, which should be invested by the central finance, local finance and mining enterprises through multiple channels to ensure the implementation of environmental treatment.

7.5 environmental problems and Countermeasures of mining development in Tongling area
Tongling City is one of the areas with the strongest mining development in Wanjiang City belt, which is seriously polluted by heavy metals and acid mine wastewater. The main heavy metal pollution elements are Cu, Cd, Hg, Pb, Zn, Cr, among which Cd is the most toxic element. Tailings in Tongling area have become the main source of heavy metal pollution in surface water. The main measures for the prevention and control of soil pollution in this city include: in-depth and meticulous investigation of soil environmental quality, strengthening the construction of soil environmental quality monitoring network, strengthening the protection of unpolluted soil, strengthening the comprehensive prevention and control of pollution sources, etc.
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