Reclamation and rehabilitation of the post-mining landscape in China

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Abstract
Coal is mined in almost every province of China. Coal mining has a profound impact on the landscape. After mine closure, the affected areas should be reclaimed to restore the original or any other purpose. Principally, the coal mining companies are responsible for reclaiming the mining landscape. This article presents the importance of coal as the core energy in China and the development and progress of reclamation in post-mining regions in China. It also introduces the legal and planning basics of reclamation. Globally, mining activities pose a strong spatial impact to the mining regions; not only due to surface disturbances or highly visible dumps, but also in terms of the larger scale influence on the environment, economy, society and culture of the mining areas. In this sense, mining regions are unique.

Importance of coal mining in China
China has significant economic recoverable reserves of coal; and with a volume of about 115 billion tons of exploitable coal reserves China’s energy supply mostly depends on coal, and China is the world’s largest producer and consumer of coal. It is reported that China’s coal production in 2008 accounted for about 42.5 per cent of total world production of coal.

In China, primary energy production currently covers 88.7 per cent of primary energy consumption; however, the total domestic energy production in 2007 amounted to 2354.4 million tons. Coal, with 76.6 per cent ranked in the first place of primary energy production, behind oil (11.3 per cent), natural gas (3.9 per cent), and hydro, wind and nuclear energy (8.2 per cent) (figure 1). From 1953 to 2007, the primary energy consumption increased from 51.0 million tons to 2655.8 million tons, although the share of coal in primary energy consumption in China has been steadily declining for 50 years. In 2007, coal with 69.5 per cent of primary energy consumption was still the most important energy carrier, with other energy carriers playing a secondary role.

Due to the large land area and the diverse geological conditions, coal is distributed in almost every province of China, however, unevenly. The main coal resources are found in the north, northwest and southwest region of China. Almost 88 per cent of demonstrated reserves of coal are distributed in the three regions.

Current situation of the mining landscape
Coal mining brought dramatic breaks to the spatial structure and also fundamentally changed the society. According to statistics, there were 129 cities in China in 2005, whose economy more or less depended on the exploitation of mineral resources, in which 55 cities were built directly because of coal mining activities. According to the State Administration of Coal Mine Safety, state-owned enterprises are mining in 74 regions, which are spread over almost every province. Coal mining is playing a dominant role in these regions as energy bases of China. However, coal production has also brought a series of problems in terms of sustainable development and the environment.

Official statistics of the subsidence in China are uncompleted. According to scientific estimates, there was a total of 660 000 cases of subsidence until 2006, and the amount is still ascending with 30 000 ha per year. In many western countries such as Germany, France, USA, etc. reclamation is an integral part of mining activity as the main measures to deal
with the problems of environment and restoration of the post-mining landscape, however, this is just beginning in China.

The development of reclamation of the post-mining landscape

Although coal production in China has a long history, the reclamation of the mining landscape is at the initial stages. Only after the 1980s and 1990s, mining laws and regulations adopted the reclamation as an integral part of mining. The development of land reclamation in China can be divided into five phases.

The first phase (before 1978):

Before the 1980s, people paid more attention to economic interests than to the environmental impact of mining overall. The reclamation and the adjustment of the mining damage and the effect were not considered appropriately. Public investment in coal mining was focused only on improvement the infrastructure of the mining regions, and new construction or expansion of the mines, so that more coal could be produced. The reclamation of post-mining land was voluntarily conducted by the miners. There was neither a reclamation plan, nor the requirement of reclamation formalised. In the 1950s and 1960s, several mines voluntarily reused the land after mining.

The second phase (from 1979 to 1988):

With the introduction of economic reform in the People’s Republic of China (PRC) from the 1980s, the state transformed from the planned economy to the market economy. A reform subsequently also took place within the coal industry. The main objectives were to ensure economic development, improve the infrastructure and develop the coal industry.

Local and private mining companies were strongly encouraged at the same time. In a short time, the local enterprises developed quickly. From 1980 to 1990, raw coal production increased by 74 per cent—the average growth rate of raw coal production was 5.7 per cent per year, while the growth rate of state enterprises was 3.3 per cent and the growth rate of local enterprises was 13.9 per cent. The rapid development of the local coal company changed the structure of the coal mining industry and caused many unexpected problems, which were demonstrated in the 1990s. During this time, the reclamation of the mining landscape was attempted. The Ministry of Coal Industry researched the agricultural reclamation in the period between 1983 to 1990, through many scientific projects. Land reclamation, as an important measure to improve the environment was recommended by the State.


In the 1980s, environmental problems in China increased dramatically because of economic reforms. The Chinese government was forced to take action, and put the limited financial resources into the environmental protection, through strengthening the legislation and the further expansion of the state environmental management and monitoring. Thereafter, the Chinese government enacted a number of different laws, ordinances and regulations on environment (eg “Water Law”, “Law on the Prevention and Control of Atmospheric Pollution”), so that three major environmental principles were gradually formed in this period: the precautionary principle; polluter pays principle; and establishing and improving the state environmental management and monitoring system.

On January 1st 1989, the regulation of the State Reclamation was promulgated. This was the first time for China to have a set of clear, written rules in Reclamation. Post-mining land reclamation was no longer optional, but mandatory in various laws, ordinances and regulations. The polluter pays principle was introduced to this area. Until late 1991, a total of about 134 000 ha of land was reclaimed. The reclamation was no longer subordinated to the coal mining itself; it had attained equally important status.
The fourth phase (1996-2005):

After the Earth Summit was held in Rio de Janeiro in 1992, China’s government introduced the concept of sustainable development in the basic development guidelines of future policy. This idea was also introduced in the development of the coal industry. Rational exploitation of raw materials and energy security could only be done under the consideration of more economical use of natural resources, and protection of the environment. Accordingly, the required reclamation was stressed in mining regions. Conservation, restoration of damaged ecosystems and remodeling of a new landscape in the post mining areas were included as a supplement to the new content of the reclamation. The land reclamation plan required to be integrated with the coal mining plan.

In July 1996, the fourth national environmental conference was held in Beijing. One of the most important points was the closure of small factories, which seriously affected the environment, such as small paper mills; paint factories; and small mines. By 1998, China had more than 61,000 local small businesses, of which 51,200 were illegal. Until Sept. 1999, 30,500 small mines were forced to close.10.

The fifth phase (2006 to present):

Although China achieved some progress and set up many pilot projects in decades, the overall environmental status of the mining regions, in principle, have not changed. Therefore, in 2006, the Government enacted a Five Year Plan, with six points to be targeted.11:

- Improving the economy in terms of environmental and social aspects;
- Adjustment and optimisation of industrial structure;
- Promoting the healthy development of rural areas;
- Promoting sustainable development of urbanisation;
- Improving the coordinated development of regions; and
- Building a harmonious society.

With these points in mind, the integrated development of mining regions is required to be promoted. The rehabilitation is based not only on the agro-economic and forest use, but also on the replacement of land for settlement, trade, industry and recreation areas, which may become the major reclamation purposes. In addition, it stresses a harmonious ecosystem, with the new figures of the post mining areas. The strategic objectives can be formulated as follows:

- Optimisation of space and settlement structure;
- Development of a sustainable economy and land use conception;
- Improvement and redesigning of the ecosystem; and
- Promotion and improvement of social and cultural structures.

With this strategy, the reclamation and rehabilitation of mining landscapes enters into a new phase. Further development of the mining regions should be considered not only with the technology and economy, but also with the society and ecosystem.

**Fundamentals of reclamation**

**4.1 Legal framework**

The magnitude of the mine reconstruction interference requires a comprehensive legal basis, the rights and obligations of mining companies, and state supervision. In particular, the China Mineral Resources Law is of great importance. Under the act, mining companies are subject to the principles of the precautionary and polluters pay system. Mining companies must respect the environment and prevent pollution under the 32nd decrees - relevant laws and regulations: the one who are affected by mining land re-cultivate rational for agricultural, forestry and other uses. If the reduction burdens the lives of the residents and the original production, the mining company should pay a reasonable compensation in money and conduct necessary compensatory measures.

Given the special importance of coal in the P.R.C. on Aug 29th 1996, for the first time the government enacted the coal law. The law stipulated that mining companies were responsible for the degradation caused by land subsidence and destruction. It was required to reclaim the post mining areas and take a monetary form of compensation for damages. Due to the rising awareness on the environmental problems, the demands are increasing on the reclamation of the mining landscape. In 1988, the Ministry of Coal Industry with the Planning Committee, Ministry of Natural Resources and Ministry of Finance jointly drafted the reclamation regulation. On Jan 1st 1989, the regulation entered into force. This involved the reclamation follows the polluters pay principle: who damaged whom solved (whoever caused the damage is responsible for the reclamation).

Coal companies are encouraged to set up the reclamation plans submitted to the competent authority. The reclamation plan is approved by the land authority, and in consultation with competent authorities in technology. Principally, comprehensive legislation in China accords with the mining activities and the sustainable development of the mining regions.

**4.2 Planning basis**

Since the founding of the P.R.C., the coal development plans of the coal mining regions on the basis of social and economic plan have been established, which is also the five-year development plan known as the coal plan. The coal plan is inter-regional, summary and technical, and the aim of the plan is to ensure a long-term secure energy supply with the environmental and social acceptability. After the Regulation on the Mining Reclamation, mining companies established their own reclamation.
plan, if their activities resulted in soil destruction. The reclamation plan establishes a framework which can be widely used to prevent disruption of the surrounding environment and landscape. Because of the scarcity of land, agricultural reclamation in China is a priority in reclamation construction.

Since the reclamation plan is not legally binding, only a few mining companies tentatively set their own reclamation plans after completion of exploitation. Although there are many scientific discussions and research projects on the reclamation process, and a variety of scientists hotly debating on the land reclamation plan types, the reclamation is still in the early stages.

Overall, the classical planning in the mining regions in general was determined and defined by the land use planning targets, known as indicators of regional development. However, these numbers indicate only temporary situations, or the rough economy of the region. It is clear that for the sustainable development of mining regions, a new plan is needed to create the favorable conditions for the landscape reconstruction and provide people living and working in mining regions continued working and living conditions. Furthermore, the cooperation and coordination in the preparation of land reclamation and restoration plan must be considered, and the legal liabilities acknowledged.

**Sustainable design and use of post-mining landscape as development tasks**

According to a scientific evaluation of coal in China in the coming decades, coal as the power generation, is used as a basis for life and is still one of the most important pillars of China’s energy sources.

The diverse and complex problems caused by China’s mining activities can be solved through multi-disciplinary and inter-regional integrated tools, such as integrated planning. The pursuing objectives and standards of these plans should be defined clearly. Many factors, conditions and objectives of the development of mountain-growing regions, particularly the elements of regional sustainable development must be considered in the reclamation of mining areas. Under these conditions, the new requirements of the reclamation are expressed as follows:

The goal of the new design of the mine region is not a simple reproduction plan, but to take a chance to the landscape redesign. After mine closure, the new construction of landscape is partly based on the geological environment, taking the factors of economic and aesthetics into account. The reclamation is not only the improvement of mining landscapes and protecting the environment, but also to create an industrial base. The future of the mining regions after mine closure will be not only a friendly and environmental settlement, but also to bring new jobs to local people.

The ecological reclamation of the mining landscape is a task requiring much time, energy and money. Therefore the reclamation process of mining land and the ecological environment is considered as a long-term conception, not to pursue one-sided short-term benefits, but to pay attention to the reconstruction project. Reclamation is a learning process. It's sometimes a problem to evaluate post reclamation with current knowledge, and it's not complete to evaluate the present reclamation in the future. Therefore, sustainable care and support for the plan, and the deficiencies of reclaims, can be remedied using the relevant knowledge at the appropriate time.

With the redevelopment, rehabilitation and restoration of a living environment, the residents in the mining regions are given new chance to construct new homes. Therefore, in this process, the cooperation of the various areas will be strengthened so that the various interest groups have a fair dialogue, and the transparency of policy and redevelopment plans will be improved. The reclamation is accompanied with various scientific investigations and
research. In order to provide ideas to improve the reclamation, the research and development of new landscape regions, and a review of environmental effectiveness should be analysed.

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