

## Challenges to Sustainability of Resource-exhausted Cities: A Case Study of Lengshuijiang, China

### Wyzwania dla zrównoważoności odnoszące się do miast pozbawionych surowców: przypadek Lengshuijiang w Chinach

Guocun Zuo\* \*\*, Qiang Chen\*

\*School of Economics & Management, Tongji University, Shanghai, 200092, China

\*\*School of Economics & Management, Hunan Institute of Science and Technology, Yueyang,  
414006, China

E-mails: zuoguocun@hotmail.com, chenqiang@tongji.edu.cn

---

#### Abstract

Resource-based cities were once the backbone of Chinese economy for decades. When natural resources were depleted, however, these cities become *negative assets* of China and urgently need sustainable transition. Given the vast number of resource-exhausted cities in China, their success transitions not only mean much to themselves but also have great implications on China's sustainability. Taking Lengshuijiang, one of the 67 resource-exhausted cities of China, as a case, this article investigated sustainable transition of resource-exhausted cities in Chinese context. Firstly, we reviewed the development problems it faces in the past two decades. Secondly, we examined the countermeasures it took since 2009. Although this article mainly focuses on Lengshuijiang, the findings and discussion will provide insights for other resource-exhausted cities of China and other parts of the world in reviewing their development strategies as most of them are facing similar sustainable challenges.

**Key words:** sustainable development, resource-exhausted cities, China

#### Streszczenie

Miasta bazujące na surowcach stanowiły trzon chińskiej gospodarki od dziesięcioleci. Gdy zasoby naturalne zostały wyczerpane, miasta te stały się *ujemnymi aktywami* Chin i pilnie potrzebują zrównoważonych przekształceń. Biorąc pod uwagę dużą liczbę takich miast, ich sukces nie tylko będzie ważny dla nich samych, ale odegra również istotną rolę w zrównoważonym rozwoju całych Chin. Jako przykład wybrano Lengshuijiang, jedno z 67 miast, które dotknęło wyczerpanie zasobów, analizując zrównoważoność dokonanych tam przekształceń. Po pierwsze oceniono problemy rozwojowe występujące w ciągu ostatnich dwudziestu lat. Po drugie, zbadano skuteczność środków zaradczych, wprowadzonych w 2009 r. Przykład miasta Lengshuijiang stanowi punkt odniesienia dla strategii rozwojowych innych miast dotkniętych problemem wyczerpania surowców tak w Chinach, jak i w innych państwach świata, ponieważ większość z nich to staje w obliczu podobnych wyzwań.

**Słowa kluczowe:** rozwój zrównoważony, miasta dotknięte wyczerpaniem surowców, Chiny

---

#### 1. Introduction

Since natural resources are the material foundation for human existence and development, harvesting natural resources is one of the most common human

activities. Some cities have been built up or developed mainly for resource-related activities, which are called resource-based cities. Sudbury in Canada, Mesabi in America and Fushun in China are all typical such cities (Yang et al., 2011). Because they dis-

play some distinctive characteristics, resource-based cities have drawn many researchers' interests. Following seminal work by Innis, researchers have studied a lot aspects of resource-based cities, including residents' sense of belonging (Marsh, 1987), social interaction (Gill, 1990), demographic characteristics (Bradbury, 1983), local labor market and employment structure (Peters et al., 1995; Halseth, 1999; Randall et al., 1996), globalization (Pani, 2009), women's rights (Dempsey, 1992), women's working conditions (Bates, 2006) and mental health (Sharma et al., 2007), and so on.

For a resource-based city, resource-related industries are often dominant in its urban economy, thus its development deeply depends on, therefore is also subject to, local resource reserves (Li et al., 2013). As most natural resources are nonrenewable, a resource-based city usually has a life-cycle of formation, growth, prosperity, recession or revival (Figure 1) (Bradbury, 1988; Wang et al. 2012). Sometimes natural resource is a *curse* rather than a *blessing* to a city (Papyrakis et al., 2007; Sachs et al., 2001). Due to over-dependence on local resources, resource-based cities often suffer from resource depletions, increasing mining costs and supply-demand change of resources (Shao et al., 2011), and their economies are inherently unsustainable (Walker et al., 2003). For these reasons, researchers pay many attentions to sustainable development of resource-based cities (for example, Azapagic, 2004; Hilson et al., 2000; Liu et al., 2011; Martinet et al., 2007; Pierce, 1992; Shen et al., 2005; Yu et al., 2008). Some of them argued that maybe long-distance commuting is a better approach to harvest natural resources than building resource-based city (Houghton, 1993; Jackson, 1987; Paker, 1988). However, when those existent resource-based cities enter their recession stages, economic reconstructing and transition are unavoidable (Barnes et al., 1990; Dong et al., 2007; Li et al., 2013).

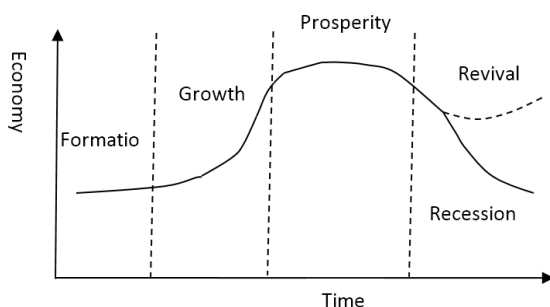


Figure 1. Life-cycle of resource-based cities

As a great nation strong in natural resources, China has built up many resource-based cities. Nowadays China has more than 600 cities, 262 of them are list as resource-based cities. Since new China was established in 1949, Chinese resource-based cities have produced 52.9 billion tons of raw coals, 5.5 billion tons of crude oils, 5.8 billion tons of iron ores and 2

billion cubic meters of timbers, thus have made enormous contributions to China's industrialization (State Council, 2013). Since the later 1980s, however, some of these cities started to confront all kinds of problems, including rapid resource depletion, difficulty in development of alternative industries, serious environmental pollutions, and coexistence of low income and high unemployment (Dong et al., 2007). Especially, those cities depleted more than 70% of their natural resource reserves, which are regarded as resource-exhausted cities in China, are struggling for survivals. These resource-exhausted cities were once known as *boiler room of the republic* and *raw materials storehouse of the republic*, and now are the *problem cities* of China. Since the mid-1990s, China's central government has made a lot of efforts to support resource-based cities' sustainability, such as special financial transfer payments to these cities, projects to expand employment, develop alternative industries and utilize energy and resources comprehensively in these cities (Li et al., 2013). One of the latest efforts is the plan for the sustainable development of the resource-based cities (2013-2020) formulated by State Council in 2013. This plan divides 262 resource-based cities into four categories according to their stages of life-cycle: 31 growth-type ones, 141 mature-type ones, 67 exhausted-type ones and 23 revival-type ones and tries to give them different supports. At the same time, local governments of some resources-exhausted cities start to actively take measures to meet their challenges.

In this article, we take Lengshuijiang as a case to investigate the sustainability challenges it faces and its responses to them. Lengshuijiang is selected as a case study because it is not only a typical resource-based city but also one of the 67 Chinese resource-exhausted cities. Given that the problems of Lengshuijiang are not uncommon in other resource-exhausted cities in China, the conceptual and analytical framework development in this article can provided reference for other resource-exhausted cities in coping with their own sustainability challenges. Insights gained from this research will shed some light on other similar cities.

## 2. Development problems of Lengshuijiang

Lengshuijiang is a county-level city, which covers an area of 439 square kilometers and has a population of 380 thousand. It located in the central of Hunan Province, which is a medium-sized province located in the south central China. Lengshuijiang possesses rich mineral resources. More than 40 kinds of mineral deposits were prospected, including antimony, iron, lead and other metals, and coal, graphite, silica, talc and other non-metallic minerals, in the territory of Lengshuijiang. It is known as the *world capital of antimony*, the *coal sea in Jiangnan*, and

the *home of non-ferrous metals* because of large reserves of antimony, coal and nonferrous metals. Although it is a smaller one in Hunan's 88 counties or county-level cities, Lengshuijiang has been an important energy and raw material base of Hunan Province for a long time. Lengshuijiang has seen impressive economic growth thanks to its rich mineral resources in the last thirty years. Its GDP amounted to 23.64 billion Yuan in 2013. It takes only about 0.2% of Hunan land and 0.5% of Hunan population, but creates 1% of Hunan GDP and contributes 0.7% of Hunan fiscal revenues. However, some problems have become increasingly prominent since the late 1980s. These problems have greatly threatened Lengshuijiang's sustainability.

### 2.1 Resource depletion

The most direct problem of Lengshuijiang is the resource depletion. Resource depletion is the inevitable fate of all resource-based cities because of the contradiction between limited supply and infinite demand of natural resources. But it was not a problem to Lengshuijiang before 1980. Lengshuijiang's mining scale was always not very large, although it has a mining history of more than one hundred years. However, the situation changed dramatically since China began the reform and opening-up policy in 1978. Hundreds of small mining enterprises were set up and the annual production volume surged. Furthermore, most of these enterprises used backward mining technology, and a large number of resources were destroyed and wasted. Predatory and destructive mining model accelerated the process of resource depletion badly. Resource depletion began to be a big problem in the early 1990s. In the 2000s, things have gone from bad to worse. Up to now, most of mineral resources in mining are on the verge of extinction. Iron ore resource has completely dried up. Antimony ore reserves has drop to 4.78 million tons, and it will be depleted in no more than 10 years at the current mining rate. Coal reserves has drop to half of the proved reserves, about 0.3 billion tons, and will be depleted in about 20 years according to current mining rate. Moreover, shallow coal seams have been completely exploited and only deep coal seams are left, so that the costs of coal mining are soaring. Other resources, such as graphite, lead, zinc and gypsum, have also been depleted or exhausted. As a result, the mining industries started to shrink. In the past ten years, 298 mining enterprises went out of business, including all four iron ore mining enterprises. Only 80 mining enterprises survived and the total production plummeted. Annual antimony production reduced to less than half of its peak, while annual coal production fell to 25% of its peak. Resource processing industry also experienced serious impacts. Antimony smelting enterprises had to cut production, some coal-washing enterprises went bankrupt, iron making enterprises had to look elsewhere for iron ore, coal chemical enterprises and

power enterprises had to acquire raw materials from other places, etc.

### 2.2. Uncoordinated economic and industrial structure

Lengshuijiang has experienced rapid economic development over thirty years through the successful utilization of mineral resources. However, its further growth may be subject to the constraints imposed by its existing economic structure, which has a strong bias towards secondary industry. As shown in Table 1, over the past ten years, the percentage of secondary industry in GDP increased significantly, while the percentage of primary industry decreased slightly and the percentage of primary industry decreased greatly. The imbalance between different economic sectors is getting worse and worse. This imbalance influences the development of Lengshuijiang in several ways. First, it brings a lot of inconveniences to the residents' livings. The residents in Lengshuijiang have to depend on the services (e.g., education, medical care, banking, and other urban services) provided in other cities. Second, it undermines investors' willingness to invest in Lengshuijiang. Insufficient provision of professional services such as accounting, banking, trading, and insurance makes some prospective investors turn to other cities. Third, it exacerbates the problems of migrant workers and left-behind children. About 40% Lengshuijiang residents live in rural areas. Declining primary industry and rising secondary industry drive more and more rural residents go to the downtown area for better jobs, leaving their children at home with the old peoples.

**Table 1.** Shares of primary, secondary and tertiary industries in Lengshuijiang's GDP, source: Hunan Statistical Bureau (2013)

Year	Primary industry (%)	Secondary industry (%)	Tertiary industry (%)	Total (%)
2003	4.78	57.67	37.55	100
2004	5.39	60.36	34.28	100
2005	4.53	65.08	30.38	100
2006	4.04	67.33	28.63	100
2007	4.85	67.95	27.20	100
2008	4.34	69.90	25.76	100
2009	3.87	67.92	28.21	100
2010	3.51	69.89	26.6	100
2011	3.88	70.79	25.33	100
2012	3.69	70.90	25.41	100

Resource-based cities usually developed their industries based mainly on local natural resource exploitation at their initial stages of urbanization and industrialization; this is a practical and rapid development pattern. However, most resource-based cities still deeply depend on resource-related industries in the subsequent course of development due to *path dependence* (Yang et al., 2011). Lengshuijiang is

such a prime example. It developed on the basis of the mining and now its industrial development is still driven by five pillar industries—mining, metallurgy, coal-fired power, coal chemical and building material industry, all related to local mineral resources. The output value of these five industries accounts for about 90% of the total industrial output value. Furthermore, most of the industrial enterprises are medium and small-sized. Lengshuijiang has about 1200 industrial enterprises, only about 100 of them are above designated size. Major industrial products of Lengshuijiang are low-tech primary products (see Table 2). This kind of industrial structure causes several problems. Firstly, it makes Lengshuijiang very vulnerable to market changes. For example, the weak coal market brought enormous difficulties to Lengshuijiang in latter 1990s. Secondly, local labor markets are full of low skilled workers. A low skilled worker is hard to find a new one when he loses his job, while a technology-intensive enterprise is difficult to find a needed worker in Lengshuijiang. Thus the efforts to establish technology-intensive industries and to change the industry structure encountered unimaginable difficulties. Thirdly, it leads to the inefficient utilization of resource and heavy environmental pollution. Five pillar industries mentioned above all belong to high pollution industries, and the fact that most small and medium-sized enterprises utilize resources inefficiently with backward technologies make things worse.

**Table 2.** Major industrial products of Lengshuijiang in 2013, source: Lengshuijiang Statistical Bureau

Product	Production	Growth rate
Raw coal	5096 thousand tons	-7.5%
Electric energy	8 billion KWh	14.0%
Crude steel	2410 thousand tons	-0.1%
Steel products	3550 thousand tons	2.7%
Soda ash	168 thousand tons	9.0%
Nitrogenous fertilizer (equivalent)	248 t thousand tons	5.5%
Cement	407 thousand tons	8.6%
Antimony products	93 thousand tons	10.1%
Clothes	3710 thousand suits	-0.5%

### 2.3 Environmental destruction

Environmental costs of Lengshuijiang's economic development are extremely heavy. First of all, long term mining brought a large area of goaf. In mid-2013, Lengshuijiang's goaf area reached about 17400 hectares, accounting for 34% of its total area. Goaf led to about 4000 ground subsidence that

resulted in disastrous consequences. According to incomplete statistics, in the goaf areas of Lengshuijiang, 85% of reservoirs leak seriously, 66 thousand people lack adequate drinking water, 68% of farmlands were destroyed and a lot of them abandoned, 418.6 thousand square meters of buildings were badly damaged, more than 12900 houses were influenced to different degree, more than 2000 houses have collapsed or been uninhabitable, and the direct economic losses amounted to billions of Yuan. Secondly, a large amount of industrial solid wastes were accumulated. These industrial solid wastes include coal gangue, fly ash, antimony slag, iron slag, arsenic alkali residue and others. There is no accurate statistics about how many industrial solid wastes accumulated in Lengshuijiang. According to a conservative estimate, tens of millions of tons of industrial solid wastes were accumulated in the territory of Lengshuijiang over the past several decades, piling up haphazardly in more than one hundred places. Moreover, it is still growing at the rate of millions of tons annually. These industrial solid wastes not only take up a lot of fertile farmland, but also cause some other environment problems such as deterioration of groundwater, degradation of vegetation, destruction of arable lands because of toxic substances penetrating. Furthermore, industrial solid waste pile collapse frequently occurs, and become a local safety hazard. Thirdly, air and water pollution are serious. Lengshuijiang produces about 140 million tons of industrial waste water and 70 million standard cubic meters of industrial waste gas each year. The quality of water of Lengshuijiang's main river is lower than the national grade five standards because of ammonia, nitrite and other pollutants. The concentrations of atmospheric sulfur dioxide, nitrogen dioxide, and other inhalable particles are also very high. The average air quality of Lengshuijiang can only reach the national grade three standards. Environmental pollution has seriously threatened the health of the residents of Lengshuijiang that the rates of cancer, silicosis, and lithiasis in Lengshuijiang have been ranked highest in Hunan Province for a long time.

### 2.4 Poor infrastructure

Inadequate infrastructure is a long-standing problem of Lengshuijiang. Lengshuijiang city was built in 1960s. The original purpose to build it was to service the surrounding mines and factories. Although large sums have been invested in Lengshuijiang by the State and the Province over past several decades, most investments were used in construction of mines and factories. The construction of infrastructure has been left to the local government. Since the local government's financial resources are limited, poor infrastructure is inevitable. Up to now, 150 thousand people crowd in the central downtown of Lengshuijiang, which is only 10 square kilometers and almost half of it is occupied by several factories. In the cen-

tral downtown, streets are narrow, schools and hospitals are crowded, traffic congestion has reached a tipping point, and the daily life of the residents has been seriously affected by production activities due to intertwining of residential areas and industrial areas. The situations are even worse in areas outside the central downtown. In some mining communities, many residents live in cramped old houses built in 1950s or 1960s, without access to running water, paved roads, clean toilets and other basic services, not to mention recreational or other facilities. Children's education is also an annoying problem in these communities. Children have to go to school tens of kilometers away without school bus services or crowd in a local small shabby classroom with fifty or sixty classmates. Poor infrastructures plus dreadful environmental pollutions force some residents choose to leave or at least let their children leave Lengshuijiang.

### 2.5 Unemployment, inequality and social stability

Due to the recession of mining and related industries, unemployment of Lengshuijiang has retained at high level for the last decade. Making matters worse is that most unemployed workers are older than forty years. It is extremely difficult for a woman over forty years old or a man over fifty years old to get a job in China (This is called 40-50 problem). The local government has made a lot of efforts to solve this problem, but has only gotten marginal success.

Lengshuijiang is relatively economic developed in Hunan province. Its *per capita* GDP reached 61700 Yuan (about 10 thousand dollars) in 2013 and was among the top ten highest in Hunan's 88 counties or county-level cities (Hunan Statistical Bureau, 2014). However, income inequality is very serious. Vast resources make a small part of the residents be rich quickly; millionaires or billionaires are not uncommon in Lengshuijiang. On the other hand, many families are fighting for their survivals. In 2013, 12 thousand families and 27 thousand people were granted a minimum living guarantee by the government (Hunan Statistical Bureau, 2014). Income inequality between urban and rural residents is particularly serious. Among 380 thousand residents of Lengshuijiang, about 240 thousand live in the central downtown or other towns and other 140 thousand live in the rural areas. The per capita annual disposable income of urban residents was 23489 Yuan while that of rural residents was only 15407 Yuan in 2013 (Hunan Statistical Bureau, 2014). It aggravates this problem that social securities in rural areas are far below in urban areas.

Unemployment, inequality and other troubles make many people frustrated. Suicide, violence, drug and alcohol abuse, gambling, prostitution and other problems haunt on some communities. Some people vent their discontents through strikes, breaking the traffic, group petitions and other ways. Social stable prob-

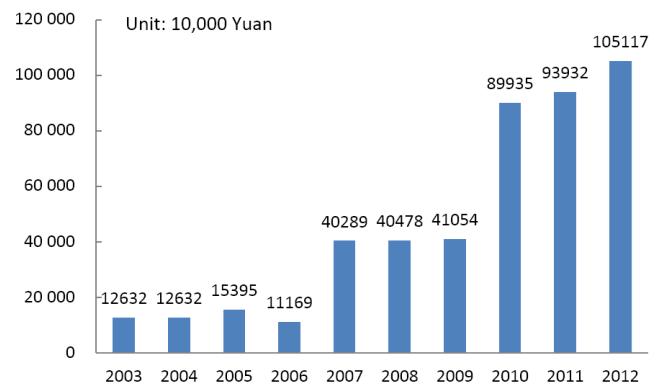
lem has also cast a shadow on the sustainable development of Lengshuijiang.

### 2.6 Low administrative status and fiscal deficit

China's administrative hierarchy consists of five levels. They are, in descending order, the top (State Council), province level, prefecture level, county level, and township level government. In China, a city with higher administrative status has more administrative power, autonomy and financial resources, and other privileges, so administrative status affects vastly a city's competitive advantages. Before 2000, Lengshuijiang and Loudi, another county-level city, had long been two well-matched competitors in the surrounding areas. Lengshuijiang even had some advantages over Loudi at that time. However, things reversed after Lengshuijiang failed in a competition for a prefecture-level-city position with Loudi in 1999. Now, Lengshuijiang is still a county-level city and administrated by Loudi which is already a prefecture-level city. In no more than ten years, Loudi has won overwhelming advantages over Lengshuijiang.

Lower administrative status brings some problems to Lengshuijiang. Firstly, it lowers Lengshuijiang municipal government's management authority. Lengshuijiang municipal government cannot effectively regulate some enterprises which are owned by governments at higher levels. For example, it cannot effectively deter their pollution behaviors and arbitrary mining behaviors. Secondly, it brings financial problems. Lower administrative status makes Lengshuijiang have to turn over a large portion of its revenues to governments at higher levels. In 2012, total revenue raised in Lengshuijiang amounted to 2.04 billion Yuan and almost 60% of it was turned over to governments at higher levels. Lower administrative status also makes Lengshuijiang at a disadvantage in obtaining subsidies and transfer payments from governments at higher levels. Thus Lengshuijiang has been plagued by fiscal deficit (see Figure 2), which greatly restricts Lengshuijiang's ability to deal with problems mentioned above.

**Figure 2.** Fiscal deficit of Lengshuijiang, source: Statistical Yearbook of Hunan Province (2004-2013).



### 3. CYSH: Lengshuijiang's responses to its development problems

Lengshuijiang took the problems of unemployment and social stability as its top priority before 2004, although all kinds of problems emerged in the late 1980s. It started to reconstruct its economy since 2004, but made less progress. The turning points emerged when Lengshuijiang was approved as a resource-exhausted city by State Council in 2009. That means huge sum of transfer payment from central government and series of preferential policies. Taking this opportunity, Lengshuijiang formulated a strategy (Called YiZhuan Sanhua, CYSH) to cope with its sustainability challenges systematically in 2009. CYSH has four main tasks: reconstructing economy, improving infrastructure, environmental protection and recovery, lessening income inequality between urban and rural residents.

#### 3.1 Reconstructing economy

As mentioned above, low tech small and medium-sized enterprises of coal mining, metallurgy, coal-fired power, chemical and building material industries dominate in Lengshuijiang's economy. The first task of CYSH aims at this problem of reconstructing economy. It plans to take actions in both developing alternative industries and strengthening existing pillar industries.

##### 3.1.1. Developing alternative industries

The first priority of reconstructing economy is to diversify economy. To do this, Lengshuijiang has actively developed following alternative industries.

(1) Hi-tech industries. Hi-tech industry is one of the main industrial developing orientations of Lengshuijiang. It set up a science park, built a center for entrepreneurship and an enterprise incubator to promote hi-tech industries. Taking two national high-tech industrialization demonstration projects, ceramic roller ring and Ganfule (a medicine), as a breakthrough, Lengshuijiang has initially established medicine industry and engineering ceramics industry. In medicine industry, absorbable protein suture, Ganfule and some traditional Chinese medicine products have been successfully marketed. Ceramics industry has also developed ceramic roller ring, ceramic drawing die, ceramic blade, and other products. There were 12 hi-tech enterprises above designated scale in Lengshuijiang in 2013, and the added value of these 12 enterprises reached 2.3 billion Yuan.

(2) Clothing and agricultural product processing industries. Due to pressure of employment, labor-intensive industries such as textile and food industries are also chose as alternative industries. A successful story is the Golden Eagle garment project invested by Golden Eagle group. Golden Eagle group's garment business not only provides about two thousand jobs but also rives related industries such as spin-

ning, weaving and garment accessories to boom in Lengshuijiang. To take advantage of rich agricultural resources of adjacent areas, Lengshuijiang also tries to develop agricultural product processing industries. A meat processing plant with annual production of 20 thousand tons and a red bayberry wine plant with annual production of 10 thousand tons have been built up.

(3) Tourist industry. Lengshuijiang boasts unique natural scenery. Boyue Cave had been developed into a well-known scenic spot in 1980s. In recent years, Daxiong Mountain, Zijiang River, and Zhadu have been developed successively. Xikuangshan, which was once the largest antimony mine in the world, will be turned into a mine sites park. Tourism industry is now a promising industry in Lengshuijiang.

(4) Other industries. Although, agriculture is not an important sector in Lengshuijiang economy, Lengshuijiang has made great efforts in it. Facility agriculture, animal husbandry, flower culture, and Chinese herbal medicine planting all have some progress. Other industries such as trade, logistic and neighborhood services also have developed quickly.

##### 3.1.2. Strengthening pillar industries

Lengshuijiang desperately need to change its industrial structure. However, alternative industries cannot be developed in a short time. Lengshuijiang will depend on its five pillar industries in a long time. Thus, it has adopted a series of measures to strengthen its pillar industries.

(1) Mine purge and limiting production. Due to various reasons, mining industry has been in disorder in Lengshuijiang. Illegal mining is a serious problem. Since 2009, Lengshuijiang has made purges in mining industry. More than 100 coal mines and 75 antimony smelting enterprises were closed. To prolong the mining time limit, total annual production of coal is limited to about 5 million tons, while that of antimony is limited to about 100 thousand tons. Lengshuijiang antimony production cut was so large that world antimony price almost doubled (Financial Times, 2011).

(2) Scale economy and cluster development. Lengshuijiang encourages leading enterprises to merge small enterprises and orders that annual production of all coal mines cannot be less than 60 thousand tons. It also guides enterprises to cluster in Lengshuijiang economic development zone and Lengshuijiang industrial park. Clustering is helpful not only for enterprises growth but also for pollution control.

(3) Extending industry chains. Short value chain and low added value are striking characteristics of Lengshuijiang pillar industries. Therefore Lengshuijiang supports enterprises to extend their value chains. Antimony-related industry has initially formed a diversified development pattern of star metal, antimony trioxide, and dust-free antimony tri-

oxide. Coal-related industry is turning to coal mining, coal washing, coal preparation and coal blending from purely coal mining. Iron-related industry has formed a chain of iron, steel, stainless steel, and fasteners.

(4) Upgrading technology and eliminating outdated industrial capacity. Backward technology is another characteristic of Lengshuijiang pillar industries. Lengshuijiang actively guides and supports enterprises to upgrading technology. All the coal mines and antimony-related enterprises have upgraded their technologies in some extents. Lengshuijiang also eliminated some outdated industrial capacities such as small coal-fired power generating units, small blast furnace and converter.

### 3.2. Improving infrastructure

Poor infrastructure has hurt Lengshuijiang's competitiveness for a long time. So the second task of CYSH is to improve infrastructure. It plans to take three major actions.

#### 3.2.1. Renewing the old urban center

Lengshuijiang has invested about 2 billion Yuan in renewing its old urban center since 2009. The most important measure is to move several large factories in downtown area out to suburbs. Thus there are more lands for infrastructures in the downtown area. East Jinzhu Road, North Tidu Road, North Huan-cheng Road and other main streets were upgraded. Binjiang Park, several parking lots and a comprehensive underground pipe network were constructed. A large number of residential areas were rebuilt. Water, electricity, gas, bus service and other facilities got a large improvement. Schools, hospitals, shopping centers were also improved dramatically. A new sewage treatment plant with a total capacity of 30 thousand tons a year was built. The living conditions in downtown area have changed considerably in just four years.

#### 3.2.2 Building a new urban center

The old urban center of Lengshuijiang is already too crowded for existing 150 thousand people-not to mention to accommodate more people. So Lengshuijiang started to build a new urban center which is located about 5 kilometers east to the old urban center since July 2010. The new urban center will cover an area of 10 square kilometers. Unlike the old one, there will be no industrial enterprises in the new urban center. It is mainly for residence, administration, education, and medical care. In the past three years, the trunk road network has been finished, a new primary school, a new hospital and the new administrative center are put into use. Several residence communities has been completed, about 30 thousand people already live there. According to plans, there will be about 100 thousand people live in the new urban center by 2020.

#### 3.2.3 Constructing a better transportation network

Lengshuijiang's transportation is poor. Its external traffic mainly depend on provincial highway 312 line and Xiangqian railway line. Neither of them is high grade. Its internal traffic is even much worse. Many people rely on dirt roads and need take several hours to the downtown which is only thirty or forty kilometers away. To change this situation, Lengshuijiang plans to build two traffic circles: one and a half hours communicational circle and half an hour fast commuter circle. The former is composed of super highway and high-speed railway and will be completed in 2015; it will make Lengshuijiang be within 1.5 hours drive eastward to Changsha, westward to Huaihua, northward to Yiyang and southward to Shaoyang. The latter is composed of improved existing and newly-built country roads, which will be finished in 2018; it will make people can reach the downtown area in half an hour from any location in the territory of Lengshuijiang.

### 3.3. Environmental protection and recovery

Environment destruction has been another threat to Lengshuijiang's sustainability. For a promising future, Lengshuijiang need to put environment destruction under control. This is the third task of CYSH.

#### 3.3.1. Building an environment protection system of multi-level and all directions

Lengshuijiang pledges to become an ecological city by 2020 in CYSH. It tries to build Zijiang River, the mother river of Lengshuijiang, into a scenic belt, and establish two ecological protection zones. One is the core protection zone which takes the new urban areas as its center; the other is the suburban protection zone which locates in the outskirts. Improving the awareness of environmental protection among the public is also a very important part of its environment protection system. Although Lengshuijiang is in an extremely adverse environmental condition, most residents lack the awareness of environmental protection. To remedy this, Lengshuijiang carried out a series of environment publicity and education activities since 2009. It also launched a campaign for Provincial Hygienic City in 2010 and successfully got the title of Provincial Hygienic City in 2012.

#### 3.3.2. Cutting emission and controlling new pollution sources

Economic growth was the first priority and environmental protection was almost ignored in Lengshuijiang in the past time. The latter got much higher priority since 2009. From then on, a large number of small enterprises such as coal mines and refineries were forced to close due to pollution. All large or medium enterprises were required to use new technology and install new equipment to reduce pollution within prescribed time limit. Any new enterprises will not be permit to open until it attains the

protecting environmental standard. Circular economy is encouraged, Lengshuijiang uses tax credit, fiscal subsidies and other preferential policies to stimulate the development of circular economy. Many enterprises are established to utilize industrial wastes of existing enterprises in recent years. Some enterprises such as gangue power plant, gangue brick factory, and slag cement factory have achieved considerable success.

### 3.3.3. *Reclaiming land and restoring ecology*

Mining caused a large area of subsidence, desertification and ecological damage in Lengshuijiang. Lengshuijiang started some projects of land reclamation and ecological restoration of mining areas since 2000. These projects included goaf backfilling, reforestation, water and soil conservation, resettlement, and reduction of heavy metal contents in water and soils. However, all of them were on small scales because of lacking money. After receiving 0.1 billion Yuan of special fund from central government in 2010 and being included in the key state project—the project of heavy metal pollution treatment of Xiangjiang River Basin in 2011, Lengshuijiang accelerated its projects of land reclamation and ecological restoration. Since then, Lengshuijiang has added 270 hectares of arable land and planted 4000 thousand trees.

### 3.4 *Lessening income disparity between urban and rural residents*

The fourth task of CYSH is to lessening income disparity between urban and rural residents. CYSH proposes two major measures.

#### 3.4.1 *Household registration deregulation*

China implements the strictest household registration system in the world. Under this system, every Chinese citizen gets an urban or rural hukou (registered permanent residence) since birth according to his parents' hukou. Hukou transfer is rigorously controlled, especially from a rural to an urban address. Hukou decides a man enjoys what kinds of treatments in a place. A man with a rural hukou living in urban area is usually unevenly treated by local government. Lengshuijiang tries to break obstacles of the household registration system. It allows its residents relatively freely transfer their hukou in its administrative scope. It also cut down privileges binding to hukou. For example, since 2010, people with rural hukou living in Lengshuijiang can enjoy the same treatment as urban residents in employment, children's education, pension, medical care, minimum living security and social assistance, and people with urban hukou were permitted to build houses in rural areas and rent arable lands.

#### 3.4.2 *Bettering public services in rural areas*

Before 2009, Lengshuijiang expended only 97 million Yuan in roads, medical services, water supply,

education, bus service, garbage dispose and other public services in rural areas each year. Since 2010, this expenditure increased to 200 million Yuan. Lengshuijiang launched a series projects to improve living conditions of rural residents. For example, it implemented a project call *three changes*. This project aimed to change the model of rural families' kitchen, bathroom, and raising livestock. It also began to plan new rural residential quarters with better public services and guide rural residents to build houses in these new residential quarters. For those rural residents who cannot afford to build new house but need it, local government supplies some subsidies. At the same time, endowment insurance, medical insurance, minimum living security and other social security policies gradually extend to cover rural residents.

## 4. Conclusions

In recent years, resources-exhausted cities in China face more and more sustainability challenges, which not only threaten the developments of these cities but also put enormous pressures on China's sustainability. One key theme that emerges from the above discussions concerns that how a resource-exhausted city to transfer to a more sustainable development trajectory in a shorter period of time.

As a typical resource-exhausted city, Lengshuijiang's development suffered from resource depletion, uncoordinated economic and industrial structure, environmental destruction, poor infrastructure, income inequality and fiscal deficit in the past two decades. Things turn out to be better after the CYSH strategy began to be implemented in 2009. Following years of transition and colossal efforts from local government and governments at higher levels, Lengshuijiang has made significant progress. Several alternative industrial have been initially developed, environmental picture has been better, infrastructure has been greatly improved, and the residents got a more suitable living condition. Furthermore, the public awareness of environmental protection and sustainable development has been promoted and the residents pay more attentions on these problems. This will greatly encourage and facilitate governments and enterprises behave more responsibly in economic activities and guarantee a more sustainable development. However, although Lengshuijiang has had some success in the past several years, there are more challenges remain ahead of it. Its environmental destruction is still serious, its natural resource reserves become much less while its pillar industries are still highly resource-intensive, its income inequality and fiscal deficit even get worse, and a large development gap between its urban and rural areas needs to narrow, and so on. Lengshuijiang still has a long way to go in its pursuit of sustainable development.



From the experience of Lengshuijiang, we consider that successful sustainable transition is absolutely a long and costly process. In Chinese context, it requires joint efforts of governments at all levels and local residents. First, it needs financial support from central government. China's tax system funnels most revenue to the central government, with the local authorities left to handle the bulk of spending on most public services. As a result, local governments have limited finances. Almost all of the resource-exhausted cities face huge fiscal deficits; they even cannot start a transition without help. Second, local government must suppress the impulse of increasing GDP. In the current regime, a Chinese mayor will be promoted to a higher position if his city has a faster economic growth. So many resource-exhausted cities ignore environmental pollutions in pursuit of economic development and results in further damage to their sustainability. Third, local residents should actively participate in the process of making local development policy. Chinese residents are usually excluded from the process of making policy, while local officials mainly are outsiders from other places. Under this condition, local policies usually pay more attention to the growth in short-term rather the sustainable development in long-term.

## References

1. AZAPAGIC, A., 2004, Developing a framework for sustainable development indicators for the mining and minerals industry, in: *Journal of Cleaner Production*, vol. 12, no 6, p. 639-662.
2. BATES J., 2006, Gendered Space of Industrial Restructuring in Resource Peripheries: The case of Corner Brook Region, Newfoundland, in: *Journal of Economic Social Geography*, vol. 97, no 2, p. 126-137.
3. BRADBURY J.H., MARTIN S.T., 1983, Winding down in a Quebec mining town: A case study of Schefferville, in: *Canadian Geographer*, vol. 27, p. 128-144.
4. BRADBURY, J., 1988, Living with boom and bust cycles: new towns on the resource frontier in Canada, 1945-1986, in: *Resource Communities: Settlement and Workforce Issues*, p. 3-20.
5. BARNES T., HAYTER R., GRASS E., 1990, MacMillan Bloedel: Corporate restructuring and community change in Chemainus, British Columbia, in: *Regional Studies*, vol. 26, p. 647-643.
6. DEMPSEY K., 1992, *A man's Town: Inequality between Women and Men in Rural Australia*, Oxford University Press, 290-315.
7. DONG S.C., LI Z.H., LI B., and XUE M., 2007, Problems and Strategies of Industrial Transformation of China's Resource-based Cities, in: *China Population, Resources and Environment*, vol. 17, no 5, p. 12-17.
8. *Financial Times*, <http://www.ft.com/cms/s/0/a66a2412-2264-11e0-b6a2-00144feab49a.html>, (17.01.2011).
9. GILL, A.M., 1990, Enhancing social interaction in new resource towns: planning perspectives, in: *Journal of Economic and Social Geography*, vol. 81, no 5, p. 348-363.
10. HALSETH, G., 1999, Resource town employment: perceptions in small town British Columbia, in: *Tijdschrift Voor Economische en Sociale Geografie*, vol. 90, no 2, p. 196-210.
11. HILSON, G., MURCK, B., 2000, Sustainable development in the mining industry: clarifying the corporate perspective, in: *Resources Policy*, vol.26, no 4, p. 227-238.
12. HOUGHTON, D., 1993, Long-distance commuting: a new approach to mining in Australia, in: *The Geographical Journal*, vol. 159, no 3, p. 281-290.
13. Hunan Statistical Bureau, 2014, Lengshuijiang's economy and society developed statistical bulletin in 2013. [http://www.hntj.gov.cn/tjgb/xqgb/ldgb/201404/t20140411\\_108825.htm](http://www.hntj.gov.cn/tjgb/xqgb/ldgb/201404/t20140411_108825.htm). (16.06.2014)
14. JACKSON, R., 1987, Commuter mining and the Kidston gold mine: goodbye to mining town, in: *Geography*, vol. 243, no 72, p. 159-170.
15. LI H.J., LONG R.Y., CHEN H., 2013, Economic transition policies in Chinese resource-based cities: An overview of government efforts, in: *Energy Policy*, vol. 55, p. 251-260.
16. LIU, Y., YIN, G., MA, L.J.C., 2011, Local state and administrative urbanization in post reform China: a case study of Hebi City, Henan Province, in: *Cities*, vol. 29, no.2, p. 107-117.
17. MARTINET, V., DOYEN, L., 2007, Sustainability of an economy with an exhaustible resource: a viable control approach, in: *Resource and Energy Economics*, vol. 29, no 1, p. 17-39.
18. MARSH B., 1987, Continuity and Decline in the Anthracite Towns of Pennsylvania, in: *Annals of Association of America Geographers*, vol. 77, no 3, p. 337-352.
19. PANI, N., 2009, Resource cities across phases of globalization: evidence from Bangalore, in: *Habitat International*, vol. 33, no 1, p. 114-119.
20. POPYRAKIS, E., GERLAGH, R., 2007, Resource abundance and economic growth in the United States, in: *European Economic Review*, vol. 51, no 4, p. 1011-1039.
21. PAKER, P., 1988, *The cost of remote locations: Queensland coal towns. Resource Communities: Settlement and Workforce Issues*, p. 79-95.
22. PETERS E., ROSENBERG M.W., 1995, Labor Force Attachment and Regional Development for Native Peoples: Theoretical and Methodological Issues, in: *Canadian Journal of Regional Science*, vol. 18, p. 77-106.
23. PIERCE, J.T., 1992, Progress and the biosphere: the dialectics of sustainable development, in:

- Canadian Geographer*, vol. 36, no 4, p. 306-320.
24. RANDALL, J.E., IRONSIDE, R.G., 1996, Communities on the edge: an economic geography of resource-dependent communities in Canada, in: *Canadian Geographer*, vol. 40, no 1, p. 17-35.
  25. SACHS, J., WARNER, A., 2001, The curse of natural resources, in: *European Economic Review*, vol. 45, no 4-6, p. 827-838.
  26. SHAO J., ZHOU J.Q., 2011, Study on the influences of industry transformation on the sustainable development of resource-exhausted city space, in: *Procedia Engineering*, vol. 21, p. 421-427.
  27. SHARMA, S., REES, S., 2007, Consideration of the determinants of women's mental health in remote Australian mining towns, in: *Australian Journal of Rural Health*, vol. 15, no 1, p. 1-7.
  28. SHEN, L., CHENG, S., GUNSON, A.J., et al., 2005, Urbanization, sustainability and the utilization of energy and mineral resources in China, in: *Cities*, vol. 22, no 4, p. 287-302.
  29. STATE COUNCIL, 2013, *The plan for the sustainable development of the resource-based cities (2013-2020)*.
  30. WALKER M., JOURDAN P., P., 2003, Resource-based sustainable development: an alternative approach to industrialization in South Africa, in: *Minerals & Energy Raw Materials Report*, vol.18, no 3, p. 25-43.
  31. WANG S.Y., GUO S.Q, 2012, Study on Countermeasures for sustainable development of Resource-Exhausted Cities, in: *China Soft Science*, no 1, p. 1-13.
  32. YANG J.R., HUANG X., ZHANG S., 2011, RESOURCE-BASED CITIES' TRANSFORMATION: REVIVE, DILIMA AND ROUTE, in: *Economic Theory and Business Management*, no. 12, p.77-83.
  33. YU, J., ZHANG, Z., ZHOU, Y., 2008, The sustainability of China's major mining cities, in: *Resources Policy*, vol. 33, no 1, p. 12-22.