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Research on Urban Regenerative Planning for Resource-exhausted Cities in Socio-economic Transition from Smart Shrinkage Perspective

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00 INTRODUCTION

ABSTRACT

Due to global social and economic developments and the intensifying urbanization process, China's urban development is displaying a novel phenomenon of expansion and shrinkage oscillations. Cities dependent on natural resources are among those worst affected by China's urban shrinkage. Resource-based cities, which are essential to China's economic development, are facing the prominent challenge of urban shrinkage as a result of China's slowing economic growth, its homogenous industrial structure, and the industrial cycle of "boom and bust" brought on by resource depletion. In these cities, the gradual lack of urban dynamism results in the disadvantage in urban competition and attractiveness. The main challenge in these cities is figuring out how to achieve better sustainability and transformation.

The concept of "smart shrinkage" is a viable alternative to the conventional growth-oriented planning paradigm, which seeks to reverse the anticipated decline in the future. Smart shrinkage entails accepting the reality of shrinkage, developing policies in anticipation of urban population reduction, and investigating new models of urban intensive development under non-growth conditions. The potentials and transition based on the smart shrinkage idea are investigated in this thesis using Hegang as the study location. Hegang, a city on the border of northeast China, is on the list of resource-exhausted cities. Its population is declining, the city's mineral resources are nearly completely depleted, there is an excess of land and structures, and the quality of space is deteriorating. Does the idea of "smart shrinkage" make sense in the context of a municipality that is losing population with Chinese characteristics? Is local operationalization of shrinkage possible? In response to the long-term shrinking trend in the context of Hegang, this research develops a theoretical framework for smart shrinkage, suggests a strategic framework for urban recovery and resilience building, reconstructs Hegang's socio-economic and spatial dimensions, and recovers it to a resilient urban system. The results of a thorough investigation may serve as a point of reference for this particular group of cities' transformation and excellent development.

Keywords: *Resource-exhausted cites, Smart Shrinkage, Post-industrialization, urban regeneration*

Source: Associated Press

"China's urban planners should not only shoulder the responsibility of 'planning for growth', but also be prepared to 'plan for shrinking', and the combination of the two can achieve Healthier cities and regional development".

MOTIVATION

As I was growing up, I witnessed China's cities and economy expanding quickly. Population migration and modifications to urban patterns are certain to go hand in hand with China's urbanization trend. Many wrestle with leaving for the promise of the big city, often lamenting that their small cities have little to offer them. Like many youngsters who grew up in small towns, we have a natural yearning for big cities, with more prospects and higher education. A significant portion of the rural population started to move into cities and to relatively developed areas as a result of the institutional mechanisms being reformed, the gradual relaxation of restrictions on farmers entering cities, the rapid development of the eastern coastal areas, and other factors.

In the past, cities with rapid and huge population increase (i.e., fast growth) have received more attention, but it's equally crucial to consider which cities are emigrating. How should these emigration cities grow? The researcher, Associate Professor Wu Kang of Capital University of Economics and Business, said: "The hollowing out of the countryside is a truth that has been widely publicized, but it is difficult for people to find that certain small and medium-sized towns have also undergone population loss." Many individuals don't believe that their city's fortunes can be changed because so many young people are moving away. According to Long, many Chinese people have a deeply ingrained belief that urbanization is necessary for the growth of both cities and their populations,“shrinking cities can only mean decay.”

What is the future of cities when they are no longer growing?

Although every city's planning is full of "growth" expectations, we cannot deny that shrinkage is part of the urbanization of the entire country; thinking from another angle, maybe this is not necessarily a bad thing?

Fig. Young people are a rare sight
Source:https://interaction.sixthtone.com/feature/2018/shrinking-cities/fularji.html

01 CONTEXT

1.1-URBAN SHRINKAGE IN CHINA

1.1.1 INDUSTRIALIZATION AND URBANIZATION

The expansion of the heavy industry and the acceleration of urbanization process are the salient characteristics of Chinese economy recently.

China's political and economic regimes have experienced a complicated development process since China established in 1949. Over the past few decades, Chinas economy has maintained rapid growth, with an average annual gross domestic product (GDP) growth rate of more than 10% .In recent years, the Chinese economy has entered a “new normal,” in which the GDP growth rate has slowed but remained stable at around 7%.

In the 1950s a progressive model called the “Five Year Plan” was developed, where Mao’s government prioritized the heavy industry development focused on supplying the domestic and export markets as a means of capital accumulation (Damas, 2014). China has continued its rise as an industrial power to the present day.

In the late 1970s and early 1980s, the reform involved de-collectivization of agriculture, opening up the country to foreign investment, and permitting private enterprises. Due to the demand for labor for economic development, the labor force began to flow from rural to urban areas., China experienced exponential economic growth and subsequent rapid urbanisation. By the end of 2019, China's urbanization rate surpassed 60 percent for the first time as the number of urban residents stood at 848.4 million.

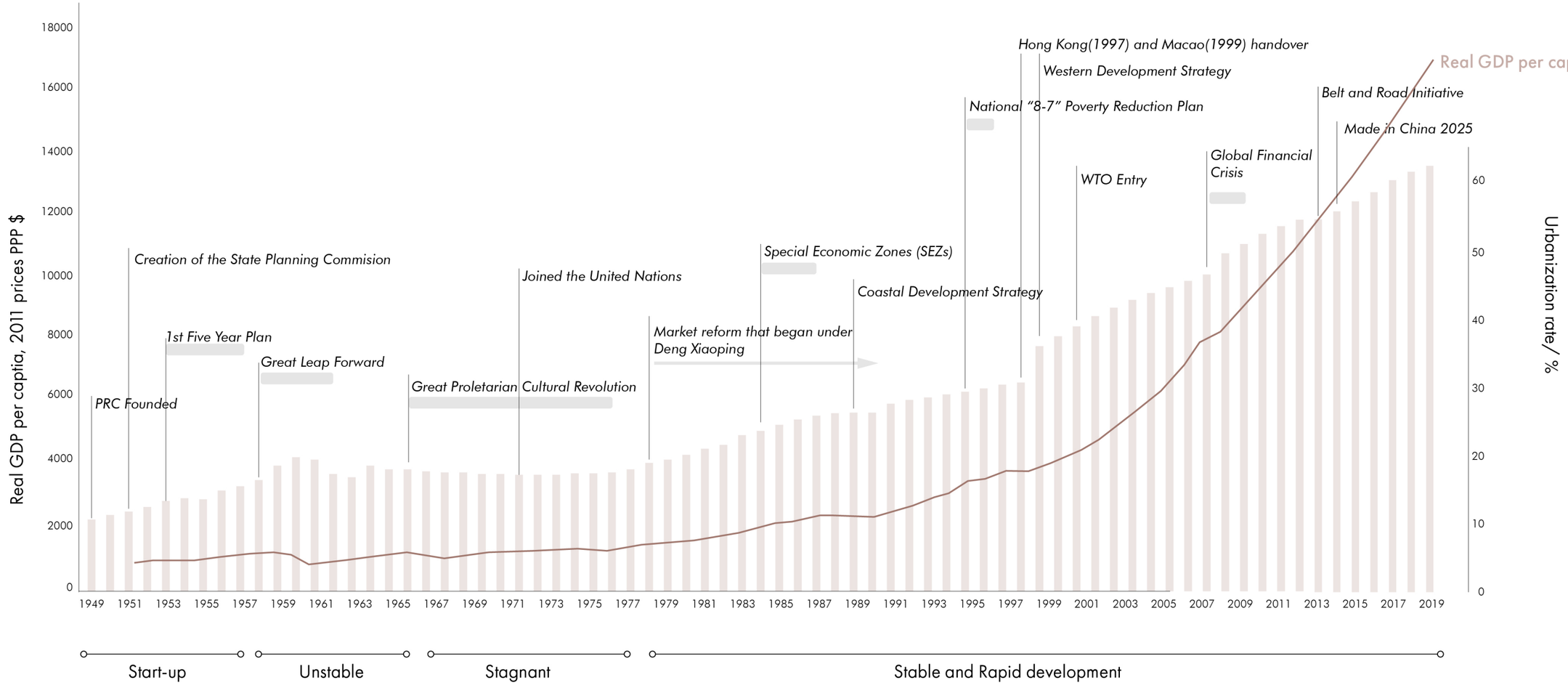


Fig. Industrialization and urbanization of China since 1949. (Source: Made by Author)

1.1-URBAN SHRINKAGE IN CHINA

1.1.2 UNEVEN DISTRIBUTION AND DEVELOPMENT IN REGIONAL SCALE

Regional inequality in China is mainly the result of development policies (Fan and Sun 2008, 2–3). Since the launch of reform in the late 1970s, the state considered growth as a more important objective (Fan, 1995).

In the 1980s, regional development had been experimental and encouraging regions to "get rich first" was a more critical concern. China's Tripartite Regional Development Policy has privileged coastal economies (Goodman 2004, 318), for instance, policy of creating special economic zones (SEZs) . National investment has an agglomeration effect, attracting private capital to flow to specific regions, which stimulated an export-led prosperity on the south-east coast (Chai 1996, 57). Coastal areas enjoy preferential policies in terms of national finance, and had gradually become core industrial centers, which have played a positive role in promoting and demonstrating the attraction of foreign investment, the development of various economic forms and business methods, and the promotion of opening up to the outside world. Therefore, factors of economic development such as capital, technology, and labor flow to developed regions. The attraction of underdeveloped regions to external funds and talents has been further weakened, which exacerbated the lag of opening up and market-oriented development in underdeveloped regions.

In conclusion, the rapid growth of export-oriented manufacturing in the coastal region was accompanied by intensive regional development disparities between coastal and inland regions, which finally led to unbalanced regional development.

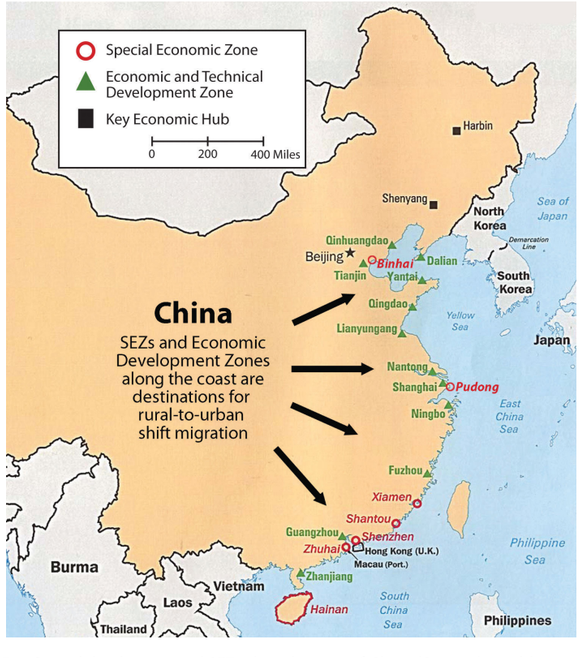


Fig. Coastal development and SEZs along the coast of China. (Source: https://open.lib.umn.edu/worldgeography/chapter/10-2-emerging-china/)

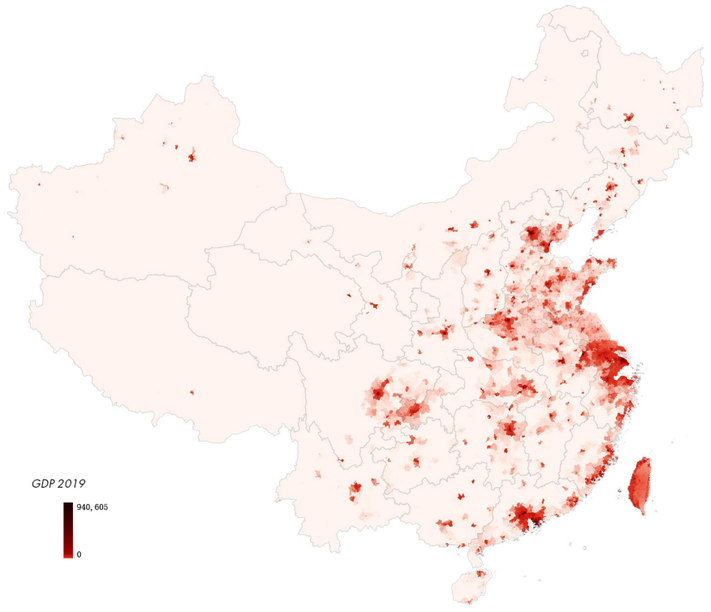


Fig. Spatial distribution of GDP in 2019. (Source: Made by Author)

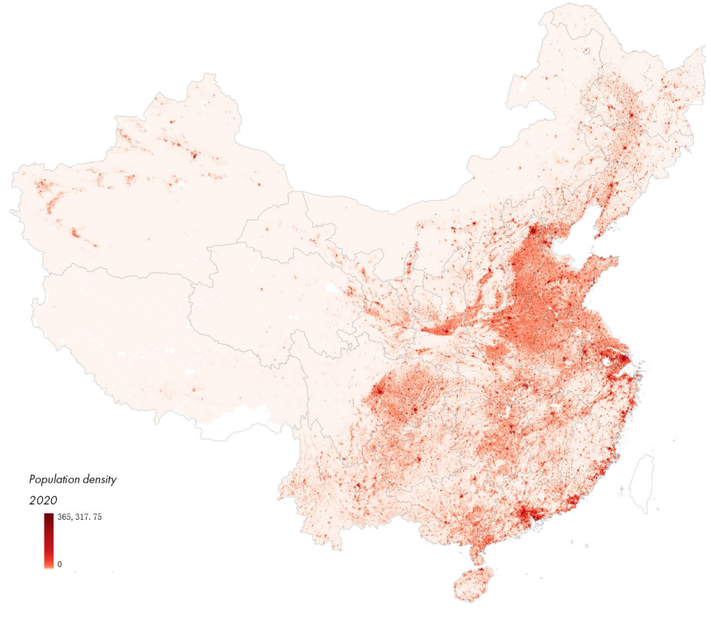


Fig. Spatial distribution of population density in 2020. (Source: Made by Author)

1.1-URBAN SHRINKAGE IN CHINA

1.1.3 MIGRATION OF POPULATION

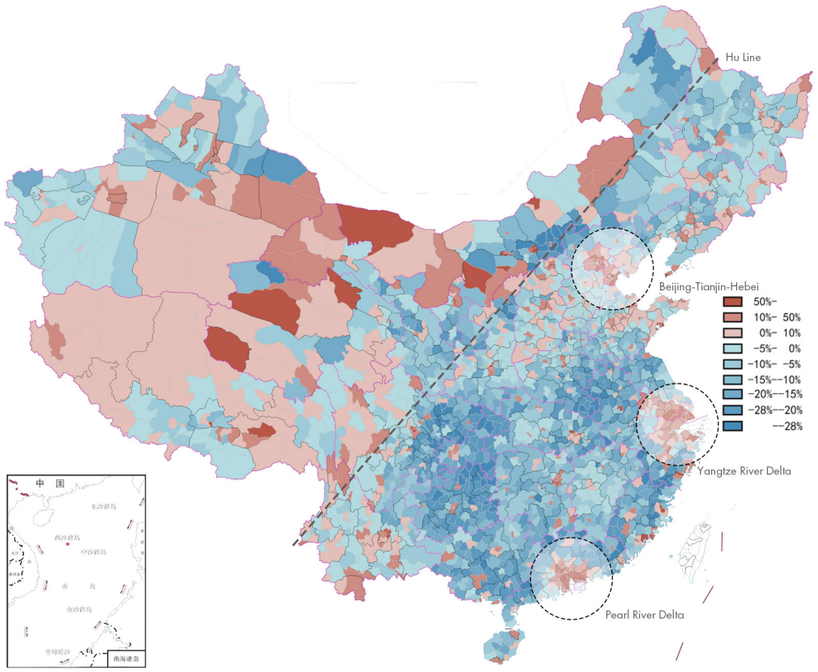


Fig. The spatial distribution of ratio of net outmigration based on population at the county level in China, 2010 (Source：风雪祁连（框框） http://matthartzell.blogspot.com/2013/09/chinese-domestic-migration-map.html)

As the country with the largest domestic migrant population in the world, China's large-scale domestic migration began in the late 1980s. The main feature of China's population flow is from rural to urban; from inland to coastal areas, economic circles and urban agglomerations are still the main areas that attract population inflow.

Since the 1990s, inter-provincial migration in China has been mainly driven by wage differentials. With the development of coastal cities and the increasing demand for labor, residents in underdeveloped areas (including migrant workers, laid-off workers, etc.) migrated in search of job opportunities to the southeast coast. In recent years, factors such as educational resources, medical conditions, culture, and entertainment needs have all had an impact on population mobility. In addition, the eastern coastal areas have the advantages of gathering talents in the eastern coastal areas, especially the Yangtze River Delta, Pearl River Delta and Beijing-Tianjin regions; the yearning of talents for big cities and the relatively easy settlement policy (hukou policy) in the eastern coastal areas make the Higher education talents are more inclined to flow.

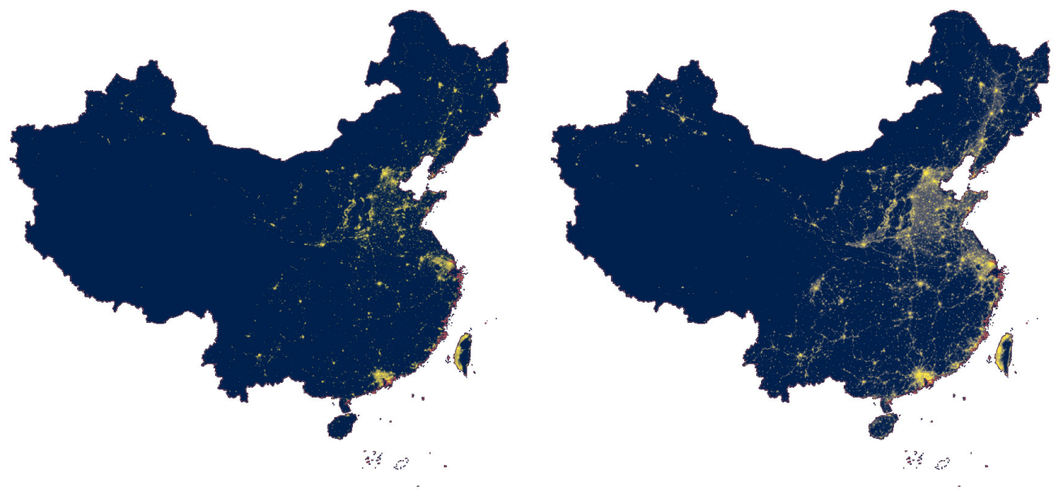
As of the end of 2017, the floating population in China reached 245 million. Among them, the inter-provincial floating population mainly composed of labor force was 97 million, double that of 2000.

1.1.4 POLARIZATION EFFECT: SHRINKAGE AND EXPANSION

Economy is the main driving force of urban development, while the volume and direction of capital flows indicate the trends of growth and decline of a city; population is the key element of urbandevelopment, and the increase and decrease in the total populationreflect urban growth and shrinkage directly; the landscape repre-sented by land use is a carrier of urban development, which sup-ports the urban economy and population activities.

a) 1984

b) 2000



c) 2010

d) 2020

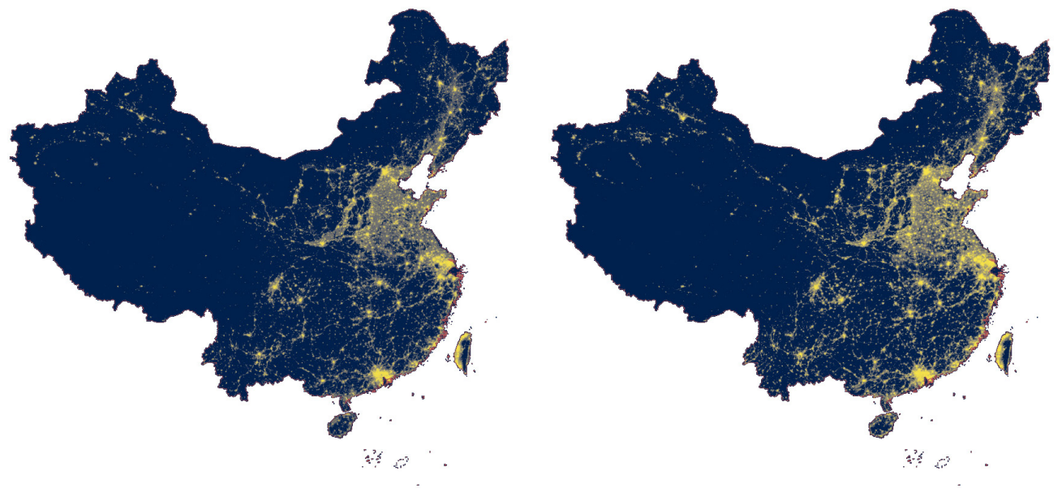


Fig. Nightlight map of China to show the expansion of urban area. (Source: Made by Author)

1.1-URBAN SHRINKAGE IN CHINA

1.1.5 DEFINITION OF URBAN SHRINKAGE

The growing studies on urban shrinkage offer varying definitions, and none are currently universally accepted. In the 1970s, the term “shrinking city” was initially used by German scholars to describe some urban areas subjected to reduction in employment opportunities and population size.

Population decline is the common denominator of shrinkage definitions, but the time span to investigate population decline varies (Hoekveld, 2012 Oswalt et al., 2006 ; Turok & Mykhnenko, 2007). Recently, some studies have pointed out the complexity of urban shrinkage, and they tend to define urban shrinkage as a combination of different dimensions, including the loss of population, economic recession, employment decrease, and social problems (Martinez-Fernandez et al., 2012).

> *"Urban shrinkage refers to a concomitant process of demographic and economic decline with a structural impact on two constitutive elements of the city, the density of the population and its economic functions, thus generating considerable social effects (Martinez-Fernandez, Audirac, Fol, Cunningham-Sabot 2012)."*

CAUSES OF SHRINKAGE

This heuristic model itemises key global and regional drivers of urban shrinkage, including economic and demographic decline, suburbanisation, contentious territorial politics and natural environmental disasters, while highlighting their impact on the spatial urban development at the local scale.

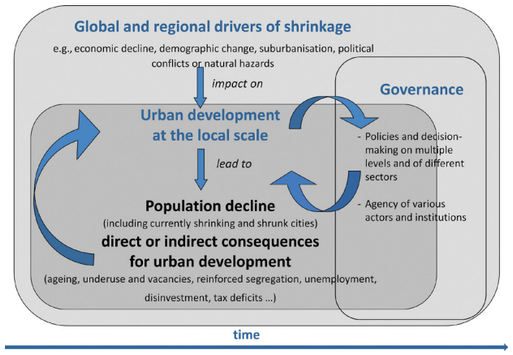


FIG. Urban shrinkage: a heuristic model. (Source: Haase et al., 2014: Figure 1)

Due to the heterogeneity of institutional and economic environments, the causes of urban shrinkage vary from country to country. Besides, causes affecting urban shrinkage rarely have an effect on their own but work in combination with other factors. The main reasons for urban shrinkage in the world are:

1) **Economic structural change:**
Due to the economic transformation and industrial restructuring caused by economic globalization, some cities and regions with slow transformation have experienced a series of problems such as industry shrinkage and job loss;
Deindustrialization has led to a serious decline in the traditional manufacturing industry and its associated industries in cities, while the decline or transfer of industrial sectors has led to the decline of industrial areas;
Unbalanced economic development, some regions have received national-level economic structural adjustments, and economic growth has slowed down or even declined, triggering population migration and continuous shrinkage;
Resource-based city with a single industrial structure. Once the resources are exhausted, the overall economic decline of the city will result.

2) **Environmental causes**, e.g.(natural) disasters, pollution or epidemics

3) **Political changes and social turmoil.** Shrinking cities can also be the result of controlled (re) settlements, the political definition of depopulation areas, or the retreat from former controlled colonisation areas. For example, other influencing factors such as the disintegration of the socialist system in Eastern European countries have changed ideology and caused great changes in economic structure.

4) **Long-term low birth rate and population aging.** The new population cannot fill the aging population and the loss of labor force, resulting in urban shrinkage, which is the mostly cause of urban shrinkage in Japan.

5) **(Sub)urbanisation (including hollowing out, segregation and sprawl):** Suburbanization is "the process by which cities expand peripherally, initially by out-migration of population and economic activity from dense urban cores, to less dense contiguous settlements. Developments in transport technology-such as railways, tramways, and improved roads-have aided suburbanization." (Scott et al., 2009) The more 'spacious' conditions in suburbs and the availability of the automobile causes residents and urban functions move from cities to the suburbs, which finally causes the shrink of urban centers。

1.1-URBAN SHRINKAGE IN CHINA

1.1.6 CONSEQUNCES OF URBAN SHRINKAGE

1. Insufficient human resources

The biggest issue facing cities that are constantly losing residents is a shortage of human resources. In the past, the growth of cities that were shrinking was frequently focused on a single resource or sector. The population's vocational education also placed a strong emphasis on serving these industries, and social ties within families or between people were largely responsible for the recruitment of industrial workers. Under such a model for a long time, this approach made it harder and harder for towns to shift economically. The direct result is that there are fewer employment prospects and a smaller proportion of small and medium-sized business employees in shrinking cities than in non-shrinking cities.

Young individuals who are comparatively more capable, have better education, possess certain talents, and are more innovative make up the majority of the population leaving diminishing cities. These skills are essential for the growth of regional innovation systems and the local economy. The loss of social interaction and the public sphere due to population heterogeneity will result in knowledge and cultural gaps, local innovation systems will become more cut off from the process of globalization as a result of talent exodus, and the competitiveness of the entire region will further deteriorate. In addition, an image of revitalization/growth can expand the future of urban development, while an image of decay can limit the possibility of urban development.

2. Fiscal crisis breaks out

Cities that are getting smaller will have more financial issues. The following characteristics demonstrate how the execution of steps to stop population loss will not be financially supported by the falling tax bases and tax revenues of smaller cities:

First, the public financial expenditure based on the assumption of urban growth has been significantly reduced;
Second, local tax revenue and local disposable fiscal revenue have decreased as a result of the population decline and the economic recession of individuals and enterprises;
Third, due to gloomy future predictions for future home prices, the increase in empty structures has resulted in a decrease in local corresponding tax collections and decreased property prices;
Finally, infrastructure and public services become less effective, however, when a city gets smaller, its actual space won't get smaller, infrastructure and public services must both maintain their magnitude. Additionally, low usage failures will result in increased follow-up maintenance expenses, which would gradually raise the unit cost and transaction cost of public services.

As a result, in declining cities, the decline in overall population does not translate into a decline in fiscal spending, and the per capita spending will rise as the population declines. Cities must also pay the additional expenses brought on by regional population migration.

3. More vancancy and abandoned buildings

The phenomenon of population decline in diminishing cities has led to a sharp rise in housing and land vacancy rates, which has a significant impact on public safety and the urban environment in addition to substantially lowering real estate-related taxes. Preventing the illicit dumping of construction trash, household waste, and other hazardous materials on vacant land has grown to be a major concern for relevant management departments in diminishing cities. And in the aging, declining industrial cities, it will be very expensive to clean up the soil that has been contaminated year-round by industry. Urban low-income individuals, the unemployed, and even criminals can live for free in vacant buildings, making them prime locations for the emergence of epidemics and the breeding grounds for illegal activities like drug trafficking and gambling. A growing sense of insecurity in the region and an increase in crime as a result of the growing number of unoccupied buildings have forced several local inhabitants to leave.

4. Planning is more challenging

Urban planning is currently moving in the direction of growth-oriented planning, which is based on an analysis of previous development strategies. As a result, the planning is less successful when the phenomenon of urban shrinkage happens since there is less coherence between it and the real situation. Planning and forecasting will become more challenging as a result of urban shrinkage, which is characterized in particular by erratic changes in population size.

The low appeal of idle buildings and land in cities to new investors presents planners with another challenge. Local and foreign investors frequently prefer to establish new areas in the city's periphery rather than develop the difficult-to-access and filthy old inner city areas since the expense of repairing older urban areas is higher than that of new land development. As a result, in diminishing cities, managing and making use of idle buildings and land has become one of the challenging issues that will take a while to resolve.

Fig.a)Vacant buildings in Detroit(Source: HTTP://EN.WIKIPEDIA.ORG/WIKI/FILE:ABANDONED_PACKARD_AUTOMOBILE_FACTORY_DETROIT_200JPG.); b) Vacant brownfield (Source: https://www.archdaily.com/964908/shrinking-cities-the-rise-and-fall-of-urban-environments);

1.1-URBAN SHRINKAGE IN CHINA

1.1.7 THE UNIQUE CHARACTERISTICS OF SHRINKING CITIES IN CHINA

Chinese shrinking cities have some unique characteristics that are not similar to their counterparts in developed countries.

First, The share of shrinking cities in China is 1/4-1/3 of the amount, both in terms of administrative cities and in terms of mentioning is scope. In addition to districts and counties with population loss, we found 266 SCs from 2010 to 2020, accounting for 39% of all 684 cities in China.

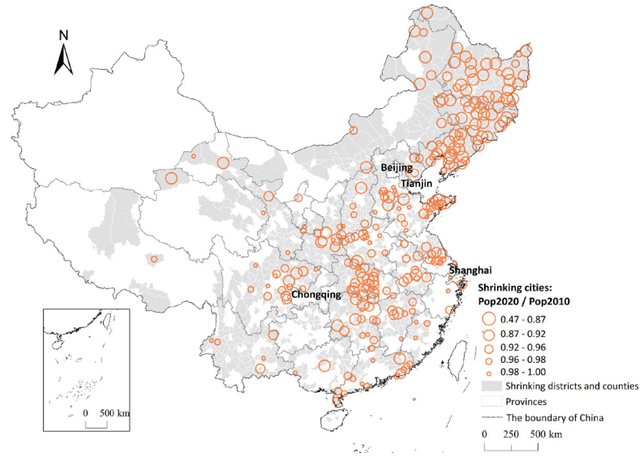


Fig. Shrinking territories at the county, district and city levels in China from 2010 to 2020. (Meng and Long.2022)

Second, while the population of each city is getting smaller, its land development and urban building sites are invariably growing.

Fig. The typology of shrinking cities in terms of population shrinkage and spatial expansion. (Yang et al., 2015)

Third, although the population is being lost, the extent of the loss is not as great, the proportion of depopulation of Chinese shrinking cities is much lower than their counterparts in developed counties. Some shrinking cities in the West do lose a lot of people, for example, the City of Detroit, Michigan, has lost over 60% of its population in the last 60 years and 25% in the recent 10 years (Neill, 2015); However, in China's urban shrinkage phenomenon, the majority of the population decline is below 10% during 2000–2010.

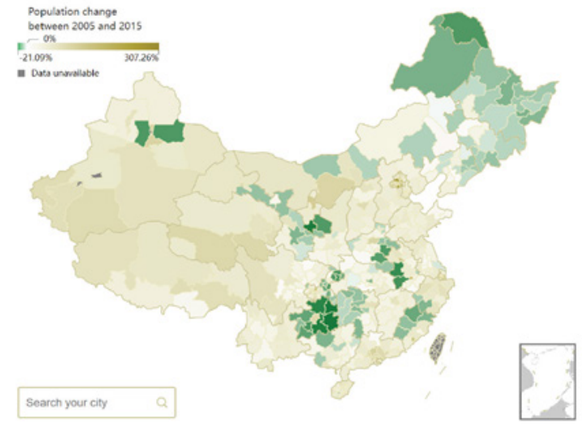


Figure. Map of China showing municipalities' population changes from 2005 to 2015. (Source: 2005 and 2015 provincial statistical yearbooks.) http://ronghuichen.com/freezing_land/

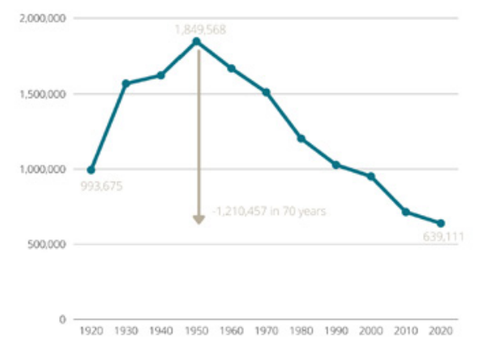


Figure. Detroit population1920-2020. (Source: Source: U.S. Bureau of the Census, 1920-2020)

Fourth, shrinkage has a lag effect on the urban economy: the population becomes smaller first, then the economy declines, and after that, the physical space begins to show scenes of decay and depression. Most shrinking cities have experienced economic growth during their depopulation process.

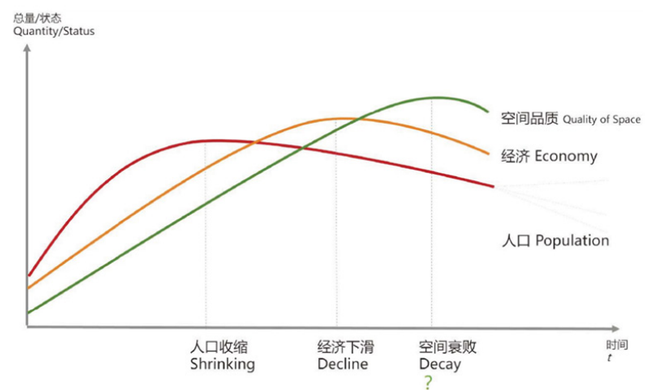


Figure. Theory/Hypothesis on Decreasing Population, Economy and Quality of Space. (Li and Long.2017)

Therefore, the four unique characteristics suggest that it is necessary to study shrinking cities in China add to global literature for enriching the related urban theories.

1.1-URBAN SHRINKAGE IN CHINA

1.1.8 TYPES OF SHRINKAGE BASED ON CAUSES IN CHINA

1)Resource-based cities:

Resource-based cities formed and developed due to resource extraction and primary processing are shrinking cities under the influence of resource exhaustion (or about to be exhausted).

Fig. Open mine in Resource-exhausted city Fuxin; Forest in Resource-exhausted city Yichun. (Source: Baidu Image)

2)Industrial cities which experienced painful economic transition:

For example, some heavy industrial cities in Northeast China cannot adapt to the needs of industrial transformation and upgrading. Their industrial structure is relatively simple, and their economic development is overly dependent on a certain traditional industry. The industrial development has stagnated or even shrunk, and we have to face the dual crises of industrial decline and population outflow.

Fig. Industrial city which needs to transform. (Source: Bloomberg)

3) Cities in less developed areas:

Residents in such areas, especially young people, will take the initiative to seek a relatively better living environment and employment environment outside. As a result, the population loss will be unstoppable, becoming a typical "population outflow city".

Fig. Hollow village. (Source: Google Image)

4) Geographically remote cities:

These cities are not transportation hubs, are far away from large urban agglomerations, and lack resource support themselves. In the wave of urbanization, they are the least attractive to the population.

- Cities at the border

Located in a remote border area, the geographical location conditions and traffic accessibility are poor, and usually lack "dialogue" with the international and domestic markets. A large outflow of development elements with population as the core leads to urban shrinkage.

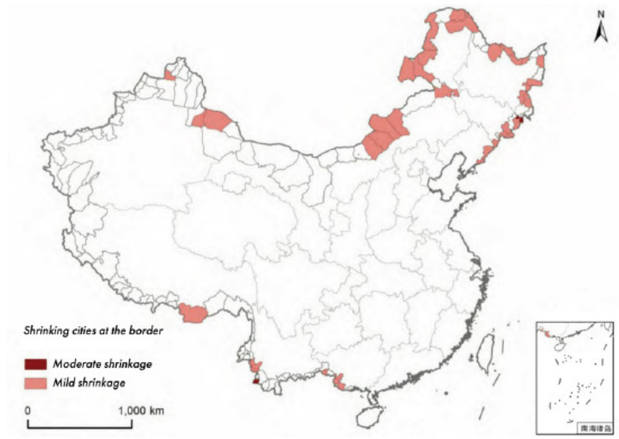


Fig. Distribution of shrinking cities at the border. (Source: Made by Author)

5) Passive Siphoning Cities:

Due to the siphoning effect of large cities on neighboring cities, the population of neighboring cities is constantly pouring into the core cities.

Fig. City clusters in China as planned. (Source: National Development and Reform Commission, 2016)

1.2-URBAN DEVELOPMENT IN POST-INDUSTRIAL ERA

1.2.1 CHINA REACHING THE LEWISIAN TURNING POINT

Since the start of its reform and open-door policies, the Chinese economy has been growing rapidly at an average annual growth rate of nearly 10%. One factor that has enabled this is the abundant supply of labor, which was practically unlimited.

Fig. Internal Labor Movement 1990-1995 . (Source: Corsman, 2015)

However, because of the effect of China's "one-child policy," which has been implemented since the early 1980s to control the population, growth in the working-age population is now about to turn negative. In addition, amid the migration of the labor force—mainly young workers—from rural to urban areas due to industrialization and the easing of the household registration system, China has passed the "Lewisian turning point" to enter into a full employment stage in its development process, with its **LABOR SUPPLY TURNING FROM A SURPLUS TO A SHORTAGE**.

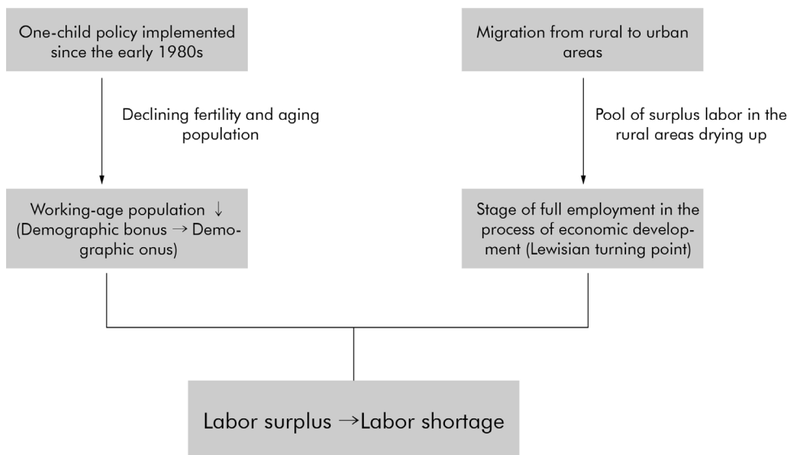


Fig. China Shifts from Labor Surplus to Labor Shortage. (Source: Kwan, 2012)

China is experiencing two turning points:

one from an increase to a decrease in its working-age population;
the other from underemployment to full employment in its economic development process, or the Lewisian turning point.

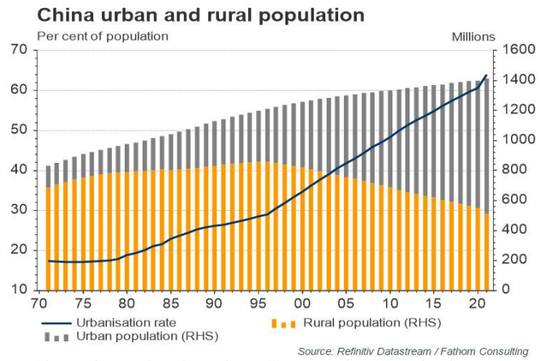


Fig. China Urban and rural population (Source: Fathom Consulting);

As a result of the rapid migration of the labor force, particularly younger workers, from the rural areas to the urban areas, there are no longer excess workers in the rural areas.

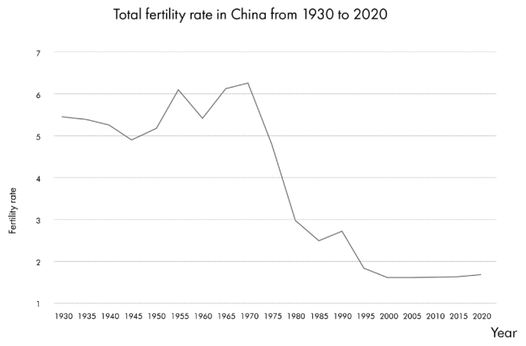


Fig. Total fertility in China 1930-2020 (Data Source:various source, UN DESA; Gapminder);

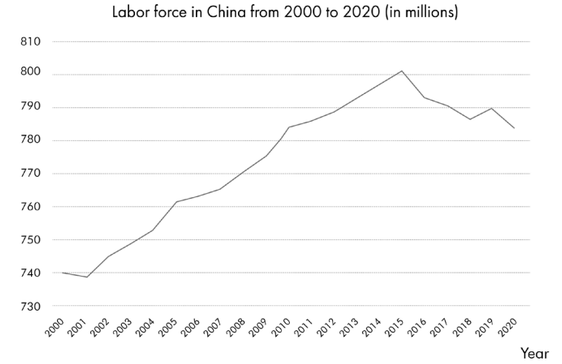


Fig. Labor force in China 2000-2020 (Data Source:National Bureau of Statistics of China);

"According to a study by Zhang and Yang, China reached the Lewis point in 2010 ; The Lewis turning point is a situation in economic development where surplus rural labor is fully absorbed into the manufacturing sector(Lewis, 1954)."

The drop in the working-age population and the arrival of this Lewisian turning point will not only lower China's potential growth rate, but also will have a large impact on wages, prices, income distribution, economic structure, government economic policies, international trade, and direct investment.

1.2-URBAN DEVELOPMENT IN POST-INDUSTRIAL ERA

1.2.2 GLOBAL FINANCIAL CRISIS

In 2008, the US subprime mortgage crisis triggered a financial turmoil on Wall Street, radiated to Western countries through the financial market, and gradually evolved into a global financial crisis, which caused serious damage to the economies of various countries.

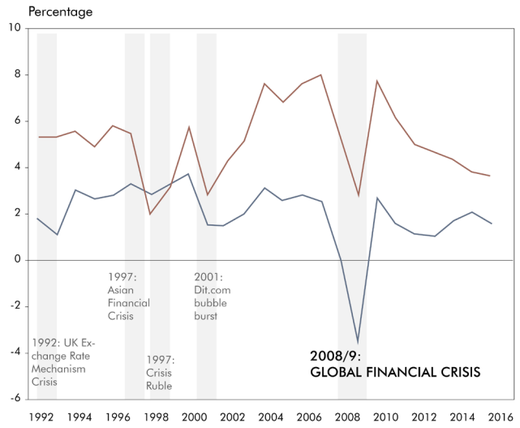


Fig. World GDP growth 1998-2015. (Data Source: UN/DESA)

The most obvious impact of the financial crisis on China's economy is the decline in exports, which is the result of reduced imports from the United States and other countries. Due to the impact of the financial crisis, the confidence of American consumers has been hit to some extent, which has led to a decrease in their consumption demand to some extent, resulting in a serious decline in China's exports to the United States.

China's economy is highly dependent on foreign trade. Over the years, China has mainly relied on high-speed export growth rates and investment to promote its GDP growth, maintaining a very rare sustained high-speed growth momentum with this development model. It can be said that export trade is an important pillar supporting China's economic growth. According to Chinese official statistics, about 40% of China's GDP is driven by exports.

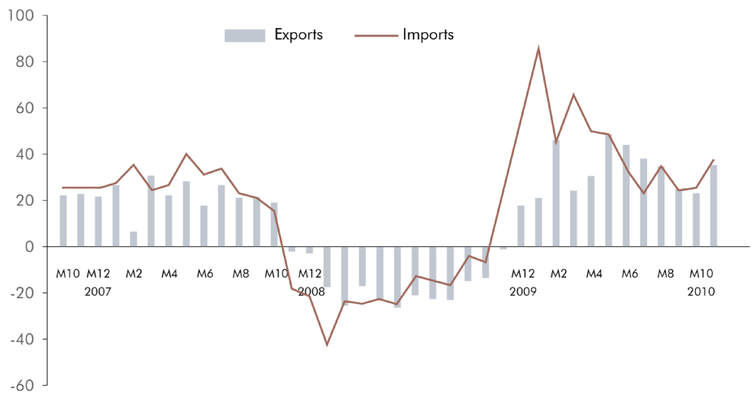


Fig. China's Gross Exports and Imports Growth. (Data Source: IMF International Financial Statistics)

After the outbreak of the international financial crisis, China's economic growth rate has dropped rapidly, business investment has declined, exports have experienced negative growth, personal consumption willingness has declined, and a large number of migrant workers have returned to their hometowns. The economy is facing the risk of a hard landing.

The financial crisis is not a problem that can be solved in a short period of time. Under such circumstances, China's foreign trade will experience a long-term trough, which forces China's economic policymakers to further think about China's economic policy issues, such as reforming the export-dependent trade policy and improving National income stimulates domestic consumption, increases investment, etc.

For example, in 2008-2009, in order to further expand domestic demand and promote stable economic growth, the State Council announced a 4 trillion yuan (585 billion US dollars) investment budget plan, focusing on infrastructure construction, investment projects such as railways, highways and airports Accounting for 37.5% of the new 4 trillion investment plan. Due to the huge space for China's infrastructure construction, this kind of project is conducive to the promotion and improvement of the domestic economy, can stimulate the development of many industries, and can also create more employment opportunities, helping the government change due to the large-scale unemployment caused by the financial crisis.

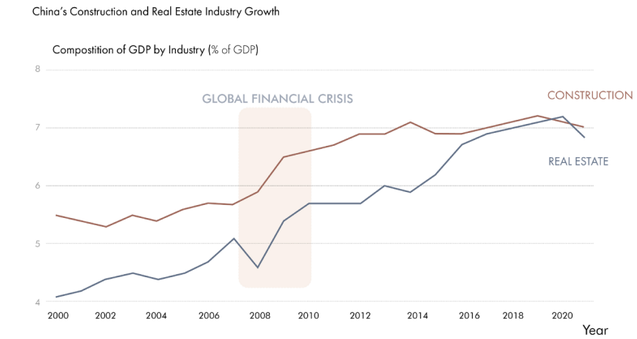


Fig. China's construction and real estate industry growth. (Data Source: National Bureau of Statistics of China)

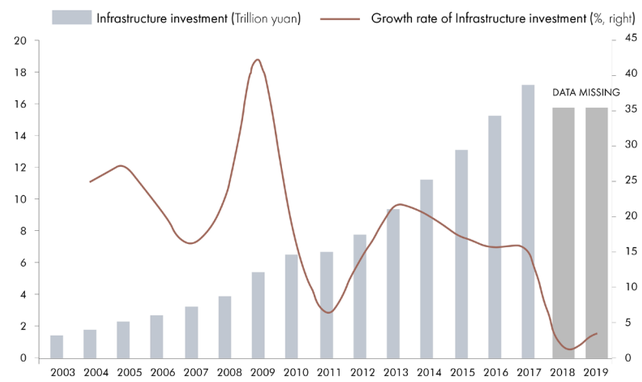


Fig. China's Infrastructure investment and its growth rate. (Data Source: Wind, Yuekai Securities)

After the international financial crisis, the economic growth of Chinese cities began to appear "diversion", the standard deviation of the real GDP growth rate increased significantly, and the polarization tendency between large cities and small and medium-sized cities was serious; some cities such as Shenzhen and Hangzhou seized the opportunity, They have quietly completed several industrial transformations and upgrades, and they are full of vitality; some cities have never recovered from a setback, falling into the dilemma of a single industrial structure, and their economic growth has stagnated.

1.2-URBAN DEVELOPMENT IN POST-INDUSTRIAL ERA

1.2.3 NEW NORMAL OF ECONOMY

The “new normal” means the Chinese economy has entered a new phase that is different from the high-speed growth pattern exhibited in the past. It is a new trend that features more sustainable, mid- to high-speed growth with higher efficiency and lower costs. The driving force of economic growth has evolved from scale-oriented to value creation, no longer sacrificing the environment and wasting resources for growth.

The new normal state has several key characteristics:

Mid- to high-rate growth

"The growth slowdown from a high rate of around 10 percent to now about 7 to 8 percent is inevitable," said Wang Yiming, vice secretary-general of the National Development and Reform Commission.

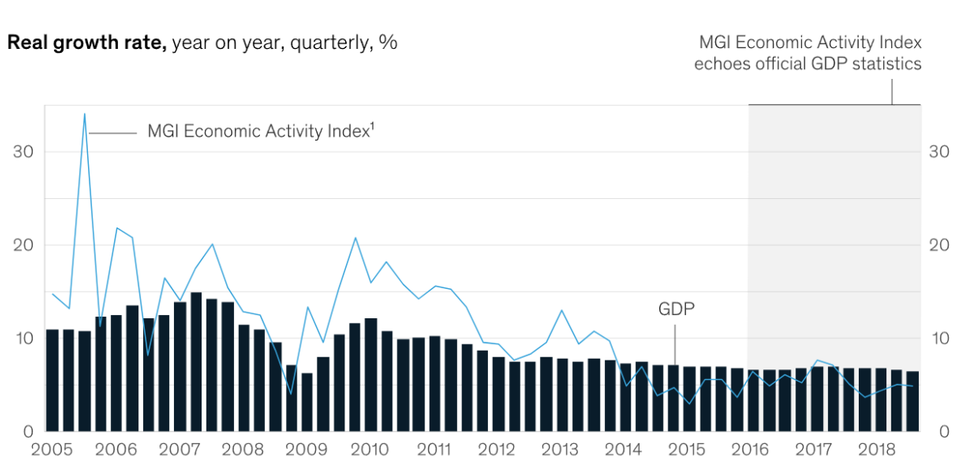


Fig. China GDP and grwoth. (Source: McKinsey& Company)

New engines

Under the new normal state, the Chinese economy will transform from the production investment-driven model into an innovation-driven model.

"The prolonged difficulties facing manufacturing industries show China can no longer rely on low cost production factors, as the prices of labor, resources and land are soaring,” said Zhao Jinping, an economy researcher with the Development Research Center of the State Council. “Technological innovation must become the main driving force.”

Structure upgraded

During the new normal state, the economic structure will undergo comprehensive and fundamental changes. The service industry will gradually become a backbone of the national economy and consumption will be the main source of demand. The gap between urban and rural areas will gradually shrink and people’s income will account for a larger share of the national economy.

Amid that process of restructuring, some industries will wither and suffer from the problem of over-productivity. Meanwhile, some new growth points will spring up.

- Green transformation and development

- The third industrial revolution: "Internet + new energy". Technological, global, green, customized and niche industries have become the characteristics of the new industrial revolution

-New energy revolution

- Industry 4.0

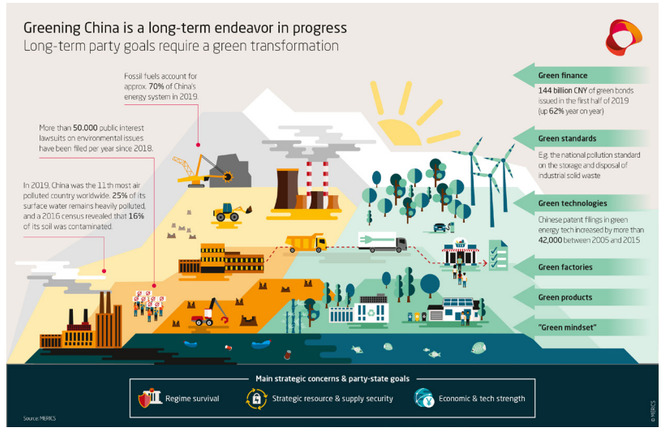


Fig. Greening China. (Source: MERICS)

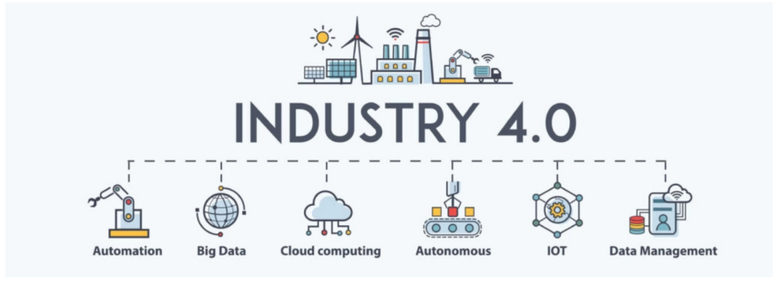


Fig. Industry 4.0 (Source:dat4zero)

Challenges ahead

The new normal state has some uncertainties and challenges. The Chinese economy has fluctuated within a comfort band this year, but the risks posed by real estate bubbles, local government debt and financial uncertainties have surfaced. Those risks are inter-related and problems in any one link could trigger a chain reaction.

1.2-URBAN DEVELOPMENT IN POST-INDUSTRIAL ERA

1.2.4 RESOURCE-BASED ECONOMY

Resource-based economy is a kind of specialized functional economy, which refers to the economy that rises with the development of resources, or the economy that thrives again due to the development of resources in its development process. As a special type of economy, an economy built or developed basically relying on resource development, its leading industries are extractive industries and primary processing industries built around resource development. The industrial development mode of "high consumption, high investment, and high pollution" of the resource-based economy has many disadvantages. While developing the economy, it leads to the excessive consumption of natural resources and the destruction of ecological environment. It is an unsustainable production and consumption mode.

Resource-based cities refer to those with mining and natural resources processing as the leading industries (The State Council of the PRC, 2013). The emergence and development of such cities are inseparable from industrialization. Up to now, there are 126 prefecture-level and 120 county-level resource-based cities in China. These resource-based cities are further classified into four types: growth, mature, recession and regeneration (The State Council, 2013). Relying on rich resources such as energy and minerals, these cities have become China's industrial bases and contributed to China's economic development.

Resource-based cities are differentiated based on the resources in which they are rich, such as oil, coal and forestry. Coal mining cities comprise a majority of prefectural-level resource-based cities with a total number of 57, and account for the highest proportion of shrinking cities (25%). The total number of metal mining cities (40) ranks second, followed by the non-metal mining cities (12) and oil mining cities (10).

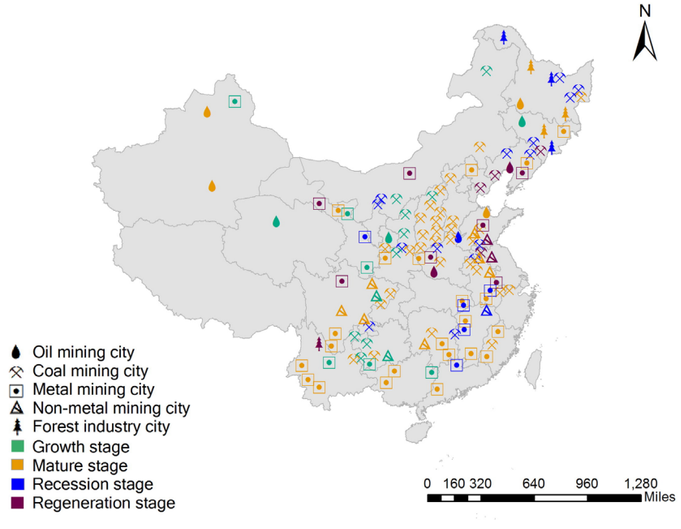


Fig. Map of resource-based cities in China. (Source:Hea et al, 2017)

Although a number of resource-based cities have high income levels, their unsustainable nature is also recognized because they rely on considerable natural resources (Walker and Jourdan, 2003).

1.2.5 RESOURCE DEPLETION

As a valuable asset that the earth has given to human beings, natural resources have always been regarded as the key support for human society and economic development. With the continuous advancement of human society, the role of natural resources in promoting economic growth has become increasingly prominent (Wang and Sun, 2019).
However, the supply of natural resources that are relied on by the resource-based industry for its mass production are unsustainable, since these non-renewable resources will eventually be depleted. For example, coal, as one of the main resources for industry, is a non-renewable resource, which means it does not grow back, or a resource that usually takes a very long time to renew.

> *"Resource depletion is the consumption of a resource faster than it can be replenished. Natural resources are commonly divided between renewable resources and non-renewable resources. Use of either of these forms of resources beyond their rate of replacement is considered to be resource depletion. Resource depletion is most commonly used in reference to farming , fishing , mining , water usage, and consumption of fossil fuels ." (Wilkipedia)*

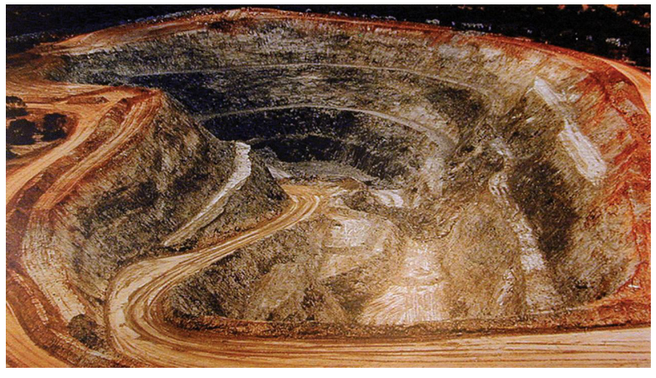


Fig. Mine. (Source:Google image)

Current supply and demand of mineral resources in China is very challenging (Zhai et al., 2019). The continuous rapid consumption of resources in China has drawn global attention; the ability of these resources to meet the next stage of development would be a great challenge for China and the world.

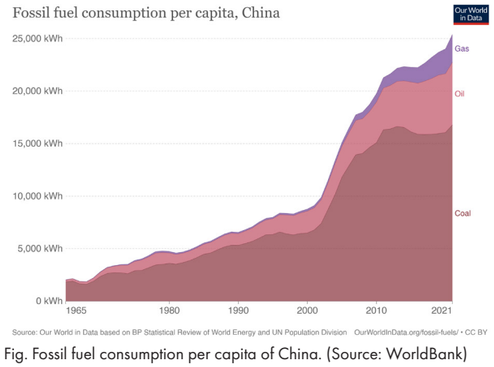


Fig. Fossil fuel consumption per capita of China. (Source: WorldBank)

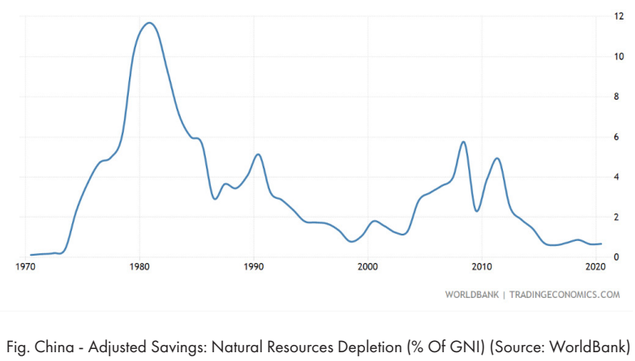


Fig. China - Adjusted Savings: Natural Resources Depletion (% Of GNI) (Source: WorldBank)

1.2-URBAN DEVELOPMENT IN POST-INDUSTRIAL ERA

1.2.6 RESOURCE-EXHAUSTED CITIES

Resource-exhausted cities indicate the cities whose natural resources are exhausting, and whose accumulated exploitation reserves have reached more than 70% of the recoverable reserves. These types of cities could encounter many sustainability risks caused by the resource curse, such as slowing economic development, difficulty in economic transformation, sluggish in fostering new growth points, rising unemployment, insufficient innovation capacity, and deterioration of environmental and ecological systems. (Xiao et al.2021)
There were 69 resource-exhausted cities nationwide by the end of 2011, according to the National Development and Reform Commision.

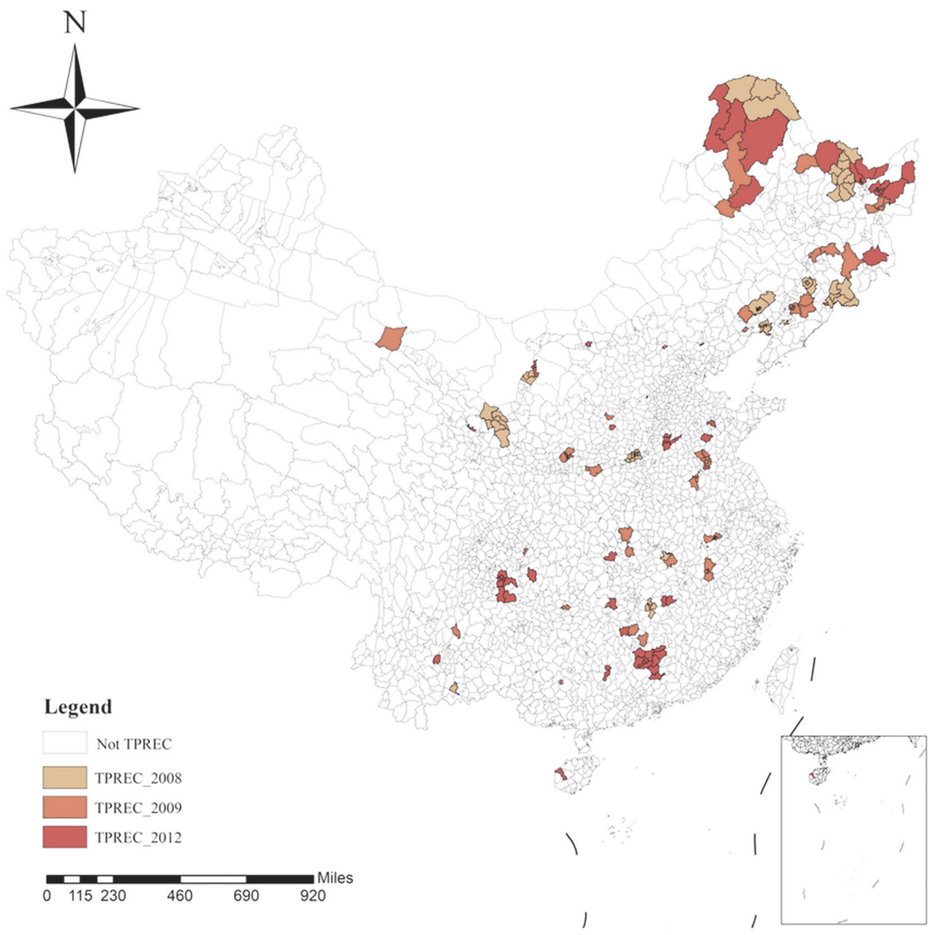


Fig. Resource-exhausted cities in China. (Source: Made by author)

Resource-based cities have played an important rolein the process of national economic development. However,as the amount of resource extraction increases year by year,cities with resource-based economic development must alsoface the results of economic transformation. Resource-based industries need to go through the following stages: explora-tion period-mining period-stable production period-declineperiod, and then resource-based cities will either face aperiod of exhaustion and decline, or choose to transformand develop. The same is true for the urban economicdevelopment process. After the prosperity period, therewill inevitably be a period of recession or transformationand revitalization.Therefore, in summary, if resource-based economiccities want to further promote the development of the city,they must carry out economic transformation.

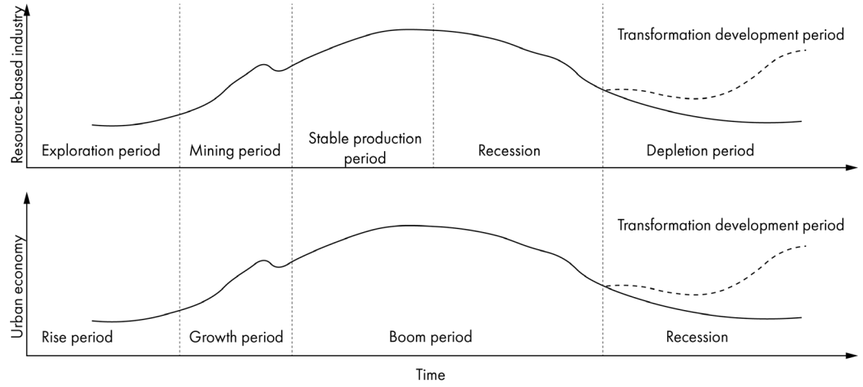


Fig. Resource-based city life cycle diagram. (based on Zhu et al., 2021)

Fig. Photos of Resource-based cities. (Source:Sohu)

1.2-URBAN DEVELOPMENT IN POST-INDUSTRIAL ERA

1.2.7 DEVELOPMENT CHARACTERISTICS OF RESOURCE-EXHAUSTED CITIES

HEAVY RELIANCE ON RESOURCES

Natural resources are the basis for the growth of resource-based industrial cities and are vital to the income and employment of urban residents. The urbanization and inudustrialization of these cities are due to resource extractions and the size of the city is influenced by the degree of resource development.

A SINGLE-PRODUCT ECONOMY

Resource-based cities rely excessively on the development of natural resources. Once the resources are on the verge of depletion, the dominant industry gradually declines until it stagnates, and it is often difficult to cultivate and develop alternative industries or new industries in a timely and effective manner; the urban economy is mainly composed of secondary industries, and the development of the remaining industries is constrained to a certain extent; In addition, the demand for labor and the training of talents in the dominant resource-based industries are usually centered on a single industry, and the reduction in the scale of resource industries leads to a decrease in employment opportunities, making it more difficult to re-employ the laid-off unemployed; The single industrial structure makes its economic interaction with the outside world relatively single, and the city is almost a replica of the enterprise, the city market regulation mechanism is not sound, lacking the conditions and advantages to cope with market economy and globalization

HEAVY SOCIAL BURDEN

The extraction and processing of resources require a large amount of low-cost labor, yet the depletion of resources leads to the decline of the dominant pillar industries born from resources, decreasing employment opportunities and generating many laid-off and unemployed people. At the same time, the decline of resource production and enterprise efficiency also affects fiscal revenue and expenditure and input to public goods; the decrease of labor income leads to the decline of residents' living standard, which in turn affects total social demand.

THE VULNERABILITY IN THE ECOLOGICAL ENVIRONMENT

Resource-based cities and industries' predatory and sloppy exploitation of resources have led to a series of ecological and environmental problems. The wastewater, waste gas and slag produced by mining have caused great damage to the environment, seriously affecting the ecological balance, human survival and development, and hindering the sustainable development of resource-based cities. The overuse of mines has led to mountain destruction, vegetation degradation and ground subsidence; the over-exploitation of underground resources has led to geological damage, such as ground sinking due to over-extraction of groundwater.

IMPACT THE STRUCTURE OF URBAN SPATIAL DEVELOPMENT

Resource-based cities are usually established according to the distribution of natural resources. The random and scattered distribution of mineral resources in geographic space makes the extractive industry also show the characteristics of spatial decentralization, and around the decentralized extractive industry form a number of independent industrial and mining areas and mining towns, making the city population and industry are more scattered in space, making the city can not be compact development, the concentration of economic activities in the central city of resource-based cities is reduced, forming a more loose urban In addition, under the development orientation of "production first, then life", the development of service industry in the central cities of resource-based cities is generally low, which further weakens the agglomeration ability of the central cities.

Fig. Piles of coal in Hegang, Heilongjiang province, 2015. (Source: VCG)

1.3-MISMATCHED PLANNING WITH REALITY

1.3.1 GROWTH-ORIENTED PLANNING

Existing academic literature has identified the pro-growth paradigm as the dominant one in China since 1978.

After the transformation to market economy in 1978, local government has been given greater fiscal responsibility and more power over urban planning (Zhao, 2015). China's tax-sharing system reform in 1994 regulated that local municipalities should transfer up to 75% of local taxes to the central government (Peng, 2014). Under the reformed system, local government has to operate with relatively less tax revenue at disposal but with identical responsibility as before (Huang & Chan, 2018). As a result, land economy reform is used by local government to generate income through urban expansion and increased commercial land use to battle fiscal distress (He et al., 2016). During this process, local government tends to collaborate with private companies to promote pro-growth urban development (He & Wu, 2009). This development pattern leads to an over-supply of housing and property. However, in fact, they are relying on overdrafting the future benefits of social and economic development to seek immediate rapid growth. This has increased the dependence of local governments on land finance and continued to intensify the establishment of The financial crisis of local governments on the land. This growth model will lead to various hidden crises in the economy, society, and ecology, as well as various governance contradictions.

Fig. Most Chinese Provincial-Level regions under heavy debt burden. (Source: Caixin.com)

Apart from the economic development goals, alignment with the development concept promoted by the central state is also an essential element in the assessment of local government officials (Wu & Zhang, 2022) and the basis for the coordination among different levels of actors (Wu, 2018). GDP-ism in the Cadre Appointment System encourages local leaders to use urban development as a tool to reach high “political performance levels” in their competition for promotions (Li & Zhou, 2005).Such behavioural pattern of local government officials, which simultaneously emphasises economic growth and the development concept promoted by the central government, impacts urban development in shrinking cities.

The cadre promotion system as well as Chinese local authorities utilize the urban land leasing and development process to maximize their personal gains, push forward the “**URBAN GROWTH MACHINE**.”

1.3.2 STATE-OWNED COMPANY

In China, State-owned companies are frequently utilised as a mechanism for implementing policy, providing socioeconomic stability and building infrastructure.Such institutional system is developed from the planned economy legacy established after the establishment of China. State-owned companies were set up and developed into ‘self-sufficient microsocieties marked by high levels of functional integration, supported by schools, shops, clinics, transport systems, and other basic services' (Douglass et al., 2012, p.171). In resource-exhausted cities, more than 50% of enterprises belong to resource enterprises, and among resource enterprises, state-owned enterprises dominate. Urban development was built around the development of state-owned companies. State-owned companies continued to receive financial subsidies and land from the government system in order to survive. Since the 1978 economic reforms, the central government initiated the separation of state from state-owned companies, which led to the laid off of workers (Girma & Gong, 2008).

Accompanied by a single industrial structure is a single employment structure. Once the resource-based industries experience recession, it is inevitable that a large number of workers will be laid off. With the resource depletion and the upgradation of industrial technology, excessive labour has been laid off, state-owned companies' social function of providing jobs was gradually lost.

The dispersion of power both vertically in state-owned companies' production chain and horizontally in different domains of urban life led to the formation of a web strongly influencing socio-economic development of resource-based industrial cities. This stable, lock-in development meant that this type of cities was lacking the drivers of change towards the market economy. Under the planned economic system, some departments and people still have a strong "waiting, relying and requesting" mentality, hoping to rely on the state and the government to solve everything. This mentality has hindered the transformation process to a considerable extent.

Moreover, the development of private companies was constrained with the strong presence of state-owned companies, they were lack of development space. This development pattern of state-owned companies and their related institutions hindered economic transition in Northeast China.

Since the peak of China's coal market in 2013, it has been going downhill. Some subsidiaries of Heilongjiang Longmay Group, which have reorganized Hegang, Jixi, Shuangyashan and Qitaihe, the "four major coal cities", have suffered continuous losses and wage arrears, and the capital chain is on the verge of breaking, mine depletion and many other problems, the difficulties lasted for two years.

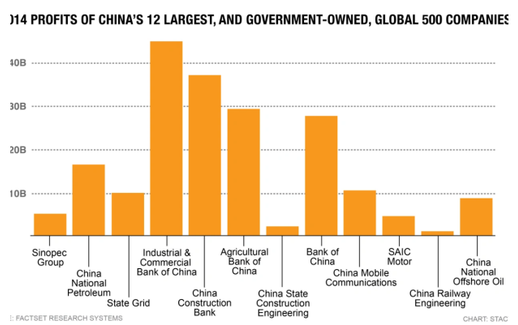


Fig. Most of China’s Global 500 companies are state-owned.(Source: https://fortune.com/2015/07/22/china-global-500-government-owned/)

1.3-MISMATCHED PLANNING WITH REALITY

1.3.3 ACTORS IN GOVERNANCE

Under China's socialist political-economic system, the government is explicitly responsible for planning and managing the national economy. The state leads the country's economic development, and the State Council leads its subordinate agencies to formulate and implement national economic plans and state budgets. A major part of the government agency is devoted to managing the economy.

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Fig. Several Opinions on the Comprehensive Revitalization of the Northeast Region and Other Old Industrial Bases. (Source: Baidu)

Premier Wen Jiabao held a State Council meeting in 2003 regarding the issue of reviving northeast China. The meeting saw the drafting of the document "Certain Opinions Regarding Implementing the Strategies of Reviving the Old Industrial Bases Including the Northeast", which would be jointly disseminated by the Central Committee of the CCP and the State Council in October 2003. The core of the program is to revitalize the region's traditional industry, while speeding up development in aspects of structural regulation, regional cooperation, economic reform, the construction of an environment-friendly economy, and increased efforts in education, healthcare, and cultural projects.

The State Council established a special Leading Group to define and adopt related strategies.The State Council asked the Northeastern provinces to better coordinate their economic development strategies.

Threatened by unemployment and salary cut, China's urban planners voluntarily evade from the plan-making process and became the pure executors of governmental officials' decision (Zhang 2002), they have defined themselves as “technicians”, whose job is to specify governmental officials' vision through a series of ostensibly “reasonable” blueprints.

During the implementation of urban policy, the overarching development discourses are established by local urban planning and policy, consisting of Five-year Plans for Social Economic Development (FYPs), urban master plans and land use plans.

Moreover, respected professionals and academics bear weight in advocating for public interests (Zhang, 2002). However, their advocacies tend to be in alliance with government officials' preferences rather than purely public interests (Abramson, 2006). Meanwhile, the participation level of non-government organisations is still considered to be low (Zhao, 2015).

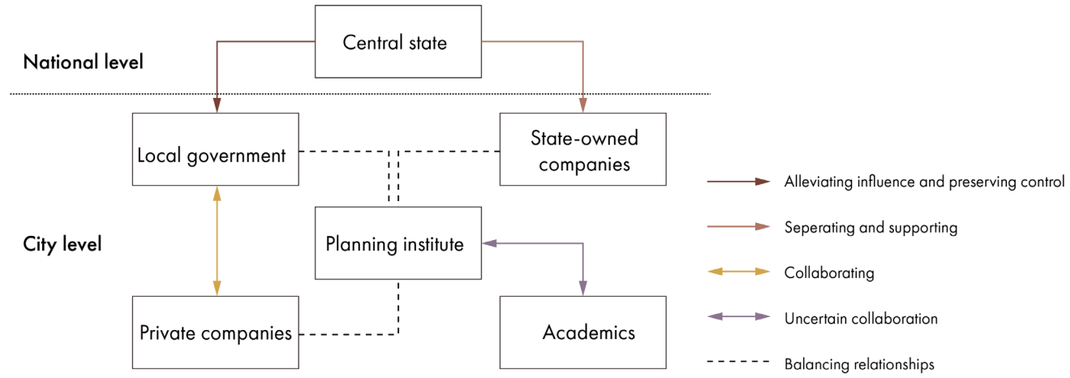


Fig. Stakeholders in planning system. (Source: Baidu)

1.3-MISMATCHED PLANNING WITH REALITY

1.3.4 THE PARADOX OF PLANNING FOR SHRINKING CITIES IN CHINA

Chinese shrinking cities adopt the growth-oriented paradigm and therefore yield two paradoxes. First, although keeping losing population, their built-up areas continue expanding. Second, in contrast to the population loss, most shrinking cities' master plans project population growth in the future.

The Institutional Paradox

After the "reform and opening-up," China's grand marketization transition has triggered a series of subordinate reforms, in which the 1994 tax reform and land marketization have largely contributed to the growth-oriented paradigm. Aiming to solve central government's fiscal hardship due to the insufficient revenue between the late 1980s and the early 1990s, the central government inducted a new tax system named "tax sharing. The tax reform drastically increased the central government's share in total governmental revenue. Therefore, the new tax system transferred the financial hardship from the central government to local governments. In order to deal with the hardship, local governments have to expand the extra-budgetary funds, including the state-owned land leasing fee, which takes the largest share of its kind (Holzer and Zhang 2004).

On the other hand, during the economic transition, urban land has been gradually commercialized. Although the land marketization process does not change the urban land's state-owned tenure status, it has commercialized its use right by creating "state-owned land leasing system," which subsequently generated a large amount of leasing fee and boosted local economy through emerging developers. The cancelation of welfare housing since 1998 coincided with China's rapid urbanization growth that millions of new urbanized residents have switched to the real estate market to seek residence. Booming real estate market successfully attracted large sums of developers to engage in urban land leasing auctions, which have generated massive revenue for local governments and have largely covered the gap between local governments' revenue and expenditure. This process has been interpreted as the "second capital circulation" from the Neo-Marxism perspective (Harvey 1978) that the growing fixed asset investment has become the major momentum of local economy.

Moreover, new cadre promotion system becomes another major incentive for China's urban expansion. The grand economic reform has changed the Chinese governmental officials' evaluation criteria from political conformity to a package of new features including good education, good local economic performance, and expertize in the specific sector. Li and Zhou (2005) have demonstrated that local economic performance is the most influential factor for governmental officials' political prospect. Under the fierce competition, municipalities have tried various ways to maximize the local economic growth, among which urban land expansion and its related industries have played an important role. Therefore, a great amount of fiscal revenue, a substantial GDP growth rate, and the bright political prospect come together to induce local governmental officials' obsession on urban land expansion, and to push themselves to engage in the land development process (Lichtenberg and Ding 2009).

However, the government officials' frantic desire for urban land development has to be authorized through the legitimate urban plans. This gives rise to the booming industry of urban planning in China. In contrast to the role of curbing irrational urban development in the Western world, Chinese urban planning has served as the facilitator of urban expansion (Wu 2015). Additionally, threatened by unemployment and salary cut, China's urban planners voluntarily evade from the plan-making process and became the pure executors of governmental officials' decision (Zhang 2002). However, China's legislations confined planners' discretion by requiring a higher level government to approve some important urban plans from a lower level government. Thus, many Chinese urban planners have defined themselves as "technicians", whose job is to specify governmental officials' vision through a series of ostensibly "reasonable" blueprints.

Among multiple urban plans in China, the urban master plan has the largest influence on shaping a city's future urban landscape. It designates a city's future pattern of land use, as well as a city's major economic and political function in the region and the large urban agglomeration. Besides, a city's urban master plan also guides many related plans. In this respect, China's urban master plan and many other related plans have become the most important media for local authorities to pursue fiscal revenue, economic growth, and personal gain. Therefore, under local authorities' pressure, even shrinking cities have planned for urban space expansion.

The Technological Paradox

Under the growth-oriented paradigm, urban planners are in favor of a large number of projected population to justify the exaggerated planned built-up area. However, restrained by the regulation, Chinese planners are facing with a problem about projecting future population in shrinking cities. And it is very difficult for the higher level government authorities to check the correctness of population projection within the lower level government's urban master plan.

The first loophole is the data problem of population projection. In China, various governmental entities keep releasing differentiated demographic data, in which the "de facto" population and the hukou population are the most common demographic data for planners (Chan 2007).
The Census publicizes data that includes the "de facto" population with the definition that the residents who have lived in an area for more than a half year, which is more accurate and reliable. However, the census data is out of date when planners are projecting the city's future population because the interval between two censuses (10 years) is too long. On the other hand, the hukou population means the number of residents who have registered in a specific, exclusive municipality's Public Security Bureau, which can be acquired from the Public Security Bureau at any time. However, a large amount of "floating population" impairs the hukou population data's accuracy. In China, large and megacities

1.3-MISMATCHED PLANNING WITH REALITY

1.3.4 THE PARADOX OF PLANNING FOR SHRINKING CITIES IN CHINA

establish a very high threshold for newcomers to migrate their hukou from former residence to current residence (Chan and Zhang 1999). Those newcomers who cannot reach the threshold thus become the "floating population," since their hukous are not in the same place as themselves. China's grand urbanization process has created a binary opposition that prosperous cities and shrinking cities have differentiated discrepancies between hukou population and "de facto" population, respectively. Many shrinking cities' former residents have migrated to elsewhere while their hukous remain there, thus these cities' hukou population exceeds their "de facto" population a lot.

The second and more problematic loophole lays in the mismatch between the demographic data boundary and the planned built-up area boundary within a city's urban master plan. The demographic data boundary is consistent with the jurisdictional boundary, while the built-up area boundary usually differs a lot with any jurisdictional boundaries.

In conclusion, China's growth-oriented paradigm has created a vicious cycle that enlarges the mismatches of the two interrelated paradoxes: shrinking population and growing urban built-up areas; and shrinking population and increasing population in the projection.

Fig. The vicious cycle of urban planning in China. (Ying and Gao, 2019)

1.4-RESPONSE TO URBAN SHRINKAGE

1.4.1 HOW TO COPE WITH URBAN SHRINKAGE?

Urban shrinkage is not a new phenomenon, but how do the shrinking cities respond to this crisis? According to the research in 2011, four types of policy responses towards urban shrinkage are identifies: (Hospers, 2011; Rink et al., 2011; Verwest, 2011).

(1) trivializing shrinkage: The policy response of trivializing urban shrinkage comes down to "doing nothing" or, as Verwest (2011, p. 67) defines it, "policy stability": the local government does not take indications of shrinkage seriously and, as a result, does not take any action.

(2) countering shrinkage: All initiatives intended to promote urban growth, such as the creation of new neighborhoods and landmarks, as well as place marketing, are included in the policy response to combat urban shrinkage. According to this policy approach, attracting new residents and businesses will help to alleviate the temporary issue of depopulation (Glock & Haussermann, 2004). Particularly in Central, Eastern, and Southern European cities, this market-based, pro-growth policy approach may be found (Hospers, 2011; Bernt et al., 2012).

(3) accepting shrinkage: Adapting the content of policies to lessen the negative effects of shrinkage can be characterized as the policy response to accepting urban shrinkage (Verwest, 2011). Urban shrinkage is acknowledged and viewed as a new policy framework in this instance. This approach to shrinkage is particularly evident in Germany, the UK, and the Netherlands. In these nations, a growing number of decreasing cities are attempting to control the consequences of population loss and find measures to stabilize the population rather than promoting expansion (Bernt et al., 2012).

(4) utilizing shrinkage:The policy response of making utilization of shrinkage begins with a favorable viewpoint of shrinking cities and proposes doing so. Planners, architects, and consultants frequently hold this opinion, particularly in the North West of Europe (Hospers, 2010).

We can group the policy responses into two broad categories: (1) COUNTERACTING SHRINKAGE and (2) ACCEPTING SHRINKAGE (Hospers, 2010 ; Verwest, 2011 ; Rink et al, 2012).

Counteracting shrinkage

The counteracting response is a view that reverses the shrinkage through a series of growth measures to put the city back on a growth trajectory, a philosophy that still believes that cities should be growing, a strategic paradigm of growth-oriented goal-oriented investment in growth-effective projects. The revitalization response, represented by urban renewal, takes urban regrowth as a goal. The means for these cities include structuring urban renewal policies, revitalizing shrinking central areas, and promoting active urban operations. Public participation and community planning are also increasingly emphasized, with communities and citizens becoming the subjects of policy action and citizens' opinions and needs becoming an important part of policy-making considerations. Through a combination of government-led and public participation, cultural creativity, knowledge economy, and technological innovation are used to regenerate shrinking areas of the city and bring in growth-valued projects to enhance the use of entertainment and recreation, business offices, and living accommodations. Typical examples include Leipzig in Germany, Liverpool and Manchester in the UK, and Pittsburgh in the US.

For example, the urban planning department of ***Leipzig, Germany,*** a "perforated" shrinking city, has implemented urban spatial renewal of abandoned brownfield sites. Through a "bottom-up" approach, designers and art institutions are guided to establish creative spaces and promote the development of creative industries such as media broadcasting, software games, performing arts and music production, successfully creating a "media and creative industry cluster";
Manchester, England, is a representative of a shrinking city. With the development goal of "capital of creative industries", the Manchester government has taken the lead in implementing a series of urban cultural revitalization plans and continuous cultural infrastructure construction. It has transformed the city's economy into a cultural and creative one by dividing the central area into distinctive sub-regions for business and finance, commercial and shopping, heritage, distinctive culture, higher education and transport services.

Fig. Pittsburgh city view. (Photographer: Andrew Harrer/Bloomberg)

Pittsburgh used to be a resource-based city, when facing with the dilemma of urban shrinkage, Pittsburgh revived itself by becoming a university-centered technology hub, which enabled Pittsburgh to successfully shift to education, tourism, and service industries, especially healthcare and high-tech industries represented by robotics-based manufacturing. In addition, Pittsburgh experienced the process of demolishing the old city into a new district, introducing high-end commercial, residential and hotel in the city center.

However, Counteracting shrinkage or the revitalization towards growth has not always been successful. For example, Cleveland in the United States, in order to maintain the growth momentum of the city, has responded to the shrinkage by using large engineering flagship projects as urban growth points, working on new high-end retail and business offices in new central areas to bring about regional economic growth, and taking stimulus investments in peripheral areas around the periphery; while the city has neglected the revitalization of shrinking areas, attempting to use local growth to fill the global shrinkage, but as a result, in addition to bringing about spotty population and economic growth, the suburbanization trend has not been alleviated, and the shrinkage has even worsened.

1.4-RESPONSE TO URBAN SHRINKAGE

1.4.2 SMART SHRINKAGE

Accepting shrinkage

Accept shrinkage approach means an attitude that accepts and uses shrinkage, accepts it and considers it as an inevitable phase, and adopts a series of measures and strategies that optimize the results of the existing shrinkage. The theory of "SMART SHRINKAGE" is a typical adaptation strategy, which originated from the German performance management model for poorer Eastern European socialist cities, and is mainly used to deal with the economic and physical environmental problems caused by urban depopulation.It was first clearly proposed by Frank Popper and his wife in 2002, and it was clearly applied as a leading strategy in Youngston 2010 planning.

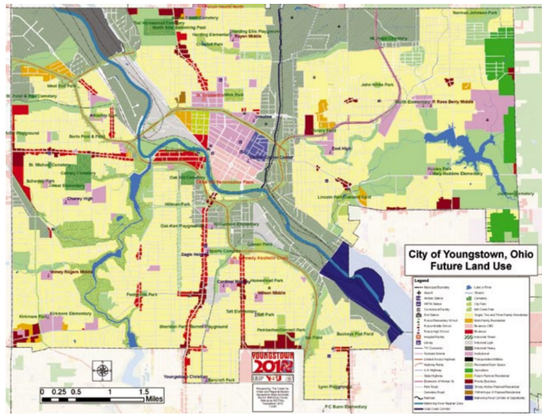


Fig. The Youngstown 2010 Citywide Plan. (Source: https://youngstownohio.gov/sites/default/files/Ytown2010_chapter6.pdf)

The practice in Youngstown shows that the strategy of smart shrinkage works: while Youngstown, which had nearly 170,000 people at its peak in the 1960s, had only 80,000 at the beginning of the 20th century, Youngstown lost only about 1,000 residents between 2005 and 2016, when the Youngstown 2010 Plan began, and the population exodus was mitigated to a considerable extent.

Popper and Popper define smart decline as "planning for less—fewer people, fewer buildings, fewer land uses."(Popper and Popper, 2002)

Hollander and Németh introduce their foundational theory for planning shrinking cities based on equity and social justice, focusing on the process of planning, rather than its implementation and effects in practice (Hollander and Németh 2011).

To summarize the core development of international thinking on the concept of smart shrinkage, the following four aspects can be obtained:

(1) Focusing on the right-sizing of cities and strategically adapting to their declining population situation;

(2) Focusing on the development of yet another area, concentrating the growth part on the advantageous area, enhancing the vitality of the area, and keeping the overall functioning of the area well;

(3) Promote the intensive use of land and convert vacant parcels mainly into green infrastructure;

4) Establishing government agencies such as land banks to promote the restructuring of vacant properties and directly participate in the renewal of parcels to ensure smart shrinkage development.

Smart shrinkage refers to different types of shrinking cities that respond to the pressure of urban shrinkage, pursue benign and sustainable urban development, step out of the political taboo implied by urban shrinkage, and actively face and adapt to the new trend of urban development of urban shrinkage.

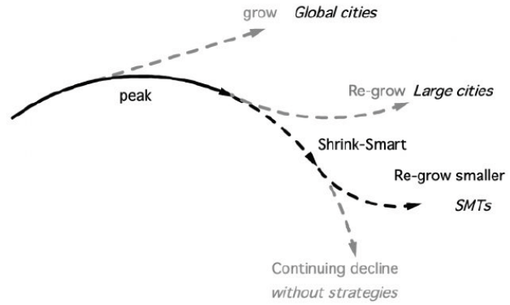


Fig. Smart shrinkage diagram. (Source: https://www.regrowtown.org/shrink-smart/)

Unlike the value of growth-oriented planning, smart shrinkage is a kind of stock planning using intensity and guided by shrinkage theory, which is a proactive shift of the dominant mode of urban development. Smart shrinkage is created to solve the problem of urban shrinkage and provides new opportunities for the transformational development of shrinking cities. It is based on the examination of the development trend of cities that may shrink, getting rid of the burden of cities that must grow, reducing the total amount of urban space construction; using the stock space to adjust and coordinate the spatial structure of cities, focusing on projects that improve the vitality and quality of cities, concentrating urban space development in small areas, finding new growth drivers for cities, and maintaining the development concept of sustainable urban operation. This also provides a new opportunity for the transformation and development of resource-exhausted cities.

Smart shrinkage has the following characteristics(Gao,2020):

(1) Streamlining: One of the main connotations of smart shrinkage is to streamline the scale of the city so that the scale of the city adapts to the existing urban population; this requires facing up to the fact that the population of shrinking cities continues to decrease, changing the traditional planning concept of population and land growth as the main theme, intensively developing land resources, improving the utilization rate of resources, making the city develop in a small and precise way, avoiding inefficient spatial expansion, and restoring the vitality of urban development.

(2) Diversification: smart shrinkage focuses on the diversification of urban development. Many shrinking cities rely too much on a single industry and have a weak resistance to external interference. Smart shrinkage should be good at discovering the potential of urban development,

1.4-RESPONSE TO URBAN SHRINKAGE

1.4.2 SMART SHRINKAGE

focusing on the diversity of urban functions, industrial structures, and regional roles to form new dynamics of urban development. On the other hand, it should ensure the diversity of urban service functions, and fully consider and meet the needs of different people in the city as much as possible through public participation and other methods.

(3) Resilience: Smart shrinkage focuses on improving the suitability and resilience of the city. It takes into account the city's internal and external environments, considers the problems that may be encountered in the future, makes effective contingency plans and reserves room for flexibility, and provides effective and feasible solutions when future development is difficult to determine, ensuring that the city can respond flexibly to unpredictable changes in the future.

(4) Integrity: The city and its region are not only geographically connected, but also inextricably linked in many aspects such as economic relations, division of functions, and ecological impacts. Therefore, the whole city and its region should be analyzed as a whole to avoid one-sided analysis of the problem.

It is undeniable that urban planning itself cannot be completely dichotomized into "growth" and "shrinkage" plans and strategies. Smart shrinkage is the positioning of development ideas at the level of the city as a whole. It argues that cities will achieve smart, compact and economic development in the process of shrinkage, and that comprehensive planning at the overall city level includes a full range of leading strategies at the levels of development strategy, spatial adjustment, industrial development, public services, and mechanism design.

Therefore, urban development thinking based on a smart shrinkage perspective should focus on the following perspectives:

(1) Rightsizing urban scale: Rightsizing is defined as "stabilizing abnormal markets and distressed neighborhoods by adjusting the amount of land available for development to match the relationship between the city's built environment and the demand of existing and foreseeable future populations". Urban development needs to break the traditional concept of "cities should grow" and change the previous development model of "spreading the pie" in the development of urban spatial structure, and pay more attention to the rationality of scale, and coordinate the balanced development of population scale and land scale. The growth and development should be concentrated in small and centralized areas, and a compact, high population density, centralized facilities, and easy access to the center should be built.

(2) Urban land use adjustment: Shrinkage-oriented urban land use can achieve efficient development of urban land, resources, etc., thus creating spatial nodes of dense local activity in the city, which can create potential development areas; Readjustment optimizes the built-up environment, leads to concentrated population living and industrial clustering and development, creates economies of scale while also shrinking the scale of basic services, and the renewal of vacant land can also reduce the city's financial burden and provide the city with flexible space for future development.

(3) Smart transformation and upgrading of industries: With the depletion of coal resources and excess coal production capacity, coal mines have basically ceased production, and industrial transformation is fundamental to stimulate the formation of long-term urban development vitality. Promote industrial transformation and upgrading to form a diversified industrial structure. Promote the integration of industry and city, promote the positive interaction between industrial areas and urban areas, and realize the matching of industrial space and living space.

(4) Ecological priority and spatial quality improvement: In the process of rapid urbanization construction and development of resource-based cities, the predatory mining methods and sloppy business models have caused serious damage to the natural landscape and ecological environment of the cities. "Ecological priority and green development" is a national development strategy and an important principle for the development of urban spatial structure, and actively promoting ecological restoration and environmental improvement is the root of sustainable urban development.

(5) People-oriented: The core element of cities is people, and urban development must be people-oriented, taking into full consideration population diversity, especially the phenomenon of aging and childlessness in shrinking cities, and strengthening the construction of public service facilities adapted to the needs of the elderly and youth, so as to guide the population to gather and enhance the urban living atmosphere; Also to promote public participation in the implementation process of urban renewal through a variety of ways, and to participate in urban self-build and co-create the urban environment through various projects to shape a sense of belonging to the city or community; only by improving residents' satisfaction and sense of belonging can people be retained and attracted, and the urban community environment will be more stable and healthy, thus changing the dilemma of urban shrinkage.

02 PROBLEM POSITIONING

2.1-PROBLEM STATEMENT

PROBLEMATIZATION FRAMEWORK: URBAN SHRINKAGE IN RESOURCE-EXHAUSTED CITIES

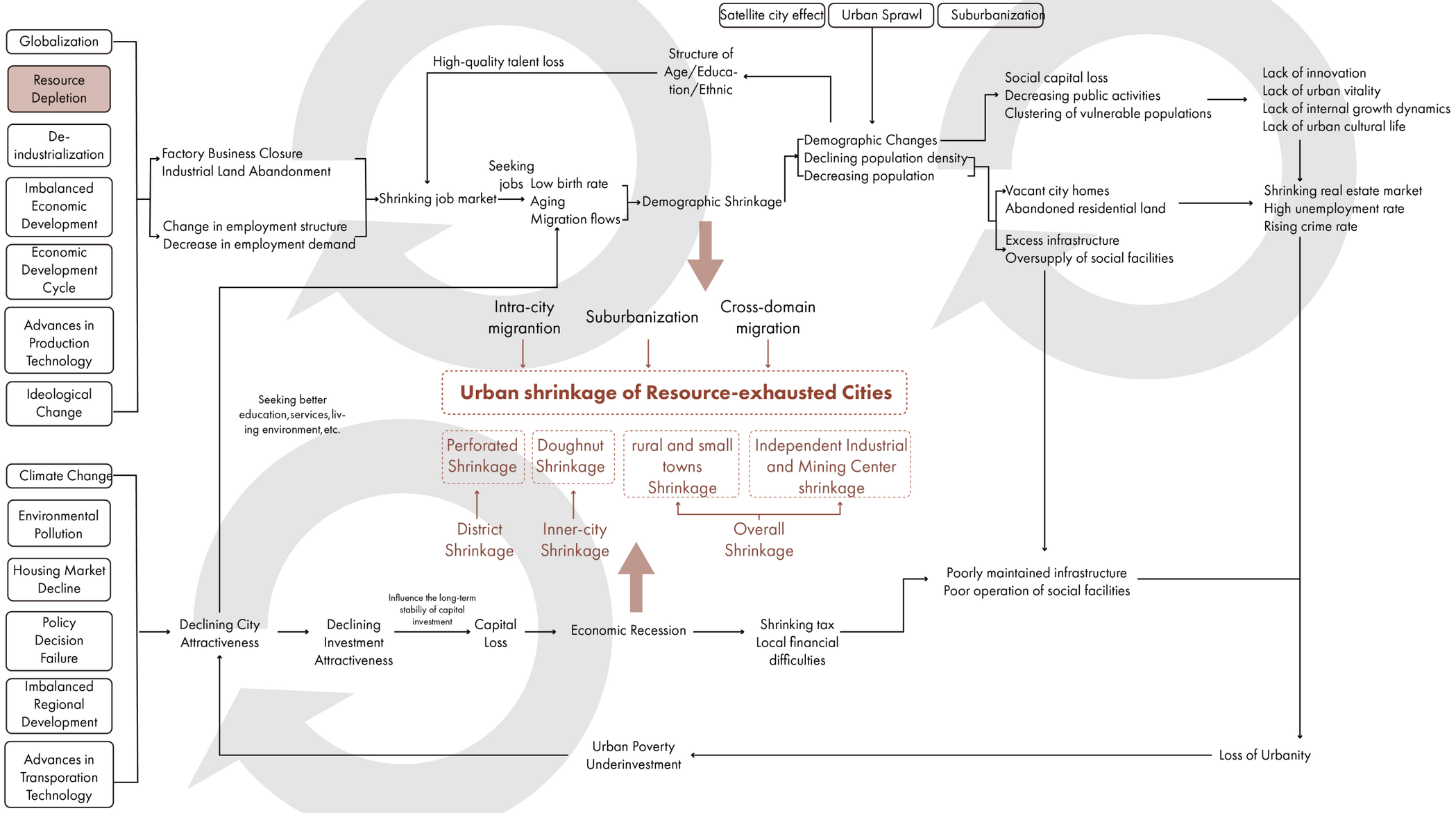


Fig. The mechanism of urban shrinkage of resource-exhausted cities in China. (Source: Made by author, refered to Zhou,2015)

2.1-PROBLEM STATEMENT

During the time of the planned economy, Northeast China had a wealth of natural resources, and the extraction of a sizable number of those resources offered a strong assurance for China's economic growth and energy supply, as well as playing a significant part in China's modernisation. Business units frequently decide to sit directly in mines and construct factories in order to exploit local resources, and the boundaries of industrial communities gradually expand outward until they finally form a functional urban space throughout the mines, which serves as the basis for the formation of the majority resource-based cities.

While resource depletion has caused the gradual removal of the conventional advantages that resource-based cities rely on, the concentration on growth rather than governance has led to major "man-land" disputes. The steep drop in the economic development level of resource-based cities in northeast China has been caused by a number of causes, including resource depletion, a single industrial structure, a lack of innovation, and a restrictive administrative framework.

Regional marginalization causes resource-exhausted cities in Northeast China to lack the endogenous power required for economic development and to be more vulnerable to economic shocks. Mine closures due to resource depletion, combined with advancements in manufacturing technology that have resulted in the use of more mechanized equipment, have resulted in a shrinking of jobs, a large number of residents losing their jobs, and a decline in average wages. Furthermore, nearly half a century of development has thrown the old mines' living areas into a crisis of land subsidence and severe collapse, and the urban living environment has deteriorated. Due to these events, a significant portion of the population has left, leaving the economy vulnerable to future economic shocks. The detrimental effects of this population exodus feed back into the urban economy and spatial system, with shrinking cities and declining urban populations resulting in reduced demand and oversupply of infrastructure and housing facilities for urban residents, rising housing vacancy rates, and significant land waste, aggravating already existing social and economic issues. There is an urgent need for transformation in the Northeast and in resource-constrained communities.

All along, coalitions of local political and social elites in the United States have formed the "urban growth machine," and as a result, the growth-oriented paradigm has become the mainstream of urban governance (Logan & Molotch, 1987), and this growth-oriented paradigm has been widely accepted in China (Wu, 2015). However, the growing misalignment between the phenomenon of urban shrinkage and growth-oriented planning has resulted in a variety of issues, including excessive government financial pressure, as well as public safety, health, and environmental concerns. (Rybczynski & Linneman, 1999; Bernt, 2009; Hollander et al., 2009). Some scholars have recently advocated for a paradigm shift away from growth-oriented planning and toward downsizing cities (Schilling & Logan, 2008; Hollander et al., 2009), also known as smart decline/shrinkage (Hollander & Németh 2011). However, smart shrinkage remains more about conceptual debates, and while some cities have published self-proclaimed rational plans, their implementation remains a question mark. Furthermore, these discussions on the concept of smart shrinkage are more focused on cities in Western countries and are still in their early stages for smart shrinkage in China's shrinking cities.

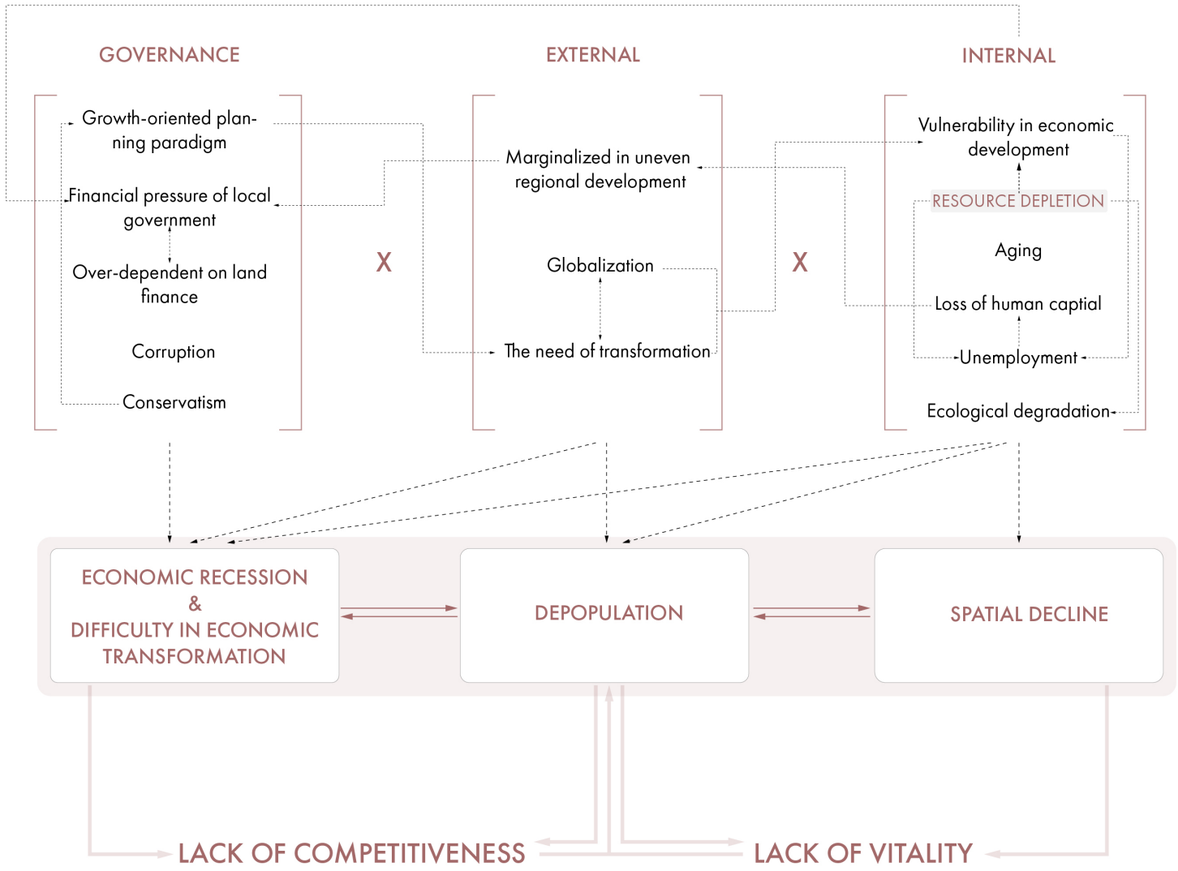


Fig. Problem statement. (Source: Made by author.)

2.2-RESEARCH QUESTIONS

How can smart shrinkage be used as a transformation strategy in the resource-exhausted cities in China to RECOVER them as resilient urban systems?

About the specific context analysis

SQ1-What are the drivers and characteristics of shrinkage in Resource-exhausted cities in Old industrial base of Northeast China?

About the historical development and previous transformation

SQ2-What spatial consequences did industrialization and transformation bring to these resource-exhausted cities and what new potentials have appeared?

About the theoretical and strategic framework building

SQ3-What is "smart shrinkage" and how can the concept be integrated in the regenerative strategies and princicples to develop resource-exhausted cities?

About strategies and principles for Hegang city

SQ4-What regenerative planning strategies and principles can promote the sustainable transformation that utilize the opportunities that stem from shrinkage?

About the application in future transformation

SQ5-How can these strategies and principles be efficiently implemented spatially and locally?

2.3-SELECTION OF SITE

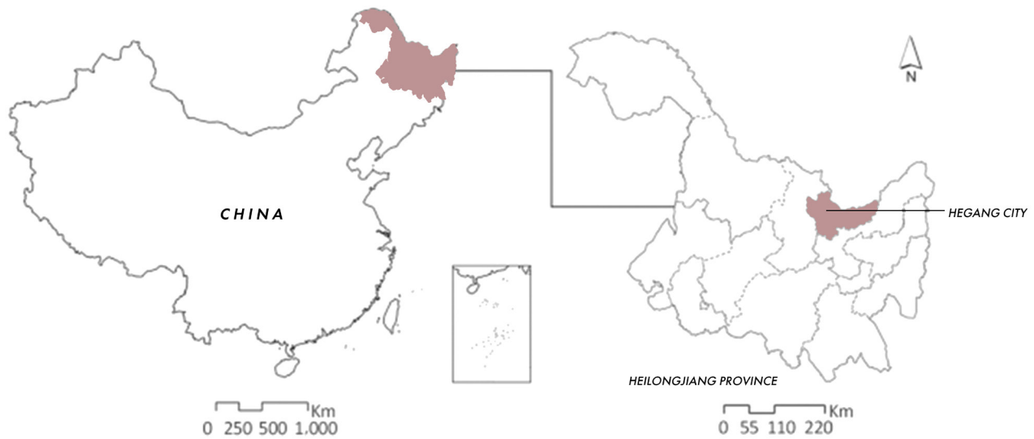


Fig. Location of Hegang. (Sourcce: Made by author)

Hegang is located in the northeast of Heilongjiang Province, China and sits on the border with Russia. It is used to be one of the most important coal production cities in northeast China, even the whole country.

Hegang covers an area of 14,684 km2 and has six municipal districts, namely Dongshan District, Nanshan District, Xiangyang District, Gongnong District, Xingshan district, Xingan district. Additionally, there are two counties under the jurisdiction of Hegang, respectively, Luobei and Suibin.

Regional development context

The Northeast Old Industrial Base was once the cradle of new China's industry, and made historic and significant contributions to the establishment of an independent and complete industrial system and national economic system, as well as the country's reform, opening up, and modernization drive. Before the 1990s, as an important industrial base in China, the Northeast region was also a relatively developed region. However, with the deepening of reform and opening up, the economic development speed of the Northeast region gradually lagged behind that of the eastern coastal regions. Since 2003, the country has started to implement the revitalization strategy of old industrial bases such as the Northeast region.

Fig. Northeast old industrial base. (Sourcce: Made by author)

A very important coal production city

Hegang developed rapidly in the early industrialization period by heavily relying on a single industry——coal. The coking coal produced is high-quality coal and has made great contributions to the industrialization process of the founding of China.

Fig. Distribution of coal mine in Heilongjiang Province. (Sourcce: Made by author)

Resource-exhausted city and shrinkage of population

With the continuous mining of large coal mines, the quantity of coal in Hegang has dropped sharply. The disadvantages of relying solely on coal for urban economic development have also gradually emerged. Therefore, within the 21 resource-based cities in Northeast China defined by The National Plan for Sustainable Development of Resource-based Cities (2013–2020), Hegang is classified as a recession group (He et al., 2017). Due the process of globalization and resource exhaustion, urban shrinkage is gradually appearing there. Due to the decline of the coal mining industry, Hegang gradually lost 1/3 of its population.

The fiscal burden and dilemma in economic transformation

Fig. Announcement from website of Hegang Municipality. (Sourcce: Made by author)

The Hegang Municipal Human Resources and Social Security Bureau announced on December 23, 2021 that the financial situation had significantly changed as a result of the Hegang Municipal Government's financial restructuring plan, and that it had been decided to scrap the plan to publicly hire grassroots government employees. Hegang was the first prefecture-level city in the nation to implement financial restructuring when the idea was first revealed at the government meeting in July. In order to recover from its "very terrible" financial predicament, Hegang would gradually increase revenue, cut spending, and carry out its regular financial operations. Widespread worry has been sparked by this.

2.3-SELECTION OF SITE

INTRODUCTION OF HEGANG CITY: THE DEVELOPMENT HISTORY OF HEGANG

Ancient China

Before the founding of the People's Republic of China

After the founding of the P.R.China

Wars and unrest

Planned Economy

Market Economy

1890s

1914
the coal field was discovered

1926
The earliest open-pit coal mine was completed

1933
The earliest inclined shaft was built

1943
Hegang City has the earliest financial institution

1945
Hegang Mining Bureau was established
Xingshan City was established

1949
Xingshan was renamed Hegang

1956
The construction of the first leisure and entertainment place for Hegang citizens started

1959
Hegang City started to build the first asphalt road

1980
Start developing graphite mine

1994
Hegang City Open Port

2011
Hegang was listed as resource-exhausted city

1908
Reclaim wasteland

1918
Xinghua coal mine established

1927
The coal railway was completed and opened to traffic

1940
Hegang City established a rice noodle processing enterprise and a school for training skilled workers

1926-1929
Baths, private schools, grocery stores, Chinese medicine clinics, post offices, etc. were successively established

1946
China's first film studio was established in Hegang

1954
The first pair of new inclined shafts in Hegang Coal Mine was completed

The earliest public transportation in Hegang

1978
The coal output of Hegang Mining Bureau exceeded 10 million tons, ranking the tenth largest coal mine in the country

2005
National mine park

2016
Xingshan coal mine officially closed

Among planned economy period,
The heavy industries were successively developed

Before 1890s, The region of Hegang was a desolate and uninhabited area	With the large-scale mining of coal, during this period, "the coal industry flourished and the mines developed" in the Hegang area, merchants came, the population surged, and various undertakings such as commerce, service industry, transportation, medical care, and education were in the embryonic stage. Gang has developed from a remote mountain village into an important industrial town.	Wars and unrest	Recovery and Development of Hegang's Economy	Rapid Development of Hegang's Economy	Hegang boomed during the coal industry's "golden decade" from 2003 to 2012.	Decline

Fig. Development history of Hegang. (Sourcce: Made by author)

2.4-CONTEXTUAL ANALYSIS

LOCATION

Periphery of urban agglomeration

Cluster cities form part of the National New Urbanisation Plan in March 2014. There are 19 city clusters planned.

Harbin-Changchun urban agglomeration, with Harbin and Changchun as the core cities, Qiqihar, Daqing, Mudanjiang, Jilin, Yanji, and Siping as the main body, radiates the urban agglomeration belt of surrounding cities such as Jiamusi and Songyuan. However, Hegang is not within the scope of the urban agglomeration, so there is limited radiation and driving ability of the urban agglomeration.

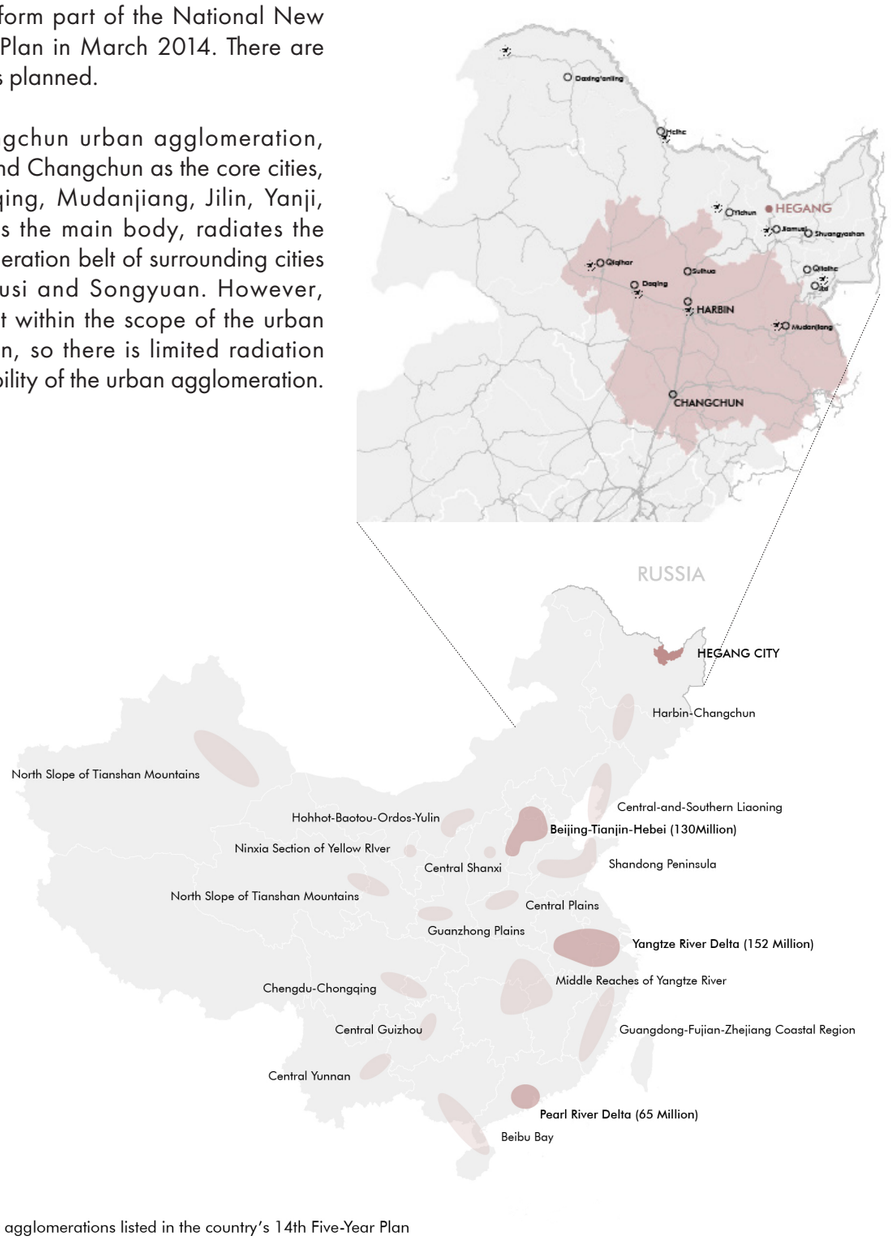


Fig. Urban agglomerations in China (Bottom); the relationship of Harbin-Changchun urban agglomeration and Hegang (Top). (Sourcce: Made by author)

Complex and unstable geopolitical pattern in Northeast Asia

From the 10s to 40s of the 20th century, the geographical relations in Northeast China showed a "semi-deformed" open state, and the whole region was in the period of warlord wars and Japanese aggression for a long time. During this period, the Northeast region ushered in a peak of immigration, and the agricultural economy and national industry developed rapidly. However, at the same time, the Japanese economy in the territory expanded wantonly, and a large amount of resources and wealth were plundered.

Since the founding of the People's Republic of China, the geopolitical relationship has changed from the dependent type in the 1950s and 1960s to the diversified and peaceful development after the 1980s; affected by other factors such as policies and other factors, the industries in the region have developed from vigorous development to slow fluctuations. Today, the geopolitical relationship in Northeast China is still very complicated, but the prospect of geoeconomic cooperation is bright.

The Chinese government actively promotes the construction of the "One Belt, One Road" and strengthens communication and cooperation with countries along the route. The "One Belt, One Road" initiative has brought opportunities for the regional development of Northeast Asia. Among them, the Hegang International Comprehensive Freight Hub Project has been listed as a key project by the Ministry of Transport.

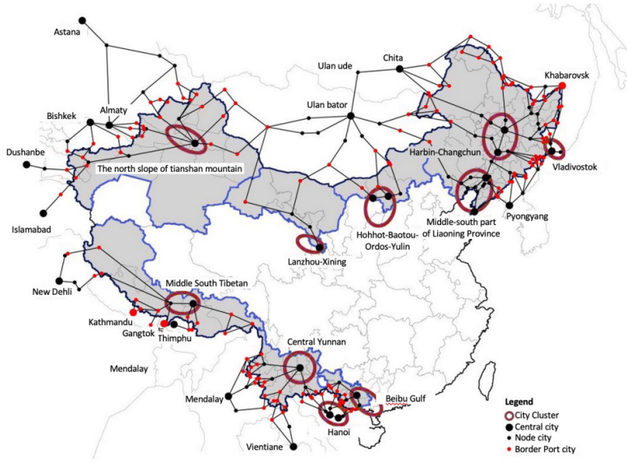


Fig. Schematic Diagram of City/Town Cluster System inside and outside China's Border and Locations of Border Port City/Town Cluster (Source: Xiao, 2016)

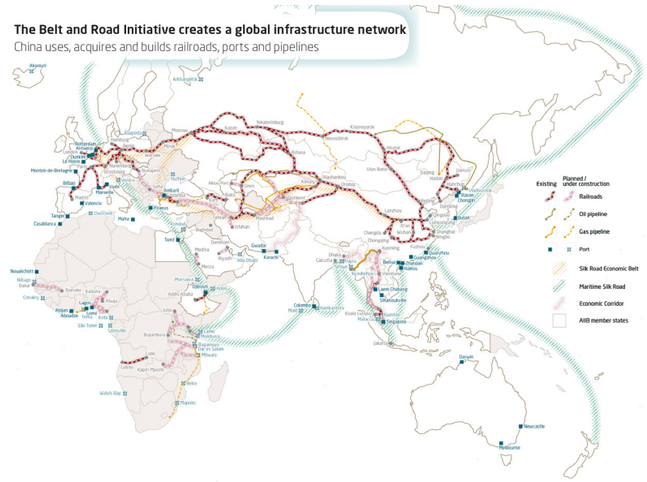


Fig. The belt and road initiative creates a global infrastructure network. (Source: MERICS)

2.4-CONTEXTUAL ANALYSIS

GEOGRAPHY

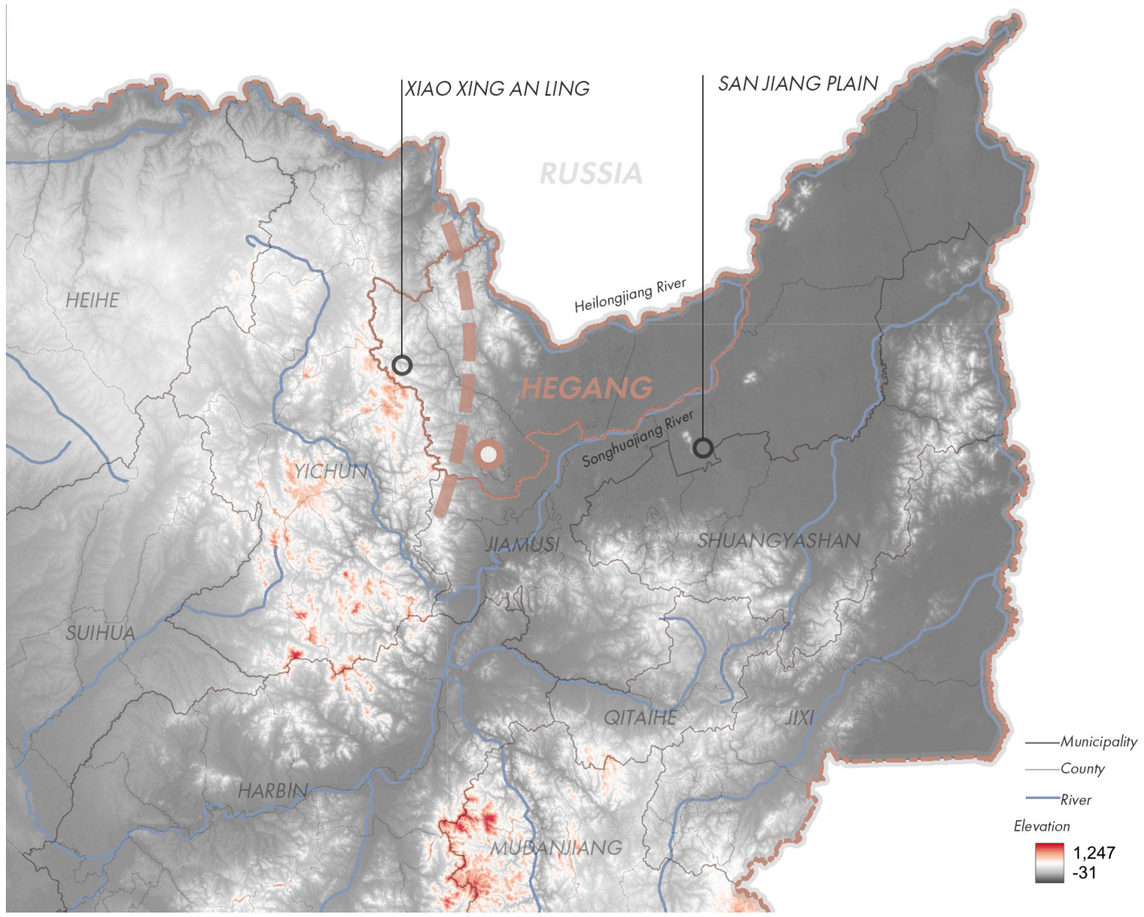


Fig. Location of Hegang. (Sourcce: Made by author)

Hegang is located in the Golden Triangle where the Three Rivers (Heilongjiang, Songhua River and Xiaoxing'anling) plains meet, with a flat terrain and an altitude of about 100-140m.

Hegang is backed by the Xiaoxing'an Mountains and 40 kilometers away from the Songhua River. It is surrounded by mountains and not near the river, which makes it difficult for Hegang to become a transportation hub and does not have the ability to radiate surrounding areas. And it is not in the center of the main agricultural production area, so it is not an ideal regional center in the agricultural era. Hegang is not located on a mountain pass, does not guard the waterway, and is not near an important traffic line. Compared with Jiamusi, which is 60 kilometers away in a straight line, Hegang has no geographical advantage.

INFRASTRUCTURE

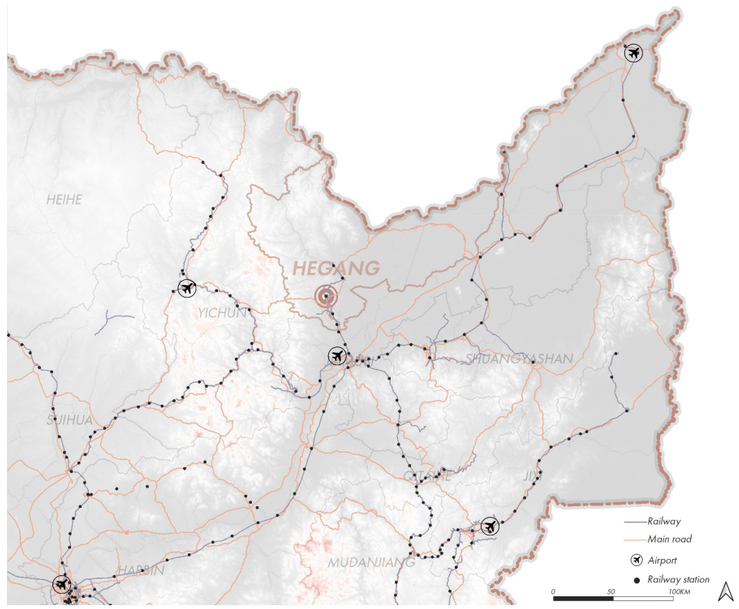


Fig. The infrastructure around Hegang. (Sourcce: Made by author)

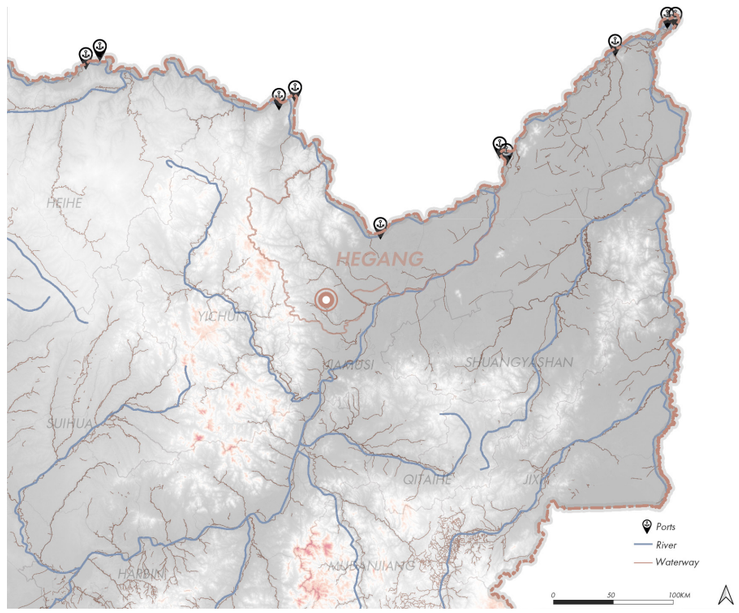


Fig. The rivers and waterways. (Sourcce: Made by author)

2.4-CONTEXTUAL ANALYSIS

ECONOMY

For a long time, Hegang's GDP has been dominated by the secondary industry, and it is one of the four major coal cities in Heilongjiang Province.Hegang boomed during the coal industry's "golden decade" from 2003 to 2012. Its GDP expanded by more than 10% every year, and exceeded the provincial and national growth rates almost every year. Coal mines and related industries have helped the secondary industry become a local pillar industry — in 2005, almost two-thirds of the GDP growth reported by the Hegang statistics bureau came from the secondary sector. In 2008, taxes paid by the coal industry accounted for 65% of Hegang's fiscal revenue.

However, since 2012, with the continuous mining of large coal mines and the unsupervised mining of small coal mines, the shallow coal reserves in Hegang City have declined sharply, and the quality of coal has continued to decline due to irregular mining, coal mining and related industries have experienced a sharp decline. In addition, the disadvantages of relying solely on coal for urban economic development have gradually emerged, leading to an overall decline in GDP.

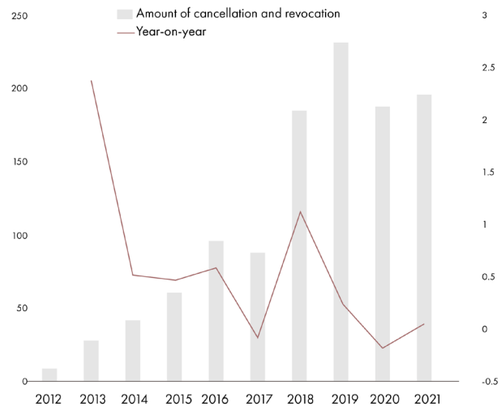


FIG. The amount of coal enterprises in Hegang City has been canceled and suspended in the past ten years. (Sourcce: Made by author)

FIG. The industrial structure and GDP of Hegang. (Sourcce: Made by author)

In recent years, the GDP of Hegang City has shown a slow growth trend, from 25.1 billion yuan in 2010 to 34.02 billion yuan in 2020. The structural proportion of the three industries in Hegang City was 24:50:26 in 2010 and 30.5:29.3:40.2 in 2020.

Facing the huge labor force released by the rapid shrinkage of the secondary industry, the weak tertiary industry can only absorb a small number of them. A large number of idle labor can only find another way out.

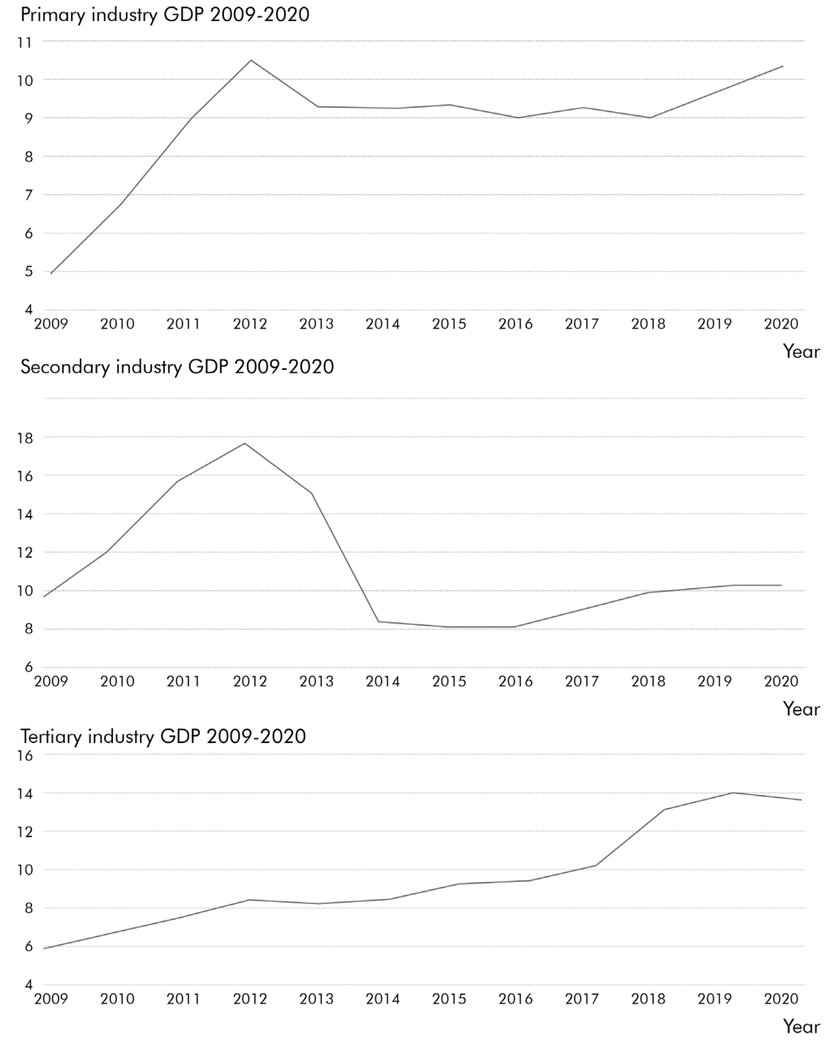


FIG. GDP in different industry. (Sourcce: Made by author)

2.4-CONTEXTUAL ANALYSIS

EMPLOYMENT

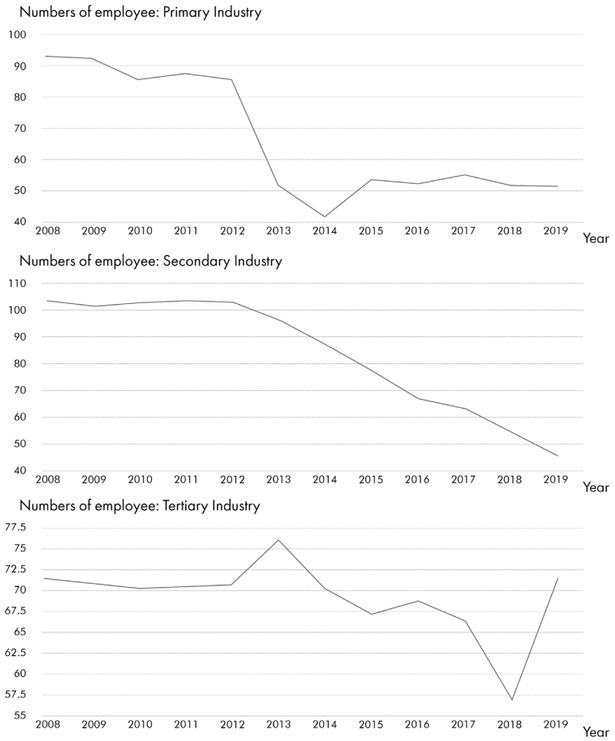


FIG. Employment in Hegang. (Sourcce: Made by author)

From 2008 to 2017, the employment situation in Hegang City was not good, and the number of employees in urban units of the three industries all decreased by a certain amount, with a total reduction of 37,100 employees. The number of employees in the primary and tertiary industries was relatively stable, and the number of employees in the secondary industry changed slowly from 2008 to 2013. Due to the downturn in the coal industry in 2014, many factories and mines were closed, resulting in a significant reduction in the number of employees in the secondary industry from 2014 to 2017.

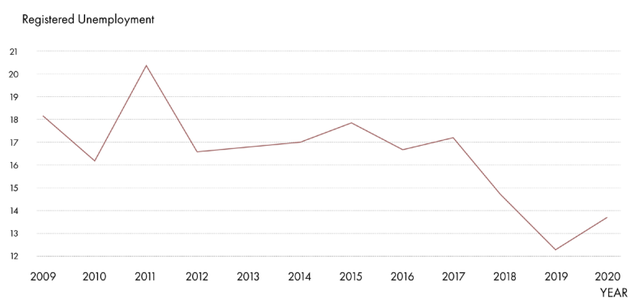


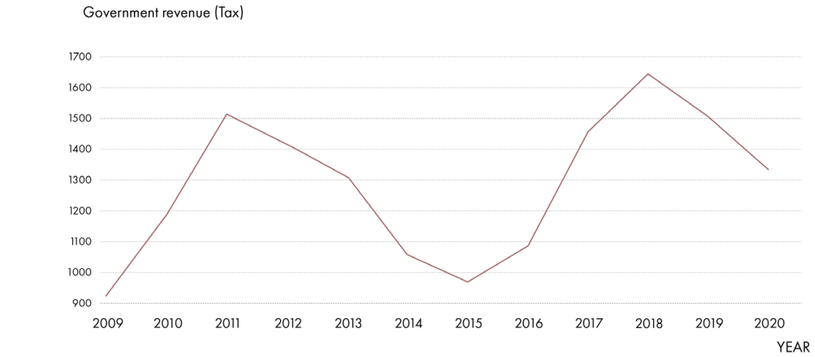
FIG. Unemployment in Hegang. (Sourcce: Made by author)

In Hegang City, the number of registered unemployed persons in urban areas showed an increasing trend during 2008-2017, from 8,700 to 13,800, with an average of 12,800 registered unemployed each year.

FISCAL BURDEN

In 2012, the coal industry entered a downturn. In 2013, Hegang City's fiscal revenue, GDP, and fixed asset investment all declined. In 2019, Hegang's plight has reached a desperate situation.

Currently, Hegang with a population of 890,000 has an annual fiscal revenue of more than 2 billion yuan ($314.71 million) but its public expending goes over 10 billion yuan ($1.5 billion), it is heavily reliant on fiscal transfer payments from governments at higher levels



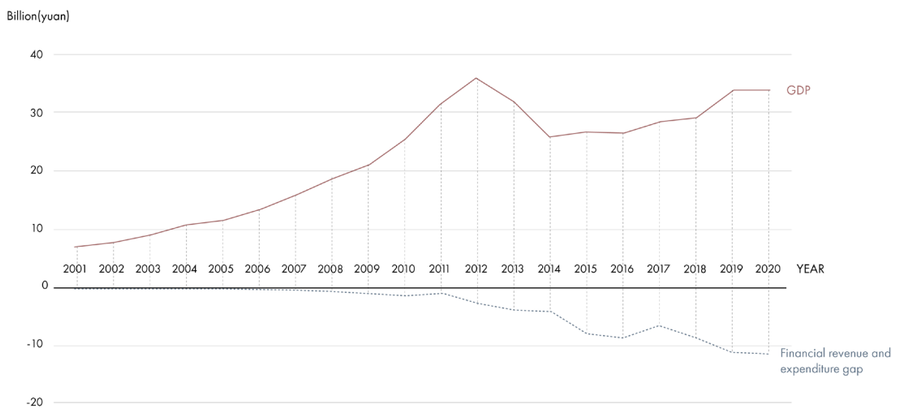


FIG. Fiscal burden in Hegang. (Sourcce: Made by author)

2.4-CONTEXTUAL ANALYSIS

DEMOGRAPHIC CHANGE

According to the seventh national census, the total population of Hegang City in 2020 is 891,271. Compared with 1,058,665 people in the sixth census in 2010, the population of the city's 6 districts and 2 counties decreased by 167,394, a drop of 15.81%, and an average annual drop of 1.7%.

Among the population composition of Hegang City, the elderly population aged 60 and above has increased by 63,000 people compared with the sixth national census, an increase of 9.75%. The proportion of the population over 60 years old is 1.1% higher than that of the whole province and 5.62% higher than that of the whole country.

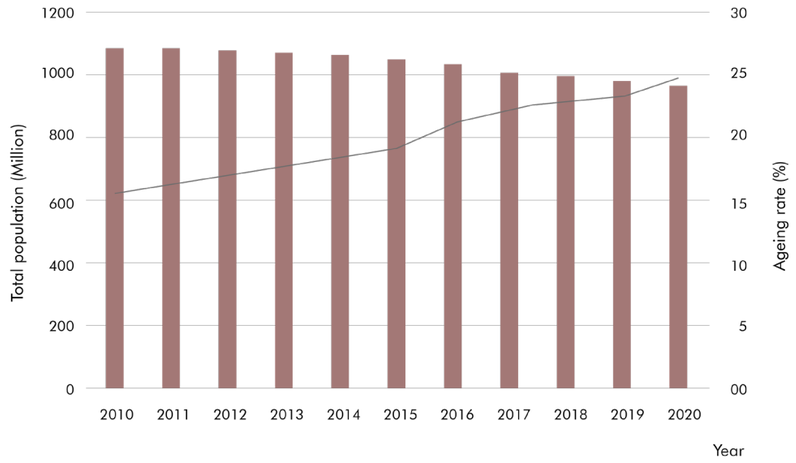


FIG. Demographic change. (Sourcce: Made by author)

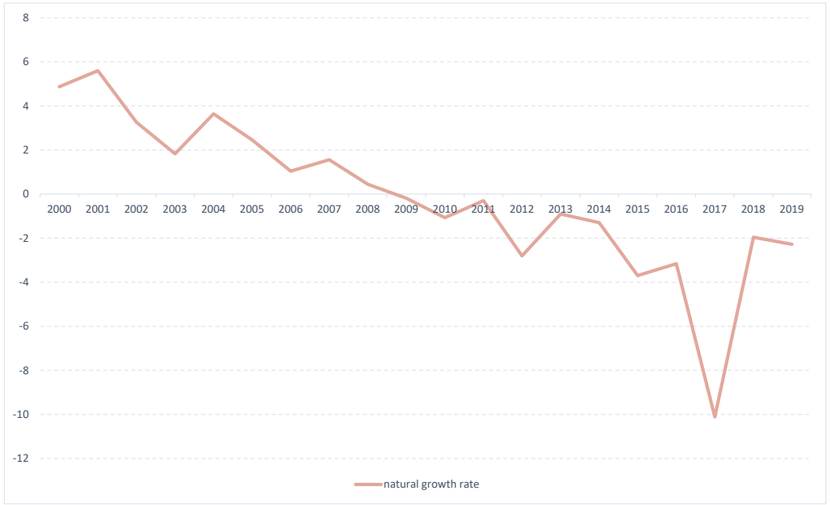


FIG. Natural growth rate of Hegang. (Sourcce: Made by author)

On the one hand, due to the impact of the family planning policy in Northeast China, the fertility rate has been relatively low;On the other hand, due to urban shrinkage in Hegang City, low level of economic development, high migration rate of machinery, and a large number of young and middle-aged population outflows, the phenomenon of urban aging in Hegang City is even more serious

To sum up, the demographic changes in Hegang are the decline in the birth rate, a large number of out-migration and the long-accumulated problem of population aging.

	Xiangyang	Gongnong	Nanshan	Xingan	Dongshan	Xingshan	Luobei	Suibin
6th census in 2010	*110916*	*140070*	*119047*	*74396*	*175239*	*44803*	*220131*	*174063*
7th census in 2020	*72867*	*136519*	*119662*	*99013*	*96218*	*21125*	*206072*	*139795*
Administrative area 2010	*9*	*11*	*30*	*27*	*4575*	*27*	*6761*	*3344*
Administrative area 2020	*8*	*12*	*31*	*254*	*4220*	*28*	*6768*	*3344*

FIG. Demographic change and Administrative area change in each districts. (Sourcce: Made by author)

Most of the districts experienced a decrease in population, while Xing'an District and Nanshan District experienced a certain degree of growth; Looking at the planning documents of the past decade, we can see that the population changes in these two areas are more affected by the changes in the administrative divisions; the industrial and agricultural areas and the Xiangyang District, where the population is concentrated, have seen a significant decrease in population as a whole.

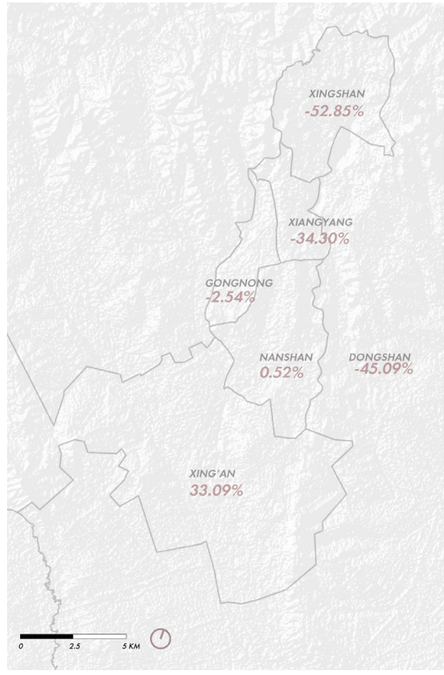


FIG. Spatial distribution of demographic change. (Sourcce: Made by author)

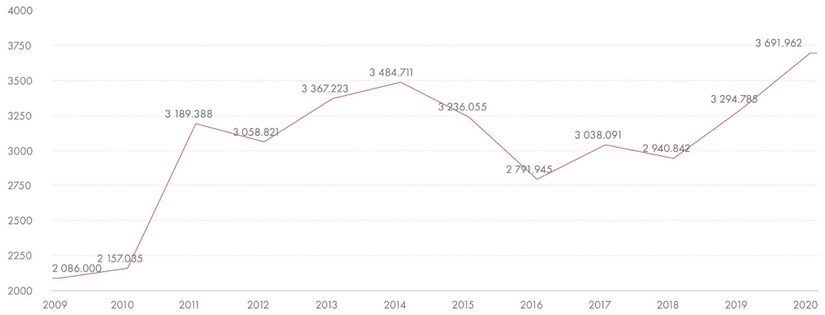
2.4-CONTEXTUAL ANALYSIS

HOUSING PRICE

Hegang has become a trending topic on social media after newspapers reported that apartments on average there were costing no more than Rmb15,000 ($2,100) to purchase.

The reason for the low housing prices in Hegang lies in the shed reform. In short, shed reform is the demolition and reconstruction of a large number of dilapidated, dilapidated and rotten houses. The so-called urban villages are shantytowns, which are one of the targets of shantytown reform. In the resource-exhausted city of Hegang, there are a large number of coal gobs, especially shanty towns. Therefore, in 2008, the country launched the affordable housing project and started the national shed reform.

The first step in the shed reform is to demolish the house, and the residents living in the shed reform house need to be resettled. Hegang hardly adopts monetization resettlement in the process of shed reform, that is, the demolition only compensates the house and does not give money. This creates an imbalance between supply and demand in the real estate market.



SOURCE: WWW.CEICDATA.COM | Hegang Municipal Bureau of Statistics

FIG.House price in Hegang

FIG.Advertisements for rent and sale on street corners in Hegang. (Source: Google Image)

POLICY REVIEW

Territorial space planning (2021-2035)

The city vision is:
Adhere to green first, low-carbon development, co-ordinate high quality and efficient economic development and ecological high standard restoration, and become a high impact open capital, green energy city and ecological livable place on the Sino-Russian border.

The development goals are:
To build a model benchmark for the construction of ecological civilization in the province, and to build a harmonious coexistence of mountain, water, forest, lake, grass and city to achieve a high level of ecological space protection;
Create a resource-based city industrial transformation, a model city to accelerate the diversification of development and actively cultivate new industries;
Cultivating a demonstration area of modern agriculture and urban-rural integration in the north and promoting the implementation of rural revitalization at a high standard;
Creating a special recreation and tourism resort on the Sino-Russian border, using rich natural resources to create a tourism model;
To create a city of ecological harmony and livability with a blend of mountains and water, and to combine the characteristics of the city to arrange service facilities and infrastructure in a coordinated manner to create a quality life;
Striving to build a city with strong competitiveness as the center of the northeastern part of the province, making full use of the city's geographical location and resources and other advantages to create a city with strong influence

Heilongjiang Province Mineral Resources Master Plan (2021-2025)

According to the mining industry in Heilongjiang Province and regional economic development, resource endowment, development of the current situation, industrial transformation and resource and environmental carrying capacity and other characteristics, clear north, west, south and east of the four regions of the exploration and development direction, the focus of mining and resource-based industrial development of differentiated development positioning and policy guidance.

Among them, Hegang is located in the eastern energy resources security development guarantee area, which is the Heilongjiang Province, coal, electricity and graphite deep processing base, the district focus on building graphite industry cluster, accelerate the development of green industries, optimize the industrial layout, enhance innovation capacity, the implementation of total control, scale development and the extension of the whole industry chain, and promote the transformation of the municipal economy of high quality. Improve coal security capacity, strengthen the coal city mining area deep and peripheral area resource exploration, increase resource reserves succession. Scientific planning layout, resolutely eliminate backward production capacity, orderly release of safe and high-quality production capacity.

03 RESEARCH DESIGN

3.1 RESEARCH AIM

This project aims to analyze the current dilemmas faced by resource-exhausted cities and the causes of their formation based on the context of urban shrinkage, and to study the difficulties of future transformation of resource-exhausted cities and explore the potential as well as advantages in the process of economic and social industrial transformation; and to construct a comprehensive strategic framework in the long-term transformation process, combined with the theory of smart shrinkage to improve urban resilience and return to the new normal.

First, the project aims to investigate the transformation dilemmas of resource-based shrinking cities in Northeast China's old industrial bases in the terms of economic, political, and people's livelihood; and to explore new opportunities for industrial upgrading and transformation based on local resources and the boom of new technologies and the Internet. More job opportunities will be created as a result of this process.

Second, analyse and study the feasibility of applying the transformation and renewal planning strategies guided by the concept of smart shrinkage in the resource-exhausted shrinking urban space in the context of China;

Third, identify urban problems from the perspective of urban spatial planning, improve the urban economic, social and physical environment, enhance the ability to deal with long-term crises, establish an optimized community public service network, and enhance the attractiveness of the city. As a result, these cities will receive more investment and be more competitive, and cities will be activated and function in a more sustainable way.

Furthermore, this project aims to investigate a feasible paradigm that can be served as a model for cities facing similar dilemmas in order to achieve regeneration of resource-exhausted cities in the process of shrinkage.

3.2 CONCEPTUAL FRAMEWORK

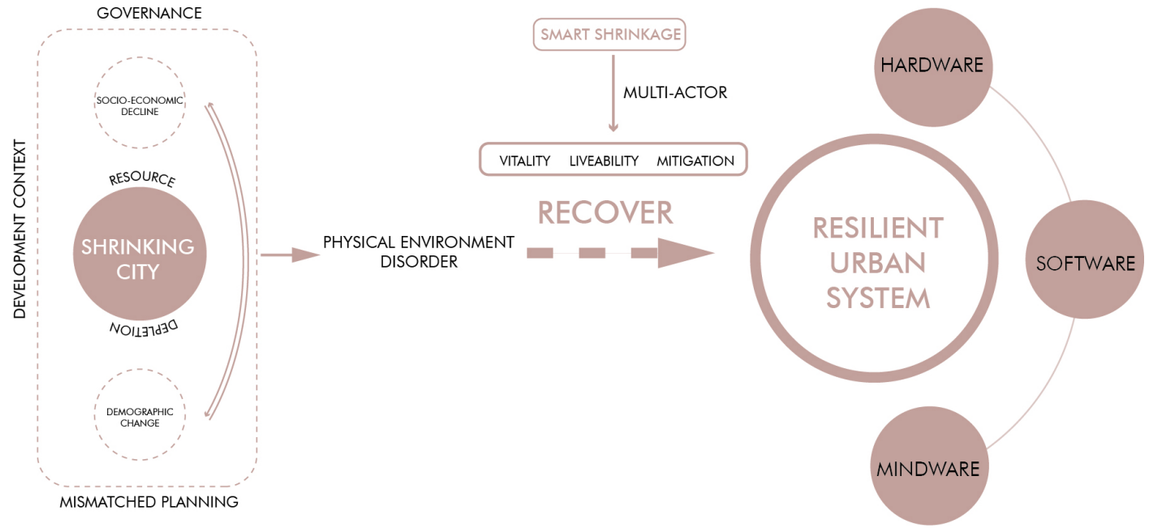


Fig. Conceptual framework. (Source: Made by author.)

3.3 METHOD

GENERAL METHODS

Literature review

A holistic approach to demonstrating knowledge and theories by researching, reading, analyzing, evaluating, and summarizing scholarly literature (typically journals and articles) about a specific topic.

Case study

A research approach that is used to generate an in-depth, multi-faceted understanding of a complex issue in its real-life context, such as shrinking cities, etc.

Mapping

A method of spatial analysis that aims to highlight and make it clear to identify problems. It includes digital processing and visualization of data.

Statistical analysis

A method of collecting, exploring and presenting large amounts of data to discover underlying patterns and trends.

Research by design

A type of academic investigation through which design is explored as a method of inquiry, by the development of a project and also exploring the different materials by which a design is carried out—sketches, mapping, among others (Roggema, 2016)

Policy review

Reviewing or evaluating policies can be used to provide context, generate questions, supplement other types of research data, track change over time and corroborate other sources (Bowen, 2009).

Stakeholder analysis

A process of identifying potential and target actors before design, issuing their needs and how they will be impacted by the project. Group them according to their power, interest and attitude, and then decide how best to engage and communicate with each group.

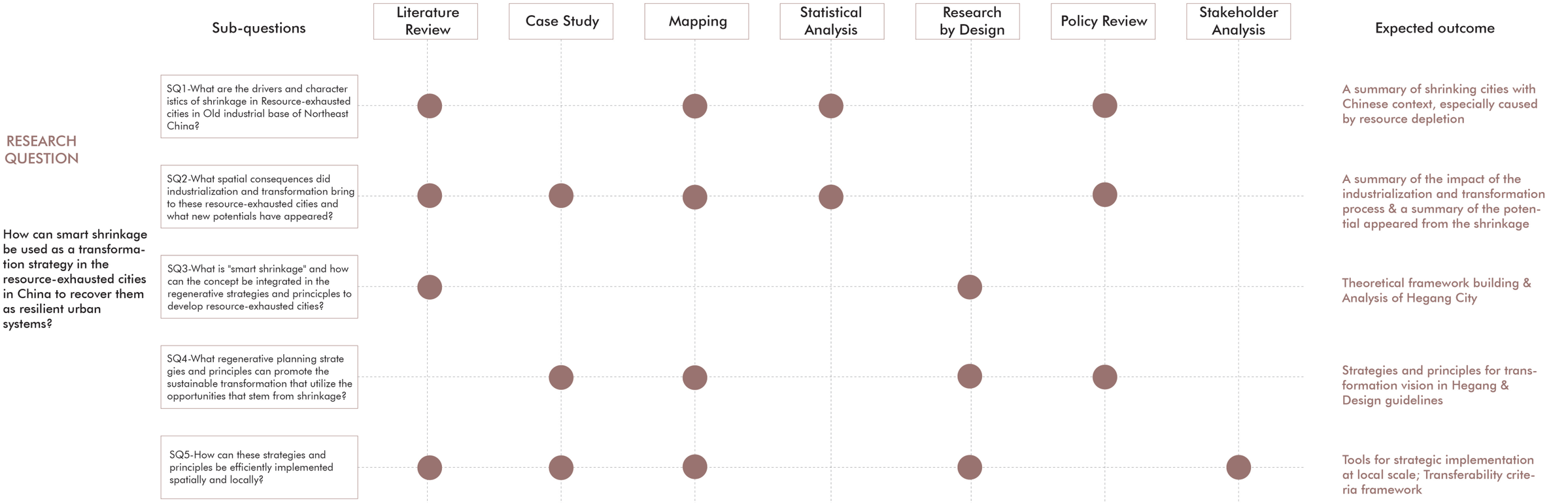


Fig. General methods. (Source: Made by author.)

3.3 METHOD

SQ1:

What are the drivers and characteristics of shrinkage in Resource-exhausted cities in Old industrial base of Northeast China?

QUESTION DEFINITION AND OBJECTIVE:

Urban shrinkage is an extremely complex and multifaceted process and there are specific characteristics in different context. The first sub-question is mainly focused on the analysis of the phenomenon of urban shrinkage based on specific Chinese context. This question aims at the definition and identification of the object of the thesis and will be composed of the main part of theoretical underpinning aspect of the whole thesis.

METHOD TO BE APPLIED:

Literature review: Understand the definition and significance of Resource-exhausted cities; the definition, causes and consequences of urban shrinkage; the special characteristics of Chinese context, for instance, the planning framework and hierarchy of China;
Mapping: Use maps to depict the overview of urban shrinkage trend in China in a visual way;
Statistical analysis: Use statistical data from municipal and central government to depict the overview of urban shrinkage trend in China in order to bridge the gap in spatial data;
Policy review: The central government has issued some policies related to the new urbanization construction to take the shrinking cities into consideration and some policies related to the regional development.

RESOURCE MATERIAL AND DATA:

Existing literature on urban shrinkage, resource-exhausted cities and Chinese context;
The revitalization planning of old industrial base of northeast China;
Key tasks of new urbanization construction in 2019;
Geographic data and GIS database;
Statistical data of statistical yearbook from municipal government and from website;

SQ2:

What spatial consequences did industrialization and transformation bring to these resource-exhausted cities and what new potentials have appeared?

QUESTION DEFINITION AND OBJECTIVE:

The second sub-research question, on the one hand, is an analysis of the historical development and status quo, where the existing challenges and problems can be summarized; on the other hand, it is considered as exploration of the potential goals and policy preferences of the shrinking resource-exhausted cities, where the government's understanding and attitude towards those cities can be noticed. Spatial renewal and restructuring are the main aspects of this thesis, apparently planning and designing are usually reflected by the interventions in space. Therefore, this question helps conduct the development of strategic framework and test the applicability in specific location.

METHOD TO BE APPLIED:

Literature review: Understand the industrialization and urbanization process in China; the status quo of industrialization in post-industrial era;
Case study: Collect the cases of the resource-exhausted cities that are facing the transformation and their reaction;
Mapping: Use maps to demonstrate the spatial consequences in the study site Hegang city;
Statistical analysis: Use statistical data from municipal and central government to depict the potentials and policy preferences;
Policy review: Study policies issued by the central government that guide the new urbanization construction; review the overall planning of specific cities to find the potentials of future development.

RESOURCE MATERIAL AND DATA:

Existing literature on Chinese urbanization and industrialization process;
The overall planning of some of the resource-exhausted cities, especially Hegang City;
Key tasks of new urbanization construction in 2019;
GIS database and open data from website;
Statistical data of statistical yearbook from municipal government and from website;

3.3 METHOD

SQ3:

What is "smart shrinkage" and how can the concept be integrated in the regenerative strategies and princicples to develop resource-exhausted cities?

QUESTION DEFINITION AND OBJECTIVE:

This sub-research question is the theoretical research. Smart shrinkage, one of the main concepts in the project, is actually not a well-known and widely used concept. In order to implement this approach, the new and logical understanding of this concept is necessary. In this question, combined with new interpretation of recovery and resilience, the theoretical framework will be built; It can help evaluate and integrate the principles and strategies extracted from the literature review, and finally help to establish a transformation strategic framework of smart shrinkage related to study site.

METHOD TO BE APPLIED:

Literature review: *[combined with Case Study]* Study the strategies of coping with shrinkage in different context; understand the meaning of smart shrinkage, as well as the strategies and principles based on smart shrinkage; understand the definition and theory of resilience and adaptive cycle; understand the concept and definition of recovery, and redevelop it based on the project; study and explore the concept of livability and urban vitality and their evaluation criteria;
Case study: Collect the cases of cities that are facing shrinkage and their reactions; the implementation of smart shrinkage;
Research by design: Develop the guidelines of smart shrinkage that adaptive to Chinese context in Hegang city based on the summary of case study and literature review;

RESOURCE MATERIAL AND DATA:

Existing literature on how to cope with shrinkage in different cases;
Existing literature on smart shrinkage;
Existing literature on resilience and recovery;
Existing literature on urban vitality and livability;

SQ4:

What regenerative planning strategies and principles can promote the sustainable transformation that utilize the opportunities that stem from shrinkage?

QUESTION DEFINITION AND OBJECTIVE:

This sub-question mainly studies the regenerative strategies and principles to promote Hegang's sustainable transformation based on the theoretical framework and analytical framework. The purpose of this research question is to form a strategic framework and master plan through the previous research for the transformation, combining its own development potentials and policy support from government.

METHOD TO BE APPLIED:

Case study
Mapping: Use the data and maps to position the problems in Hegang City;
Research by design: Combine the analysis with strategies and principles;
Policy review: Explore the potentials and opportunities from the policies in regional and local scale;

RESOURCE MATERIAL AND DATA:

GIS database and open data from website in Hegang scale;
Theoretical research and framework;
Vision building for the project;

3.3 METHOD

SQ5:

How can these strategies and principles be efficiently implemented spatially and locally?

QUESTION DEFINITION AND OBJECTIVE:

The last sub-question still focuses on the local scale, which includes two part, one is testing whether the planning strategies can be implemented in the local scale and can promote the transformation to get the spatial regeneration; the other is to explore the stakeholder engagement in the implementation process and explore the possibilities of cooperation between different departments to form the steps to realize the future vision.

METHOD TO BE APPLIED:

Literature review: Study the theory of empower, governance and social inclusiveness;
Case study: Study the regenerative planning cases; study the co-governance practices;
Mapping: Use the maps to point the potential design area and help locate the strategies in Hegang City;
Research by design: Use the design language to depict the strategies and principles;
Policy review: Explore relationship between departments that are regulated in the policies and explore potential cooperation in the planning;
Stakeholder analysis: Discuss and confirm all the possible stakeholders that are involved in the implementation of the plan; In each strategies, explore the their relationships;

RESOURCE MATERIAL AND DATA:

Existing literature on governance and co-governance;
Satellite map and analysis in Hegang scale;
Overall planning of Hegang city and development planning documents;

3.4 RESEARCH FRAMEWORK

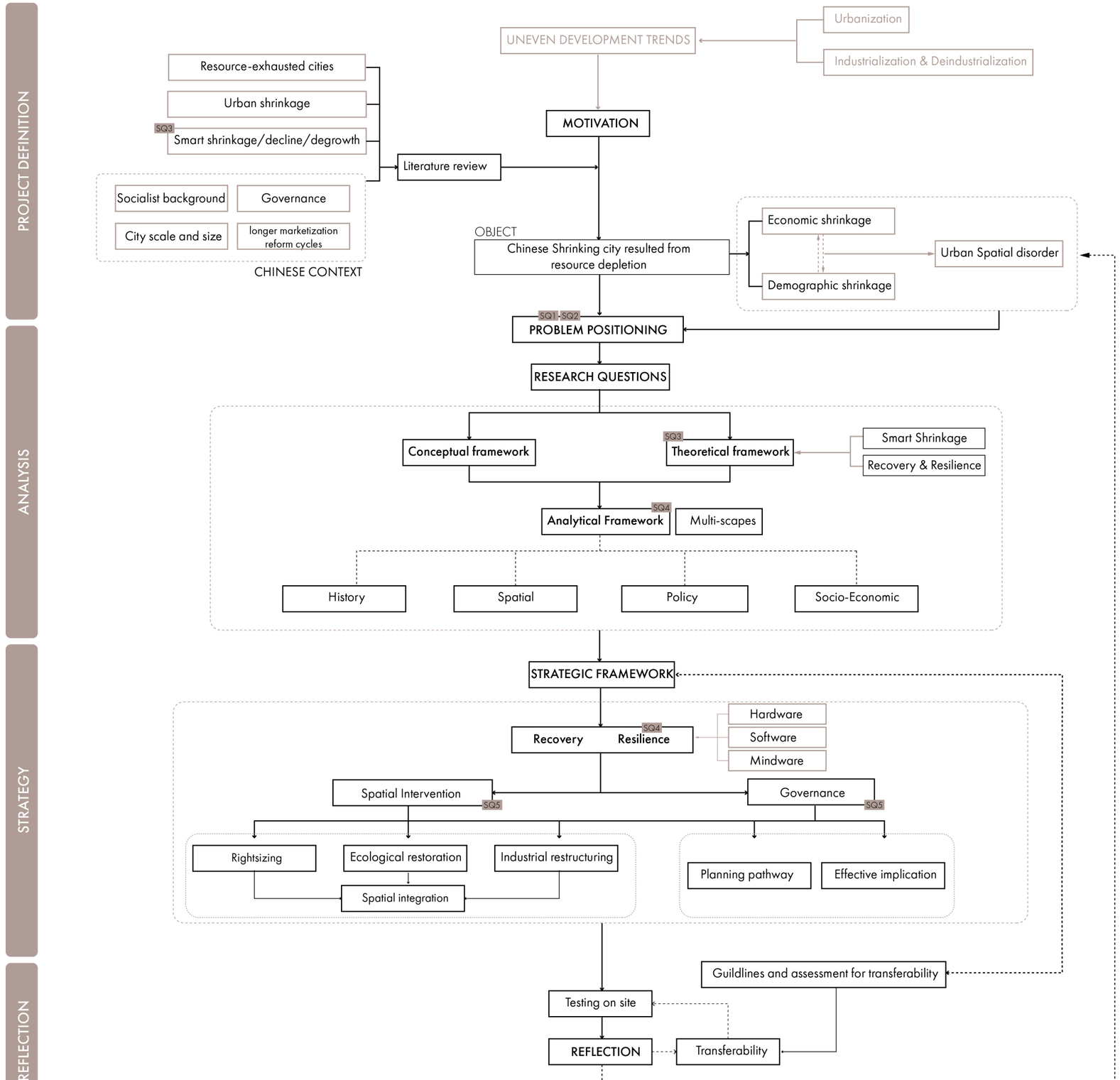


FIG. Resarch framework. (Source: Made by author)

3.5 THESIS PLAN

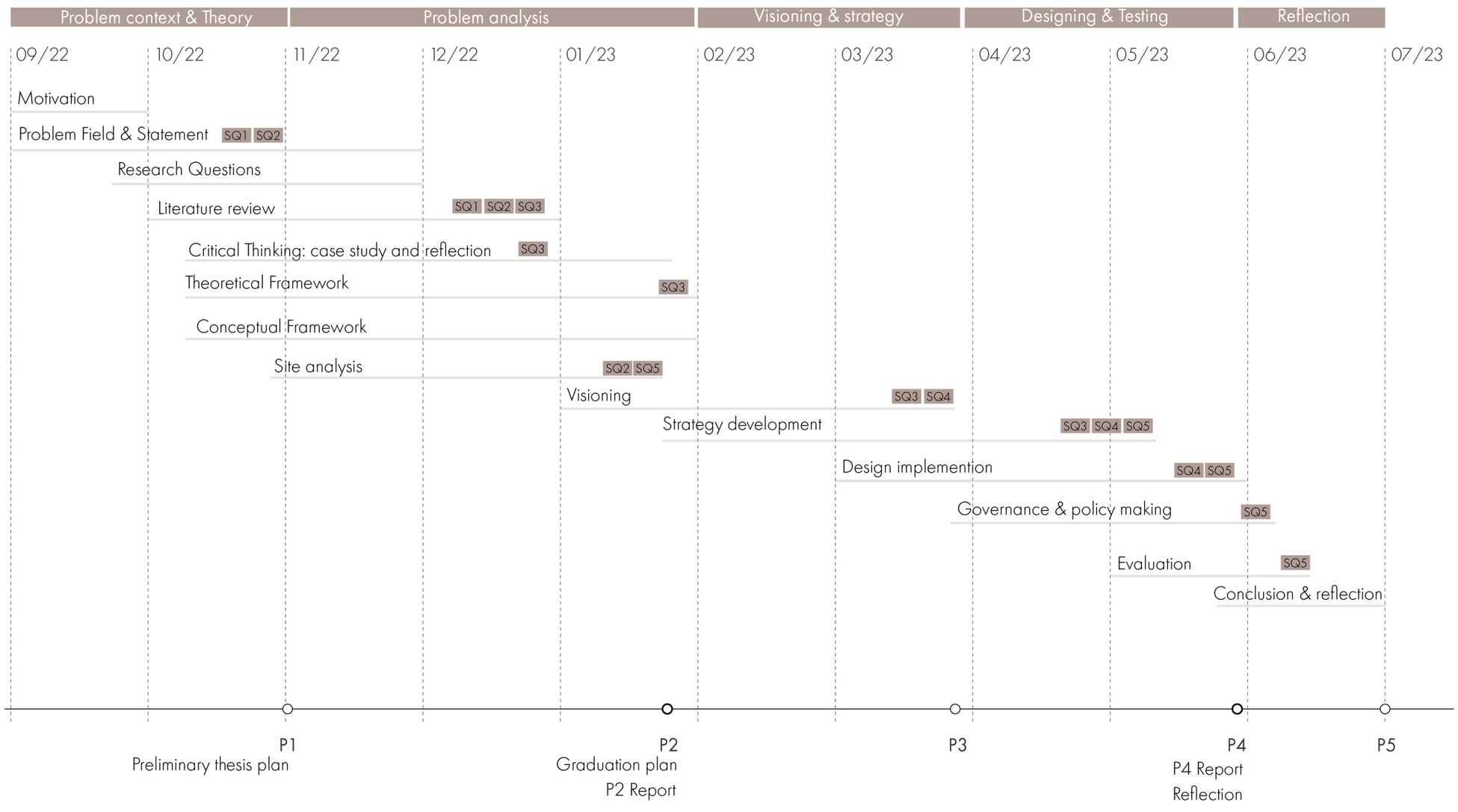


FIG. Thesis plan. (Source: Made by author)

3.6 EXPECTED OUTCOME

DESIGN ASSIGNMENT

First of all, through historical development and literature review, analyze the context, causes and consequences of urban shrinkage, and summarize the transformation dilemma faced by post-industrial shrinking cities facing resource depletion, which are the most characteristic among shrinking cities in China; At the same time, summarize the current methods to deal with the problem of urban shrinkage, discuss the feasibility of the concept of "smart shrinkage" in the Chinese context through theoretical research and analysis of the current situation, and form a theoretical framework that are adaptive to the transformation of resource-exhausted shrinking cities;

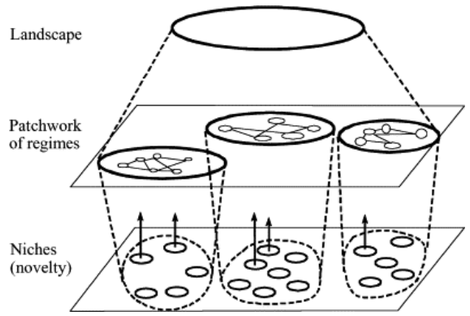
Secondly, through spatial analysis, summarize the status quo of Hegang City, and define its decline in terms of population, economy, and space; combine policy overviews, explore its development potential during the shrinking process, and propose plans for different spatial elements Design principles and related strategies;

Third, based on design principles and research purposes, strategically implant design and planning; propose the establishment of a cooperation sequence for planning and development stakeholders, and explore their participation time path and spatial distribution in the process of realizing planning and development, so as to ensure the success of transformation proceed smoothly;

Fourth, discuss the transferability evaluation system framework for evaluating whether the strategic framework can be used in different cities in similar situations, and provide some implementation guidelines.

EXPECTED OUTCOME

- Strategic planning based on 'smart shrinkage' for urban transformation in multi-levels



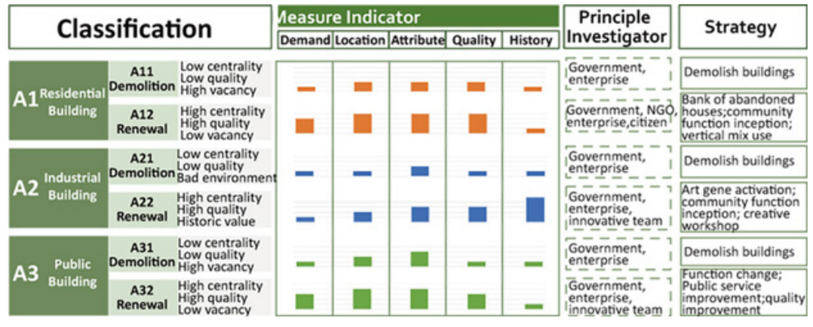
(Source: Frank W. Geels, 2022)

- Vision based on smart shrinkage

- Strategic plan of Hegang center city and design implementation in local scale

Source: https://mp.weixin.qq.com/s/n6CAXW-R0tP4xsuis8W_IQ

- Design Guidelines for Different Types of Spatial Elements



Source: Long, Y., Zhang, E. (2021). Fine-Scale Recognition-Based Design Guidelines for Dealing with Shrinking Cities: A Case Study of Hegang. In: Data Augmented Design. Strategies for Sustainability(). Springer, Cham. https://doi.org/10.1007/978-3-030-49618-0_6

- Improved Governance model based on Chinese context, which means a new model for more participatory actors to express their voices and serve as regulators on the basis of the existing political system remaining unchanged.

04 THEORETICAL RESEARCH

4.1 THEORETICAL UNDERPINNING

RECOVERY

Define Recovery

Definitions of recovery vary in the literature. The recovery process is generally accepted beyond reconstruction. Recovery is generally understood as the process of rebuilding, repairing, or reconstructing and returning a system to a functional state after a major event or shock (e.g., Blaikie et al., 1994, Coppola, 2011). It is a multi-dimensional, nonlinear and complex process. It concerns changing from physical recovery to rebuilding of people's lives and livelihoods (functional recovery) (Brown et al., 2010). To be more specific, recovery is a holistic process "through which those affected by disasters achieve desired levels of social well-being, quality of life, sense of place and belonging, and civic engagement" (Tierney & Oliver-Smith, 2012). If recovery is a process then what is the intended outcome?

A common principle of recovery is "building back better." However, 'building back' may rebuild the vulnerability which caused the disaster but also because it's not possible to return to the pre-disaster situation: the disaster itself will have caused irreversible changes within the affected area and disaster recovery will take place within wider social, political and economic changes at various scales. Additionally, in particular, there is often limited agreement regarding what "better" means and there are typically multiple views on how to achieve outcomes across various recovery scenarios (March et al, 2017). Recent thinking is that recovery should aim to achieve a 'new normal'. It's important to note that the 'new normal' might not be 'better' – it might just be adaptation to a new situation (Chang, 2010).

Three values of Urban Recovery

1.Mitigate the negative impacts of urban shrinkage

Shrinking is a complex process that affects multiple dimensions of a city. The combination of factors associated with shrinking cities can have mutually reinforcing effects, potentially leading to further shrinking. Hospers (2014) indicated that the impact of urban shrinkage is extensive, including "hardware", "software", and "mindware" of a city. Hospers (2013, 2014) explains urban hardware as the "visible, tangible and countable" elements of a city such as infrastructure but also the local economy. The software of a city refers to the norms and values of inhabitants and the way the inhabitants act and interact. Urban mindware relates to the image of the city, which can have an impact on current and future trends with regard to population development.

Urban hardware effects that are commonly regarded to when discussing shrinkage are, amongst others, vacancy of all types of real estate, decay of real estate and the public space, dilapidated infrastructure, high unemployment rates due to the closure of industrial factories, few job opportunities and low willingness to invest. With fewer residents and smaller municipal budgets, cities are challenged to maintain the standard of living for their residents and the public provision of education, health care, and public transportation. This puts pressure on the investments required to upgrade and ensure the provision of public services.

Shrinkage also affects the urban software of a city. According to Hospers (2013), in cases of shrinkage, the young and gifted often leave. This brain drain of youth causes their offspring to be born elsewhere, which causes the local population to age. As a result, the socio-demographic makeup of a decreasing city changes. According to empirical research, entrepreneurship, creativity, and innovation are less likely to flourish in aging cultures. This is unfortunate because, in particular, decreasing cities can In some areas of the city that experience rejuvenation, shrinkage can also cause sociospatial polarization. The issue of existing social networks in the city weakening or perhaps dissolving due to contraction is another issue. This not only inhibits innovation and entrepreneurship but also diminishes social networks and, as a result, lowers the spirit of the neighborhood.

Lastly, shrinkage affects the urban mindware since shrinkage has a negative image and when the residents of a shrinking city are aware of this negative image, they might feel inferior to people living in 'successful' cities and this discourages local empowerment.

4.1 THEORETICAL UNDERPINNING

RECOVERY

2.Increase liveability under shrinking trend

Processes of decline inevitably affect the liveability of communities. In general, urban shrinkage is often thought to cause a decline in the quality of life of residents. However, Delken (2008) and Hollander (2011) believed that urban shrinkage did not mean the decline of residents' quality of life or satisfaction. On the contrary, under the premise of ensuring the supply of urban public goods and services, a decrease in urban population will enable residents to obtain a better lifestyle (Hollander and Németh 2011).

In terms of definition of liveablity, De Chazal (2010 , p. 586) argued that "in its simplest sense, liveability can be seen as a pure expression of values or desires" , however, De Chazel also concedes there is a need for working definitions applicable to specific circumstances and proposes that liveability can be broadly defined as: "a statement of desires related to the contentment with life in a particular location of an individual or set of individuals" (p. 587).

McCrea and Walters (2012) attempted this in their study, defining "liveability" as an individual's perspective and their subjective evaluation of the quality of both tangible (e.g. public infrastructure) and intangible (e.g. sense of place) features of place. The definition of liveability can be considered as two division, "experienced in" the context of the urban environment (i.e. the subjective social environment) and "derived from" the urban environment (i.e. the objective physical environment).

In addition, in the urban regeneration literature, liveability has come to mean the ability of a centre to maintain and improve its viability and vitality. These two terms mean the capacity of a city centre to attract investment continuously and to remain alive. In conclusion, liveability is the sum of the socio-physical and socio-cultural factors that can improve and upgrade living standards of any spaces (Jomehpour, 2015).

Liveability is multi-faceted, measurable by various subjectively and objectively quantified indicators. Leby and Hashim (2010) evaluated subjective liveability according to social, physical, functional and safety dimensions, finding that the built environment, safety, open spaces and access to public facilities (i.e. schools and hospitals) represent core measurements for liveability evaluation. Elsewhere, Saitluanga (2014) compared objective and subjective liveability across six dimensions: economic, social, household, accessibility, satisfaction with socio-economic environment and satisfaction with the physical and infrastructural environment (e.g. park, public transport and municipal services).

3.Boost the urban vitality of development

Urban vitality is the original driving force for urban function display and land development; it reflects the interaction between urban human activities and space(He et al, 2018). From the perspective of urban sociology, urban vitality is regarded as a concrete representation of urban competitiveness, which is subdivided into three parts: economic vitality, social vitality and cultural vitality (Yang, 2020), to be more specific, macroscopical urban vitality mainly reflects the level of urban economic and social development, as well as the resource base and progress potential of urban culture, environment and space, etc (Ma et al., 2021). The changes of urban development factors in the process of urban shrinkage often leads to the decline of urban competitiveness.

The vitality of cities refers to their capacity to develop and closely relates to their population and economy behave. The phenomenon of population reduction and negative economic growth caused by urban shrinkage seems to have become an important obstacle to urban development. A shrinking city loses its vitality rather than simply its population, to be more specific, the dynamics of urban shrinkage and expansion during the large magnitude of migration caused the migration of human capital. The most qualified and the youngest leaving first, particularly highly qualified human capital of knowledge-based economies, who plays a key role in attracting business investors and generate and augment opportunities and rewards for themselves (Gornig & Mundelius, 2012).

Recovery means awakening the vitality of cities and realizing the goals of the high-quality development of cities by adjusting the vital elements of cities and improving cities' comprehensive competitiveness. The strategies should based on indicators of urban vitality among five aspects: economy, society, culture, environment and space, which means the triggers in economic redevelopment, improvement in social inclusiveness, the richness in cultural demonstration, the improvement in environmental equality such as the level of vegetation cover, ecological consumption, public health, and the reasonable arrangement of facilities which means the availability of public facilities, public services, land use and infrastructure in cities.

4.1 THEORETICAL UNDERPINNING

RESILIENCE

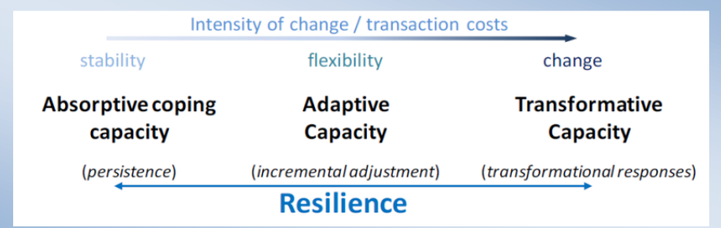
Resilience is the ability of households, communities and nations to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living in the face of long-term stresses, change and uncertainty (Mitchell, 2013). Resilience can be boosted by strengthening three different types of capacities:

Absorptive capacity: The ability of a system to prepare for, mitigate or prevent negative impacts, using predetermined coping responses in order to preserve and restore essential basic structures and functions. This includes coping mechanisms used during periods of shock. Examples of absorptive capacity include early harvest, taking children out of school, and delaying debt repayments.

Adaptive capacity: The ability of a system to adjust, modify or change its characteristics and actions to moderate potential future damage and to take advantage of opportunities, so that it can continue to function without major qualitative changes in function or structural identity. Examples of adaptive capacity include diversification of livelihoods, involvement of the private sector in delivering basic services, and introducing drought resistant seed.

Transformative capacity: The ability to create a fundamentally new system so that the shock will no longer have any impact. This can be necessary when ecological, economic or social structures make the existing system untenable. Examples of transformative capacity include the introduction of conflict resolution mechanisms, urban planning measures, and actions to stamp out corruption.

Figure 3: The relationship between absorptive, adaptive and transformative capacities for strengthening resilience



Source: Béné et al (2012)

The framework proposed by the OECD (Figueiredo et al., 2018) focuses on four dimensions that call for different types of objectives

the economic dimension targets diversification and innovation;

the social one ensures that society is inclusive and cohesive;

the environmental component focuses on sustainable urban development and adequate and reliable infrastructures;

the governance aspects require long-term vision, sufficient resources, collaboration with other levels of government; and a participatory government.

Fig. 4 areas that drive resilience. (Souece: OECD)

In the current approach, resilience is seen as a dynamic attribute associated with a process of continuous development(Pendall, 2010). Resilience, in this case, is not a return to a state of "prior normality", but a creative change and adaptation in order to support long-term positive dynamics(Bănică, 2017).

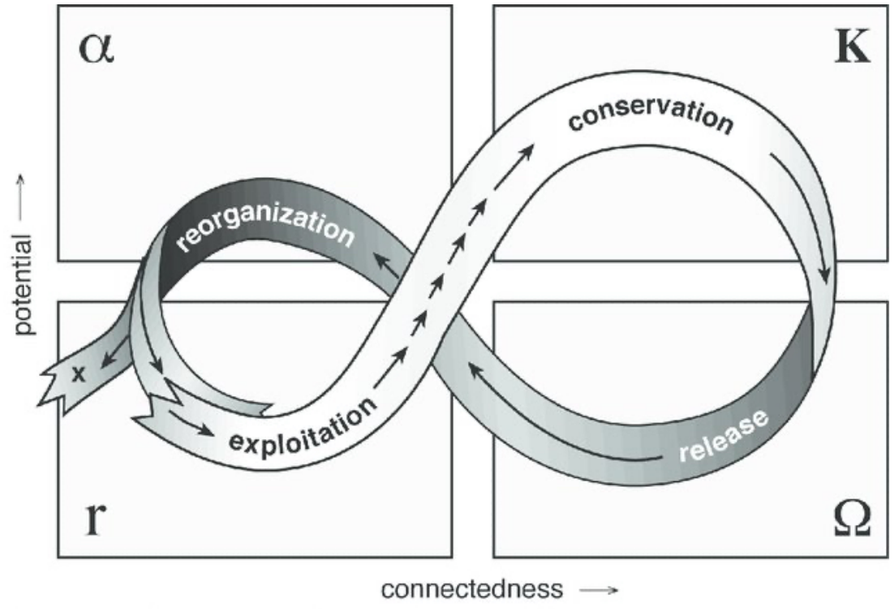
Specifically, the resilience concepts have been applied to address the adaptation problem of human social and urban systems to shocks and chronic stress (Hu & Hassink, 2017 ; Wang et al., 2020). A topic of interest in the areas of urban growth and shrinkage is the issue of making cities more resilient to cope with uncertain disturbances and changes in the external environment and thereby become capable of achieving long-term sustainable development (Kotilainen et al., 2015 ; Zhang & Li, 2018). The notion of resilience can help in understanding how cities resist shocks and recover from recessions (Martin et al., 2016).Furthermore, it may help reveal how they make transformations and innovations using urban advantages and potential opportunities to formulate appropriate policies (Alves et al., 2016 ; Du et al., 2019).

4.1 THEORETICAL UNDERPINNING

RESILIENCE

Adaptive cycle

The adaptive cycle theory is a widely recognized theoretical tool for describing the interaction between disturbances and reorganization of the system, as well as for detecting system evolution. The theory holds that a dynamic system experiences four stages: exploitation (γ), conservation (K), release (Ω), and organization (α) (Holling, 2001).The adaptive cycle is neither immutable nor absolute, while the most diverse socio–economic and/or ecological systems have different evolutions. Cities are complex, adaptive, self-organizing (eco)systems. The urban system evolution is not linear but circular, extending through different stages of the adaptive cycle in different rhythms from this theoretical perspective (Bănică et al., 2017).



The adaptive cycle (from Panarchy, edited by Lance H. Gunderson and C.S. Holling: Figure 2-1 (page 34). Copyright © 2002 Island Press.

Fig. The adaptive cycle. (Schoon y van der Leeuw, 2015)

Shrinking cities are confronting certain constraints, confusion and crisis, they are in conservation phase or facing breakdowns, which is less flexible to negative influences and shrinkage represents a result of response to shocks. This way, they can be stuck in a crisis without the ability to start a process that can lead to new choices and development opportunities (Schlappa and Neill, 2013). In this phase of cycle, the future needs to be reinvented based on the changing context and their abilities and strengths that may be different from the past. The learning process in a period of uncertainty, confusion and crisis is a major link between shrinking cities and resilience.

The essential relation between shrinking cities and resilience capacity is represented by the “learning” segment of the cycle (dotted line in Figure) in a period governed by uncertainty, constraint, confusion and crisis when there is a tension between the actual state and the possible alternatives.

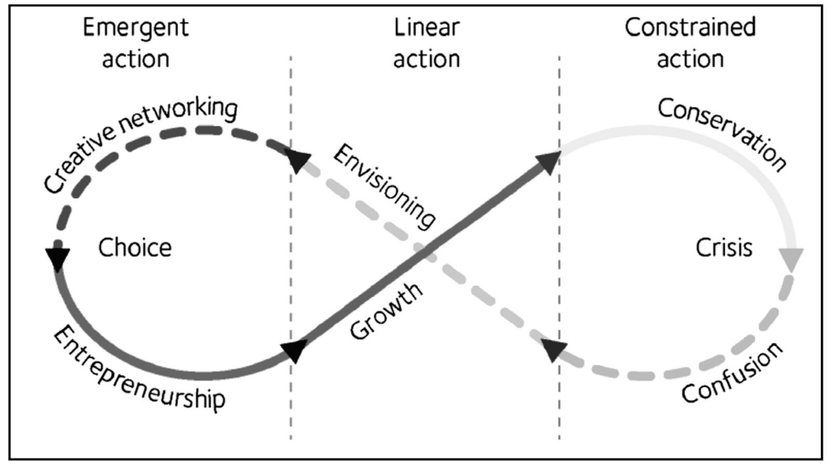


Fig. Adaptive cycle of shrinking city. (Source:Schlappa and Neill, 2013)

4.1 THEORETICAL UNDERPINNING

RESILIENCE

In the exploitation phase (γ), cities are based on resource extraction with the primary goal of growth; cities accumulate large resources (innovation, capital, information, technology, etc.) following targeted development paths. Moreover,new relationships of network connections, trust and interdependence are gradually established. At this stage, the system structure becomes more stable, compact and orderly.

In the conservation stage (K), the system model tends to mature, resource-based cities form a mature industrial structure dominated by a single industry, and elements (capital, labor, technology, etc.) Some industrial systems (especially leading industries) operate together, and the system is relatively stable.

When resources are gradually exhausted, as a crisis impacts the urban system, local finances are in trouble, and the city enters the release phase (Ω), and the urban system is losing order and stability. At this stage, the urban system needs to maintain its main functions in crisis and turmoil, and evolve on a new path. If the leadership does not take the appropriate development path, fails to adapt to the crisis or form a sustainable development model, the urban system will enter a lower cycle until it enters a complete recession; And if there are ways such as "creative shrinkage", "smart shrinkage" and "elastic shrinkage", which imagine intelligent adaptation while shrinking naturally (though sometimes indirectly) during the release phase of the adaptation cycle, developing strategies on a smaller scale in a more sustainable manner, that urban The system then enters the reorganization phase (α) of a new cycle more adapted to the shrinking status quo.

The reorganization stage(α) is a period of system creation and renewal such as economic policy adjustment and industrial restructuring, and the system is facing a process of transformation from old to new development models. In the actual development, the city's accumulation and regime in the past interfere and interact with each other in the development process, affecting the direction of urban development (Bănică et al., 2017; Martin & Simmie, 2008). Therefore, the new path is to a certain extent It is rooted in the past development path. At this stage, new opportunities will arise to lead the further development of the city as the urban system gradually stabilizes towards innovative development.

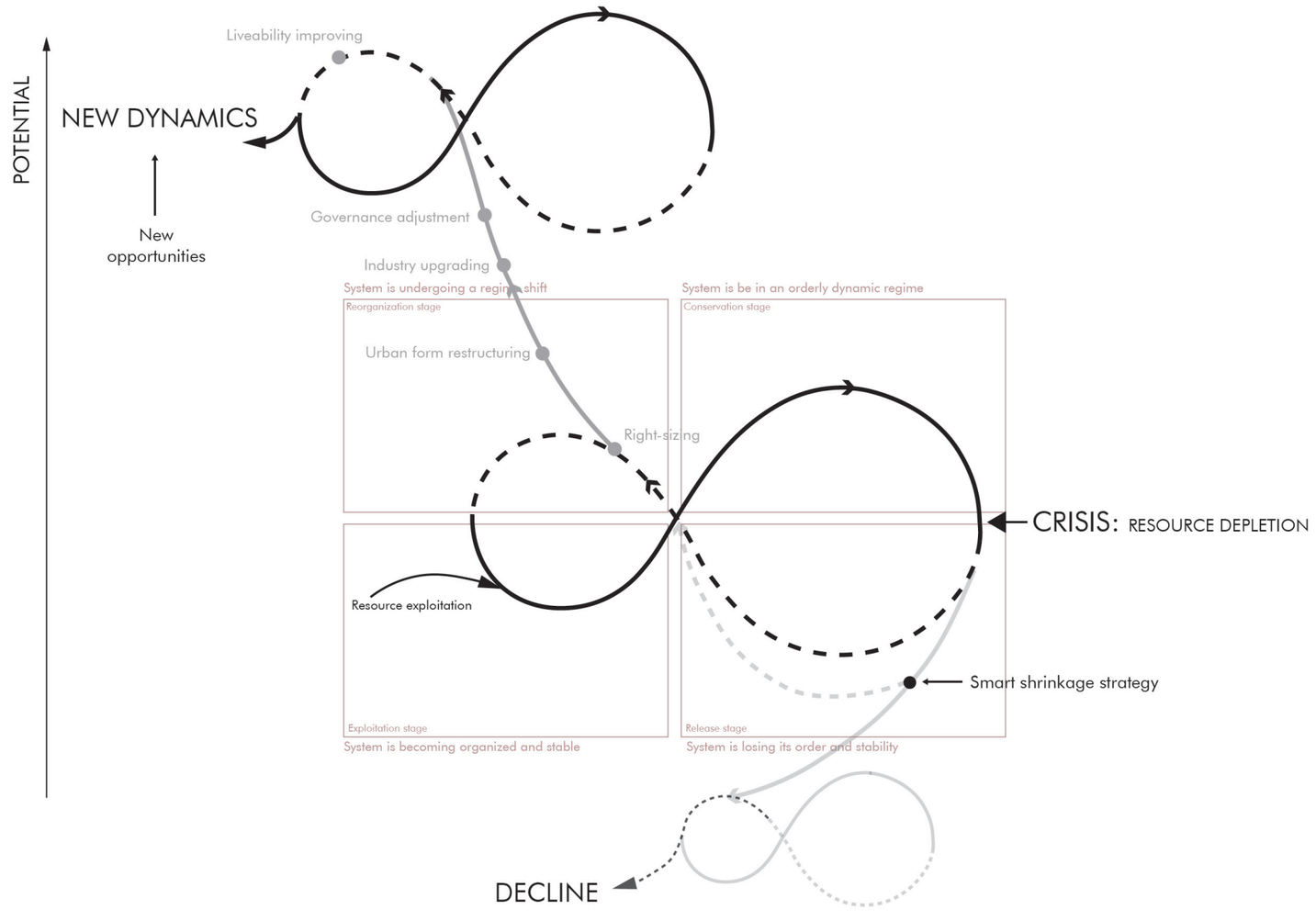


Fig. Adaptive cycle of shrinking city with smart shrinkage concept. (Made by author)

4.2 THEORETICAL FRAMEWORK

Theories and supportive knowledge are summarized to form a theoretical framework, underpinning how to recover from the long-term shrinking crisis and enhance the resilience, then realize the sustainable transformation in shrinking resource-exhausted cities.

The theoretical framework of this project comprises the following:

the shrinking city caused by resource depletion with Chinese context; transformation strategy; urban recovery framework summarized by myself; urban system resilience.

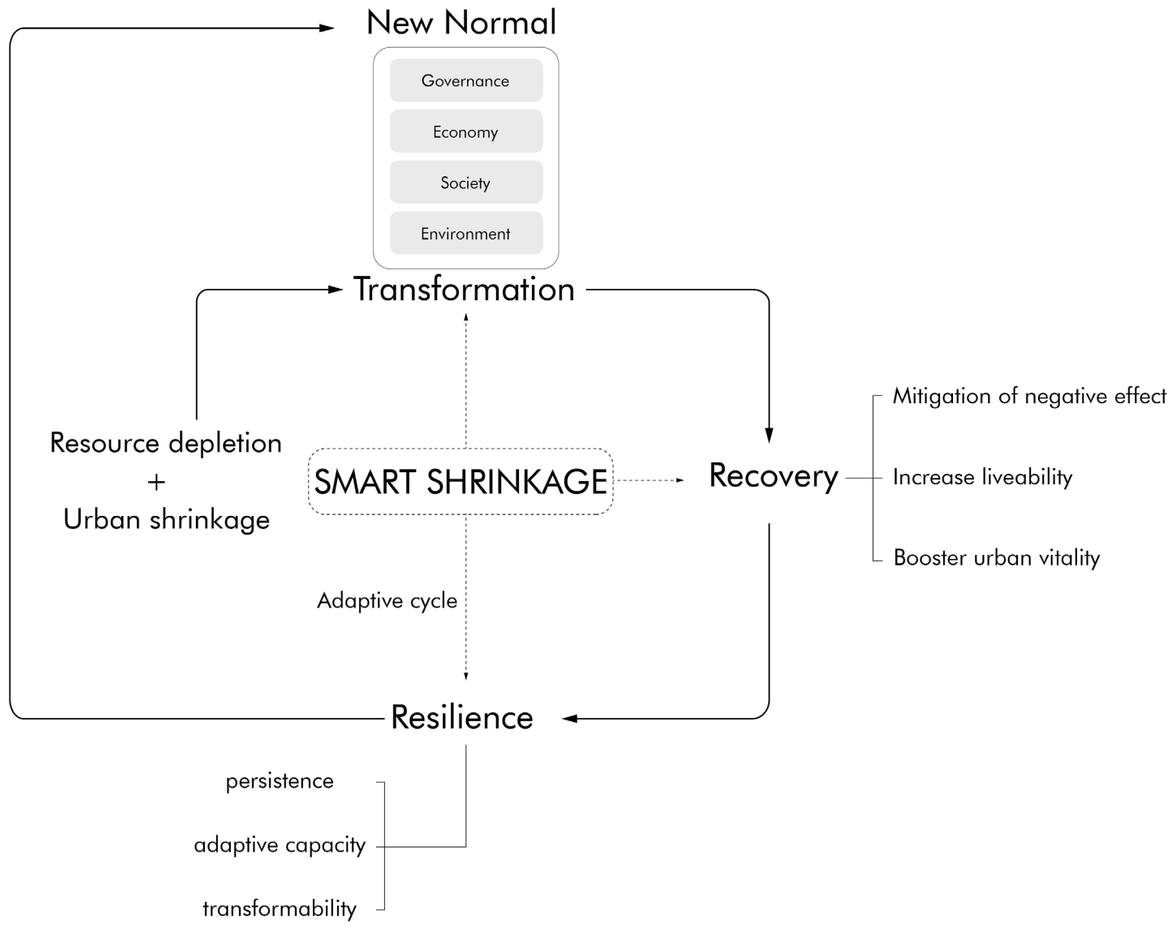


Fig. Theoretical framework. (Made by author)

05 ANALYSIS

5.1 SPATIAL ANALYSIS

LANDUSE

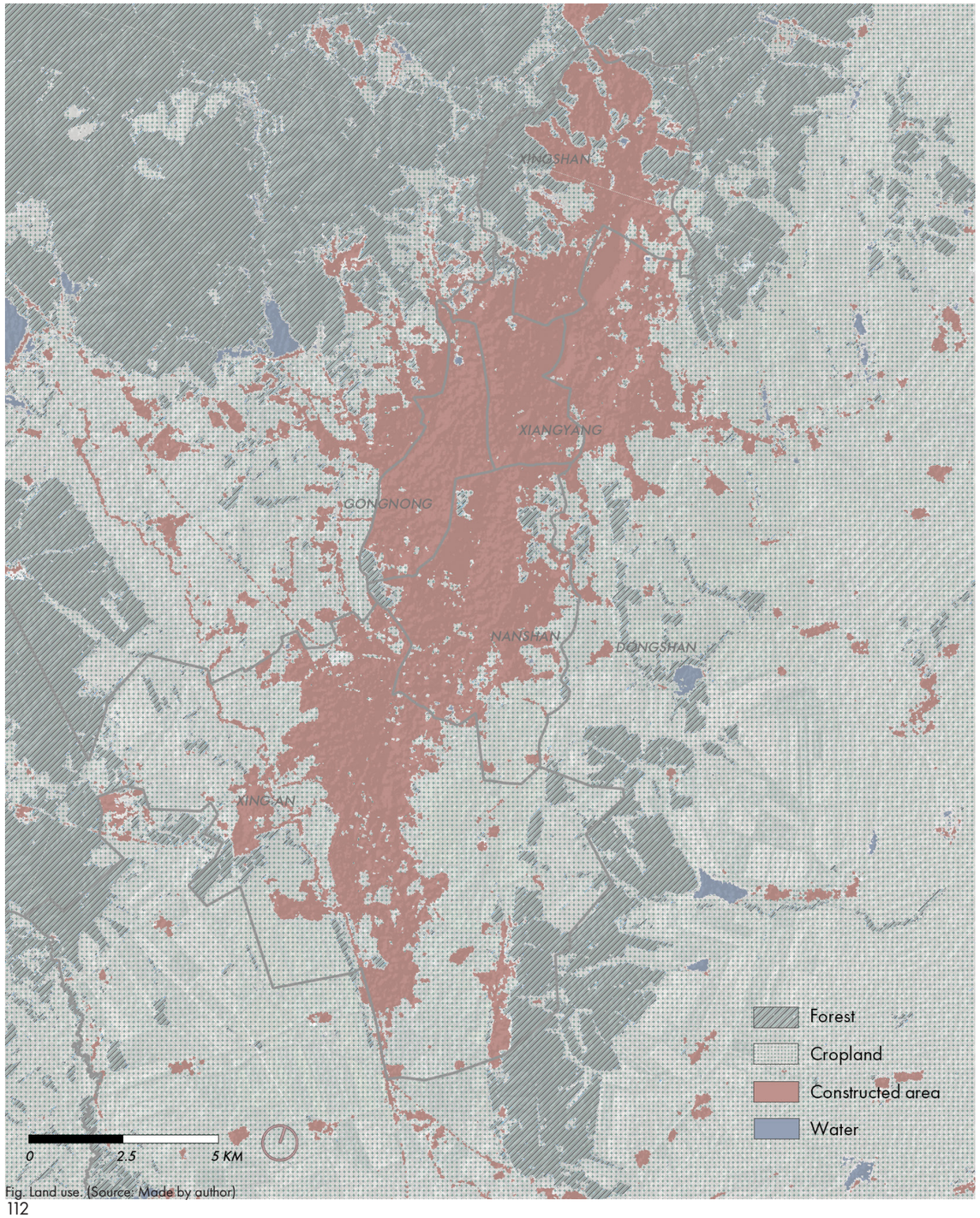


Fig. Land use. (Source: Made by author)

Detailed land use

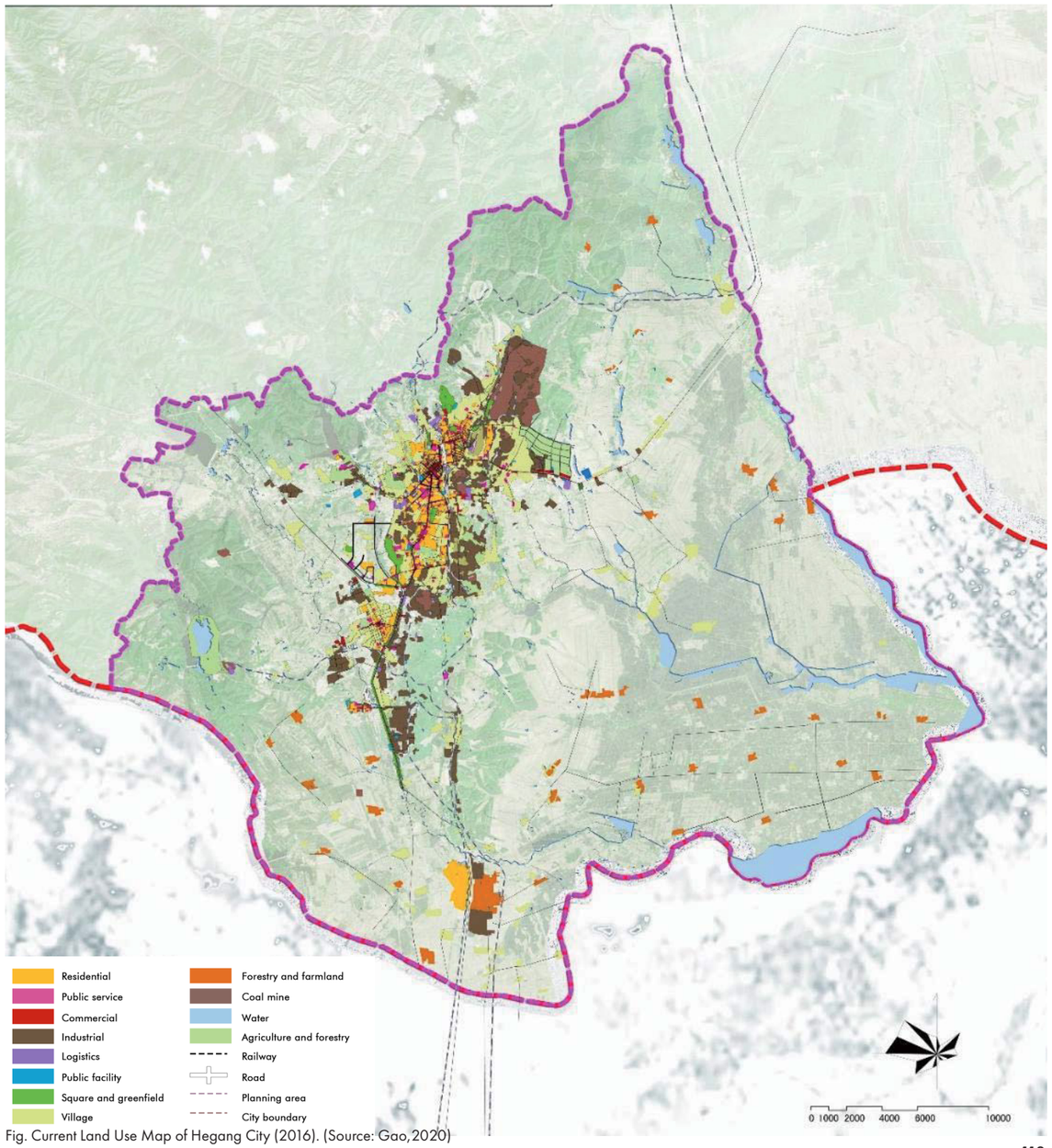


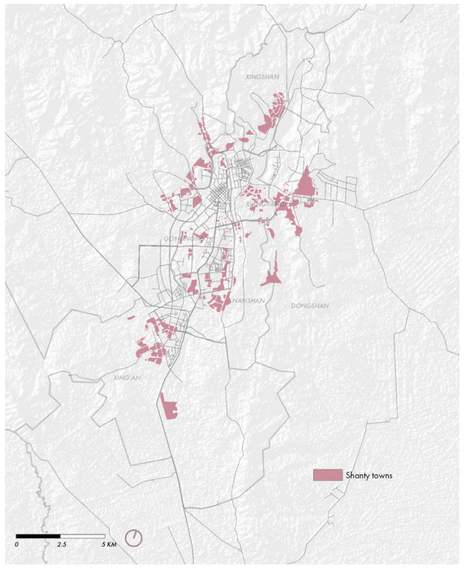
Fig. Current Land Use Map of Hegang City (2016). (Source: Gao, 2020)

5.1 SPATIAL ANALYSIS

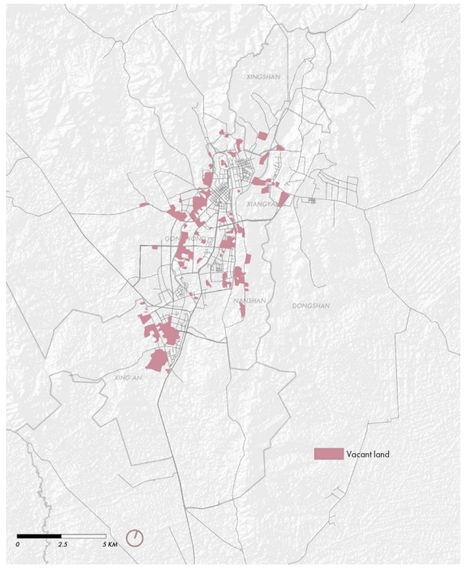
LANDUSE

The northern part of Hegang City is distributed along the valley, develops to the northernmost point, and then continues to extend southward. The central area of Hegang is divided into Chaoyang District and Gongnong District, and each district is vertically arranged in a strip shape from north to south.

The districts of Hegang City are established for the mines, relying on the mining areas to follow the model of "mines first, then the city" to develop in groups, resulting in a large number of districts, and the land occupation of each district is too small.



a) Shanty towns

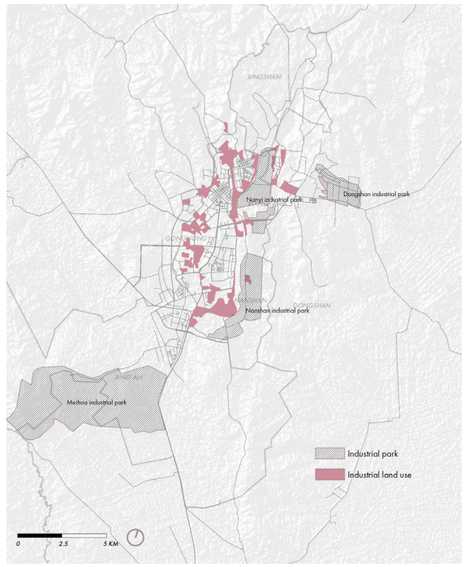


b) Vacant land

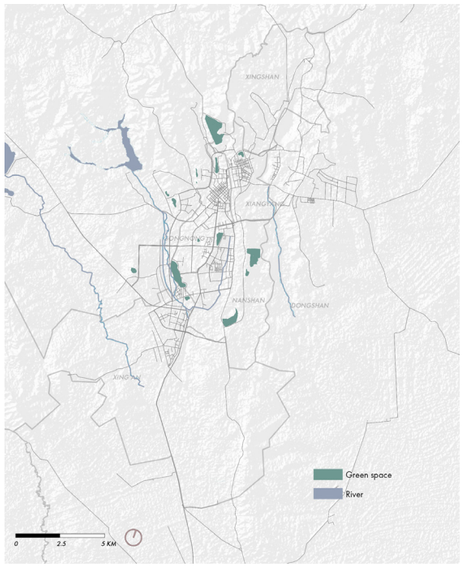
Fig. Distributions of various land use. (Source: Made by author)

Shanty towns (Source: Baidu image)

Vacant resettlement houses(Source: Baidu image)



c) Industrial area



d) Natural landscape

Fig. Industrial area and the city view of Hegang. (Source: Bilibili & Google Image)

5.1 SPATIAL ANALYSIS

RESOURCE DISTRIBUTION

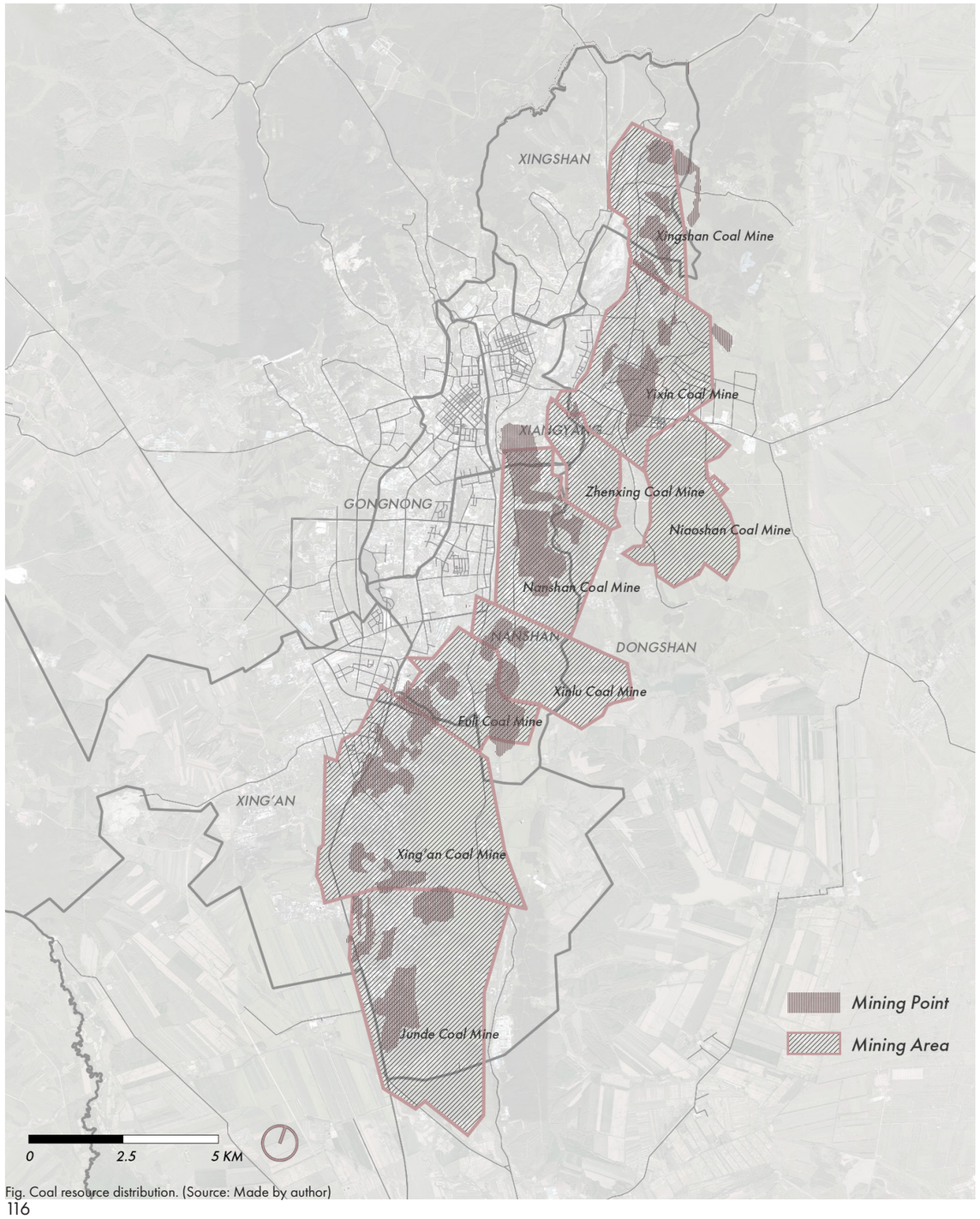


Fig. Coal resource distribution. (Source: Made by author)

Coal mining in the Hegang mining area (mainly including Xingshan, Yixin, Zhenxing, Niaoshan, Nanshan, Xinlu, R&F, Xing'an and Junde coal mines) began in 1917 and has a history of 100 years. The current mining area starts from Xingshan Mine in the north and ends at Junde Mine in the south. It is 27km long from north to south, 4km wide from east to west, and covers an area of 108km^2. The approved production capacity is 13.51 million t/a.

The black part in the northernmost part of the urban area is the pit mountain or coal pile, and the isolation zone formed by the mines in the east of the urban area forms a clear boundary with the suburbs.

Fig. Hegang Coal Mine Open Pit. (Source: Google Image)

5.1 SPATIAL ANALYSIS

SPATIAL STRUCTURE DEVELOPMENT

Early urban formation stage

The city of Hegang is developed by coal, and the urban space development depends on the distribution of coal resources, and the city takes the form of "being built by coal". In the early stage of urban development, as each district relied on the development of large state-owned coal mines, and the living In the early stage of urban development, as each district relied on large state-owned coal mines for development, and the living area was generally near the coal mines, forming a relatively independent area with large state-owned coal mines as the core, so Hegang City was initially scattered layout.

Urban Growth stage

The coal reserves in Hegang City are relatively concentrated and distributed in a belt shape. In 1926, the north-south Jiamuhe Railway was built to transport mined coal. With the development of the city, urban life, commerce, and service land began to move away from the coal mining area and developed along the railway direction, eventually connecting the relatively scattered coal mining areas in the early days into one piece, making the urban spatial form of Hegang City a contiguous belt-shaped structure . During this period, the expansion of construction land in Hegang City changed significantly.

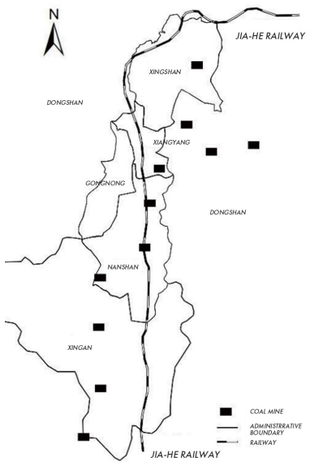


Fig. Railway and coal mine in Hegang City. Source: Gao,2020

The development of urban construction land from 1990 to 2015 can be roughly divided into three stages: the slow development stage from 1990 to 1995, the construction land is concentrated in the Xiangyang District and the Industrial and Agricultural District, and now it has become the urban administrative and commercial center of Hegang City. From 1995 to 2005, the city developed rapidly towards the south, and the construction land expanded to the south. During the period of rapid urban expansion from 2005 to 2015, urban construction land increased substantially to the periphery. The large amount of basic farmland in the south of Hegang City and the coal mining subsidence area in the east restricted the direction of urban development. Therefore, the main expansion directions in this stage were northeast and west direction.

The paradox between population loss and urban expansion emerges in the later stage of urban growth when the coal industry declines and there is a significant lag effect between urban shrinkage and decay and population decline can also be seen.The contradiction between people and land is a common problem in shrinking cities. While the urban population is declining, the land for urban construction is growing without restraint, which continues to increase the cost of urban operations.

According to the population scale change data, Hegang is a significantly shrinking city, but as of 2017, the scale of construction land in the downtown area of Hegang has reached 96.37 square kilometers. The per capita construction land has increased from 103.8m2/person in 2005 to 150.63m2/person in 2017, far exceeding the national upper limit.

Year	2005 (status quo)	2010 (Planned)	2017 (status quo)
Scale of land use	68.51km²	78.69km²	96.37km²
Scale of land use per capita	103.8m²	104.23m²	150.63m²

The newly added construction land is mainly second-class residential land and industrial land. The total amount of urban scale expansion is large, the quality is low, and the land use intensity is extremely poor.

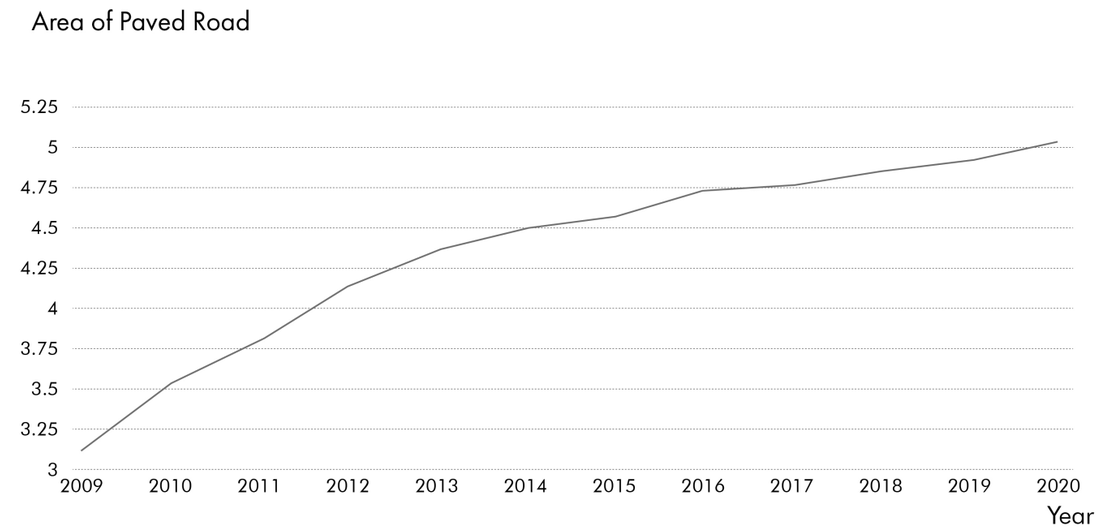


Fig. Area of Paved Road in Hegang 2009-2020.
Source: www.ceicdata.com | Hegang Municipal Bureau of Statistics

5.1 SPATIAL ANALYSIS

EXPANSION & SHRINKAGE

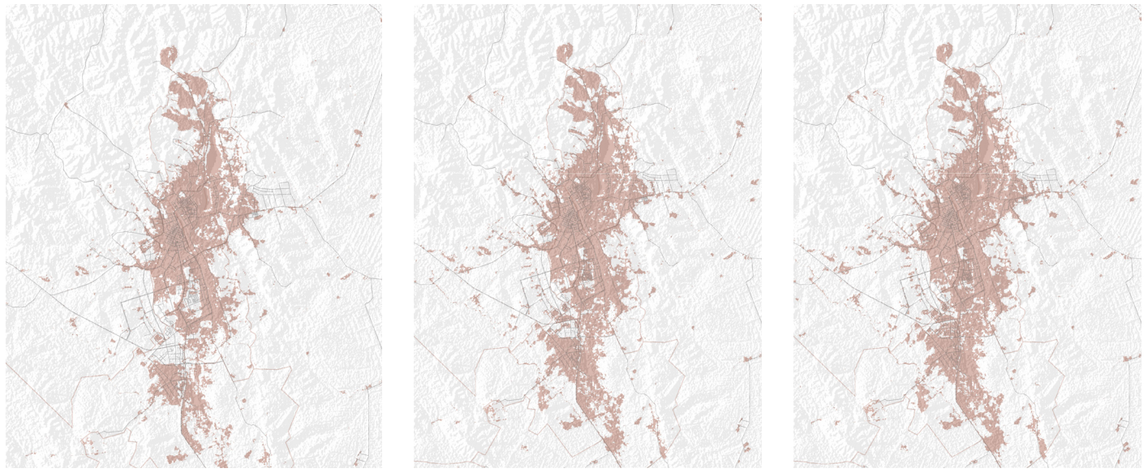


Fig. Constructed area 2000/2013/2019. (Source: Made by author)

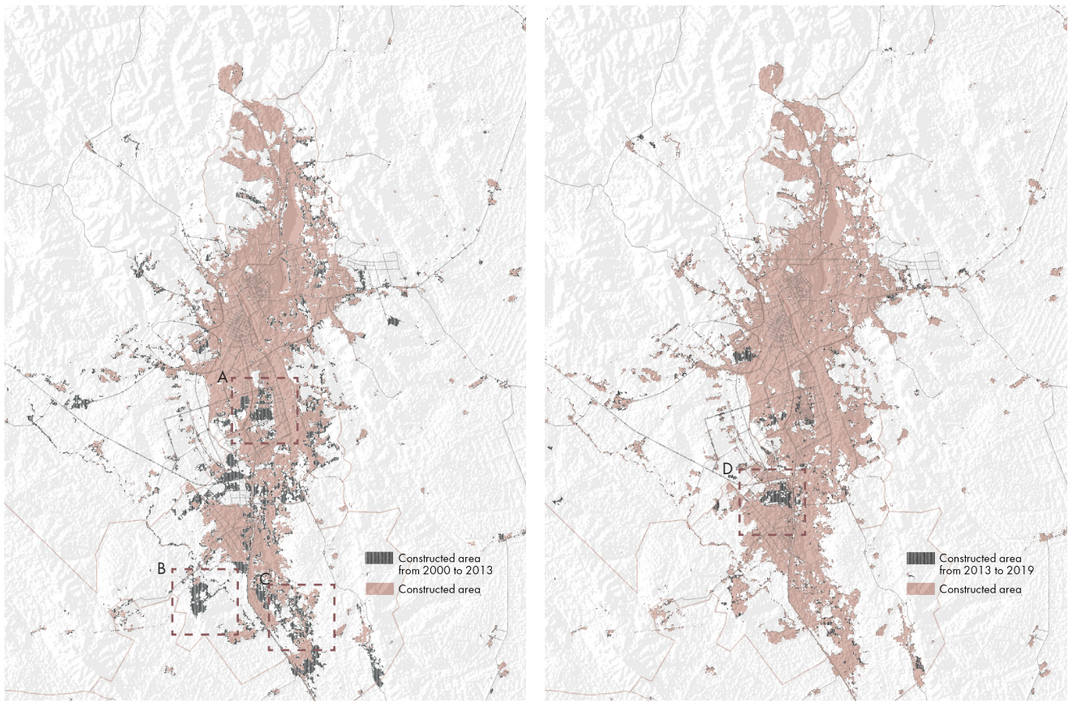


Fig. Variation of constructed area 2000-2019/2013-2019. (Source: Made by author)

Between 2000-2013 and 2013-2019, the biggest changes in urban construction land are residential land and industrial land.
Among them, A) is the expansion of residential land, B) is the expansion of industrial parks, C) is the expansion of coal mine land, and D) is the newly-built resettlement housing area after the reconstruction of shantytowns

Fig. Satellite map of changed constructed area. (Source: Baidu Map)

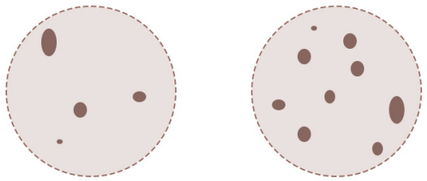
5.1 SPATIAL ANALYSIS

EXPANSION & SHRINKAGE

Urban shrinkage stage

In recent years, Hegang City has suffered from serious population loss, and the urban construction land has continued to expand and develop, resulting in more idle land within the city and poor utilization of infrastructure, which has destroyed the continuity of land within the city. On the other hand, Hegang City has been taking coal as the leading industry, and with the over-exploitation of resources, a large number of coal mining sinkholes have appeared in the urban area, cutting the urban space and seriously affecting the urban ecological environment, which eventually led to a perforated shrinkage in Hegang City.

> *The population shrinkage is occurring in all areas of the city, with a high degree of mixing of vacant and abandoned buildings with other buildings in use. There is a "perforated" shrinkage of the city, like a piece of paper with a number of random holes punched out of it, and the urban fabric no longer continues.*



If we judge the growth and shrinkage of the city's internal regions based on the spatial changes in the radiance value of lights at night, we can see that there are shrinkage phenomena in different ranges and degrees in various jurisdictions in the city, and the overall "perforated" spatial pattern.

Growth areas generally show a weak growth trend, and only a small area in the core area of the city—Xiangyang District and the Industrial and Agricultural District—has a good momentum of development. The four peripheral industrial and mining districts of Nanshan District, Xing'an District, Dongshan District, and Xingshan District, especially the areas adjacent to the core area, are in a severe shrinkage situation, and the areas with more active social and economic activities are shrinking. In the development state where growth and shrinkage coexist, the development gap between regions has further expanded, and the core-periphery structure of urban space has become prominent.

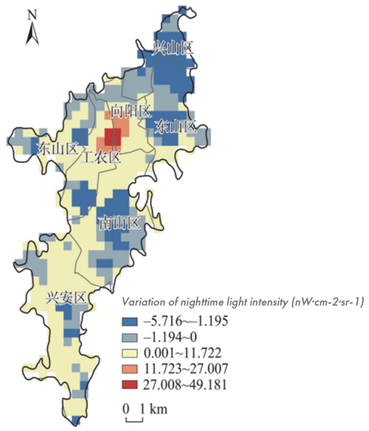


Fig. Variation of nighttime light intensity in Hegang City during 2013-2019
Source: Liu Yanjun. Spatial differentiation of housing prices and mechanism of influence in a shrinking city: A case study of Hegang (2022). Progress in Geography, 41(5): 812-824.] DOI: 10.18306/dlkxjz.2022.05.006

POI DISTRIBUTION

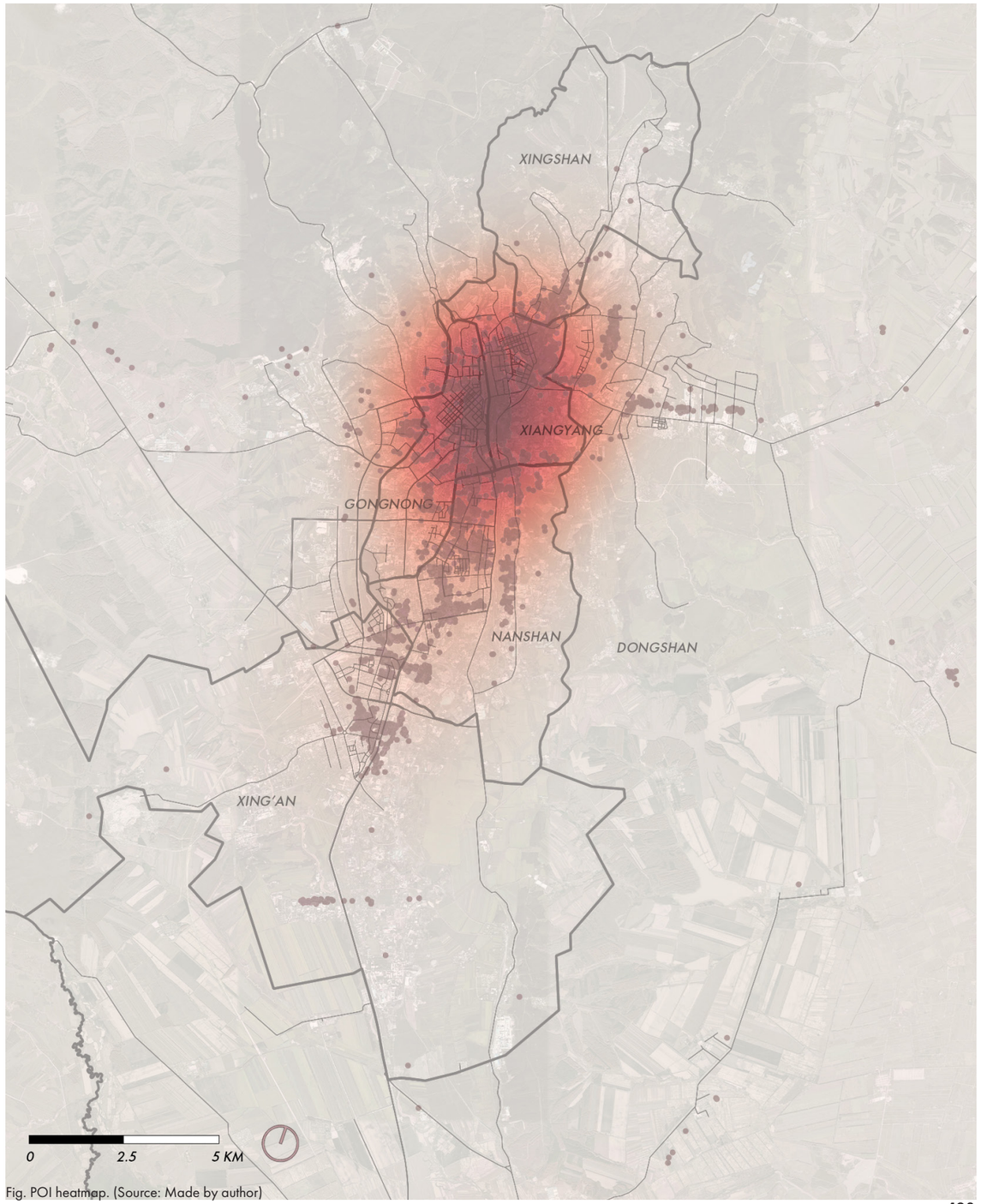


Fig. POI heatmap. (Source: Made by author)

5.1 SPATIAL ANALYSIS

POI DISTRIBUTION

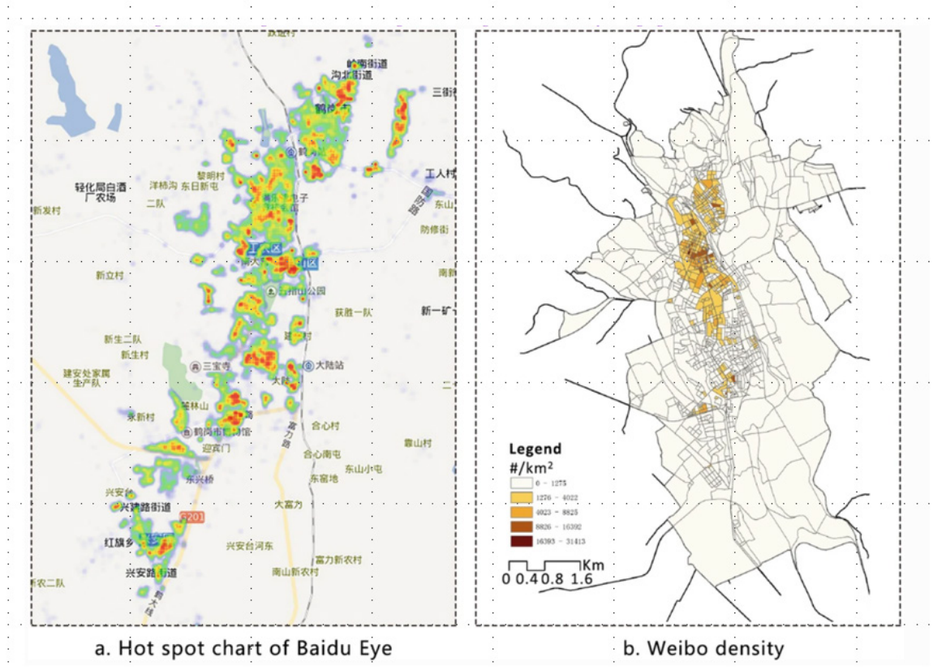
The POI (point of interest) in Hegang presents an uneven spatial distribution, mainly located in the Xiangyang District and the Gongnong District in the central area.

a) Residential area　b) Educational facilities　c) Shopping stores

d) Companies　e) Dining facilities　f) Medical facilities

Fig. Distributions of various facilities identified by POI data.(Source: Made by author)

Data from social media network data and mobile phone data can also show the real use of urban space. The Baidu Eye data generated by Baidu Maps (Google Chinese version) can be used to illustrate the distribution of Baidu users, which can almost be regarded as a uniform sampling within a city. The distribution of Weibo (the Chinese version of Twitter) data can be used to show where young people are active in cities(Long and Zhang, 2021). It can be seen that the urban population is concentrated in the old city and tends to expand to the south.



a. Hot spot chart of Baidu Eye　b. Weibo density

Fig. Hot spot chart of Baidu eye and Weibo density.(Source:Long, Y., Zhang, E. (2021). Fine-Scale Recognition-Based Design Guidelines for Dealing with Shrinking Cities: A Case Study of Hegang. In: Data Augmented Design. Strategies for Sustainability(). Springer, Cham. https://doi.org/10.1007/978-3-030-49618-0_6)

5.1 SPATIAL ANALYSIS

TRANSPORTATION

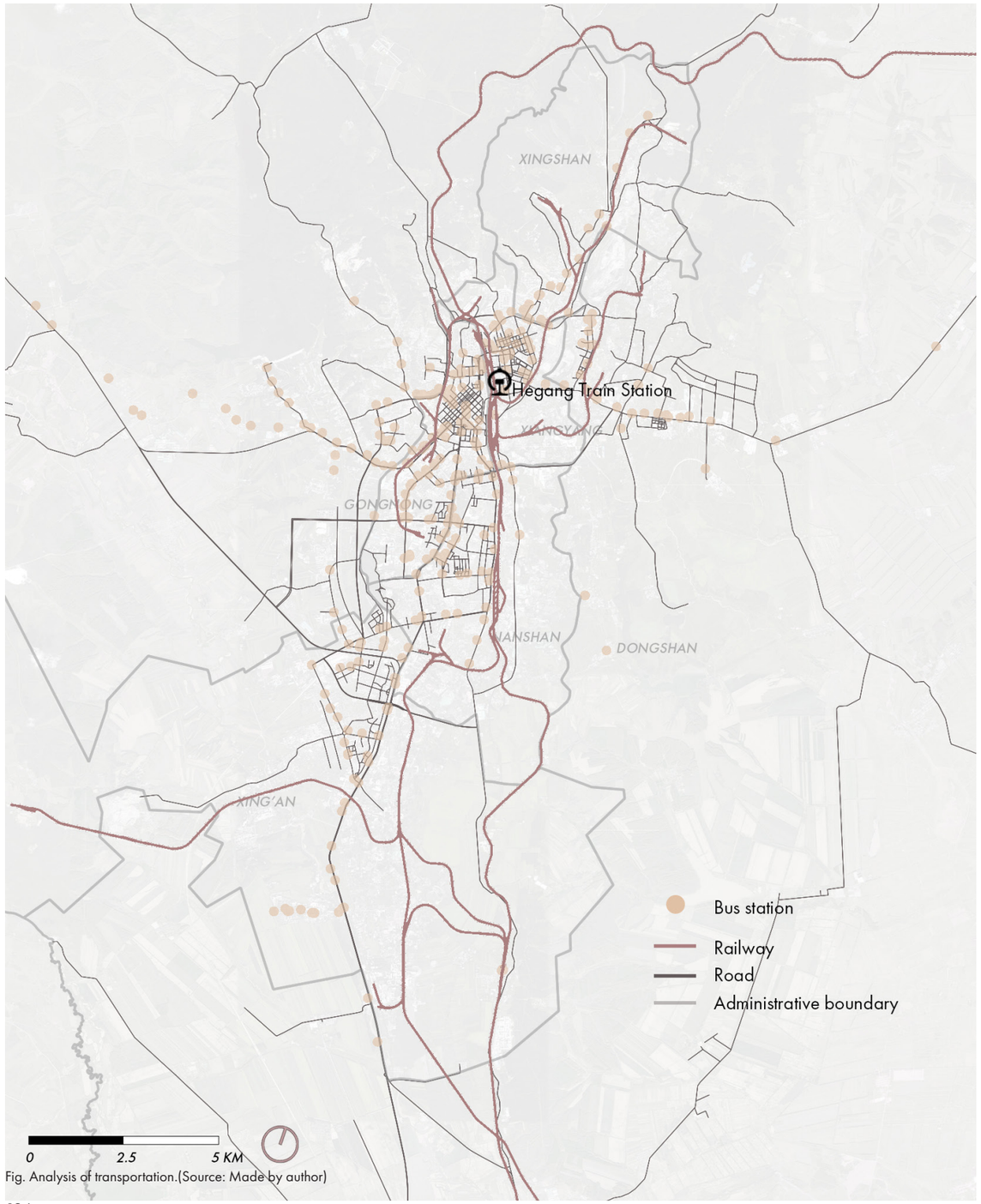


Fig. Analysis of transportation.(Source: Made by author)

The main urban traffic roads in Hegang can see the city develop in the northeast-southwest direction; the main means of transportation in Hegang is the bus, which passes through the urban area. Xiangyang District and Gongnong District are the downtown areas of Hegang, but the two districts are separated by train lines and railway stations, and are only connected by two north-south arterial roads, resulting in inconvenient traffic between the two districts.

Fig. The result of spatial syntax analysis. (a) Global integration. (b) Global choice (Long and Zhang, 2020)

5.1 SPATIAL ANALYSIS

ECOLOGICAL DEGRADATION

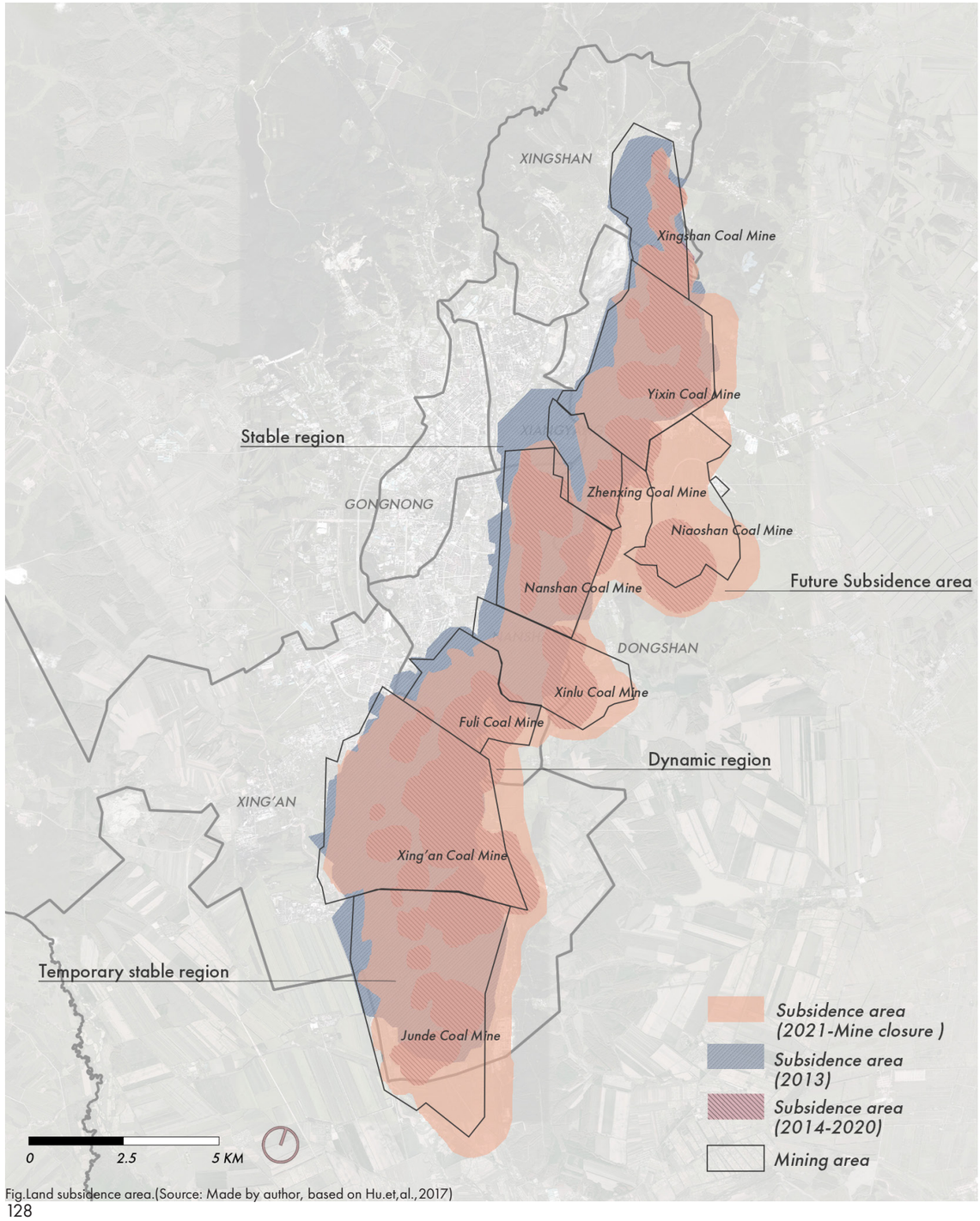


Fig.Land subsidence area.(Source: Made by author, based on Hu.et,al.,2017)

With the large-scale coal production, coupled with the impact of changes in natural conditions, the Hegang coal mining area has produced a large area of coal mining subsidence. Coal mining subsidence not only caused geological disasters to cause great losses to people's lives and property, but also caused frequent vegetation cover degradation, soil quality reduction, soil erosion and other phenomena, which caused great damage to the ecological environment.

The Jiahe (Jiamusi-Hegang) Railway runs through the north and south of Hegang City, with the railway as the dividing line, and the east of the railway is the coal mining area. As of 2013, the area of coal mining subsidence in Hegang City was 77,932.12 hectares, forming a coal mining subsidence zone about 27 kilometers long and 5 kilometers wide to the east of the railway, the maximum subsidence depth is 30 meters, and the land surface is still sinking at a rate of 1.3 meters per year. It is predicted that the coal mining subsidence area will expand to 9400.31 hectares in 2020. The horizontal distance from the coal mining subsidence area to the Hegang Municipal Government is about 2.5 kilometers. Large areas of coal mining subsidence have serious impacts on urban land, groundwater sources, ecological landscapes, infrastructure, and urban spatial structures.

With the continuous expansion of Hegang's urban space to the east, a large number of coal mining subsidence areas have been incorporated into urban land, and coal fields and urban land are interlaced. With the expansion of the subsidence area, potential safety hazards are also increasing, and the contradiction between the demand for urban land and the exploitation of resources has become increasingly prominent.

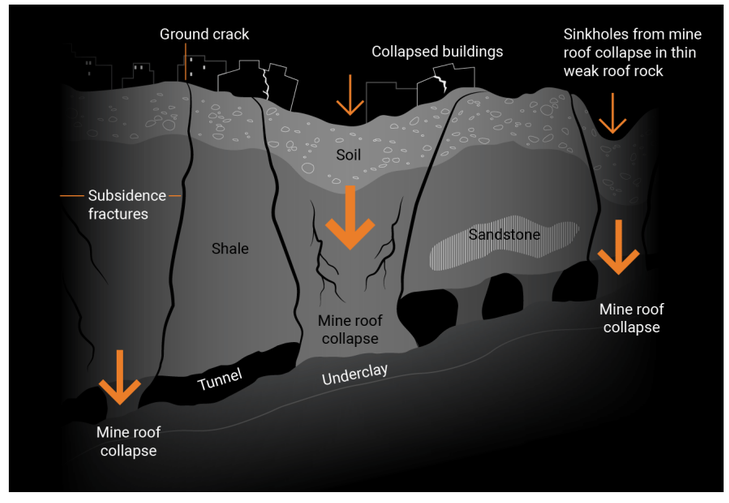


Fig. The process of coal mine land subsidence (Source: Google Image)

5.2 SWOT ANALYSIS

Strength

Rich in vegetation resources, the forest coverage rate reaches 58%, and the plain soil at the confluence of the two rivers is very fertile;

Located on the border, only across a river from Russia;

Hegang has the industrial foundation since 1950s;

Weakness

Hegang has a sound industrial foundation, but coal is the main industry, and urban development relies heavily on a single industrial structure. As a result, there are huge gaps in industries other than coal, whether it is supply chain, investors or talent cultivation, which affects the transformation and development of cities;

Economic development has begun to decline, which is not very attractive for investment;

The aging of the population is serious, and the loss of young talents leads to the decline of Hegang's innovation ability;

Opportunity

Currently, because low-price housing is very popular on the Internet, it can be developed with the help of the Internet digital economy;

With the development of the Internet, some enterprises relying on the Internet may consider relocating their enterprises to such low-cost cities;

At present, Hegang is vigorously promoting the graphite industry

Threat

Due to historical development, Hegang City pays very little attention to non-coal industries, and has very limited attention to investment, investment, and policy in other industries;

Unstable and complex geopolitical pattern;

Population loss has led to a low utilization rate of service facilities, which puts a lot of pressure on government finances;

A large number of vacant resettlement houses produced by the shed reform and abandoned industrial land produced by the closure of coal mines have deteriorated the urban environment; the decline of the coal mine industry has caused a large number of unemployed people and urban security problems.

5.3 REFLECTION ON ANALYSIS

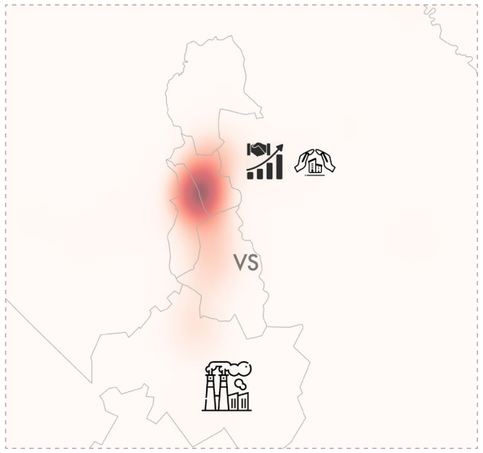
SUMMARY OF SPATIAL STRUCTURE

Limited development space

Loose urban spatial structure

Vulnerable ecological environment

Unbalanced distribution of functions within the city



Human-land scale contradiction

WHY "SMART SHRINKAGE" ?

- The trend of continued population loss is inevitable
- A large amount of vacant land has appeared in the city, and it is difficult to redevelop and utilize it
- Mismatch between population size and public service facilities
- The long-term single coal industry makes the foundation of industrial transformation relatively difficult, and the government's finances are on the verge of collapse, making it difficult to carry out large-scale investment
- Cities have weak regional competitiveness, weak ability to attract investment and resources, so even with large-scale financial support, it is difficult to achieve effective transformation and development
- The aging population is serious, the brain drain leads to low innovation ability, and the feasibility of developing sustainable high-tech industries is low
- The geographical location is relatively remote, and the city is not attractive enough

Therefore, growth-oriented planning paradigm doesn't fit shrinking status quo, and the approaches aimed at urban regrowth that do not match urban shrinkage.

5.3 REFLECTION ON ANALYSIS

VISIONING BASED ON "SMART SHRINKAGE" IN HEGANG

The spatial structure of Hegang City should be aimed at agglomerating efficient development and stimulating urban vitality, and finally get rid of the negative impact brought by urban shrinkage. Small and refined development will make Hegang City an ecologically livable small city.

Improving Liveability

The goal is not to pursue rapid economic development, but to improve the quality of urban living by optimizing the urban stock space. Strengthen the construction of public service facilities to provide residents with complete public services; improve the transportation system to provide residents with convenient travel conditions; Taking advantage of the waterfront features, beautiful waterfront scenery and geographical advantages surrounded by mountains and water, the development should highlight the livable characteristics of the waterfront, strengthen the awareness of comprehensive environmental construction, and create an ecologically livable small city with a good ecological environment and suitable for human habitation; Comprehensively carry out the management of abandoned mining areas, the improvement of coal mining subsidence areas, the restoration of soil, plants, and water resources, and improve the living space and ecological space of the city.

urban restructuring

Appropriately gather the population and industries of Hegang City, exert the agglomeration effect, improve the land utilization rate, reduce the waste of capital, and obtain the maximum benefit.

Reasonably predict the population size, simplify the scale of urban land use, and delineate the priority development boundaries of cities; Optimizing the spatial distribution of the population so that the population is relatively clustered and the balance between employment and housing can ensure that basic public service facilities serve more people, avoid excessive construction waste, and promote the formation of a new core of the city and stimulate the vitality of the city. Optimize the proportion of land use functions, reset low-efficiency land use functions, rationally plan the scale of residential land, and replace excess residential land in future urban construction. Increase public service facilities, commercial and business facilities, elderly care facilities, cultural tourism facilities, and park green spaces, etc.

Industrial Planning and Restructuring

Industrial development is the main driving force for changes in the urban spatial structure. Through industrial upgrading and transformation, the industrial structure will be changed, and the adjustment of the industrial spatial structure will also lead to changes in the urban spatial structure.
Tap the development potential based on the regional development policy; give priority to the industrial continuation model, rely on the existing resource conditions, extend the industrial chain, continue the development of the coal industry, develop the coal chemical industry, obtain greater industrial benefits, and promote urban social and economic development. At the same time, by exploring other industries with potential and advantages in the city, policy guidance gives priority to the cultivation of emerging industries,with the development of industrial clusters and the improvement of urban functions, it will gradually transform into an industrial substitution model, improve the urban industrial development structure, and complete the final transformation of a resource-exhausted city.
Hegang City has begun to focus on the development of coal chemical industry, green food, cultural tourism, and trade with Russia to promote industrial transformation and development.

Governance model adjustment

Establish a departmental linkage mechanism and organize various government departments to implement cross-regional and cross-departmental cooperation; Improving the public participation system, smart shrinkage is a people-oriented development concept, so public participation occupies an important position in it, which can not only ensure the protection of the rights of diverse stakeholders in society, but also facilitate the smooth implementation of urban construction and management.

06 PROPOSAL

6.1 VISION

Toward an ***integrated*** and ***liveable*** Chinese post-industrial city.

Under the background of insufficient endogenous motivation and limited external development conditions, Hegang City, which is in shrinkage, seeks to adapt to the shrinking trend of development, and no longer takes urban growth and expansion as the primary goal;The goal of urban development is to streamline, agglomerate, efficiently develop and stimulate urban vitality, get rid of the negative impact brought by urban shrinkage, and achieve small and delicate development, making Hegang an ecologically livable small city.

Based on ecology, it is possible to stimulate and restore urban vitality by constructing and optimizing an urban system that combines production, life, and ecology; Combining the current landscape resources and the ecological restoration of the physical environment in the process of post-industrial development, complete the city's green network and restore the city's ecological vitality; Through the support of the industry, the combination of the extended secondary industry chain and the new industries in the process of ecological restoration forms a sustainable industrial network, which provides impetus for urban economic development; Appropriately gather population and industries, increase land utilization rate, reduce capital waste, and thus achieve maximum benefits; At the same time, based on the population structure, the construction of public service infrastructure will form a living circle with complete living service facilities, which will help restore the vitality of the city.

The recovery of endogenous power promotes the construction of urban resilience. Hegang has finally transformed into a sustainable city in terms of industry, ecology, and social life. Citizens have hope for the future of the city, and the city will be able to handle crises with ease in the future.

Living

Ecology

Production

6.2 PRINCIPLES

	PRINCIPLES	SMART SHRINKAGE CONCEPT	LOCAL CONTEXT
REGIONAL	Network of cooperation	/	- **Internal and External Limited developing conditions**: Remote location; Periphery of urban cluster; Lack of internal devel opment momentum; Limited urban expanding space; - **Provincial industrial planning requirements**: Regional cooperation in clusters - **Similar development context** (history and culture) as surrounding cities
	Efficiency of space and public services	- Right-sizing of urban scale and reduce the scope of infrastructure services - Re-adjust the built environment - Focus on high quality urban center - Dense community - Re-adjust to the aging and less child future - 'Land bank' and land management	- High vacancy of space and buildings (resettlement housing) -Abandoned coal mining area and demolished shanty towns - Population decline and change of demographic structure - Low space quality: space disorder - Inequality of development within central city
MUNICIPAL	Smart environment of green cities	- Re-adjust to Green infrastructure (e.g. bike infrastrurcture/food infrastruc-ture) - Green retirement city (e.g. urban gardening)	- Pollution and ecological degradation caused by coal mining industry - Rich and original natural landscape resources -Call for green development and ecological restoration
	Stable and sustainable economic development	- Industrial upgrading and transition	- The recession of secondary industry and Facing the industrial transforma-tion - Potential of Internet celebrity economy: social media - Potentials from transition - Location advantage : border trade economy - Lack of basement for other industry - New resources: graphite industry
	Participatory governance with flexibility	- stimulate and encourage the public participation - participate in urban self-constrtuction through studios and projects(e.g. living laboratory) - stronger and stable community - land management and land bank	- Solidified governance system - Growth-oriented planning paradigm in the past - Shift of consciousness of government and local residents - Migration of population

6.2 PRINCIPLES

Based on the theory and principles of smart shrinkage, combined with the current urban conditions, five planning principles can be obtained, including ***network of cooperation*** on a regional scale, and ***efficiency of space and public services***, ***smart environment green cities***, ***stable and sustainable economic development*** and ***participatory governance with flexibility*** at the city scale.

The regional-scale planning principles bring external opportunities for urban development, while the urban-scale principles correspond to the four aspects of urban resilience, ultimately forming a resilient urban system and enhancing the internal vitality of the city.

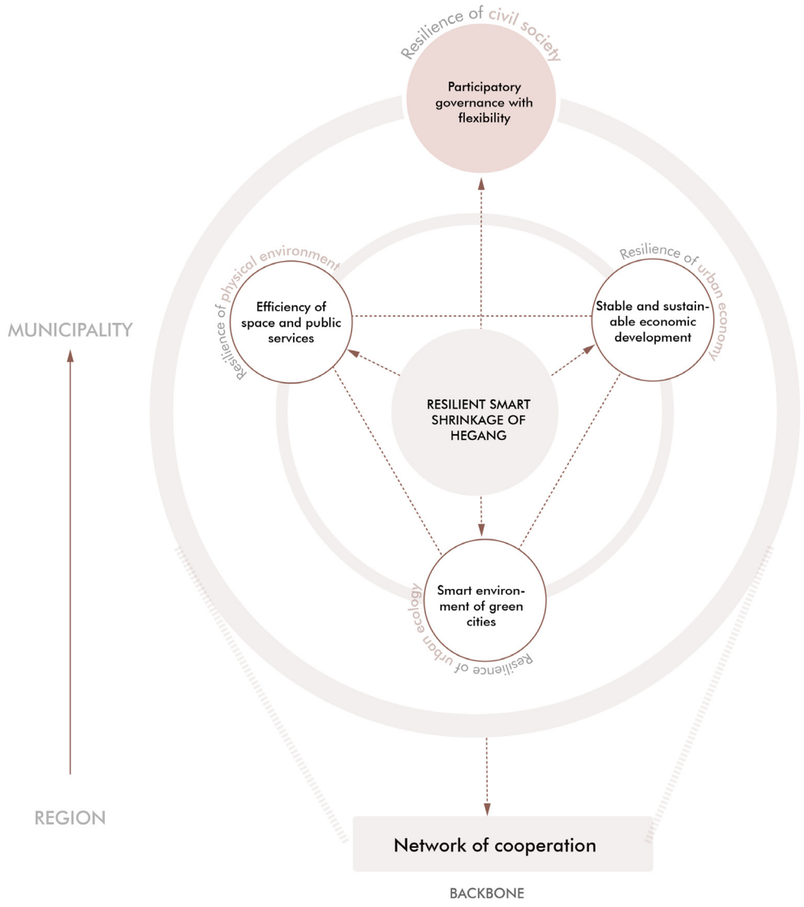


Fig.Synergy of principles.(Source: Made by author)

The network of cooperation focuses on externally generated opportunities for overall urban development. Hegang is located on the border and at the same time on the outskirts of the urban agglomeration; In order to tap the development potential, it is necessary to combine provincial and regional planning, cooperate with surrounding cities facing the same situation, form a new urban agglomeration, and complete the intercommunication between resources, capital, knowledge, and population.

The efficiency of space and public services aims to guide the agglomeration of resources, exert the agglomeration effect, improve land use efficiency, and reduce capital waste. It includes: optimizing the urban spatial structure, integrating to form an urban system with a simplified spatial structure and a vitality center with clear functional positioning; The construction and improvement of public services and infrastructure will provide residents with a comfortable and livable living environment.

Smart environment green cities are concerned that long-term industrial development has neglected the vulnerability of the ecological environment, and it is necessary to emphasize the importance of ecology in order to seek sustainable transformation; For the industrial development after coal mining, the requirement of constructing an ecological restoration corridor is put forward; In terms of space, relying on the existing natural landscape resources, construct an urban ecological pattern and form a multi-level, multi-functional green network system; At the same time, consider the feasibility of coordinating ecological and industrial development; Large-scale coal mining subsidence areas also put forward certain requirements for urban disaster prevention.

Stable and sustainable economic development puts forward requirements for optimizing industrial structure, and industrial structure adjustment will also lead to changes in urban spatial structure. In the face of the crisis of resource depletion, adopt industrial transformation:
Extend the industrial chain, optimize advantageous industries; tap potentials, gradually add alternative industries, gradually get rid of dependence on coal resources, increase the proportion of primary and tertiary industries, and improve the industrial development structure;
Promote industrial clusters in space, build an industrial development platform in policy, and promote collaboration among primary, secondary, and tertiary industries and between different departments.

Participatory governance with flexibility emphasizes public participation and coordination among stakeholders. Cooperation can improve the feasibility of transformation, and public participation can help monitor the implementation of policies and the creation of urban vitality, and the sense of identity and belonging of citizens will also be generated.

6.3 STRATEGIES

DETAILED STRATEGIES

PRINCIPLE- Network of cooperation

- **Regional transport infrastructure upgrading**

  To provide development basis for regional integration.

- **Ecourage Regional cooperation and establish regional industry development cluster**

  To utilize the foundation and advantages of regional industrial development, avoid disadvantages such as remote locations, then promote the formation of collaborative industrial development clusters with extended industrial chain.

PRINCIPLE- Efficiency of space and public services

- **Identify and Assess the urban space**

  Investigate and collect the urban space data, according to current conditions, identify the low-efficiency land in the urban area of the whole city by combining social, economic and various conditions.

- **Establish the Database of urban space and public services**

  To manage the urban space and public services data in a smart and digital way.

- **Rightsize the urban scale and public service facilities**

  Promote the centralized distribution and rational layout of medical care, social welfare, commercial facilities and residences; Improve the value and efficiency of facilities and urban space, and reduce the waste of space and government expenditure.

- **Renewal of vacant space**

  Utilize the urban vacant space as 'Resource' , for instance, transform low-efficiency and vacant land into green spaces, public activity spaces, cultural activity centers, sports venues, etc. through green infrastructure, tempo rary use, function replacement and other updating methods to stimulate the value of vacant spaces, avoid further deterioration of the area, and maintain regional image.

- **Centralize and decentralize population and land use**

  Centralized population and functions reduces unnecessary investment for construction and enable the gather-ing of funds, resources, talents, etc, which finally contributes to long-term cost-effective development.

- **City public transport network upgrading**

  Complete the accessibility of public transport, improve urban slow-walk traffic system and thereby timprove quality of residents' urban normal life.

- **Improve the spatial quality**

  Improve the overall appearance of the city, form a multi-level community life circle suitable for aging, child-friendly, walk-friendly, green and low-carbon vision.

PRINCIPLE- Smart environment of green cities

- **Ecological restoration**

  Restoring and protecting regional ecological space, establishing ecological corridors and national parks, using greening to nourish towns and other measures, and promoting the formation of an ecological pattern of natural and harmonious symbiosis in the region; On the basis of protecting natural landscape land, provide residents with places for entertainment, experience, communication and learning, and form an ecological environment for sustainable urban development.

- **Build Green infrastructure system**

  Form a multi-scale, networked, multi-functional sustainable green infrastructure system.

- **Construct Disaster prevention facility**

  In view of the risks such as ground subsidence that may occur in the long run, prepare for the urban disaster prevention space plan.

- **Recover the coal mining land to cropland**

  Return part of the construction land to farmland, renovate the farmland by integrating the scale of the farmland, replanning the roads in the field, transforming and improving the irrigation and drainage facilities, and improving the soil of the farmland to improve the quality of the farmland; realize the further development of regional modern agriculture and forestry.

PRINCIPLE- Stable and sustainable economic development

- **Build industrial development sharing platform**

  Construct a sharing platform, establish relevant industrial infrastructure and service, provide communication chance for domestic and foreign researchers and industries, and provide a place for citizens to experience and learn in person.

- **Adjustment of industrial structure**

  - **Establish the sustainable green structure of graphite industry**

    Utilize existing product resources, promote the development of graphite-related secondary industries through the circular economy development model, and achieve technological innovation and product upgrades through international cooperation channels.

  - **Extend the chain of coal-chemical industry**

    Optimize advantageous industries, upgrade the original industrial model with advanced technology and concepts, promote the sustainable and green transformation of industries with backward structures, strengthen competitiveness, and create new brands.

  - **Market building for cross-border trading industry, tourism business and agriculture**

    Excavate and refine the development foundation and advantages of the region, and create a develop-ment foundation and future market by formulating relevant encouragement and development policies at the government level to attract and gather related industries.

6.3 STRATEGIES

DETAILED STRATEGIES

- **Encourage the collaboration among industries**

  Realize the coordinated development of the primary, secondary and tertiary industries in the region.

- **Low-end Labor training**

  Provide skills upgrading training for workers to better adapt to the upgraded industry and reduce unemployment.

- **Build "Industry+life" community**

  Promote the matching of industrial space and living space in close proximity, provide workers and other workers in and around the industrial park with perfect residential, commercial, service or green space functions, so that production, living and ecology are coordinated with each other and the economic vitality of the park is enhanced.

- **Reorganize the industrial distributions**

  Gather the industries and form industrial clusters; provide reserved space for start-ups and future development; Improve the industrial park and related community, and formulate the basis for working and living.

PRINCIPLE- Participatory governance with flexibility

- **Build 'Land bank' system**

  Collect, temporarily manage and dispose of vacant properties, transforming vacant land and buildings into green assets to maintain neighborhood stability and encourage property reuse; also as an economic and community development tool to restore real estate markets in shrinking cities

- **Living laboratory**

  Based on the principle of people-oriented, pay attention to the needs and life of residents, and attach importance to urban public activities and social interactions; promote the enthusiasm of local people for life and realize the revitalization of the neighborhood through public participation in community construction and community building.

- **Build Regulatory agency**

  Add supervisory agencies to urge the public to actively participate from the bottom up, and to make government information policies open and transparent.

- **Encourage collaborative planning**

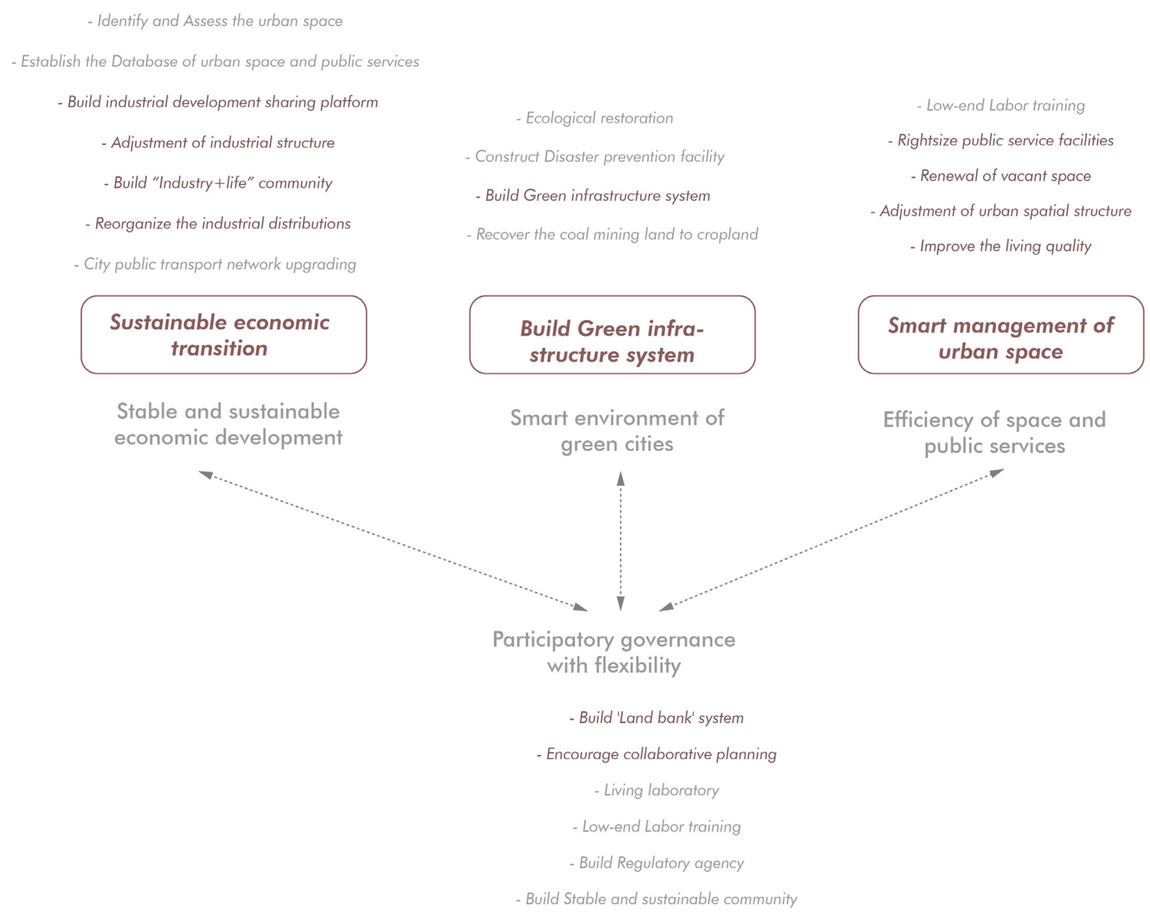
  Encourage cooperation between the government, professionals, research institutions, universities, enterprises and the public, build a framework for cooperation planning, realize technological innovation and improve the quality of the urban physical environment; the public participates through various channels and provides feedback and information.

- **Build Stable and sustainable community**

  Improve the living environment and improve public service facilities; fully consider the age structure of the community population and respect the wishes of residents; use the neighborhood committee as the grassroots autonomous network to improve community management, and build a platform for residents to fully participate in planning and construction to achieve multi-party co-construction

In order to see the transformation of Hegang city more clearly at the spatial level, I will select some strategies for detailed description.

Summarize them into three main strategies that *SUSTAINABLE ECONOMIC TRANSITION, BUILD GREEN INFRASTRUCTURE SYSTEM, SMART MANAGEMENT OF URBAN SPACE.*



6.3 STRATEGIES

6.3.1 STRATEGY - SMART MANAGEMENT OF URBAN SPACE

Adjustment of urban spatial structure

In the context of Hegang's shrinkage, there is a relative surplus of urban space and insufficient overall efficiency of land use, so in the process of transformation and development, it is necessary to jump out of the way of spreading a large amount of low-utility land around the city to obtain growth, and to combine the "compact city" and "shrinking city".

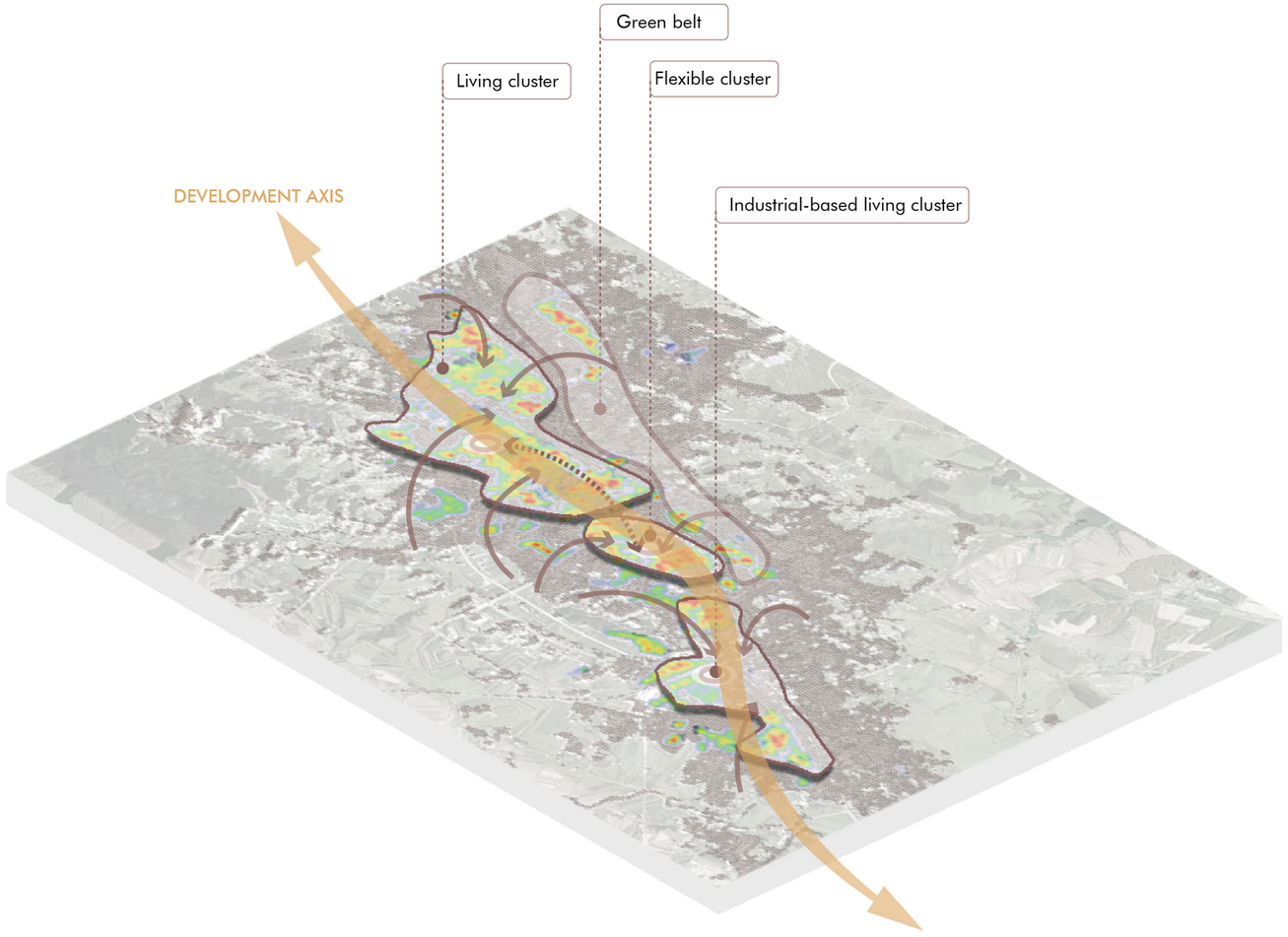
Taking into account the conditions and constraints of urban development and construction, the urban development and construction strategy of Hegang is determined to be the implementation of the "vibrant central city - high quality peripheral functional areas" development approach. That is, to promote population distribution and industrial clustering, priority development areas focused on small, concentrated areas.

Among them, strengthen the main center of the old city, prioritize urban resources into the central city, concentrate living service facilities and commercial business space in the central city, appropriately increase the development density, improve the green space system and public service system in the central city, improve the quality of services and space, and make it an attractive and job-rich urban public service center group;

Implementing ecological restoration and shrinkage of the eastern coal mining and sinkhole areas, guiding the relocation of enterprises in the sinkhole areas and the transformation of shantytowns, and reasonably introducing new functions;

Improving the construction of the southern industrial park, guiding scattered industries in the urban area to transfer to the southern cluster, and building a cluster of industrial bases integrating production, R&D, trade and logistics, and supporting services;

Other areas in the urban area that are currently more fragmented are used as flexible development space, reserving possibilities for future development.



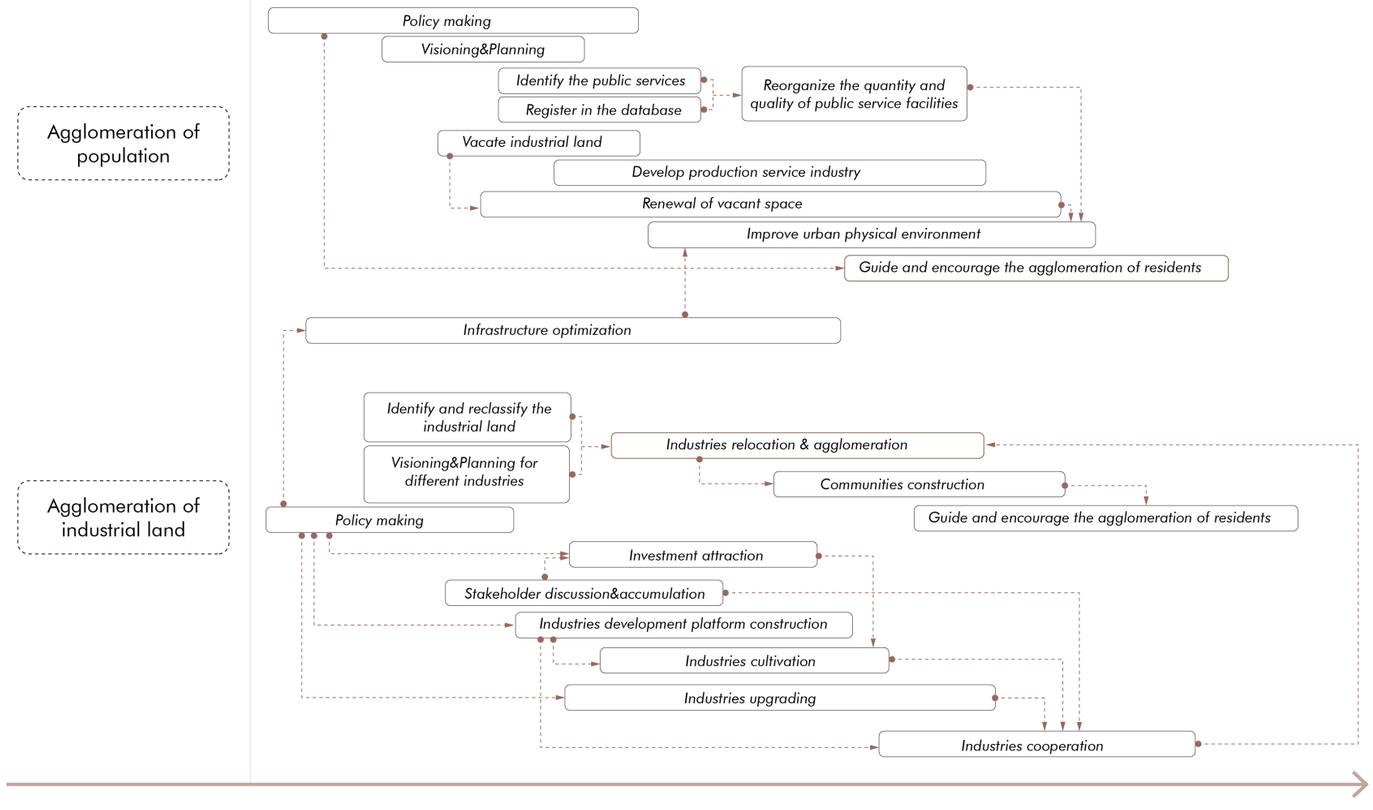
6.3 STRATEGIES

6.3.1 STRATEGY - SMART MANAGEMENT OF URBAN SPACE

Adjustment of urban spatial structure

The adjustment of urban space is to implement the agglomeration of urban land, which in turn attracts the agglomeration of population, and finally forms a development center.

Whether it is the concentration of industrial land or the concentration of population, it is necessary to first ensure the improvement of infrastructure, provide the basis for industrial development and basic living security;Secondly, policy support and promotion are also very important links, in which the government can provide financial, technical and other support to help coordinate multi-party cooperation.



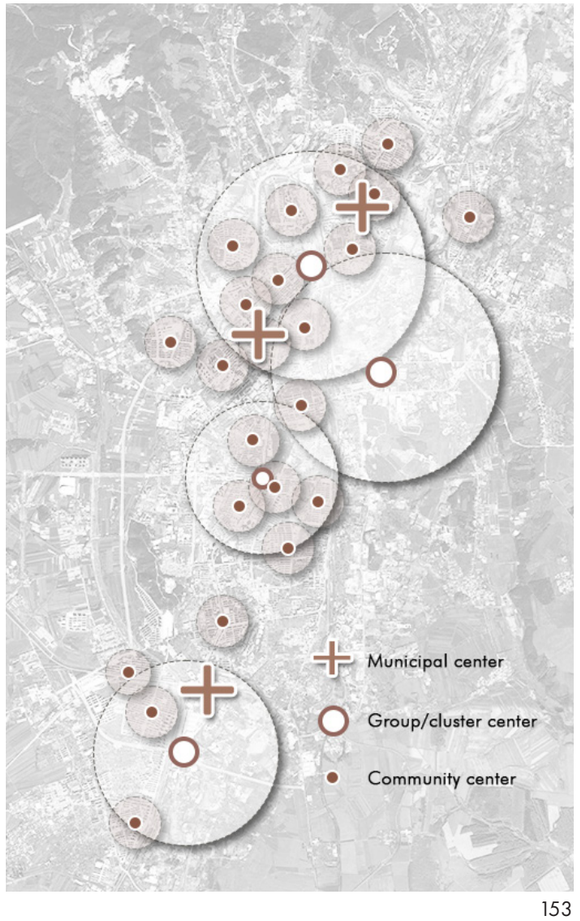
Rightsize public service facilities

Livability is an important criterion for building a vibrant urban center. As a livable city, it should have multi-layered public services that meet the needs of residents.

The strategy of zoning increase and decrease is implemented for the infrastructure of Hegang City to improve the efficiency of the use of municipal implementation. The old city group should enhance the municipal supply because of the dense population and more active urban life; the industrial group in the south needs new municipal pipeline network because of the planned gathering of industrial parks;For the abandoned land of coal mine, shantytown and other areas where demolition has been implemented or planned to be implemented, on the basis of ensuring the existing regency supply, the unused municipal facilities should be dismantled, the unnecessary municipal pipeline network should be reduced, and the transportation and maintenance cost of municipal facilities should be lowered.

The plan divides the public service facilities of Hegang City into municipal, group and residential area configurations. Among them, there are three municipal centers, the administrative center center centered on Xiangyang District; the commercial center center centered on Gongnong District; and the comprehensive service center for urban industrial development planned to be built near the new railway station in the south, which together drive the renewal and development of the built-up area of Hegang City.

The service centers of urban life functions are formed within each group. The public service center of the central city group is dominated by commercial, entertainment and cultural offices; the new industrial district group forms a research and innovation and comprehensive service group; the ecological restoration area in the east forms a public service center dominated by urban leisure and new industrial services; the flexible groups within the city do not have a clear functional service center, and the collection of residential and centers is dominated.

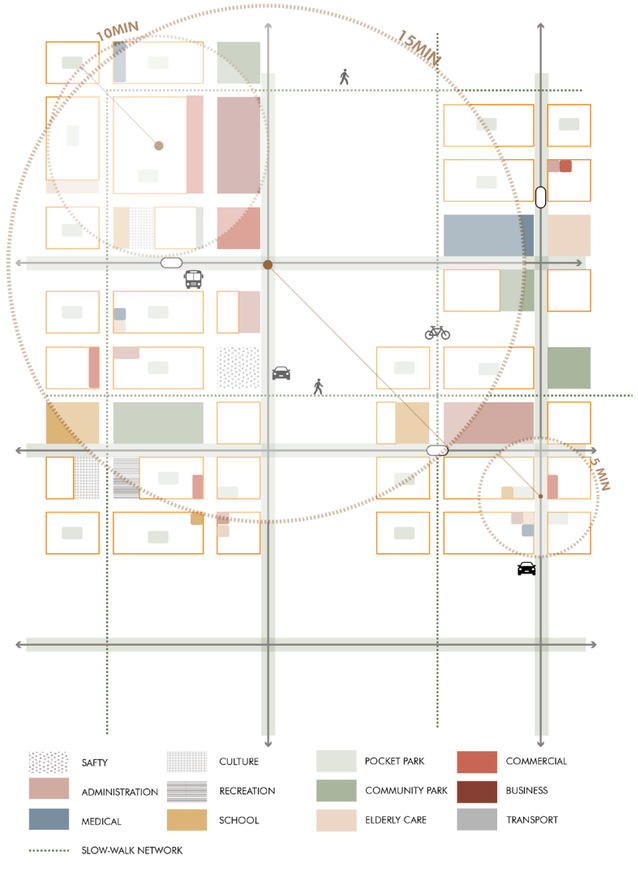


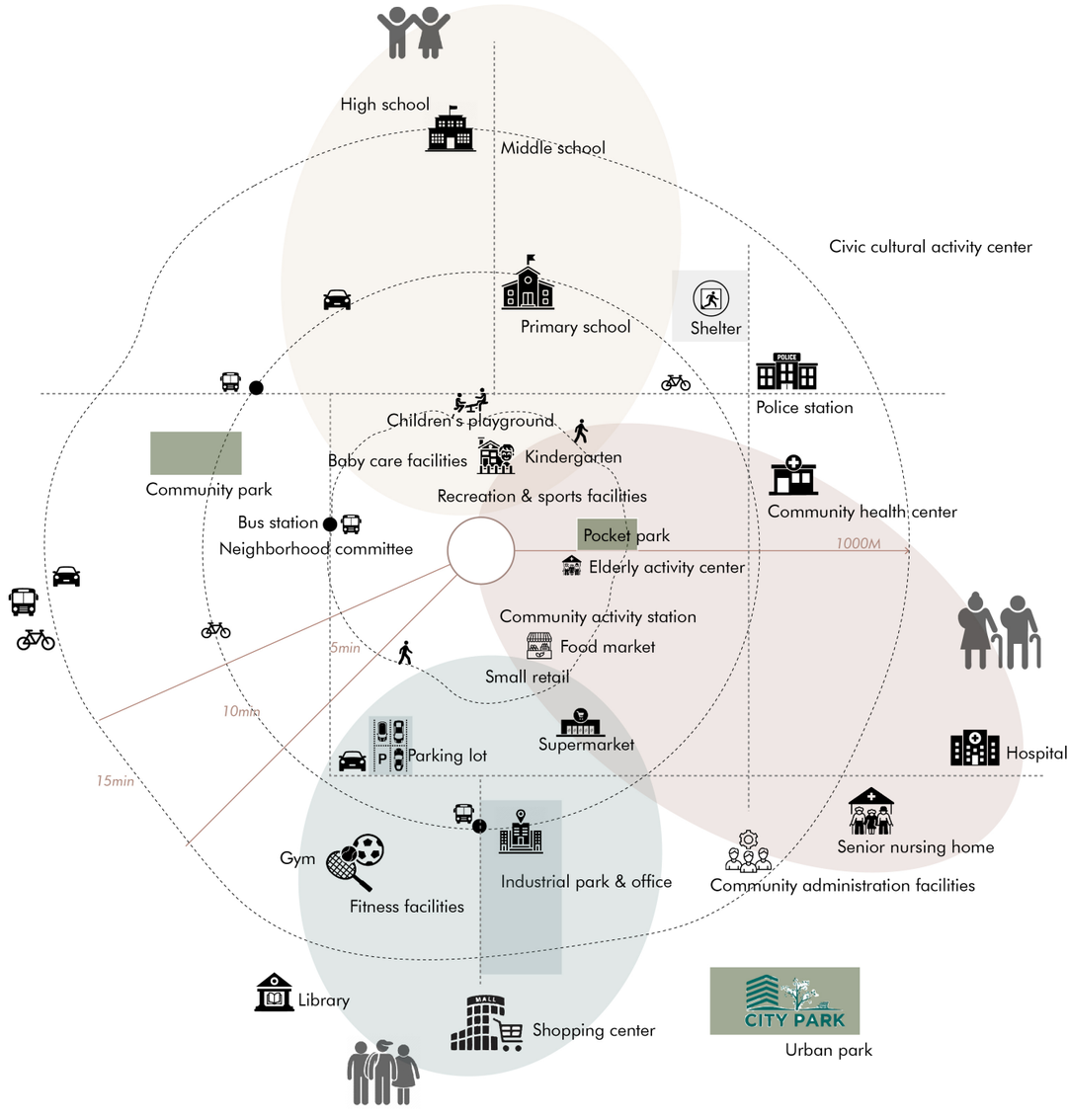
6.3 STRATEGIES

6.3.1 STRATEGY - SMART MANAGEMENT OF URBAN SPACE

Improve the spatial quality

Residential community-level centers provide a variety of basic services for residents' daily life in the construction of centralized community public service center layout in Hegang City, forming a comprehensive public service system with orderly gradations and coordinated levels. Through the construction of public service system, it promotes the activation of urban functions and enhances the popularity of urban areas. According to the use needs of different people, improve and optimize the construction of green space, public space, schools, elderly care, medical care, security and other service facilities to form a 5-10-15 minute community living circle suitable for people of different ages.





6.3 STRATEGIES

6.3.1 STRATEGY - SMART MANAGEMENT OF URBAN SPACE

Renewal of vacant space

The problem of population outflow and aging in Hegang City is serious. Excessive housing supply leads to a high housing vacancy rate. Some commercial and public service facilities are redundant. In addition, the demolition of shantytowns and industrial relocation have resulted in a certain amount of vacant urban land. In this regard, four different update modes are proposed:

MODE	ATTITUDE TO SHRINKAGE	ACTION	PARTICIPATION MECHANISM
Demolition	Not admit/Seek for growth	Demolish the vacant buildings	Government-led/Attract market
Transferability	Admit/Solve problem	The land bank reclaims vacant land, and grass-roots organizations such as neighborhood committees obtain the right to reuse the land	Government-led/Attract residents
Transition	Admit/Wait for growth	Transit vacant industrial or commercia land by encouraging local businesses and organizations to actively envision new uses for vacant land, transforming vacant resources into temporary places with multiple functions.	Government-guided/Social participation
Change	Admit/Utilize shrinkage	Reuse the vacant property and give it new function; Turn vacant land into "green infrastructure"	Government-led/Social participation

For different vacant land, analyze its needs, advantages, current conditions, etc., propose different design guidelines, and confirm the relevant responsible persons.

For urban vacant land, use functional replacement as the main method, and transform it into different landscape land or agricultural land according to its indicators to form a green infrastructure system, and it can also be used as a reserve land for future development;

For urban vacant buildings, the vitality of the district is stimulated through resource optimization and reorganization, and some buildings with poor basic conditions are selected to be demolished; vacant buildings are developed with multiple functions, functional transformation and other measures

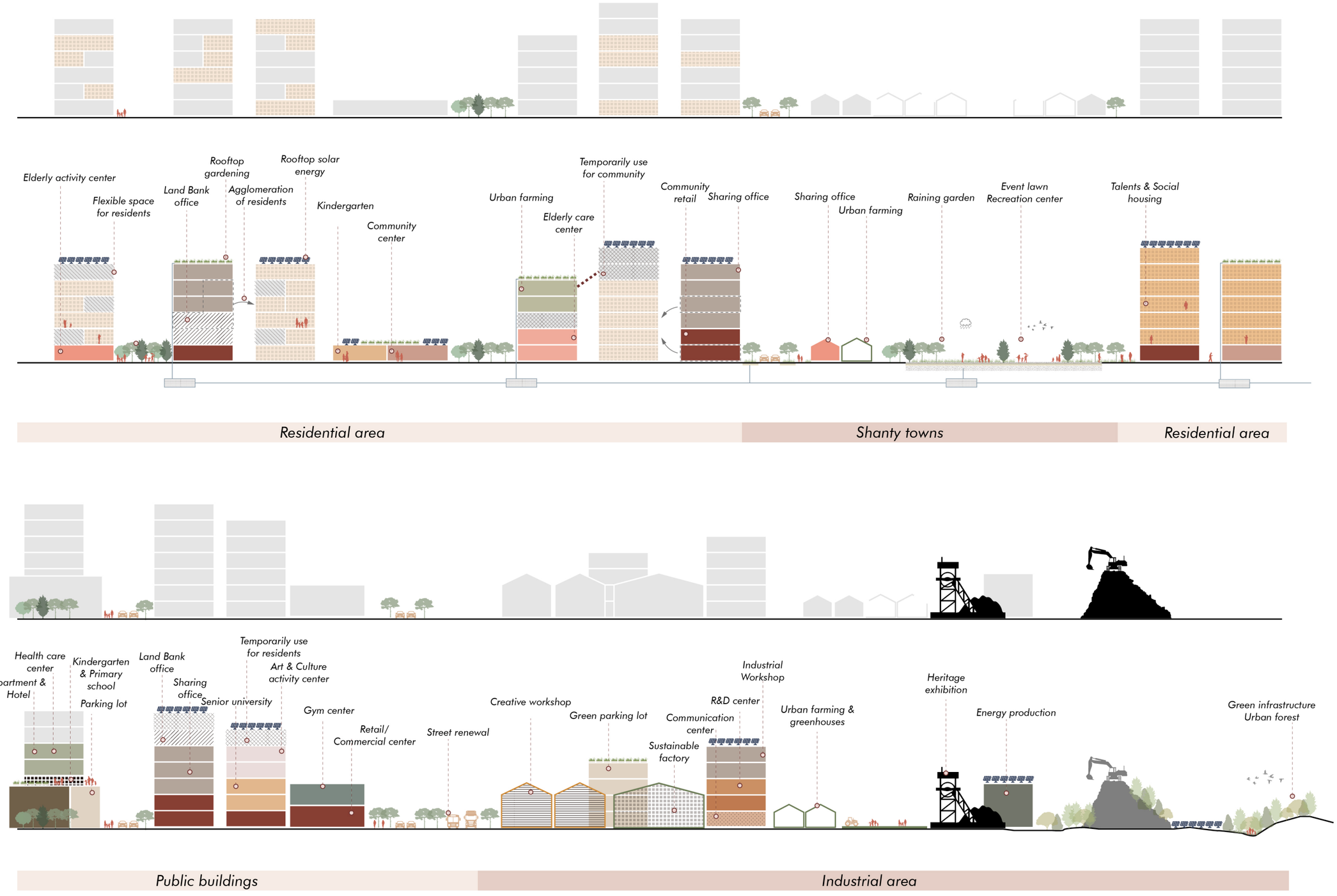
Renewal guideline

CLASSIFICATION			MEASURE INDICATOR (Demand / Location / Quality / History)	STAKEHODER	STRATEGIES
VACANT LAND	Infrastructure			Government/enterprises	Green buffer Protection green
	Parking lot	Near roads Small areas		Government/enterprises/NGO	Green parking facility Permeable pavement
	Square	Near active zone High accessibility		Government/citizen/N-GO/planner	Public service infrastructure Landscape element/Sculpture Interactive scenery Portable pavillion/Market
	Park	Near residential area Near rivers; Large area		Government/citizen/NGO	Urban vegetation/Event lawn Waterfront sidewalk Playground Slow walk
	Garden	Near residential area Small area		Government/citizen/NGO	Healing garden Permeable pavement Recreation facility Fitness equipment
	Farm	Far from residential area With farm Large area		Government/enterprises/citizen	Reclaim farm Urban farming Horticultural alley Green house Build shutter
	Restoration Coal mine	Small/Large		Government/enterprises/citi-zen/NGO/consulting compa-ny/planner/scholar	Refuse backfill Landscape design Bio-landscape & wetland Recreation park Urban Habitat Energy supply Ecological restoration Reclaim cropland Agriculture & Horticulture Industrial heritage park Underground Storage
SHANTY TOWNS	Demolished shanty towns	Scattered distribution		Government/enterprises/N-GO/innovative team/plan-ner	Raining garden Urban farming Event lawn Recreation center Elderly community center
	Demolition	Low historic value Low quality High vacancy		Government/enterprises	Demolish buildings
	Renewal	High historic value High quality Low vacancy		Government/enterprises/citi-zen/innovative team	Partly remediation Function transformation
RESIDEN-TIAL BUILDINGS	Demolition	Low centrality Low quality High vacancy		Government/enterprises	Demolish buildings
	Renewal	High centrality High quality Low vacancy		Government/enterprises/citi-zen/innovative team/Land Bank/NGO/Planner/Neigh-borhood committee	Land Bank Vertical mixed function -Commercial -Public service Temporarily use Elderly care center Community activity center Urban farming Half of a good house Talents & social housing
INDUSTRI-AL BUILDINGS	Demolition	Low centrality Low quality Bad environment		Government/enterprises	Demolish buildings
	Renewal	Centralized distribution High/moderate quality Historic value		Government/state-owned enterprises/citizen/innovative team/Land Bank/NGO/Plan-ner/private enterprises	Land Bank Creative workshop Green infrastructure Art gene activation Industrial heritage exhibition Community function inception Energy production facility Sustainable industrial park
PUBLIC BUILDINGS	Demolition	Low centrality Low quality High vacancy		Government/enterprises	Demolish buildings
	Renewal	High centrality High quality Low vacancy		Government/state-owned enterprises/citizen/innovative team/Land Bank/NGO/Plan-ner	Land Bank Public function improvement Vertival mixed use Quality improvement

6.3 STRATEGIES

6.3.1 STRATEGY - SMART MANAGEMENT OF URBAN SPACE

Renewal guideline



6.3 STRATEGIES

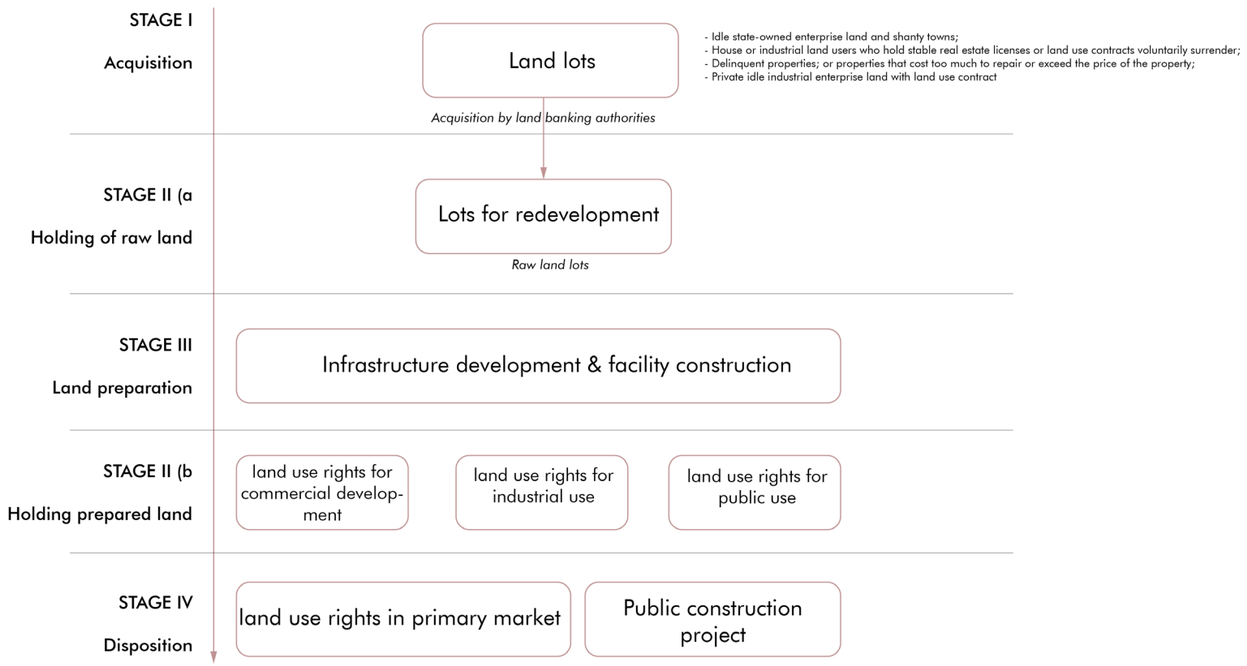
6.3.1 STRATEGY - SMART MANAGEMENT OF URBAN SPACE

Strengthen land management efforts: Build Land Bank system

Land banking is a strategy that favors shrinking cities back to the right size, as it collects, temporarily manages, and disposes of vacant properties to maintain neighborhood stability and encourage property reuse. It could also serve as an economic and community development tool to revive a shrinking city's real estate market.

The land bank for shrinking cities mainly recycles the following four types of land: state-owned enterprise land and shanty towns that were idle during the planned economy period; housing or industrial land users with stable real estate licenses or land use contracts voluntarily handed over; delinquent property ; or properties whose maintenance costs are too high or higher than the housing price; private idle industrial enterprise land with a land use contract.

In the specific operation, the party branch, as the smallest government authority, will educate the public to understand the interests of the land bank, encourage users to deposit vacancies on the land into the land bank, fight for the law of the land bank, ensure the interests of the public, and monitor vacant houses at the same time dynamic changes. In terms of finance, the source of funds is a necessary condition for the success of the land bank; the government should support the land bank through the fiscal budget, and the funds obtained by the land bank through the management of vacant properties will be used to support the demolition of vacant buildings, restoration and landscaping.



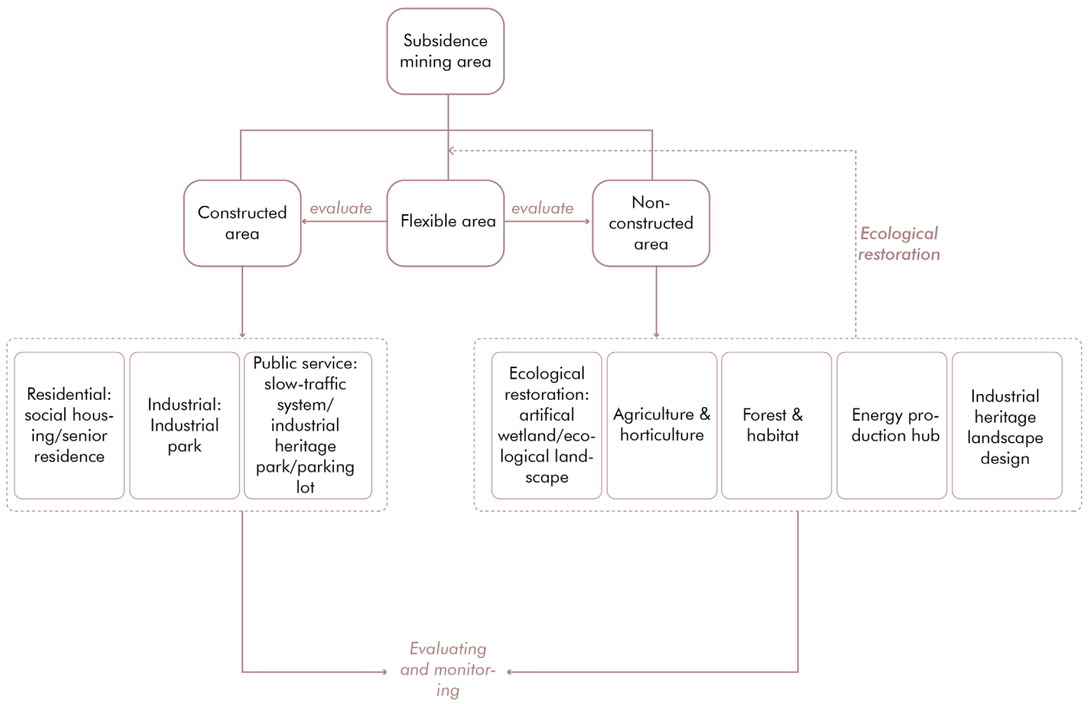
6.3 STRATEGIES

6.3.2 STRATEGY - BUILD GREEN INFRASTRUCTURE (GI) SYSTEM

Ecological restoration

As a coal resource-based city, Hegang's coal mining for many years has caused large coal collapse areas.

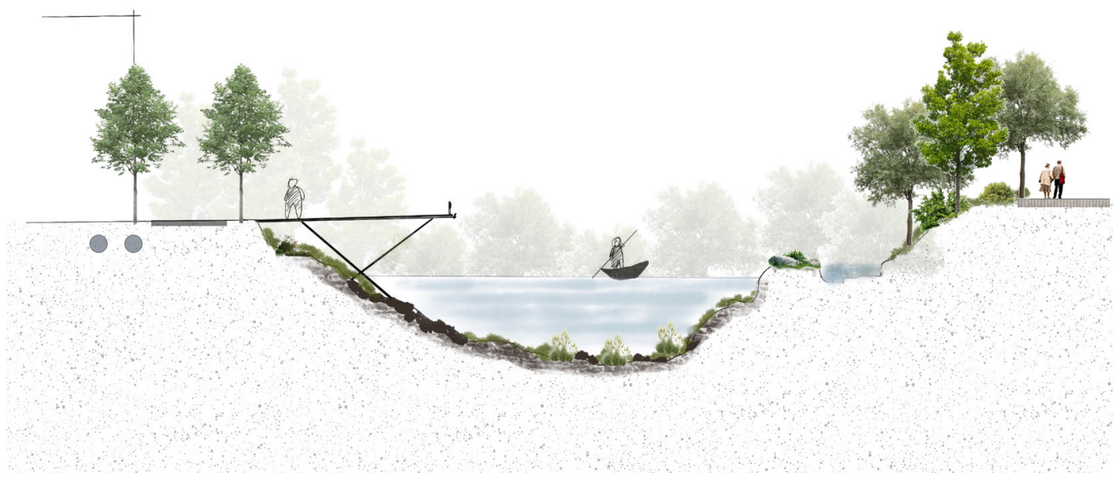
The coal mining subsidence area in the east of Hegang City runs through the north and south of the central city of Hegang and is large in scope. A large amount of urban land is affected by the coal mining subsidence and has a large impact on the spatial structure of the city. Relocate the scattered industrial and mining enterprises in the coal mining subsidence area to industrial industrial parks, demolish and rebuild the shantytowns with transformation value, and relocate those that do not have the conditions for transformation and use them as ecological cultured green areas, industrial land or government reserve land;To carry out ecological treatment on mine abandoned land and coal mining subsidence area, such as soil, plant and water resources restoration, increase urban green space, open space as well as agricultural planting land, and improve urban living space and ecological space, while the area can also be used as a guarantee for farmers to increase income and urban ecological green lung.



There are 16 rivers, ditches and streams in Hegang, locally known as "two rivers and 14 ditches", which are well endowed with water resources and should have been the key elements to create a coherent public space and enhance the urban landscape as the main landscape element throughout the city; however, due to the ground subsidence and collapse in the mining area, there is no channel for the production of mines and the living sewage of dense shantytowns. Resulting in serious pollution of river water bodies, also known as black smelly water bodies, with a total length of 56.55 km all black smelly water bodies, 3 heavy black smelly and 13 light black smelly. In recent years, Hegang City invested 1.345 billion yuan to implement the "two rivers and fourteen ditches" clear water show shore comprehensive treatment project, has achieved initial results, January 2023, the municipal government in the government website published "Hegang City, the white paper on the protection of rivers and lakes".

The most important economic rationale for urban restoration and rehabilitation is the improvement of ecosystem services and urban quality of life (Elmqvist et al., 2015). The aim of river rehabilitation is to meet the urban drainage and flood control functions while improving the habitat function of certain species by enhancing natural dynamics and vegetation, building water landscape spaces and aquatic ecosystems, providing water-friendly platforms, and restoring attractive recreational and educational green spaces.

The usual measures include: sewage treatment, hydrophilic landscape design, barge design, and ecological paving



6.3 STRATEGIES

6.3.2 STRATEGY - BUILD GREEN INFRASTRUCTURE (GI) SYSTEM

As a "green life support system" for nature and human society, green infrastructure is of great significance to improving ecosystem service functions and ensuring sustainable urban development. The planning based on the comprehensive network of green infrastructure regards the whole city as an organic whole, comprehensively consider the idle or abandoned assets of shrinking cities, existing residents or unemployed persons, urban ecological environment and landscape, commercial investment and asset value and other factors, as well as the interrelationships among these factors, so as to realize the comprehensive renewal and sustainable development of shrinking cities .

A series of natural ecological resources such as Hegang's waterfront, forests and gentle slopes in the Xiaoxing'an Mountains provide the foundation for the sustainable development of the central city and the construction of an ecological network.

Based on the current natural resources and combined with the vacant land, a multi-scale and multi-form ecological network integrating ***corearea, corridor, site and stepping stone*** is formed; It can not only improve the current situation of oversupply of urban land, but also increase the value of surrounding land through green space, create a beautiful environment for citizens, and store urban space as green space for future development.

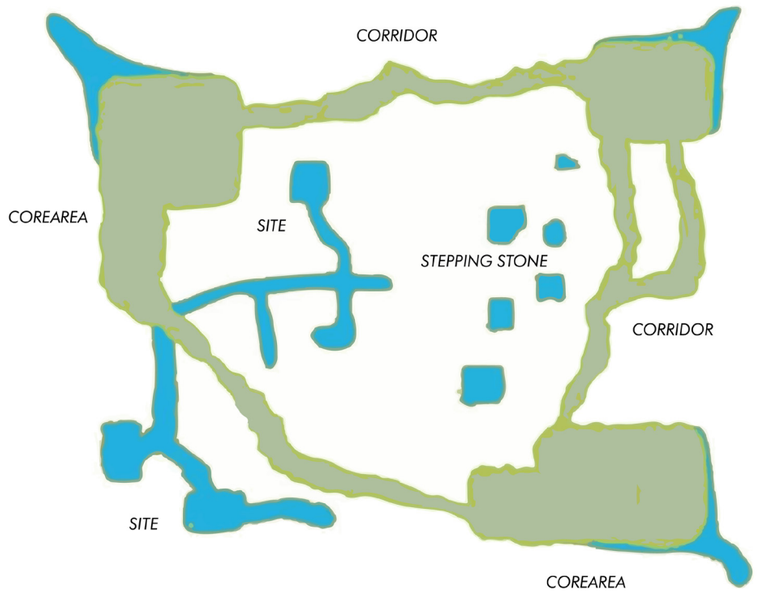
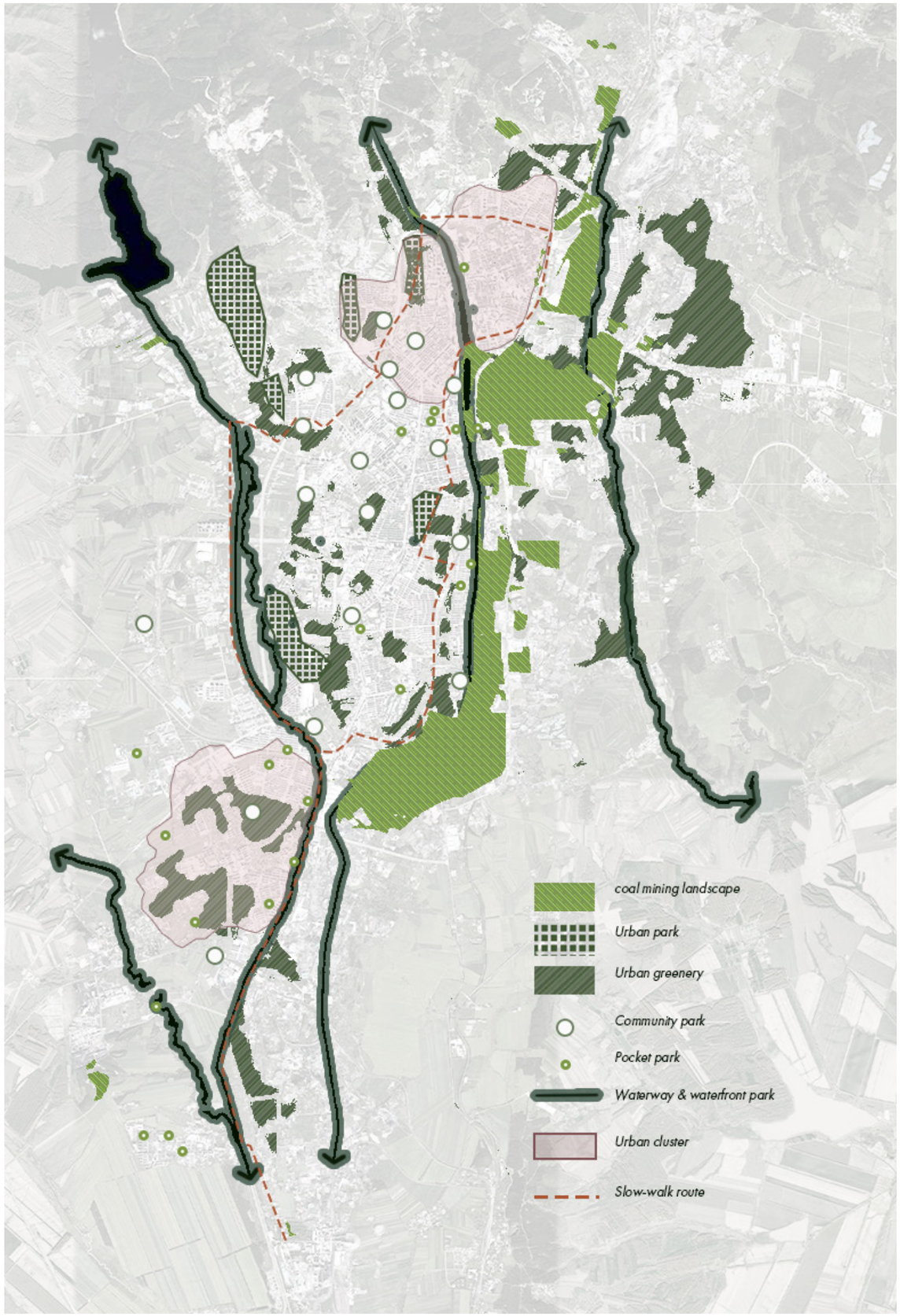


Fig.Concept of Green Infrastructure network.(Source: Made by author)



6.3 STRATEGIES

6.3.2 STRATEGY - BUILD GREEN INFRASTRUCTURE (GI) SYSTEM

Corearea is the core area of the GI network, and it is also the most important carrier for various ecological processes in the entire ecological network. corearea provides stable habitats for different species and is key to ensuring biodiversity within the system. corearea has a variety of shapes and scales, generally including nature reserves, forests, plantations, parks, urban green spaces, etc.

Corridor mainly plays the role of Unicom GI network. The basic forms of corridors are linear green belts and green corridors, rivers/floodplains and surrounding linear green spaces, etc. In addition to performing necessary natural ecological functions, the corridor also provides space for exercise, leisure and recreation for nearby residents.

A site can be understood as a small-scale patch or corridor that, although relatively small, can still exert important ecological and social value. Common sites include: wildlife sanctuaries, urban agriculture areas, and natural/semi-natural recreational spaces.

The stepping stone is an isolated and fragmented small ecological node in the GI network. Stepping stones are not directly connected to the GI network in form, and often include special species protection areas, endangered species habitats, or community green spaces, private gardens, and green roofs in cities.

STEPS OF BUILDING GREEN INFRASTRUCTURE SYSTEM

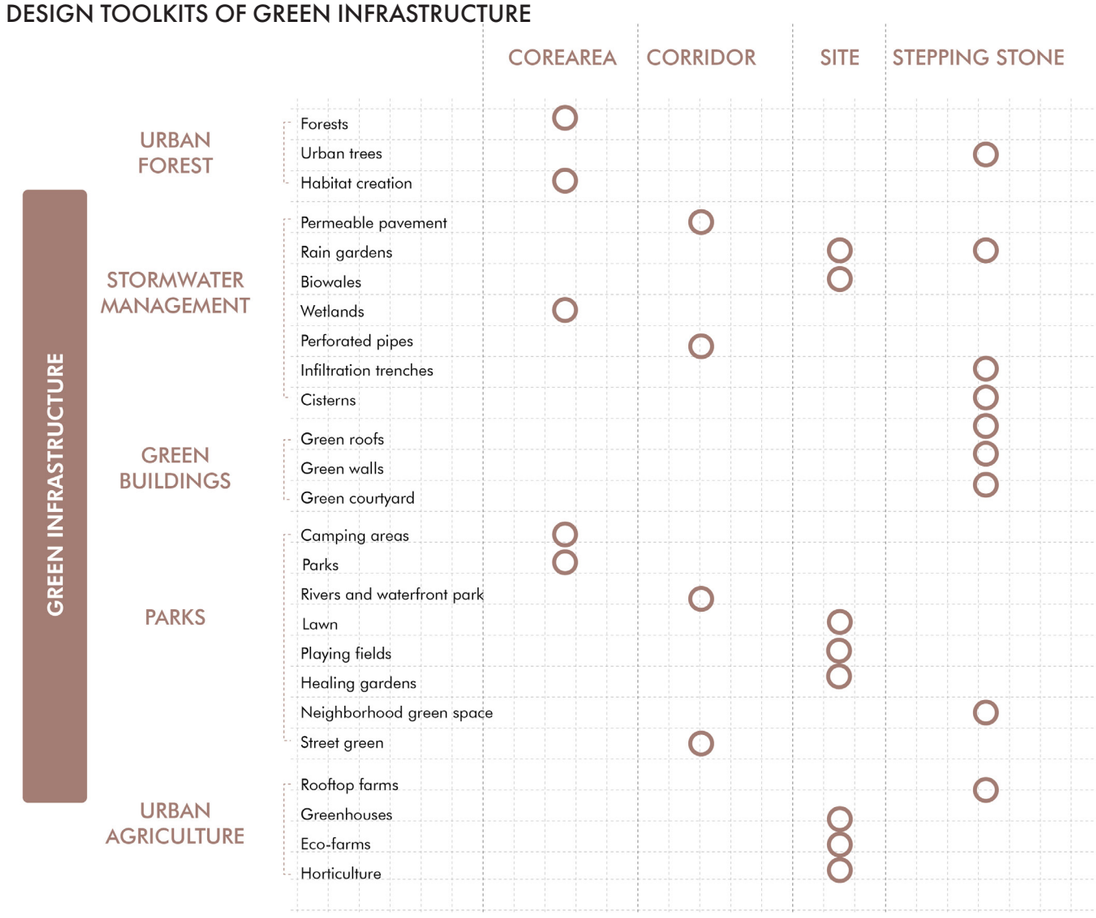
Step1: Analyse the need of land use and Identify the current natural landscape resources, Research on the current local soil conditions
Step2: Reclassify the land use and vacant buildings
Step3: Assess the value of the land based on residents' preference

Step4: Confirm the locations /types/stakeholders of green infrastructure
Step5: Make the green infrastructure network plan and the green corridor
Step6: Design on sites
Step7: Make the plan for ecological restoration

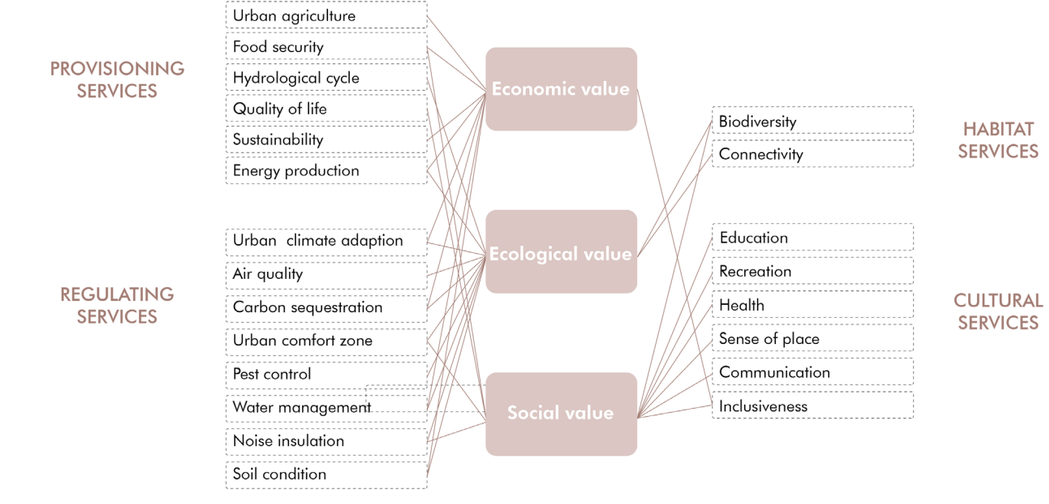
Step8: Demolish/Renewal the vacant building
Step9: Transform the vacant space to green infrastructure

Step10: Public participation
Step11: Make the strategies for short-term and long-term maintenance
Step12: Maintain

DESIGN TOOLKITS OF GREEN INFRASTRUCTURE

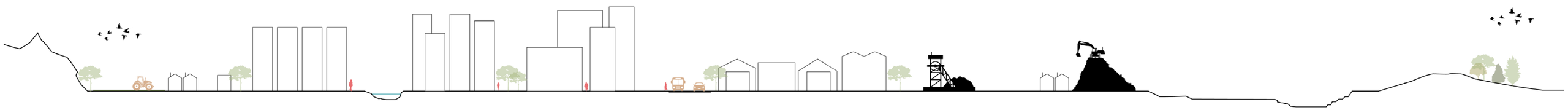


FUNCTION OF GREEN INFRASTRUCRURE



6.3 STRATEGIES

6.3.2 STRATEGY - BUILD GREEN INFRASTRUCTURE (GI) SYSTEM



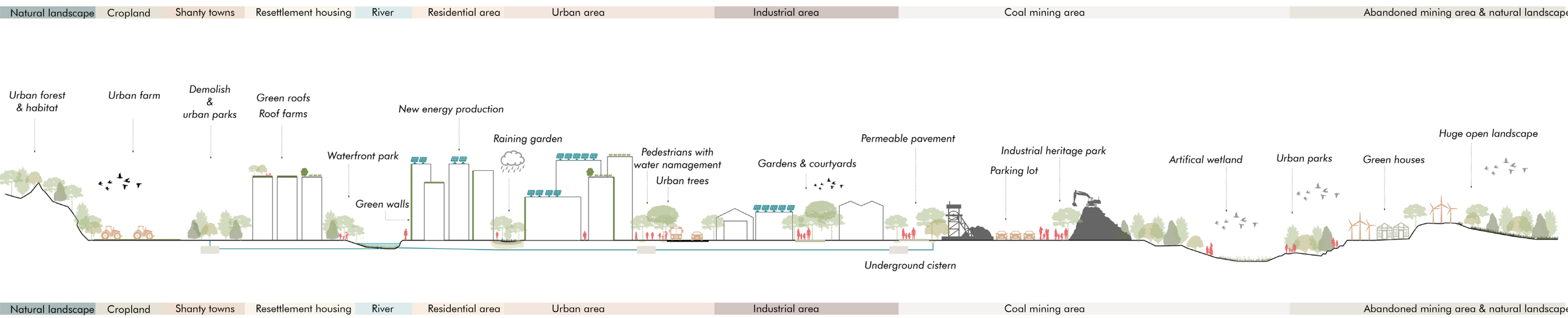


Fig.Section of design toolkit implementation.(Source: Made by author)

6.3 STRATEGIES

6.3.2 STRATEGY - BUILD GREEN INFRASTRUCTURE (GI) SYSTEM

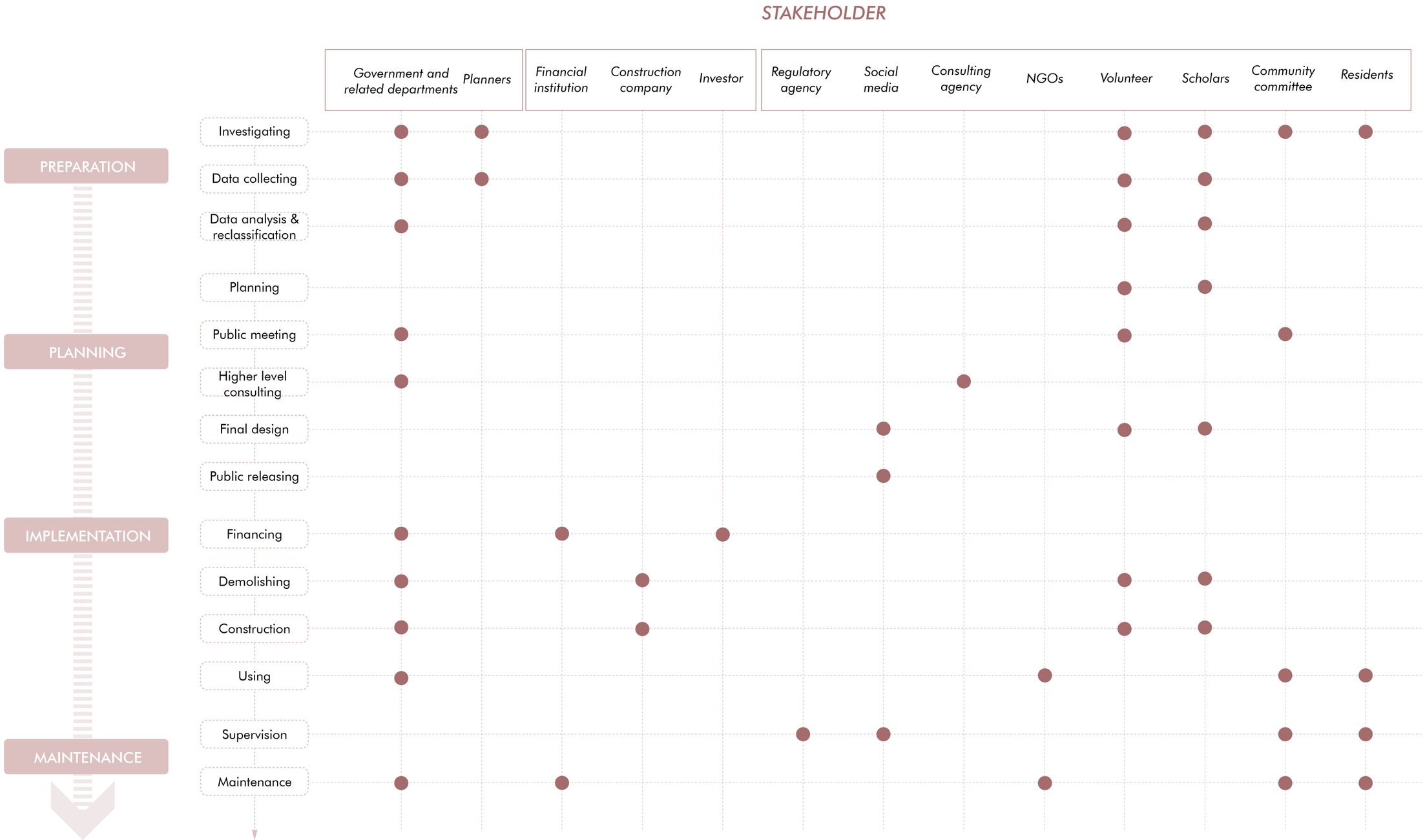


Fig.Stakeholders of build GI system.(Source: Made by author)

6.3 STRATEGIES

6.3.3 STRATEGY - SUSTAINABLE ECONOMIC TRANSITION

Due to the over-dependence of Hegang on coal resources and the complexity of industrial transformation, a composite industrial transformation model should be adopted to form a diversified industrial structure. The promotion of industrial upgrading is not only to optimize the stock, but also to actively develop new catalytic points to guide industrial transformation.

Among them, priority will be given to the development of the coal industry and graphite industry through the industrial succession mode, relying on the existing resource conditions, extending the industrial chain, and developing the coal chemical industry as well as the high-end graphite battery industry to obtain greater industrial benefits and promote the social and economic development of the city.

At the same time, by tapping other industries with potential and advantages in the city, the policy will guide the priority cultivation of new industries, and with the development of industrial clusters and the improvement of city functions, gradually change to the industrial substitution mode, improve the city's industrial development structure, and complete the final transformation of resource-depleted cities.

Specifically, firstly, we should research and screen the existing industrial base, select key enterprises from the perspectives of enterprise R&D capability, tax output and development potential, slim down and adjust the industrial functions, supply the city's surplus public services to relevant enterprises' talents with priority and preferential treatment; and set up comprehensive service centers such as research centers and government service centers, establish relevant infrastructure for research and development, provide enterprises with productive services, enhance the technological innovation capability of outstanding enterprises, and reduce their social costs of transformation and upgrading.

On the other hand, combined with its own natural resources, it actively takes the initiative to dock, introduce and develop high-tech industries with high added value and strong driving capacity, and dock them to low-priced stock industrial land.

At the same time, the overall bankruptcy enterprises are retired, and industrial land in the central city is replaced to the concentrated areas on the periphery of the city to reduce the cost of land for enterprises, enhance the economic benefits of industrial development, and provide space for creating a vibrant, high-quality living area in the central city. The vacant land vacated by the declining industrial manufacturing industry will be used for ecological restoration, and the restored land will be used to vigorously develop and expand agriculture, and develop tertiary industries such as tourism in combination with agriculture to extend the agricultural industry chain and shape a new image of the city.

For shrinking cities, the gathering and development of industries implies the further development of the concentration of economic factors and division of labor, which brings urban tax revenue to enhance the city's ability to supply public services and provide assets that can sustainably generate tax revenue for the sustainable development of the city. At the same time, the availability of jobs also means a larger labor force, which in turn stabilizes the "dependent" youth and elderly population.

In addition to promoting industrial transformation toward diversification, promoting the integration of industry and city is also a very important part; uniting industrial construction and urban construction with each other to drive urban development.

Hegang City is in a critical period of industrial transformation, promoting the transfer of industries in the old city center, accelerating the investment of park industries and guiding enterprises into the park, giving play to the agglomeration effect of functional areas, making the new industrial center and industrial clusters into the new growth core of Hegang City, developing industries and manufacturing industries at the high end of the value chain as well as R&D and other knowledge economy-based industries;

It also uses the core of the old city cluster and ecological restoration area to develop trade and tourism functions, as well as sustainable green industries, to promote the development of the tertiary industry in Hegang City, and to build an industrial system with high, medium and low-end coordination, providing jobs for people of different skill levels, thus driving urban development.

In the industrial park, it promotes the matching of industrial space and living space in close proximity, replaces inefficient industrial land with residential, commercial, service or green space functions, achieves land compounding, coordinates production, living and ecological functions with each other, and enhances the economic vitality of the park.

6.3 STRATEGIES

6.3.3 STRATEGY - SUSTAINABLE ECONOMIC TRANSITION

Adjustment of industrial structure

As a resource-based city, Hegang's current industrial structure is dominated by coal mining. With the depletion of resources, the city urgently needs industrial transformation.

Extend the coal industry chain, promote the in-depth transformation of coal resources, actively promote the deepening of the chemical industry without electricity, and improve industrial competitiveness;

Abandoned coal mines, coal gangue can be crushed to form low-cost concrete, which can be used as a green building material industry;

After the restoration of the ecological environment, the subsidence of coal mining can complete the reconstruction of farmland, the redevelopment of wetland landscape, the combination of industrial landscape and culture, and then develop urban agriculture and tourism;

In addition, part of the abandoned land can be transformed into an underground warehouse to play a storage function and combine with the transportation infrastructure to develop the logistics industry;

Combining high and new technology to actively develop modern agriculture, as well as deep processing of agricultural and sideline products, and develop green food industry;

The biomass energy produced by the development of urban agriculture and modern agriculture can be reused, and the vacant land can develop new energy systems, photovoltaic +, and develop new energy production;

Accelerate the construction of a modern industrial system for graphite deep processing, build a production base for graphite mining, selection, and processing; build a high-end graphite industrial base for automotive power battery production, high-purity graphite production, etc.

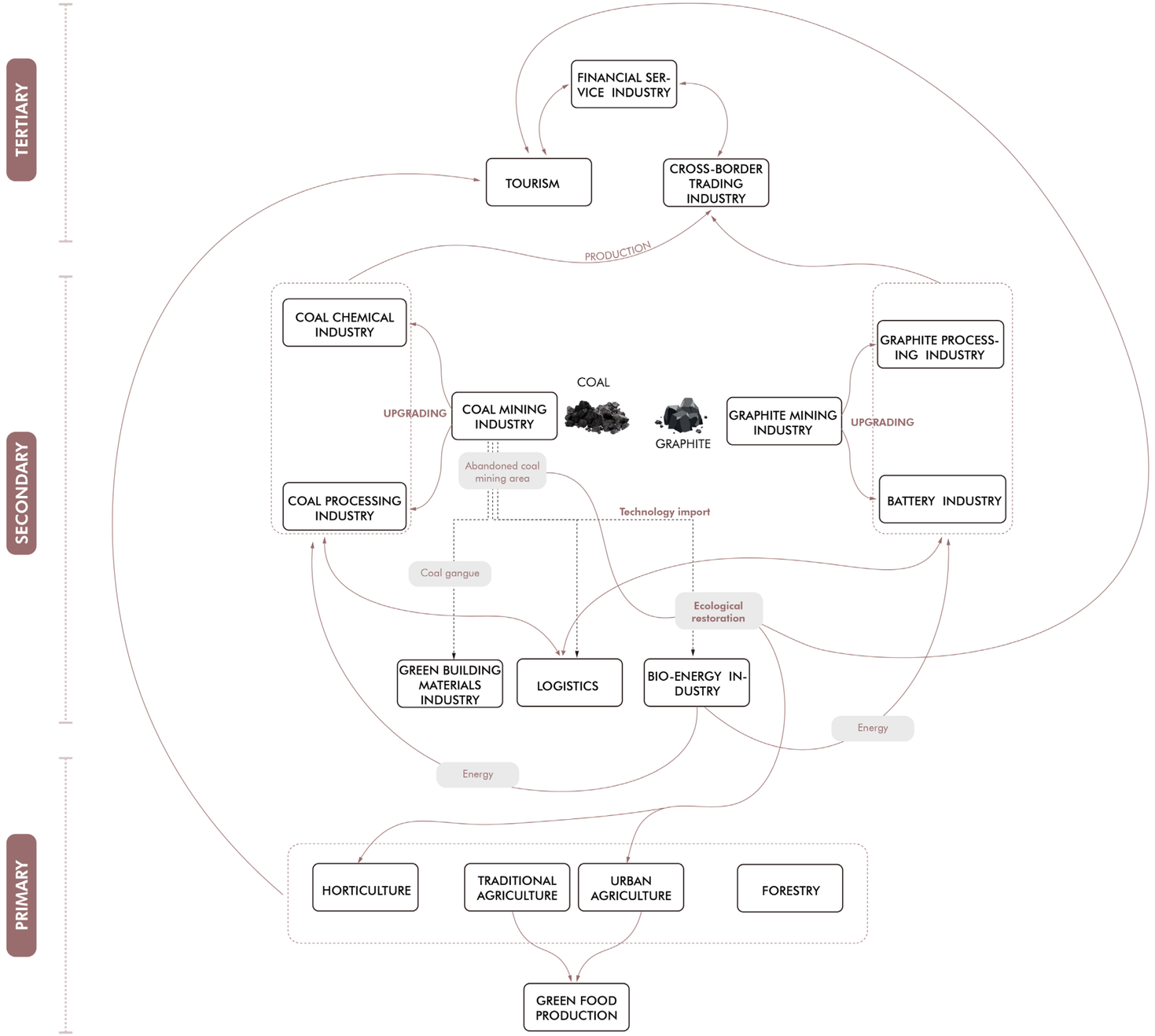


Fig.Upgraded industrial structure.(Source: Made by author)

6.3 STRATEGIES

6.3.3 STRATEGY - SUSTAINABLE ECONOMIC TRANSITION

Build industrial development sharing platform

Building an industrial development platform on the basis of government leadership and school-enterprise cooperation, integrating scientific research, business incubation, communication, logistics, service, exhibition and sales, talent reserve, venture capital, etc., to promote industrial transformation and upgrading.

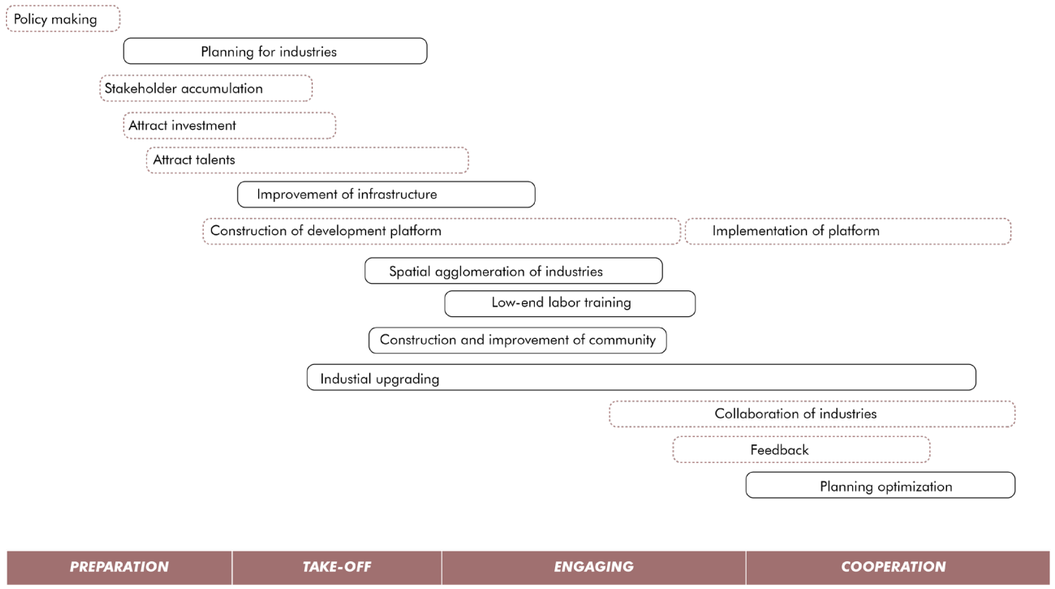


Fig.Phases of industrial development platform establishment.(Source: Made by author)

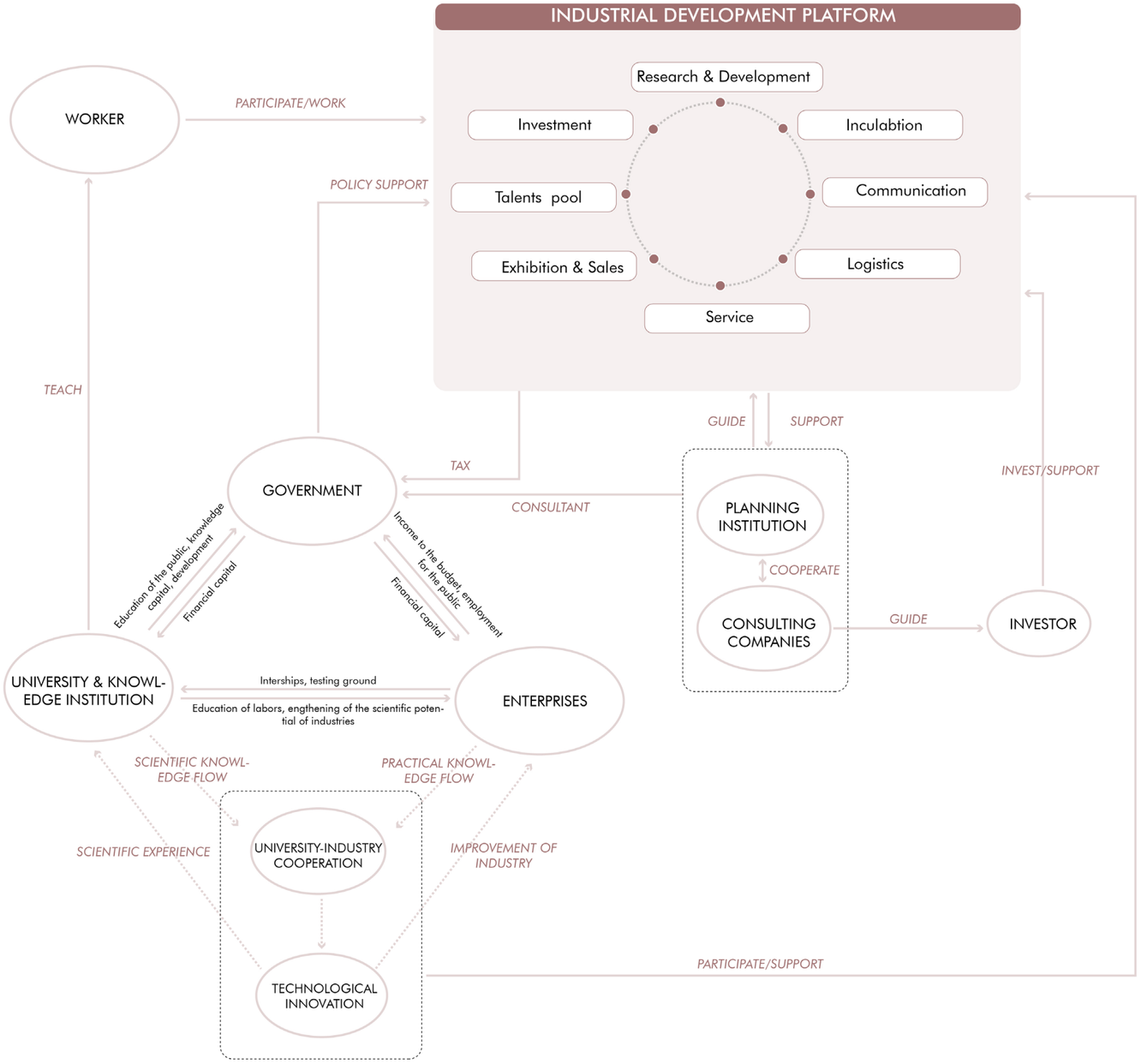


Fig.Stakeholders and relationships among industrial development platform.(Source: Made by author)

6.3 STRATEGIES

6.3.3 STRATEGY - SUSTAINABLE ECONOMIC TRANSITION

Reorganize the industrial distributions

Combined with the industrial transformation ideas of Hegang City mentioned above, according to resources, environment and market conditions, optimize the industrial space layout;Based on the smart shrinkage theory, change the status quo of relatively scattered layout, increase industrial concentration, form industrial growth cores and clusters, and support industrial development;

Due to the restrictions of the old city and the coal mining subsidence area in the east, the industry-related industries are guided to concentrate in the south, forming an industrial cluster development area. The old city focuses on the renewal of the old city, improving service facilities at all levels, and serving as the core area of the service industry; reducing the construction land in the eastern coal mining subsidence area, building an ecological conservation area based on ecological restoration, and developing related green industries;

Finally, a number of industrial parks for the development of different industries will be formed, forming an overall industrial development axis from north to south;

In addition, commuting routes are set up to connect industrial areas in surrounding cities and industrial gathering nodes in subordinate villages and towns.

1)Hi-tech industrial park: Relying on the existing food and agricultural and sideline food processing enterprises, gather high-tech and food enterprises, and promote the green and high-end development of the food industry through technological innovation;

2)Graphite industrial park: Planning and development of high-purity graphite industry chain, automotive power battery industry chain, energy storage battery industry chain and graphene R&D and application industry chain, etc.

3)Coal chemical industrial park: Vigorously develop new coal chemical industry and extend the industrial chain, focus on the development of acoustic machine processing in the coking industry, and develop in-depth processing products, forming a coal chemical industry cluster integrating coking products, organic chemical raw materials, and new chemical materials;

4)Logistics industrial park: The main layout is logistics warehousing, small and medium-sized enterprise entrepreneurial zone, industrial incubation and high-tech areas

5)Post-coal mining industrial park: Based on ecological restoration, restore the abandoned coal mine land to cultivated land and garden land, develop garden industry and urban agriculture; reuse coal gangue to produce green building materials; Landscape redevelopment after restoration of the ecological environment and reuse of industrial relics in abandoned coal mines can form industrial relic parks and tourism nodes; Biomass reuse and photovoltaic power generation can form the basis for the development of new energy industries.

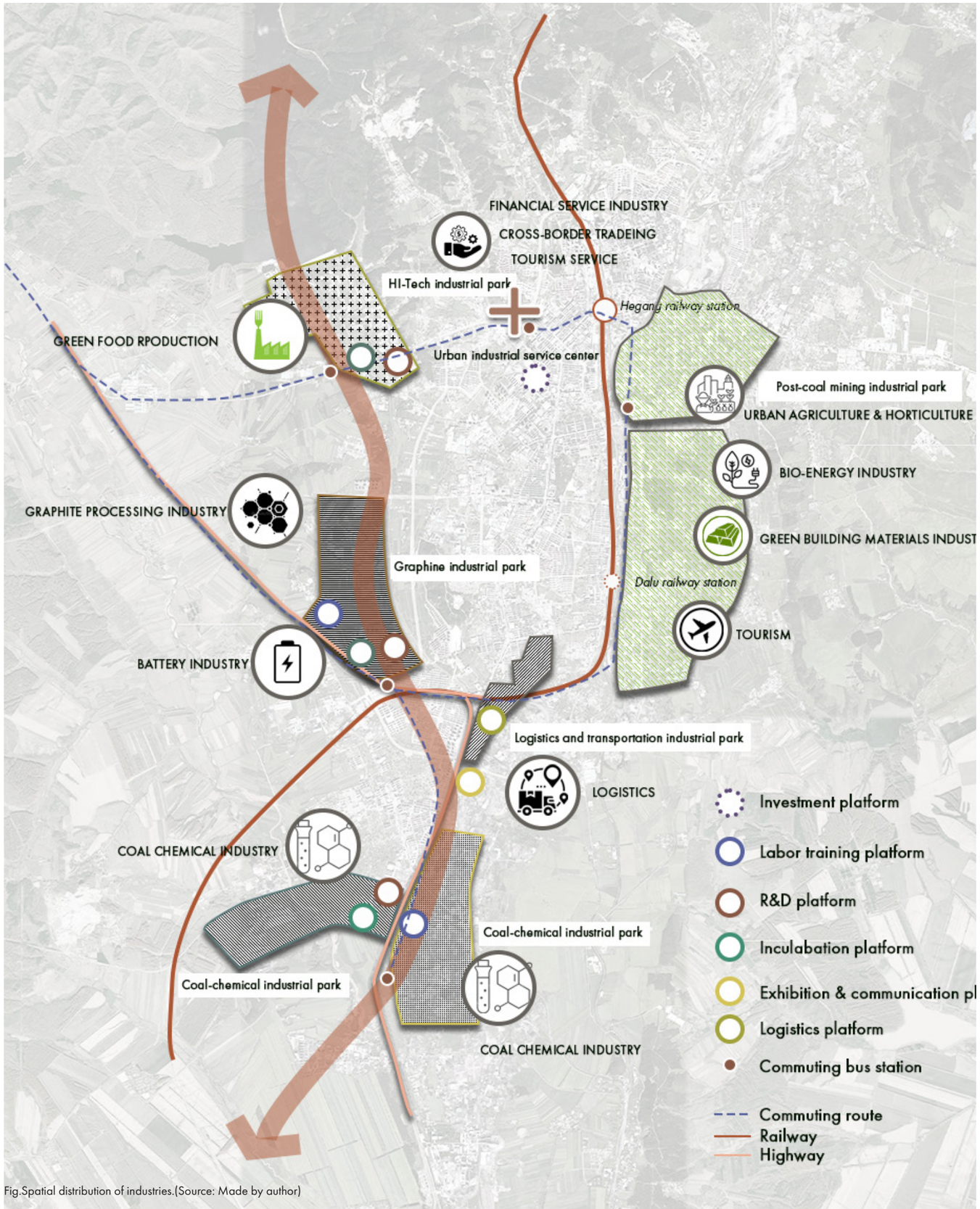


Fig.Spatial distribution of industries.(Source: Made by author)

6.3 STRATEGIES

6.3.3 STRATEGY - SUSTAINABLE ECONOMIC TRANSITION

Build 'Industry+Life' Community

Integration of industry and city, in the industrial park, optimize infrastructure construction, replace inefficient industrial land with residential, commercial, service or green space and other functions, to achieve the complex use of land; Supplement and improve productive service facilities and living service facilities, cover public service facilities, form industrial residential communities, and coordinate production, living and ecological functions.

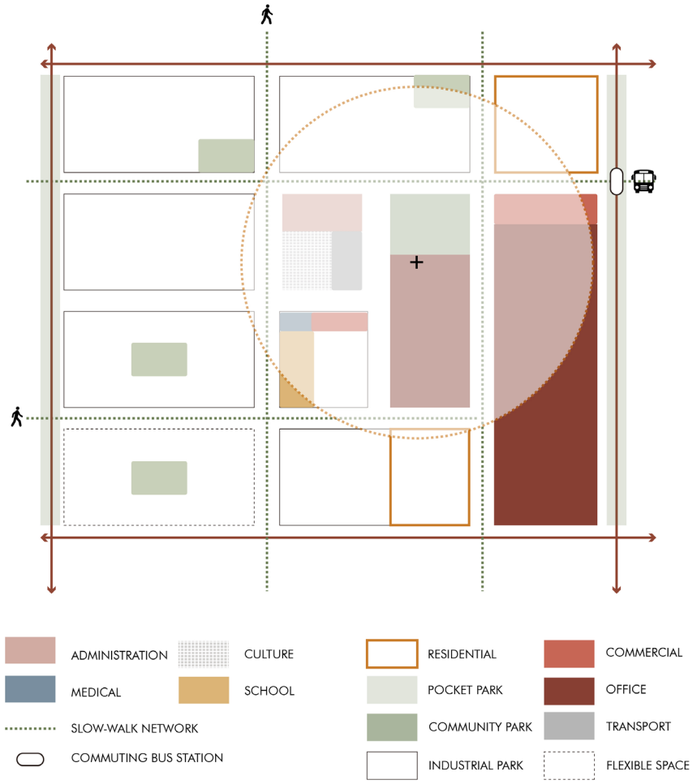


Fig.Concept of industrial based community.(Source: Made by author)

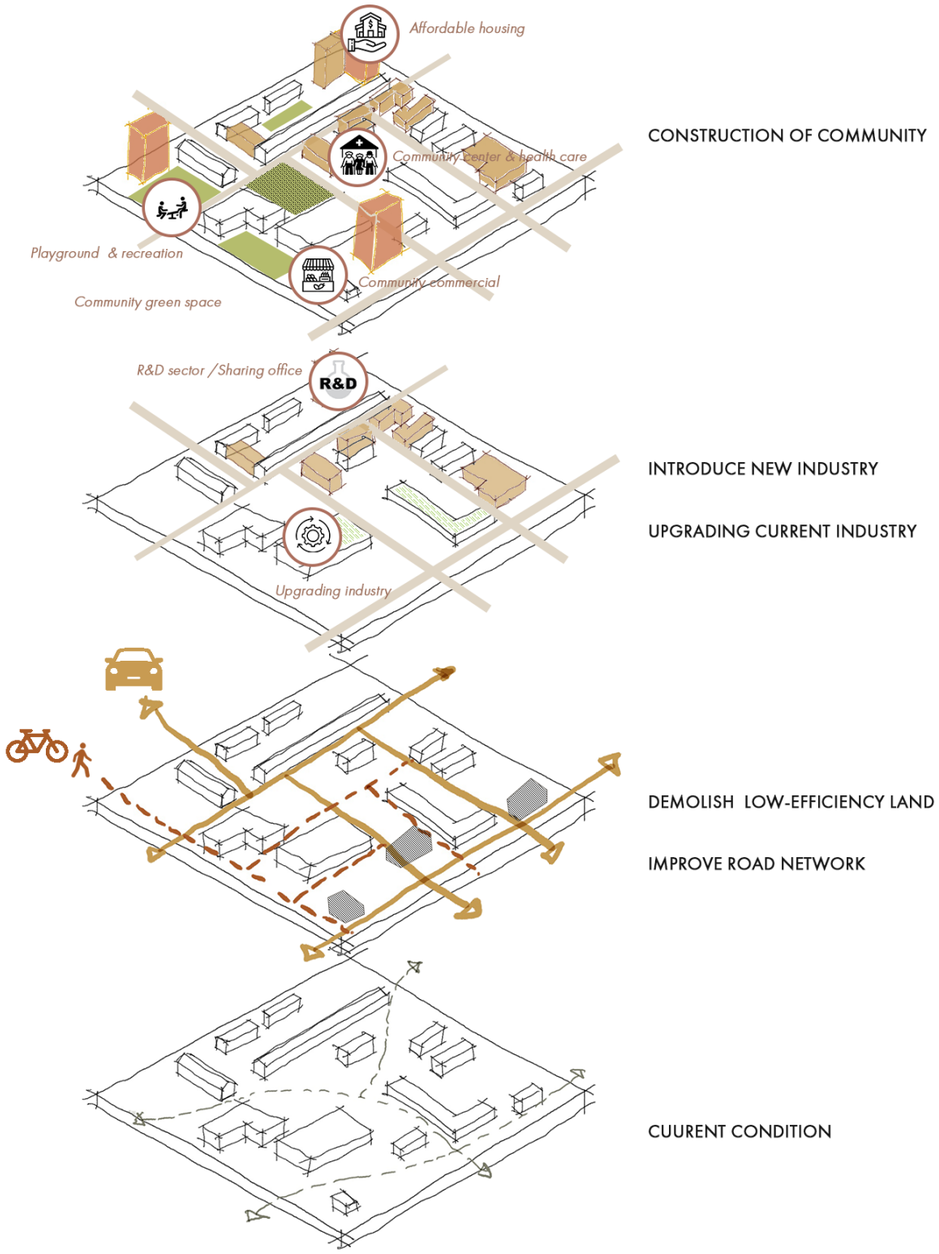
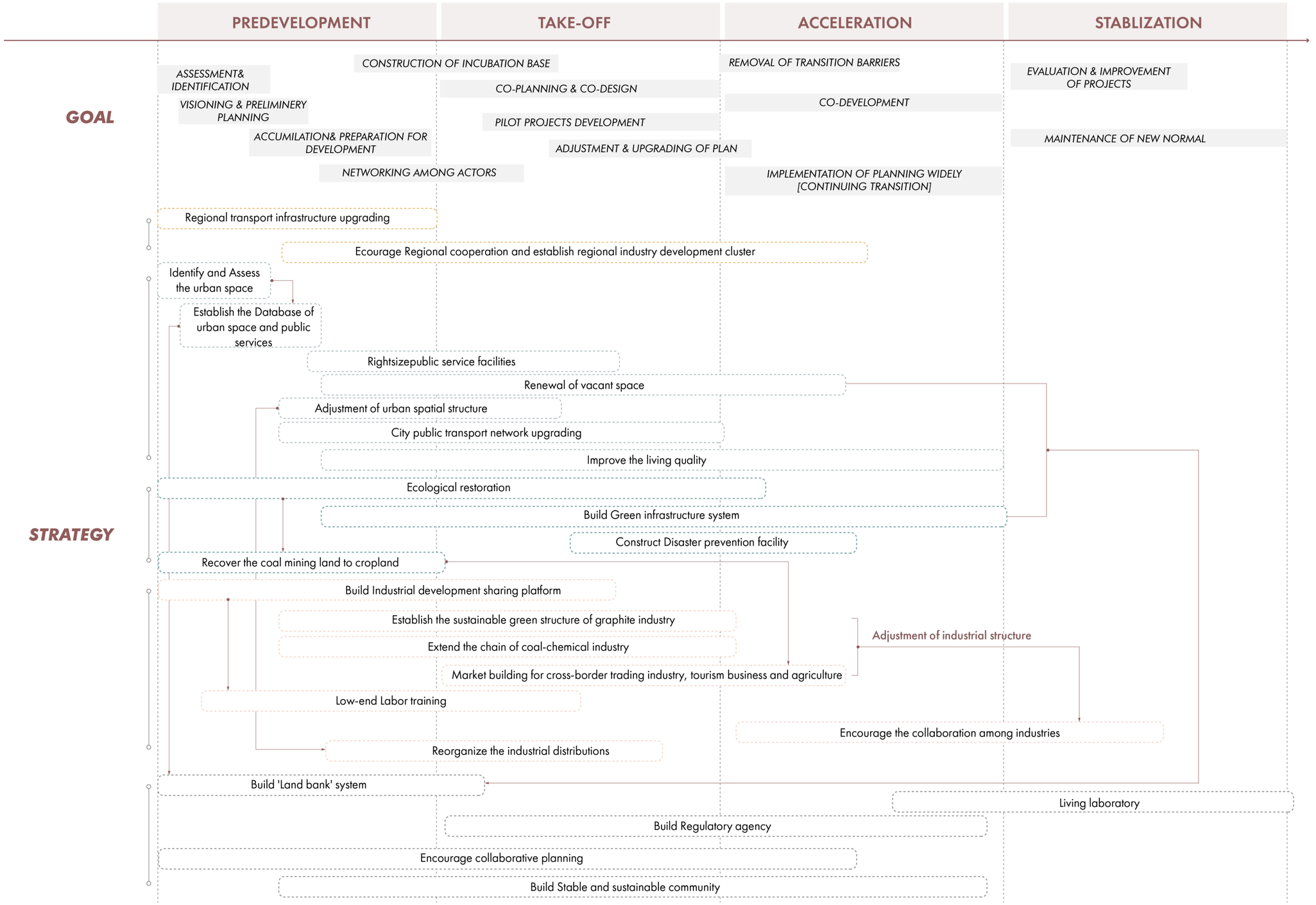


Fig.Steps of Industrial-based community.(Source: Made by author)

07 IMPLEMENTATION

7.1 PHASE

PHASE OF TRANSFORMATION PLANNING



7.2 GOVERNANCE

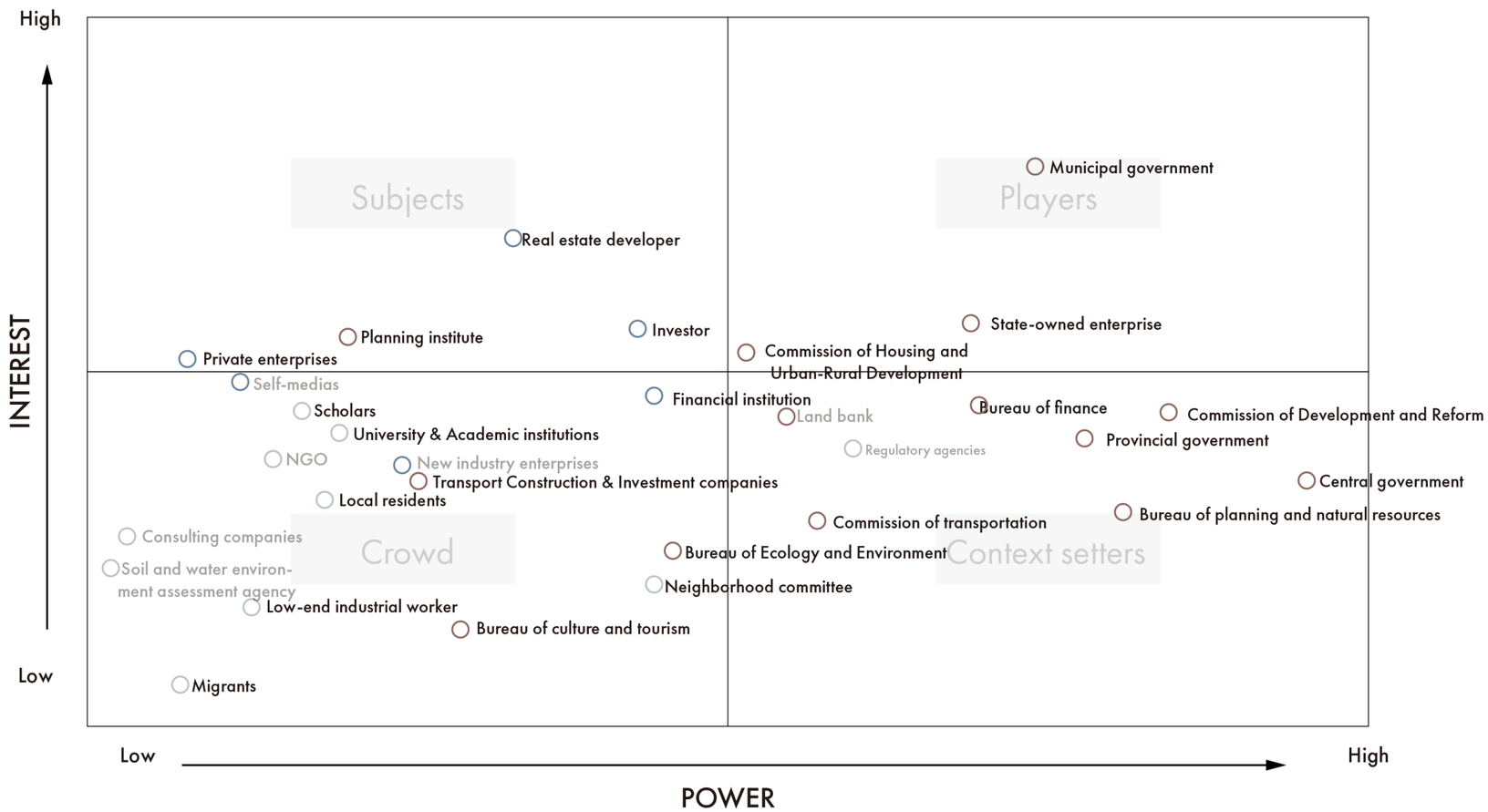
STAKEHOLDER OVERVIEW

As a multi-faceted urban spatial planning scheme, the composition of public stakeholders in this project is relatively complex. It involves the coordination among departments of finance, urban planning, industry, natural environment, housing and urban-rural development, cultural tourism, transportation, etc. in the grassroots government; and the existence of large state-owned enterprises as the mainstay of industrial development, urban development, and infrastructure construction in resource-based cities.

The private sector includes enterprises of new implant industries, small, medium and micro private enterprises, investors, financial institutions, and real estate developers.

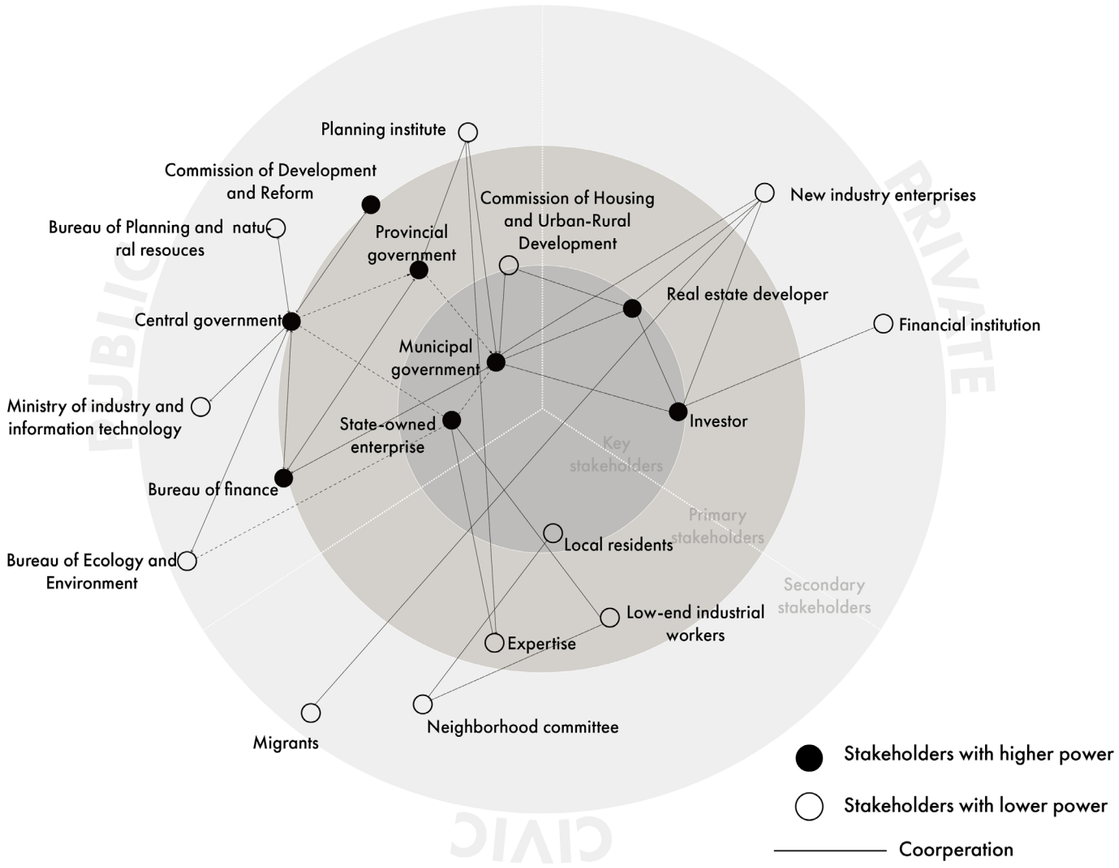
Citizens, workers, scholars, academic institutions and universities, NGOs, neighborhood committees, consulting firms, grassroots organization regulatory agencies and social media dominate the civil society sector.

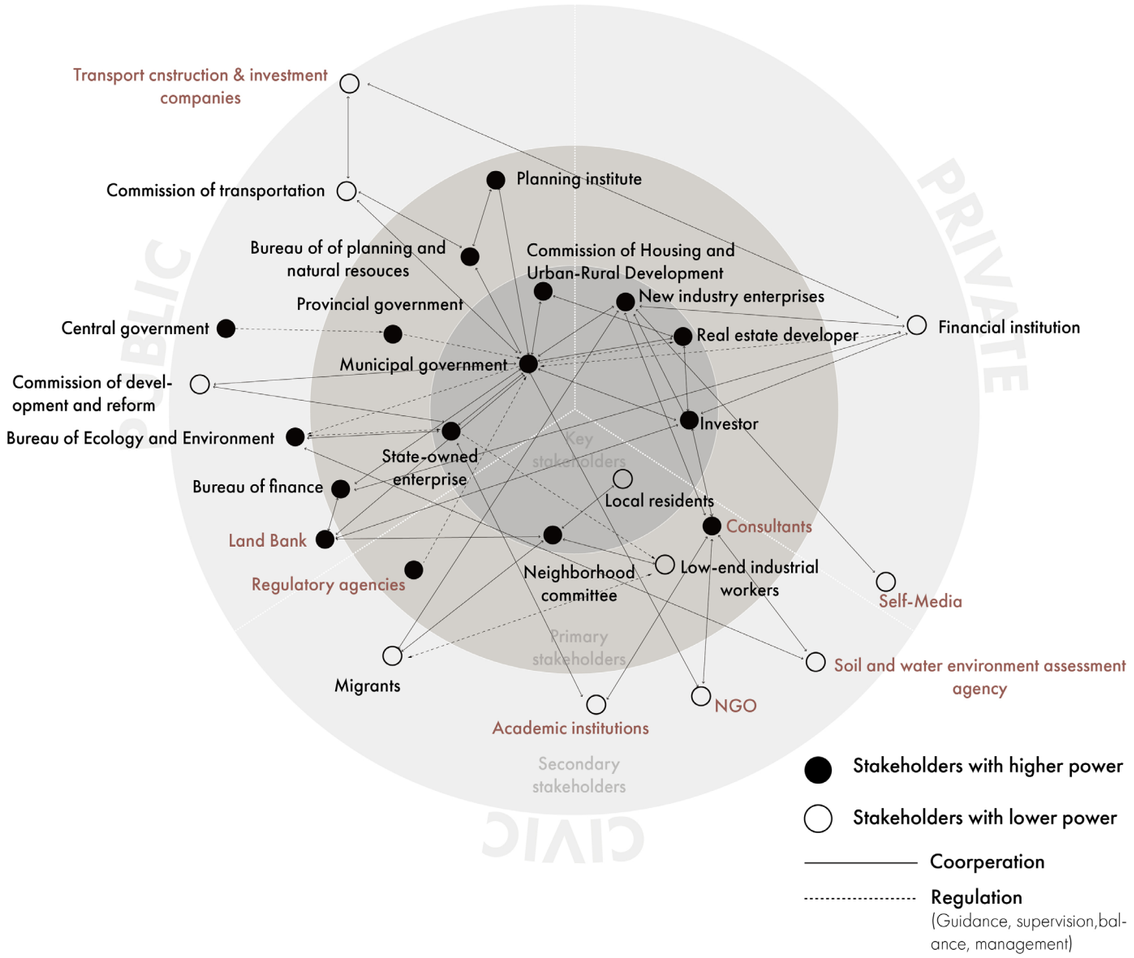
PUBLIC	PRIVATE	CIVIL SOCIETY
Central government	Investor	University & Academic institutions
Provincial government	Financial institution	Scholars
Municipal government	Private enterprises	NGO
Bureau of ecology and environment Bureau of finance Bureau of culture and tourism Bureau of planning and natural resources Commission of transportation Commission of development and reform Commission of housing and urban-rural develop ment	Real estate developer	Consulting companies
	New industrial enterprises	Residents
	Self-medias	Neighborhood committee
		Migrates
		Low-end industrial workers
State-owned enterprise		Regulatory agencies
Planning institution		Soil and water environment assessment agency
Land bank		
Transport Construction & Investment companies		



7.2 GOVERNANCE

STAKEHOLDER ENGAGEMENT

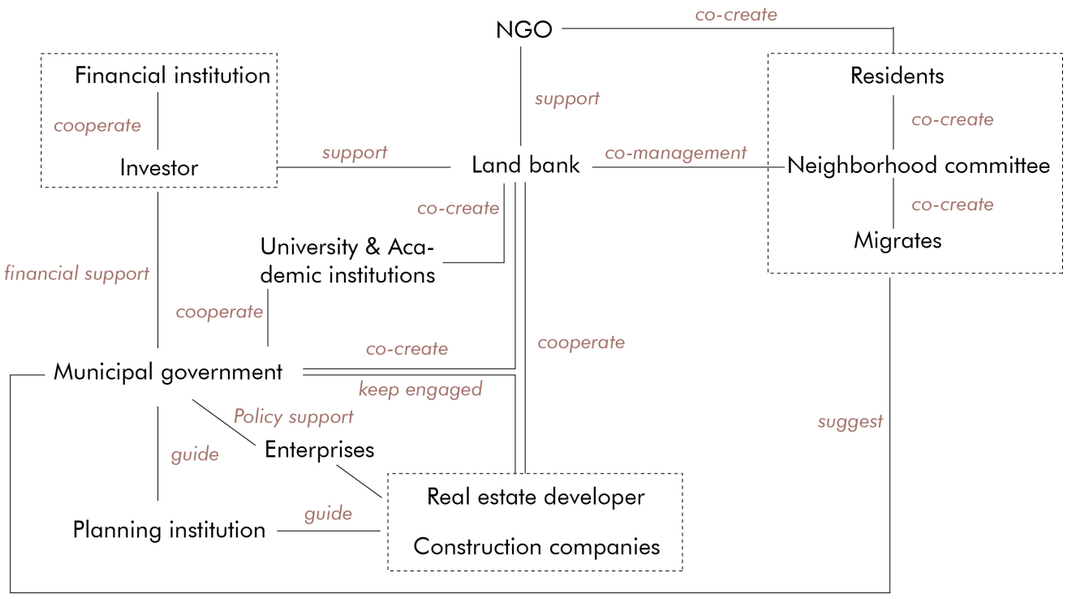




7.2 GOVERNANCE

PARTICIPATORY GOVERNANCE

LIVING



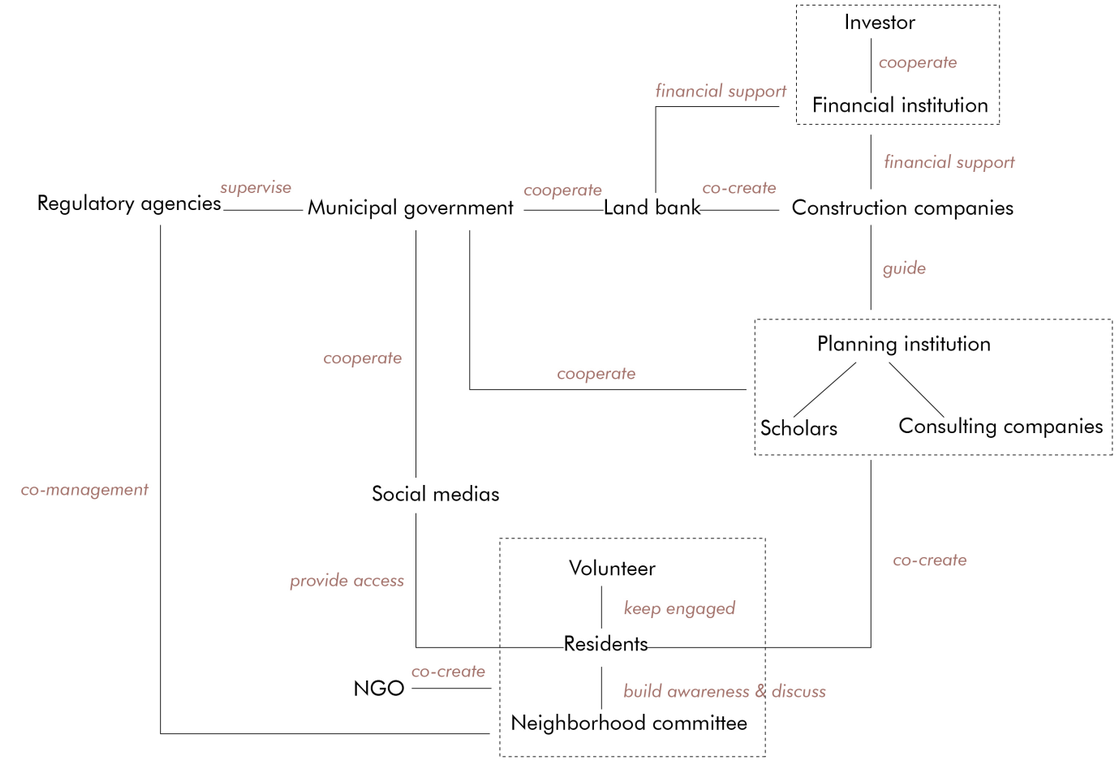
The municipalities take the lead in the management and analysis of the urban physical space and urban life by creating a database of urban spaces and public services with the support of technology companies and investors;

The planning department leads the planning process in conjunction with the relevant departments (Housing and Urban-Rural Development, Planning and Natural Resources, Transportation, and Finance) for the improvement of the different spatial elements of the city, and the modification and optimization of the plans in response to the needs of citizens and neighborhood councils, etc;

The government launches construction projects based on the plan to attract financial support from financial institutions and investors, cooperates with land banks to collect savings and manage vacant land and buildings, and the government, land banks, NGOs, etc. work together with real estate developers and infrastructure departments to reorganize the spatial structure of the city, such as the clustering of population and industrial elements, the optimization of infrastructure layout, and the rehabilitation of vacant assets;

Residents and migrant workers propose needs and renovations under the guidance of grassroots organizations such as neighborhood committees, co-create community construction, and manage the temporary use of vacant assets together with NGOs and land banks.

ECOLOGY



The process of building a green infrastructure system is led by the government to attract investors and financial institutions to provide financial support;

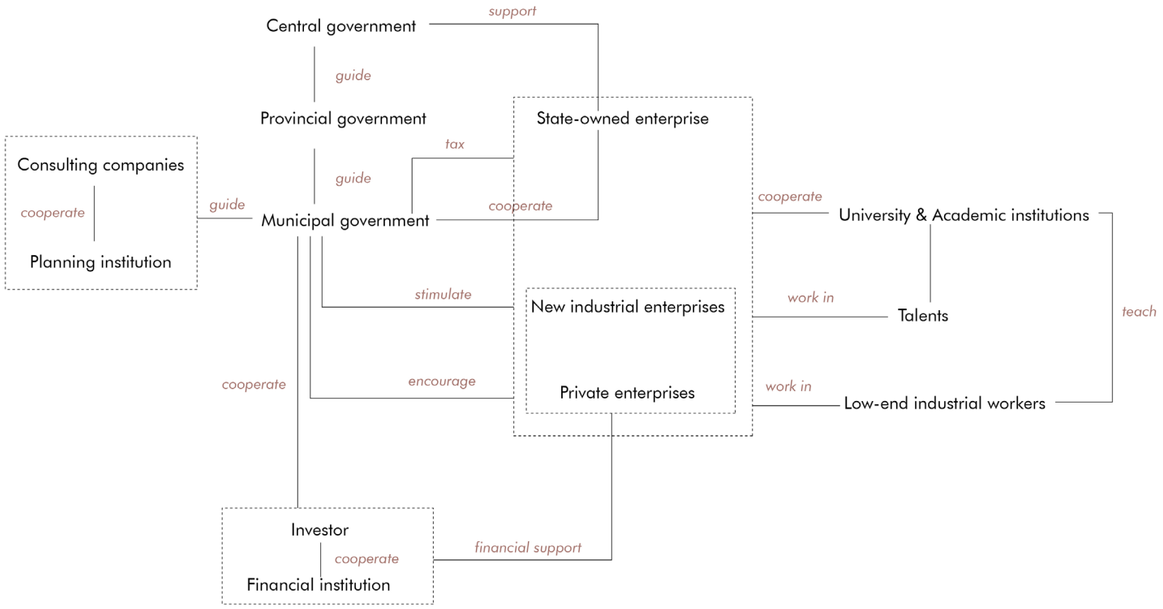
The relevant government departments (Planning and Natural Resources Bureau, Ecology and Environment Bureau, Finance Bureau, etc.) cooperate with land banks to assess the value of land and unify the management of saved land; combining urban development policies, proposing guidelines for finishing, repairing and renewing under the guidance of planning institutes, consulting firms and scholars and experts, and joint construction companies to renew vacant assets, with the final land and the buildings on it packaged and leased to corresponding enterprises or returned to grassroots community organizations for use;

Civil society stakeholders in the planning and design and implementation of maintenance stages also occupy a position that cannot be ignored, where social media such as social media platforms, news papers, etc. provide a way for residents and volunteers to provide feedback and monitoring. The residents and volunteers are guided by the neighborhood committee and the participation of experts, scholars and NGOs to co-create and co-manage the strategy, while the government guides the formation of a private regulatory body to monitor the transparency of the whole renewal process.

7.2 GOVERNANCE

PARTICIPATORY GOVERNANCE

PRODUCTION



The same government-led process in promoting sustainable economic transformation, in which the central government's policy support for regional revitalization, the provincial government's region-specific planning guidance and policy support, and the municipal government's specific participation in urban industrial transformation in conjunction with various departments (Planning and Natural Resources Bureau, Housing and Urban-Rural Development Department, Finance Bureau, Ecological Environment and Environment Bureau, and Cultural Tourism Bureau);

Cooperation between planning institutes and consulting firms to complete urban industrial analysis and transformation proposals, guide the government to introduce policies for relevant industrial support, and build development platforms and market bases for sustainable industrial systems;

Cooperation between universities, research institutions and enterprises led by the government with the support of investors and financial institutions to establish a platform for urban industrial investment and development, to promote the industrial upgrading and transformation of state-owned enterprises in the coal and graphite resource category, and to stimulate the emergence and incubation of new industries and encourage the development of private enterprises through preferential policies;

In the process of industrial transformation, the introduction of universities, scientific research institutions, etc. brings young scientific talents to Hegang, while training departments are established to train local workers with low education and more backward technology, so that they can better integrate into the upgraded industries in the future and reduce the unemployment rate in the city.

CORE SYSTEM

In an ideal urban transformation and development, the government, residents, and enterprises are the core main forces of urban development, and they form a complete cycle with economic connections as the link. In the process of transformation, the key to governance is to rebuild the benign economic relationship between the government, enterprises and residents, to activate, improve and upgrade the industrial and social development of the city, to enhance the sense of acquisition and belonging of enterprises and people in the city, and to realize comprehensive development of the city.

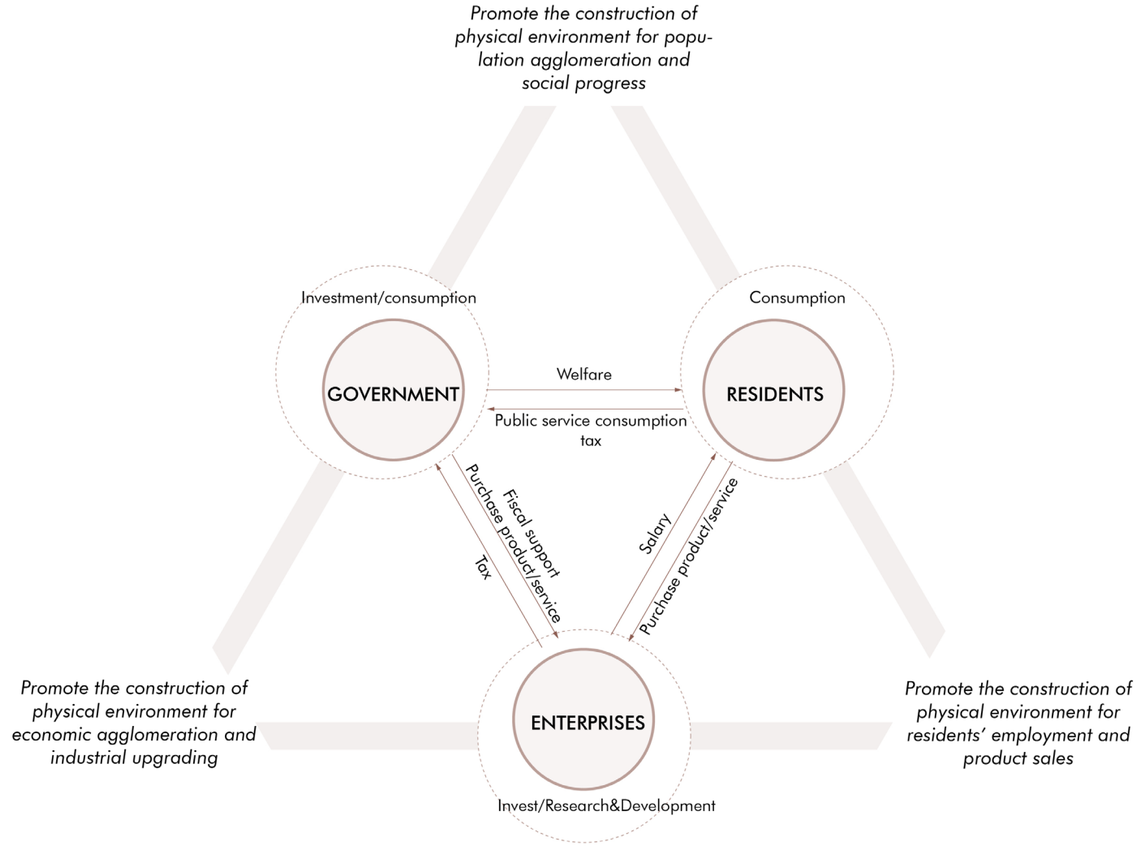
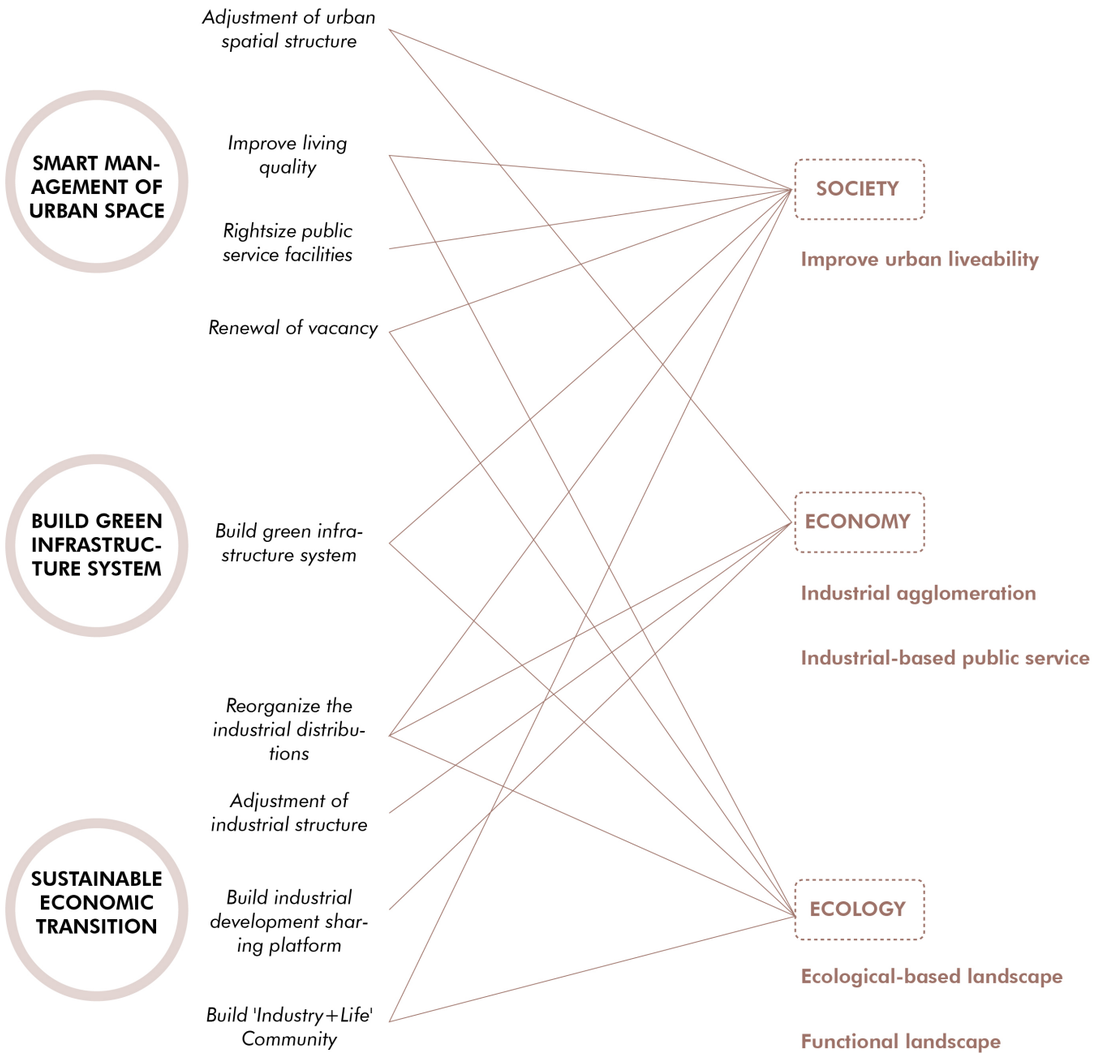


Fig.Model of governance.(Source: Made by author)

7.3 DESIGN TOOLKIT

SPATIAL DESIGN TOOLBOX

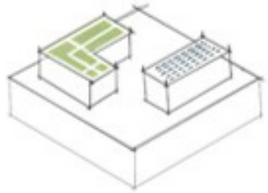
The specific design tools are divided into three aspects: social, economy, and ecology. Design tools are related to spatial strategies.



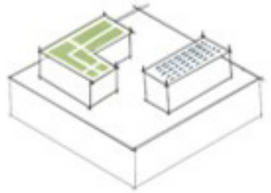
SPATIAL DESIGN TOOLBOX -1 SOCIETY

IMPROVE URBAN LIVEABILITY

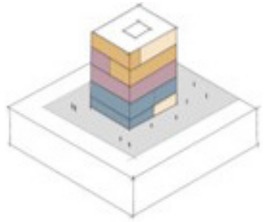
1 Rooftop gardening & farming



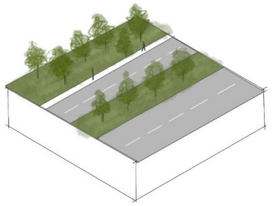
2 Rooftop energy



3 Vertical mixed use



4 Greenstreet & slow traffic system

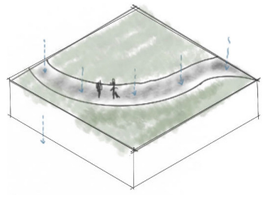


5 Permeable pavement

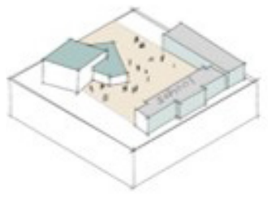
6 Flexible open space

7 Food market

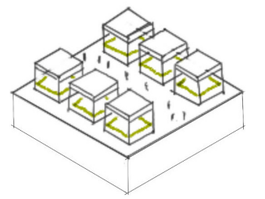
8 Pocket park



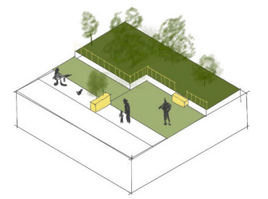
9 Community center



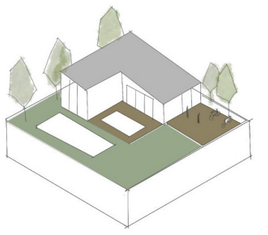
10 Elderly care



11 Hospital

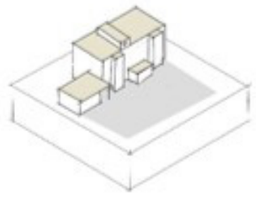


12 School (including kindergarten)

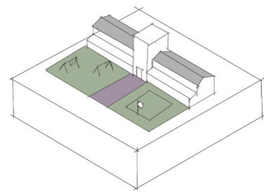


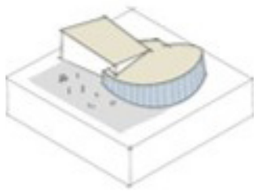
13 Cutural activity center & Public gym

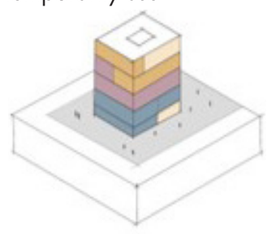
14 Flexible space for temporarily use

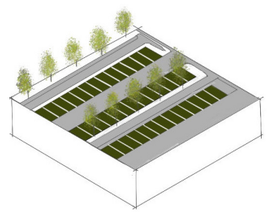


15 Green parking lot







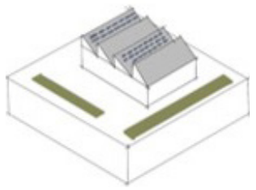


7.3 DESIGN TOOLKIT

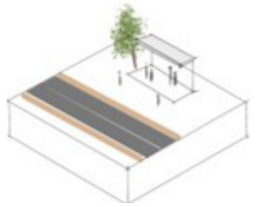
DESIGN TOOLBOX -2 ECONOMY

INDUSTRIAL AGGLOMERATION

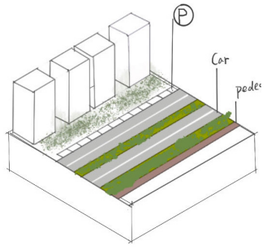
1 Renewal of industrial buildings



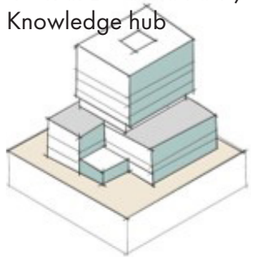
2 Commuting bus station



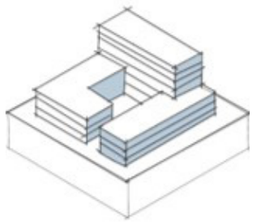
3 Improve infrastructure



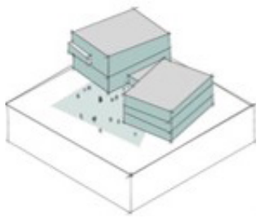
4 R&D sector/ Knowledge hub



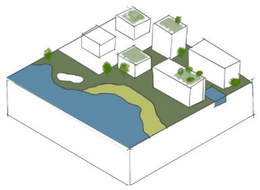
5 Sharing office



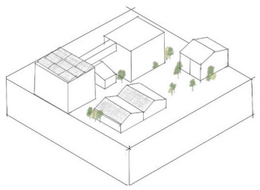
6 Exhibition hall/ Communication center



7 Sustainable industrial park

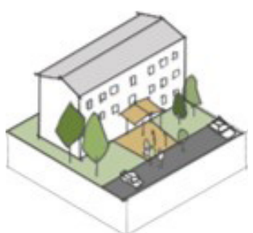


8 Labor training center

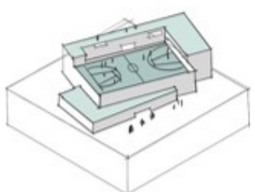


INDUSTRIAL-BASED PUBLIC SERVICES

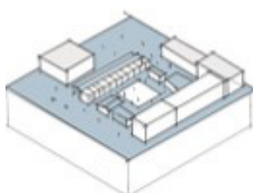
1 Talents housing/ Affordable housing



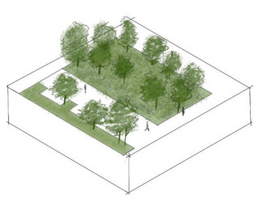
2Social activity center



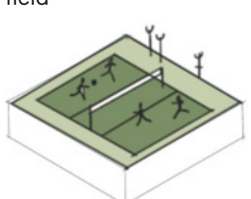
3 Commercial



4 Community park



5 Recreation&sports field

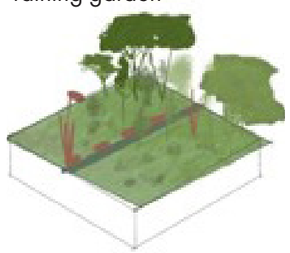


DESIGN TOOLBOX -3 ECOLOGY

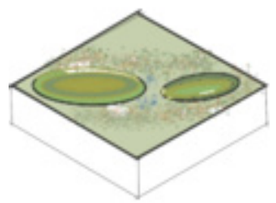
ECOLOGICAL-BASED LANDSCAPE

1Garbage backfill

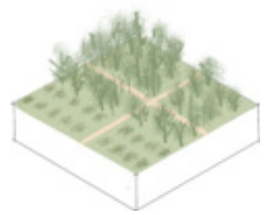
2 Bio-landscape and raining garden



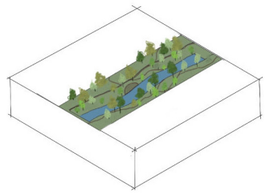
3 Artificial wetlands



4 Plant purification



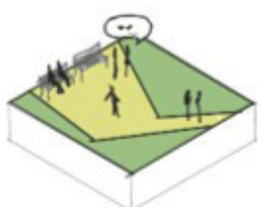
5 Waterfront park



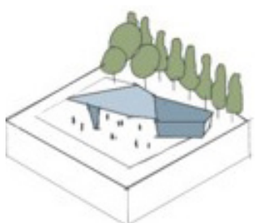
FUNCTIONAL LANDSCPE

1Pedestrian pathway

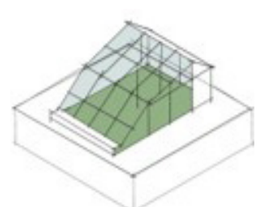
2 Recreation space



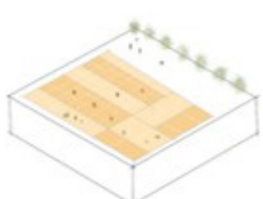
3 Open Pavillion



4 Greenhouses



5 Urban farming



6 Clean energy production

7.4 DESIGN IN LOCAL SCALE

SELECTION OF DESIGN SITE

Fig.Selection of design site.(Source: Made by author)

Site I is located in the center of the old city, and the existing problems are:

Two districts of the old city separated by the railway;
The traffic system is not smooth, and there are many dead ends;
Lack of vitality in the community;
Fragmentation of green spaces;
Risk of coal mining subsidence area;

GOAL:
Integrate and create a vibrant city center to enhance the livability of urban life;
Perfect construction of green infrastructure network;
Ecological restoration, and implanted functions, integrated into urban development.

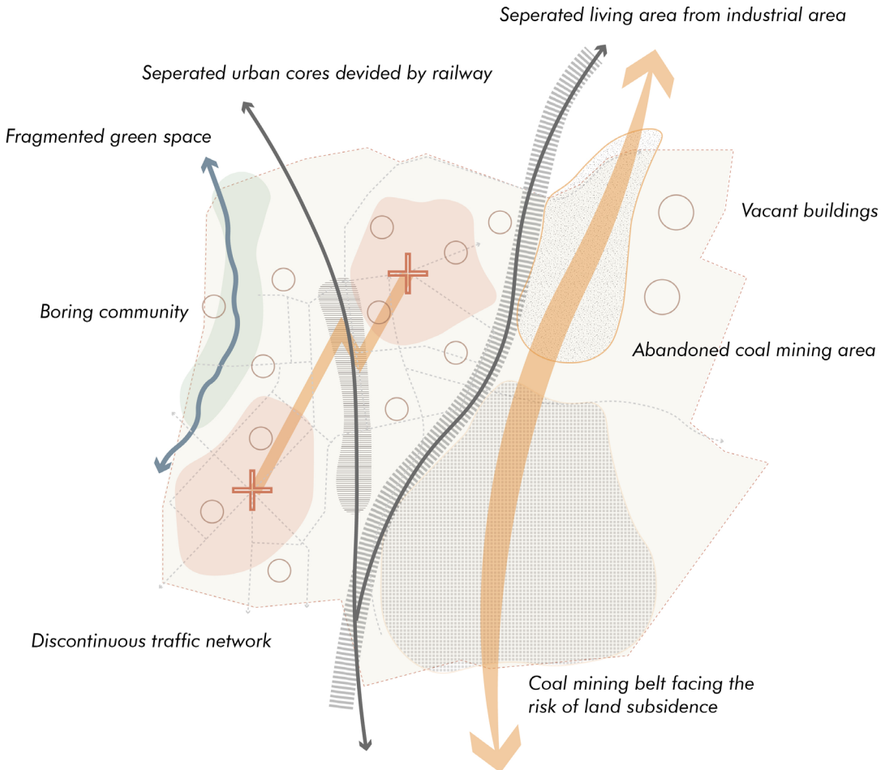
Site I is located in the new cluster of industries, and the existing problems are:

Far from the old city center;
ecologically sensitive;
More vacant land and vacant buildings;
Low-level industry, chaotic spatial distribution;

GOAL:
Protect ecologically sensitive areas and improve the construction of green infrastructure networks;
Industrial aggregation, upgrading, and the completion of industry-city integration

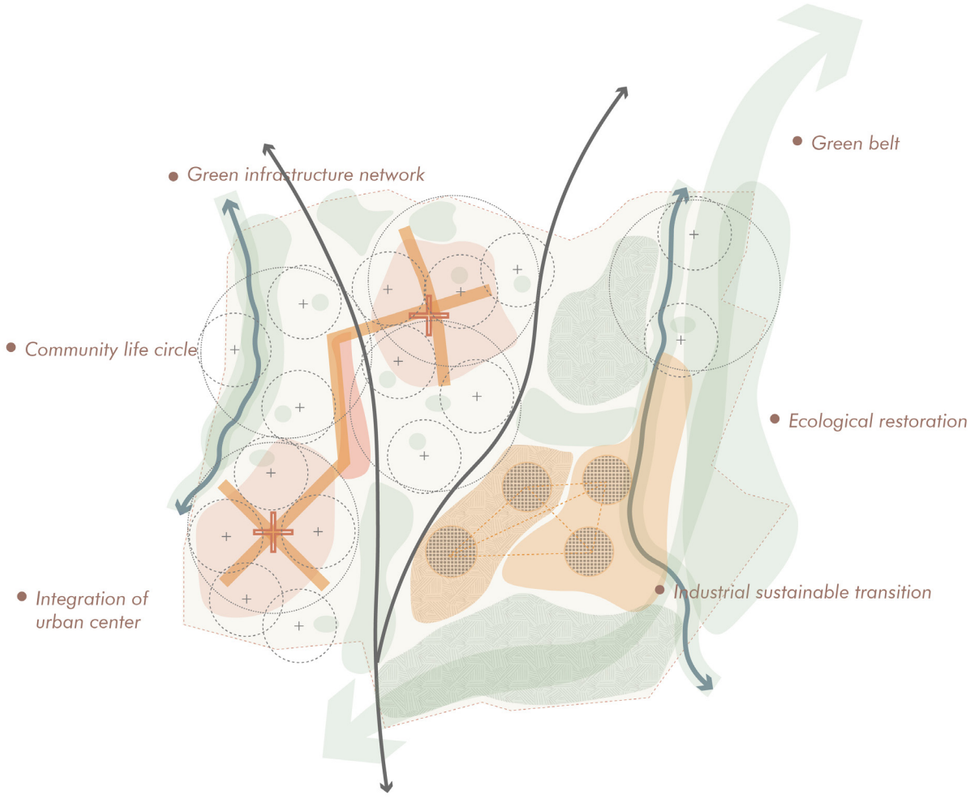
7.4 DESIGN IN LOCAL SCALE

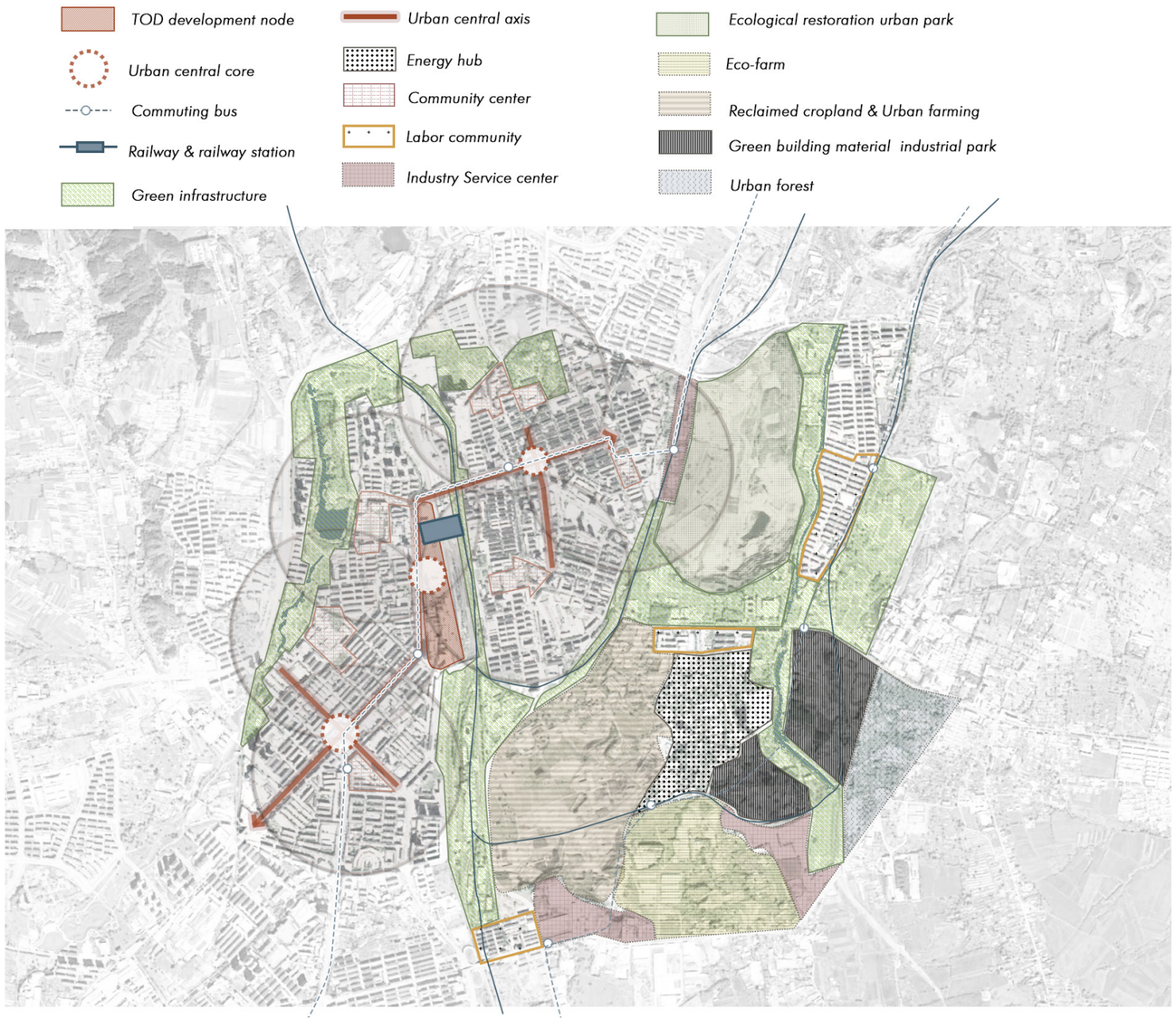
DESIGNING-I



7.4 DESIGN IN LOCAL SCALE

DESIGNING-I





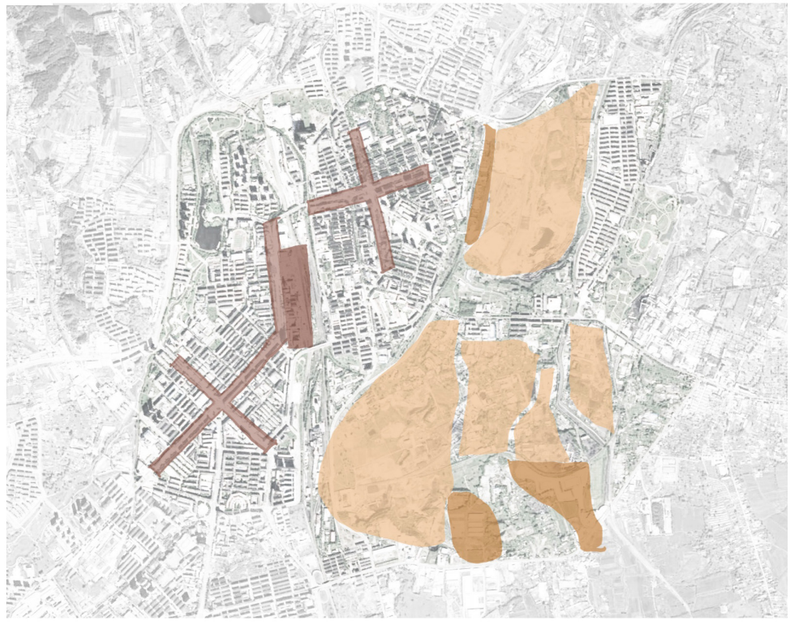
7.4 DESIGN IN LOCAL SCALE

DESIGNING-I

PREDEVELOPMENT

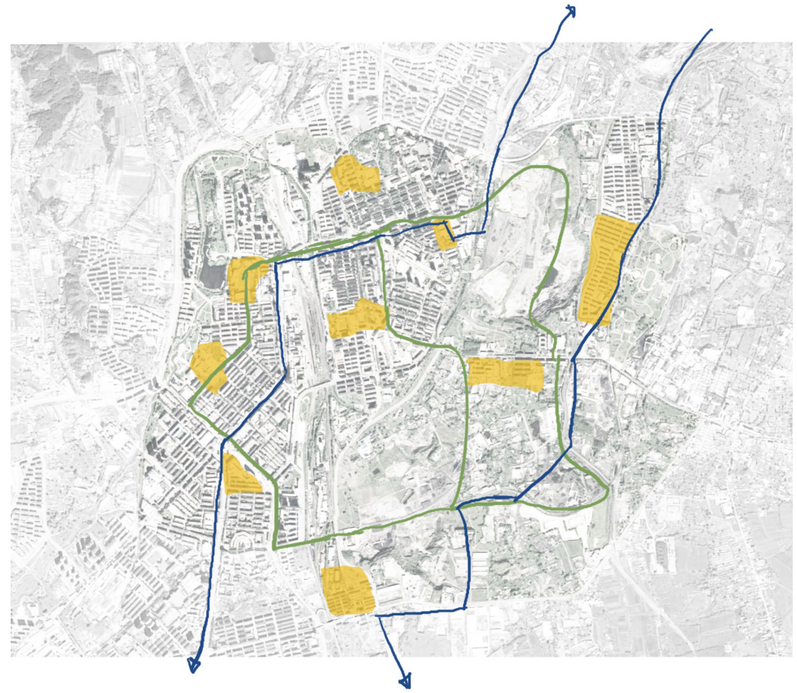
In the predevelopment stage, the goal is to focus on the transformation foundation.the first step is to restore the ecological environment in the waterfront area and land subsidence coal mining area;

the second step is to optimize the infrastructure, including solve the dead-end road network in the core city area, and optimize the road network density and quality in abandoned coal mining area.



TAKE-OFF

In the take-off stage, the goal is to working on the pilot projects in the transformation period. The first step is to integrate urban center, the creation of major commercial integrated service axes and a commercial office complex located near the train station in accordance with the current urban situation creates an overall public service core that stimulates the generation of urban vitality.
In the abandoned land of coal mines after ecological restoration, divide the area to introduce different industries, such as tourism, urban agriculture, clean energy industry, green building material industry, etc. for industrial relics combined with ecological parks.



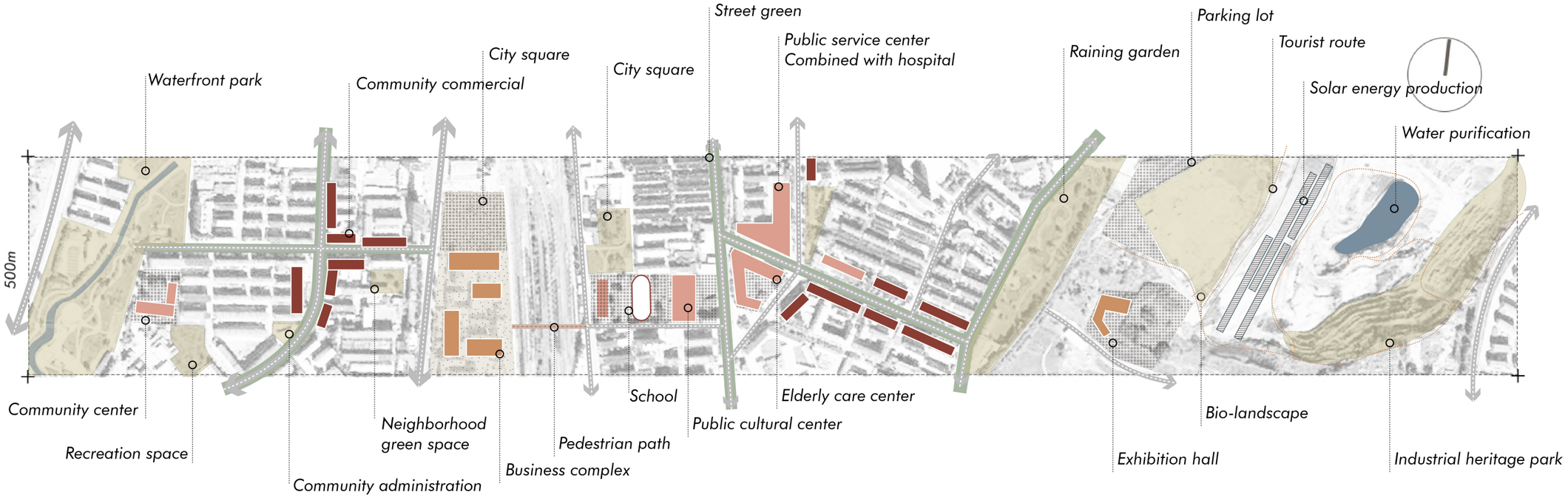
ACCELERATION

In the acceleration stage, the goal is to continue focusing on development. The first step is to streamline the scale of urban public service facilities, categorizing and redistribution according to the needs of the 5-10-15 minute community living circle.

The second part is to optimize the services for living and working, such as commuting bus, by considering the needs of citizens in a comprehensive manner.

7.4 DESIGN IN LOCAL SCALE

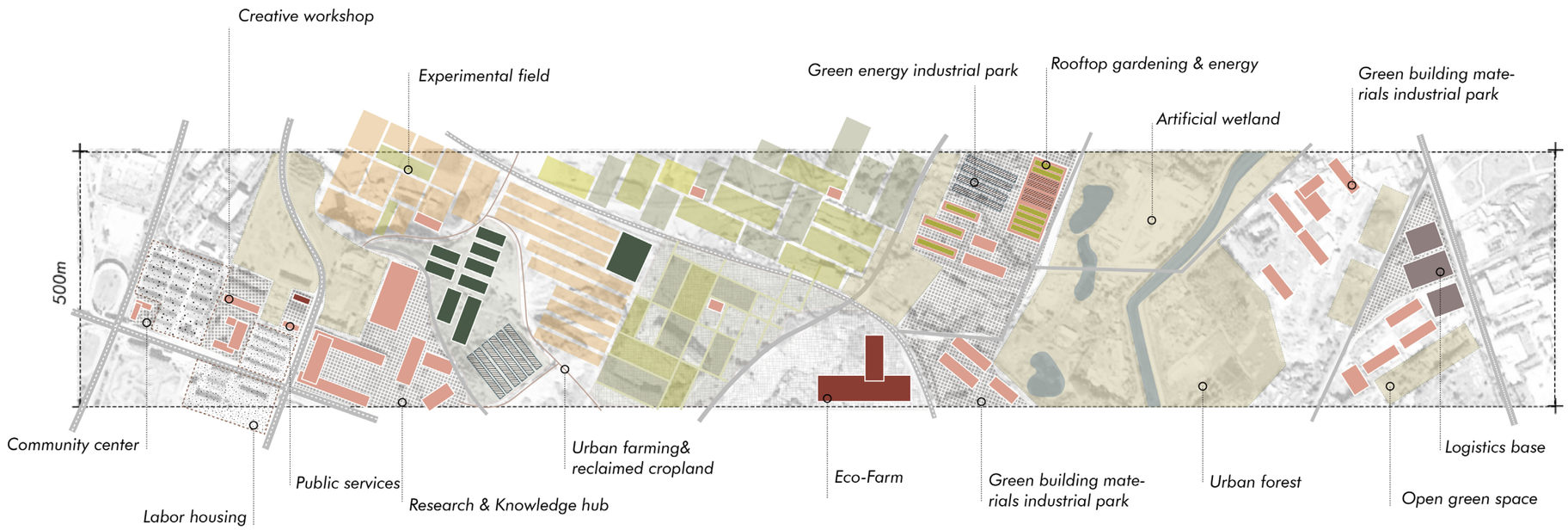
DESIGNING-I-01




Mickey
Lee
Benetton

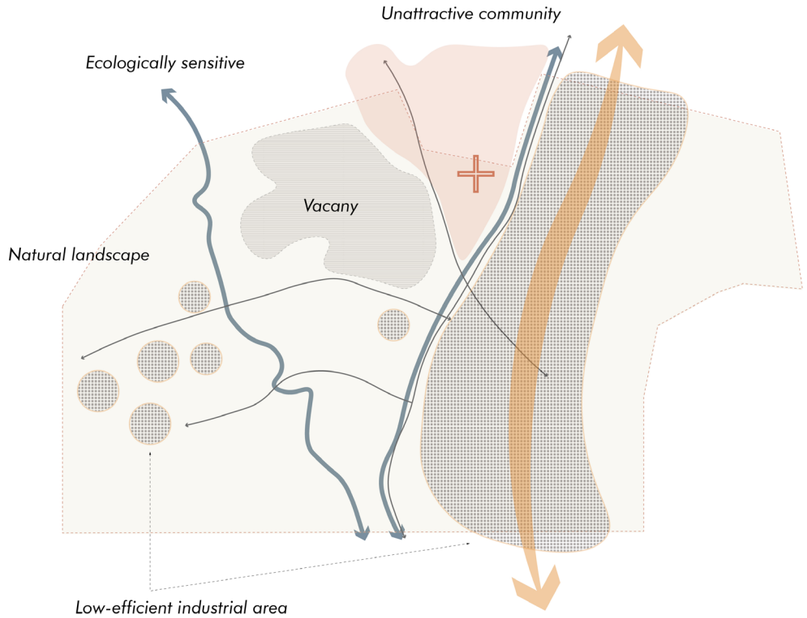
7.4 DESIGN IN LOCAL SCALE

DESIGNING-I-02



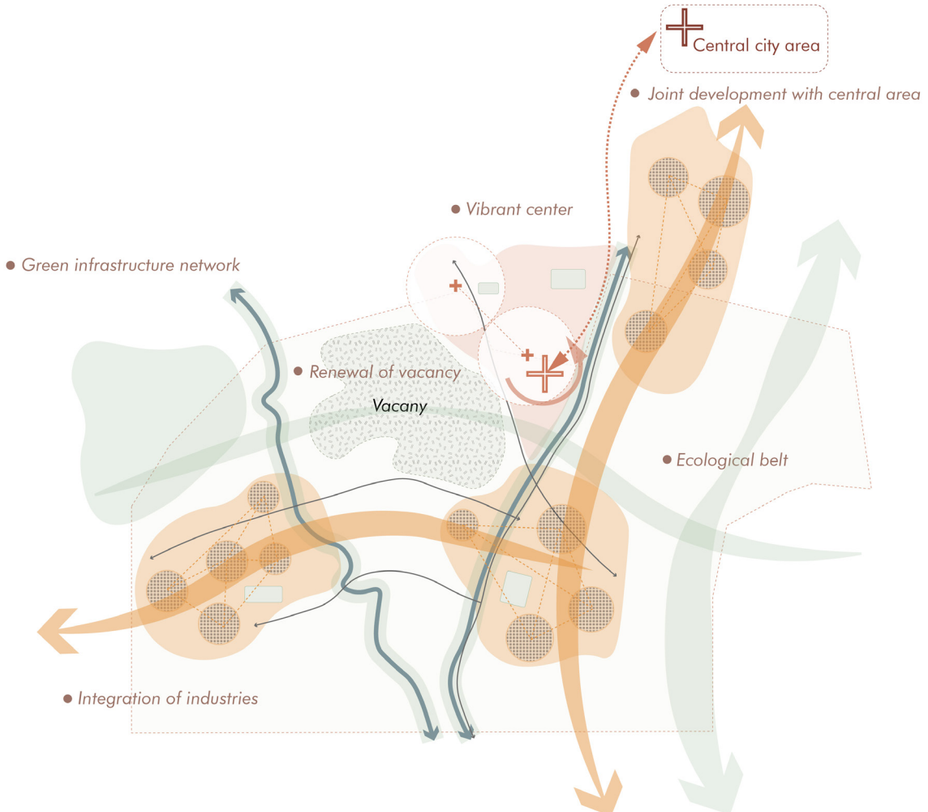
7.4 DESIGN IN LOCAL SCALE

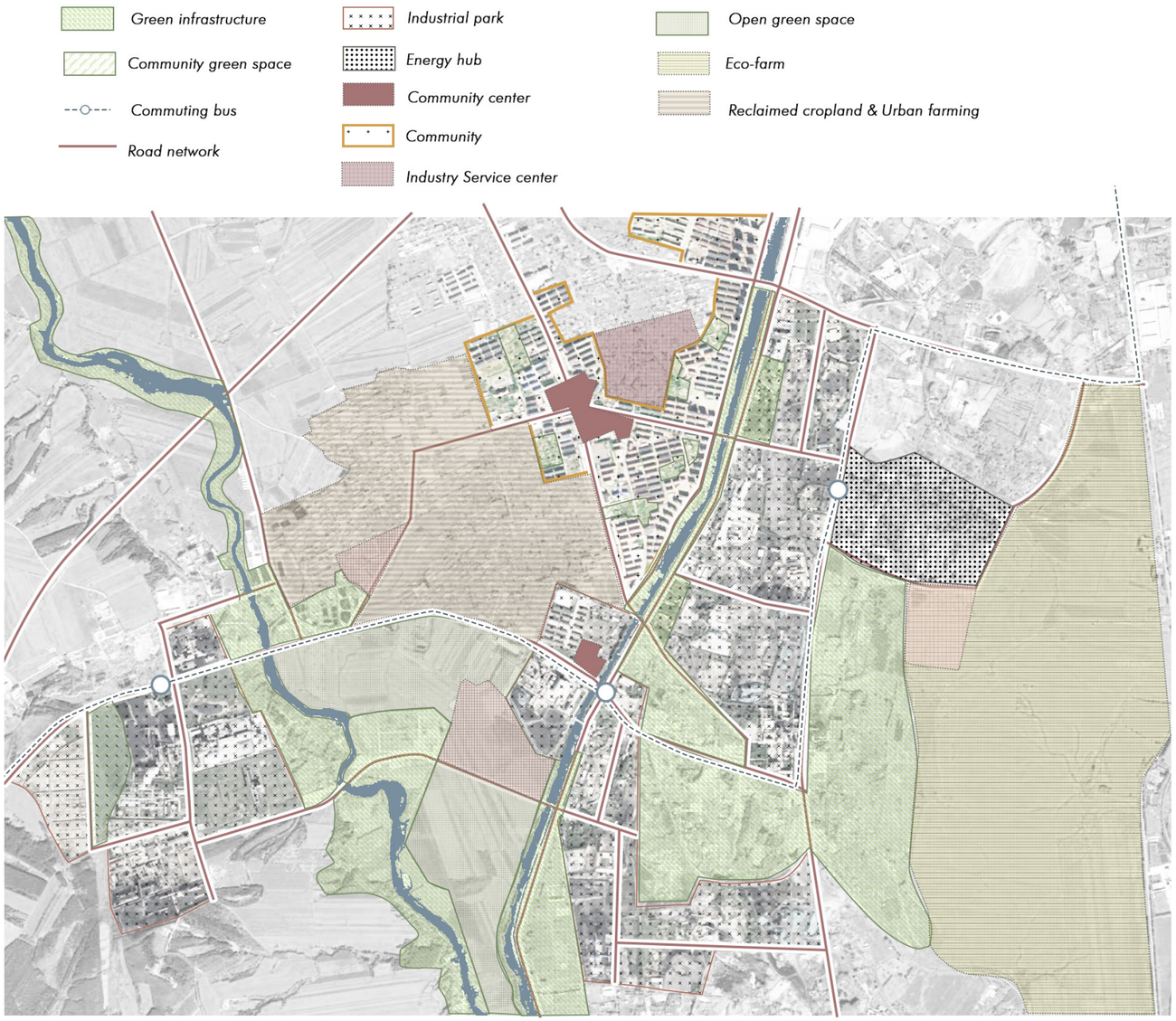
DESIGNING-II



7.4 DESIGN IN LOCAL SCALE

DESIGNING-II





7.4 DESIGN IN LOCAL SCALE

DESIGNING-II

PREDEVELOPMENT

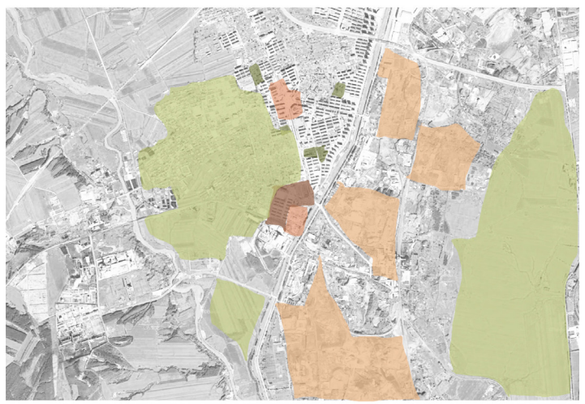
In the predevelopment stage, the goal is to focus on the transformation foundation.The first step is to restore the ecological environment in the waterfront area and land subsidence coal mining area;

The second step is to optimize the infrastructure, including increase the road network density and quality in abandoned coal mining area and future industrial park area.

TAKE-OFF

In the take-off stage, the goal is to working on the pilot projects in the transformation period. On the one hand, to create a prior sustainable business industrial zone, to create a hub for industrial incubation, research and innovation, and integrated industrial services, and to introduce new industries for development;

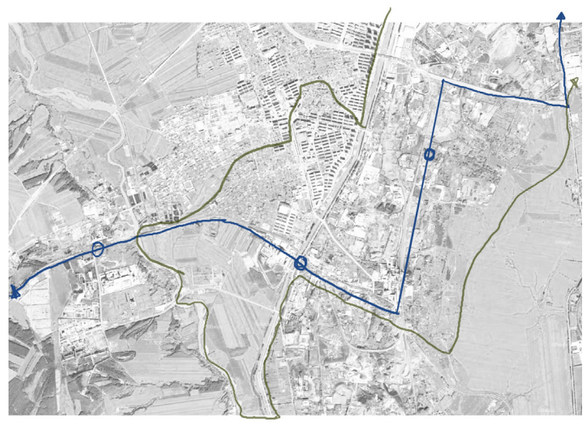
On the other hand is the renewal and utilization of vacant space (such as demolished shantytowns) by land remediation and reclamation into agricultural land.



ACCELERATION

In the acceleration stage, the goal is to continue focusing on development.On the one hand, the expansion of industrial development, the formation of industrial parks, and the creation of a comprehensive industrial system such as coal chemical industry, urban agriculture, and clean energy industry;

On the other hand, it is for the optimization of supporting service facilities in industrial parks to form industry-related residential communities.

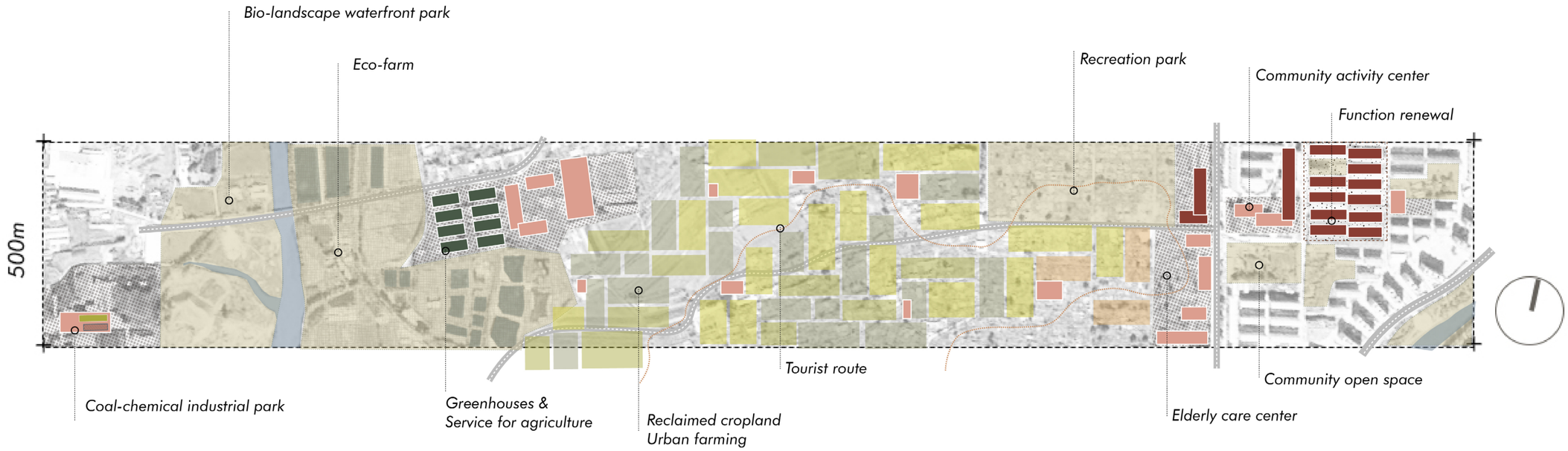


STABLIZATION

In the stablizaiton stage, the goal is to optimize the urban life. The action is to optimize the services for living and working, such as commuting bus, by considering the needs of citizens in a comprehensive manner; as well as the formation of slow-traffic system.

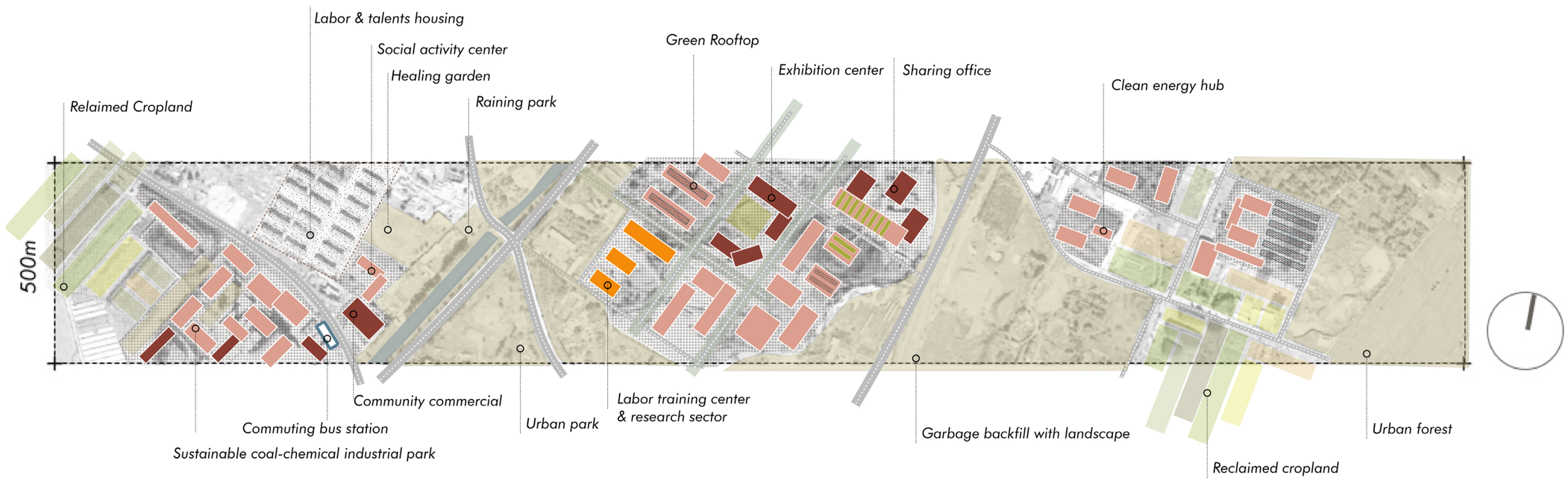
7.4 DESIGN IN LOCAL SCALE

DESIGNING-II-01



7.4 DESIGN IN LOCAL SCALE

DESIGNING-II-02




пл. Малышева
Malyshevoi Sq.
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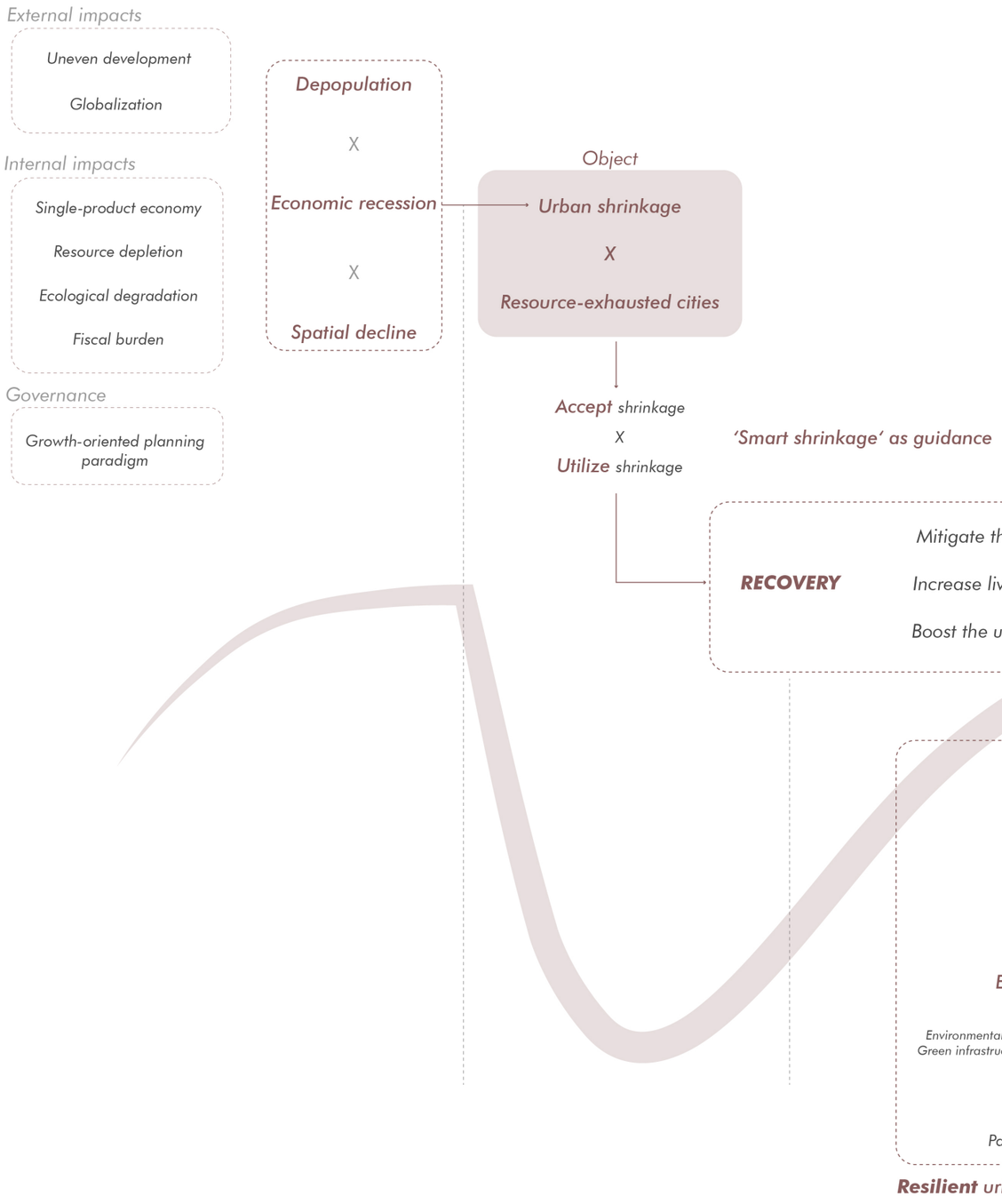
56 52
56 05МИН

08 REFLECTION

8.1-CONCLUSION

8.1.1 SUMMARY OF RESEARCH FINDINGS



8.1-CONCLUSION

8.1.1 SUMMARY OF RESEARCH FINDINGS

Answering research questions

This project investigates the sustainable transformation strategy of Hegang City as a shrinking resource-exhausted city in the process of shrinkage based on the theory of smart shrinkage.This project was based on the main research question:

" How can smart shrinkage be used as a transformation strategy in the resource-exhausted cities in China to recover them as resilient urban systems? "

SQ1-What are the drivers and characteristics of shrinkage in Resource-exhausted cities in Old industrial base of Northeast China?

Firstly, by studying the background reasons for the emergence of resource-exhausted shrinking cities and the countermeasures of shrinking cities, we conclude that the dilemmas faced by shrinking resource-based cities in the Chinese context are:

(a) The unbalanced regional development and global market changes lead to a decrease in the competitiveness of such cities;
(b) The economic vulnerability of a single industry in the development of resource-based cities themselves, the secondary social problems of industrial decline, and the neglect of ecological importance in the development process leading to population loss, industrial decline and spatial disorder, and the gradual loss of urban vitality;
(c) The solidified planning mindset and the overpowering voice of state-owned enterprises and the government have led to a growth-oriented urban planning paradigm that has not been able to solve the problem of shrinkage.

SQ2-What spatial consequences did industrialization and transformation bring to these resource-exhausted cities and what new potentials have appeared?

The development of the old industrial bases in Northeast China has played a crucial role in China's industrialization, and in this process, many resource-based cities and industrial cities were created; and the decline in recent years has caused the state to pay attention to the revitalization of this region, and a large number of policies and plans have brought hope to the resource-based cities in transition.

For the shrinking resource-exhausted cities, the urban spatial structure and economic and social environment formed by the development mode of "mining first and then city" do not have the conditions to develop into big cities, while external conditions such as location and policy inclination make these cities not dominant in the regional development; forcing to reverse the shrinking trend will only put excessive pressure on government finance and so on. Therefore, the ultimate goal of transformation for these cities is not exactly to achieve the growth of city economy and population again, but to conform to the trend of urban shrinkage without forcibly reversing the trend of shrinkage, and to use the opportunity and potential of shrinkage to achieve an adaptive new normal.

SQ3-What is "smart shrinkage" and how can the concept be integrated in the regenerative strategies and princicples to develop resource-exhausted cities?

Through the study of literature and case studies, the characteristics and realization strategies of the smart shrinkage theory are outlined. The smart shrinkage theory emphasizes urban lean development, and the core idea is to increase the aggregation of factors through shrinkage, reshape urban space, cultivate new growth poles, restore the vitality of cities, recover their economy and improve the human living environment. Specifically, streamlining the scale of the city, focusing on diversified urban development, improving the adaptability and resilience of the city and regional integration. This provides theoretical support for the proposed transformation and recovery strategy of Hegang City.

The study understands the development of Hegang city and the characteristics of urban spatial development, analyzes the development of Hegang city and the main problems facing the transformation process, combines the theory of smart shrinkage and the current situation of the city to propose the future development of Hegang city with production, living and ecology as the three main development pillar, with intensive and efficient and dynamic and livable as the transformation goal, and restores it to become a city with economic, social, ecological and other aspects of resilience system.

In the concept of recovery, the return to a new normal of adaptation to shrinkage involves:

Mitigate the negative impacts of urban shrinkage
Increase liveability under shrinking trend
Boost the urban vitality of development

For the urban development of Hegang, five planning principles are proposed to build a regional cooperation network at the regional scale, and at the city scale, to achieve efficiency of space and public services, smart environment green cities, stable and sustainable economic development and participatory governance with flexibility.

SQ4-What regenerative planning strategies and principles can promote the sustainable transformation that utilize the opportunities that stem from shrinkage?

Due to the excessive dependence of resource-exhausted cities on coal resources and the complexity of industrial transformation, it is proposed that Hegang City should adopt the model of composite industrial transformation, including industrial succession to extend the industrial chain and tap the potential to develop alternative industries. In other words, on the one hand, the secondary industry led by coal power chemical industry and high-end graphite industry should be continued to improve the utilization rate of resources and increase the additional output value of resources; On the other hand, based on the integration of urban factors and potential to cultivate new sustainable industries, and increase the development of tertiary industries such as production service industry, improve the city's industrial development structure with the development of industrial clusters, and improve the city's economic resilience.

8.1-CONCLUSION

8.1.1 SUMMARY OF RESEARCH FINDINGS

Answering research questions

It is difficult to reverse the population decline in Hegang in a short period of time, so we choose to guide the efficient development of resource concentration, moderately gather the population and industries in Hegang, create a dynamic urban core, and realize multi-group development; improve urban public service facilities and transportation system, improve the livability of human living environment, and improve the utilization rate of land while reducing the pressure of government financial expenditure caused by excessive construction; At the same time, we consider the reuse of the stock of land, optimize the function ratio and replace the inefficient and idle land, improve the supporting service functions of the city and reserve space for future development as flexible space.

As a coal resource-based city, years of coal mining have caused extensive ecological damage, including coal mining sinkholes and pollution of soil, vegetation and water resources; Therefore, it is proposed to manage ecological environment, build green infrastructure and construct ecological city pattern; build urban ecological network based on urban ecological resources, in addition to combine a large amount of unused land in the city and ecological restoration land for green infrastructure construction, as urban green space to enhance the living environment of residents and as reserve space for future development.

SQ5-How can these strategies and principles be efficiently implemented spatially and locally?

The importance of land in the process of urban renewal and urban shrinkage development of Hegang, therefore, it is necessary to strengthen land management and improve the land reserve system for functional replacement and renewal use; And in order to guarantee the implementation of the regeneration strategy, the authors also propose a collaborative management mechanism between different departments and a public participation system to give full play to the functions of different participants, which will enhance the sense of identity and belonging of urban residents while ensuring the power of socially diverse interests and the efficiency of planning implementation.

8.1.2 LIMITATIONS

This project explores the sustainable transformation path of resource-depleted shrinking cities from the perspective of smart shrinkage and puts forward the authors' own hypothesis, but it is undeniable that this project still has limitations:

Firstly, the planning and research of this project mainly focus on the city scale, lacking path exploration on the regional scale, which makes the transformation strategy more like an idealized pioneering attempt to pry the regional development, and at the same time, unable to drive the coordinated development of the region;

Second, due to the impact of the global epidemic and the strict epidemic prevention policy, on-site research is not possible. At the same time, the author was unable to conduct on-site experience due to the non-disclosure of data information. The large amount of information and analysis inevitably exists after the information and is influenced by the research of related scholars, which will have some limitations on the accuracy of the results;

Thirdly, in the context of China's planning system and planning, in recent years, there has been such a view as "stock planning", which means that under the condition that the total scale of construction land remains unchanged and urban space is not expanded, urban renewal and other means are used to promote the optimal adjustment of the functions of built-up areas. However, these planning ideas focus more on urban land use, while shrinkage-oriented planning ideas such as "smart shrinkage" involve the overall planning of economic, social, and physical space environments, and require the participation of multiple stakeholders such as government, communities, and market players. Due to the different interests of different sectors, conflicts will inevitably arise in the implementation and operation stages of the strategy, and the existing policy and institutional levels cannot guarantee the implementation of shrinkage-oriented planning for the time being, so it is difficult to judge whether the planning strategies proposed by the author are realistic and feasible, which will have some impact on the long-term planning strategies and design stages.

8.1-CONCLUSION

8.1.3 FUTURE RESEARCH

First, in the future, it is possible to obtain large scale and high precision spatio-temporal big data to represent human activities and analyze the distribution of people within the city more precisely; in addition, due to the availability of data, the analysis accuracy of this project is insufficient, so with the rapid development of remote sensing technology and intelligent algorithms, a more in-depth and precise analysis of the city can be conducted, and the combination of geographic data and various machine learning algorithms can be considered;

Second, in order to be able to better formulate development strategies for shrinking cities, there is a need to consider newer and rational methods to reveal and simulate the complexity of the urban shrinking process, in which there is a need to reasonably predict relevant policies as well as population change trends and propose adaptive planning based on population change, industrial change, etc.;

Third, a series of data-based strategies such as intelligent management of urban space through digital platforms and industrial synergy development platforms are proposed in this project, which can further analyze the feasibility of related strategies and propose relevant policies to guide their implementation path in the future;

Fourthly, the research of this project focuses on the scale of urban center, on the one hand, there is a lack of research on the trend of shrinkage between urban and rural areas, and in the future research combined with the analysis of the exploration of transformation planning between Hegang city district and other districts, counties and towns; On the other hand, the authors are well aware that the development of cities cannot be separated from the regional development system, so in the future research they need to study the feasibility of smart shrinkage strategies of resource-depleted cities shrinking around them at the regional scale, implement the positioning of different cities in the region, and explore the competition and synergistic cooperation relationship between cities;

Fifth, this project investigates the complex evolutionary paths and sustainable transformation paths of resource-depleted shrinking cities represented by Hegang. However, there are many resource-based cities in China. There is a need to strengthen in-depth research on shrinkage in cities and regions of different types and sizes. With a better understanding of the interrelated processes of urban evolution, new policies for sustainable development in shrinking cities can be explored, and the migration paths of smart shrinkage planning strategies among different cities can be studied in more depth and detail;

Sixth, the feasibility of planning needs to be assessed from a practical perspective, and relevant governance mechanisms and policies need to be considered to sustain effective transformation and sustainable development in the long term

8.2-RELEVANCE

8.2.1 SCIENTIFIC RELEVANCE

Although there is currently a considerable amount of research in planning academia on the causes and consequences of urban shrinkage, as well as the principles and strategies for dealing with it, there are still some significant gaps.

First, current research on urban shrinkage and smart shrinkage is primarily based on the context of Western countries, whereas China's social institutions, economic and social development background, cultural heritage, and governance systems differ from those of Western countries; although Chinese scholars have introduced the concept and understood and reflected on it, current research in the Chinese context primarily focuses on the connotation, theory, and in European and Asian cities.

However, current Chinese research is focused on the connotation, theory, and practice in European and American cities, while practice and application in Chinese cities is still in its infancy.

Second, how to develop clear and specific design principles and overall planning strategies that policymakers and practitioners can use to help the sustainable development of shrinking regions and cities on multiple levels, such as economic, social, and physical space. Under the theoretical framework of smart shrinkage, this study seeks to find more opportunities and possibilities for resource-depleted cities in shrinkage as well as transition dilemmas, how to tap the potential of cities and cultivate innovative industries to drive urban regeneration, how to revive urban vitality in existing decaying urban spaces, and how to become more resilient small and medium-sized cities.

Overall, the theoretical significance of this thesis lies primarily in the intention to fill a knowledge gap and enrich research in the related field.

8.2-RELEVANCE

8.2.2 SOCIETAL RELEVANCE

Due to resource depletion and regional decline, resource-based cities in northeast China's old industrial bases are experiencing unprecedented urban shrinkage, including economic decline, population decay, ecological decline, urban spatial decay, and loss of urban vitality; the cities no longer provide a good living and employment environment for their residents, and their attractiveness continues to decline, forming a vicious cycle. These cities and regions represent uninhabitable and economically healthy parts of the city, and current planning focuses more on the development of this area from the perspective of the government and policymakers, despite the fact that attention to the needs of the population in these areas is also a major concern.

The use of regeneration policies to shrink and reuse existing space provides opportunities for future urban development, achieving sustainable urban regeneration, increasing attractiveness, mitigating the more deteriorating consequences of urban shrinkage, assisting in the improvement of the urban population's living environment, increasing employment opportunities, and so on; and even has broader social

8.2.3 ETHICAL CONSIDERATIONS

The first is that in order to investigate, comprehend, and solve this problem, we must learn at multiple scales, from local to larger, and even national. However, our exploration and research may be biased or neglectful. There are also context-specific issues to consider, such as historical and cultural factors.

The second is the power game, such as the competition between state-owned enterprises, the government, and the private sector, as well as the limited power and influence of planners in the Chinese planning system; it is critical to balance and coordinate among stakeholders in the Chinese political system and context.

The urban structure in China's resource-based northeastern cities is relatively homogeneous, and the type of capital is primarily state-owned enterprises (SOEs). SOEs play an indispensable role in the city, and those that have been present for many years have a strong voice in negotiations with the local government. The lack of private capital infusion in the Northeast, when compared to other regions of the country, has not only contributed to the region's low economic dynamism, but has also resulted in a decrease in the initiative and execution of green and sustainable development.

More importantly, we must think about the citizen level. Although we are aware that policies for the transformation and revitalization of these cities are primarily focused on the top level, and citizens are at a disadvantage in overall planning, and their voices are rarely heard by policymakers, we must still consider the individual level's inclusiveness in sustainable transformation.

Furthermore, because China is a developing country, economic development is the first priority, and we often overlook the importance of ecology as a result, but in the transition of resource-depleted cities, how to deal with the ecological damage caused by early mineral development is also a very essential part.

8.3-REFLECTION

8.3.1 TRANSFERABILITY

This project focuses on how resource-exhausted cities in the Chinese context can break through the dilemma of transformation and development in the face of urban population shrinkage and economic downturn. Firstly, research the background of the problem, and summarize the common problems of shrinking resource-exhausted cities and their causes; It puts forward an idea that is contrary to the previous planning model, that is, no longer plans to reverse the shrinkage situation, chooses to accept and adapt to the shrinkage, taps the development potential, and finally achieves a dynamic new balance under the shrinkage situation.

In this process, transformation strategies are put forward for urban economy, society, material space, governance and other aspects, which is an in-depth discussion on the topic of smart shrinkage; the general design principles provide ideas and references for urban transformation facing similar difficulties.

8.3.2 ASSESSMENT

The economical, social and environmental planning of resource-exhausted shrinking cities' smart shrinking transformation is in line with the principles of ***Sustainable Development Goals (SDGs)***.

This research focuses on promoting decent work and economic growth, Industry, innovation and infrastructure, sustainable cities and communities; By promoting industrial transformation, it not only provides the driving force for the long-term economic development of the city, but also solves the employment problem of urban residents, making the city more stable; Aiming at the adjustment of urban spatial structure and the restoration of the ecological environment, it reduces the burden on the city, and at the same time provides a new development direction for the industry, provides residents with a safe place to live, and improves the quality of life; In addition, strategies and linkages can enhance the resilience of the entire city in the economic, physical and social environments, and promote the sustainable development of the city.

Fig.17 SDGs.(Source: https://sdgs.un.org/goals)

8.3-REFLECTION

8.3.3 RESEARCH REFLECTION

What is the relation between your graduation project topic, your master track (Ar, Ur, BT, LA, MBE), and your master program (MSc AUBS)?

Cities are complex, with multi-facetted and interrelated challenges, they are seen as both the source of and solution to today's economic, environmental and social challenges.

From my own perspective, the study of urbanism centers on how inhabitants of urban or urbanising areas interact with the social and built environments of cities in a context of complex and rapid social and cultural change, ultimately leading to sustainable lifestyles. My graduation thesis is based on a resource-based post-industrial city, exploring the possibilities of its future sustainable development in a period of industrial transformation and the long-term urban shrinkage caused by the former, which is closely related to the field of urbanism. As an integrated approach, urbanism-based research including strategic and spatial planning provides the project with multiple levels of understanding of cities, including levels of urban built environment and economic and social analysis. Planning Complex Cities Studio which I chose has explored a lot in the complex regions in transformation and combined both spatial planning and governance schemes, providing a good platform for me to deeply explore. In this project, through multi-faceted analysis and theoretical research on the city, urban design is used as a means to explore how to achieve the research goals from the perspective of strategic planning, which is in line with the concept of Planning Complex Cities Studio.

How do you assess the value of your way of working (your approach, your used methods, used methodology)?

An extensive literature review, data analysis (including maps and statistics), and policy research are the starting point of this study. Combined with the existing theoretical research base, the causes and consequences of the emergence of the urban shrinkage phenomenon, as well as the development history and development elements of the subject of the study - resource-depleted cities - and the transformation problems they face, are explored in depth. This is the basis for the development of the subsequent strategy design and an important foundation. Although smart shrinkage is a relatively new concept and there are not many cases of cities that have been implemented and achieved good results, there is still a lot of useful information from case studies of cities with similar backgrounds, different scales, and different strategies. Research by design can complement design and research by complementing the lack of research in the early stages of the process, while the analysis of the current situation in the research process can guide the development of design principles.

During the study, the epidemic did not allow for fieldwork, which had a slight negative impact on the overall study. On the one hand, I relied too much on rational data analysis and literature research, which made me lack personal subjective feelings about the study site as a planner, while on the other hand, the impressions of the city obtained through social media and other channels were biased. In my opinion, this is what I regret throughout the research process.

What do you learn from the project during the research process?

All content should be supported by reasonable basis based on literature research and logical reasoning and analysis, and any point of view cannot be based on imagination;

In the process of exploration, always pay attention to your own goals, always think about the concept of the project and the research subject; there will inevitably be deviations in thinking during the process of advancement, but you must reflect on your own direction in stages;

How to study and absorb the case should consider the background of the case, the problems to be solved, the highlights and core concepts;

Constantly compare with your own research topics, and constantly reflect on how to carry out in the context of this project, instead of blindly applying it.

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