An Multi-scale Analysis of Material Stock Accumulation in China's Infrastructure

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Introduction

With the rapid rise of Chinese economy, a large amount of material has been consumed for the construction and maintenance of infrastructure, which has also caused severe environmental impacts. As shown in Fig.1, the total investment on buildings and transport facilities has been booming for the last decades. A number of studies have been conducted on material stock analysis in China. However, most of them take the whole China as a case neglecting the massive disparity between regions and urban-rural areas. This study will analyze material stock accumulation in multi-scales. We first estimate the evolution of material stock of infrastructures including buildings and roads and railways in 31 provinces with an urban-rural division. Secondly, we investigate the regional disparity of material stock and use shift and share method to analyze the driving factors behind the inequality. Finally, a certain policy implications are discussed in order to achieve a dematerialization society in China.

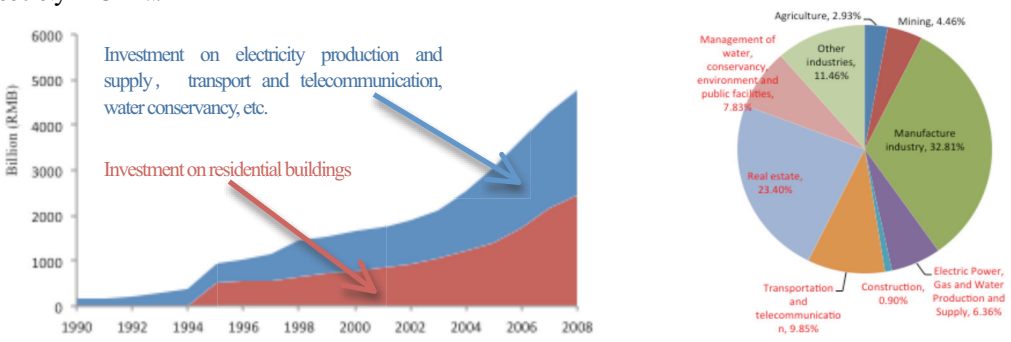

Figure 1 investment on buildings and infrastructures in China

Methodology

Figure 1 illustrates the structure building system. According to survey, Chinese buildings are identified as three types of materials—steel encased reinforced concrete (SRC), reinforced concrete (RC), brick and tile. We will get floor area per capita and population from statistical yearbook, and then to calculate the amount of each material by equation:

$$MS_i^t = MS_i^{t-1} \times (1 - \kappa_i^t) + \Delta A^t \times I_i \tag{1}$$

Where *MS i(t)* is the amount of material *i* stocked in year *t*, and $\triangle A$ is the newly constructed buildings' floor area in year *t*. *I i(t)* is the input intensity of material *i* in year *t*.

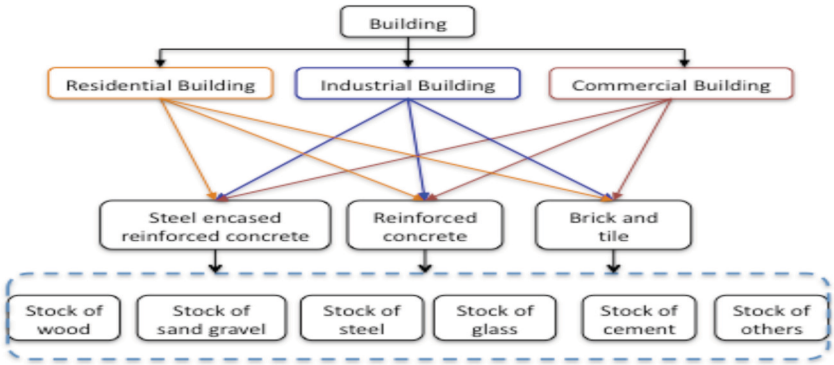

Figure 2 Flow chart for calculation of the material stock of buildings

Similar with Eq. (1), we calculate the material stock of transport of 31 provinces. Figure 2 illustrates the flow diagram for the calculation of the material intensity of the railway system. First, China's railway system is divided into single and double track railway. Steel consumption per kilometer of railway is then calculated according to track type. The railway system incorporates concrete and wooden sleepers. The steel, cement, and sand and gravel contents of each concrete sleeper can be obtained according to the ratios of materials employed in their

construction. Gravel consumption can also be determined by volume per kilometer of ballast bed. Finally, the material intensity of single and double track railway lengths can be obtained according to the weight of the rails, the number of sleepers, and the volume of ballast beds. Figure 3 is the flow diagram for the calculation of the material intensity of the highway system. The highway system uses cement and asphalt concrete paving materials. Several classes of highways are also distinguished by their sub-grade structures, which result in different material intensity. The material intensity of each class highway can thus be determined according to structure and material consumption. This study did not include unpaved roads in the material intensity analysis.

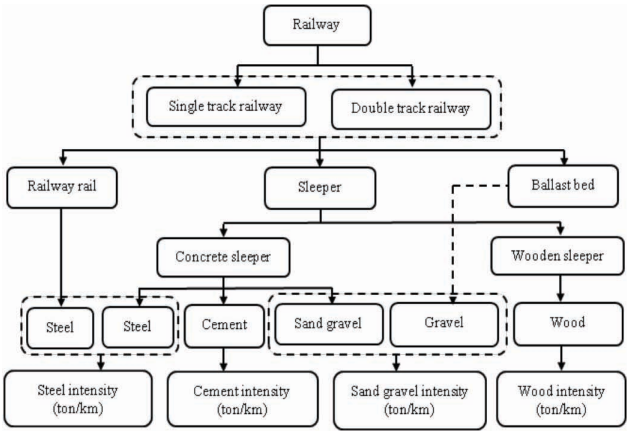

Figure 3 The flow chart for calculation of the material intensity of railway

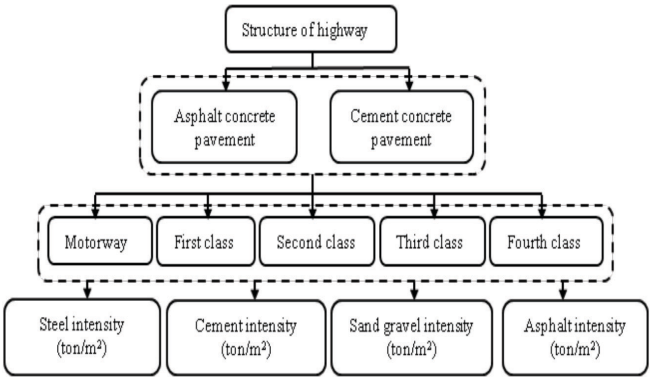

Figure 4 The flow chart for calculation of the material intensity of highway

Source: Huang et al. (2010)

Data

Table Data and material used for calculation

	Type	Sub-type	Data Source
Infrastructure	Building	Residential	China Statistical Yearbook on construction
		Industrial	China Statistical Yearbook
		Commercial	China Urban and Rural Construction Statistical Yearbook
	Transport	Railway	China Transport Statistical Yearbook
		Road	China Statistical Yearbook
Social Economic	Population	Urban	China Population Statistical Yearbook
		Rural	China Statistical Yearbook

Results and Discussion

The result of this study will show the stock amounts of different kinds of material contained in infrastructure. We can learn material stock's distribution conditions of whole China and the disparity of different provinces and urban-rural areas through analysis and discussion, and then we can know the reason why there exists this kind of disparity phenomenon, at the same time, provide valuable information for government.

As future study, we will choose Shanghai city as research area to calculate its material stock amount in spatial sector by means of 4d-GIS data. So then we can further learn the accumulation of material stock accurately.

Reference

1. Tao Huang etc., Study on the Material Stock of Transportation Construction Associated with the Development of Infrastructure, ENVIRONMENTAL INFORMATION SCIENCE, No.24, 2010.
2. Kohei NAGAOKA, Hiroki Tanikawa ・・・, (2008), Estimation of surface/ subsurface・・・・, Journal of Environmental Systems conference of JSCE, pp.303-308