SPATIAL MATERIAL STOCK ANALYSIS USING 4D-GIS: A CASE STUDY IN TIEXI DISTRICT OF SHENYANG, CHINA

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Introduction

With the rapid development of Chinese urbanization, a large amount of material has been consumed for the construction and maintenance of infrastructure, which has also caused severe environmental impacts. Shenyang city is a typical old industrial base in China, has been reconstructed and relocated for more than 100 years. 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 analyze the material stock of the whole China by statistical data neglecting statistical distribution characteristics and material intensity' s regional differences of infrastructures. This study will take 10km^2 area of Tiexi district in Shenyang city (**Fig. 2**) as an example to analyze material stock accumulation in building and transportation infrastructure by 4d-GIS method. We first make 4d-GIS data from 1910 to 2011 base on the historical maps and statistical data of research area. Secondly, we estimate the accumulation of material stock of infrastructures including buildings and roads and railways through surveying material intensities and suitable calculation methodologies. Thirdly, we analyze the temporal and spatial evolution of infrastructure material stock. Finally, the future waste amount of building in research area is estimated through analyzing its demolition rate and average life span.

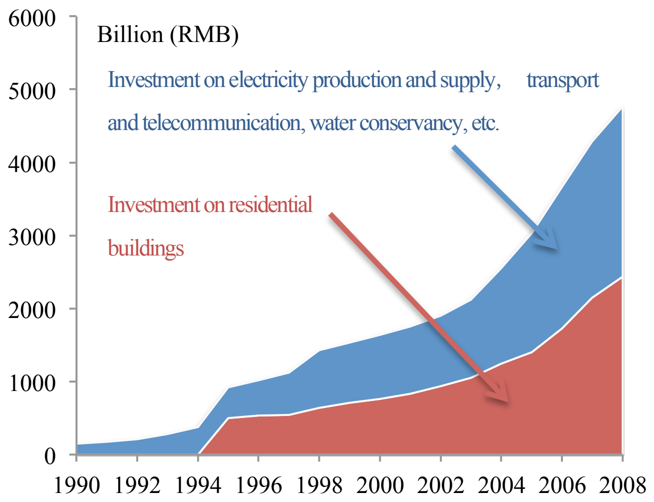

Fig. 1 investment on buildings and infrastructures in China

Fig. 2 Research area of 10 km^2 in Tiexi district, Shenyang city

Methodology

Material stock estimation of research area is based on both 4d-GIS data and statistical data. Fig. 3 shows the methodology of material stock estimation by these two kinds of data sources. Firstly, we extract special information for selected area to establish the spatial information database. In the similar way, we survey the material intensity data classified by structures of infrastructures including building, road, railway, as the result of establishing the statistical data. Secondly, based on the spatial and statistical information database, we can estimate the material stock of these infrastructures through equation (1).

$$MS^t_{i,m,n} = \sum (S^t_{m,n} \times I^t_{i,m,n}) \quad (1)$$

Where $MS^t_{i,m,n}$ is the total amount of material *i* stocked in structure *m*, type *n* in year *t;* and $S^t_{m,n}$ is the volume of spatial data of structure *m*, type *n* in year *t* from 4d-GIS data. Spatial data means the amount of physical structures, for example, building floor area, and the area of road. $I^t_{i,m,n}$ indicate the intensity of material *i* in structure *m,* type *n* in year *t*, which is a kind of indication of distribution of a given material *i* per stock in structure *m*, type *n*.

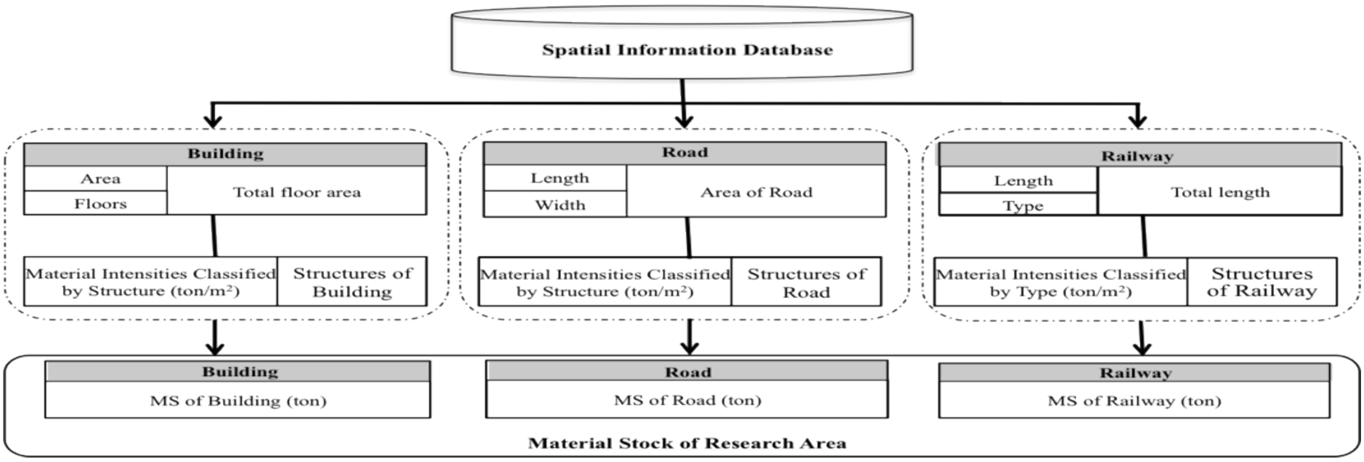

Fig. 3 Methodology of estimating material stock using GIS data

Table 1 Data and material used for calculation

Data Type	Type	Structure	Data Source
Statistical Data	Building	Residential	Comprehensive Statistical Data and Materials on 60 Years of New China (2010) Shenyang Statistical Yearbook (1981-2011) China Transport Statistical Yearbook (1986-2009) Shenyang Statistical Yearbook (1990-2010) Liaoning Statistical Yearbook (1981-2011)
		Industrial	
		Commercial	
	Transport	Railway	
		Road	
4d-GIS Data	Building and transportation infrastructure's shape file in Tiexi District, Shenyang city		Arc GIS data for Tiexi district (1997), Google earth photos of Shenyang city (2011) , Urban planning maps of Shenyang city (1910, 1932, 1947, 1968, 1978, 1986, 1997, 2011)

Results and Discussion

Based on the data source as shown in Table 1, material stock accumulation in research area is estimated. The result will show the temporal and spatial evolution of building and transportation infrastructure in research area as shown in Fig. 4. Not only that will imply special change of material stock distribution of building and transportation infrastructure in research area, but also can reveal the historical evolution of material stock in research area ranging from 1910 to 2011. Finally, the future waste amount of building in research area is estimated through analyzing its demolition rate and average life span, so that a certain policy implications are discussed in order to achieve a dematerialization society in Shenyang city.

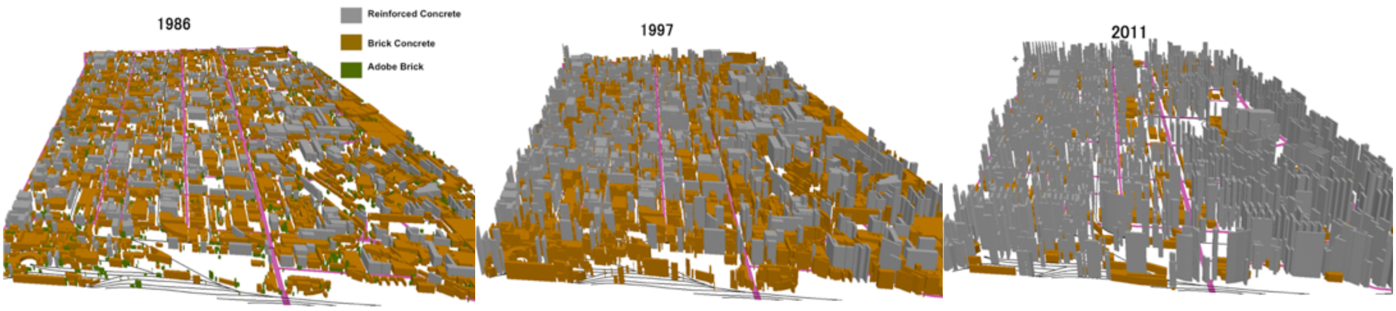

Fig. 4 The temporal and spatial evolution of building and transportation infrastructure in research area

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