Estimation of Material Stock in Urban Civil Infrastructures and Buildings for the Prediction of Waste Generation

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Objective

Overview of Material Flow for buildings and roadways

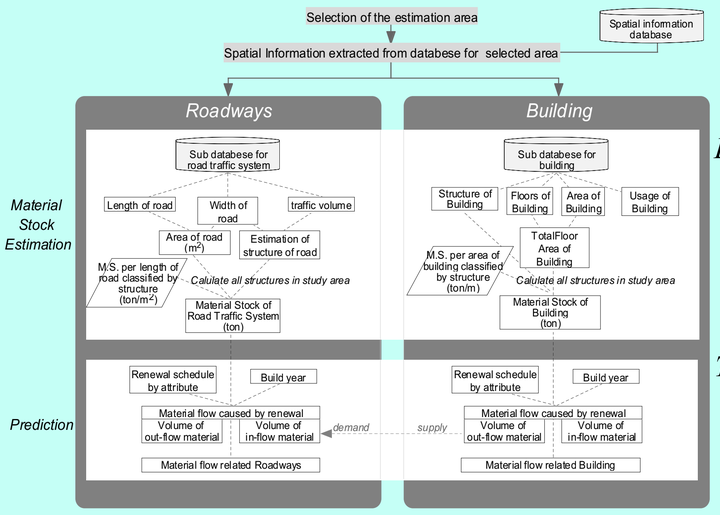
Construction materials account for 48% (1.1 billion tons (1995)) of all material flow in Japan. Most of these materials are accumulated in cities as stock. In the near future, the stock will cause the new material flow as wastes.

In this study,

1. **MFA** (*Material Flow Analysis*) **is applied to a city.**
2. **the material stock of buildings and roads is quantified using a GIS.** (*geographical information system*)
3. **the change in the material flow for the near future is estimated.**

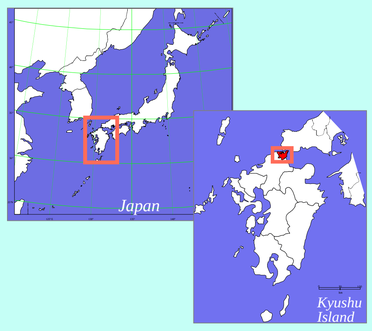
Method and Data

Method of estimating roadway- and building-related material stock

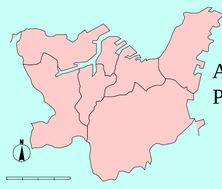


Estimation of material stock accumulated in every urban civil infrastructure according to resources type and the number of years the stock has been held. The bottom-up approach is applied to every structure using the GIS.

The renewal schedule is set according to the attributes of each structure, and the material flow for the near future is estimated.



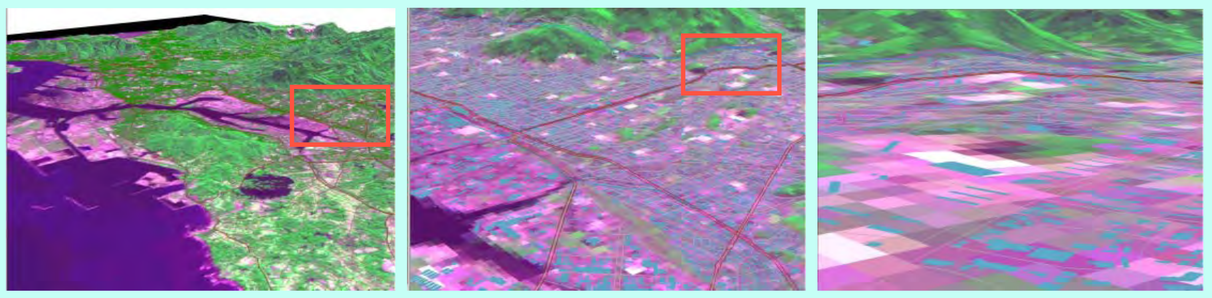
SPOT HX(1995) + GIS database



Area: 484km²
Population (1995): 1,019,598 persons

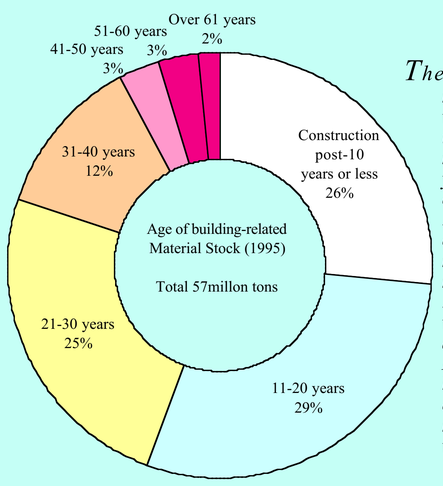
Kitakyushu City (Fukuoka Pref., Kyushu Island in Japan) was selected for a case study since good quality spatial data are available for this city.

GIS database using the present analysis



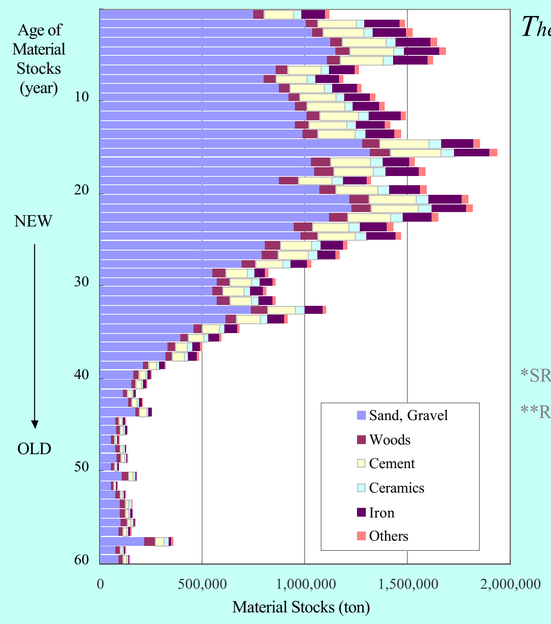
Result: Estimation of Material Stock

Age of material stocks related the buildings



The amount of building-related material stock was 57 million tons, and the average age of the material stock was 20.4 years. In addition, 80% of material stock is under 30 years old. On the other hand, 20% (11 million tons) of the material is passed over 30 years. These buildings were constructed during a period of rapid growth. In the near future, these buildings will become overage stock, and cause new material flow as waste.

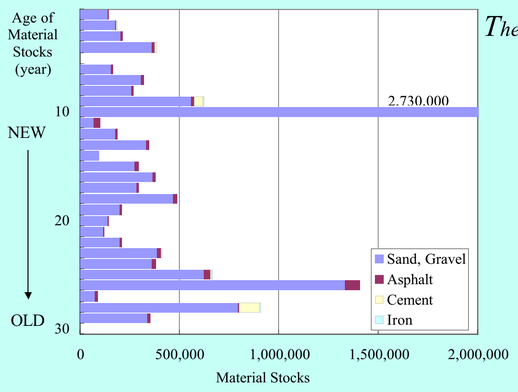
Distribution of the age of building-related material stock



The distribution of the age of building-related material stock in Kitakyushu City (1995). Sand and Gravel made up 67% of all material stock. Since the proportion of SRC and RC** structures has increased starting in the 1960's, the material stock of iron, cement, and sand and gravel, has increased.*

*SRC: steel framed reinforced concrete
**RC : reinforced concrete

Distribution of the age of roadway-related material stock



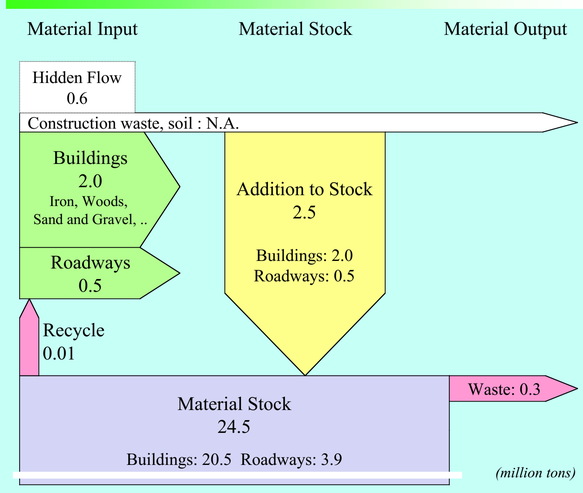
The distribution of the age of roadway-related material stock in Kitakyushu City. Some statistic error seems to be included because a time lag exists between the year in which roads opened for use and the year in which construction was started. In this estimation, the former data is used for the calculation.

Thus, the distribution of roadway-related material stock is biased. However, roadways were renewed according to a road master-plan (another cause of over endurance), so the extinction curve is not like that for the buildings.

Result: Change of Material Balance

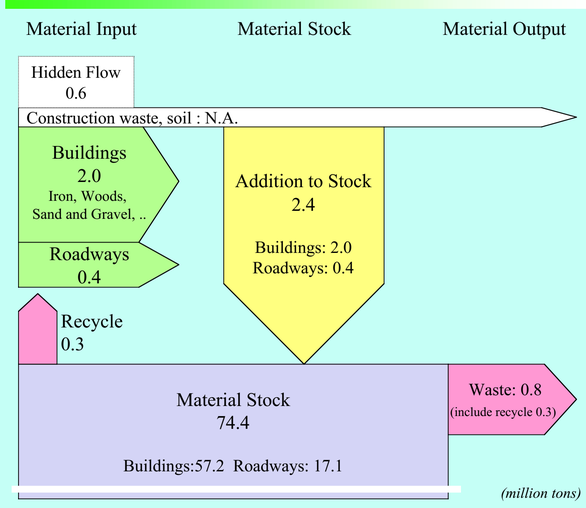
Material Flow Balance for buildings and roadways in Kitakyushu City

1970



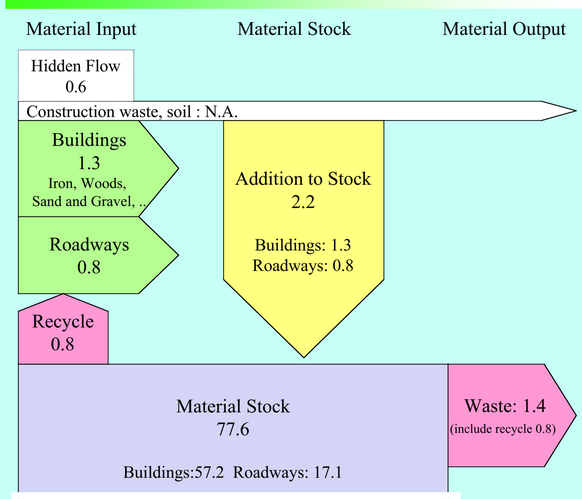
The roadway-related material stock projected for 2020 increases remarkably compared to 1970 and 1995. This is a result of the roadway network being rapidly developed due to the popularization of the automobile and population growth. However, in the study area, in recent years, construction for function enhancement and maintenance, such as width expansion and pavement renewal, rather than new roadway construction has been increasing.

1995



The material input in 2020 is projected to be 2.1 million tons, a decrease of 88% compared with the figures for 1995. The material input for buildings decreases from 2.0 million tons (1995) to 1.3 million tons (2020), but the material input for roadways increases from 0.4 million tons (1995) to 0.8 million tons (2020).

2020



Considerable material input is required for maintenance and repair of the developed roadway network. In addition, recycled material is estimated to be 0.8 million tons in 2020, which is approximately the same volume of the material input for roadways. The waste concrete generated from buildings is recycled as pavement material for roadways. Therefore, balancing overage buildings and roadway renewal is important.