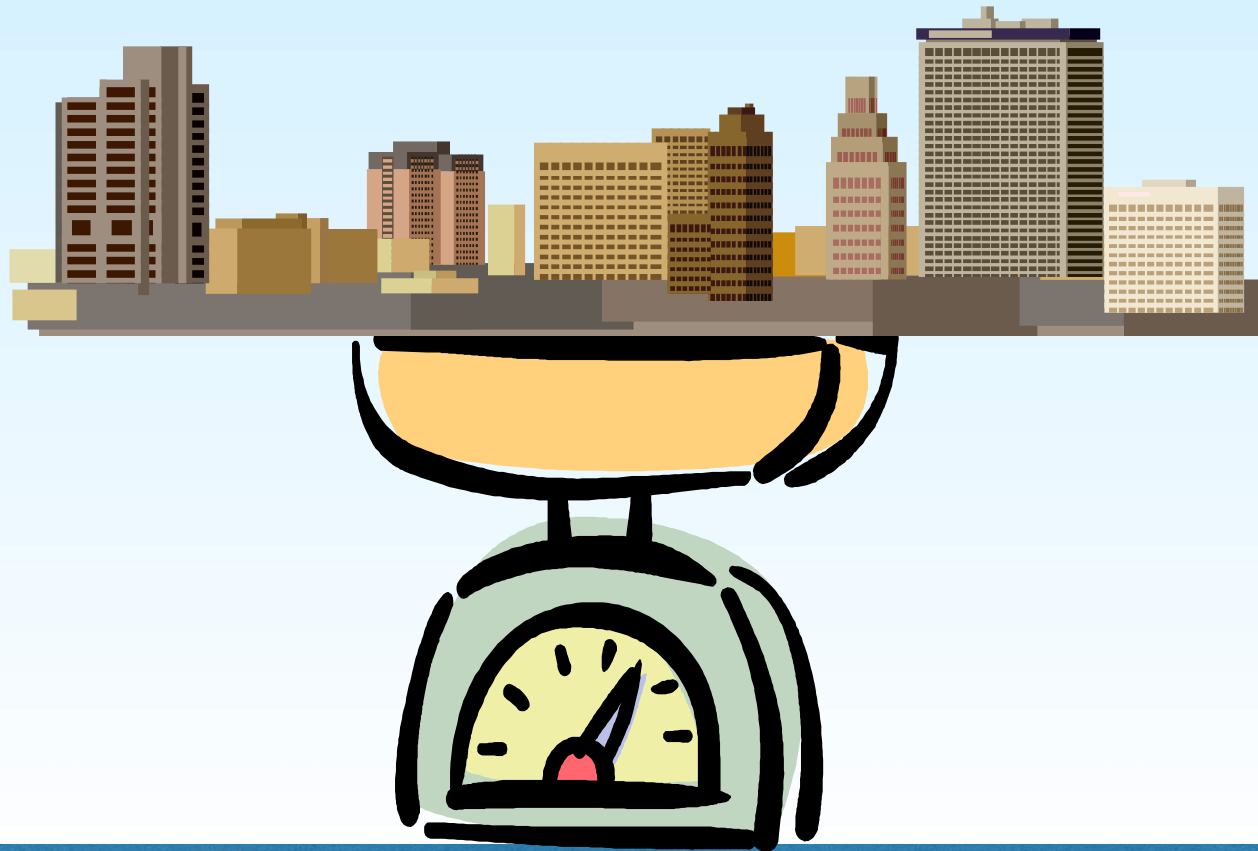


The weight of society over time and space: a case of Japan



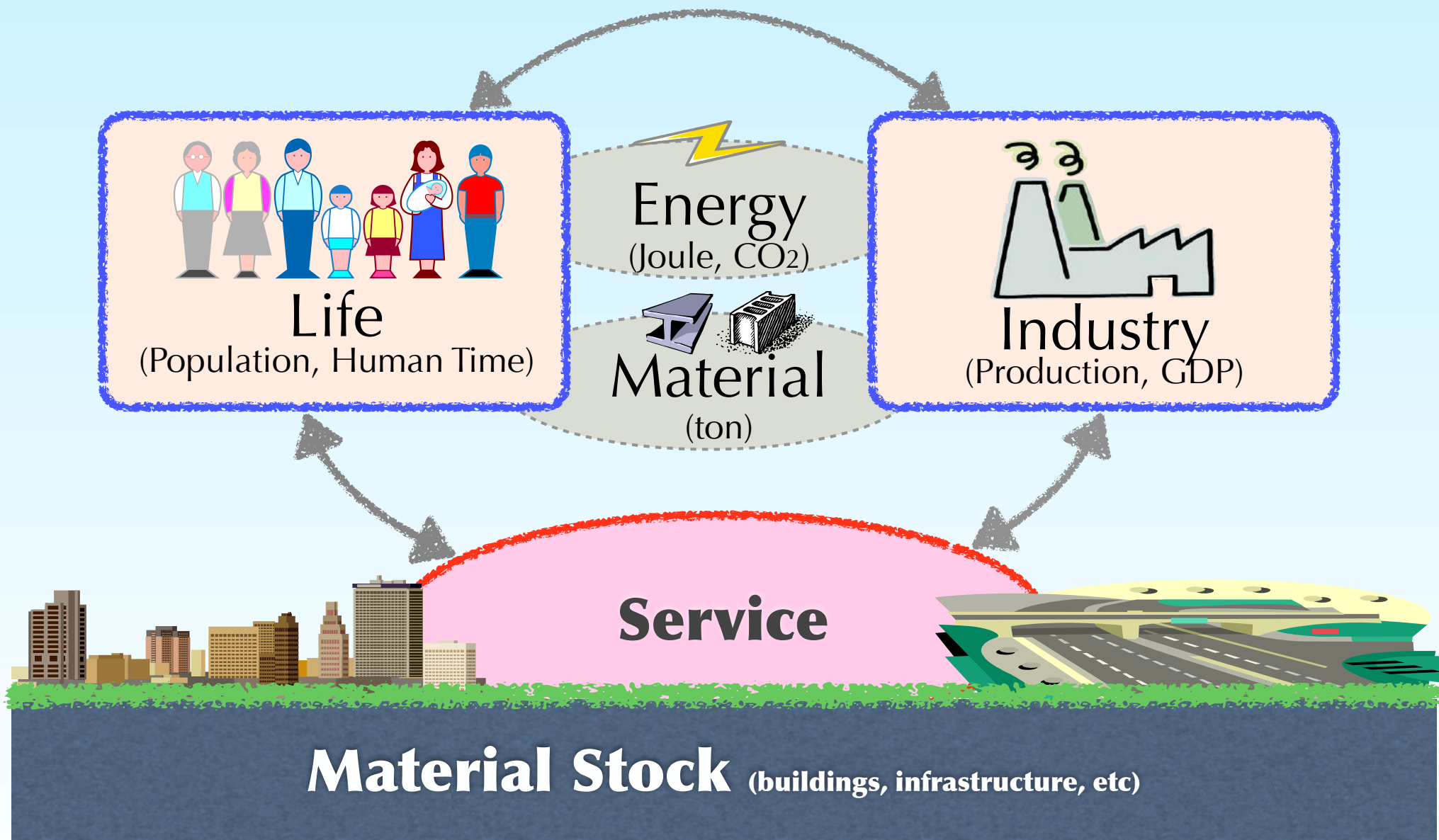
Keijiro Okuoka

Hiroki Tanikawa





Stock and Service:

“How much material do we need for our life?”



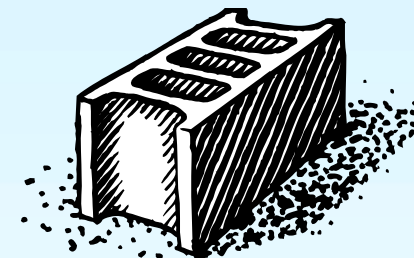
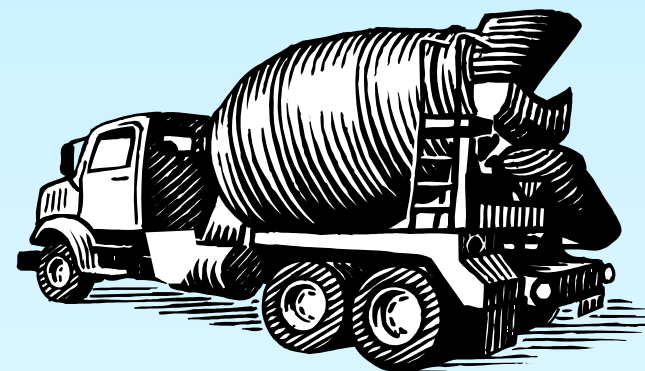
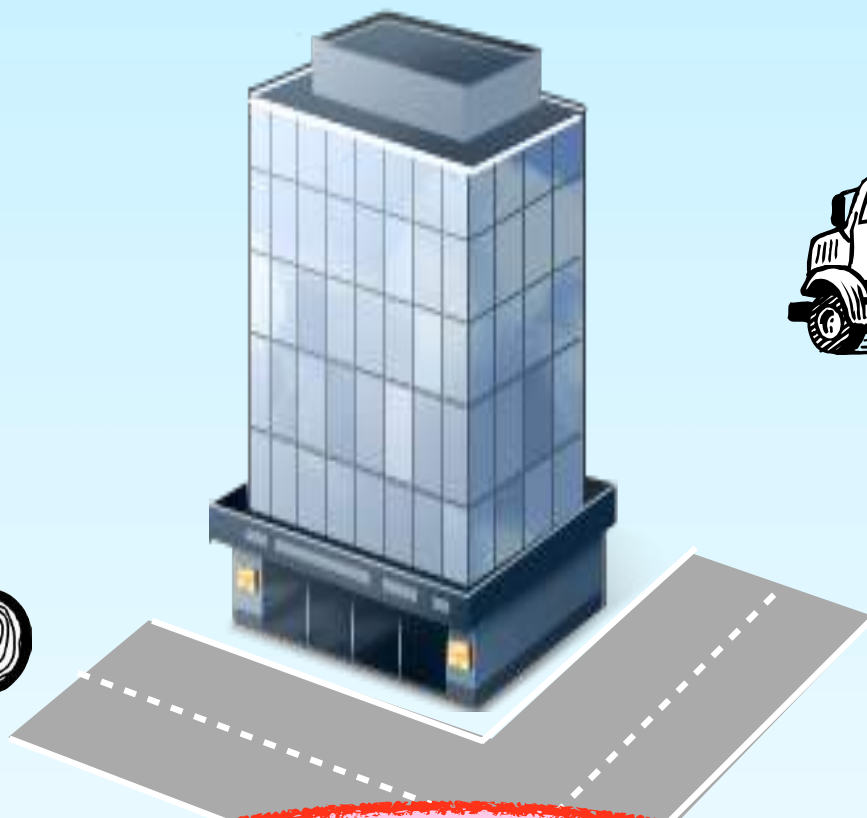
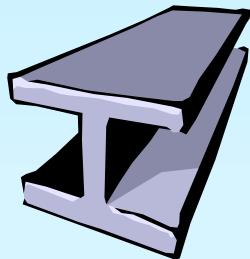
Lifespan of Material Stock

Lifetime of MS	State	Impact
Shorter 	Keep re-building MS by every generation	<ul style="list-style-type: none"> • High Lv. resource input / output and CO2 emission for MS. • High cost to keep city service. • Over capacity of recycling
Longer 	Accumulation of capital beyond generations	<ul style="list-style-type: none"> • Low Lv. resource input / output and CO2 emission for MS. • Possibilities of Urban mining with future tech.



Material Stock (buildings, infrastructure, etc)

Reference: Hisato Okamoto (2011) *Stock-type Society Theory*

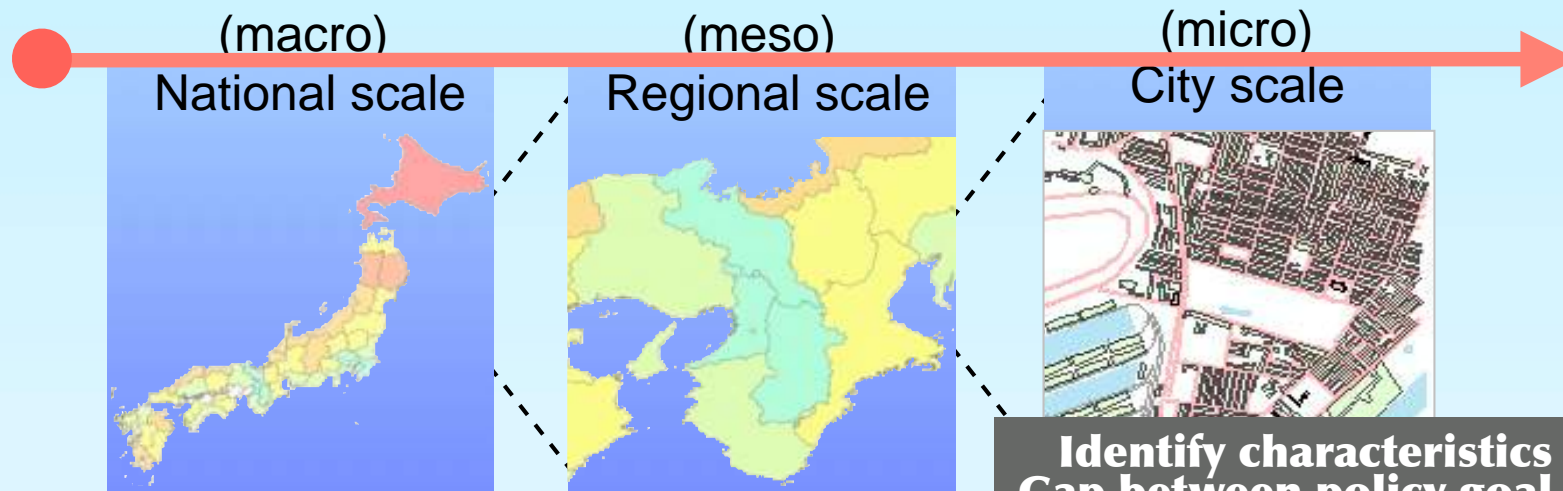


Service

Material Stock (buildings, infrastructure, etc)

Multi-scale MSFA model: 4d-GIS

**Spatial
Scale**



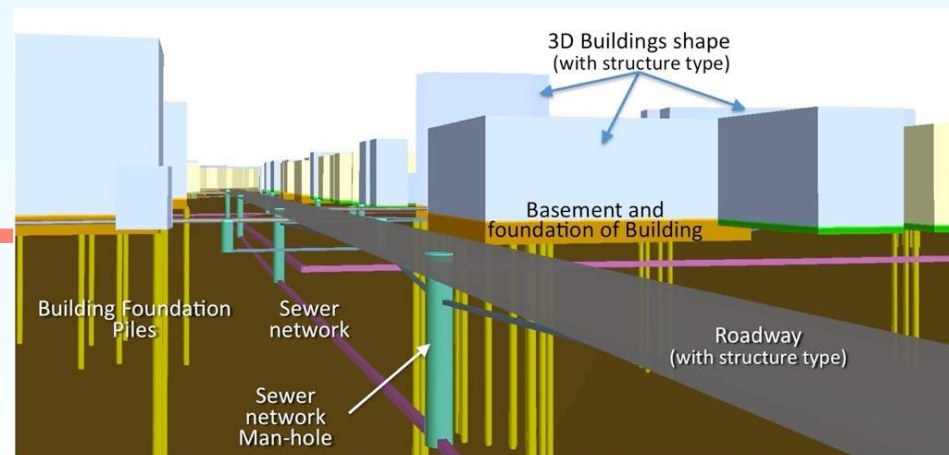
**Identify characteristics of Area.
Gap between policy goal of nation,
region and city.**

Time Scale

1800 1850 1900 1950 2000 2050

**Spatial Metabolism.
Forecasting, Backcasting
Scenario approach**

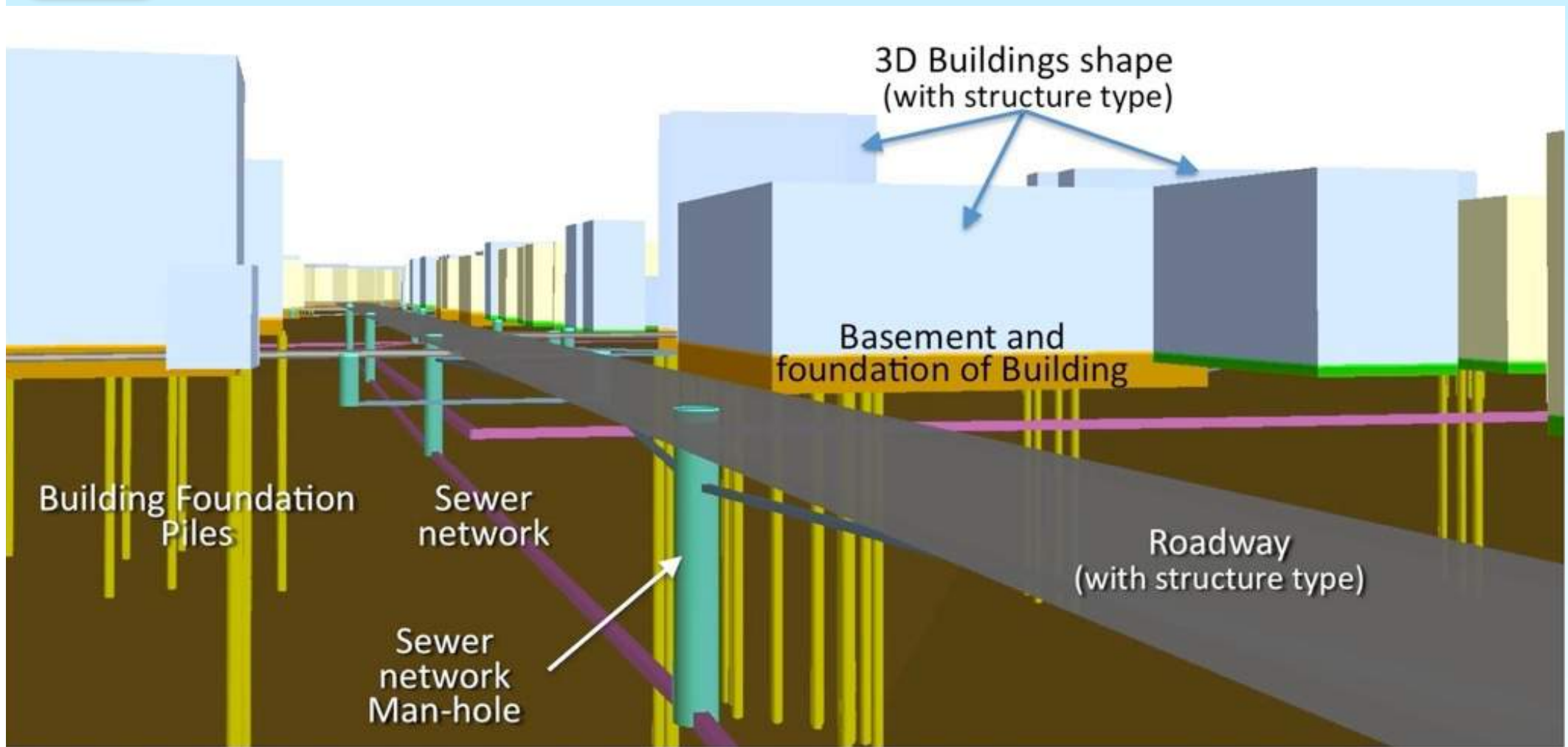
**Surface /
Subsurface**



Upper ground

Under ground

**Possibility of Waste
Generation, Recyclability**



Wakayama 1855-2014
Nagoya 1970-2009
Kitakyushu 1980-2013
Tokyo 1990-2012



Manchester 1849-2004



Shenyang 1910-2011
Wuhan 1980-2010

4d-GIS database Wakayama City Centre, Japan, 1855 - 2004

(11.03 km², 11,000 buildings, 46,012 peoples, 2004)



Commercial Area

Office Area

Residential Area

1855



1886





4d-GIS database

Wakayama City Centre, Japan, 1947

1947



1958



4d-GIS database

Wakayama City Centre, Japan, 1976

1976





4d-GIS database

Wakayama City Centre, Japan, 1987

1987



4d-GIS database Wakayama City Centre, Japan, 2002

2002

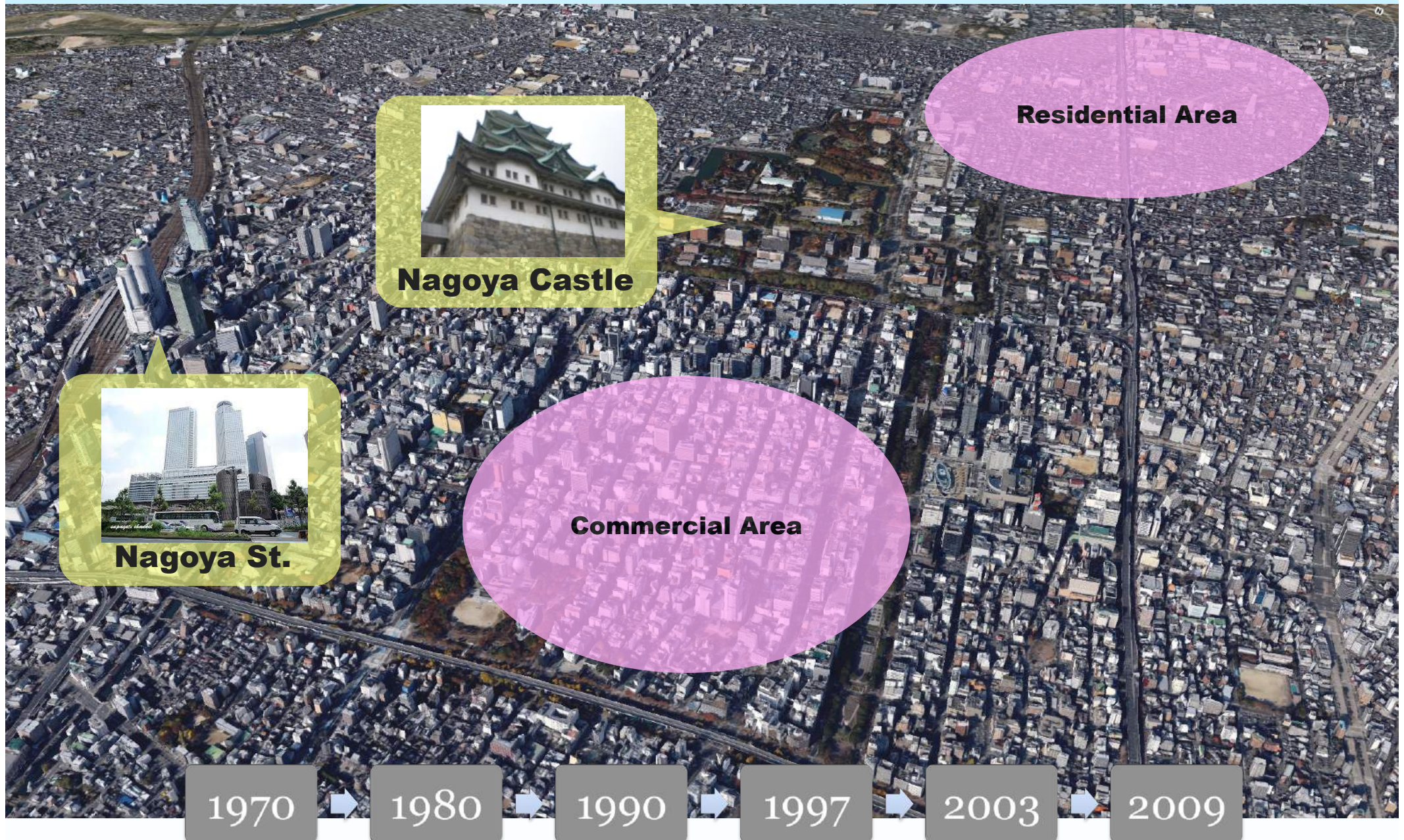


4d-GIS database Wakayama City Centre, Japan, 2004

2004



4d-GIS database Nagoya City Centre, Japan, 1970 - 2009



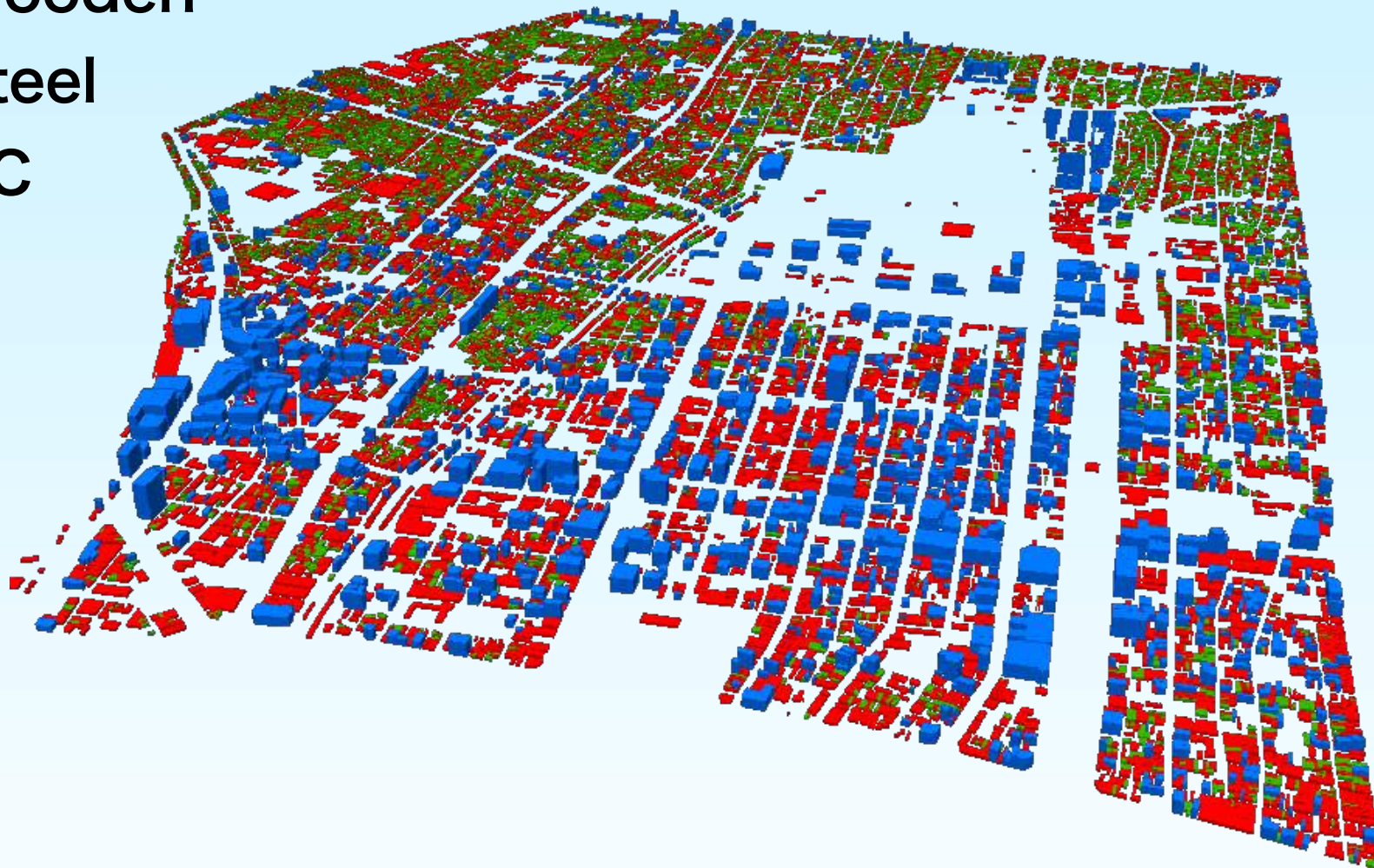
4d-GIS database Nagoya City Centre, Japan, 1970 - 2009

- Wooden
- Steel
- RC



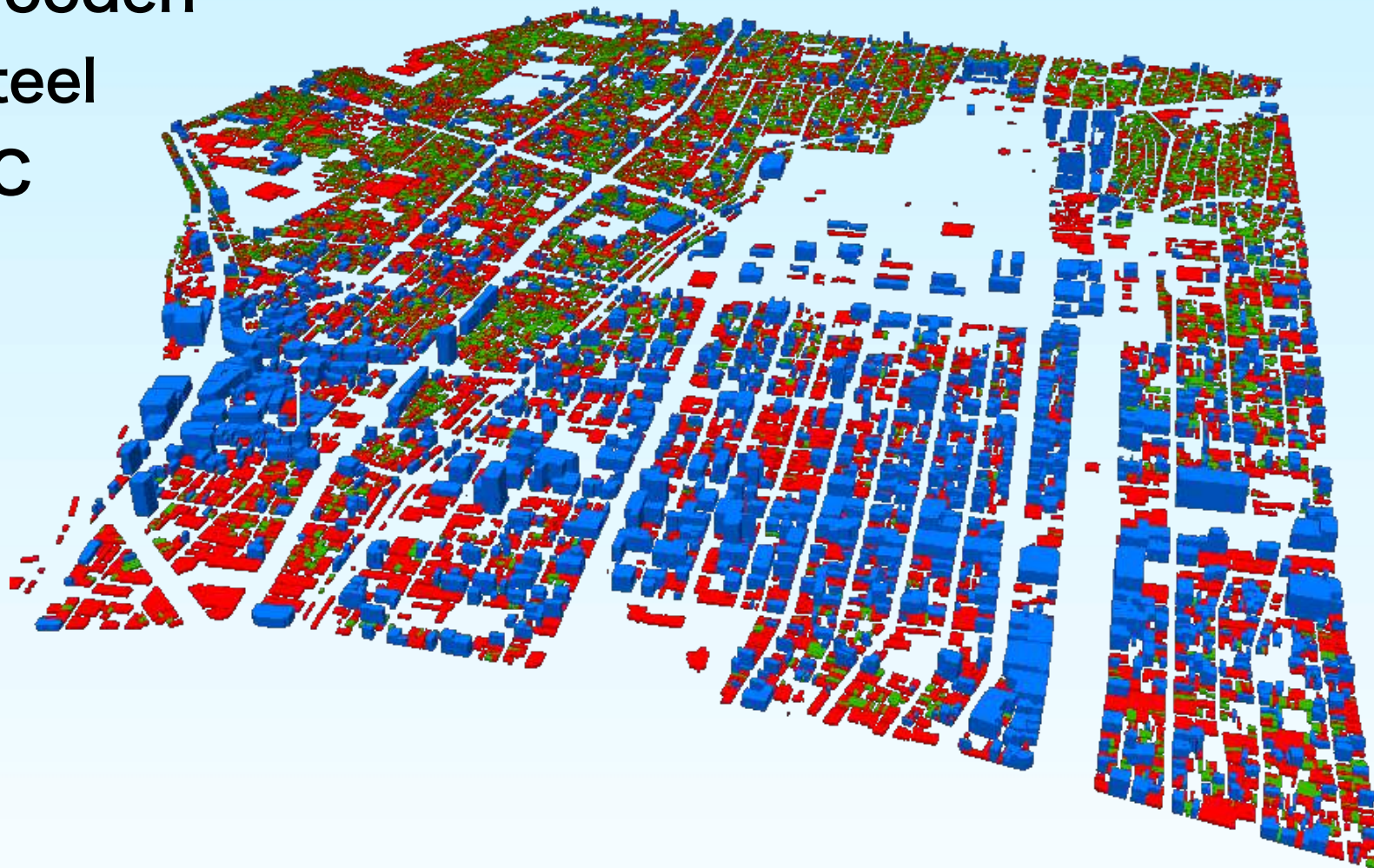
4d-GIS database Nagoya City Centre, Japan, 1970 - 2009

- Wooden
- Steel
- RC



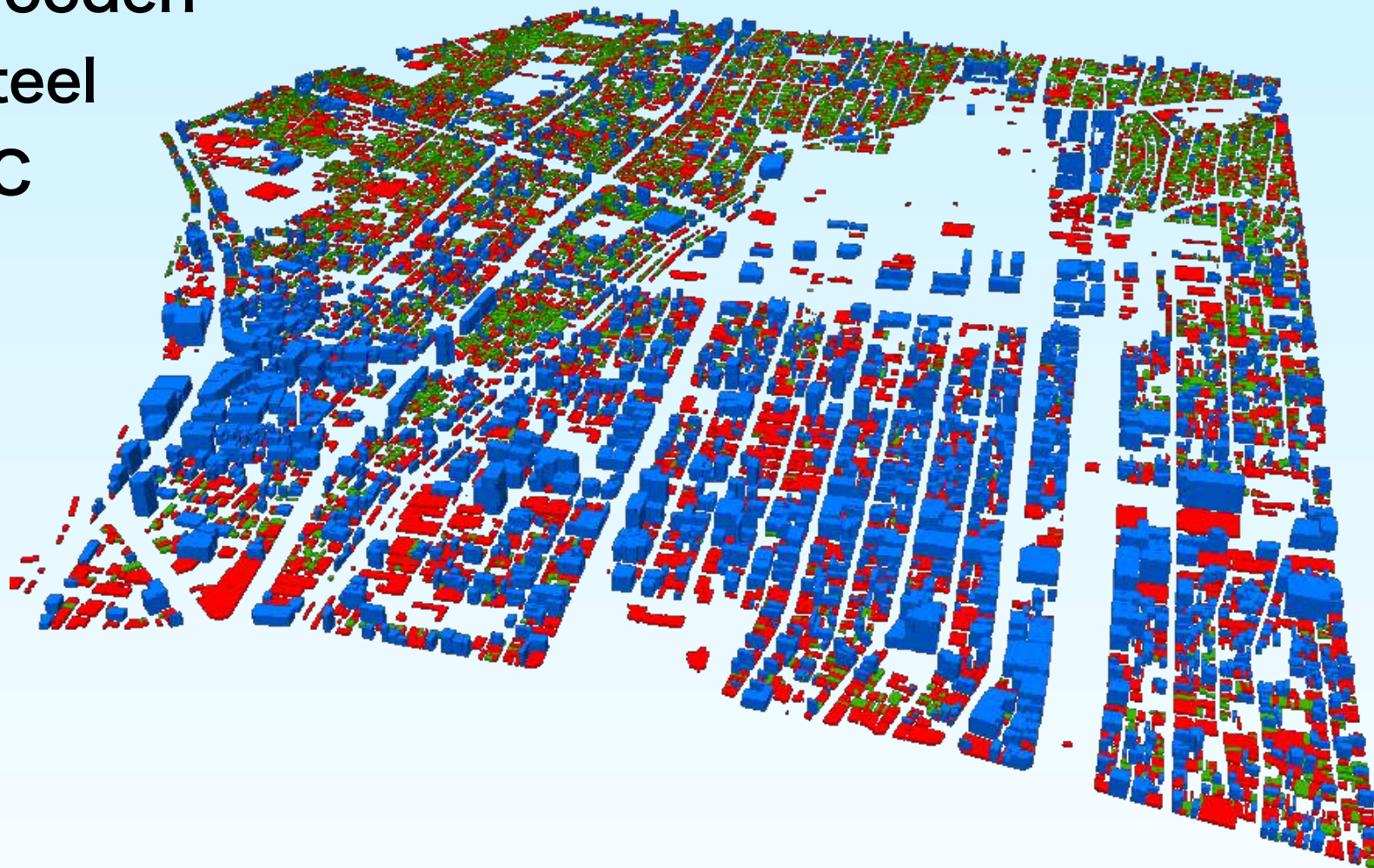
4d-GIS database Nagoya City Centre, Japan, 1970 - 2009

- Wooden
- Steel
- RC



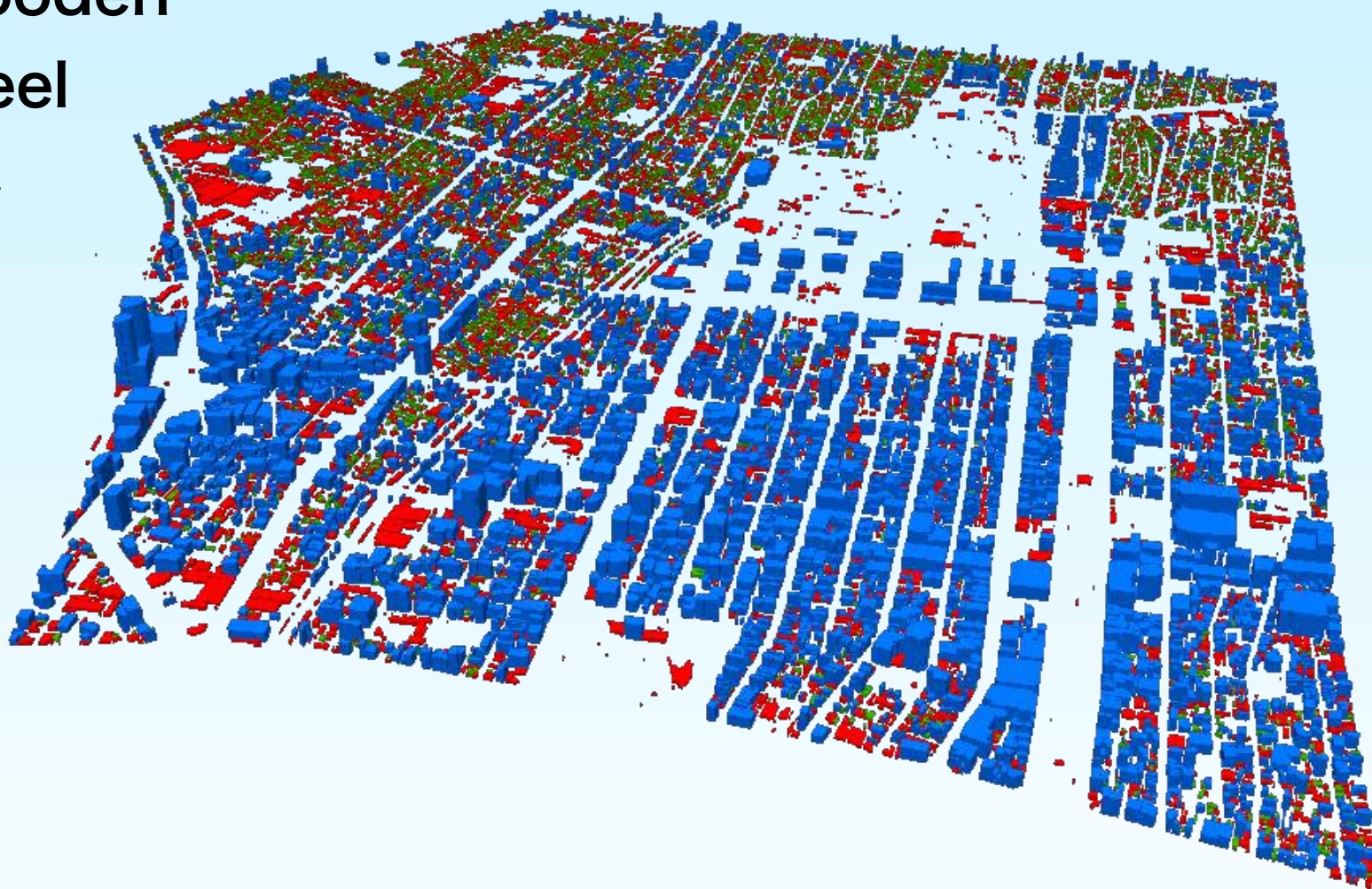
4d-GIS database Nagoya City Centre, Japan, 1970 - 2009

- Wooden
- Steel
- RC



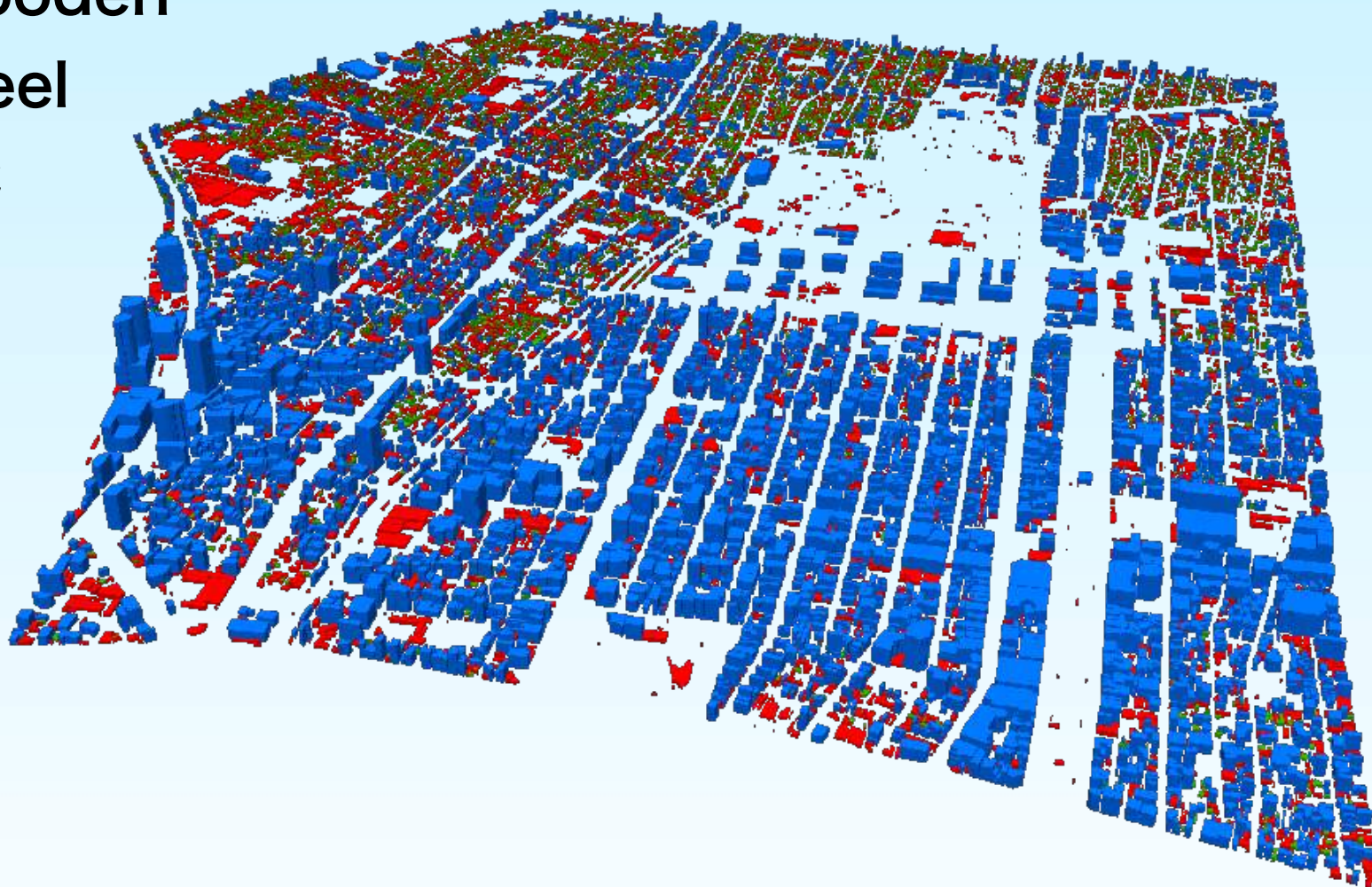
4d-GIS database Nagoya City Centre, Japan, 1970 - 2009

- Wooden
- Steel
- RC



4d-GIS database Nagoya City Centre, Japan, 1970 - 2009

- Wooden
- Steel
- RC



4d-GIS database

Nagoya City Centre, Main Station, Japan, 1970 - 2009



1970



1980



1990



1997

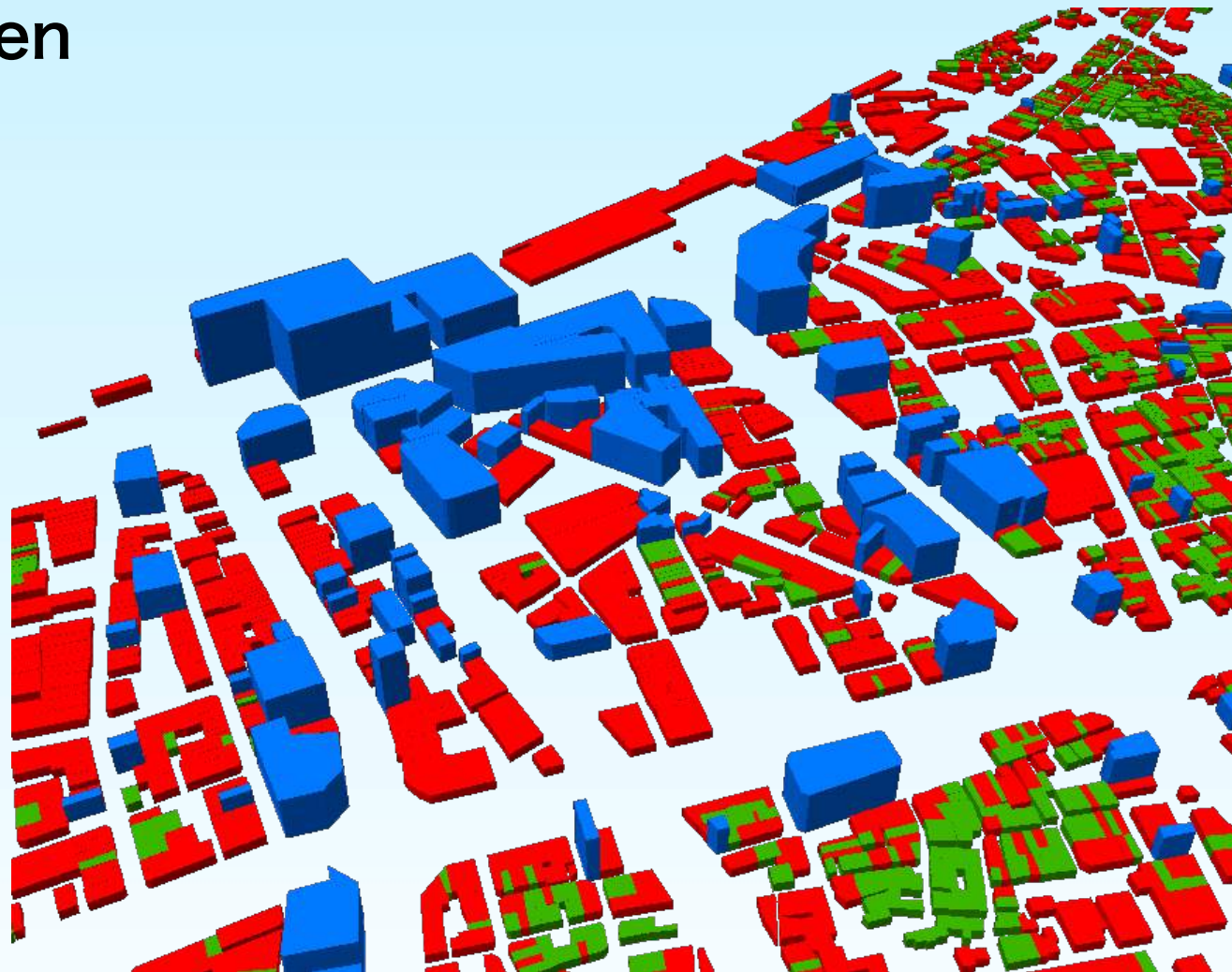


2003

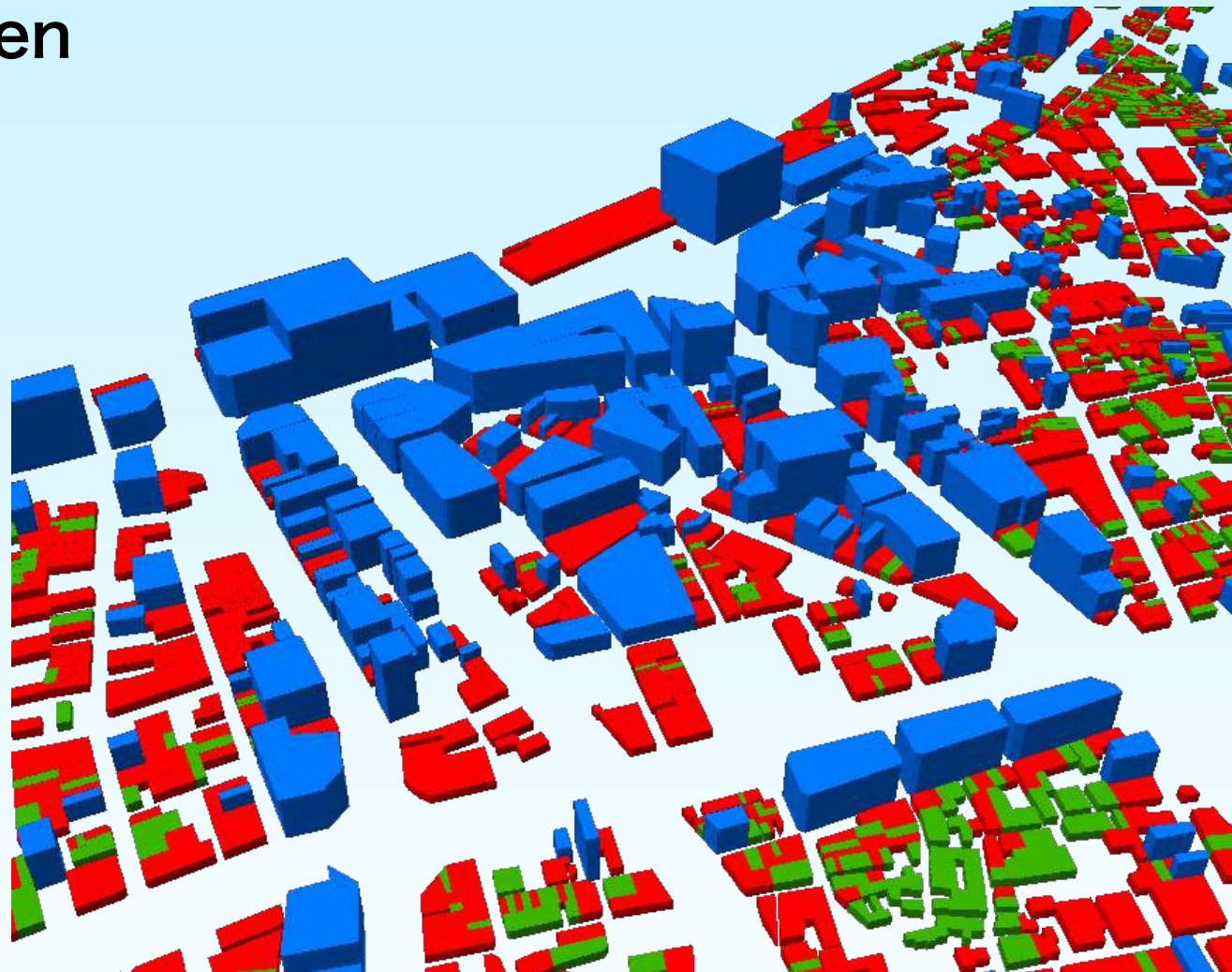


2009

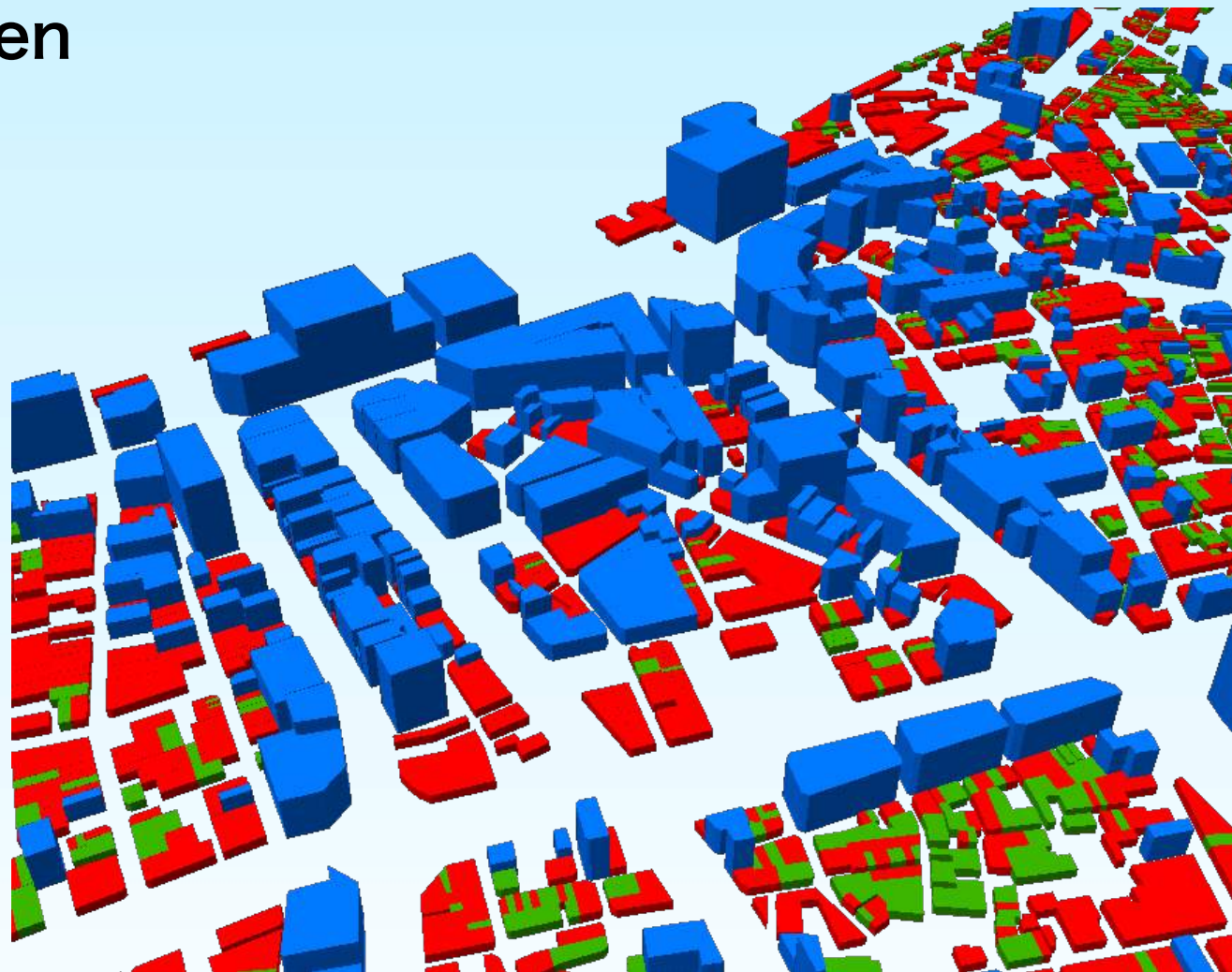
- Wooden
- Steel
- RC



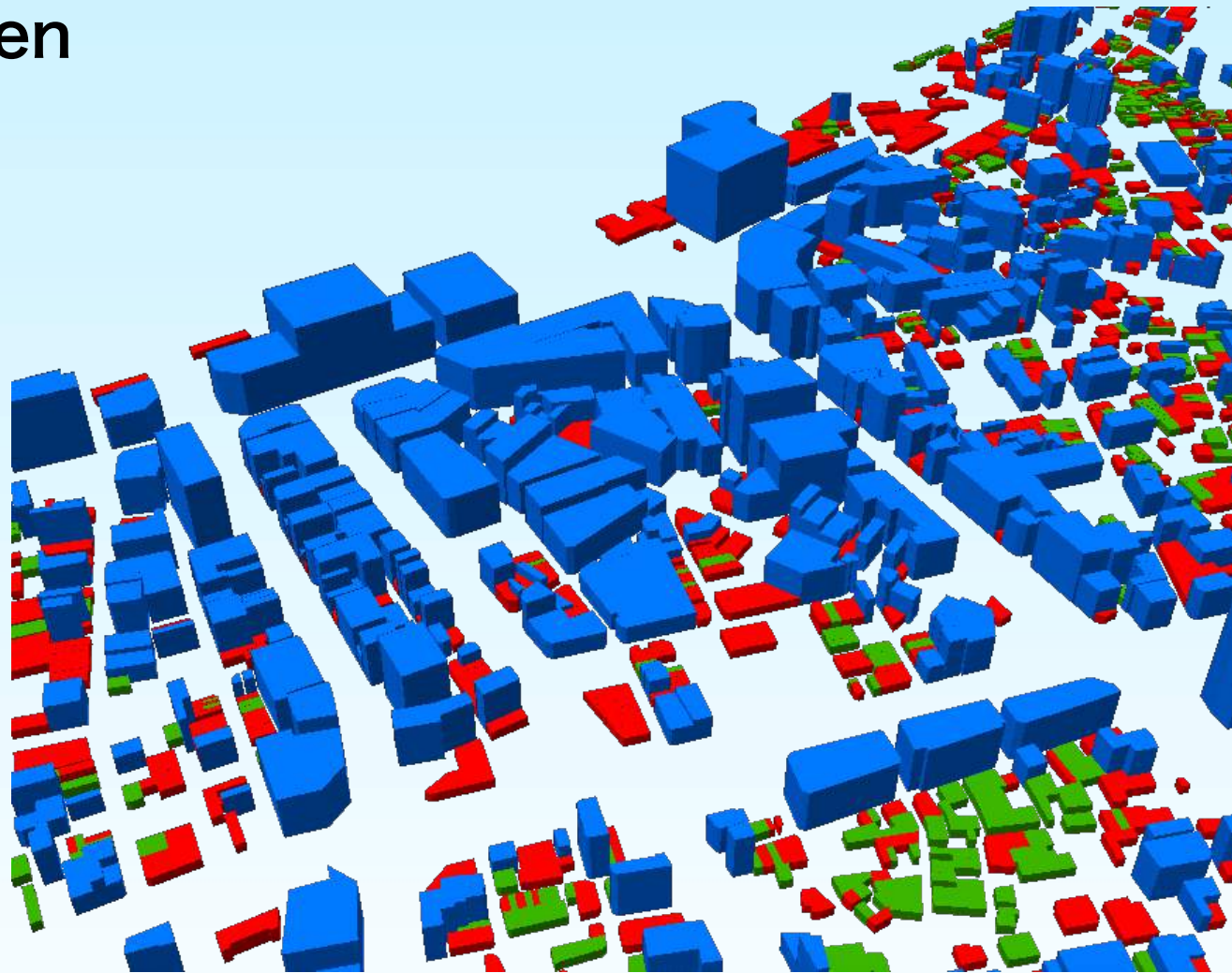
- Wooden
- Steel
- RC



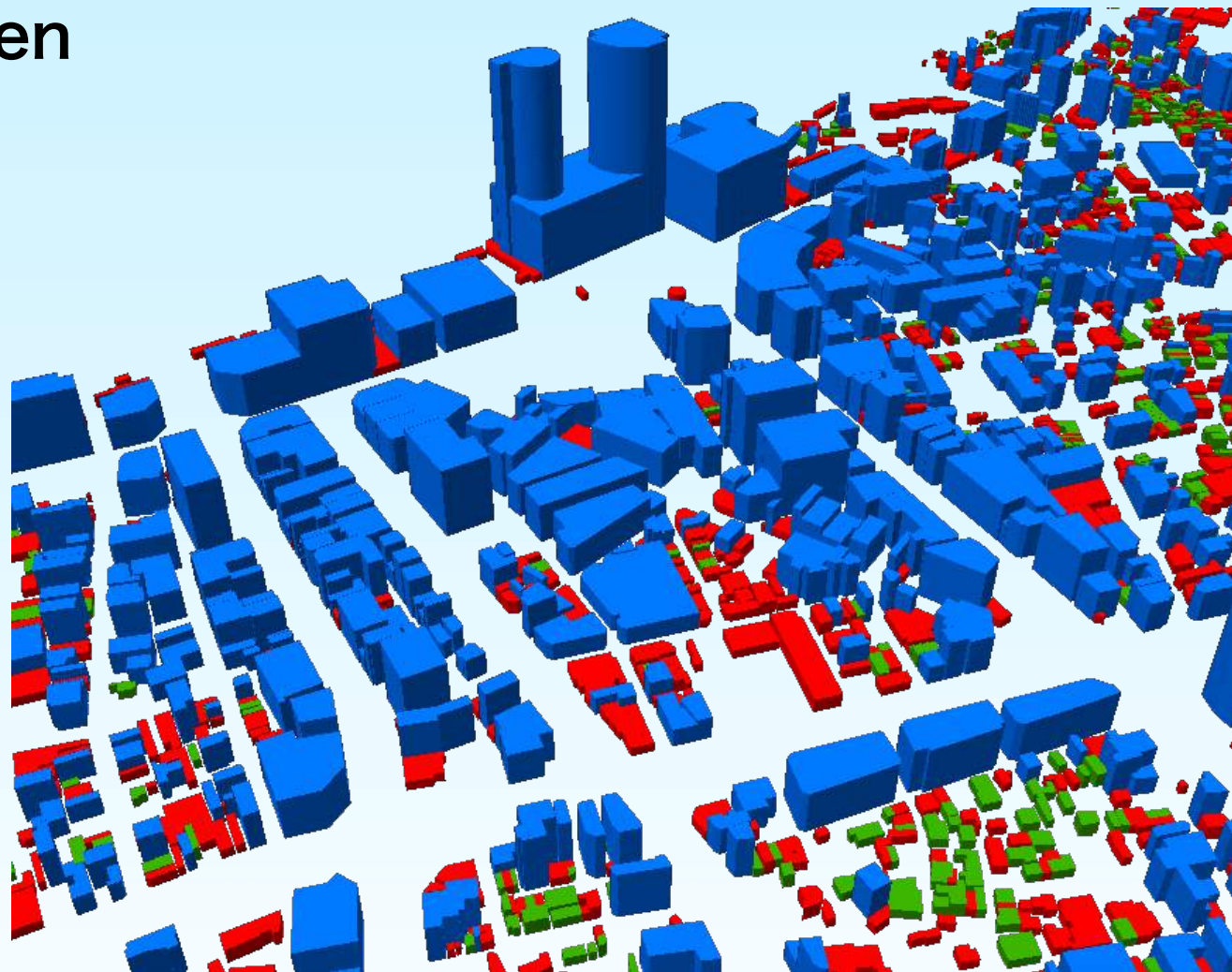
- Wooden
- Steel
- RC



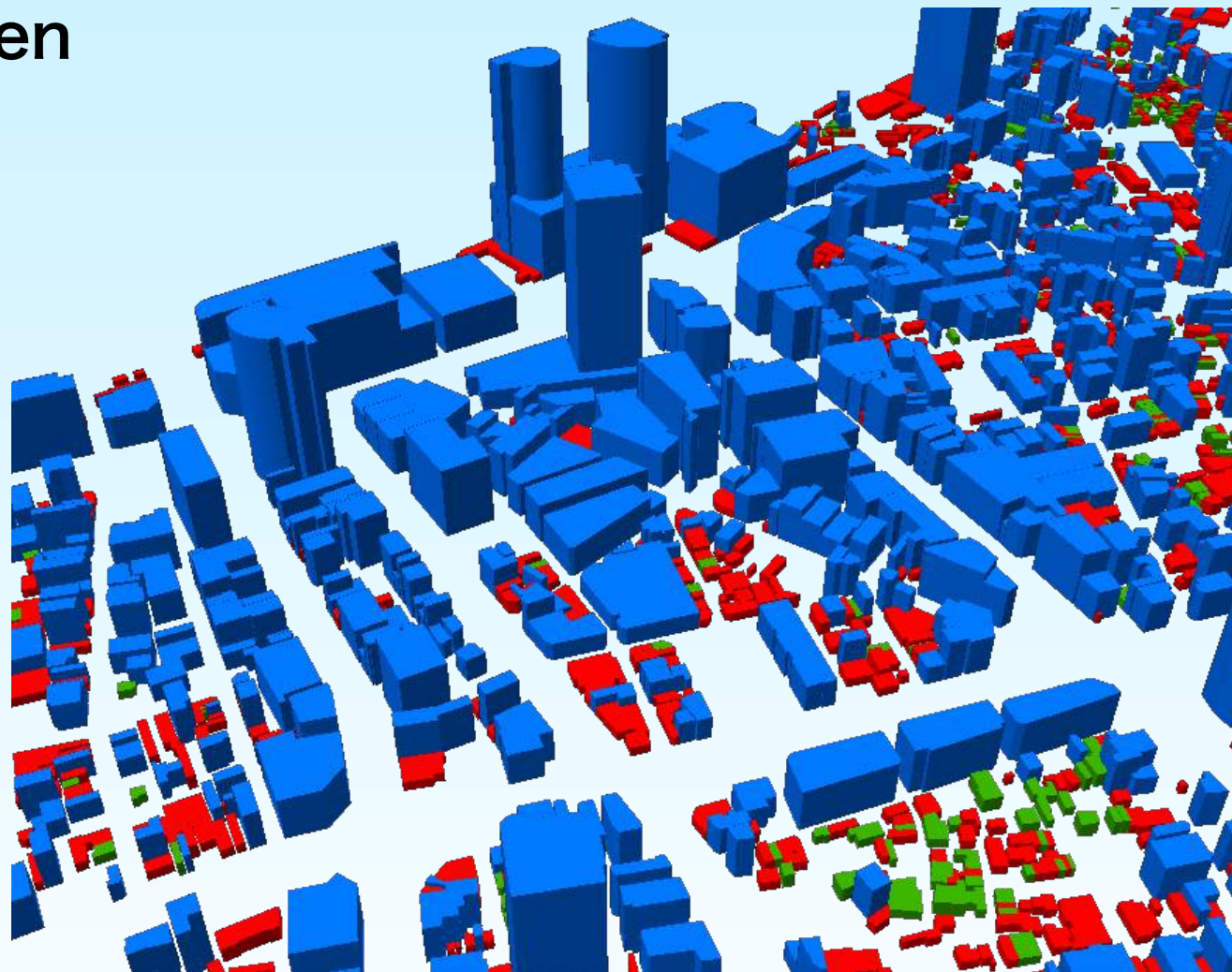
- Wooden
- Steel
- RC



- Wooden
- Steel
- RC



- Wooden
- Steel
- RC



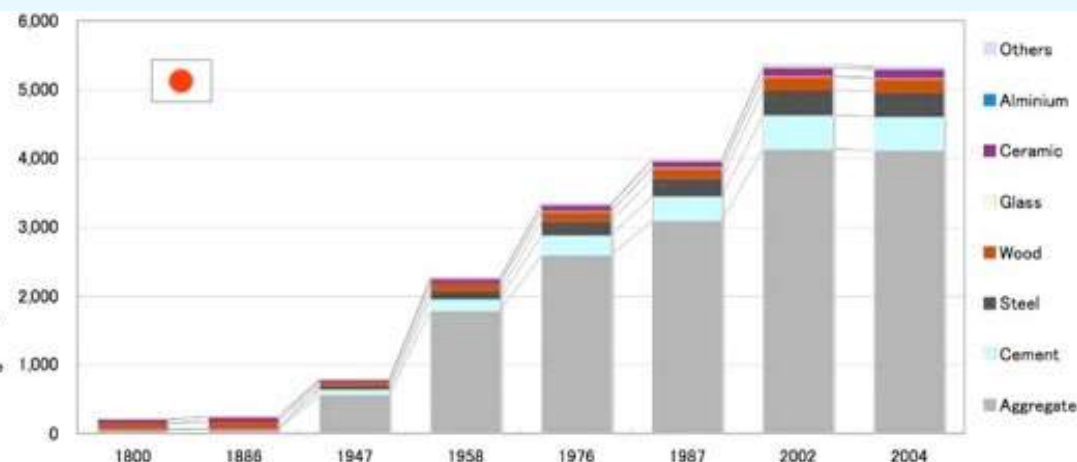
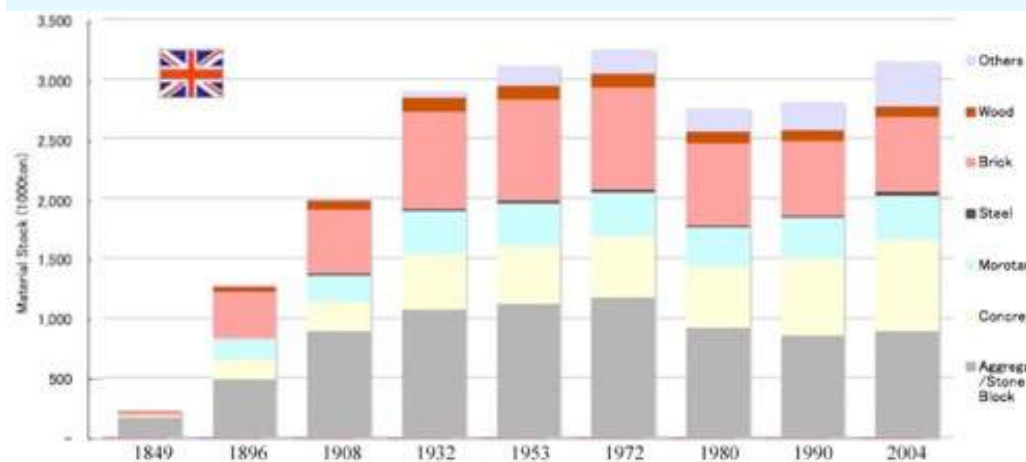
Urban Stock Overtime / 4d-GIS (Four dimensional GIS)



Old Trafford, Manchester, UK 



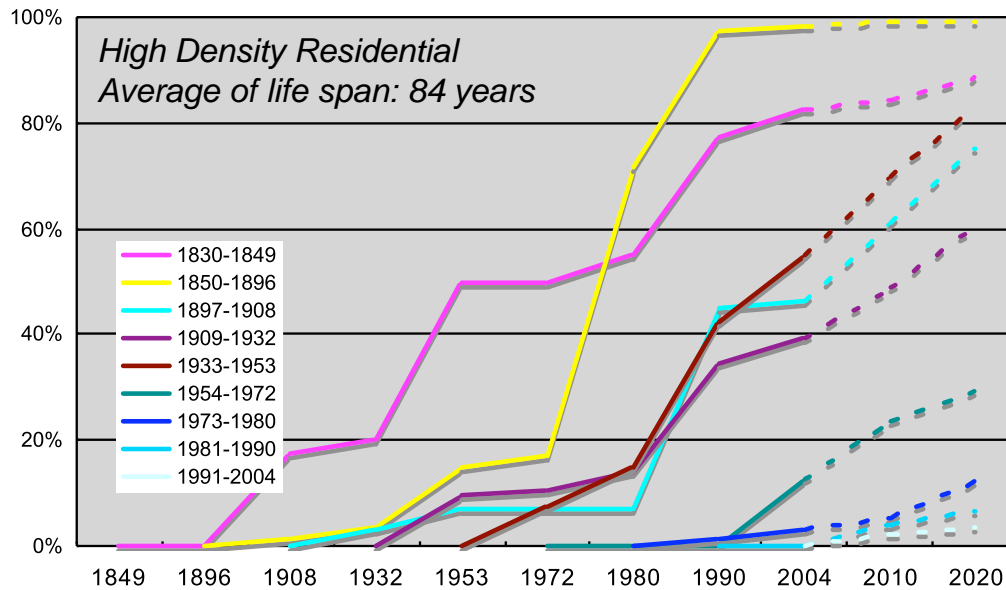
City Centre, Wakayama, Japan 



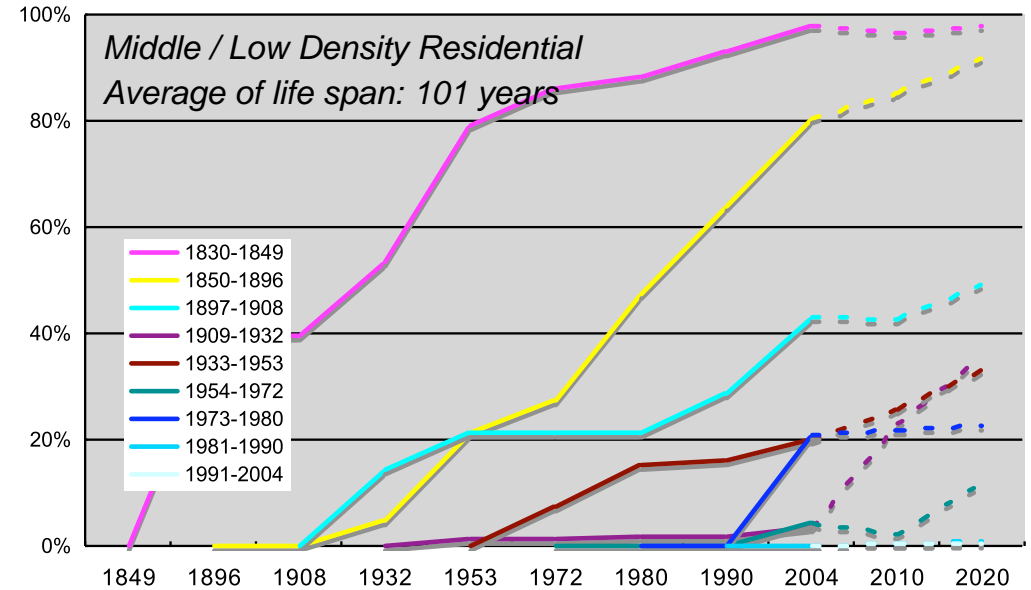


Demolition Rate and Average Life Span of Buildings

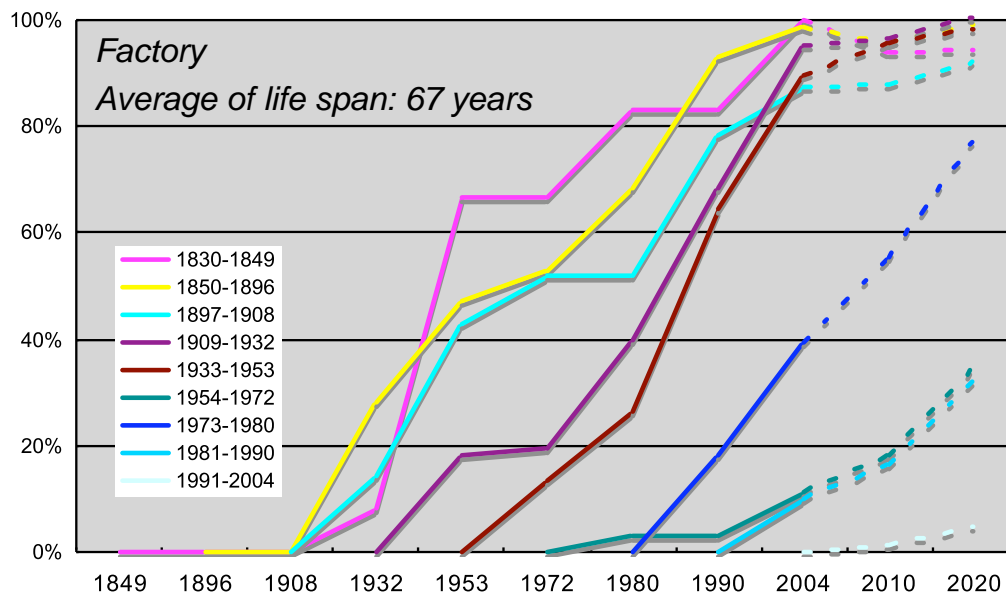
Extended Demolition Rate of High Density Building (%)



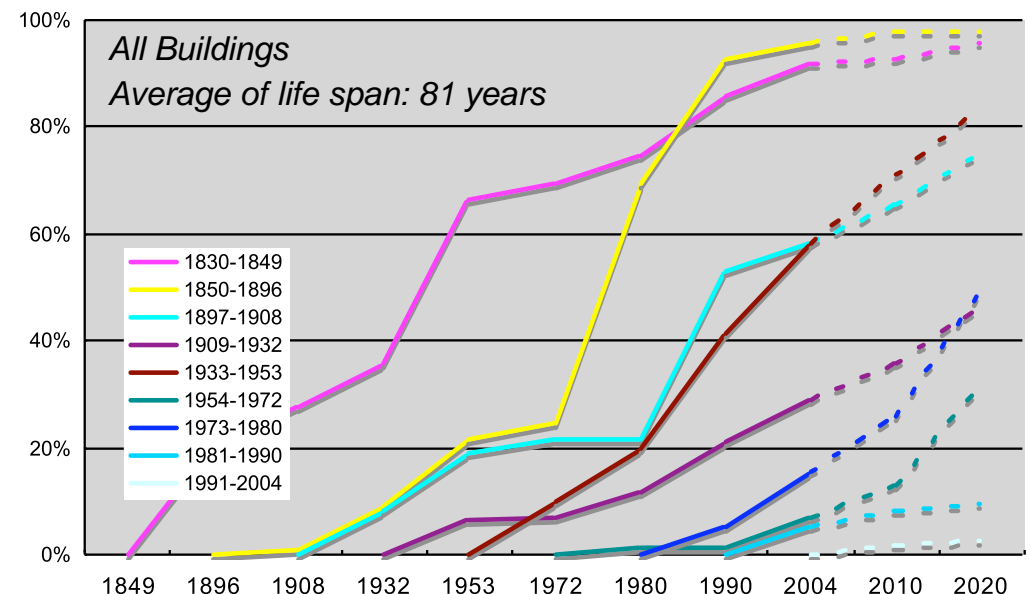
Extended Demolition Rate of Middle / Low Density Building (%)



Extended Demolition Rate of Factory Building (%)



Extended Demolition Rate of All Buildings (%)



Distribution: MS of Building and Infrastructure

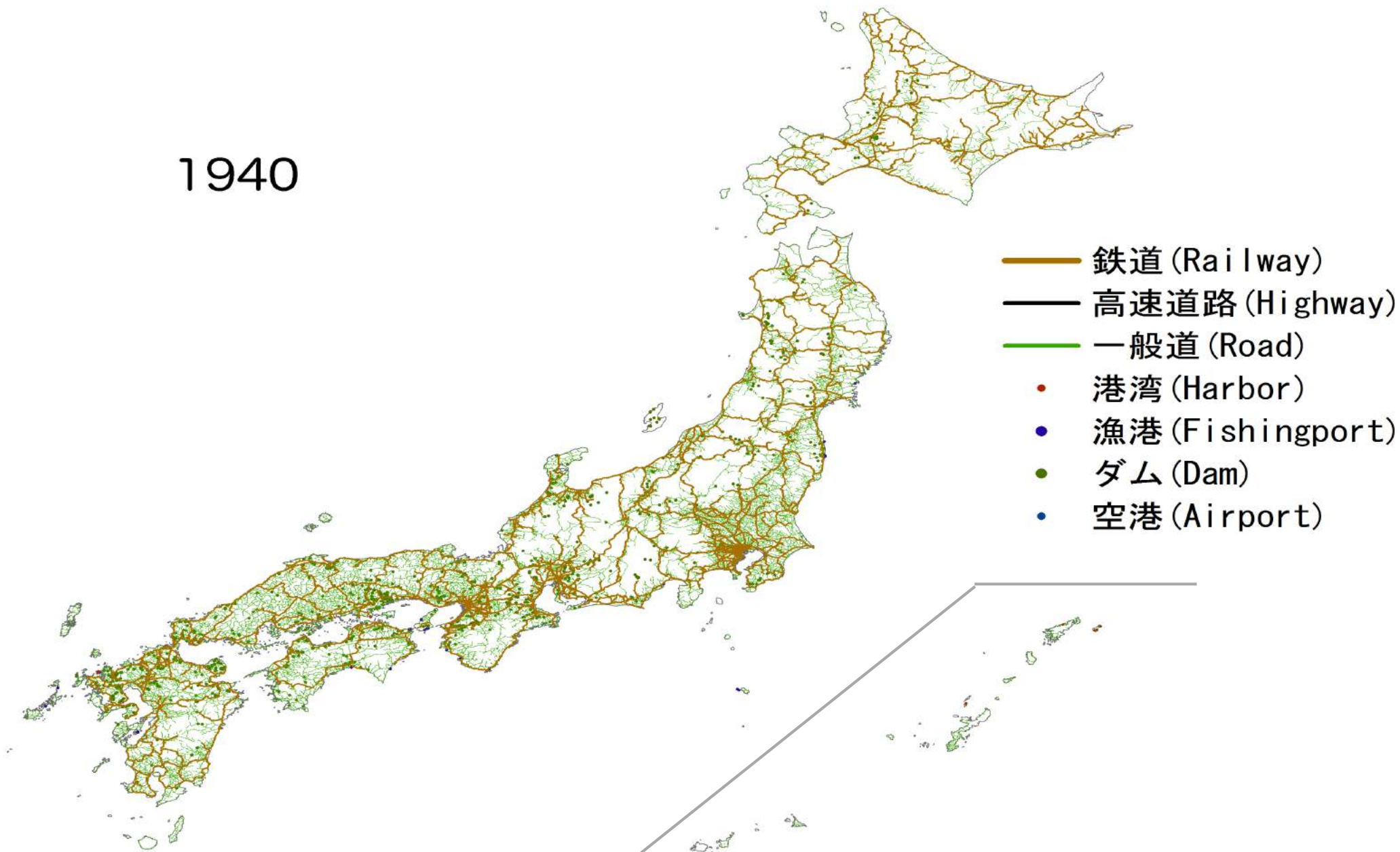


Japan, 2010



Distribution: MS of Building and Infrastructure

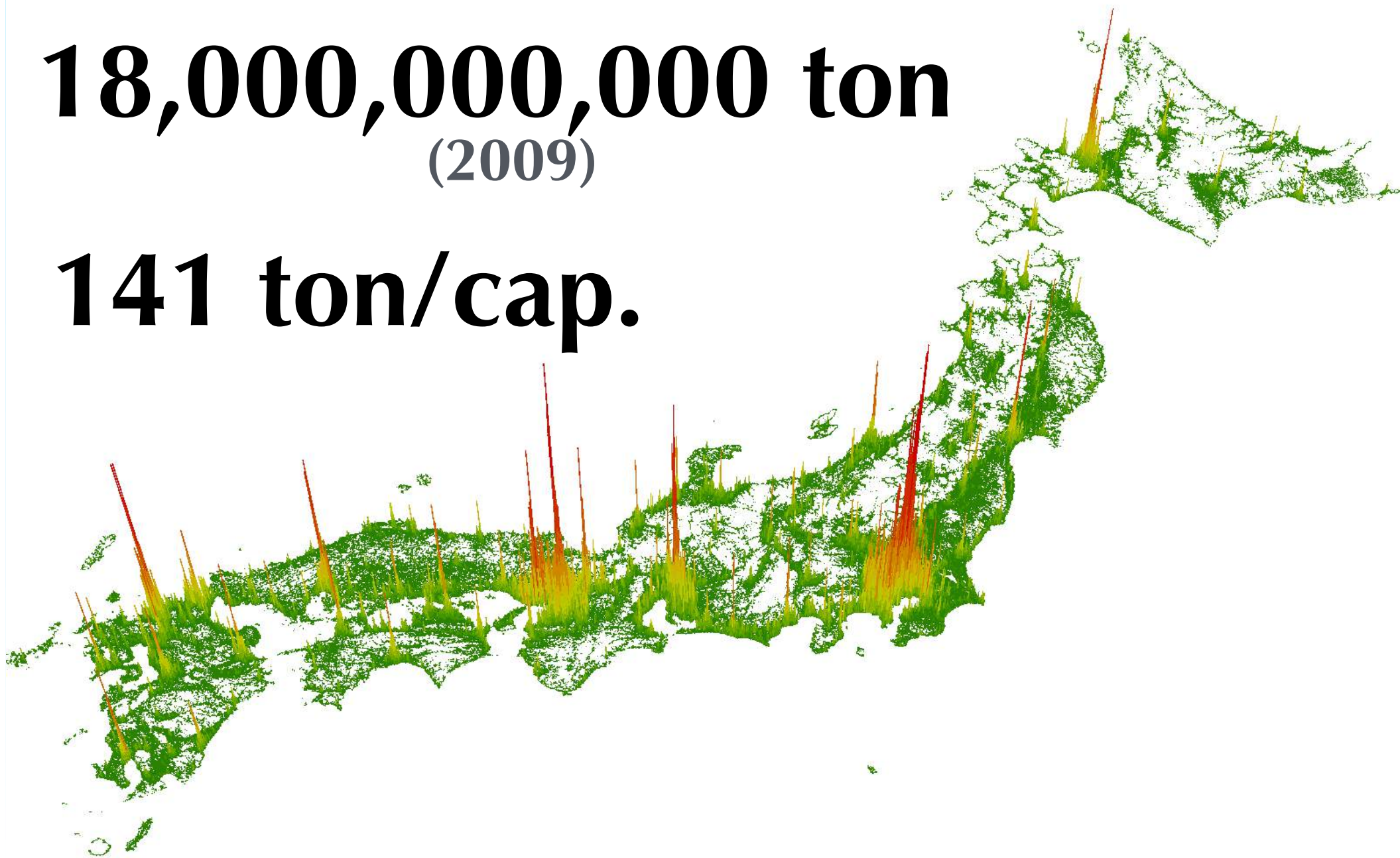
1940



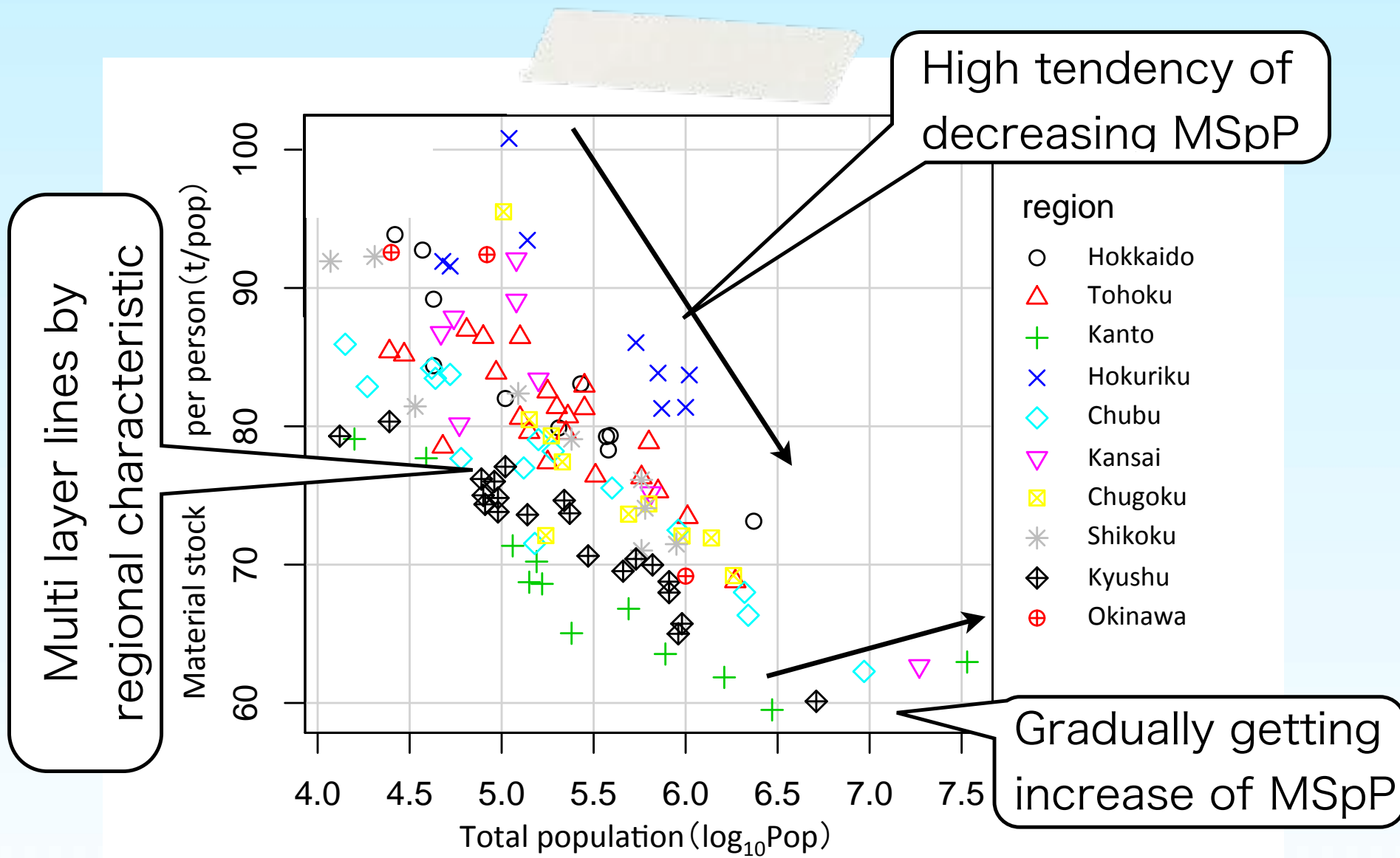
Distribution: MS of Building and Infrastructure

18,000,000,000 ton
(2009)

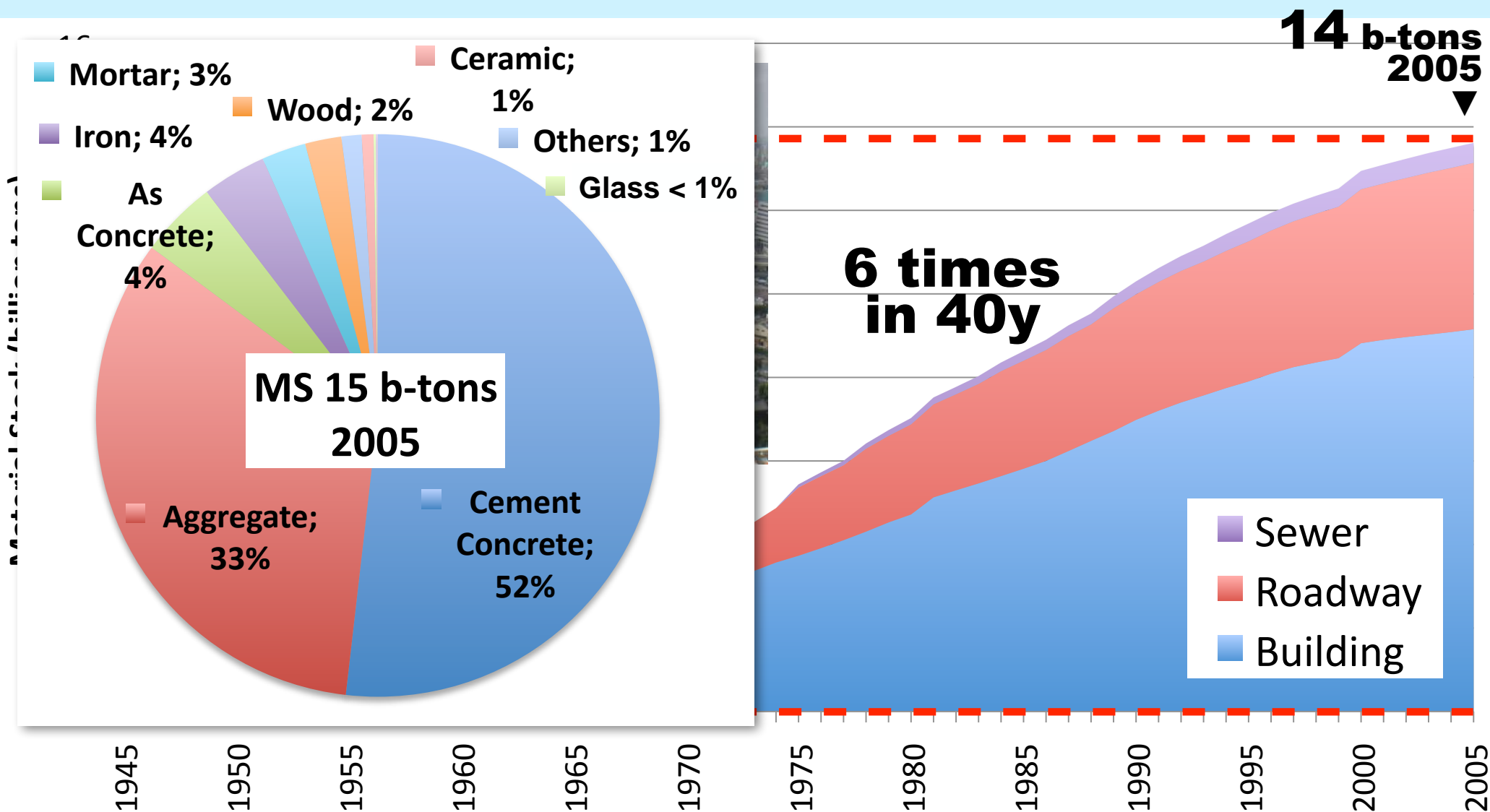
141 ton/cap.



Material stock intensity by population in urban area

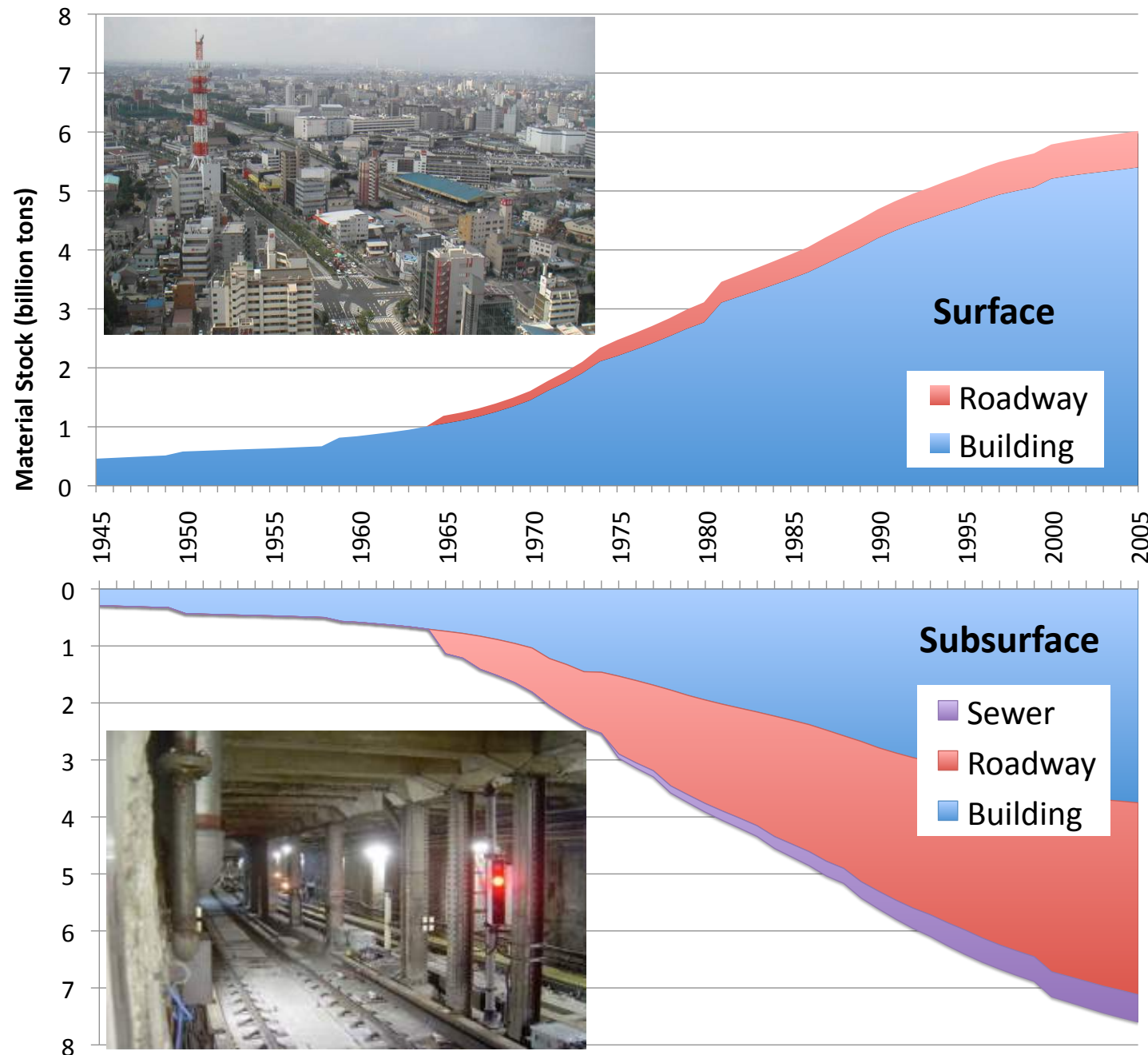


National Scale: MS, Construction minerals (construction minerals, 1945 - 2005, Japan)



Recyclability: National Scale: Surface / Subsurface MS

(construction materials, 1945 - 2005, Japan)



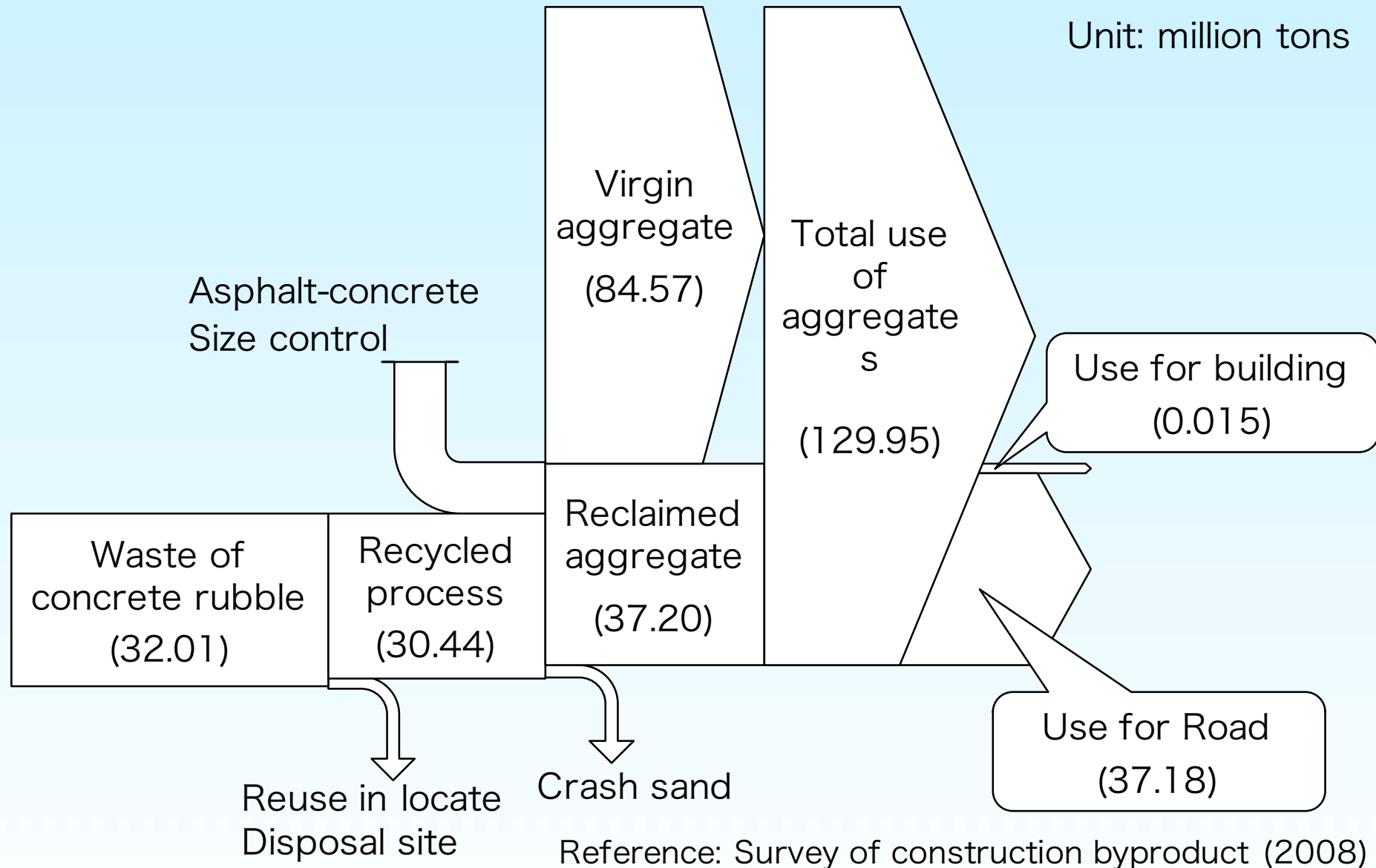
**6.0 b-tons
on ground
in 2005**

**56%
of MS is
underground!**

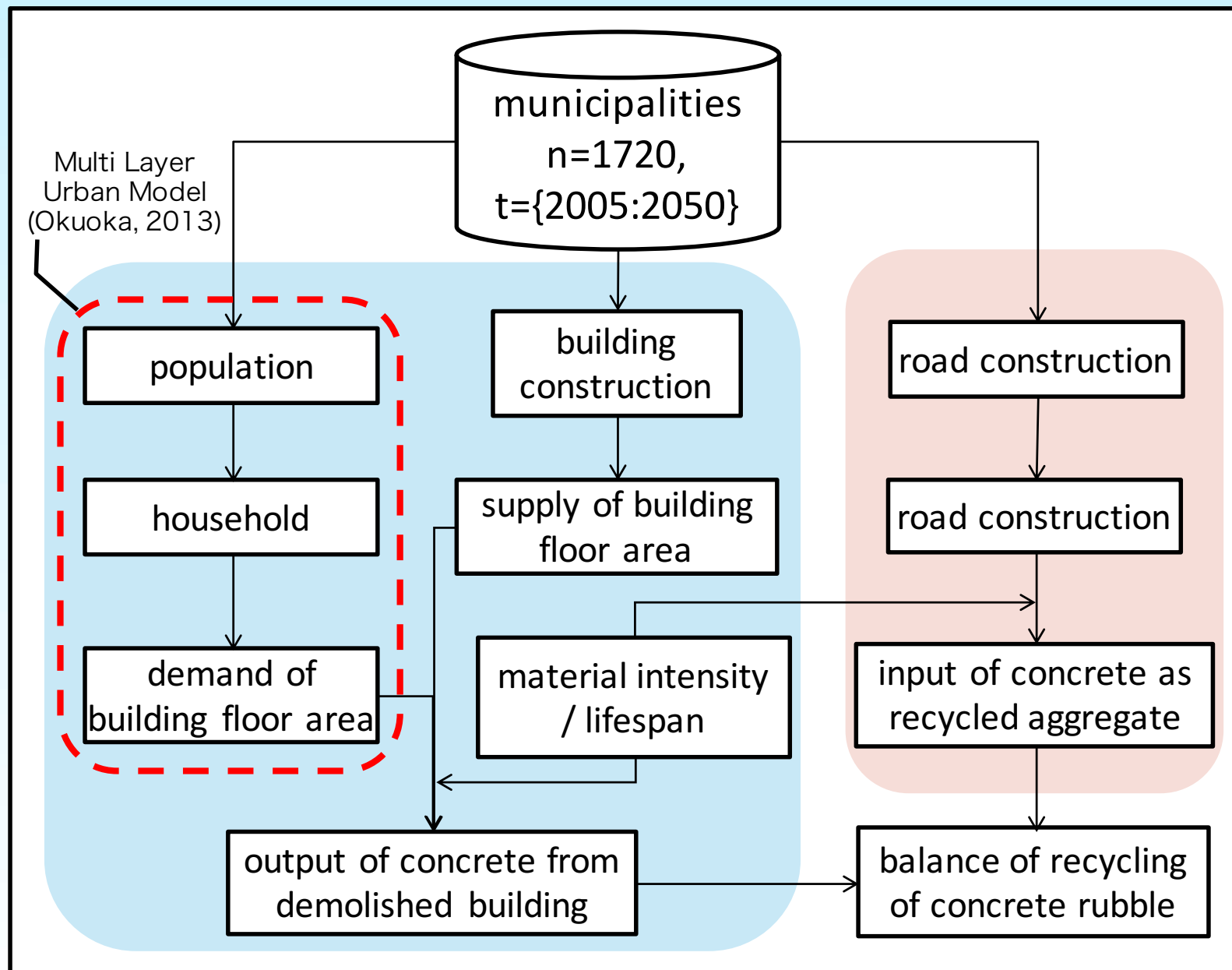
**7.6 b-tons
underground
in 2005**

Recycling flow of concrete rubble in Japan

Unit: million tons



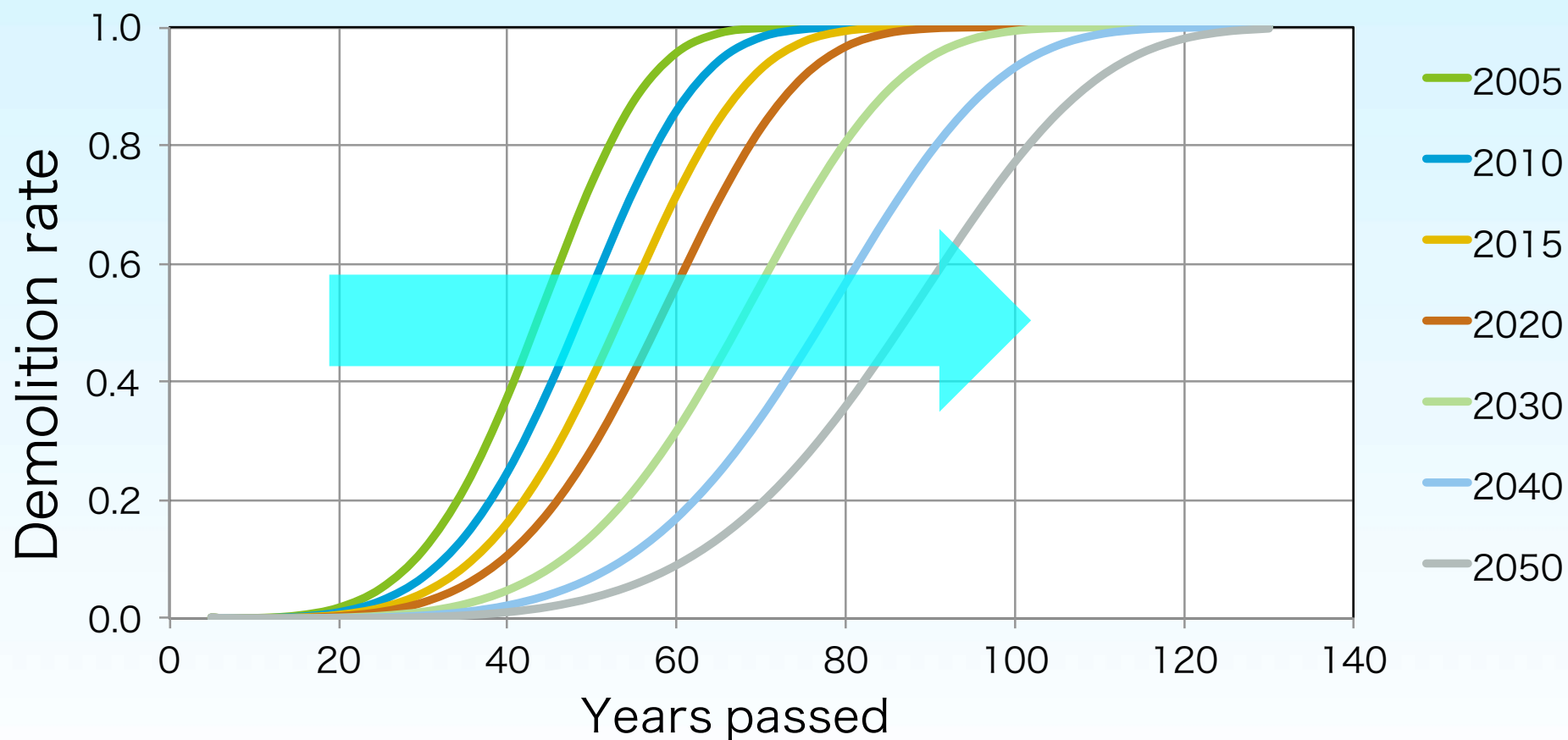
Estimation of concrete rubble recycle



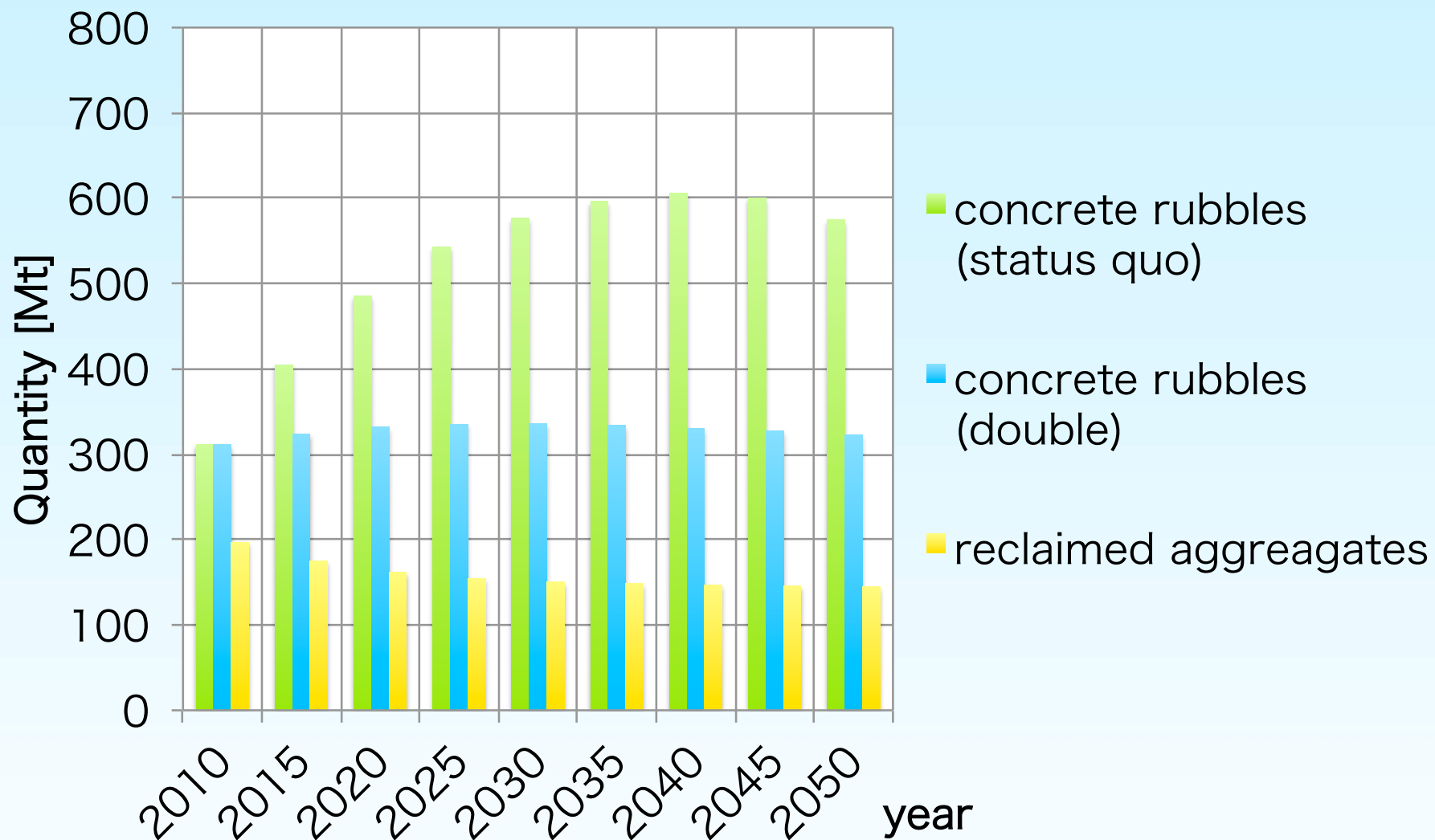
Scenario Setting

- ✓ Lifespan of building : ①Status quo: SQ
②Double*: W

*assume to gradually make lifespans twice longer by 2050



Time-series estimation of aggregation



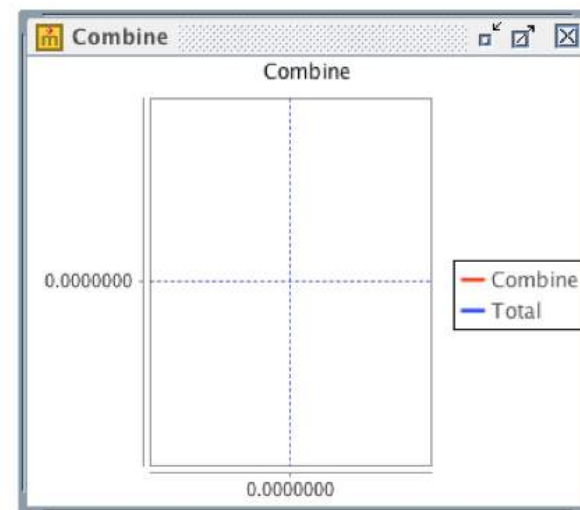
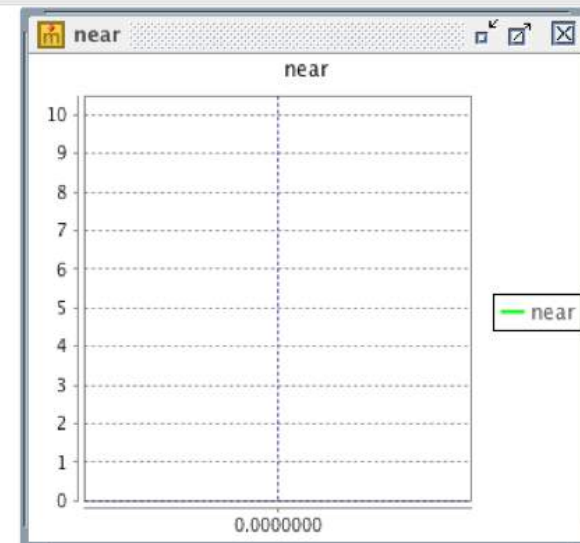
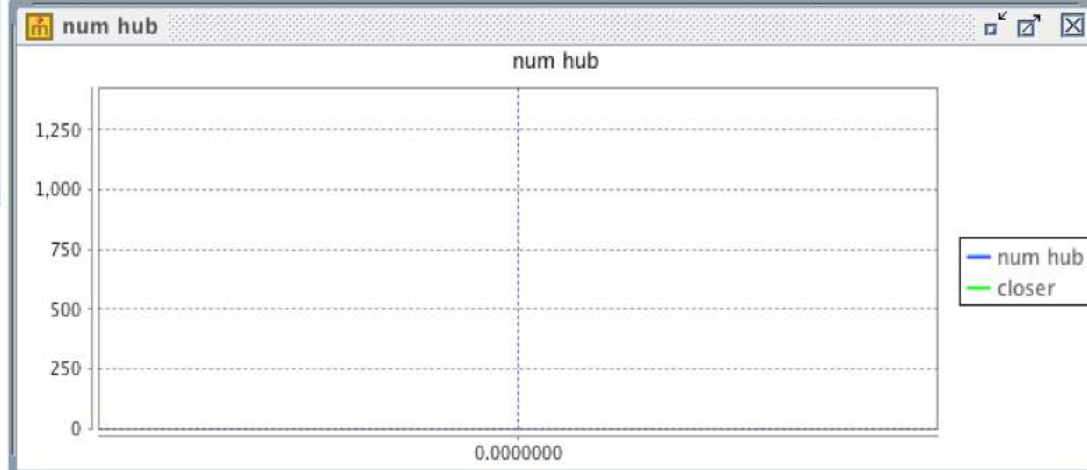
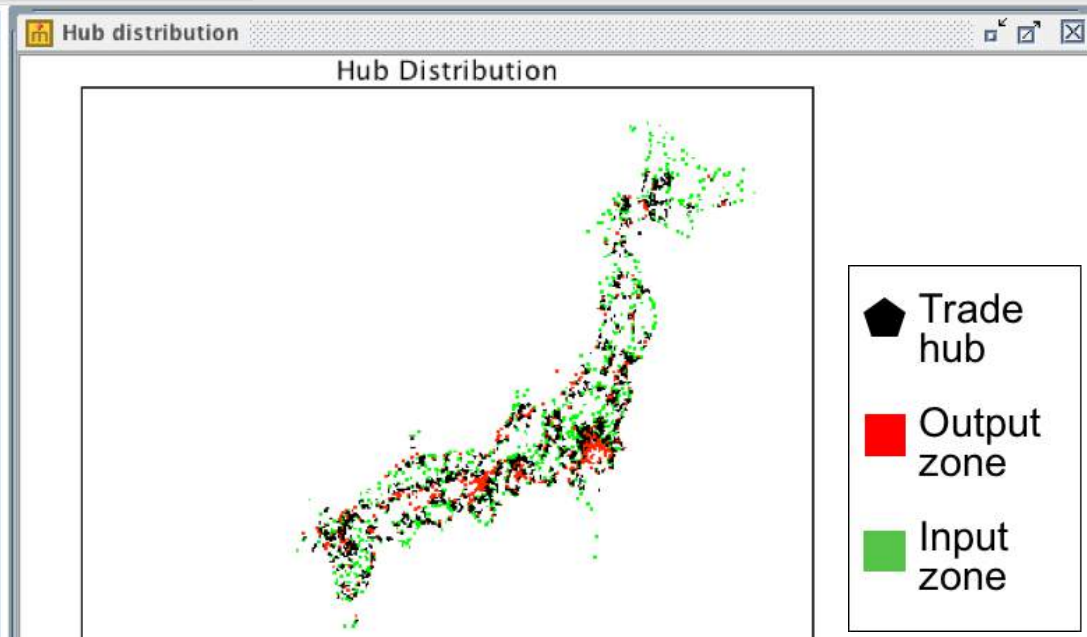
Transportation simulation: multi agent system -Artisoc-

ファイル(F) 編集(E) 表示(V) 挿入(I) 設定(S) デバッグ(D) 実行(R) ログ(L) ウィンドウ(W) ヘルプ(H)

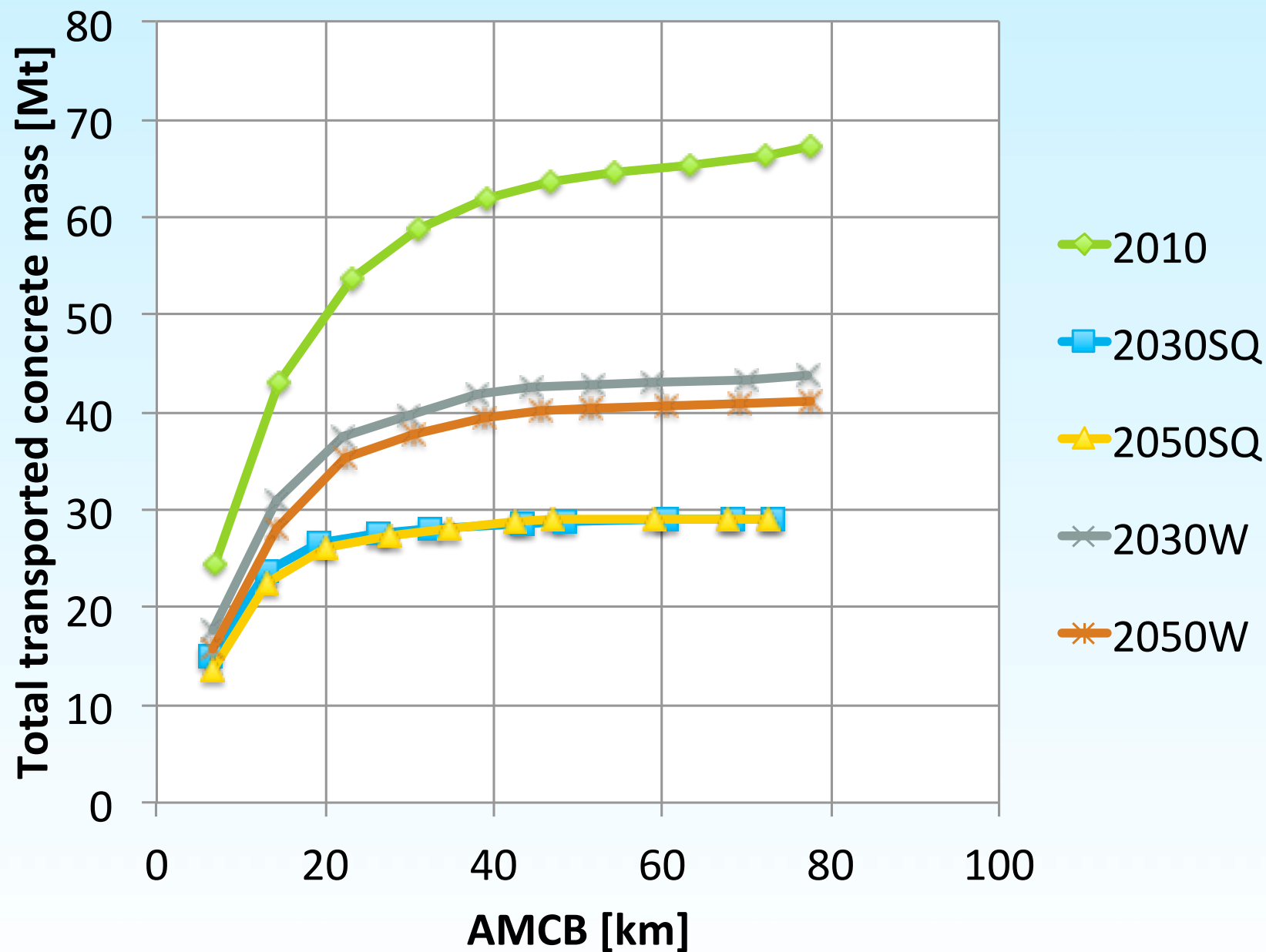


ツリー

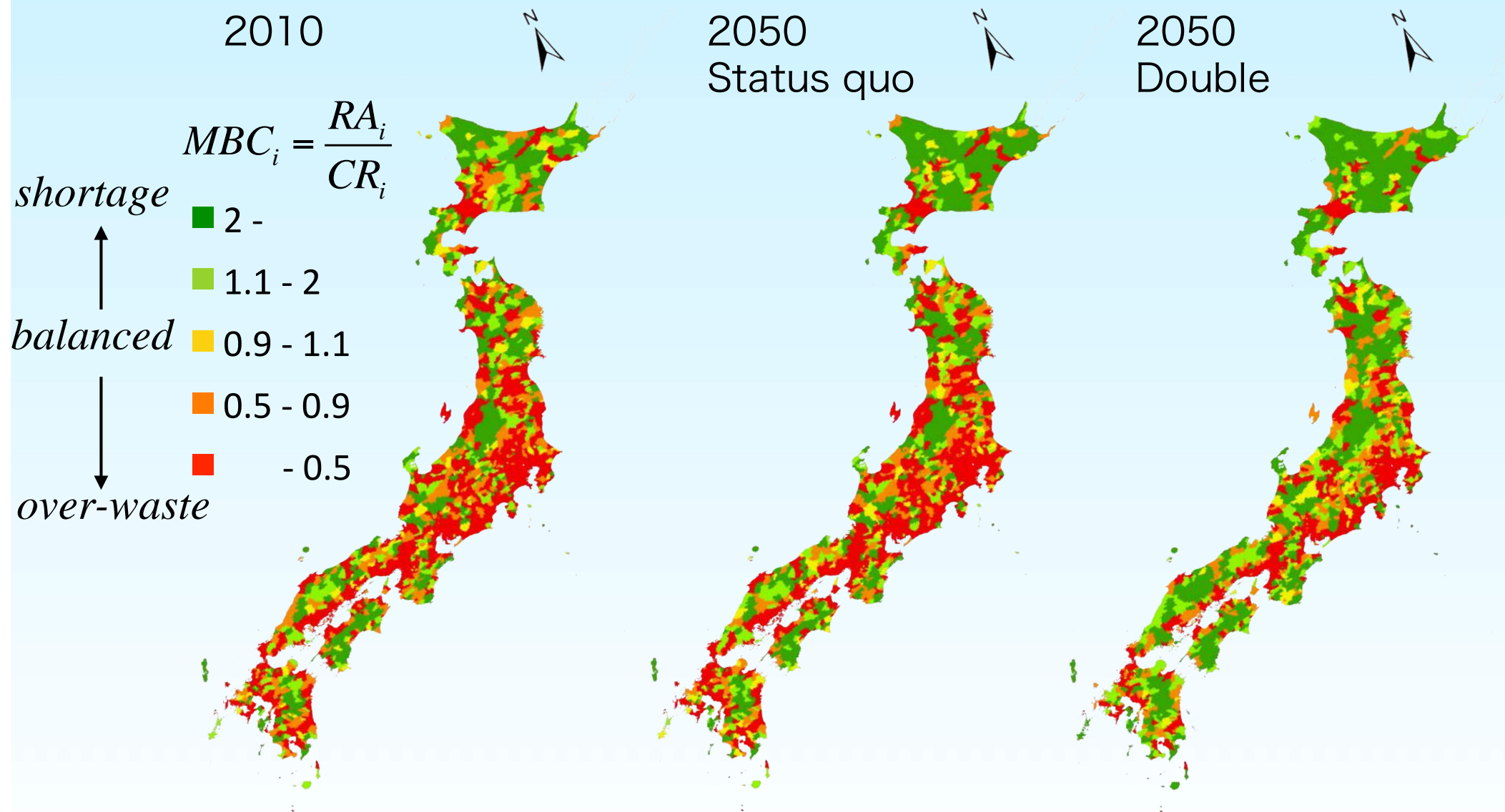
- Universe
 - Japan
 - hub_x
 - hub_y
 - hub_concrete
 - hub_dist
 - num_hub
 - default_hub
 - near
 - combine
 - total_com
 - stable
 - closer
 - year
 - correct_search_hub
 - correct_new_dist
 - muni_xy
 - hub_muni_xy
 - hub_dem_x
 - hub_dem_y
 - hub_sup_x
 - hub_sup_y
 - scenario
 - write



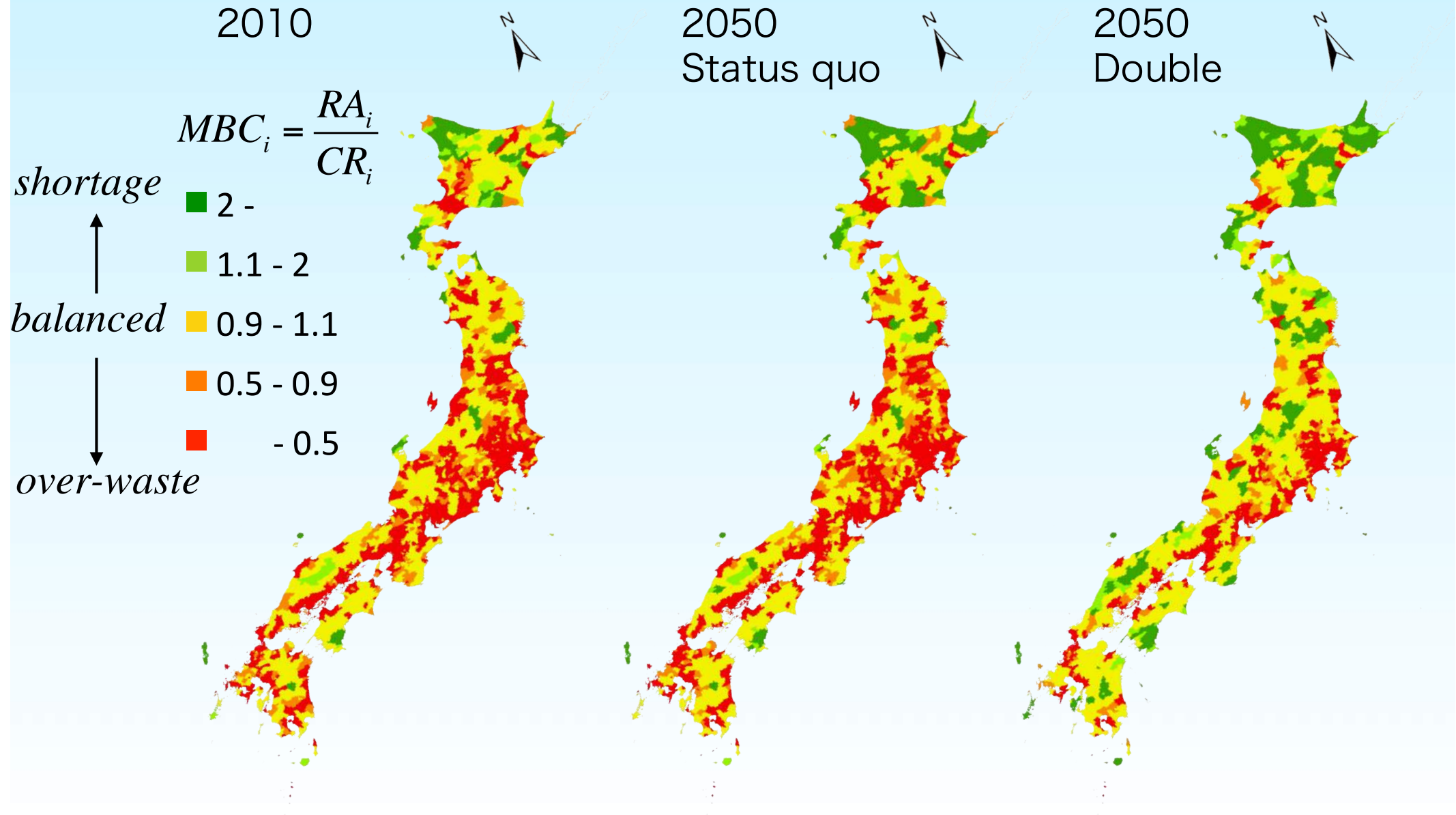
Quantity of trade of concrete rubble



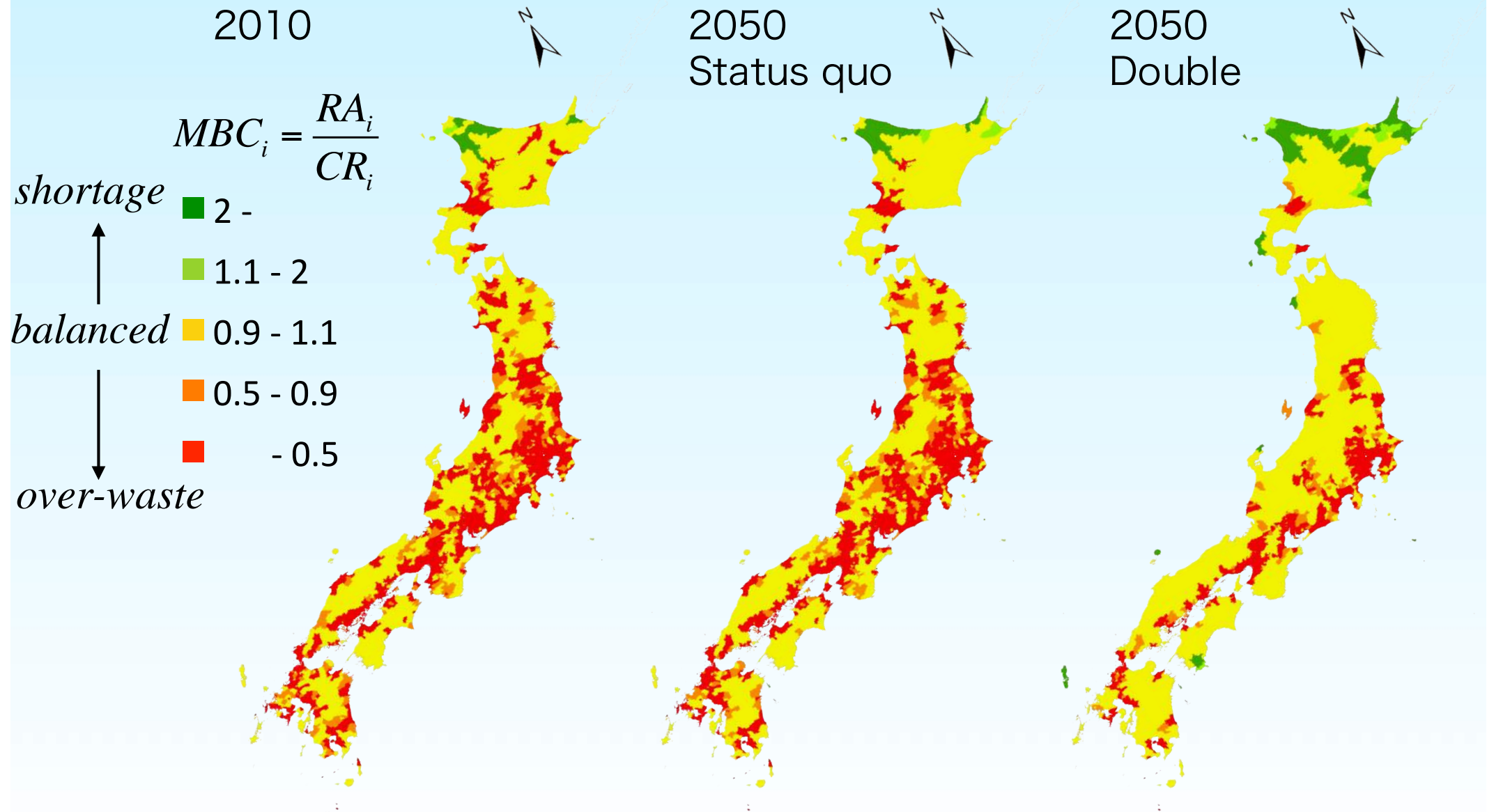
Material balance of recycle distribution (non-transportation)



Material balance of recycle distribution (20km transportation)

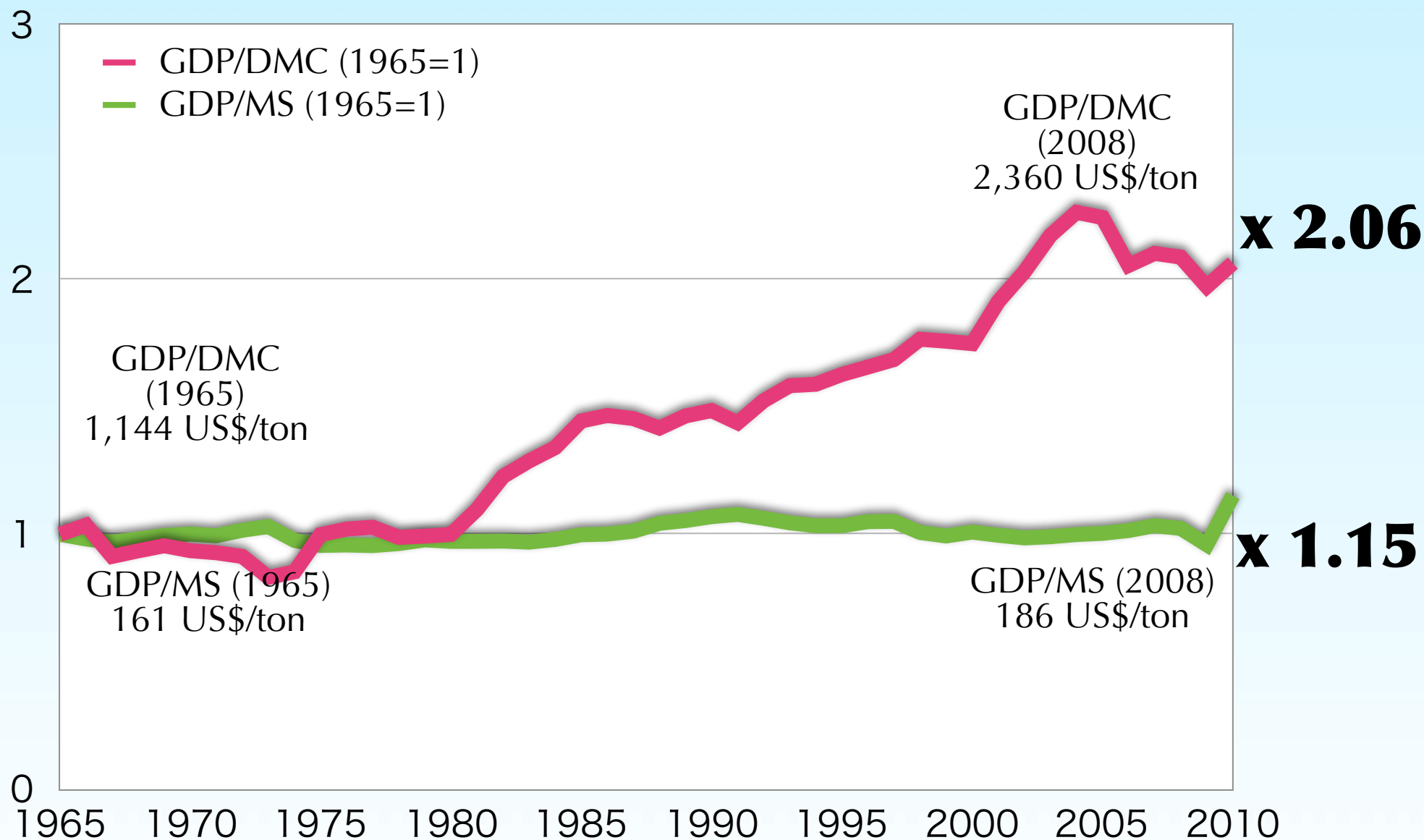


Material balance of recycle distribution (50km transportation)



Material Productivity, Japan, 1965-2010 (1965=1)

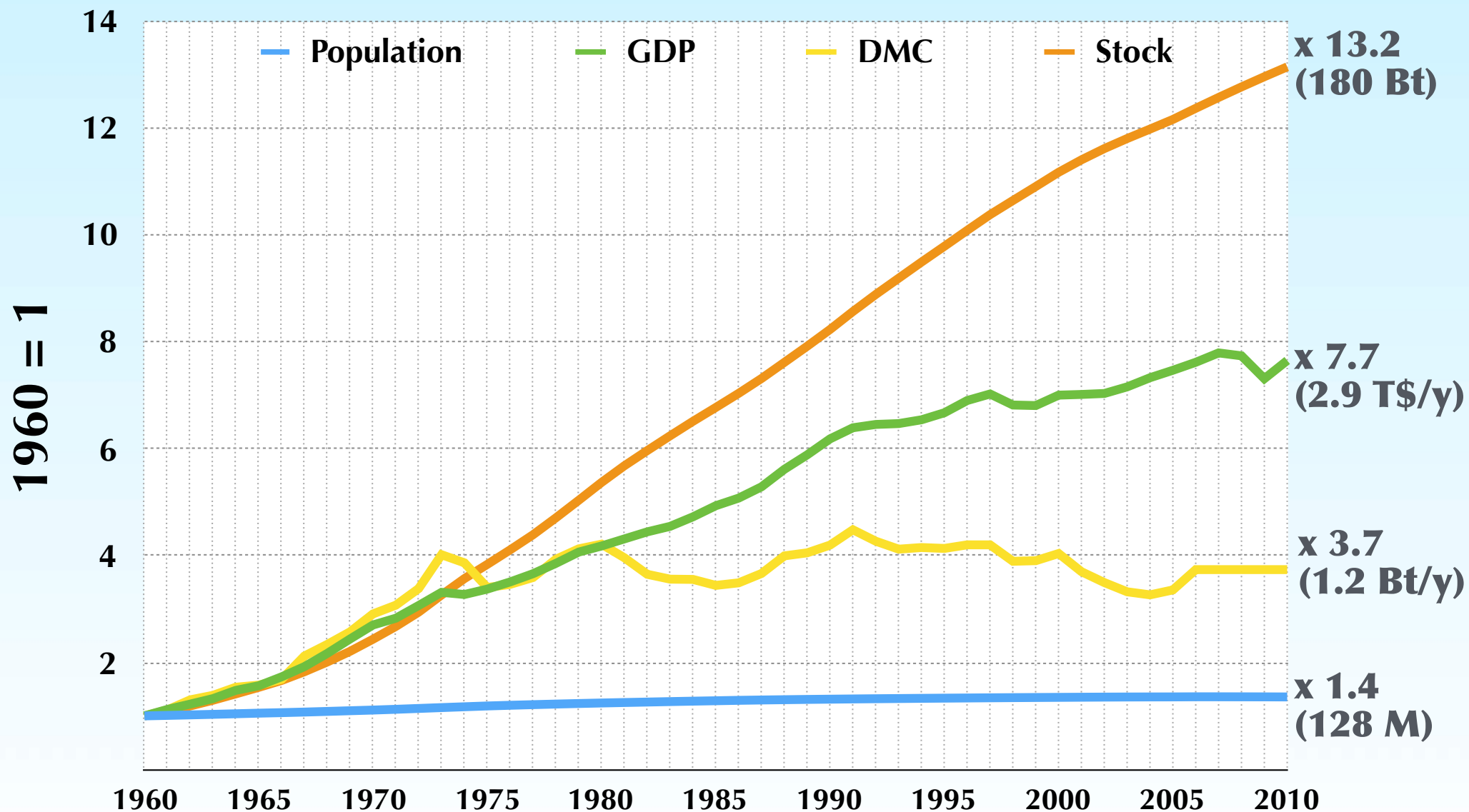
(MS includes construction minerals, metals, and timber)



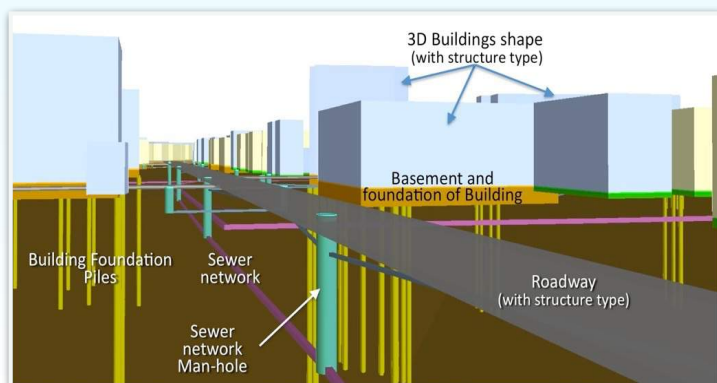
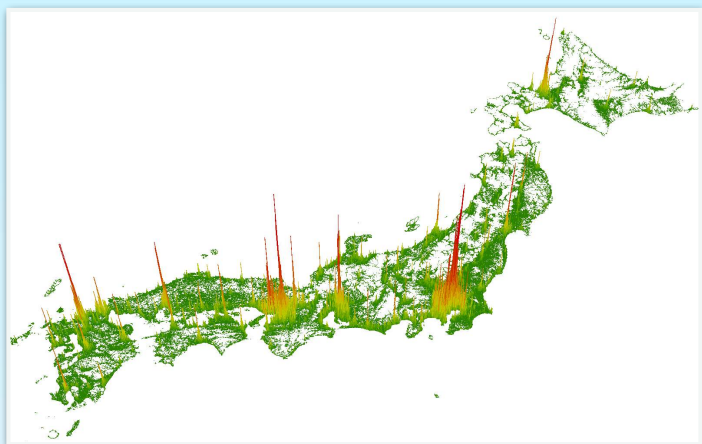
GDP: constant 2000 JPY - USD

MS / MF Indicators: Japan, 1960-2010

(1960=1, MS includes building and infrastructure)



Practical Application on MSFA



Setting MSFA Indicator to support national Law

-The Fundamental Plan for Establishing a Sound Material-Cycle Society, MoE (循環型社会推進基本計画, 環境省)

Three Material Flow Indicator + Stock Indicator

-Stock type society and longer life span structure
-International Studies of 4dGIS and MSFA

Action on Climate Change and Resource Issue

-Possible avoidance of CO2 emission with controlling metabolism

-Connect CC to Resource Consumption (steel, cement)
-Examine Possible Adaption options

Management of “Demand” and “Supply” of Recycling Materials, Regional Circulation Area

-Understanding changing patterns of urban mass

-Efficient use of raw materials

-Maximizing / Optimizing Recycling Systems

Resiliency and Disaster Waste Management

-Disaster Waster management plan for local government

-Network Analysis of extra ordinal situation



Looking forward to seeing you in Nagoya Univ, 28-30 Sep. 2016



ISIE SEM
AP 2016
Nagoya



ISIE SEM AP 2016 Nagoya

The joint 12th International Society for Industrial Ecology (ISIE)
Socio-Economic Metabolism section conference
and the 5th ISIE Asia-Pacific conference

28-30 SEPTEMBER 2016
NAGOYA, JAPAN



<http://isiesemap2016.org>



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Thank you for your attention

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tanikawa@nagoya-u.jp

