

# The Role of Zoning in Cross-border Industrial Land Transition: Lessons from Tokyo Metropolitan Area

Keywords: Peripheries, Temporal-spatial analysis, Spatial pattern, Land use, Regional development

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# Contents

## 1. Background and Objectives

Complexity and challenge of regional development  
Industrial space in metropolitan peripheries  
Research planning in periphery via lens of industrial land  
Objectives of this research

## 2. Research Framework

Position of industrial land transition in zoning system  
Hypotheses based on modified Bid Rent theory  
Roadmap and Suburban Development Zone  
Data used

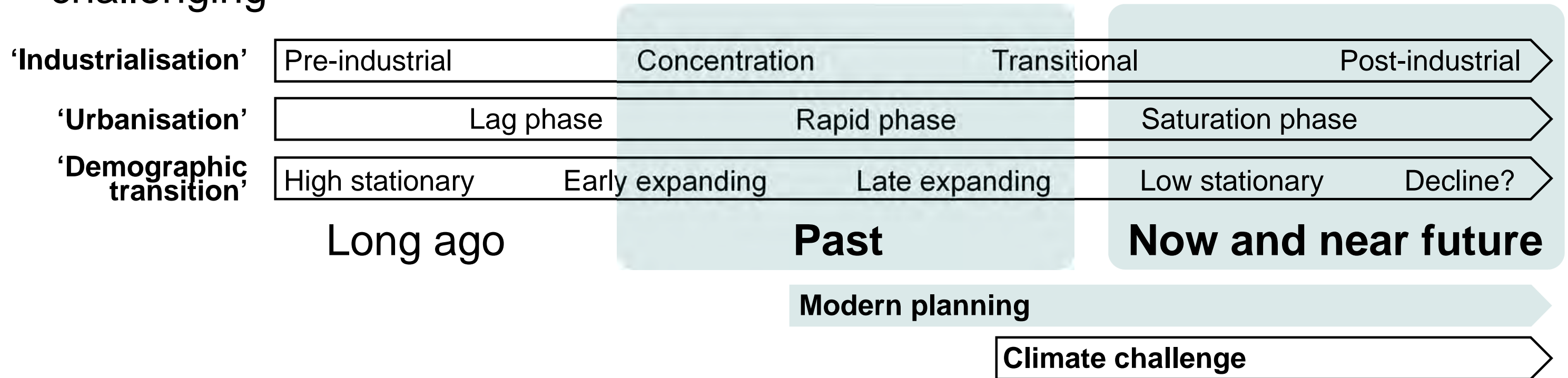
## 3. Results

Multi-layer analysis  
Industrial land transition at metropolitan scale  
Absolute and relative amounts of industrial land transition  
Hierarchical clustering for samples of industrial space  
Descriptive statistics for 6 industrial spatial patterns  
Features of industrial land transition  
In each land use zone

## 4. Discussion and Conclusion

# Complexity and challenge of regional development

Sustainable planning in **urban peripheries** for the future is complicated and challenging



## Tokyo Metropolitan Area (TMA):

- Secondary **industrial employment and shipping value decrease** from 1990 (MLIT, Japan)
- Population-based **urbanization level** is nearly 90% (by 2018 data, Japan Nationwide 70.5%), rapid phase ends around 2000
- Minus natural population growth since 2010, current ageing rate 26%, **peak population** expected before 2030 (MLIT, Japan and Tokyo Pre.)

■ **Challenge: drastic land use change in the metropolitan peripheries**

## Industrial land in metropolitan periphery

- **Historical result** and **driver** of urbanization
- **Leapfrog development** and Land use conflicts between **conservation** and **development**
- **Hectic road transport** and vehicle commuting
- Sensitive to demographic transition
- Key role in the **complexity** of urban peripheries



from Google map



Landscape of periphery industrial space in Tokyo Metropolitan Area (TMA)

# Research planning in periphery via lens of industrial land

## Planning in the peripheries:

- Approaches and challenges for sustainable planning in urban peripheries (D. Geneletti, et al., 2017)
  - Peripheries are **not a focus** of sustainable planning research
  - Approaches are mainly context-specific and solution-oriented
  - Multi-scale and multi-sector research is needed for urban peripheries
  - Urban peripheries offer opportunities for environmental sustainability
- **Zoning—land use mismatch** and tradeoffs between different land use planning (E. Talen, et al., 2016 / M. Dorning, et al., 2015)

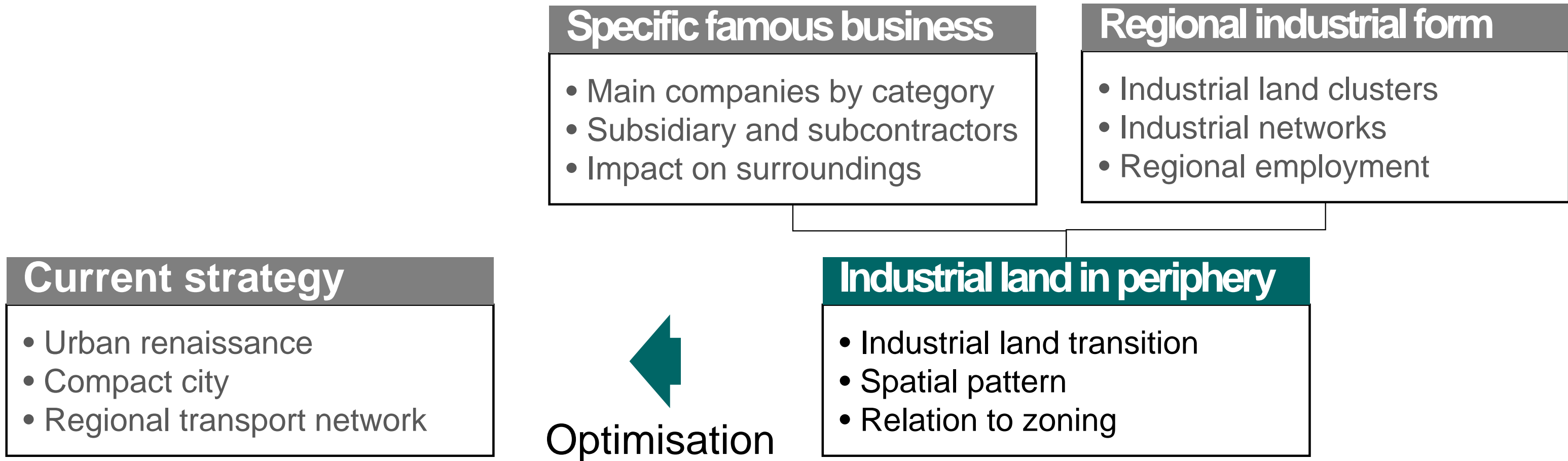
## Industrial land in the peripheries:

- **Typical cases** study of industrial and urban developments (K. Shimooka and J. Asano, 2019)
- Relation between urban renewal and **industrial land location** (A. Kondo, 2017)
- Landowner interactions and **spatial development patterns** (J. Koch, et al., 2019)

## ■ Bridge the two fields for sustainable planning in urban peripheries

- Review of regional industrial land transition
- Study its relation to zoning in metropolitan peripheries

# Objectives of this research

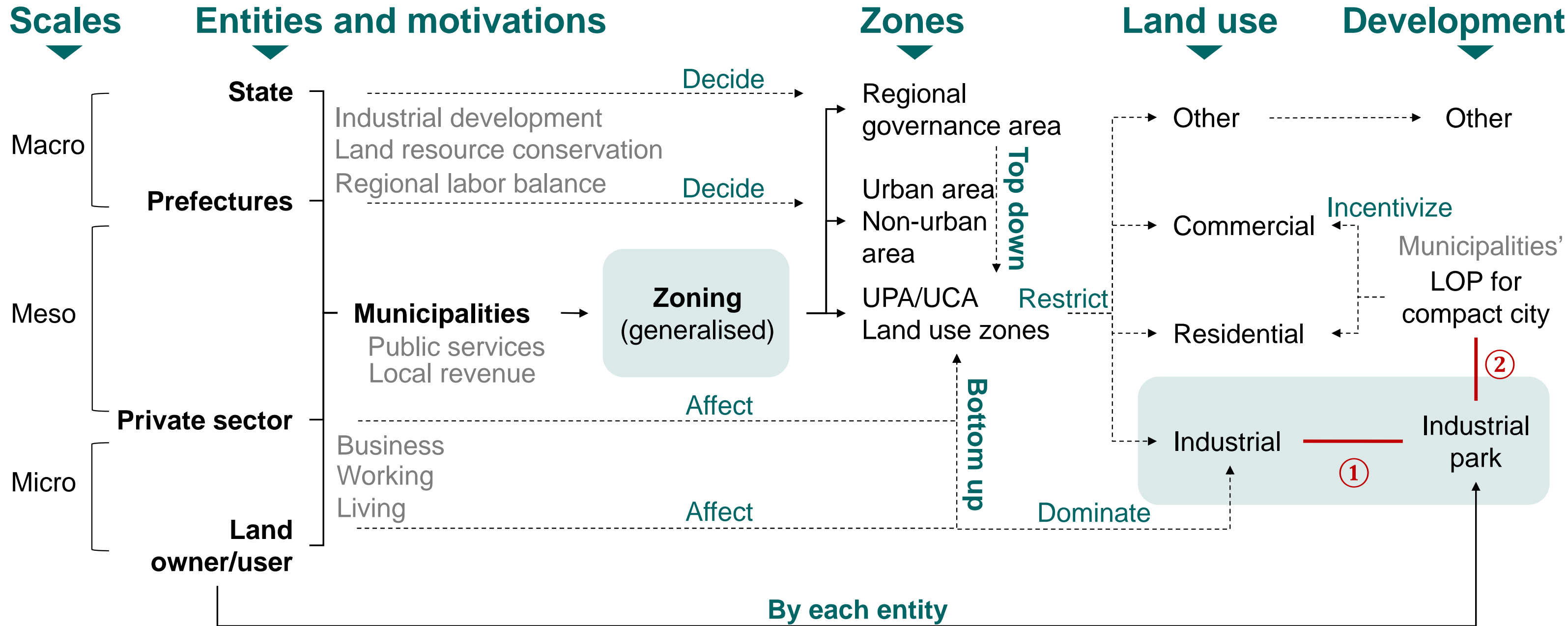


To clarify the **features of industrial land transition** in Tokyo Metropolitan Area (TMA) and verify **the relevance of periphery zoning**

## ■ Significance

Deepen urban periphery research for sustainable planning  
Bridge land use planning and urban planning

# Position of industrial land transition in zoning system



## Issues to be solved:

- ① Spatial order: how many industrial land transit to planned area
- ② Spatial pattern: how the transition affect to work-live linkage

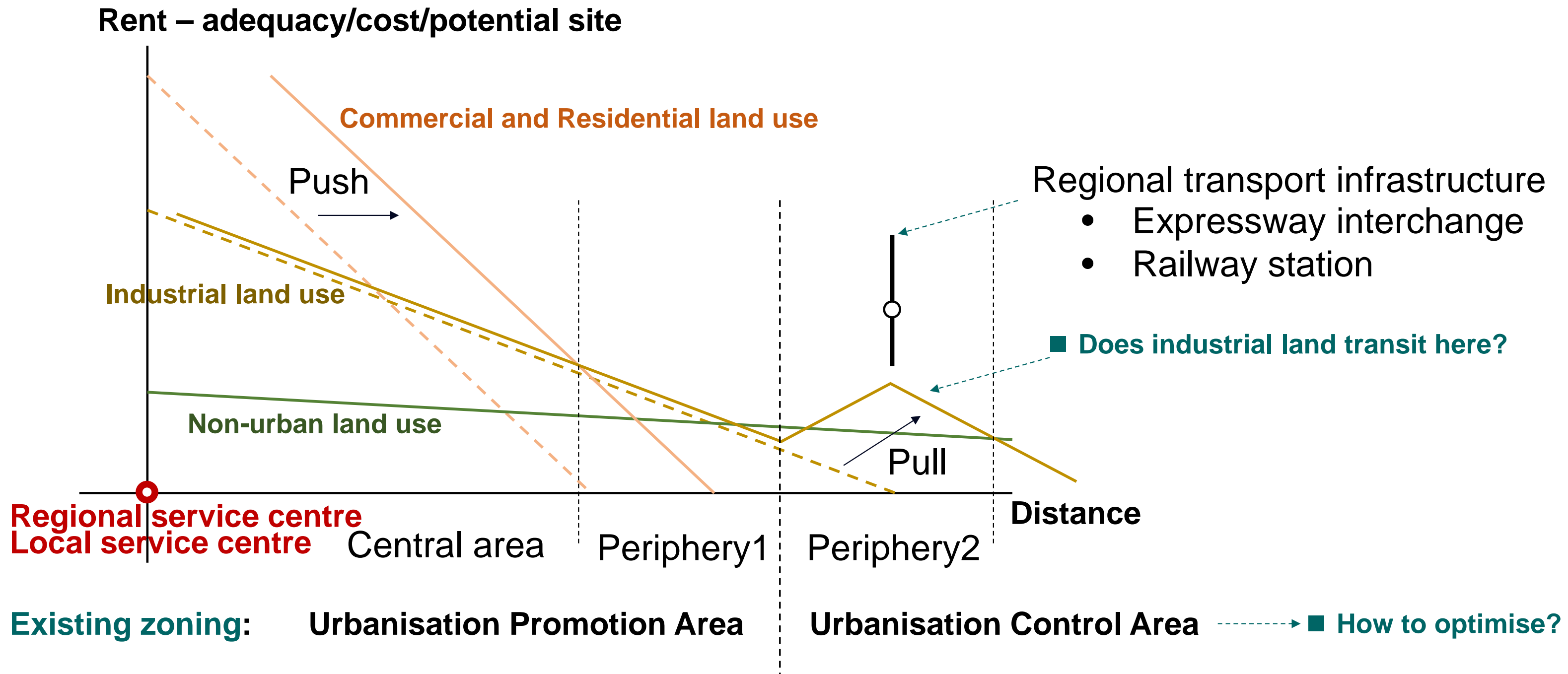
UPA: Urbanisation Promotion Area  
UCA: Urbanisation Control Area  
LOP: Location Optimisation Plan

# Hypothesis based on modified Bid Rent theory

## Industrial land transit to peripheries with transport infrastructure

**Push** – Population/employment increase → outwards urbanization(growth/sprawl)

**Pull** – Regional transport network develop → transport-sensitive land use relocation

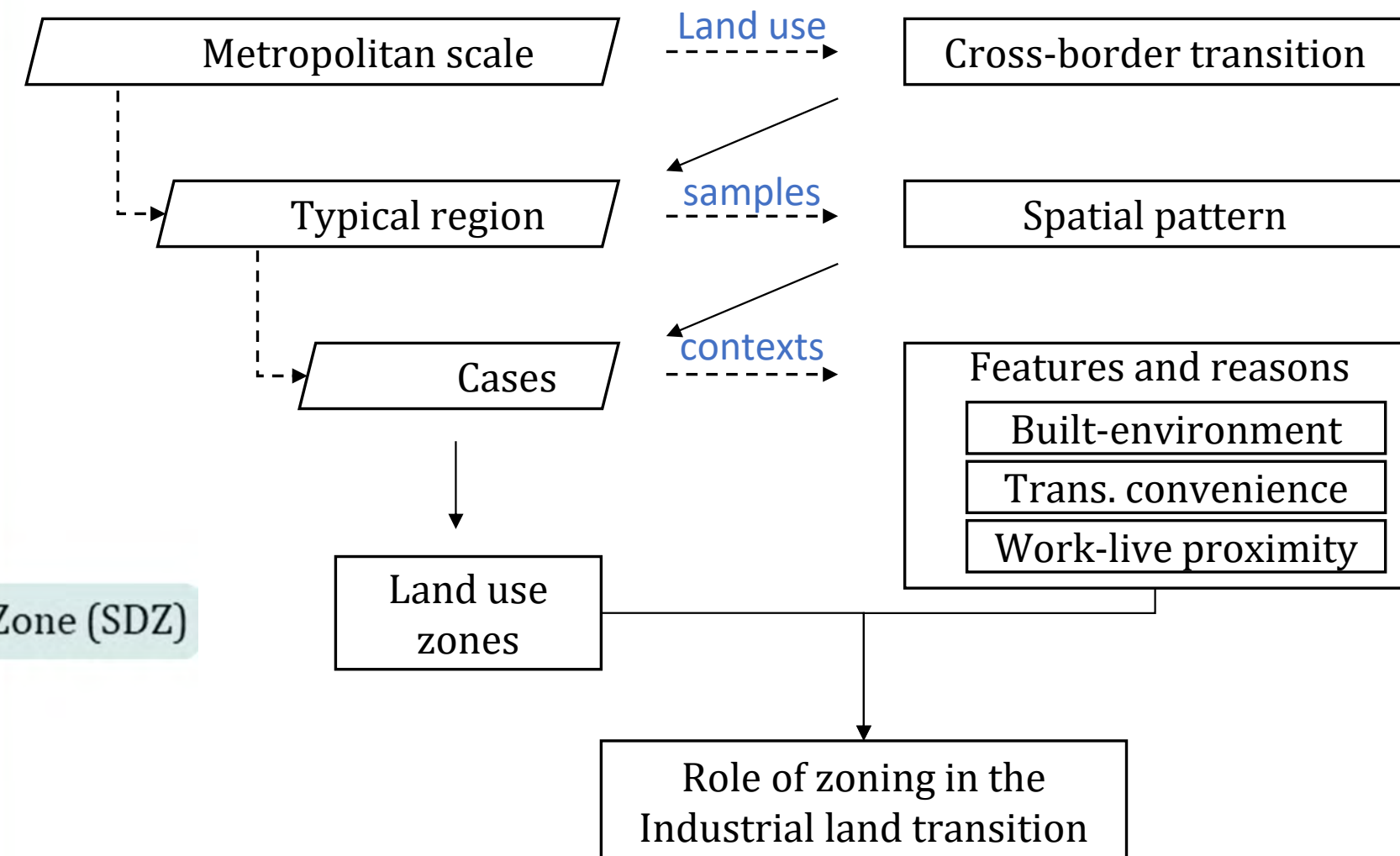
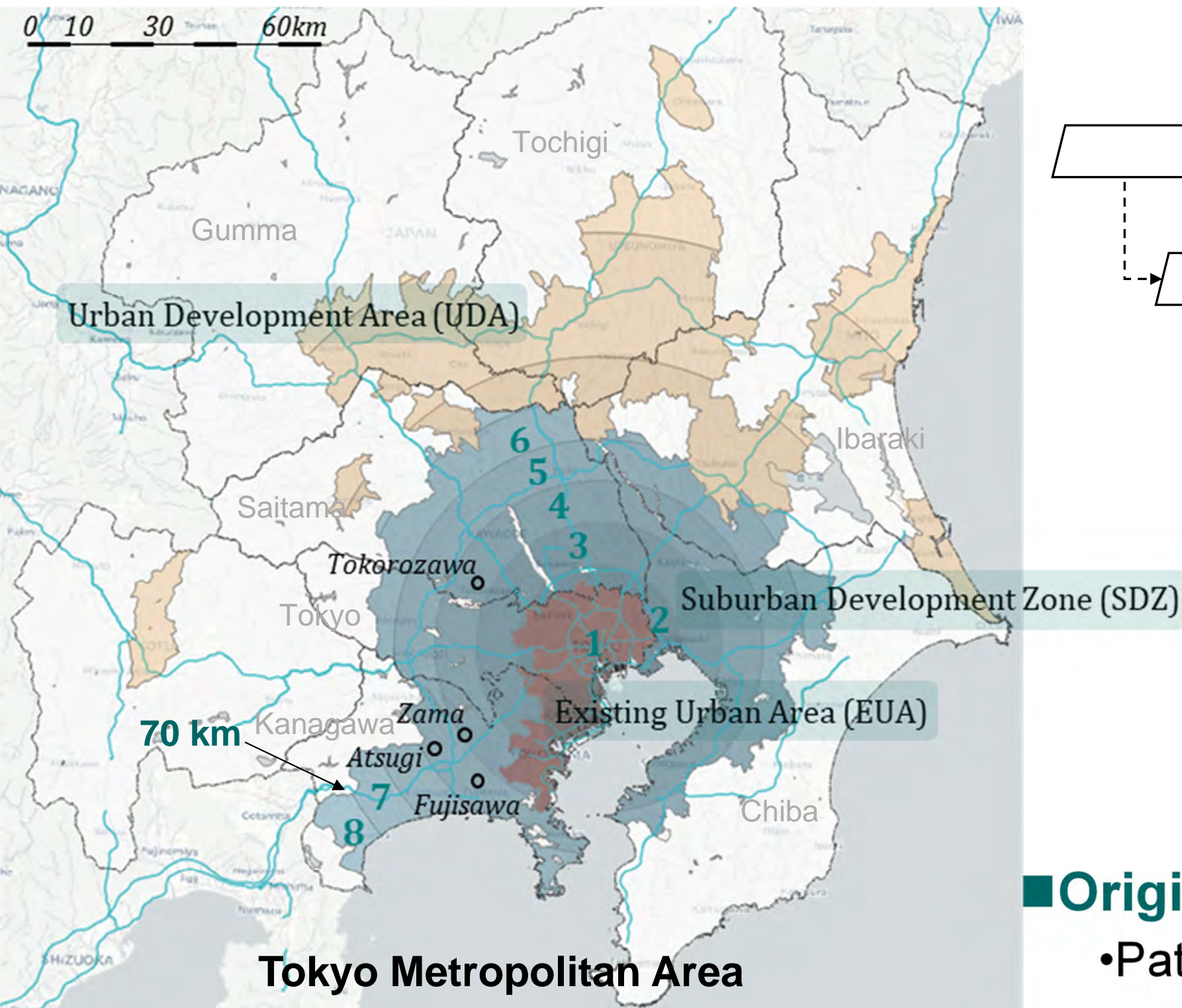




# Roadmap and Suburban Development Zone

**Study area: SDZ** preserve green space and promote well-planned urbanisation

- UDA for ease the concentration of industry and population into the metropolitan centre
- EUA promote capital city infrastructure while suppress over-concentration of industry and population



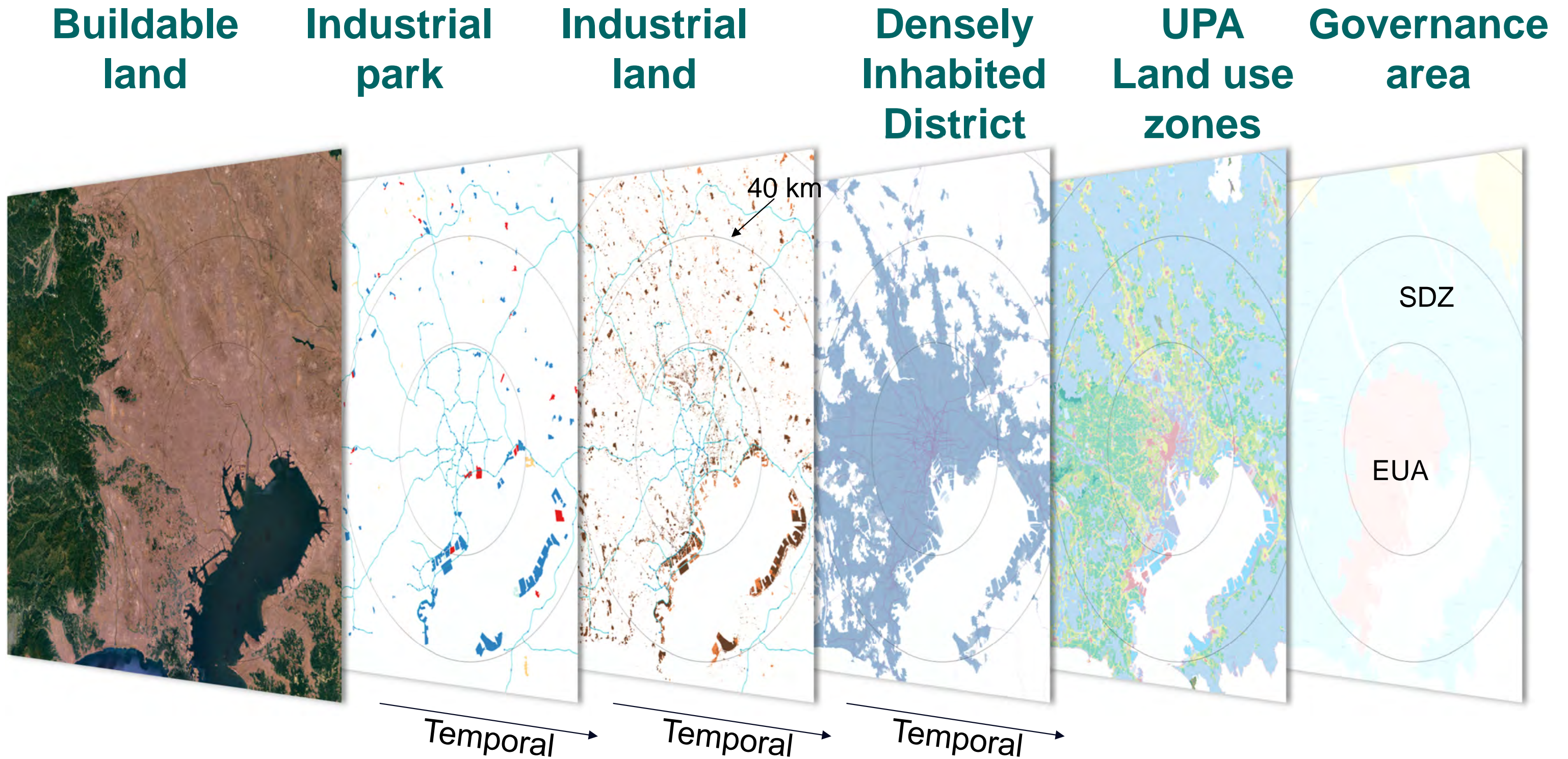
## Originality:

- Pattern-based temporal-spatial regional research

# Data used

Group	Dataset	Source	Parameters	Assumption
<b>Zoning (generalised)</b>	Governance area of TMA	MLIT 2007	Existing Urban Area (EUA) Suburban Development Zone (SDZ) Urban Development Area (UDA)	Policy → industrial employment → population change
	City Planning Area (CPA) data	MLIT 2010	UPA, UCA, Other zoned area and Blank CPA	Top down zoning ↔ industrial land → population
	Land use zone	MLIT 2011	Quasi-residential zone (QR), Neighborhood commercial zone (NC), Commercial zone (C), Quasi-industrial zone (QI), Industrial zone (I), Exclusively industrial zone (EI)	Industrial area raising large population locates in industrial-related zones
<b>Population</b>	Densely Inhabited District (DID)	MLIT 2010	Inside DID, 1km to DID and other area	Industrial area drags the frontier of DID
<b>Transport</b>	Expressway interchanges	MLIT 2019	5km to interchanges and other area	Industrial development relies on speedy transport
	Railway stations	MLIT 2009	1km to station and other area	Size of industry varies by different distances to local service center
<b>Land</b>	DEM data	MLIT 2005	Slope below 11 degree and other area	Industrial development chooses flat area
	Land use	Relevant prefectures 1980, 1990, 2000, 2010	Industrial land use and relevant land use	
<b>Development</b>	Industrial parks	MLIT 2009	Inside an industrial park or not	Industrial parks helps concentrating industrial land

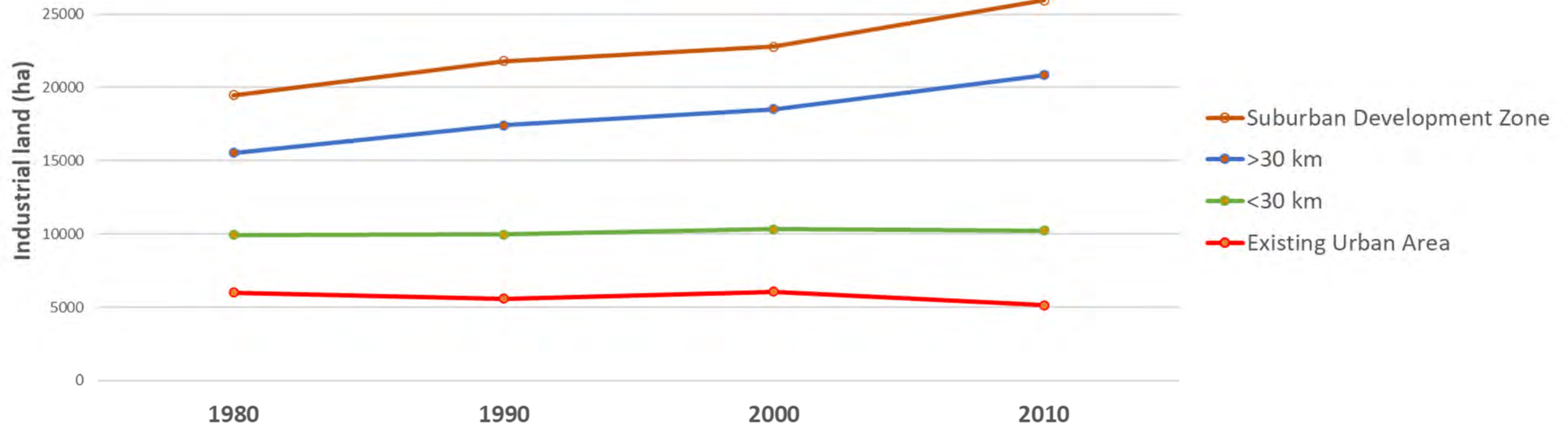
# Multi-layer analysis



■ Temporal-spatial analysis for uncovering features of industrial land transition and verifying the siting gaps against zoning.

# Industrial land transition at metropolitan scale

- Industrial land transit from metropolitan centre to peripheries
- 30 km is the threshold, 30-50 km areas increased the most

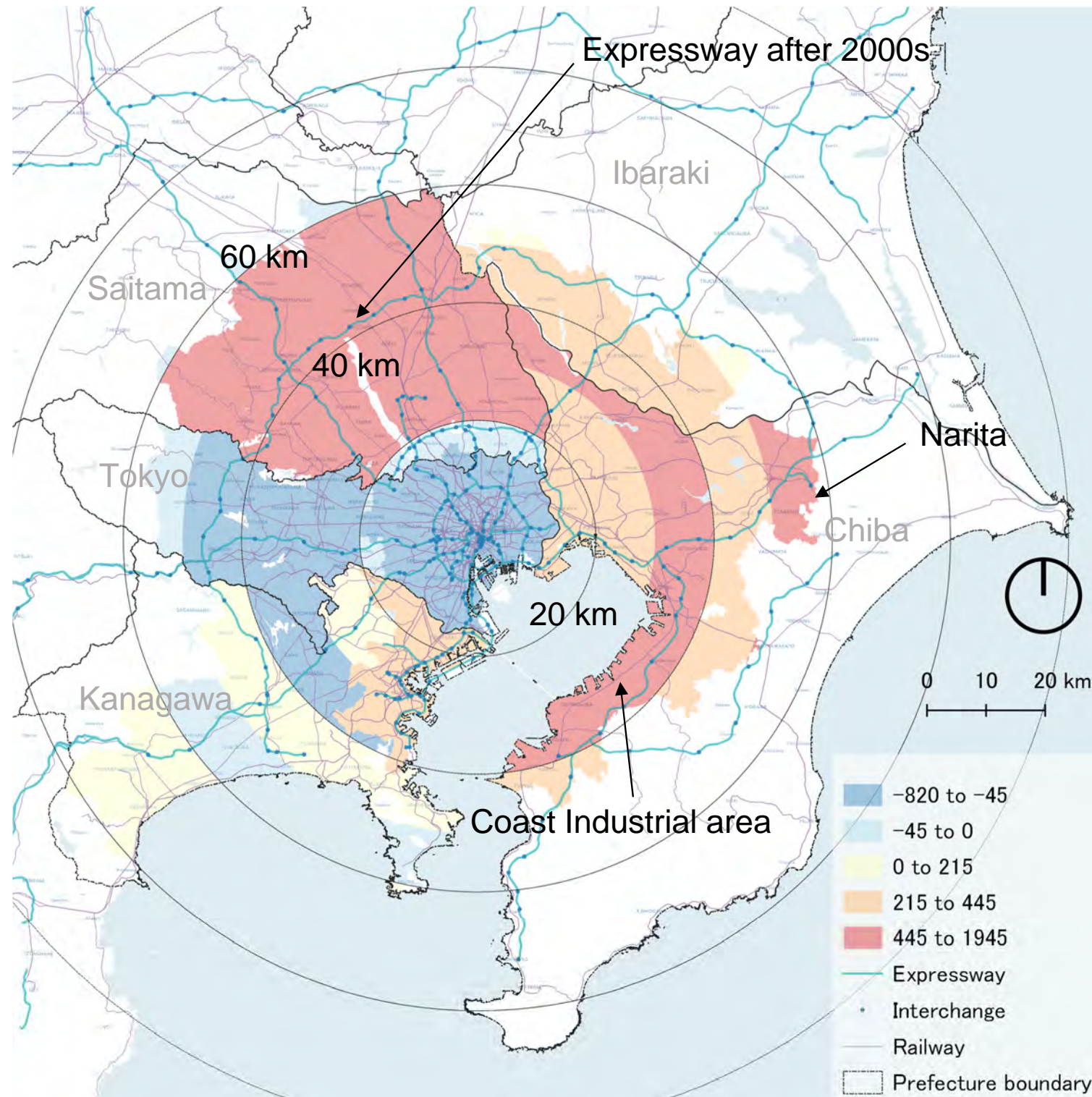


Serial number and Area	1980	1990	2000	2010	1980-2010		2010	
					Changes	Rate	Proportion	to Buildable land
1 Existing Urban Area (EUA)	6009	5594	6075	5139	-870	-14.5%	16.5%	5.8/100
2 10-20 km	1680	1749	1596	1884	204	12.1%	6.1%	6.9/100
3 20-30 km	2256	2613	2664	3198	942	41.8%	10.3%	3.3/100
4 Suburban Development Zone (SDZ) 30-40 km	8685	9506	9579	11221	2536	29.2%	36.1%	6.8/100
5 40-50 km	4648	5316	5992	6222	1574	33.9%	20.0%	3.9/100
6 50-60 km	1541	1925	2202	2627	1086	70.5%	8.5%	3.8/100
7 60-70 km	445	469	532	536	91	20.5%	1.7%	5.5/100
8 >70 km	216	215	226	243	27	12.5%	0.8%	7.8/100
<b>Total</b>	<b>25480</b>	<b>27387</b>	<b>28865</b>	<b>31070</b>	<b>5590</b>	<b>21.9%</b>	<b>100%</b>	<b>5.0/100</b>

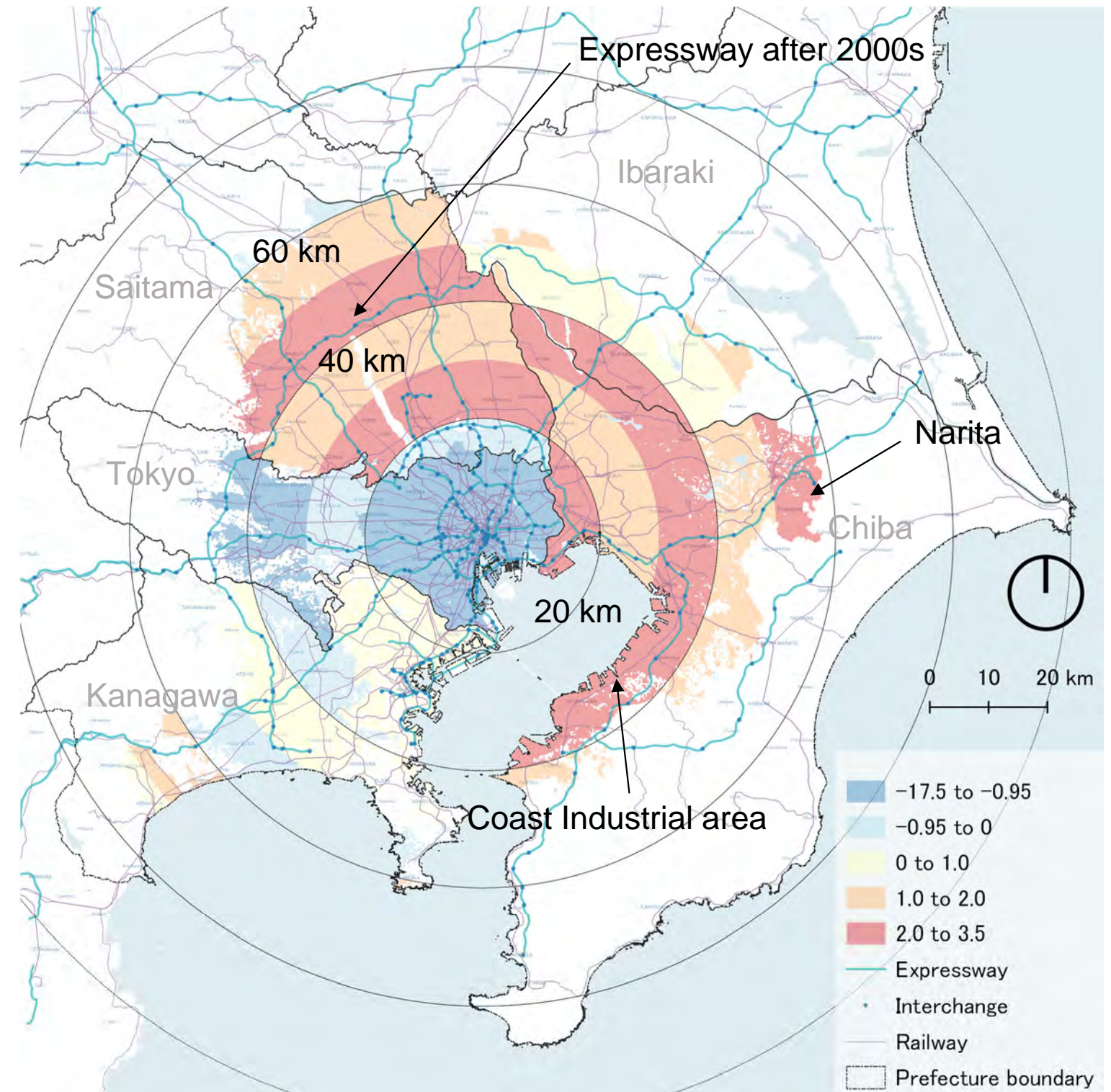
Industrial land transition in peripheries of TMA from 1980 to 2010 (unit: ha)

# Absolute and relative amount of industrial land transition

- Industrial land transition from metropolitan centre to the north and east part



Area of industrial land change between 1980 and 2010  
(classified by equal count, unit: ha)



Area of industrial land change to Area of land slope below 11 degree  
(classified by equal count, unit: %)

# Hierarchical clustering for samples of industrial space

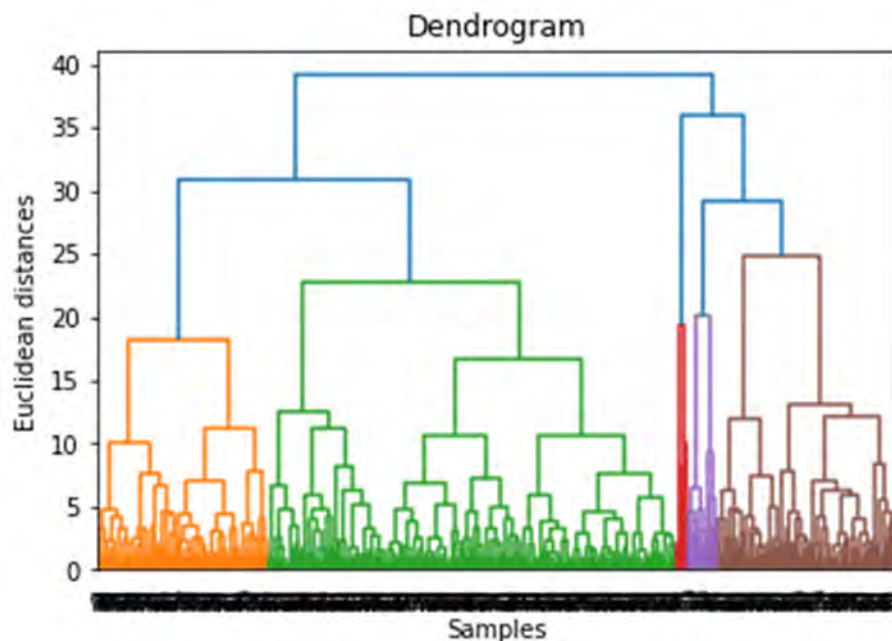
- 3km-radius samples: Parameterisation of assumed spatial patterns and hierarchical clustering based on Ward's method (Ward, 1963).

Cluster number

Sample amounts

- Concentration degree** Total industrial land (3 km)  
Industrial land in 1 km circle
- Size of industrial land** Max piece of industrial land  
Median piece of industrial land  
Industrial land outside 800m to DID
- Transport-convenience** Distance to expressway interchange  
Distance to local hub station  
Distance to central station  
Length of main roads

Standardised parameters

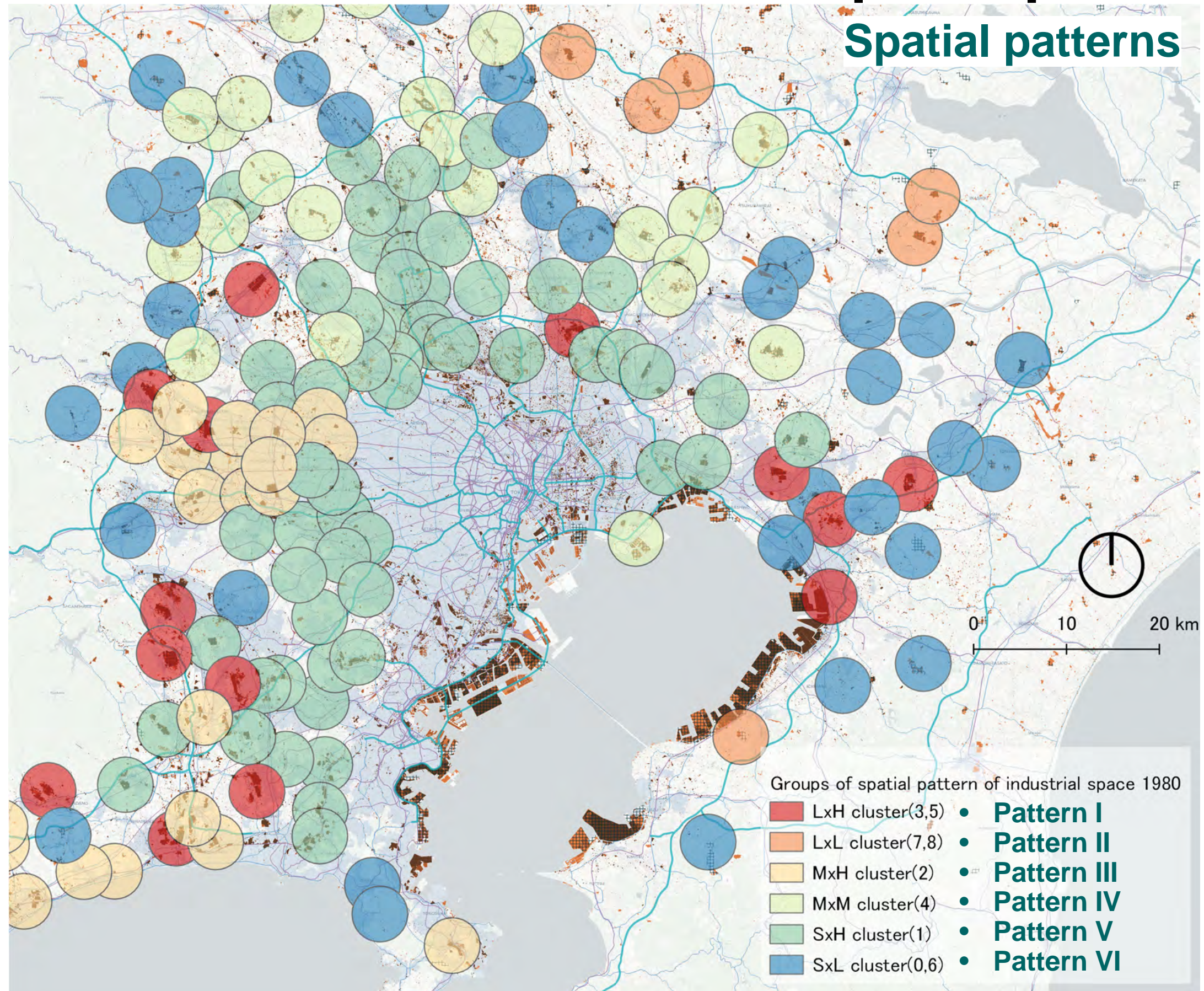


9 clusters to 6 patterns



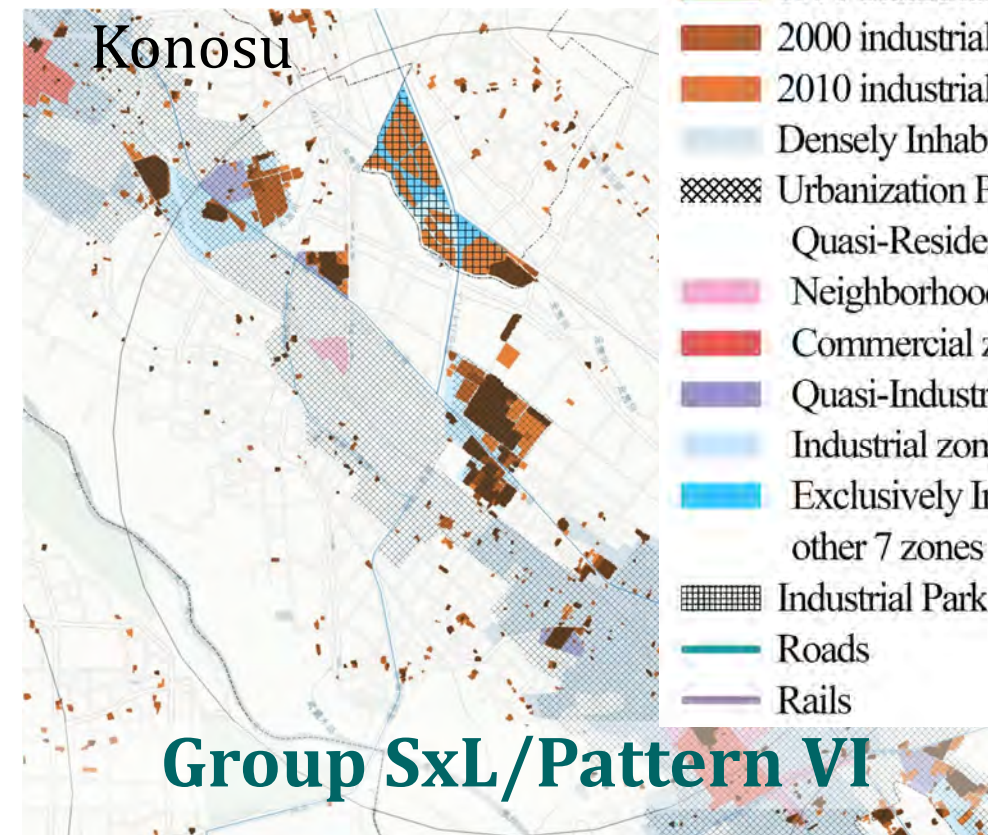
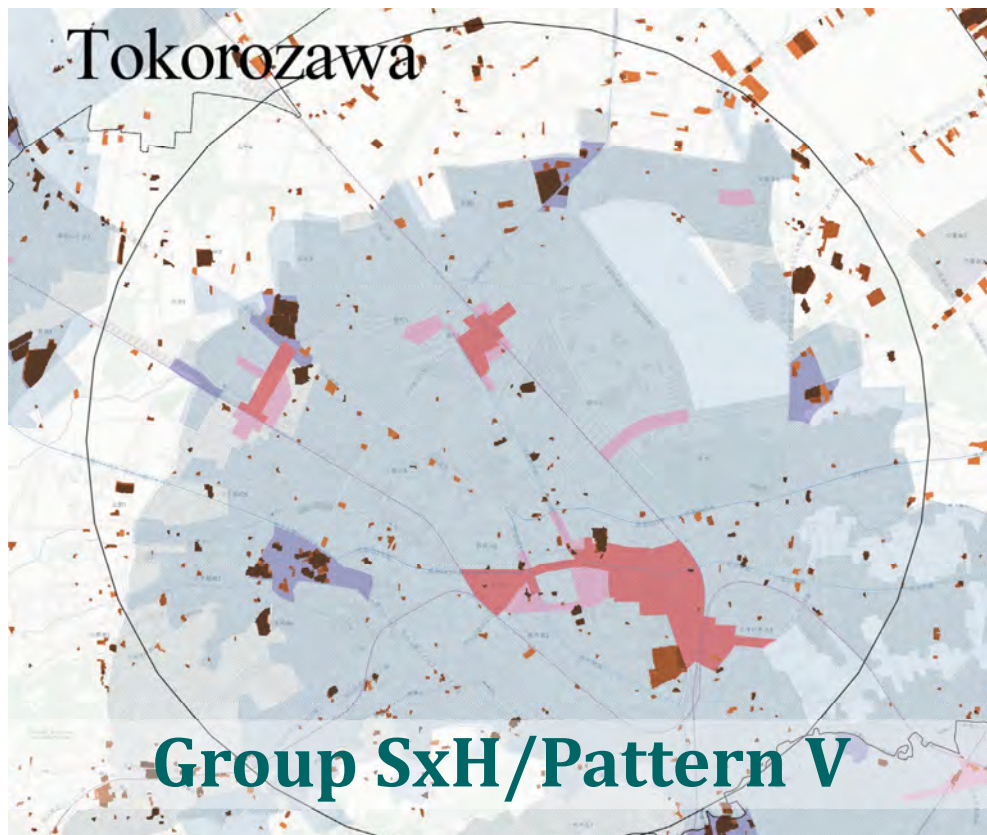
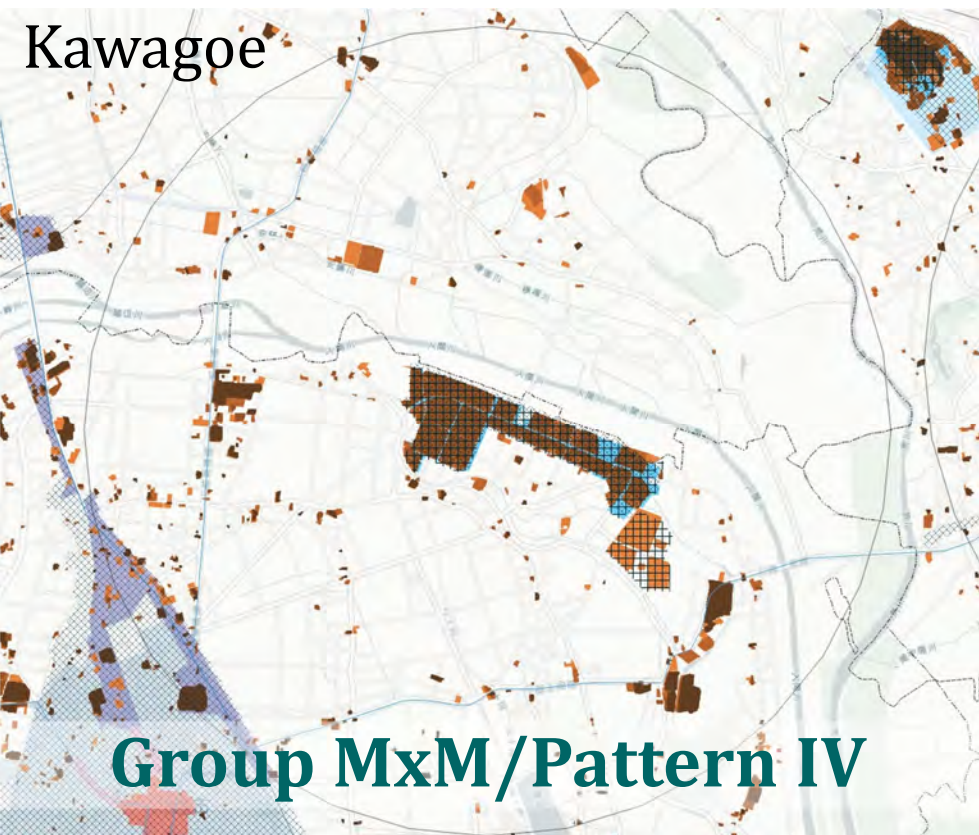
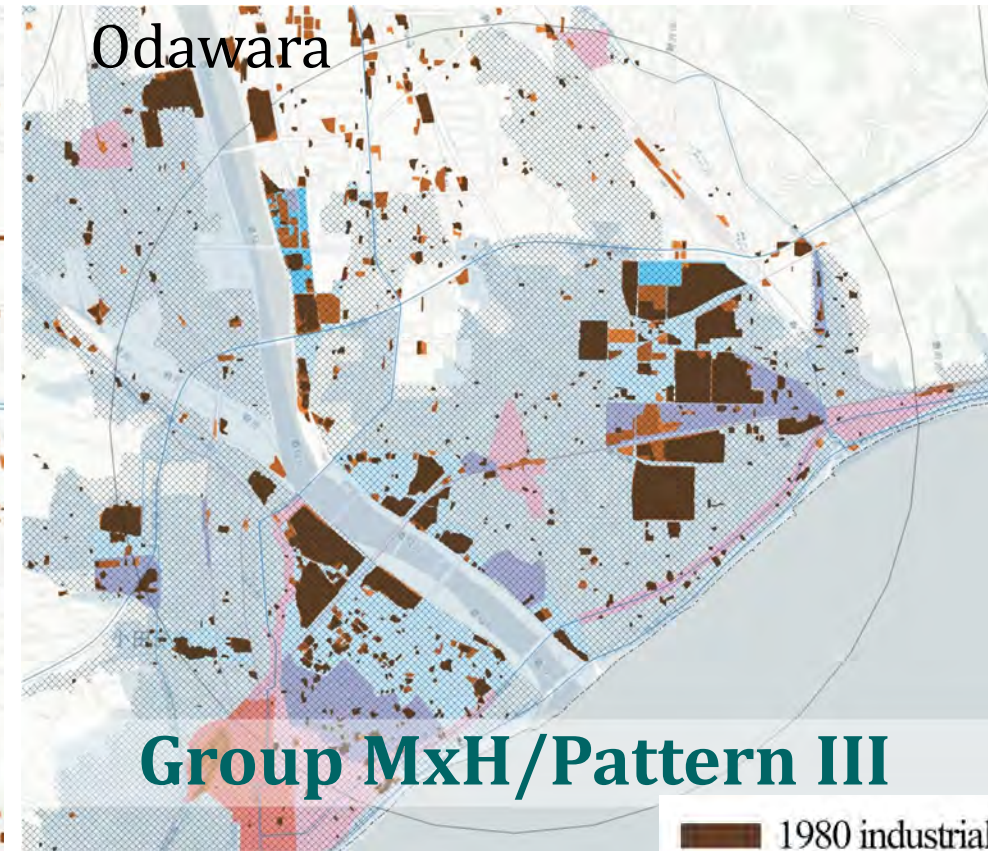
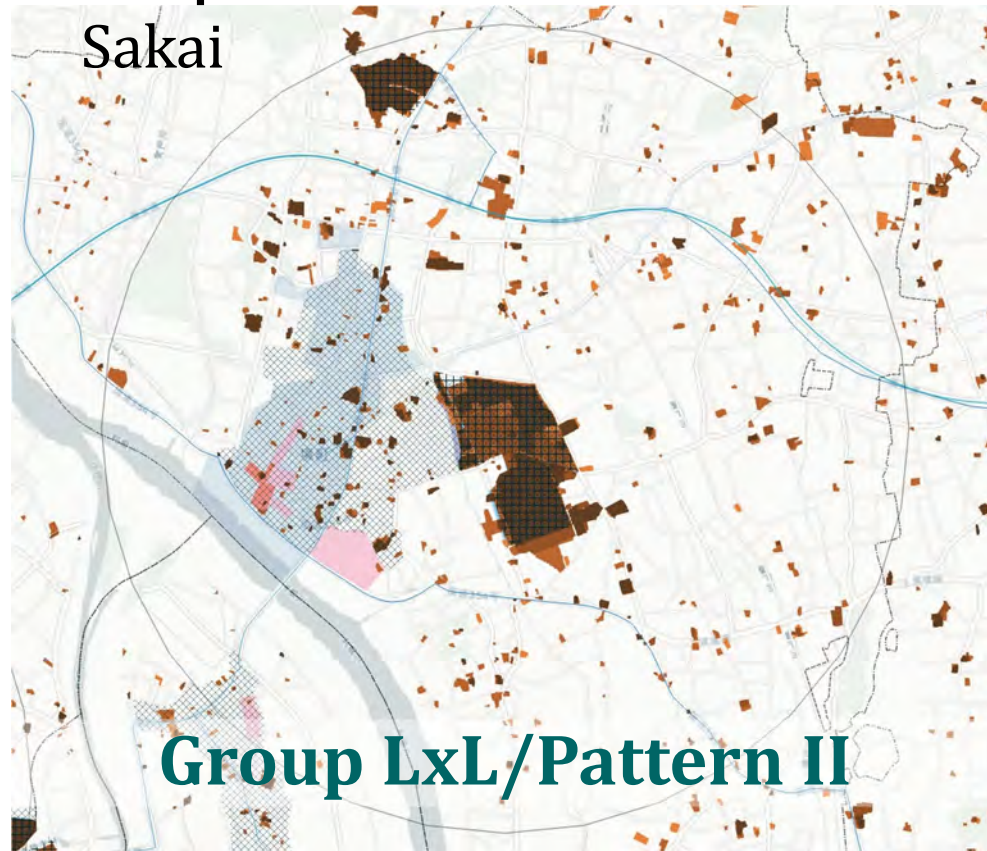
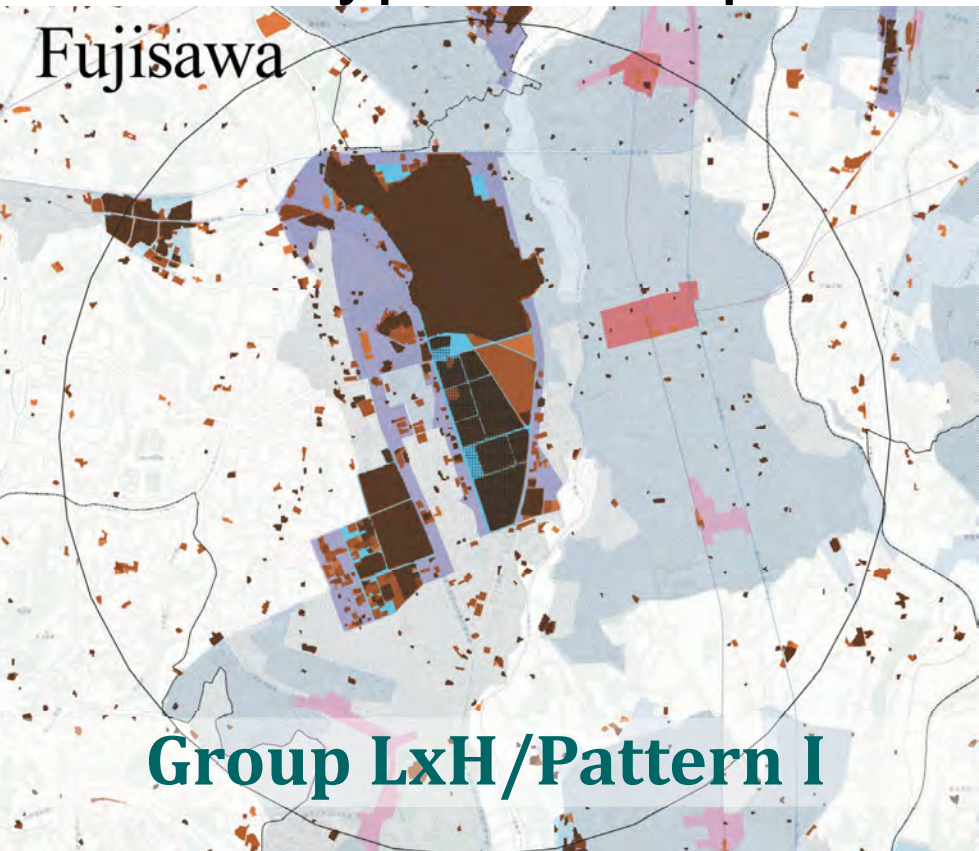
Patterns	Essence	Description
I	<b>LARGE-size clustered with HIGH transport-convenience</b>	<b>General agglomeration</b> , mainly <b>large-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>15-min driving</b> to nearest expressway interchange, <b>sufficient</b> road network.
II	<b>LARGE-size clustered with LOW transport-convenience</b>	<b>Clustered</b> industrial spaces, mainly <b>large and middle-scale</b> industrial land use <b>far away from</b> DID, <b>far away from</b> nearest expressway interchange, <b>low-level</b> of road network.
III	<b>MIDDLE-size clustered with HIGH transport-convenience</b>	<b>General agglomeration</b> , mainly <b>middle-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>15-min driving</b> to nearest expressway interchange, <b>sufficient</b> road network.
IV	<b>MIDDLE transport-convenience</b>	<b>Clustered</b> industrial spaces, mainly <b>middle-scale</b> industrial land use <b>far away from</b> DID, <b>within 15-min driving</b> to nearest expressway interchange, <b>low-level</b> of road network.
V	<b>SMALL-size dispersed with HIGH transport-convenience</b>	<b>General agglomeration</b> , mainly <b>small-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>within 15-min driving</b> to nearest expressway interchange, <b>sufficient</b> road network.
VI	<b>SMALL-size dispersed with LOW transport-convenience</b>	<b>Dispersed</b> industrial spaces, mainly <b>small-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>far away from</b> nearest expressway interchange, <b>low-level</b> of road network.

# Descriptive statistics for 6 industrial spatial patterns



# Features of industrial land transition

- Typical samples of each pattern





## Features of industrial land transition

- Industrial land decrease cases: far from industrial park and expressway interchange while near to local urban service centre

Region	3km-radius sample of City	Spatial pattern	1980	1990	2000	2010	1980-2010	
							Changes	Rate
40-50 km	Fujisawa	I	233	243	264	255	22	9%
40-50 km	Sakai	II	93	121	154	118	25	27%
60-70 km	Odawara	III	204	200	188	172	-32	-16%
30-40 km	Kawagoe	IV	34	88	101	121	87	256%
30-40 km	Tokorozawa	V	34	37	50	32	-2	-6%
30-40 km	Konosu	VI	165	177	169	186	21	13%

Industrial land transition of the 6 typical samples (unit: ha)

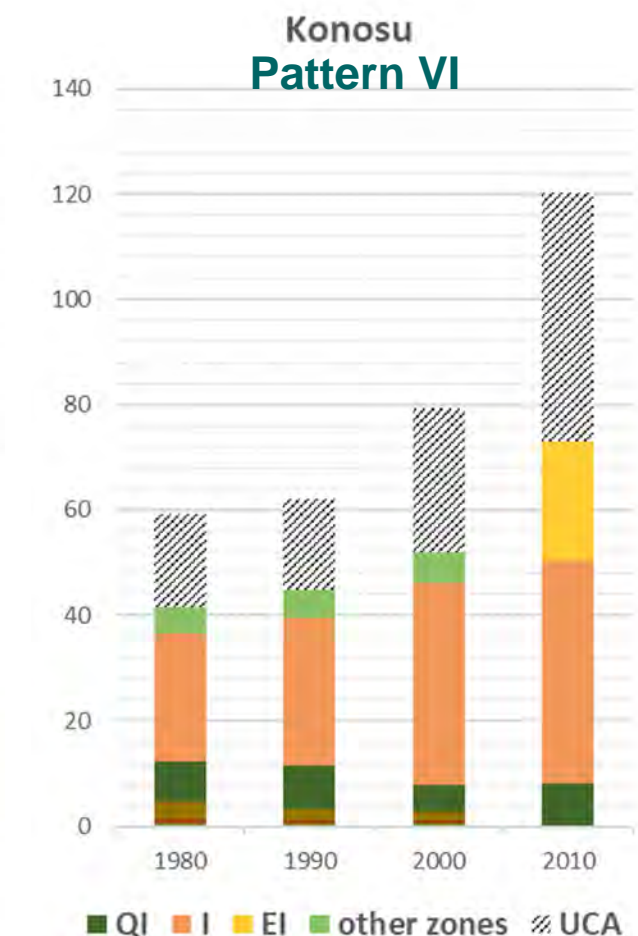
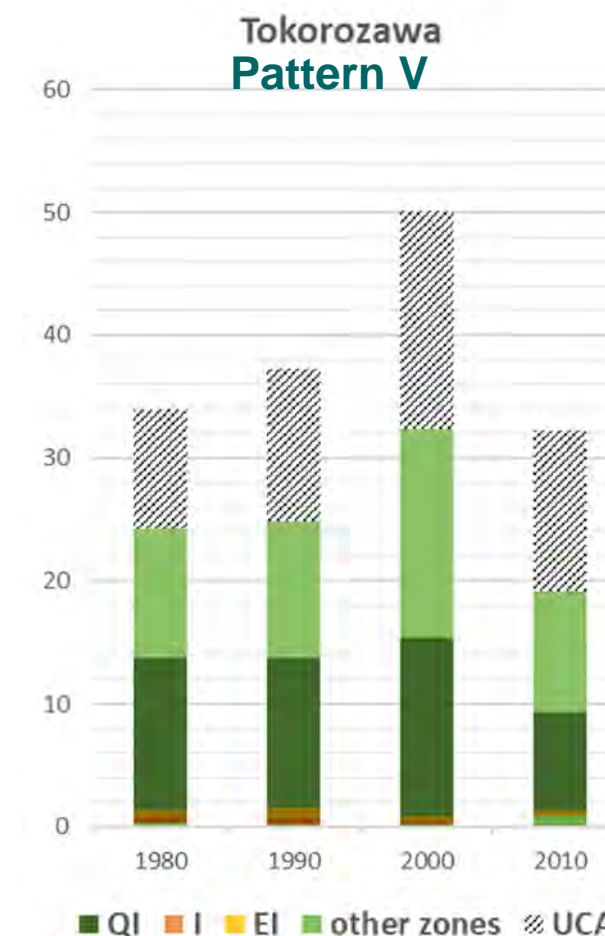
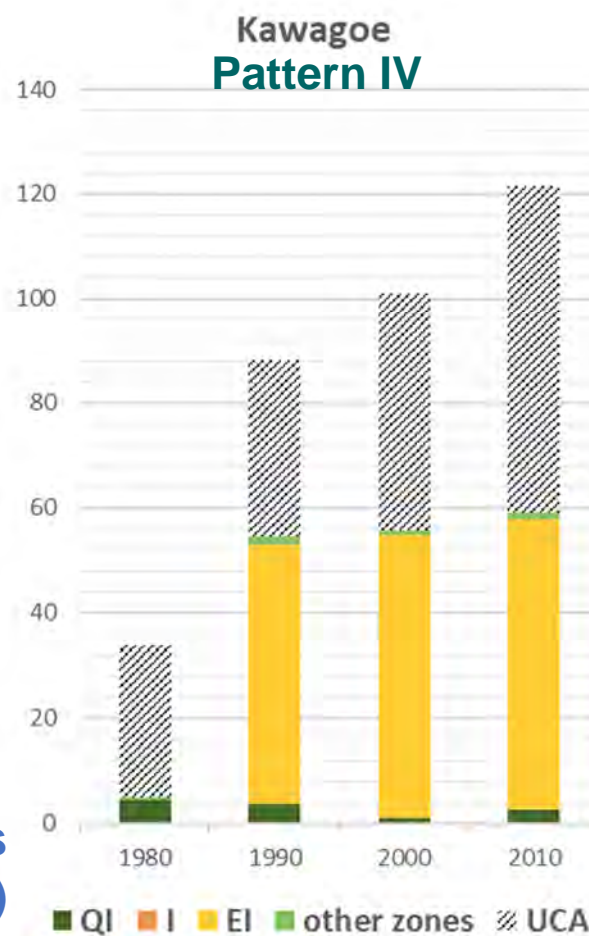
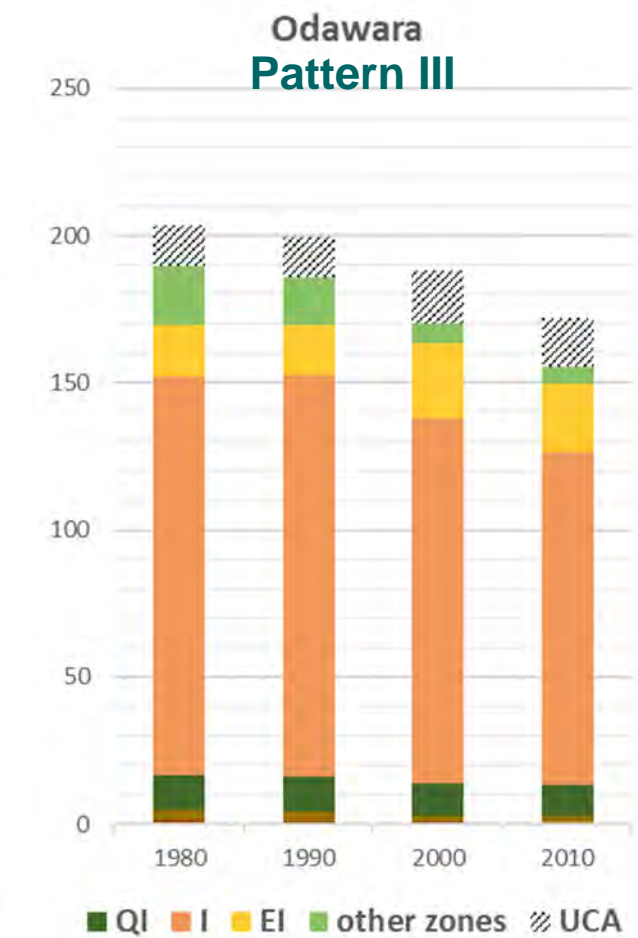
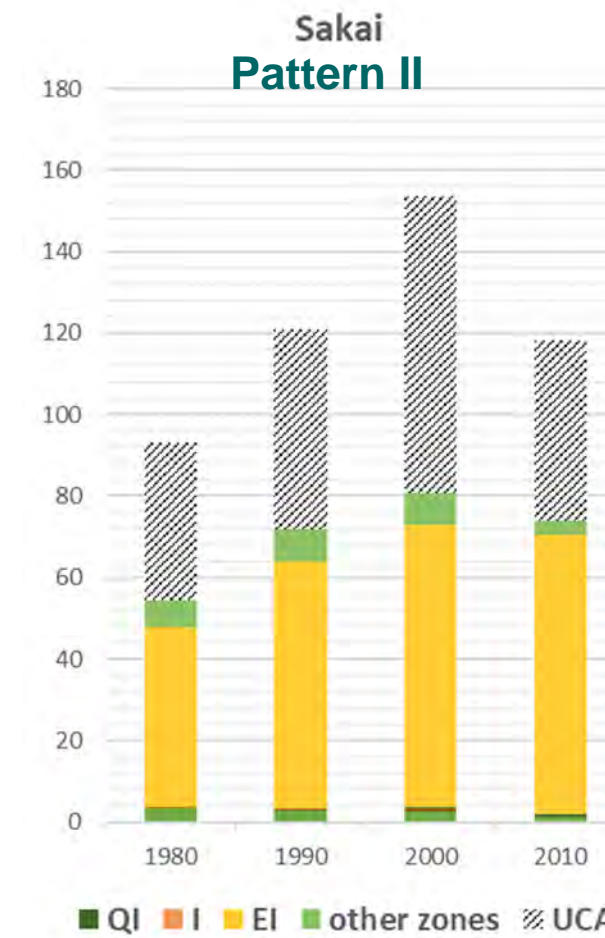
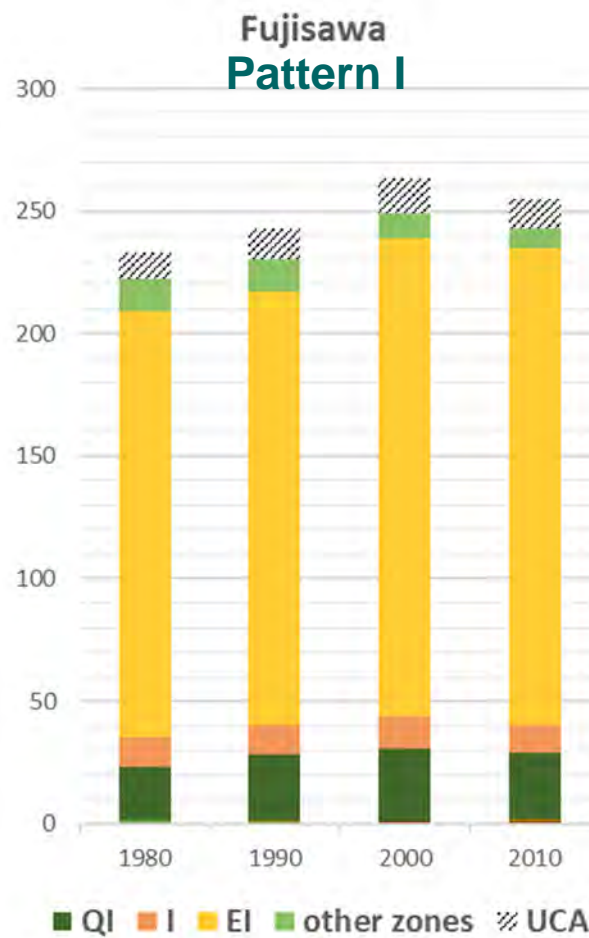


3km-radius samples in	Spatial pattern	Distance to (m)				Number of main roads		
		City hall	Local hub station	Expressway interchange	Industrial park	National	Prefectural main	Prefectural general
Fujisawa	I	6500	1500	4600	0	1	2	1
Sakai	II	1400	10800	4700	0	2	1	0
Odawara	III	2900	300	7500	4400	3	0	0
Kawagoe	IV	3600	4800	5300	0	1	2	0
Tokorozawa	V	1000	1900	6600	7900	1	2	0
Konosu	VI	3100	2700	9200	1300	2	2	0

Built-up environment, transport-convenience and work-live proximity of the 6 typical samples

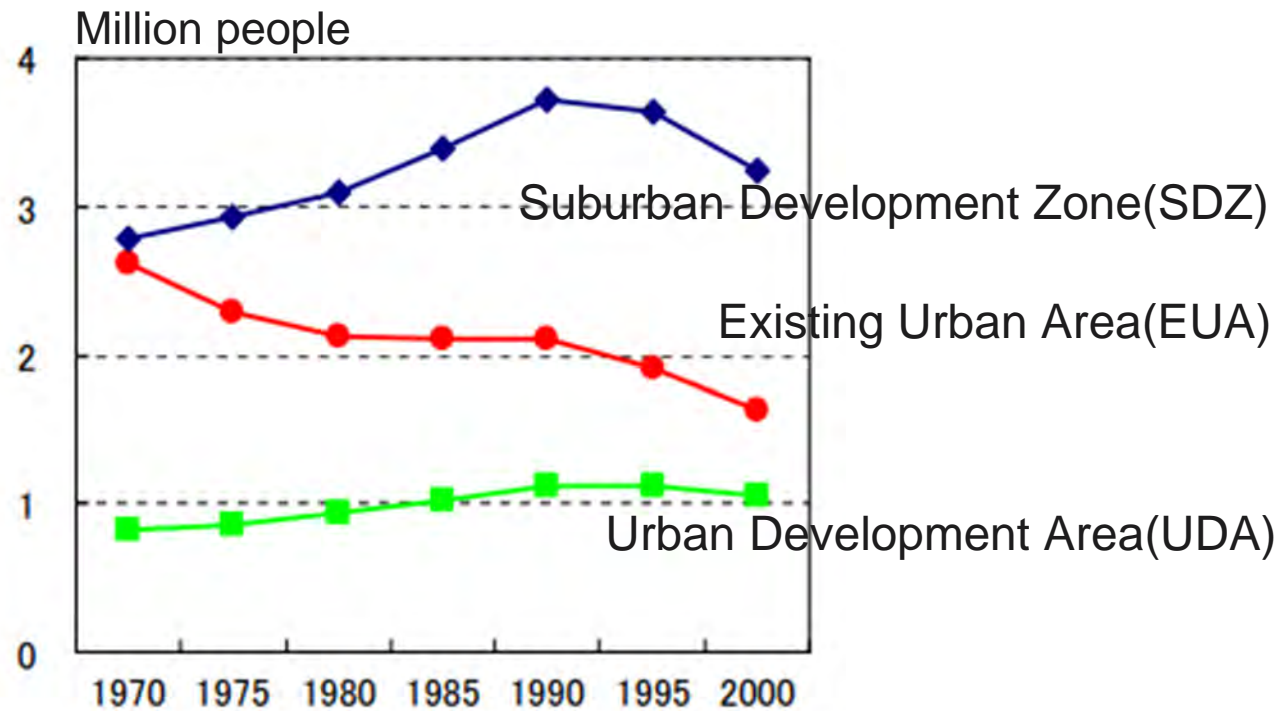
# In each land use zone

- Industrial land increased samples are the ones having designated Exclusively Industrial Zone (EI)
- Industrial zone (I)
- Quasi-industrial zone (QI)
- Fujisawa and Odawara have a better control of industrial location in the Urbanisation Control Area (UCA)

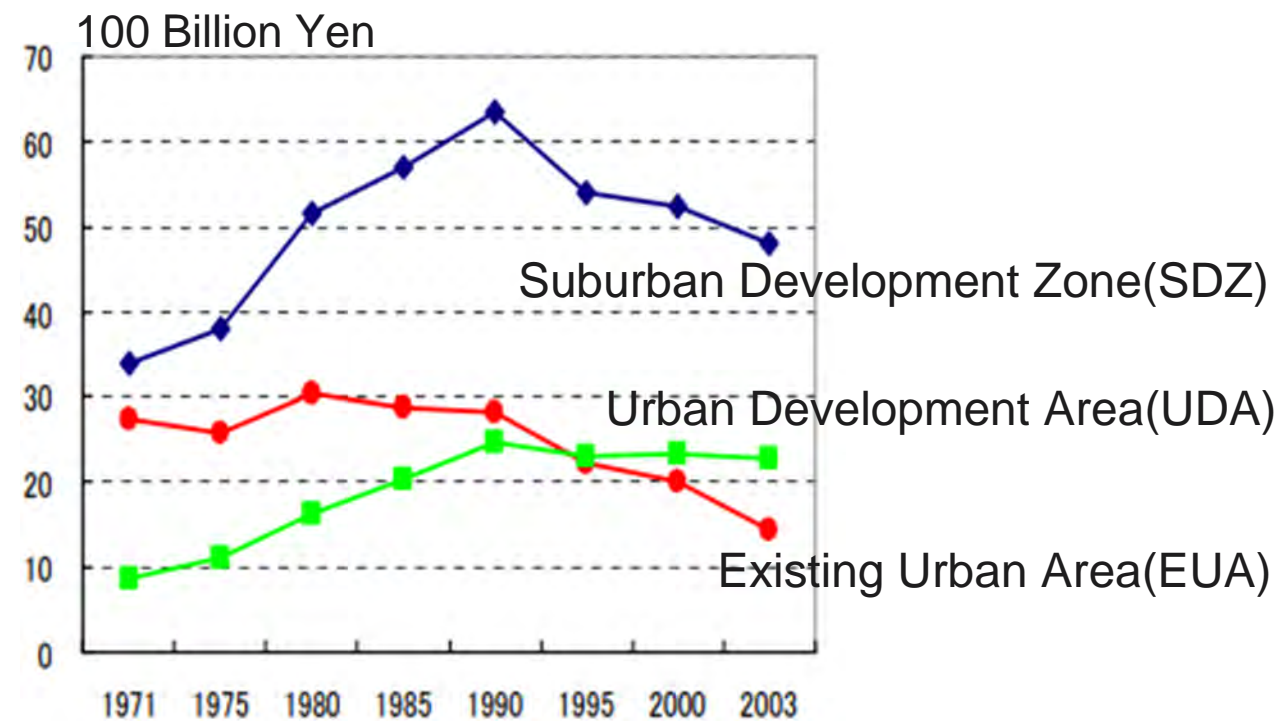


Industrial land transition in planned zones (zoning of 2005 as criteria)

# Sustainable industrial land transition needs more study and literature review



Secondary industrial employment in Tokyo Metropolitan Area



Industrial shipping value in Tokyo Metropolitan Area  
Source: MLIT, Japan 2010

- Industrial land in SDZ, especially areas further than 30 km, keeps increasing from 1980 to 2010
- The results shows industrial transition to areas having **regional transport infrastructure**, which includes expressway, seaport and airport
- However, secondary industrial employment and shipping value decrease from 1990 (MLIT, Japan)
- Normal in a transitional stage of urbanisation and industrialization? Factors remain unstudied
- **Land use efficiency** in the metropolitan peripheries is questioned
- On the background of **industrial structure transition**, by what **common value** and **methodology** to judge the efficiency of industrial land in the peripheries is crucial.

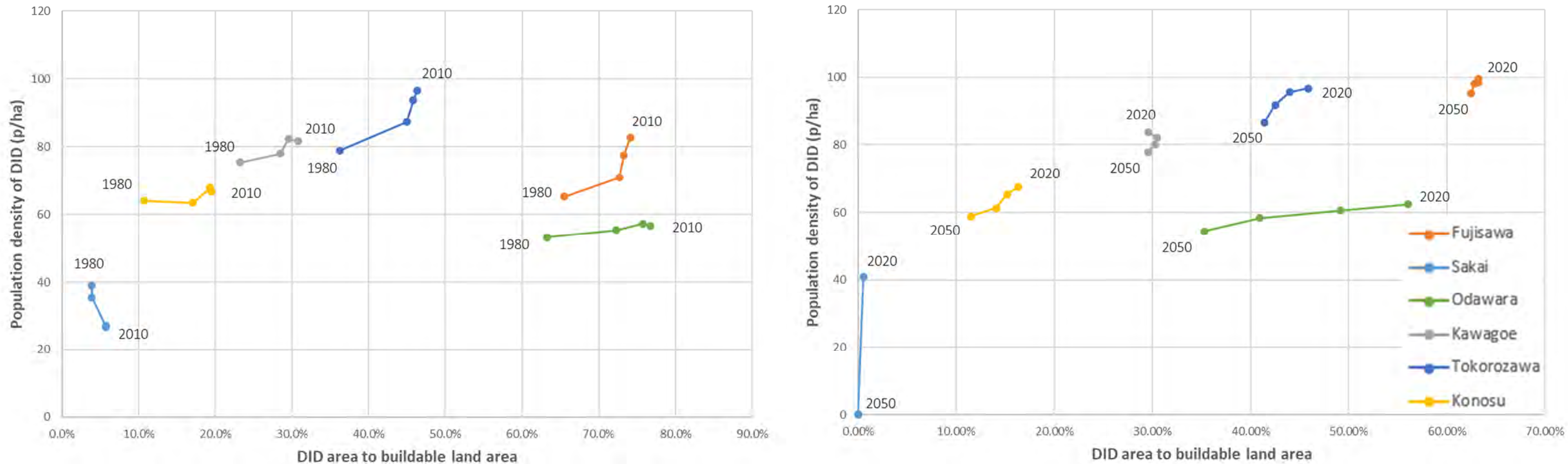
# Transport-convenience weighs more in industrial transition than nearness to the residential community in TMA peripheries

- At metropolitan scale, industrial land transit to the peripheries with high-quality of road transport and regional transport infrastructure
- Among the typical cases in 30-50 km area
  - Pushing-out power from residential community against industrial space was observed
  - Pulling-in power of **industrial park** on industrial land transition was observed
- The dynamics need further research

Patterns	Description
I	General agglomeration, mainly <b>large-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>15-min driving to</b> nearest expressway interchange, <b>sufficient</b> road network.
II	<b>Clustered</b> industrial spaces, mainly <b>large and middle-scale</b> industrial land use <b>far away from</b> DID, <b>far away from</b> nearest expressway interchange, <b>low-level of</b> road network.
III	General agglomeration, mainly <b>middle-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>15-min driving to</b> nearest expressway interchange, <b>sufficient</b> road network.
IV	<b>Clustered</b> industrial spaces, mainly <b>middle-scale</b> industrial land use <b>far away from</b> DID, <b>within 15-min driving to</b> nearest expressway interchange, <b>low-level of</b> road network.
V	General agglomeration, mainly <b>small-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>within 15-min driving to</b> nearest expressway interchange, <b>sufficient</b> road network.
VI	<b>Dispersed</b> industrial spaces, mainly <b>small-scale</b> industrial land use <b>within 800 m</b> distance to DID, <b>far away from</b> nearest expressway interchange, <b>low-level of</b> road network.

# Future land use planning and regional planning

- Under new circumstance of municipal demographic transition in the metropolitan peripheries, planning strategy needs to be optimised for adapting to a balance between smart shrinkage and regional development
- Regional cooperation and zoning restriction is required for land resource conservation and sustainable development



Demographic transition patterns of the municipalities where the 6 typical industrial spaces locate  
(Left: 1980 to 2010, right: 2020 to 2050, calculated by Japan government data)

# Lessons of industrial land transition in TMA

- Industrial land use in TMA transit from metropolitan core to peripheries where has complicated spatial pattern and well-equipped regional transport infrastructure. The 30-50 km is the most challenge area for sustainable planning
- The industrial park could become the main carriers of the industrial transition to save the land resource
- The implementation of zoning needs to be improved for land resource conservation, especially in the municipalities having not designated Exclusively Industrial Zone
- The delineation of zoning needs to adapt to the built-up environment and transport infrastructure for an ordered urban land development in the peripheries

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**Thank you very much!**



For more comments,  
questions and suggestions