A Study on the Processes and Characteristics of Postwar Urban Area Formation in Regional Core Cities from 1960 to 2015

Comparing between Cities with the Postwar Reconstruction Project and Those without

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Abstract

In Japan, where many local cities face shrinking issues, it is necessary to research city formation process after World War II and consider its characteristics in order to conduct smart shrinking initiatives with Location Optimization Plans enacted since 2014. Therefore, I analyzed influencing factors to urban area formation from the focusses on municipality merger, infrastructure development, railroad and bus service network and Public Housing development, etc. taking four regional Core Cities from 1960s to 2015. In order to grasp urbanized area formation process correctly on more microscopic district level, I adopt population data in Survey Districts for the National Census and in order to clarify the fundamental differences of infrastructure level in urban center, I compared between cities with Postwar Reconstruction Project and those without. Consequently, 1) The population densities of urban areas in regional Core Cities had steadily decreased since 1960. On the other hand, there was clearly a spatial structural difference between the cities with the Postwar Reconstruction Project and those without. The population densities and the population sizes of station spheres were higher in the cities with the Postwar Reconstruction Project. 2) There was a clear difference in the urban area expansion in the period from the period of high economic growth till the initial Area Classification between the cities with the Postwar Reconstruction Project and those without. 3) The factors of bringing the characteristics of urban area expansion in the period from the initial Area Classification till today (1975 ~ 2015) were the degree of the expansion of Urbanization Promotion Areas and the promotion of Land Readjustment in the suburbs.

Keyword: Urban Area Formation, Areal Structure of Population Density, Postwar Reconstruction Project, Area Classification, Regional Core City

1. Background and Objective of the Study

Location Optimization Plans (Ricchi Tekiseika Keikaku) based on the Act on Special concerning Urban Reconstruction (Toshi Saisei Tokubetsu Sochi Hou) enacted in August 2014 are being developed and operated in various cities. The Designated Areas of Residence Attraction (Kyojyu Yudo Kuiki) in each city based on the plan extend, except for a few exceptions, to mostly 80% of the Urbanization Promotion Areas (Shigaika Kuiki) of the city and in most cases correspond to the previous urban areas before the initial Area Classification (Kuiki Kubun) was done.¹⁾ Especially in cities like regional Core Cities (Cyukaku Shi),⁽¹⁾ which have more than a certain size of Urbanization Promotion Areas, the designation of the two attraction areas described in the Location Optimization Plan has an aspect of locationally returning to the past urban areas. In most today's prefectural capitals (300 ~ 800 thousand in population), on the other hand, the population in 1946 was 100 ~ 200 thousand, and most today's conurbation areas were developed

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in the period of high economic growth and before the initial Area Classification.⁽²⁾ Therefore, clarifying the process of urban area formation during this period not only helps to reveal the issues of city planning at the time but is also important for grasping the roots of today's existing urban areas. Furthermore, we can comprehensively grasp the characteristics of the process of urban area formation in regional Core Cities after World War II by diachronically grasping, in addition to the process of urban area formation in this period, the process after the Area Classification by the City Planning Act (Toshi Keikaku Hou) of 1968 until today. This fundamental knowledge is indispensable for judging the credibility of Location Optimization Plans, and at the same time, especially the formation process which focuses on the spatial density structure seems to be closely related to the feasibility of the plans. The objective of this study is to grasp, with the population density as the index, the process of substantial urban area expansion in the period from the period of high economic growth until today and to reveal the characteristics of the process.

There are two methods of grasping the process of urban area formation: one being to clarify the expansion process of plans, such as the expansion process of designated Use Districts (Youto Chiiki), and the other to clarify the expansion process of substantial urban areas due to development and construction activities. In addition, the latter method includes one to trace the process of locating infrastructures, such as roads and infrastructure development, and public facilities, such as administrative facilities and educational facilities; and one to clarify the residential urban areas. As for grasping the residential urban areas, it has been difficult to fully grasp it because there are not many detailed maps such as Housing Maps (Jyutaku Chizu) in the period from the period of high economic growth till the initial Area Classification. This study therefore uses the population data of Survey Districts (Cyousa Ku) for the National Census in Densely Inhabited Districts (DID), which has been made public since 1960, to grasp the process of urban area formation in terms of the population densities of Survey Districts. While DID is an index showing substantial urban areas, the population density of each Survey District can spatially show the degree of population density in the unit of a more microscopic district. This is the methodological uniqueness of this study.

Among the past studies, while there are a relatively large number of studies which discuss the issues of city planning by understanding the relation between the expansion of urban areas accompanying population increase and the degree of Use District designation and infrastructure development, namely, studies which grasp the expansion process of city plans, those discussing the process of substantial urban area expansion were scarce. For example, there are studies on the urban area formation in Kumamoto City from the Meiji era (1868 ~ 1912) till Showa 30s (1955 ~ 1965) seen in terms of, for example, the relocation of public facilities,^{(2), (3)} and a study on the process of sprawl progress in Sendai City from the end of Meiji era till early Showa 50s (1975 ~ 1980).⁽⁴⁾ They are, however, case studies on single cities of Kumamoto and Sendai, and the certainty of the studies is limited because the determination of urban areas depends on, for example, Topographical Maps (Chikei Zu) made by the Geospatial Information Authority of Japan. On the other hand, the study by Maruoka et al.⁽⁵⁾ is close to the subject of this study in that it focuses on the long-term transformation process of the density structure of DID and the utilization of land from the past, considering the application to Location Optimization Plans. It, however, focuses only the period of 1970 ~ 2015, and does not consider the preceding period. In addition, the study by the author⁽⁶⁾ clarifies the characteristics of the process of urban area expansion in cities with the Postwar Reconstruction Project (Sensai Fukko Jigyō) (cities where the Land Readjustment Project for Postwar Reconstruction was carried out) during the period of

high economic growth, using the data of Survey Districts of the National Census. It, however, does not consider cities without the Postwar Reconstruction Project nor analyzes the period after the Area Classification. The present study uses the population data of Survey Districts to clarify the characteristics of the process of urban area expansion after World War II until today, including the comparison between the city groups having different reconstruction processes among the regional Core Cities: cities with the Postwar Reconstruction Project and those without.

2. Method of Study and Focuses of Analysis

2-1. Period and Cities Studied

Because of the reason described above, the period studied in this study was set as the period from the period of high economic growth till today. As the basic materials for grasping the process of urban area formation in this period, we used the population data of Survey Districts of the National Censuses at four time points: 1960 (roughly in the first half of the high economic growth period), 1975 (the completion of the initial Area Classification), 2000 (the time of transition to population decrease), and 2015 (today).⁽³⁾ As the cities to be studied, we first picked up a group of regional Core Cities which were cities with the Postwar Reconstruction Project and a group of cities without, which were studied in studies by the author.^{(7), 8), (4)} Then, we set two indexes: the percentage of the districts of the Land Readjustment (Tochi Kukaku Seiri) Project in the Urbanization Promotion Areas in 1970, which corresponds to the time of the initial Area Classification, and the expansion rate of Urbanization Promotion Areas in the period from 1975, when the initial Area Classification was mostly completed, till 2015,⁽⁵⁾ and obtained the distribution of the cities picked up (Fig. 1). From the distribution, we selected Toyohashi and Gifu as cities with the Postwar Reconstruction Project and Nagano and Akita as cities without the Postwar Reconstruction Project, on the conditions that cities should have fewer geographical restrictions, such as mountains and rivers; they should have an expansion rate of Urbanization Promotion Areas from 1975 to 2000 close to its average; in case of cities with the Postwar Reconstruction Project they should have a high percentage of Land Readjustment districts as of 1970 (this is a characteristic of cities with the Postwar Reconstruction Project); in case of cities

Figure1 The Reason Why to Choose Target City

without the Postwar Reconstruction Project they should include both cities having a relatively high percentage of Land Readjustment districts in 1970 and those having a low percentage. These conditions allowed us to grasp the actual state of mostly average cities in the period from 1975 to 2015, when urban areas were expanded by the operation of Area Classification along with the progress of motorization, considering the difference between the cities with the Postwar Reconstruction Project and those without (the difference in the process of urban area formation from the period of high economic growth to the initial Area Classification).⁽⁶⁾ In addition, the substantial urban areas in this study were set as areas having a population of 40 /ha or more, according to the definition of DID.

2-2. Focuses of Analysis for Characteristics of the Process of Urban Area Expansion

We set three focuses of analysis for grasping the characteristics of the process of substantial urban area formation: 1) the patterns of urban area expansion, 2) the peak population density, and 3) the factors and background of bringing the patterns and the peak population density. 1) is for grasping the geographical morphological characteristics of urban area expansion, and 2) for grasping its qualitative characteristics. Analyzing also the factors and background of these characteristics, we thought that this method of analysis had the convenience of applying it to the comparison among cities and enabled us to grasp the fundamental factors of urban area formation.

For the factors and background of 3), we considered especially land use planning (the area of Use Districts), infrastructure development (especially the presence or absence of areal development projects, such as projects of Land Readjustment or Land Improvement (Tochi Kairyo)), public transportation networks (especially networks of railroads, streetcars, and buses), and Public Housing (Kouei Jyutaku) developments. The area of Use Districts was included for analysis because Urbanization Promotion Areas were considered as urban areas according to the City Planning Act after the Area Classification (after 1970). Furthermore, we focused on Land Readjustment and Public Housing developments as the factor promoting planned urban area formation, on public transportation infrastructure as the factor promoting the private development of housing land, and Land Improvement projects (agricultural infrastructure development) as the factor promoting sprawl-like urban area formation. Although these factors seemed to include the basic factors indispensable for overlooking the suburban development of local cities, we also included other factors, such as industrial development, as is suitable for the state of each city. While this study was intended to simultaneously compare multiple cities, it required the detailed analysis of each city, and therefore we suppressed the number of cities to be compared to four typical cities. Consequently, we analyze the characteristics of urban area expansion after World War II till the initial Area Classification (1960 ~ 1975) in Chapter 3 and those after the completion of the initial Area Classification till today (1975 ~ 2015) in Chapter 4. In Chapter 5, we summarize the knowledge obtained in this study and discuss the characteristics of urban area expansion after World War II, considering the difference between the cities with the Postwar Reconstruction Project and those without and also the difference between before and after the initial

Figure 2 Area frame for the analysis of urbanization area changing

Table1 Population, area, density and included rate of population in each defined area at four times (Toyohashi City)

*1		railroad station sphere (500m radius) *2						bus stop sphere(300m radius) *2				land readjustment project *3				
		population n in sphere	population outside sphere	area (ha)	population on density (/ha)	population n rate in sphere(%)	population n in sphere	population n outside sphere	area (ha)	population on density (/ha)	population n rate in sphere(%))	population on in district	population n outside district	area (ha)	population on density (/ha)	population n rate in district(%) (/)
central urban area (124.4ha)	year1960	19,353	0	124.4	155.6	100.0%	19,235	118	124.1	155.0	99.4%	18,911	442	107.7	175.7	97.7%
	year1975	12,931	0		104.0	100.0%	12,849	82		103.5	99.4%	12,314	617	107.7	114.4	95.2%
	year2000	8,122	0		65.3	100.0%	8,039	83		64.8	99.0%	7,775	347	107.7	72.2	95.7%
	year 2015	7,272	0		58.5	100.0%	7,204	68		58.0	99.1%	6,155	1,117	111.2	55.4	84.6%
I . 1960DID (1081.6ha)	year1960	69,335	10,891	704.3	98.4	86.4%	59,005	8,779	783.0	75.4	87.0%	39,726	40,500	432.0	92.0	49.5%
	year1975	57,572	13,300		81.7	81.2%	58,078	12,794		74.2	81.9%	41,954	28,918	468.7	89.5	59.2%
	year2000	40,719	12,172		57.8	77.0%	42,997	9,904		54.9	81.3%	34,929	17,962	468.7	74.5	66.0%
	year 2015	39,124	9,038		55.5	81.2%	41,004	7,158		52.4	85.1%	31,796	16,366	468.7	67.8	66.0%
II . initial urbanization promotion area (3724ha)	year1960	6,367	25,926	426.2	14.9	19.7%	16,217	16,076	2499.0	6.5	50.2%	4,013	28,280	313.4	12.8	12.4%
	year1975	15,815	96,797		37.1	14.0%	50,863	61,749		20.4	45.2%	13,370	99,242	385.2	34.7	11.9%
	year2000	22,095	155,447		51.8	12.4%	57,189	120,353		22.9	32.2%	42,598	134,944	827.7	51.5	24.0%
	year 2015	26,533	153,890		62.3	14.7%	63,444	116,979		25.4	35.2%	49,025	131,398	843.8	58.1	27.2%
III . expande d urbanization promotion area (795.9ha)	year1960	0		0	-		236		73.7	3.2		74		6.2	11.9	
	year1975				-		278			3.8		77		6.5	11.8	
	year2000	0	17,698		-	0%	2,882	14,816		39.1	16.3%	2,453	15,245	81.5	30.1	13.9%
	year 2015	0	17,442		-	0%	2,972	14,470		40.3	17.0%	6,163	11,279	148.2	41.6	35.3%

*1 Any value of the area is one measured on GIS, and may differ from the value in the plan document. The population of any sphere was obtained by calculating the populations of subareas according to their proportions in survey districts and summing the populations. *2 Some of the populations of (railroad) station spheres overlap with those of bus stop spheres. The populations of these spheres may also overlap with those of land readjustment areas. *3 In the land readjustment projects, some areas in the land readjustment projects for postwar reconstruction overlap with some in the later land readjustment projects.

Area Classification.

2-3. Area Frames for Analysis According to the Populations of National Census Districts

For conducting the analysis described in Section 2-2 above, we set the Area Classifications common to the four cities as shown in Fig. 2. They are, from the center of the city toward the outer rim, the Central Urban Area (according to the Central City Revitalization Basic Plan (Cyushin Shigaichi Kasseika Kihon Keikaku)), the DID (Densely Inhabited District) as of 1960, the Urbanization Promotion zone as of 1975, and the Urbanization Promotion zone as of 2000 and 2015. We set the resulting four zones, or the Central Urban Area and the three zones I ~ III, as the basic frames of urban areas.⁽⁷⁾ We also set the districts of Land Readjustment in progress and the railroad station spheres (the spheres of 500 m in radius) at each of the four time points. In addition, we set the sphere within 300 m from each bus stop as the area of bus service, assuming that it was the area common to the four time points.⁽⁸⁾ Then, the population of each area frame was calculated by superimposing the populations of Survey Districts at each time point over the data of GIS (Geographical Information System). Although the data of the Survey Districts in 1960, 1970, and 1975 is not consistent because the Survey Districts were considerably changed, allocating populations to these area frames allowed us to obtain the population of each area frame consistently among the time points. Table 1 shows the population data in case of Toyohashi City.

3. Outline of the Urban Area Expansion in the Studied Cities

Table 2 shows various characteristics related to the process of urban area formation in the four cities studied in this study. First, the expansion rates of the area of Use Districts before the Area Classification (1965 ~ 1975 in the table) are mostly larger than those in 1975 ~ 2015. In essence, this seems to reflect the concentration of population in the period of high economic growth, resulting in the decrease of expansion rates after 1975.⁽⁹⁾ The expansion rate of -14.5% of Toyohashi resulted from the fact that the city planned to increase the area of Use Districts already in 1965 as a result of the designation of the East Mikawa Special Zone for Industrial Development (Higashi Mikawa Kougyou Seibi Tokubetsu Chiiki). If compared with the value before that time, the expansion rate in 1965 ~ 1975 would be 55.3%. Considering this situation, Toyohashi is the city whose expansion rate throughout the whole period is the least. On the other hand, Gifu has

Table 2 Characteristics of use district designation, land readjustment, public housing development, public transportation.

	Use district designation* ¹	District of land readjustment* ²	Public housing development* ²	Public transportation	Terrain	Industrial development
Toyohashi	Expansion rate 1965-1975: -14.5% 1975-2015: 24.2%	Total: 2235.8 ha. 74.7% started by 1975. 25.3% in 1975-2015.	Total: 7325 units 45.1% started by 1975. 54.9% in 1975-2015	National Railways, private railroads, streetcar and bus lines	Plains in all directions	designated city to 'Special zone for industrial development'. Exclusive industrial zone in harbor area (1003 ha)
Gifu	Expansion rate 1965-1975: 105.8% 1975-2015: 42.3%	Total: 2472.9 ha. 88.2% started by 1975. 11.8% in 1975-2015.	Total: 4911 units 34.6% started by 1975. 65.4% in 1975-2015	National Railways, private railroads, bus lines. Also streetcar lines	Plains in 3 directions. Mountains northeast	No designation of exclusive industrial zone
Nagano	Expansion rate 1965-1975: 86.9% 1975-2015: 25.8%	Total: 917 ha. 20.9% started by 1975. 79.1% in 1975-2015.	Total: 7282 units 52.3% started by 1975. 47.7% in 1975-2015	National Railways, private railroads, bus lines	Plains in 3 directions. Mountains northwest	Exclusive industrial zone (237 ha)
Akita	Expansion rate 1965-1975: 112.4% 1975-2015: 20.5%	Total: 1503.1 ha. 42.4% started by 1975. 57.6% in 1975-2015.	Total: 4199 units 14.2% started by 1975. 85.8% in 1975-2015	National Railways, bus lines	Plains in 3 directions. Sea in the west	New industrial city. Exclusive industrial zones in harbor area and riverbank area (852.4 ha)

*1 The data was calculated, based on the city planning annual reports 1966, 1975, and 2016. *2 Calculated from materials issued by each city.

the largest expansion rate.

As for Land Readjustment, its area in Toyohashi and Gifu, which were both cities with the Postwar Reconstruction Project, was about 2,200 ~ 2,500 ha, among which 74.7 ~ 88.2% was started by 1975. This indicates that these cities had well-developed infrastructures of Land Readjustment not in the suburbs but in the existing urban areas. On the other hand, while Akita, a city without the Postwar Reconstruction Project, conducted Land Readjustment relatively well, the actual total area before 1975 remained to be 637 ha. In Nagano, the actual area in this period was only 192 ha. As this data indicates, Land Readjustment in cities without the Postwar Reconstruction Project was carried out mainly after 1975, or in suburban areas. In this way, the development structure of Land Readjustment infrastructure was different between the cities with the Postwar Reconstruction Project and those without.

As for the construction of Public Housing developments,⁽¹⁰⁾ the supply of housing was almost the same between Toyohashi and Nagano and between Gifu and Akita. In case of Nagano, the construction of Public Housing developments was actively done even before 1975 (52.3% of the whole). Therefore, in Nagano, not Land Readjustment but the construction of Public Housing developments seems to have played a large role in the process of urban area formation before 1975. In Akita, on the other hand, the construction of Public Housing developments rapidly progressed after 1975. As for public transportation networks, Toyohashi and Gifu had private local railroads and streetcar lines, in addition to the former Japanese National Railways (Kokutetsu). Since these transportation networks were located in existing urban areas finished with Land Readjustment, which were mainly areas of the Postwar Reconstruction Project, it can be said that the existing urban areas had well-developed city infrastructures before 1975, or before motorization spread. Among cities without the Postwar Reconstruction Project, while Nagano had a local railroad, Akita did not but had bus services as the main public transportation system at the time. Considering these views, we examine the characteristics and factors of the process of urban area formation in existing urban areas in the next section.

Since we selected cities having fewer geographical factors (Section 2-1), it was geographically possible for any of the cities to expand its urban area at least in three directions. Finally, as for industrial development, Toyohashi and Akita are industrial cities which were designated as a Special Zone for Industrial Development (Kougyou Seibi Tokubetsu Chiiki) or a New Industrial City (Shin Sangyou Toshi), and have large-scale Exclusive Industrial Zones (Kougyou Senyou Chiiki) as a Use District. Since the designation was done mainly around mid-1960s, this is also

Table3 Expanding rate of urbanized area in target cities

*1				Year *1				expantion rate(%)		year *1				expantion rate (%)				
				1960	1975	2000	2015	1960-1975	1975-2015	1960	1975	2000	2015	1960-1975	1975-2015			
cities with the postwar reconstruction project	Toyohashi	area (ha)	use district designation	1,206.0	4,980.0	5,775.9	5,775.9	312.9	16.0	Gifu	1,574.6	5,046.9	8,340.2	8,340.2	220.5	65.3		
			land readjustment district	539.7	961.6	1,552.3	1,571.9	78.2	63.5		1,030.4	2,270.2	2,706.7	2,708.8	120.3	19.3		
			railroad station sphere (500m radius)	828.7	1,254.9	1,254.9	1,254.9	51.4	0.0		1,099.5	2,055.9	664.1	664.1	87.0	-67.7		
			bus stop sphere (300m radius)	907.1	3,406.1	3,479.8	3,479.8	275.5	2.2		1,371.6	3,740.8	3,966.3	3,966.4	172.7	6.0		
		population	use district designation	99,579	196,415	256,253	253,299	97.2	29.0		142,134	305,813	343,148	342,245	115.2	11.9		
			land readjustment district	58,637	67,638	87,755	93,139	15.4	37.7		114,153	155,927	132,866	137,190	36.6	-12.0		
			railroad station sphere	88,688	86,318	70,936	72,929	-2.7	-15.5		117,656	167,988	33,688	31,496	42.8	-81.3		
			bus stop sphere	78,240	121,790	111,107	114,624	55.7	-5.9		129,943	242,702	187,243	189,610	86.8	-21.9		
	population density (/ha)	use district designation	82.6	39.4	44.4	43.9	-52.3	11.2	90.3		60.6	41.1	41.0	-32.9	-32.3			
		land readjustment district	108.6	70.3	56.5	59.3	-35.2	-15.8	110.8		68.7	49.1	50.6	-38.0	-26.3			
		railroad station sphere	107.0	68.8	56.5	58.1	-35.7	-15.5	107.0		81.7	50.7	47.4	-23.6	-42.0			
		bus stop sphere	86.3	35.8	31.9	32.9	-58.6	-7.9	94.7		64.9	47.2	47.8	-31.5	-26.3			
	cities without the postwar reconstruction project	Nagano	area (ha)	use district designation	1,117.2	3,865.7	4,768.0	4,768.0	246.0		23.3	Akita	1,542.8	6,331.9	7,913.3	7,913.3	310.4	25.0
				land readjustment district	57.9	161.2	570.3	570.3	178.4		253.8		230.0	605.6	1,123.6	1,123.6	163.3	85.5
				railroad station sphere	396.8	769.8	810.7	810.8	94.0		5.3		699.5	920.1	927.4	927.4	31.5	0.8
				bus stop sphere	644.1	1,533.5	1,735.1	1,735.1	138.1		13.1		1,054.4	3,171.4	3,383.1	3,383.1	200.8	6.7
population			use district designation	119,855	196,559	238,158	226,167	64.0	15.1	103,654	216,635		280,992	263,096	109.0	21.4		
			land readjustment district	4,870	7,380	27,974	33,667	51.5	356.2	10,903	20,383		53,761	53,140	86.9	160.7		
			railroad station sphere	34,008	45,110	37,160	33,994	32.6	-24.6	14,873	20,677		18,546	17,068	39.0	-17.5		
			bus stop sphere	54,160	69,223	67,934	61,573	27.8	-11.1	40,414	54,658		65,747	59,622	35.2	9.1		
population density (/ha)		use district designation	107.3	50.8	49.9	47.4	-52.6	-6.7	67.2	34.2	35.5		33.2	-49.1	-2.8			
		land readjustment district	84.1	45.8	49.1	59.0	-45.6	28.9	47.4	33.7	47.8		47.3	-29.0	40.5			
		railroad station sphere	85.7	58.6	45.8	41.9	-31.6	-28.5	21.3	22.5	20.0		18.4	5.7	-18.1			
		bus stop sphere	84.1	45.1	39.2	35.5	-46.3	-21.4	38.3	17.2	19.4		17.6	-55.0	2.3			

*1 The data of 1960 was calculated within the 1960 DID for the cities with the postwar reconstruction project and within the 1965 DID for those without. The data of 1975 was calculated within the urbanization promotion area at the time (at the time of the initial area classification), and so was the data of 2015. The data of 2000, however, was calculated within the urbanization promotion area as of 2015, because the area as of 2000 is nearly the same as the area as of 2015.

discussed in our analysis. Considering these characteristics of the cities, I analyze factors of urban area formation in these cities below.

Table 3 compares the four cities by organizing the areas and populations of the specific areas at different time points as given in Table 1 into data in groups of four time points. The table shows that the population of the urban area in 1960 was nearly the same among the four cities, while Gifu had a slightly larger value. As for the expansion of Use Districts, while the rate of expansion differs among the cities,⁽¹¹⁾ the populations of the Use Districts, especially after 1975, fall in the range of about 230 ~ 340 thousand, showing that the four cities are medium-size regional Core Cities. It shows that the four cities are appropriate for comparison. It should be noted that the population densities of the Use Districts decreased nearly consistently. While the population densities of the existing urban areas as of 1960 were 67.2 ~ 107.3/ha, they decreased to 35.5 ~ 49.9/ha as of 2000, with that of Akita having fallen below 40/ha. The expansion rate during 1975 ~ 2015 was larger in the area of Use Districts than in the population density in the three cities other than Toyohashi, which can be attributed to the sparse area expansion during the period when the Area Classification was carried out. The same trend can be seen in the population density of the 500-m sphere of a railroad station (the station sphere), and the population densities of the station spheres fell to 18.4 ~ 58.1/ha as of 2015. It is characteristic that the population density of the station spheres was higher in the cities with the Postwar Reconstruction Project, which is because infrastructure as a result of the Postwar Reconstruction Project and public transportation

networks, such as a streetcar network, had been well-developed mainly in the Central Urban Areas. This can be clearly seen in the populations in 1960, which include the populations of station spheres, and the corresponding populations of the cities with the Postwar Reconstruction Project

were far greater. As for Akita, on the other hand, the population density of the station spheres and that of the 300-m spheres of bus stops (the bus-stop spheres) are both remarkably small, which indicates that the urban area formation in Akita through the period after World War II ~ the period of high economic growth ~ the initial Area Classification did not depend on public transportation networks. Finally, as for the districts of Land Readjustment in progress (the Land Readjustment districts), the population densities of the districts in 1960 of the two cities with the Postwar Reconstruction Project reached 108.6 and 110.8/ha, and the populations of the districts in the cities were far greater than those of the cities without the Postwar Reconstruction Project. This clearly indicates the advantage of having the infrastructure of the Postwar Reconstruction Project in the Central Urban Area. In addition, it is possible to clarify the characteristics of the progress of Land Readjustment in each city by examining the population growth in the Land Readjustment districts. In fact, while the populations in 1960 of the Land Readjustment districts in Toyohashi and Gifu were about 58,000 ~ 114,000, their later growth was relatively slow. In Nagano and Akita, on the other hand, the rate of population growth in the Land Readjustment districts during 1975 ~ 2015 was 160.7 ~ 356.2%, which supports the fact that Land Readjustment was carried out mainly in this period. Land Readjustment in this period in Nagano and Akita was carried out intensively in suburban areas. As shown in Table 3, it can be considered that since the population densities of Land Readjustment districts were relatively high, densely populated urban areas were formed in the suburbs of these cities. In Gifu, on the other hand, although the expansion rate of the districts of Land Readjustment recorded 19.3% during 1975 ~ 2015, the

Figure 3 Spatial population density structure in Toyohashi at 1960

Figure 4 Spatial population density structure in Gifu at 1960

expansion of Land Readjustment was carried out mostly in early times in the existing urban areas.

Consequently, the population of the districts of Land Readjustment reached its peak in 1975, and turned downward

Figure 5 Spatial population density structure in Toyohashi at 1975

during 1975 ~ 2015. As shown above, the four cities seem to be good examples for studying the progress of Land Readjustment and the influences of public transportation in the expansion of urban areas.

4. Characteristics of Urban Area Expansion from the Postwar Period till the Initial Area Classification

4-1. Patterns of Urban Area Expansion and Their Factors

There are three characteristic patterns of urban areas in the cities with the Postwar Reconstruction Project in this period: the periphery of center type, the periphery of subcenter type, and the linear type, among which the periphery of subcenter type was shown to take a form of detached areas by the past study by the author.⁶⁾ In this section, we examine if these patterns exist

in cities without the Postwar Reconstruction Project. First, the periphery of center type is the expansion pattern in which urban areas expand as if oozing out. It is the pattern of general sprawl. Both Toyohashi and Gifu had a densely populated central area of a population density of more than 100/ha in their urban areas as of 1960 (Figs. 3 and 4), and the central areas expanded to the peripheral regions as of 1975 (Figs. 5 and 6). The same phenomenon can be seen in Nagano and Akita: the Central Urban Area as of 1965 (Figs. 7 and 8) having expanded as of 1975 (Figs. 9 and 10). Secondly,

Figure 6 Spatial population density structure in Gifu at 1975

the periphery of subcenter type is the form in which urban areas expand in the peripheries of old towns or villages before their merger or in which urban areas develop in a form of detached areas as a result of the development of, for example, Public Housing developments.⁽¹²⁾ In case of Nagano, it can be clearly seen that the central area of old Amori village

(incorporated in Nagano City in 1954) and subcenters, such as Public Housing developments, whose development started in 1965, had expanded toward their peripheries as of 1975 (Figs. 7 and 9).

Especially in 1975, there were many Public Housing developments in the suburbs at the time, and there were many areas of a population density of more than 60/ha around them, which shows that the Public Housing developments played a large role in the progress of urban areas. Similarly in Akita, the central areas of old towns, such as Tsuchizakiminato and Araya (both incorporated in Akita City in 1941), and the peripheral areas of Public Housing developments (such as the Akita Municipal Housing Complex; Yotsuya Danchi) had expanded as of 1975 (Figs. 8 and 10). Thus, the peripheral of subcenter type can also be seen commonly in the cities without the Postwar Reconstruction Project. The linear type is the form in which densely populated areas are developed linearly along a private local railroad or a streetcar line.⁽¹³⁾ In Toyohashi and Gifu, the linear expansion of urban areas along such lines extending east and west or north and south can be seen (Figs. 3, 4, 5, and 6). Similarly in Nagano, where the Nagano Electric Railway (Nagano Dentetsu) is operated, the linear expansion of urban areas can be seen in the section extending from the central part to the northeast (Fig. 7). In Akita, however, which had no private railroad nor streetcar line, the linear type cannot be seen. It shows that the linear type is a form of urban area expansion which

Figure 7 Spatial population density structure in Nagano at 1965

Figure 8 Spatial population density change in Akita at 1965

depended on railroads whose station intervals were short.

On the other hand, the degree of concentration of areas with a population density of more than 100/ha and the range of urban area expansion were different between the cities with Postwar Reconstruction Project and those without. In the central areas of Toyohashi and Gifu as of 1960, highly populated areas of more than 100/ha sprawled to form a large area (Figs. 3 and 4). In Nagano and Akita, on the other hand, areas of 40/ha ~ 100/ha were mixed (Figs. 7 and 8), and this structure further progressed in 1975, showing a sign of sparsification in the central part (Figs. 9 and 10). This difference in the population density is clearly shown in the peak population densities of the Central Urban Area and the 1960 DID as shown in Table 4. Compared to Toyohashi and Gifu, the peak population densities of these areas of Nagano and Akita were apparently lower. Furthermore, the expansion of urban areas in Toyohashi and Gifu as of 1975 can be grasped as spreads having roughly the form as of 1960. In Nagano and Akita, on the other hand, the expansion of urban areas was wider and of medium population densities (levels of 40 ~ 100/ha), resulting from the sparsification of the central part together with the increase of the population density in the surrounding area. There are two possible factors for this difference, as follows. The first is the deployment pattern of the Land Readjustment Project, mainly the Land Readjustment Project

Figure 9 Spatial population density structure in Nagano at 1975

Figure 10 Spatial population density structure in Akita at 1975

The first is the deployment pattern of the Land Readjustment Project, mainly the Land Readjustment Project

for Postwar Reconstruction. In Toyohashi and Gifu, in addition to the Postwar Land Readjustment (292.6 ha in Toyohashi and 470.6 ha in Gifu), the following Land Readjustment was carried out in an areally continuous way (Figs. 3 ~ 6). It can be thought that the existence of the public transportation infrastructure within this area made it possible to maintain the densely populated area until 1975. In Nagano and Akita, on the other hand, there was no Land Readjustment infrastructure in the central parts, and the Land Readjustment which had been started by 1975 was carried out in the suburbs (areas of population density of less than 20/ha) as the development of new urban areas. Therefore, the difference of the two city groups seems to arise from the presence or absence of the infrastructure for maintaining densely populated areas. The second factor is the multicore city structure relating to the form of the peripherals of subcenters and the influence of Public Housing developments in the suburbs. Since Akita has a multicore structure which has two relatively large subcenters originating from old towns, it seems possible that the expansion of urban areas tends to progress along the highways connecting these subcenters (e.g., Section A in Fig. 10). Furthermore, the agricultural infrastructure had been developed so much in Akita as of 1960 that the development of agricultural fields in the area outside the urban area at the time had been mostly completed. While 1975 corresponds to the initial time of motorization, it seems that the expansion of urban areas in an areally and relatively managed form was easy to progress in areas such as Area A in Fig. 10 by diverting agricultural areas into residential areas (shown by the succession of rectangular blocks). Contrary, in Nagano, many Public Housing developments existed widely in the suburbs as of 1975 (Fig. 9), and small highly populated areas appeared, each corresponding to each housing development. Such highly populated areas seem to have served as nurseries for the wide expansion of urban areas. In addition, since there was no agricultural infrastructure development as was in Akita in the periphery of the urban area in Nagano, urban areas expanded in the form of sprawl-like urban areas mostly having only narrow roads, as typically shown by Areas A and B in Fig. 9. Thus, the form of

Table4 The peak population density and its time point in each area

area *		Toyohashi		Gifu		Nagano		Akita	
		population density (/ha)	Year	population area (/ha)	Year	population area (/ha)	Year	population area (/ha)	Year
Central urban area	all area	155.6	1960	203.3	1960	118.3	1960	60.0	1965
	inside land readjustment district	175.7	1960	203.3	1960	99.0	1965	87.1	1965
	outside landreadjustment district	84.6	2015	-	-	118.5	1965	50.9	1965
	inside station sphere	155.6	1960	203.3	1960	123.0	1965	22.2	1965
	outside station sphere	-	-	-	-	107.9	1965	217.1	1965
	inside bus stop sphere	155.0	1960	203.3	1960	124.2	1965	60.0	1965
	outside bus stop sphere	-	-	-	-	91.3	2015	-	-
I. 1960DI D	all area	74.2	1960	78.0	1960	105.0	1965	74.2	1965
	inside land readjustment district	92.0	1960	112.9	1975	83.6	1965	41.8	1965
	outside landreadjustment district	62.3	1960	90.5	1975	72.6	1965	72.0	1965
	inside station sphere	98.4	1960	114.3	1975	76.8	1975	21.1	1965
	outside station sphere	35.3	1975	86.5	1975	75.9	1965	102.3	1965
	inside bus stop sphere	75.4	1960	105.4	1975	68.5	1965	35.7	1965
	outside bus stop sphere	42.8	1975	102.6	1975	78.1	1965	129.5	1965
II. Initial urbanization promotion area	all area	42.1	2015	54.3	2015	48.4	2000	38.9	2000
	inside land readjustment district	58.1	2015	45.8	2015	42.7	2015	55.6	2000
	outside landreadjustment district	39.0	2000	61.1	2000	49.4	2000	36.3	2000
	inside station sphere	62.3	2015	43.6	1975	39.5	2000	44.4	2000
	outside station sphere	40.3	2000	56.7	2015	49.8	2000	38.7	2000
	inside bus stop sphere	25.4	2015	36.6	2000	37.3	2000	15.2	2000
	outside bus stop sphere	67.3	2000	99.2	2015	53.8	2000	57.7	2000
III. Expanded urbanization promotion area	all area	62.4	2000	20.5	2015	35.0	2015	17.1	2015
	inside land readjustment district	41.6	2015	33.6	2015	30.4	2015	21.2	2015
	outside landreadjustment district	83.4	2015	20.2	2015	39.7	2015	15.4	2015
	inside station sphere	-	-	-	-	18.4	2000	15.8	2015
	outside station sphere	62.4	2000	20.5	2015	35.8	2015	17.1	2015
	inside bus stop sphere	40.3	2015	28.7	2015	21.9	2015	15.8	2000
	outside bus stop sphere	70.6	2000	19.9	2015	38.7	2015	18.4	2015

* The land readjustment districts, the station spheres, and the bus-stop spheres overlap partially with each other. The areas having the peak population density in 2015 have the gray background, because they may have the peak in a later year.

the expanded urban areas is distorted.

4-2. Characteristics of the Peak Population Densities

The peak population densities of the Central Urban Area and the whole zone of 1960 DID⁽¹⁴⁾ were recorded in 1960 (1965 in case of the cities without the Postwar Reconstruction Project) (Table 4). The peak population densities of the specific spheres, such as the districts of Land Readjustment, the station spheres, and the bus-stop spheres, were recorded also in 1960, except for Gifu, which shows that the population densities of the existing urban areas in each city had their peaks in the period of high economic growth. As is typically seen in the values of the peak population densities (the peak values) of the Central Urban Areas, the peak values reached 175.7 ~ 203.3/ha in Toyohashi and Gifu, where the almost whole area of the Central Urban Area corresponded to the area of the Postwar Reconstruction Project, while the peak values remained to be 87.1 ~ 99/ha in Nagano and Akita, which had no Postwar Land Readjustment infrastructure.⁽¹⁵⁾ This clearly shows the difference due to the presence or absence of the Postwar Land Readjustment infrastructure. On the other hand, the difference in the peak value of the whole zone of 1960 DID was small between the four cities, and it shows that the existing urban areas of even the cities without the Postwar Reconstruction Project had a highly populated, compact urban area structure at this time. In Toyohashi and Gifu, however, the peak values were clearly different between the areas inside and those outside the station spheres: the inner being higher than the outer. In Nagano and Akita, the difference is not clear, and the areas outside the station spheres had a higher population density in Akita.⁽¹⁶⁾ In this way, the presence or absence of private railroads or streetcar lines, described in the previous section, was reflected in the difference in the peak values.

The initial Urbanization Promotion zone is the zone which had been designated as an Urbanization Promotion Area in 1975. While the peak value of the zone in cities with the Postwar Reconstruction Project occurred in 1965, that in cities without occurred earlier, in 2000. This

Table5 Area of each zone

Unit (ha)	Toyohashi	Gifu	Nagano	Akita
Central urban area	124.4	153.7	194.8	114
I. 1960DID	1081.6	1420.9	922.4	1428.8
II. Initial urbanization promotion area	4286.4	3472.3	2748.5	4789.1
III. Expanded urbanization promotion area	283.5	3293.3	902.3	1581.4

Figure 11 Spatial population density structure in Toyohashi at 2000

complements the fact that moderately populated areas rapidly expanded in the latter cities during 1965 ~ 1975, which was an expansion of areas with lower populations than the cities with the Postwar Reconstruction Project. The initial Urbanization Promotion zone is the largest among the four zones (Table 5), and the next chapter describes the characteristics of the expansion of urban areas, focusing on this zone, in the period from the initial Area Classification till 2015.

5. Characteristics of Urban Area Expansion from the Initial Classification till 2015

5-1. Patterns of Urban Area Expansion and Their Factors

5-1-1. Cities with the Postwar Reconstruction Project

Except for Zone A in Fig. 12, the expanded Urbanization Promotion zone (Zone III defined in Fig. 2) in Toyohashi were industrial Urbanization Promotion Areas designated, mostly detached from the central area and separated east and west (B ~ D in Fig. 12). Excluding these areas, the expansion of Urbanization Promotion Areas toward 2015 was relatively compact (the expansion rate for 1975 ~ 2015 was only 9%, excluding the industrial Urbanization Promotion Areas), and many urban areas were relatively highly populated, with the population density being mostly 40/ha or more. Its main factor is the increase of the population density (to a value more than 60/ha in many areas) in the districts of Land Readjustment started before 1975 (A ~ D in Fig. 5) and the districts of Land Readjustment started during 1975 ~ 2000 (E in Fig. 12) or 2000 ~ 2015 (A in Fig. 12). Other than the districts of Land Readjustment, the increase of the population density also occurred in the districts reclaimed by the Land Improvement project (F in Fig. 12). Since the expansion of Urbanization Promotion Areas was carried out restrainedly in Toyohashi in this way, the districts of Land Readjustment accepted population increase, resulting in an areal expansion of highly populated areas. On the other hand, the decrease of highly populated areas in the 1960 DID zone (Zone II defined in Fig. 2, hereafter noted in the same way) resulted, as a whole, in a transition to an urban area having a form of plateau if the population density was compared to altitude. Highly populated area of more than 100/ha decreased, randomly scattered in the form of,

Figure 12 Spatial population density structure in Toyohashi at 2015

for example Public Housing developments, only in the suburbs and the central area. In other words, highly populated areas are scattered on the plateau as protrusions. In addition, since the Exclusive Industrial Zones were designated, separated from the Urbanization Promotion Areas (B, C, D in Fig. 12), the relation between the industrial areas and the residential areas such as the proximity of workplaces and homes cannot be seen.

Since Gifu designated excessively large Urbanization

Promotion Areas at the time of the initial Area Classification,⁶⁾ the increase of the expansion rate of Use Districts during 1965 ~ 1975 reached 105.8% (Table 2). Thus, Gifu had a large initial Area Classification zone (Zone II). The zone was an extensive nonurban area at the time, as typically seen as Zone A in Fig. 6, and still had many districts of population density less than 20/ha even in 2015, as seen in Fig. 14. Furthermore, the increase of the expansion rate of Urbanization

Figure 13 Spatial population density structure in Gifu at 2000

Figure 14 Spatial population density structure in Gifu at 2015

Promotion Areas during 1975 ~ 2015 was also large, or 42.3% (Table 2). The expanded areas (Zone III) extend to the far suburbs located northwest ~ north ~ northeast of the urban area, and the areas include many nonurban districts of population density less than 10/ha as of 2015. This possibly excessive expansion of Urbanization Promotion Areas is a characteristic of Gifu. It can be seen that in such a situation the sparsification of highly populated areas rapidly progressed, as described in case of Akita in Section 4-1. The patterns of the sparsification were the disappearance of highly populated areas of population density of more than 100/ha, which were in a peripheral form or a linear form (Fig. 14), and the settlement of population in the Land Readjustment areas in the suburbs, whose

development was in progress at the time of 1975 (A and B in Fig. 13). In addition, the influence of municipal mergers is also possible. One of the factors of expanding the Urbanization Promotion Areas at the time of the initial classification is the municipal mergers in 1950s. For example, the Urbanization Promotion Areas were expanded in the south to west parts of the city, incorporating villages of old Uzura, Ichihashi, and Kurono in 1950 and Kagashima in 1955 (Fig. 14). It only resulted in the increase of the population density during 1975 ~ 2015 in the form of the peripherals of subcenters, such as these old villages and Public Housing developments in the suburbs (Fig. 14). It showed a form of dispersed populated

Figure 15 Spatial population density structure in Nagano at 2000

Figure 16 Spatial population density structure in Nagano at 2015

areas, in which the peripherals of subcenters were distributed like islands within an extensive low population area. Furthermore, as motorization progressed during this period, the streetcar network was abolished in Gifu by 2000 (the streetcar network in the existing urban area is not seen in Figs. 13 and 14). It can be considered that it further accelerated the disappearance of the linear-type urbanization and the expansion of urbanization to the suburbs. The structure of population density at the time of 2015 has a form of mountain ridges which shows the traces of the peak and main ranges. It is also a sponge-like form which has many small voids in the central part and, toward the suburbs, randomly dispersed large mountain feet and relatively large areas of low population.

5-1-2. Cities Without the Postwar Reconstruction Project

The expansion of the Urbanization Promotion zone (Zone III) in Nagano was being carried out in the south (Area A in Fig. 15) and the east and north (Areas B ~ D in Fig. 15) of the Urbanization Promotion zone as of 1975 all through Land Readjustment. The expansion was carried out by 2000, and almost no further expansion was done during 2000 ~ 2015. Although the expansion of urban areas actually progressed toward the suburbs as of 1975 (Section 4-1), the initial Urbanization Promotion zone (Zone II) was large (Table 5), and there still existed many areas of a population density less 40/ha even in 2015. The areas of a population density well over 40/ha were the districts of Land Readjustment started during 1975 ~ 2000 (Areas E and F in Fig. 15) and the districts of Land Readjustment carried out in Zone III (Areas A, C, D, and G in Fig. 15, where over 40/ha was achieved in 2015, Fig. 16). Thus, what definitely contributed to the increase of population density in Nagano during 1975 ~ 2015 was the districts of Land Readjustment in the suburbs. On the other hand, the development of agricultural fields in the nonurban areas was delayed, and there were many areas with poor areal road infrastructure. Consequently, the urbanization of Zone II remained at the level of population density of 40 ~ 60/ha in many areas, and together with the dissolution of highly populated areas in the Central Urban Area, the dispersion of population further progressed. The most populated areas in the urban area are not located in the central area but dispersed within the whole

Figure 17 Spatial population density structure in Akita at 2000

area. The structure of population density in Nagano has transformed into a hilly form with many ups and downs.

Akita is a city with a large Zone II, its expansion rate of use districts during 1965 ~ 1975 being 112.4%. As described in Section 4-1, a rapid expansion of urban areas was observed in Zone II at the time of 1975. Akita, however, differs from Nagano in that its development of agricultural fields was carried out in areas surrounding the urban area and Land Readjustment was actively carried out. The population density reached 60 ~ 100/ha in 2000 in the districts of Land Readjustment started by 1975 (Area B in Fig. 17) and the districts of Land Readjustment started during 1975 ~ 2000 (Areas C ~ E in Fig. 17), both located outside the 1960 DID zone. In addition, the existence of the infrastructure of regular-

Figure 18 Spatial population density structure in Akita at 2015

form areas, though for agriculture, in the periphery has brought the areal spreading of areas of a population density more than 60/ha. Furthermore, the Public Housing developments, which were constructed full-scale after 1975, formed highly populated areas scattered in and outside the urban area. Therefore, Akita had a form of a plateau with protrusions of highly populated areas as of 2000, which is similar to Toyohashi as of 2015. The data of 2015 (Fig. 18), however, shows that there were areas of population density of 20 ~ 60/ha mixed among the areas forming a plateau of population density of 60 ~ 100/ha, showing the beginning of the decrease of population density as a whole. Zone III of Akita includes the southeast area of the urban area (Onoba Public Housing Development (Onoba Danchi Housing Complex) and Onoba New Town in Fig. 17) and the east area (Area A in Fig. 17). While the population density of the Onoba Public Housing Development remained the same as before as of 2015, the population of the Onoba New Town, detached from the former, had hardly increased. Thus, although the areal infrastructure development in Akita had brought a plateau-like urban area having medium population densities as of 2000, the decrease of population had brought the random decrease of population densities as of 2015, resulting in a sponge-like form. The difference from Gifu is the formation of a sponge form in the dissolution process of a plateau, and the form characteristically has relatively large voids. It should be noted that the Exclusive Industrial Zone in Akita extends along the Omono River and is located closer

to the urban area than in the case of Toyohashi. It, however, shows that the industrial zone is not the cause of urbanization. In other words, considering the urbanization process in Toyohashi and Akita, the large-scale development of an industrial area was clearly not related to the progress of the nearby residential urban areas.

These analyses show that the largest influence on the formation of urban areas during 1975 ~ 2015 was given by the size of the Urbanization Promotion zone (especially the size of the initially designated Urbanization Promotion zone) and the structure of infrastructure development including the districts of Land Readjustment. If Zone II was too large, the extensive dispersion of urban areas was brought even if the city had a highly populated central core (Gifu), and the transformation into a sponge-like urban area was easily brought as population decreased even if an urban area of a medium population density having the form of a plateau had been formed (Akita). If districts of Land Readjustment were expanded adjointly outside the districts developed by the Land Readjustment Project for Postwar Reconstruction, extensive urban areas of medium to high population densities could be formed (Gifu and Toyohashi). On the other hand, if districts of Land Readjustment were concentrated in the periphery of Zone II or within Zone III, urban areas of a hilly form without the core was formed (Nagano).

5-2. Characteristics of the Peak Population Densities

In Toyohashi and Gifu, which were cities with the Postwar Reconstruction Project, the initial Urbanization Promotion zone (Zone II) seems to be still in the process of increasing population density as of 2015. Except for Toyohashi, which had a limited expanded Urbanization Promotion zone (Zone III), the population density of Zone III of Gifu was 20.5/ha in 2015,⁽¹⁷⁾ and the speed of its urbanization was low. If we assume that the zone with the population density at its peak was the area of most rapid urbanization, it can be said that the zone of peak urbanization, which started from the central urban zone as of 1960, had moved to Zone B as of 2015. However, in Nagano and Akita, which were cities without the Postwar Reconstruction Project, Zone II reached its peak in 2000, and it can be said that the zone of the peak population density was moving toward the outer area as of 2015. This shows that the cities without the Postwar Reconstruction Project had a larger speed of the transition of population to the suburbs. As described in Chapter 4, the underlying cause of this seems to be related with the presence or absence of infrastructure development in the existing urban areas, mainly the Central Urban Area. Furthermore, if we focus on the peak population density itself, the peak population densities of Zones II and III were not necessarily higher in the cities with the Postwar Reconstruction Project, and they appeared at different times. Thus, there was not definite difference between the two city groups. In addition, due to the advancement of motorization, the population density was higher in the area outside the bus-stop sphere in any city, as typically seen in Zone III. Therefore, the service level of public transformation was not a necessary condition for the expansion of urban areas anymore.

The population densities of the zones in each city at 2015 (Table 6) shows that difference was very small among the zones from the central urban zone to Zone II. Especially in the cities without the Postwar Reconstruction Project, the population density was higher in Zones I and II than in the Central Urban Area. In addition, although the population density in the central

Table6 Population density change in each zone

year		1960	1965	1975	2000	2015
Central urban area	Toyohashi	155.6	-	104.0	65.3	58.5
	Gifu	203.3	-	114.4	62.7	55.7
	Nagano	-	118.3	75.6	48.5	44.2
	Akita	-	60.0	34.3	29.7	31.0
I. 1960DID	Toyohashi	74.2	-	65.5	48.9	44.5
	Gifu	94.6	-	65.5	67.6	54.5
	Nagano	-	105.0	97.8	76.3	63.3
	Akita	-	74.2	63.1	49.2	40.9
II. Initial urbanization promotion area	Toyohashi	7.5	-	26.3	41.4	42.1
	Gifu	15.9	-	39.9	50.8	54.3
	Nagano	-	16.3	33.3	48.4	46.4
	Akita	-	14.6	25.6	38.9	36.3
III. Expanded urbanization promotion area	Toyohashi	-	-	-	62.4	61.5
	Gifu	-	-	-	18.5	20.5
	Nagano	-	-	-	28.0	35.0
	Akita	-	-	-	13.1	17.1

[-] means not subject to survey.

urban zone was higher in the cities with the Postwar Reconstruction Project, no characteristic difference can be seen in Zones I and II between the two city groups. Therefore, in the characteristics of the expansion of urban areas during 1975 ~ 2015, when motorization had well permeated, the difference due to the presence or absence of the Postwar Reconstruction Project was small not only in the factors of urban area expansion but also in the peak population density.

6. Conclusion

In this study, I comparatively analyzed the difference between cities with the Postwar Reconstruction Project (Toyohashi and Gifu) and those without (Nagano and Akita) and the difference in the process of urban area expansion between the period from the period of high economic growth till the initial Area Classification and the period thereafter until today, using the population data of Survey Districts of National Censuses. The following summarizes the result of this study.

- 1) The population densities of urban areas in regional Core Cities had steadily decreased since 1960, from 67.2 ~ 107.3/ha to 35.5 ~ 44.4/ha as of 2000. On the other hand, there was clearly a spatial structural difference between the cities with the Postwar Reconstruction Project and those without. The population densities and the population sizes of station spheres were higher in the cities with the Postwar Reconstruction Project, which clearly shows the influence of the Land Readjustment infrastructure, mainly through the Postwar Reconstruction Project, existing in the Central City Area already in the period of high economic growth. On the other hand, Land Readjustment in the cities without the Postwar Reconstruction Project progressed widely in the suburbs (outside the 1960 DID zone) after 1975.
- 2) There were patterns of urban area expansion common to both the cities with the Postwar Reconstruction Project and those without: “the periphery of center type,” in which the Central Urban Area expanded toward the outer; “the periphery of subcenter type,” in which the urban areas of incorporated towns and villages or separate developments, such as Public Housing developments, expanded toward their peripheries; and “the linear type,” in which the formation of urban areas progressed along private railroad lines with short station distances or streetcar lines. The linear type, however, depended on the existence of railroads, and was not seen in cities without the development of railroads.
- 3) There was a clear difference in the urban area expansion in the period from the period of high economic growth till the initial Area Classification between the cities with the Postwar Reconstruction Project and those without. While the form of the central area, which had been formed as a result of the sprawling of highly populated areas of more than 100/ha seen in 1960, was still observed in 1975 in the former cities, the sprawling of highly populated areas as of 1965 was slight in the cities without the Postwar Reconstruction Project, and the population decrease in the central area and the expansion of urban areas to the initial Area Classification zone (Zone II) as of 1975 progressed rapidly. The possible factors of this are the lack of Land Readjustment infrastructure in the central area and the multicore city structure arising from the existence of many subcenters.
- 4) The factors of bringing the characteristics of urban area expansion in the period from the initial Area Classification till today (1975 ~ 2015), in which motorization had permeated, and the public transportation infrastructure, such as railroads and bus services, had become less important for urban area expansion, were the degree of the expansion of Urbanization

Promotion Areas and the promotion of Land Readjustment in the suburbs. Considering the reasons of the dissolution of the city structure in 1960s, which included highly populated existing urban areas, the excessively large designation of initial Urbanization Promotion Areas (large Zone II) served as the underlying cause of the formation of dispersed voids of low population densities in the suburbs, and the promotion of Land Readjustment in the suburbs (Zones II and III) of the cities without the Postwar Reconstruction Project, which did not have Land Readjustment infrastructures in the existing urban areas, brought urban areas of more than medium population density (40/ha) in the suburbs, further accelerating the dispersion of urban areas.

- 5) If we consider the zone showing the peak population density as the area of most active urbanization, the transition of urbanization from the center of this zone to the suburbs was faster in the cities without the Postwar Reconstruction Project than the cities with the project. In addition to the difference in such a transition, the decrease of the population densities of the Central Urban Areas and the similarity of the peak population densities of Zones II and III progressed from the time of the initial Area Classification to today, and consequently the difference in the levels of population density between the cities with the Postwar Reconstruction Project and those without disappeared by 2015.
- 6) As a result of these transitions described above, the spatial structures of population density of the cities, which showed a clear form of a single mountain ridge in 1960s (multiple peaks in Akita), have transferred as of 2015 into a form of a plateau with randomly located protrusions of highly populated areas on top in Toyohashi; into a spongy form having many large or small voids in the central area and the suburbs, considered as in the course of the dissolution of the mountain ridge, in Gifu; a hilly form without the center and with many ups and downs in Nagano; and a spongy form considered as in the course of the dissolution of the plateau with randomly located protrusions of highly populated areas in Akita.

In this study, only four cities were compared as typical regional Core Cities. It is for a future study to improve the validity of this study by including the comparison with other cities and to consider the actual application of our study to Location Optimization Plans. If a suggestion to Location Optimization Plans from the limited knowledge by this study is abstracted, the followings could be considered. Since either of four cities has compact urban structure with higher population density in 1960-1970s, the idea going back to urban structure in that era by Location Optimization Plan could be justified to some extent. However, in the case of city without forming linear type structure in the past, like Akita, it wouldn't be credible and feasible to apply Location Optimization Plan, the scope of which is 'compact plus network'. Making strong network by public transportation newly would be main serious issue. Thus, the credibility and feasibility of future shrinking initiative by Location Optimization Plan can be considered from the urban area formation process in the postwar era.

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Note

- (1) The Core City system has been administered since 1996. The population requisite for a Core

City was a population of 300 thousand or more before April 2015, and have been lowered to 200 thousand or more since then.

- (2) In this study, a city is considered as a Core City if its population was 200 thousand or more in 1970, which corresponds to the time of introduction of the Area Classification system.
- (3) The population data of 1960 and 1975 was obtained at the Statistical Library of the Statistics Bureau of Japan. For some cities, however, the oldest obtainable data was that of 1965, and I used it for the data of 1960. The data of 2000 and 2015 was obtained at e-Stat (<https://www.e-stat.go.jp/>) (last view on Dec. 10, 2020).
- (4) Since the process of urban area formation is analyzed in this study, the cities to be analyzed are required to have a size of urban areas more than a certain level. In addition, since conditions are different between regional cities and metropolitan areas, where urban areas are sprawled and the interaction between cities is large, we focus on regional Core Cities, in which the processes of urban area formation can be grasped independently.
- (5) The reasons of setting the two indexes are as follows. First, the percentage of the districts of Land Readjustment as of 1970 was adopted because the results of previous studies by the author (References 7) and 8)) show that the accumulation of Land Readjustment districts before 1970 (before motorization permeated, and the planned expansion of urban areas was carried out by the system of Area Classification) was totally different between the cities with the Postwar Reconstruction Project and those without. Secondly, past studies have revealed that the degree of urban area expansion in cities with Area Classification has been equalized because the system of Population Frames (Jinkou Frame Houshiki) has been adopted in the expansion of Urbanization Promotion districts after the Area Classification system was introduced. Therefore, the expansion rate of Urbanization Promotion districts in the period from 1975 to 2015 was adopted.
- (6) Because there is structural difference between regional city and city in metropolitan conurbation area, this study targets regional city, discriminating these both. As a definition of metropolitan conurbation area, it is appropriate that it includes Urbanized Area (Kisei Shigaichi) and Zone for Suburban Development (Kinkou Seibi Chitai) by Metropolitan Area Development Law (Syutoken Seibi Hou), Urbanized Zone (Kisei Toshi Kuiki) and Zone for Suburban Development (Kinkou Seibi Kuiki) by Kinki Metropolitan Area Development Law (Kinkiken Seibi Hou), and Zone for Urban Development (Toshi Seibi Kuiki) by Cyubu Metropolitan Area Development Law (Cyubuken Seibi Hou). Although Gifu and Toyohashi are located near Nagoya, which is center city of Cyubu metropolitan area, both cities are outside Zone for Urban Development. Thus, we can consider both cities are regional cities.
- (7) The Central Urban Area was set as the area which was an area setting common to all four cities and was most suitable for grasping the state of the central part of each city. Next, the DID as of 1960 was set as the urban area in the period of high economic growth. For Nagano and Akita, however, the population data of Survey Districts in this period was not available, and the DID as of 1965 was used instead. Although the data of Use Districts in this period should be more appropriate, the availability of City Planning Maps (Toshi Keikaku Zu) was different among the cities, and I could not obtain all necessary City Planning Maps in this period. I thus adopted DID. As for the Urbanization Promotion Areas as of 1975, 2000, and 2015, the Urbanization Promotion Areas mostly at these time points in each city were extracted from the City Planning Maps and superimposed over GIS. Since the expansion of Urbanization Promotion Areas during 2000 through 2015 was relatively small in each city,

- the expanded area of Urbanization Promotion during 1975 through 2015 was set as Zone III.
- (8) As I went back to the past, 1960 or 1975, some materials of bus line networks or bus stops in each city were lost, and I could not obtain them. Therefore, I simply set our bus-stop spheres, based on the information of the present bus service networks and bus stops, to grasp the populations in the spheres.
 - (9) According to City Planning Annual Reports (Toshikeikaku Nenpou, compiled by the City Planning Association of Japan), the expansion rates of Urbanization Promotion Areas during 2000 through 2015 are 0.2% in Toyohashi, 5% in Gifu, 0.8% in Nagano, and 2.7% in Akita, showing a further decrease. Since the difference in the expansion between the cities is small, as this data shows, the expansion of Urbanization Promotion Areas during 1975 ~ 2015 was defined as a whole as “the expanded Urbanization Promotion zone,” as described in Section 2-3.
 - (10) In this study, the Prefectural Housing (Ken-ei Jyutaku) and the Municipal Housing (Shiei Jyutaku) are together expressed as the Public Housing.
 - (11) Since I analyze the process of urban area expansion in this study, I excluded the Urbanization Promotion Areas (including the Central City Area) incorporated later through municipal mergers. Thus, the Urbanization Promotion Areas of the districts of Shinonoi and Matsushiro were not considered in the analysis of Nagano. On the other hand, all Urbanization Promotion Areas in three other cities were considered for analysis.
 - (12) The progress of the periphery of subcenter type in Toyohashi and Gifu is described in detail in Reference 6).
 - (13) This type did not occur along railroads of the former Japanese National Railways because the intervals of their stations were long.
 - (14) As shown in Fig. 2, the 1960 DID zone here is the area of 1960 DID excluding the Central Urban Area. Thus, the initial Urbanization Promotion zone and the expanded Urbanization Promotion zone are defined in the same way as zones.
 - (15) The area of Land Readjustment in progress in the Central Urban Area of Nagano as of 1965 was only 2 ha, corresponding only to about 1.0% of the Central Urban Area of 194.8 ha.
 - (16) Because of its urban area structure in Akita, which originated from an old castle town and has a bustling area (area A in Fig. 8) in the south of the castle ruins, the highly populated area is located outside the station sphere of Akita Station. In addition, since the castle ruins and business districts occupy a large part of the Central Urban Area, the population density of the station sphere is low.
 - (17) As described in Section 5-1-1, Zone III of Toyohashi expanded by only 9% during 1975 ~ 2015, excluding the Exclusive Industrial Zones, where the construction of housing is prohibited. Therefore, as can be seen in Table 4, Zone III reached its population peak in 2000, earlier than Zone II.

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