Study on the Composition of the Residential Environment and Environmental Cognition in Collective Housing

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***Abstract*—This paper investigates, analyzes, and considers the living environment, the characteristics of environmental perception, and their relationships, based on a survey of the residents of the housing complex in Makuhari Baytown, which was built using a new planning technique. In this study, it was found that the average size of the cognitive domain of the residents that has a courtyard which is available for a non-resident tends to increase.**

Keywords-Environmental recognition; Cognitive area; Collective housing; Makuhari Baytown; Living environment

I. INTRODUCTION

The plan for the center of the complex was to make it multistory, and to use standardization, which is one of the modern city theories followed in the design of a housing complex on an urban scale, with the aim of alleviating the shortage of houses. However, a uniform plan that does not consider the surrounding environment would result in a housing complex that would deteriorate after a time, and would eventually be destroyed, be rebuilt, or become antiquated, fall into ruin, and transform the district, making it quite different from the original plan. It is necessary to consider the environmental conditions of existing buildings and the original city plan and building codes, along with the surrounding environment, in order to ensure the plan will result in a sustainable housing complex. This consideration changes the existing problem, which is quantitative, to a qualitative problem.

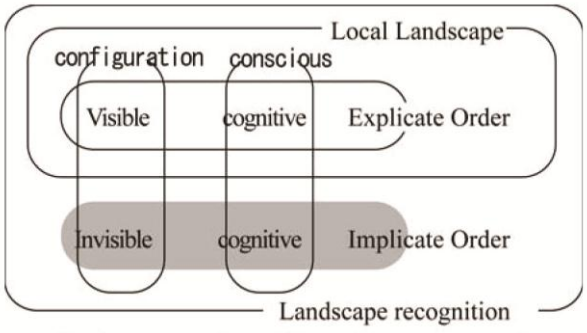
In the previous study, [6] Sketched maps drawn by children have analysed and considered the relationships between the actual physical environment of the town and the images that children drew of their environment, as well as the mutual relationships between the environmental changes that affect the children's spatial cognition.

Landscape recognition is the process by which an inhabitant recognizes the regional landscape. Regional symbiosis, which has been increasingly important in the recent years, is based on the premise that the resident feels that the surrounding environment is common property. Therefore, the shared recognition of the local landscape, which is valuable common property, is important.

The local landscape is defined by the correlation between morphological character, a physical-environment characteristic of space, and cognition based on spatial vision. Moreover, the visual information a person receives in daily life defines the cognitive region, which is a composite image of visible things and invisible things in specific positions. Landscape recognition is formed by relationship between the explicate order (visible cognitive region of consideration) and the implicate order (subconscious invisible cognitive region). The explicate and implicate orders are inseparable reciprocal processes (Figure 1).

Therefore, environmental recognition is analyzed based on landscape recognition.

Figure 1. Conception of Landscape recognition.



 ISBN: 978-1-61208-178-6

II. INVESTIGATION AND OUTLINE OF ANALYSIS

A. *Region for research investigation*

The investigation covered Makuhari Baytown, a residential housing area in the new center of the city of Makuhari, and constructed by a Chiba prefecture corporate agency in the Tokyo Bay shore area. It was possible to house 26,000 people in the 84-ha area, and 8,900 households were planned (Figure 2) .The route enclosing the housing area was constructed as the first part of the residential quarter plan (Figure 3).

The design was based on the guidelines, and an inside layer, a multistory section, and a high rise area are allocated in every city block. The layout of the plan included the development of a route enclosing the residential housing, and another enclosing the entire residential quarter (Figure 3).

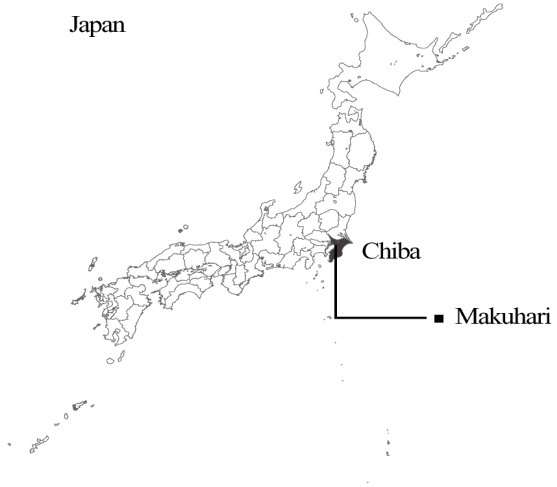


Figure 2. Location map of Japan in Makuhari

Figure 3. Investigation aerial photograph (2006)

Figure 4. Arrangement plan

In many commercial and residential buildings, the lower floors house commercial facilities, which led to the invention of "The city is made in the house" development concept. The population, the number of houses, and the number of households, have all expanded during the passage of 15 years from the town's opening. As of August 2009, around 40 housing complexes have been built so far, and the population now exceeds 23,000.

B. *Methods of analysis*

In the present study, residents of apartments and condominium complexes in the town were asked to complete a perceived area questionnaire survey. Next, a multivariate analysis was done to analyze the address space configuration of the research zone and the residents' perceptions of the space surrounding them, which were quantified. The individual data obtained from the questionnaire was analyzed and a factor axis was extracted. The patterns were analyzed, and the features of the perceptions of the residents in the apartment and condominium complexes in Makuhari Baytown were obtained from a series of analyses.

C. *Outline of the investigation*

Investigation period: 25, 26 July, 1, 2, 7, and 31 August, and 8 September, 2010.

The search procedure: Residents of 43 residential buildings in the housing complex were given the questionnaire survey to complete.

 ISBN: 978-1-61208-178-6

TABLE I . OUTLINE

Business district	Quarter	Residential building name Middle(5~6F)		Reidence floor	Residences
M2	M2-1	Patios 1st Street		6	117
	M2-2	Patios 2nd Street		6	132
	M2-3	Patios 3rd Street		6	114
	M2-4	Patios 4th Street		6	114
	M2-5	Patios 5th Street		6	113
	M2-6	Patios 6th Street		6	118
M1M8	M1-1	Patios 7th Street	North Building	5	
			South Building	6	
			East Building	5	
			West Building	5	
	M1-2	Patios 8th Street		6	130
	M8-1	Patios 9th Street		6	115
	M8-2	Patios 10th Street		6	120
M7	M7-1	Patios 11th Street		8	190
	M7-2	Patios 12th Street		6	136
	M7-3	Patios 13th Street		7	115
M3M6	M3-1	Patios 14th Street		5	110
	M3-2	Patios 15th Street		6	126
	M3-3	Patios 16th Street		6	112
	M6-1	Patios 17th Street		7	125
	M6-2	Patios 18th Street		6	115
M4M5	M4	Patios 19th Street	North Building	5	189
			South Building	5	
			East Building	7	
			West Building	6	
	M5-1	Patios 20th Street		7	200
	M5-2	Patios 21th Street	North Building	6	214
			South Building		
			East Building		
			West Building		
Business District	Quarter	Residential Building Name High(~20F)		Reidence Floor	Residences
H1	H1-1	Grand Patios higashi-no-machi	1st pavilion	14	148
			2nd pavilion	13	105
			3rd pavilion	14	78
			4th pavilion	9	54
	H1-2	Grand Patios nishi-no-machi	1st pavilion	14	35
			2nd pavilion	14	94
			3rd pavilion	14	62
			4th pavilion	14	105
			5th pavilion	10	79
H2	H2-1	Buena terraza	A building	14	
			B building	10	
			C building	14	138
			D building	7	
	H2-2	Makuhari beach terrace	Park residence	6	
			Sunny residence	18	
			Bay residence	18	
H3H4	H3	Marinefort	Sun right	14	91
			Sunset right	19	73
			Sunset center	19	112
			Sunset left	19	
			Sunrise	7	
	H4	Mira mar	1st pavilion	7	
			2nd pavilion	7	
			3rd pavilion	14	
H5H6	H5	Mira río	1st pavilion		44
			2nd pavilion	5	50
			3rd pavilion	14	108
			4th pavilion	14	110
			5th pavilion	14	133
	H6	Makuhari south coat	A building	14	
			B building	14	
			C building	10	
			D building	14	
M9	M9	Makuhari aqua terrace	Dia residence	5	
			Canal residence	14	
			Bay residence	14	
			Aqua residence		

Business District	Quarter	Residential Building Name Super-high-rise(~40F)		Reidence Floor	Residences
SH1	SH1	Central Park east	E	11	42
			F	14	113
			G	12	72
			H	10	43
		Central Park west	A	14	63
			B	12	71
			C	14	47
			D	12	99
		Central Park sea tower		32	226
		Central Park park tower		33	226
SH3	SH3-1	Patios Elist	T building	8	35
			R building		
	SH3-2	Patios Grand axiv	1st pavilion	14	49
			2nd pavilion	14	74
			3rd pavilion	18	105
	SH3-3	Patios Avance	V	14	95
			L	22	129
	SH3-4	Patios Grand exia	1st pavilion	14	99
			2nd pavilion		52
			3rd pavilion	8	37
SH4	SH4-1	First wing	A building		142
			B building		100
			C building	14	36
			D building	19	137
			E building	19	137
	SH4-2	Cities fort	White form	19	142
			Green form	14	150
			Orange form	8	91

To clarify each resident's cognitive domain, the questionnaire survey was done by the by Sphere graphic method*. Residents had to have lived in the housing complex three years or more, and had to be at least 10 years old. To ensure there was no bias, the questionnaire survey covered each region of "Makuhari Baytown".

The survey content. The following items were investigated:

①Attribute investigation
②Consideration range survey recognized local resident
③Rote investigation in daily life
④Perceived area survey in range of action
⑤Perceived area component investigation in range of action
⑥Perceived area survey of responses to phrases such as familiar waterside, familiar green space, and bustle
⑦Perceived area component investigation
⑧Landmark investigation
⑨Visible consideration investigation of component of ②, ⑤, ⑦ and ⑧.
⑩Comparative study of the current housing and previous type of residence

The survey was conducted according to the overview above, and we obtained 164 valid responses, which are summarized in TABLE I and TABLE II. Cognitive domain data were obtained, and we considered the data analysis as a multivariate analysis.

 ISBN: 978-1-61208-178-6

TABLE II . DATA ON THE RESPONDENTS

Age	Teens	24	Apartment name	Patios 1st Street	3
	Twenties	9		Patios 2nd Street	5
	Thirties	17		Patios 3rd Street	5
	Forties	69		Patios 4th Street	6
	Fifties	22		Patios 5th Street	5
	Sixties	16		Patios 6th Street	4
	Seventies	6		Patios 7th Street	4
	Eighties	1		Patios 8th Street	4
Sex	A man	75		Patios 9th Street	3
	Woman	88		Patios 10th Street	6
Residence Year	3~6years	56		Patios 11th Street	6
	7~10years	52		Patios 12th Street	3
	11~13years	28		Patios 13th Street	4
	14~17years	27		Patios 14th Street	3
	18years~	1		Patios 15th Street	4
Residence Floor	1~5	100		Patios 16th Street	4
	6~10	46		Patios 17th Street	4
	11~15	11		Patios 18th Street	3
	16~20	1		Patios 19th Street	
	21~24	1		Patios 20th Street	3
	25~30	3		Patios 21th Street	3
	31~	2		Patios 22th Street	3
The Direction of the room	North	13		Patios Avance	5
	South	59		Patios Elist	3
	East	14		Patios Grand axiv	4
	West	22		Patios Grand exia	4
	Northeast	1		Central Park east	6
	Northwest	3		Central Park west	8
	Southwest	20		Central Park sea tower	6
	Southeast	25		Central Park park tower	3
Employment	Company emploee	57		Grand Patios higashi-no-machi	6
	Civil servant	4		Grand Patios nishi-no-machi	4
	Independent enterprise	6		Buena terraza	3
	Profession	2		Makuhari beach terrace	3
	University student	27		Marinefort	4
	High shcool student	19		Mira mar	3
	Junior high shcool student	37		Mira rio	4
	Part-time job	3		Makuhari southcoat	4
	Full time housewife	4		First wing	4
	The unemployed	5		Cities fort	5
Past Resident Status	Detached house	25	The effective number of answers: 164samples		
	Lodgings	3			
	Private apartment	80			
	Company residence	23			
	Public corporation	25			
	Others	4			

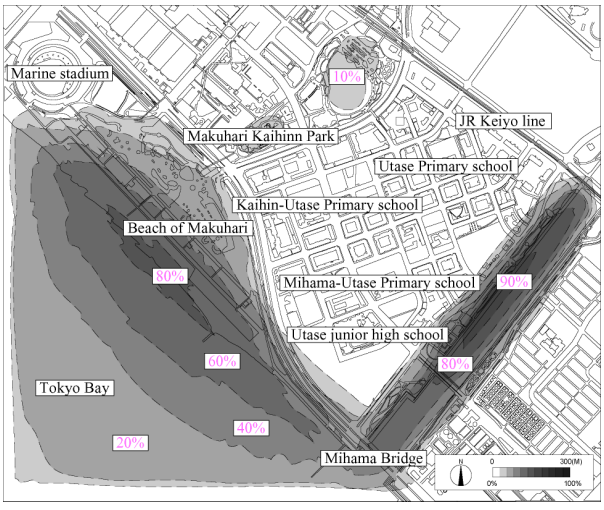


Figure 5. Cognitive Region Map "Familiar Waterside" (All)

*Sphere graphic method
This method is effective when focused on a subject who has adequate recognition of the area. It is suitable for studying elatively limited spaces in small areas, such as the area surrounding a personal dwelling. The subject's cognitive area is obtained by indirectly exploring the structure through a spread, a spatial break, etc.

III. CONSIDERATION OF RESIDENTS' ENVIRONMENTAL PERCEPTION

Subjects from the study demonstrated their cognitive domains by sphere graphic method such as "My Town," "familiar waterside," "familiar green," "buzz," "action range," and "neighbors." From their responses, cognitive domain diagrams were created (Figure 4).

The perceived area chart, in which all residential buildings in Makuhari Baytown had been summarized, was analyzed. The division perceived area chart was made for an inside layer, multistory, and high rise residential buildings to compare the analyses of the cognitive domains of each residential building type by height. This comparison analysis was carried out.

IV. CONSIDERATION OF COGNITIVE CONSTRUCT THAT USES MULTIVARIATE ANALYSIS

This section considers the psychological impact of the Makuhari Baytown design on its residents. An important part in the plan was the "Enclosed roadside" concept to target residents of residential mid-rise buildings (Figure 6).

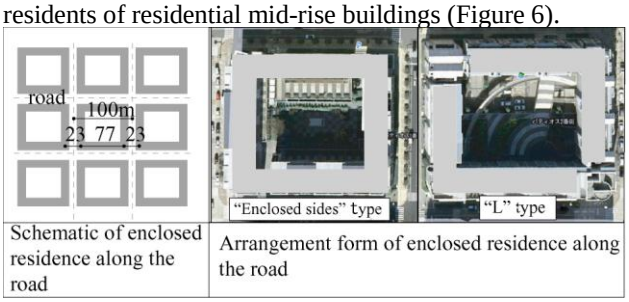


Figure 6. Characteristic of enclosed residence along the road

TABLE III. ITEM CATEGORY TABLE

IN(Item Number),CN(Category Number),PN(Plot Number),FRE(Frequency)

IN	Item	CN	PN	FRE
1	Sex	1	A man	39
		2	Women	43
2	Age	1	10~29	18
		2	30~45	27
		3	46~59	26
		4	60~79	11
3	Residence Year	1	3~5years	17
		2	6~8years	10
		3	9~11years	11
		4	12~14years	24
		5	15~18years	20
4	Residence Floor	1	1F	5
		2	2F	16
		3	3F	20
		4	4F	21
		5	5F	9
		6	6F~	11
5	Perceived neighborhood (horizon)	1	0~10ha	36
		2	10~50ha	21
		3	50~90ha	14
		4	90ha~	11
6	Attribute	1	Point	46
		2	Line	1
		3	Respect	29
		4	Time	6
7	Number of components	1	1	61
		2	2	11
		3	3~	10
8	Visibility neighborhood	1	visibile	34
		2	unvisibile	29
		3	no cognition	19
9	Liberating level of courtyard	1	possible	31
		2	impossible	51
10	Living building arrangement	1	Type "L"	35
		2	Type "Enclosed sides"	47

Examples of the shaft to extract the common factors by quantification III* by using multivariate data obtained from surveys of previous chapters, we discuss factors that are critical to the recognition of residents (TABLE III). Quantification III was employed for 82 samples and residential buildings in which residents lived in the middle floors.

The first axis "Correlation coefficient:" 0.492140
The number of years in residence increased more than the item category plot chart, and the thing that decreases is understood (Figure 7). Moreover, it ranks highest in an item range high-ranking table (TABLE IV).The first axis is interpreted from the above-mentioned factor as a settled axis.

The second axis "Correlation coefficient:" 0.450089
The attribute becomes a quick fact from the item category plot chart in the positive direction, and the thing that is a physical element is understood in the negative direction (Figure 6). It ranks highest in an item range high-ranking table (TABLE IV). The second axis is interpreted from the above-mentioned factor as the axis of the formation of the local resident perceived area.

The third axis "Correlation coefficient:" 0.418563
It becomes impossible to use the degree of openness to the courtyard from the item category plot chart in the positive direction, and the thing that can be used in the negative direction is understood. The arrangement form understands similarly and the thing that there is all sides enclosing type in the positive direction, and L type is located in the negative direction is understood . The third axis is interpreted from the above-mentioned factor as the axis of the degree of freedom of access to the courtyard. It has been understood that "Liberating level of the courtyard" is a factor that alters the perception characteristics of the residents.

TABLE IV. TOP TABLE ITEM RANGE

The 1st axis			2nd axis			3rd axis		
IN	Item	Range	IN	Item	Range	IN	Item	Range
3	Residence Year	3.733166	6	Attribute	9.777477	6	Attribute	6.880096
5	Cognitive region area	3.438209	4	Residence floor	5.886572	3	Residence year	4.172621
2	Age	2.694054	3	Residence year	4.866726	4	Residence floor	3.478414
7	Number of components	2.61696	7	Number of components	4.708679	9	Liberating level of courtyard	2.280037
4	Residence floor	2.453967	2	Age	3.732348	10	Arrangement form	1.986933
9	Liberating level of courtyard	2.452993	5	Cognitive region area	3.602709	2	Age	1.856149
6	Attribute	1.909773	8	Visibility	2.260094	7	Number of components	1.666257
8	Visibility	1.798911	10	Arrangement form	0.935666	1	Sex	1.645543
1	Sex	0.749161	9	Liberating level of courtyard	0.336151	8	Visibility	1.537859
10	Arrangement form	0.066751	1	Sex	0.046749	5	Cognitive region area	1.120360

*Quantification#III
The purpose of this analysis is to classify samples from relationship between categories (characteristic items) and the samples. The result is shows as scatter diagrams.
The procedure of the analysis is
1) the relationship between categories are analysed,
2) from the result, reveal latent common factor showed as axes of scatter diagrams (Item category plotting fig.) .
3) By the possession of samples on these scatter diagrams (Sample plotting fig.), they are classified, and their characteristics are grasped.

V. CONSIDERATION OF STRUCTURAL CHANGES IN THE RESIDENT FACTOR ANALYSIS AND TYPOLOGY

This study used samples obtained from the results in a score quantification # III, cluster analysis (Ward method), and revealed the characteristic features of each type of pattern recognition by each resident that typify the be. This paper identified at least 40 patterns in types I-IV. Euclidean distance cluster analysis helped obtain a dendrogram (Figure 6, Figure 7).

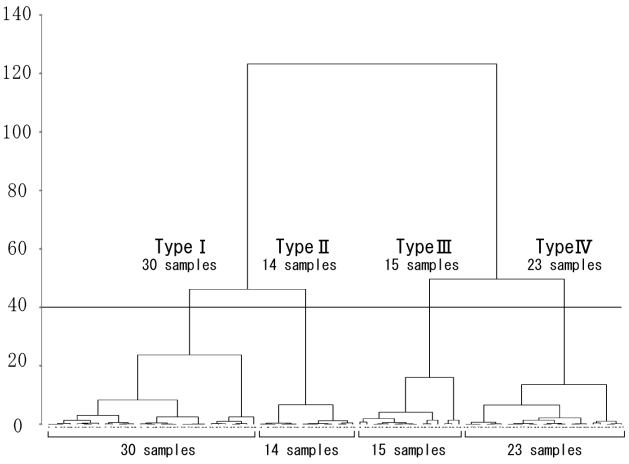


Figure 7. Cluster analysis dendrogram (Ward method)

Type I (30 samples)
Type I represents large residential buildings with open entry to a courtyard that is open to residents only. The average length of residency was 11.3 years. Many factors are involved, but they do not include a time element.

Type II (14 samples)
This type consists of a residential building with an open courtyard that is accessible to residents only. The average length of residency was 15 years.

Type III (15 samples)
In regard to the degree of openness of the courtyard entry, this type consists of large residential buildings with an open entry to the courtyard, which is also available to non-residents. Attributes of the neighborhood that form the cognitive domain include a time element.

Type IV (23 samples)
Type IV comprises large residential buildings with an open courtyard also available only to non-residents. The average length of residency was 7.5 years. The cluster analysis was made based on the four patterns of local resident perceived area charts (Figure 8).

TypeI: Perceived area mean value: 11.61 ha
TypeII: Perceived area mean value: 11.26 ha
TypeIII: Perceived area mean value: 95.94 ha
TypeIV: Perceived area mean value: 42.81 ha

 ISBN: 978-1-61208-178-6

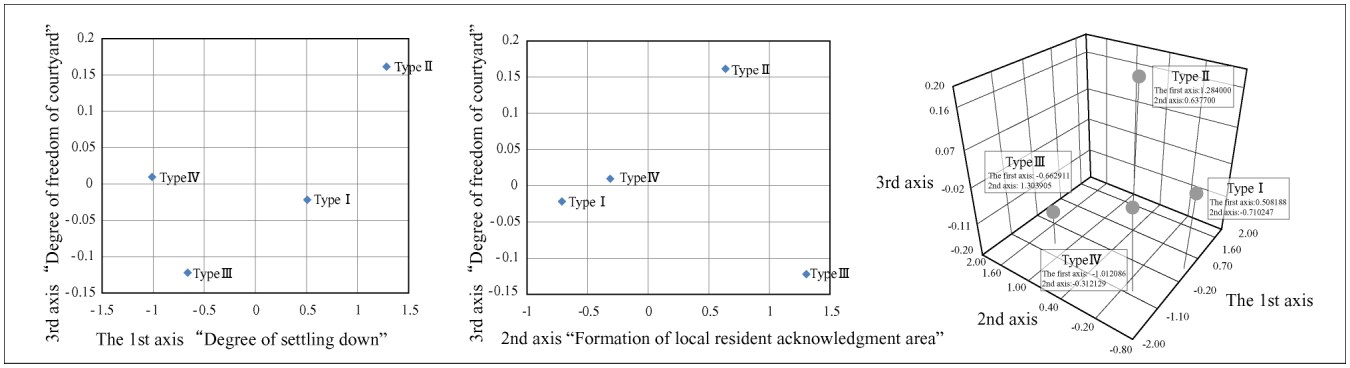


Figure 8. Pattern sample plot chart

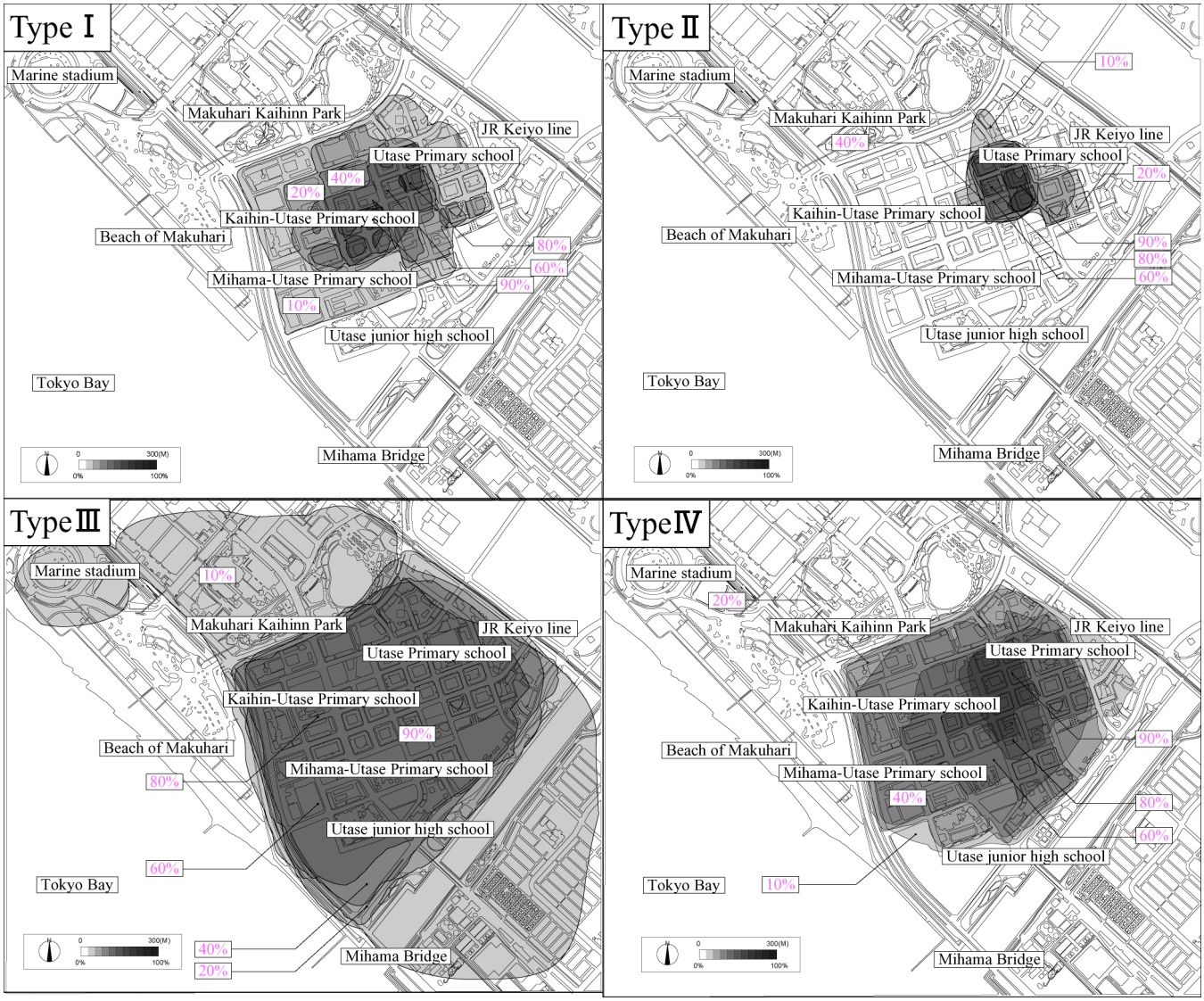


Figure 9. Cognitive region map "neighborhood"

VI. SUMMARY

The results of the above-mentioned analysis show the relationship between the characteristics of the living environment in Makuhari Baytown and the perception of the environment by the residents.

1. When the patternizing of the residents in the courtyard type route house is done according to the local resident perception characteristic, the factor of "Settle down", "Formation of the local resident perceived area," and "Degree of freedom of access to the courtyard" are the key indicators.

2. As the pattern characteristic, in pattern 1, there are a lot of ratios of the residential building with a courtyard that only the resident can use, and the length of residency was the longest in Type I. In Type Ⅱ, the residential building has a courtyard that only the resident can use, and the average length of residency is the longest in this type. The perceived area mean value for this type is the lowest. Type III is a pattern that there are a lot of ratios of the residential building with a courtyard that can be used exclusively by the resident, and the residency years are short. The perceived area mean value is the maximum. Type IV is a pattern that there are a lot of ratios of the residential building with a courtyard that can be used exclusively by the resident, and in this type the average length of residence is the shortest. The design characteristics of the courtyard type and the composition of the cognitive area were able to be considered by analyzing the living environment of the type of courtyard and "Local resident" perception characteristics. It is thought that the results achieved in this master's thesis will lead to a theory relating to techniques for planning and constructing a uniform current housing complex and for city planning that considers characteristics of the location as well as those relating to the types of residents and the surrounding environment.

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