A FEASIBILITY STUDY ON EVALUATION OF DISTRICT ENVIRONMENTAL METHOD USING REMOTE SENSING OF TM & IKONOS DATA FOR HEALTHY CITY NO2 - A CASE STUDY IN URBAN AREAS OF TOKYO BAY 2000 -

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Key Words: Healthy City Level, Urban Areas of Tokyo Bay, Geographic Information System (GIS), Remote Sensing (TM, IKONOS)

ABSTRACT: At 5:46 a.m. on January 17th, 1995, the worst disaster in postwar Japan changed Kobe. The ratio of the Kobe Government's houses destroyed by fire came to 98.9% in all of the burned out area. As it turned out, the houses and other buildings densely packed in the narrow streets in the city center may have been the main factor of this Kobe urban disaster. We have been pointing out the importance of the risk forecast of overcrowdedness of the wooden houses. This paper examines a report on the urban areas of Tokyo Bay in the event that it were to suffer similar damage in the future. In addition, two analysis of district characteristics were done using surveying urban geographic information system (GIS) and remote sensing. The healthy city level was estimated by methods using remote sensing from Landsat TM & IKONOS data. Also the relationship between Urban Index(UI) and Normalized Difference Vegetation Index(NDVI) was determined. We proposed that UI relates to the overcrowded ratio, and NDVI relates to healthy city level. We attempted to improve the GIS and remote sensing as effective methods for good urban design tools.

1 INTRODUCTION

W.H.O. showed that it had to straighten various conditions of the city to improve a body, mental, social, healthy level of the inhabitant who lived as "Healthy city project" in the city the proposal. And, that tries to have with the problem of health to achieve the effect, and construct the mechanism to achieve city inhabitant's high, healthy level and the process in the city.(Figure 1)

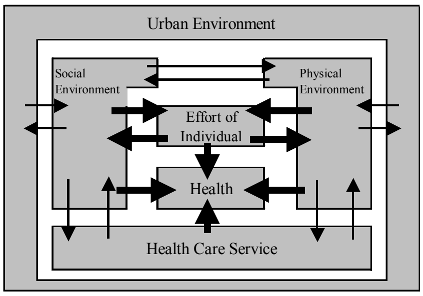

Figure1. Concept model about relation of environment of city and person's health (C) 1998 TAKANO [1)]

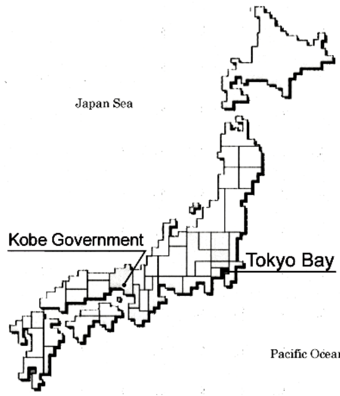

Figure 2. Kobe Gov. and Tokyo Bay

2 PURPOSE OF STUDY

The work of the WHO healthy city project is being developed in the city of 1,000 or more in the world now. Healthy promotion of the inhabitant is located to one of important pillars of the city policy, and the advantage of the healthy city policy is confirmed as common recognition in the city in which it works on the project as the next generation achieves continued development of the city. City planning by which the maintenance of the change in the population structure, the population movement, and the residence environment and health are valued and the city which healthily affects in view, and organizing for a healthy city and the evaluations is assumed to be the firm one. It can be said that pursuing a healthy problem of the inhabitant who lives in the city from the standpoint of "Healthy city" and "Healthy City Planning" is necessary. In this report, That aims at a city environmental evaluation of 16 districts in the metropolitan area by which a city environmental investigation and the analysis of remote sensing are integrated.

3. CURRENT RESEARCH REPORT

3.1 Disaster situation of Kobe Government (1995)

The following has already been classified from the urban disaster prevention research of the Kobe Government (Figure 2) on 1996, 2000 [2),3)]. The fire situation due to the earthquake in 1995 (Great Hanshin Earthquake) was generated as a city problem of the reality. The fire rank chart was made from the fire situation chart of the Nagata and Suma district in Kobe Government (Figure 3). Moreover, the situation of a fire was understood in respect. Next, the city evaluated the environment from NDVI and UI analysis by remote-sensing techniques according to the district for scatter chart (Figure 4).

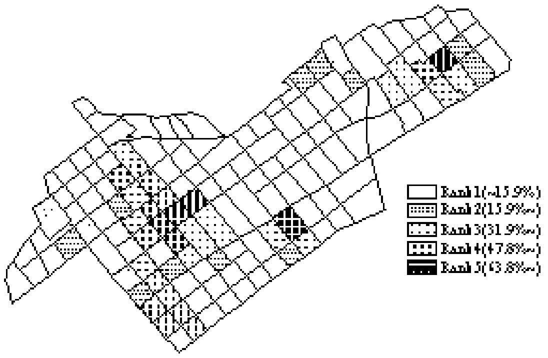

Figure 3. The Fire Rank Chart (Nagata and Suma district)

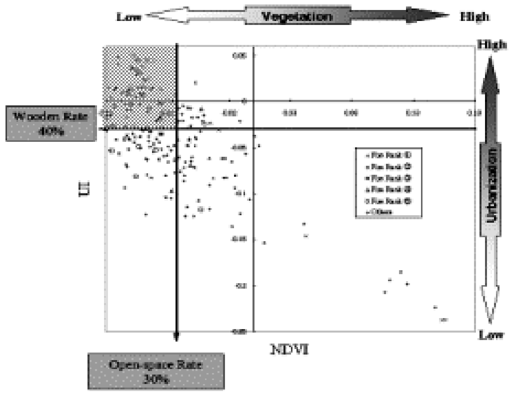

Figure 4. NDVI & UI scatter chart

3.2 Forecast of dangerous district in Kobe Government (1995)

When Figure 3 and Figure 4 are compared, it has been understood that a large scale fire (rank4 and rank 5) were occured in the gray zone(Wooden ratio: more than 40%, Open space ratio: less than 30%) in Figure 4. In addition, a fire dangerous district has been forecast through the evaluation of a wooden ratio(more than 40%) and the open space ratio(less than 30%) using remote sensing analysis (Figure 5). Next, proportions of the number of fire hazard pixels on each town even number eyes were calculated from Figure 5, the rank division was done, and the fire hazard forecast chart in unsupervised-classification by the remote sensing analysis was made. (Figure 6)

Thus, we have developed the method of automatically detecting the disaster danger district among forecast of the overcrowded area of Kobe Government.

4. RESEARCH DEVELOPMENT

4.1 Selection of investigation district

It was analyzed for paid attention to 4 points hereafter and the district was selected.
1. The overcrowdedness district along river and bay shore metropolitan area
2. District where still a lot of wooden overcrowdedness districts remain
3. District where population density is high
4. District where a lot of breaking out of fire numbers existed

Therefore 16 districts were selected are as follows that Table 1 is shown.

4.2 Land coating classification

(1) Supervised Classification

It was analyzed Supervised Classification as ground truth by using structural current state of building chart, current state of building floor number chart, and current state of land use chart.

(2) Unsupervised clasification

Also it was analyzed unsupervised classification by using the ISO-DATA method .

4.3 Investigation of city environmental evaluation

It was selected as basic information on the city by six items : the population, the number of houses, the each city areas, the densities, population of the aged, and the composition ratios of population. Moreover, six items : the number of death people, the numbers of cancer death people, the breaking out of fire numbers, the emergency mobilization numbers, the traffic accident numbers, and the crime numbers were selected as an index which showed the health level of the city. 12 items in total were assumed to be a city environmental investigation index.(Table 2)

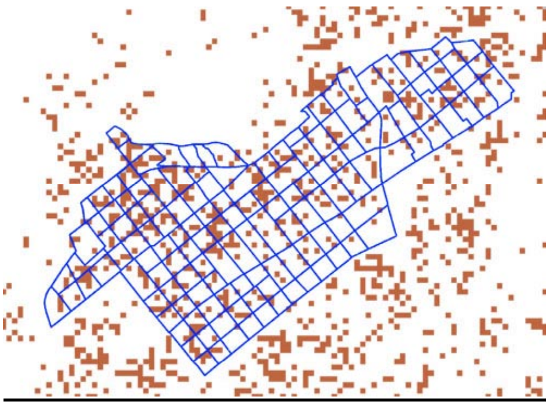

Figure 5. Fire hazard district classification chart (Nagata and Suma district)

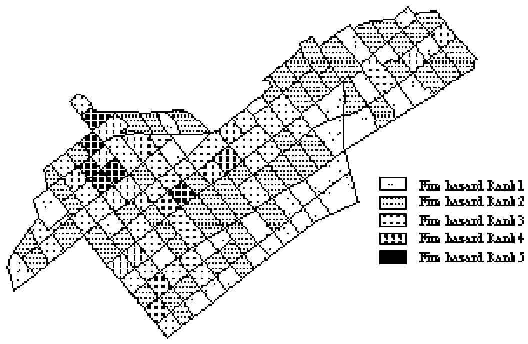

Figure 6. Fire hazard forecast chart by unsupervised-classification(Nagata and Suma district)

Table 1. Investigation District

Tokyo	**Adachi** Ward, **Katsushika** Ward, **Edogawa** Ward	
Saitama Pref.	**Kawaguchi** City, **Souka** City, **Koshigaya** City	
Chiba Pref.	**Ichikawa** City, **Kashiwa** City, **Matsudo** City, **Urayasu** City, **Funabashi** City, **Narashino** City	
Kanagawa Pref.	Yokohama City	**Tsurumi** Ward
	Kawasaki City	**Kawasaki** Ward, **Saiwai** Ward, **Nakahara** Ward

Table 2. Increase ratio of 12 items(%)

		1 Density of population	7 Number of the death	8 Number of Cancer deat	9 Number of fire	10 Number of emergency	11 Number of Traffic accident	12 Number of Crime
Tokyo	Adachi-Ward	-0.6	44.2	82.3	-4.8	82.8	62.7	42.6
	Katsushika-Ward	-2.3	25.8	4.7	15.2	74.7	69.8	16.1
	Edogawa-Ward	14.1	4.2	66.5	1.5	116.9	100	98.5
Saitama	Kawaguchi	12.3	68.3	102.6	-16.3	59.6	58.4	152.9
	Souka	14.4	62.1	8.6	26.7	61.2	78.1	202.3
	Koshigaya	18.3	75.1	93.2	0.5	66.9	107.6	223.4
Chiba	Ichikawa	7	42.5	62.1	-8.2	71.8	99.1	32.5
	Kashiwa	17.9	81.2	105.8	-1.2	100.9	249.5	32.2
	Matsudo	6.9	59.2	86.3	-6.4	77.2	48.2	6.6
	Urayasu	32	75.5	157.3	70.1	109.2	102.1	111.3
	Funabashi	6.1	66.4	70.5	14.9	98.6	53.9	29.2
	Narashino	9.6	76.7	94.8	57.7	76.3	78.8	4.8
Kanagawa	Yokohama,Tsurumi-Ward	3	33.8	76.1	10	65.5	25.6	41.1
	Kawasaki,Kawasaki-Ward	-17.9	24.4	25.4	1.9	48.5	98.5	36.2
	Kawasaki,Saiwai-Ward	-2.2	46.2	58.6	-26.1	94.8	60	14.3
	Kawasaki,Nakahara-Ward	3.6	50.6	5.7	34.6	24.4	29.2	23.7
		30 ～	70 ～	100 ～	50 ～	100 ～	100 ～	100 ～

5. CITY ENVIRONMENTAL EVALUATION ACCORDING TO DISTRICT

5.1 City environmental analysis by TM data

Urban Index (UI) and Normalized Difference Vegetation Index (NDVI) in 1985, 2000 were calculated by the remote sensing analysis (Figure 7,8).

$$Landsat\ NDVI = \frac{BAND4 - BAND3}{BAND4 + BAND3}, \qquad Landsat\ UI = \frac{BAND7 - BAND4}{BAND7 + BAND4}$$

It was derived by using above such these definition for the Landsat TM image in 2000 and 1985 was done. (Figure 9). Urbanization in the Tokyo bay shore region is shown between 1985 and 2000. Moreover, the land coating classification previously described was done by using a similar image at the time of two, and the pixel number change in vegetation areas and the overcrowdedness district was measured (Table 3). In addition, the city environmental investigation index selected by 4.3 was calculated as a value for each unit area, and the change ratio was obtained (Table 3). As a result, it is understood that a lot of NDVI decrease in Kawaguchi City, Urayasu City and Nakahara Ward. Moreover, the thing that the overcrowdedness area increases in Koshigaya City, Urayasu City are understood. Especially, it was understood that pixel of NDVI were a lot of thing which decrease in Urayasu City. Therefore, when the change in the city environment was seen, the tendency to an increase to various, unhealthy elements including the population density was able to be understood in the district where the change was large.

5.2 City environmental analysis by IKONOS data

Next, Urayasu City was analyzed by IKONOS data. This process was improve the accuracy of the analysis of TM data. In the TM data, it was necessary to do the land use classification by one pixel (30m mesh). However, the analysis by 8-10M is possible in the analysis of the IKONOS data. It is possible to understand as the overcrowdedness town ground and the road situation are detailed as understood from (Figure 10). The district where theover-crowdedness area was formed without doing the city planning from the road pattern in the past can be understood. Moreover, the road pattern made in premediation can be understood, and the difference of both is understood well. The difference whether the road plan was composed disorder it or composed with the plan can be judged by doing in this manner. Thus, the analysis by the IKONOS data can be used by a strong tool in the city planning in the future.

Table 3 Pixel number of RS analysis (Pixel) (%)

		1985		2000		Inctease Ratio (%)	
		Vegetation area	Overcrowded urbanarea	Vegetation area	Overcrowded urbanarea	Vegetation area	Overcrowded urbanarea
Tokyo	Adachi-Ward	6,631	15,597	6,066	16,543	-8.52	6.07
	Katsushika-Ward	2,542	8,090	3,241	9,220	27.50	13.97
	Edogawa-Ward	3,173	13,238	2,974	16,974	-6.27	28.22
Saitama	Kawaguchi	12,768	17,058	8,874	15,453	**-30.50**	-9.41
	Souka	4,042	9,387	5,040	8,040	24.69	-14.35
	Koshigaya	9,585	13,412	12,876	18,393	34.33	**37.14**
Chiba	Ichikawa	9,238	14,181	9,899	16,971	7.16	19.67
	Kashiwa	11,357	24,058	16,448	24,435	44.83	1.57
	Matsudo	10,351	15,384	8,417	17,401	-18.68	13.11
	Urayasu	5,337	4,791	4,035	6,541	**-24.40**	**36.53**
	Funabashi	13,668	21,712	14,581	22,221	6.68	2.34
	Narashino	2,640	6,014	3,592	6,787	36.06	12.85
Kanagawa	Yokohama,Tsurumi-Ward	3,032	9,164	2,954	8,466	-2.57	-7.62
	Kawasaki,Kawasaki-Ward	3,073	9,170	3,839	8,513	24.93	-7.16
	Kawasaki,Saiwai-Ward	1,081	3,281	968	3,240	-10.45	-1.25
	Kawasaki,Nakahara-Ward	2,149	5,079	1,239	5,456	**-42.35**	7.42

`-20	30 `

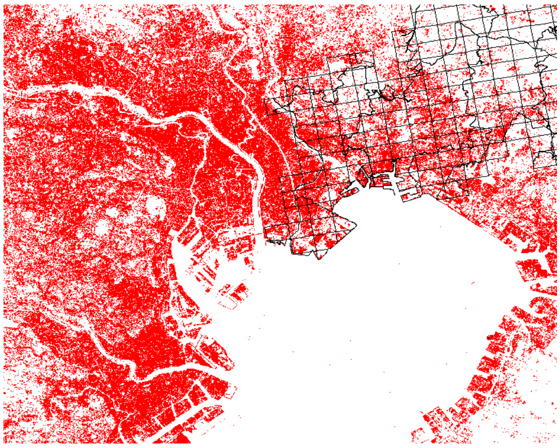

Figure 7. UI (Urban Index) ;Tokyo Bay 1985 TM

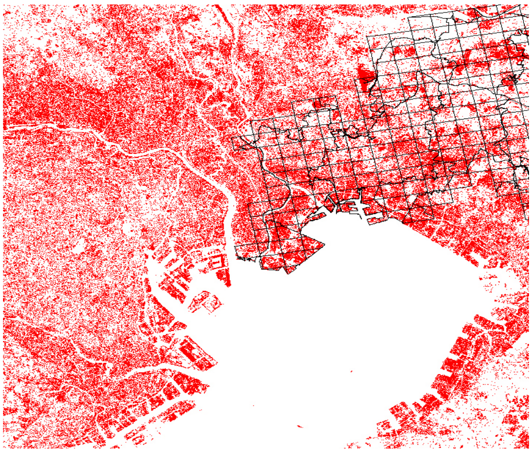

Figure 8. UI (Urban Index) ;Tokyo Bay 2000 TM

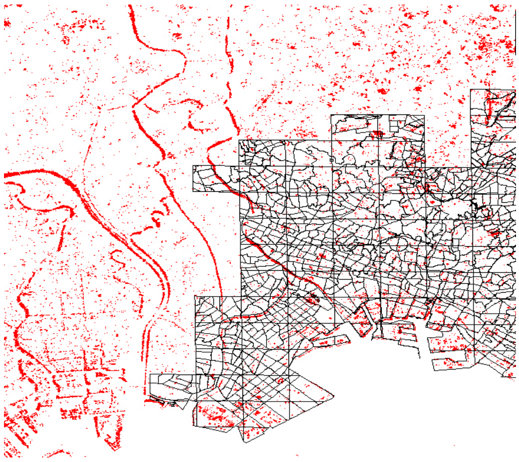

Figure 9. UI (Urban Index) '00-'85 ;Tokyo Bay TM

5.3 IKONOS Normalized Difference Vegetation Index (NDVI)

Next, Urayasu City is NDVI image analyzed by the IKONOS data. Urbanization in the Tokyo bay shore region is shown 2000. IKONOS NDVI can be obtained by the following expressions.

$$IKONOS\ NDVI = \frac{BAND1 - BAND2}{BAND1 + BAND2}$$

Band1: Visible optical region. (Red), Band2: Near infrared rays region.

A white area shows the green tract of land. It is clear that the green tract of land on the overcrowdedness town ground is few though the green tract of land is installed in the district where the city planning was done. (Figure 11) Thus, order in the city planning in the investigation district and a situation disorder can be adequately judged from Figure 11.

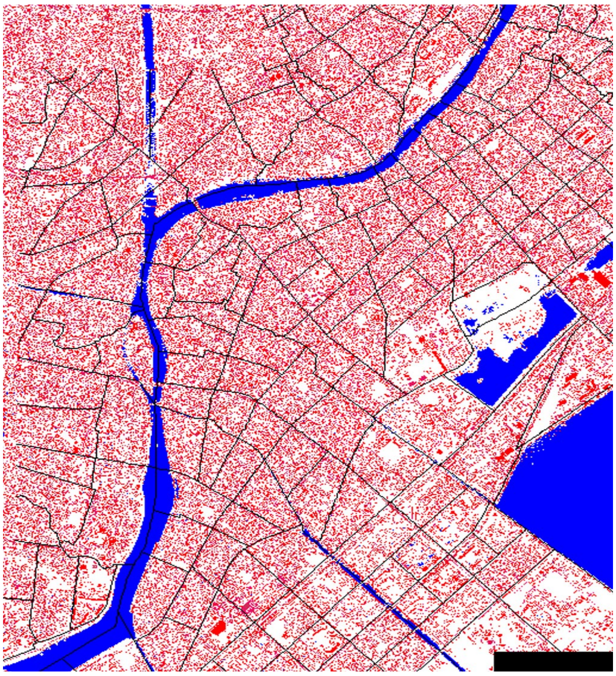

Figure 10. Urban Classification (Unsupervised clasification) Urayasu City, 2000 IKONOS

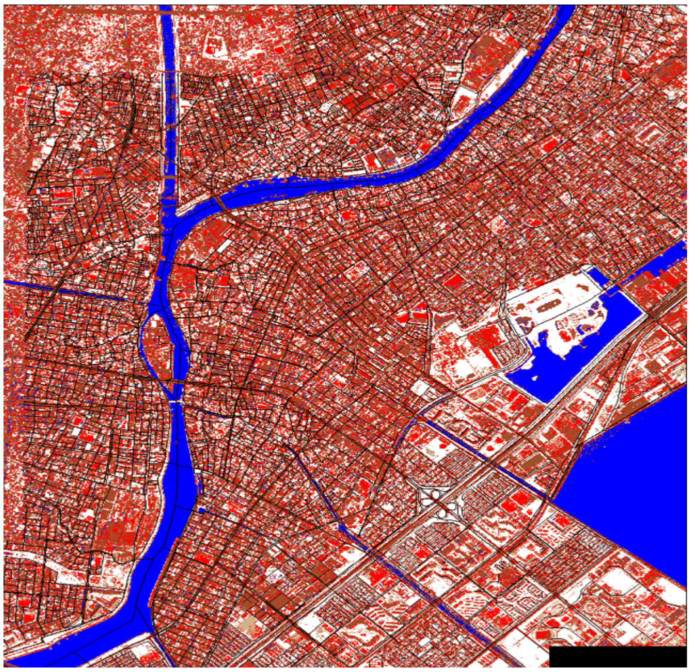

Figure11 IKONOS NDVI (Urayasu City, Tokyo Bay, 2000, IKONOS)

5.4 Analysis of population of Urayasu City

The population change of the Urayasu City from 1985 to 2000 was shown according to the district. As for the opulation in the entire Urayasu City, the Nekozane district where a lot of overcrowdedness town ground existed understood the population decreased though it increased to about twice in 1985 at the time of in 2000. (Figure 12) Moreover, the population distribution of the Urayasu City was made from the census. The following investigation index are provided and will be analyzed as an index which shows health in the future. (Teble 4) In addition, the population distribution chart according to the county at the time of in 1995 was made . (Figure 13) The population can be perceived to concentrate on the old town ground in the Urayasu City. Moreover, there is a tendency with high population density in the house overcrowdedness ground, and the population of the coast district developing in recent years increases, too. Therefore, it is necessary to develop the measure by which the improvement of the health degree is measured from the viewpoint by which the concentration of an excessive population density is avoided on the overcrowdedness town ground.

6. RESULT AND CONSIDERATION

It was limited to 16 districts of the Tokyo bay shore and a city environmental evaluation and UI were analyzed. The data used was able to specify the situation of the overcrowded urban area which was one of unhealthy elements by Landsat TM and the IKONOS data. (Figure 7,8,9,10,11). The IKONOS data more than of the Landsat TM data was clearer, and the district characteristic was able to be understood that the road pattern and the building situation of the existing town ground were seen. It is very reassuring to change from summarized grasp of Landsat TM, and to have obtained the means to enable a detailed grasp of the district by the IKONOS data.

As for the earthquake phenomenon, it does not understand when to happen in earthquake zone in Japan. Therefore, a ratio of the road, a ratio of open space, a ratio of wooden houses, and a ratio of vegetation areas, etc. are made by about 10~20m mesh standard by using the district situation chart obtained from this IKONOS data, and it will be necessary to attempt the multi layer analysis overlapped with city geographical information system (GIS) in the future.

The following problem points were obtained from the research at this time. That is, it is a point it to be necessary to reexamine a new investigation index to raise the health degree of the city, and to make the city environment better in addition. Therefore, it is important to add "Index of healthy development in the city" shown in the above table to this research analysis. (Table 4)

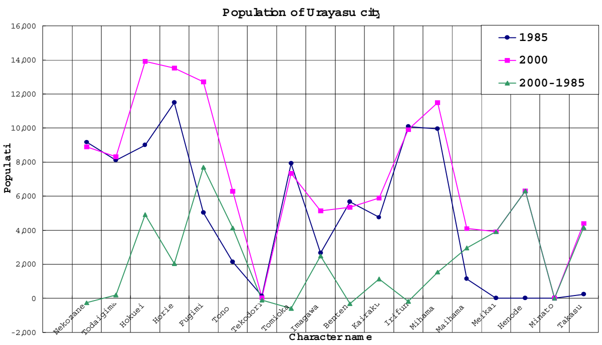

Figure12 Population of Urayasu City

Figure13 Population overcrowdedness according.
(Urayasu City 1995)

Table 4 Index of healthy development in the city

1. Healthy Index
Death rate, Disease rate, Health service, Traffic Accident rate, etc.

2. Environmental Index
Green tract of land area, Air & Water pollution,
Public service, Road development rate, Inhabitant area rate, etc.

3. Social economic Index
Residential area, Crime rate, Unemployment rate, Elderly person welfare, Welfare rate, Day-care rate, etc.

7. CONCLUSION

We member want to establish this IKONOS data and an analytical technique as a method of the effective contribution as the tool of the city planning in the future through the district where the city environment deteriorated was caught by the IKONOS data in the research at this time. That is, the automatic detection technique is developed by the remote sensing analysis of the specified area decision etc. of the dangerous forecast district and the improvement district. In addition, we want to make in healthy cities such as plans of the improvement plan and making the improvement execution manual and to aim at the improvement of the remote sensing technique to change . It is necessary to investigate a new progressing the accuracy improvement and the city planning technique of remote sensing analysis and GIS analysis in the future to construct a healthy city where it can keep living pleasantly in the future.

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