

CS-173 MONITORING IMPERVIOUS AREA BY USING SATELLITE IMAGE

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1. Introduction

One of methods to estimate the percentage of impervious area is by estimating Modification Coefficients [1]. This Modification Coefficients can be selected by comparing the percentage of impervious area interpreted from aerial photograph and estimated from satellite data. This study aims to evaluate the values of the Modification Coefficients for High, Medium and Low Densities and to investigate for the time range for which it can be used after evaluation. The images used are SPOT HRV (1988, 1990 and 1991), LANDSAT TM (1988, 1991, 1993) and JERS-1 OPS VNIR (1993) with the ground resolutions of 20x20m, 30x30m and 24mx18m, respectively. To define and to evaluate Modification Coefficients, color Aerial Photograph taken in 1987 (Scale 1:13000), 1991 (Scale 1:10000) and 1995 (Scale 1:5000) are used as true data.

2. Methods and Analyses

The study area is Komatsu basin which occupies 3.54 km² of commercial-residential land. This basin is located in the central part of Miyazaki city, Kyushu island, Japan. Considering the drainage system the Komatsu basin is divided into 17 zones. The outline of Komatsu basin is shown in Figure 1.

The image of study area are taken out from CCTs. The landcover of central Miyazaki city is classified to nine categories by combining of Ward clustering algorithms and Nearest Neighbor Classification Methods. Among them urbanized area is classified into three categories, High Density, Medium Density and Low Density categories. These categories contributed to the impervious area of the basin.

The percentage of impervious area of every zone can be estimated by equation as follow; $D = (C_1 N_H + C_2 N_M + C_3 N_L) / \sum N$, where D percentage of impervious area, C_1 , C_2 , C_3 and N_H , N_M , N_L are Modification Coefficients and number of pixels of High Density, Medium Density and Low Density, respectively and $\sum N$ is whole number of pixels.

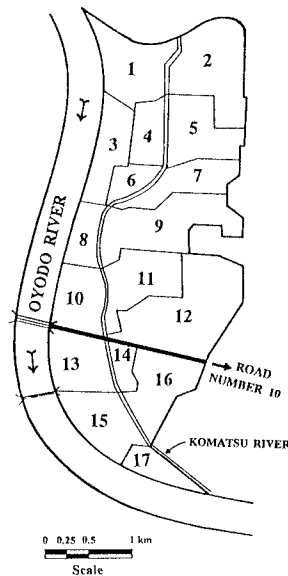


Figure 1. Outline of study area

combination of High Density, Medium Density and Low Density categories are changed by trial and error method to minimize the Residual Sum of Squares. This combination values can be selected when the Residual Sum of Squares is smallest.

Owing to the periodic characteristic of satellite data these categories can be extracted periodically. The percentage of impervious area can also be interpreted from aerial photograph periodically. However the interpretation are more costly and time consuming. Therefore monitoring percentage of impervious area cost-effectively can be done by using satellite image only. By comparing estimated and interpreted percentage of impervious area after several years from selection, the usefulness of Modifications Coefficients is evaluated.

3. Results and Discussion

In this study, the Modification Coefficients is decided by comparison between percentage of impervious area interpreted from aerial photograph taken in 1987 and estimated from landcover

The Modification Coefficients are conversion parameters of High, Medium and Low Densities with values from 1% to 100%. To define the Modification Coefficient, the percentage of impervious area interpreted from aerial photograph and estimated from the landcover classified from satellite data are compared. From this comparison the Residual Sum of Squares can be calculated. The Modification Coefficient

categories images classified from HRV and TM are observed in 1988. From this comparison the Modification Coefficients of 75%, 65% and 50% are selected for High Density, Medium Density and Low Density categories, respectively as shown in Table 1.

Table 1. Modification Coefficients and Residual Sum of Squares in 1988.

Modification Coefficients			Residual Sum of Squares.	
High	Medium	Low	HRV	TM
75%	65%	50%	951	989
75%	60%	45%	1268	1064
70%	60%	50%	1340	1179

By the Modification Coefficients decided in 1988, monitoring of the percentage of impervious area was evaluated. Figure 2 shows the monitoring results of changes of the percentage of impervious area in Komatsu basin. From this figure, urbanization of the study area is gradually increased from 1987 to 1995.

To evaluate the time range of Modification Coefficients decided in 1988, the percentage of impervious area are interpreted in 1991 and 1995. Figure 3 shows the comparison between the percentage of impervious area interpreted and estimated in 1991. This figure shows good agreements. From this results the Modification Coefficients can be used until 1991. The total percentage of impervious area of 17 zones in 1993 estimated from TM and OPS (63% and 62.7%) have values between the interpretation results in 1991(61.6%), and in 1995 (68.8%). According to the land use development trend as shown in figure 2

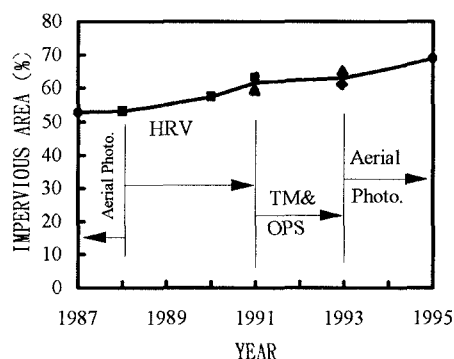


Figure 2. Changes of Percentage of Impervious area from 1987 to 1995.

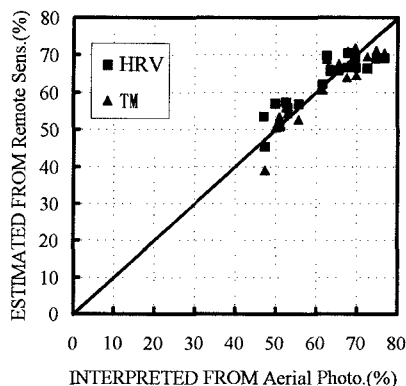


Figure 3. Comparison between percentage of impervious area in 1991.

the percentage of impervious area in 1993 can be extrapolated from the interpretation results in 1991 and in 1995. The extrapolation results are agree well with estimation results. Therefore the Modification Coefficients decided in 1988 can be used until 1993.

4. Conclusions

1. In case of Miyazaki city, Modification Coefficients of High Density, Medium Density and Low Density categories can be selected to be equal to 75%, 65% and 50%. The agreement between percentages of impervious area estimated from remote sensing satellite data and interpreted from aerial photograph in 1991 can be confirmed. Therefore this coefficients can be used until 1991.
2. The agreement between 1993 percentage of impervious area extrapolated from interpretation results in 1991, 1995 and estimated from OPS in 1993 can be confirmed. Hence the selected Modification Coefficients can be use to estimate the percentage of impervious area from other satellite data and can be used until 1993.
3. Satellite remote sensing data is useful to monitor the impervious area in urbanized area.

Reference

- [1] C. Deguchi and S. Sugio, "Estimations For Percentage of Impervious Area by The Use of Satellite Remote Sensing Imagery," Proceedings of Sixth Int. Conference on Urban Storm Drainage, IAHR/IAWQ, 1993, 372-377.