Land Cover Analysis Using Fine Resolution Satellite Data and GIS Data

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Abstract

Normalized vegetation index (NVI) and albedo are computed using the fine resolution satellite remote sensing data. The characteristics on their frequency distributions for corresponding land uses are analyzed by superimposing the Detailed Digital Information on them. The frequency distributions generated by raw data in 10m meshes under consideration are compared to these made by the averaged data in each 10m meshes which seems to represent the popular coarse resolution satellite remote sensing data. By using these fine resolution data together with the GIS, albedo of the building roofs and roads seem to be distinguished. The characteristics on the frequency distributions of NVI and albedo for individual land uses are examined, and these for the raw value of 4m mesh are shown to be almost similar to those for the averaged value in 10m mesh. However in some land use categories, the specific materials of land cover contained in the categories are found to enlarge the standard deviation.

Keywords: remote sensing data; fine resolution; land use; normalized vegetation index; albedo

Introduction

The climate of each place is formed in the basis of the interaction with land use or land cover and geographical feature. Therefore, it is required to get to know the actual condition of land use and land cover, in case the local climate is examined. The factors that affect especially the local climate are green cover ratio, albedo (solar radiation reflectance), anthropogenic heat release, aerodynamic roughness parameter, etc. In order to investigate the distribution of these parameters, remote sensing data and Geographical Information System (GIS) are used conveniently [1].

In Kyoto city area of Japan, as a purpose of using for the analysis of the distribution of land cover, authors have examined conventionally the characteristics of the distribution of satellite remote sensing data Landsat TM for each land use classification obtained from Detailed Digital Information (10m grid land use), which is made by Geographical Survey Institute of the Ministry of Land, Infrastructure and Transport of Japan [2]. In this study, about 25km² in the northern Kyoto area is the test area. With applying the same analysis method as that is using Landsat TM data, the characteristics of land use in the case of using the fine resolution satellite remote sensing data is considered. The application possibility to the urban climate analysis is examined. The fine resolution data are the multi-spectrum data observed in four bands with the resolution of 4m.

Computation of NVI and Albedo Using the Fine Resolution Satellite Remote Sensing Data

The data used in this study are observed by the fine resolution satellite IKONOS, and provided from Japan Space Imaging Corporation. The data consist of 4 bands as same wavelength width as that of Landsat TM data. The resolution of the multi-spectrum data is 4m. The data used in this study are observed at 10:39 on October 19, 2000.

By the same method as that is using the Landsat TM data, Normalized Vegetation Index (NVI) is computed by the following equation (1). Here, it has multiplied by 100 for convenience on account of calculation. NVI is one of the vegetation indexes using the characteristics in which the reflectance of vegetation becomes large in the near infrared wavelength zone (band 4).

NVI=(R4-R2)/(R4+R2)*100  (1)

where Ri (i=1,4) means the radiation luminosity value of each band. NVI distribution is shown in Fig. 1.

By the same method as that is using the Landsat TM data, the pan chromatic value (Kpan) is computed by the following equation (2).

Kpan=2Ri (i=1,4)  (2)
The data of Sakyo ward is not provided.

In consideration of References [3]-[6], the values of albedo are assumed to be 0.03 for the water surface, 0.12 for the green surface, 0.15 for the city surface, 0.20 for the bare surface. The regression curve shown in Fig.4 is obtained. Albedo distribution is presumed using this regression curve. It is shown in Fig. 2.

**Comparison between Detailed Digital Information and NVI, Albedo Distribution**

Detailed Digital Information on the test area is shown in Fig.3. The number of the category means as follows. 1: Forest and wasteland, 2: Rice field, 3: Farmland and others, 4: Developing lot, 5: Vacant lot, 6: Industry, 7: General low-rise residence, 8: High-density low-rise residence, 9: Medium and high-rise residence, 10: Commerce and business, 11: Road, 12: Park and green area, 13: Public-benefit institution, 14: River and lake, 15: Sea. Area according to each land use category in the test area is shown in Fig.5.

However, since as for Detailed Digital Information of Kyoto city, the data of Sakyo ward is not provided, the black portion of the right-hand side in Fig.3 is made into the outside of the analysis.

Since the resolution of Detailed Digital Information is 10m and that of remote sensing data is 4m, values are picked up from remote sensing data according to 10m mesh of Detailed Digital Information. In the following examination, comparison between the data picked up according to 10m mesh and the data which averaged the values in 10m mesh is performed.
The square frame in Fig.2 means the area where the data are picked up, and they are shown in Fig.6. This area is about 200m*200m centering on the elementary school. The ground where albedo is larger than the others can be recognized. Moreover, it can be distinguished that albedos of the school building roofs of the north side and the east side of the ground are also small. If we can use this data, it will be thought by combining with GIS that albedos of the building roofs and roads can be distinguished. Therefore, for example,
it is thought that the use as boundary conditions for local thermal environmental prediction based on a scenario, such as repainting the roofs of the elementary school in large albedo paints, is possible. From the average value of 10m mesh of albedo distribution, although distinctination of the ground is possible, the outline of the school building cannot be distinguished clearly.

The Frequencies of NVI and Albedo for Each Land Use of Detailed Digital Information

The frequency of NVI and albedo for each land use of Detailed Digital Information are shown in Figs.7-10. In the case of using the value of 4m mesh, the frequency of NVI is shown in Fig.7, and the frequency of albedo is shown in Fig.9. In the case of using the averaged value in 10m mesh, the frequency of NVI is shown in Fig.8, and the frequency of albedo is shown in Fig.10. The standard deviation and the average value for each land use of NVI and albedo are shown in Fig.11, 12, using the value of 4m mesh and the averaged value in 10m mesh.

As for the tendency of the frequency of NVI and albedo for each land use, between Figs.7 and 6, and between Figs.8 and 9 are well alike. The standard deviation using the value of 4m mesh is larger than that using the averaged value in 10m mesh.

In the land use where the standard deviation is larger, for example in the land use of River of NVI and in that of Public of albedo, some differences in the tendency of the frequency are recognized. Since not only the water surface but also a ground, plants, etc. of both sides of the river are contained in the land use of River of Detailed Digital Information, it is thought that the values of NVI varies. Since not only the building roof surface but also a ground, plants, etc. in the public zone are contained in the land use of Public of Detailed Digital Information, it is thought that the values of albedo varies.

Summary

Normalized vegetation index and albedo are computed using the fine resolution satellite remote sensing data. The characteristics on their frequency distributions for corresponding land uses are analyzed by superimposing the Detailed Digital Information on them. The frequency distributions generated by raw data in 10m meshes under consideration are compared to these made by the averaged data in each 10m meshes which seems to represent the popular course resolution satellite remote sensing data. By using these fine resolution data together with the GIS, albedo of the building roofs and roads seem to be distinguished. The characteristics on the frequency distributions of NVI and albedo for individual land uses are examined, and these for the raw value of 4m mesh are shown to be almost similar to those for the averaged value in 10m mesh. However in some land use categories, the specific materials of land cover contained in the categories are found to enlarge the standard deviation. Realistic boundary conditions can be generated from the fine resolution satellite remote sensing data, by which numerical prediction on local thermal environments based on scenarios, such as green planting on buildings and roads and retrofitting roofs by paints with greater albedo values, is thought to be available.

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