Green structural analysis by hierarchical cluster analysis and linear model regression analysis and evaluation of green environment for continuous cityscape using green visibility and green coverage

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Introduction
The purpose of this study is to analyze and consider green environment, which is a finite resource indispensable for sustainable town development, from the viewpoint of landscape. By combining the green coverage rate, which indicates the planar spread of the green environment, and the green viewing rate, which indicates the visual situation, it becomes possible to understand the green environment three-dimensionally and to analyze the image data necessary for analysis. We try to improve the efficiency of data acquisition and analysis by acquiring from remote sensing and big data archives. The green coverage and NDVI values obtained from Landsat 8 and the green visibility and sky occupancy calculated using images obtained from the Google Street View Image API were used as the data to be analyzed. For NDVI, thresholds of 1.0 and 2.0 are set and used as indicators of the distribution of green spaces and the distribution of high-quality green spaces, respectively. In addition, the image analysis of the supervised classification is used to calculate the green viewing rate.

Analysis and Results
1) Cluster analysis
R, which is an open source programming language, is used with variables green coverage (NDVI>1.0), green coverage (NDVI>2.0), green viewing ratio, and sky occupancy obtained from each survey point. A cluster analysis was performed using the Ward method. All the 42 points analyzed were classified into four clusters at height=4 based on the clustering results. They were classified and positioned as city. Next, the cluster with the highest percentage of green was positioned as Suburban, and the two clusters with values between them were named Middle Region A and Middle Region B. Mid-area A has a superior green coverage rate (average green coverage rate 13.20%, average green coverage rate 37.94%) and a higher sky occupancy rate (average 41.72%) than the green visibility rate, and has a good view of green in the horizontal direction Environment has been deployed, and Mid Region B has a vertical green environment with a superior green visibility rate (average green visibility rate 20.79%, average green coverage rate 19.75%) compared to the green coverage rate. Mid-area B looks more lush than middle-area A with only the green-vision rate, which indicates the visual characteristics of the green environment. It can be said that it is a green area, and the sky occupancy is high considering the disaster prevention aspect (Intermediate area A average: 41.72%, Intermediate point B average: 30.11%) Intermediate area A is more suitable for housing there is a possibility. From this, it can be said that when discussing the change of the green environment in continuity, it is important to consider not only the apparent environment but also the spatial environment.

2)Regression analysis between variables
There were three significant correlations between each variable.
There was a certain positive correlation between green visibility in front of block and green visibility in NDVI0.1. It can be guessed that this is because the green in the suburban area is calculated from the

green of the distant green area, the field, and the thicket forest.
There is a negative correlation with Green Visibility in NDVI0.1, although Path Green-Visibility is rough with P value=0.1to0.2. It can be guessed that this is because much of the green on the route is calculated from narrow street trees that do not spread horizontally.
The green viewing rate is highly significant and positively correlated with the route and the front of the block. This is thought to be because the panorama of the urban area passes through 360 degrees and a homogeneous panorama is developed. In Tokyo, the concept of borrowed scenery seen in other urban areas cannot exist, so the buildings are so superb. It indicates that it is dense and complicated. This correlation is particularly strong as compared to the others, and it is considered that the correlation clearly shows the regionality of a large city located in a large plain called Tokyo.

Conclusion

The landscape in Tokyo's green environment was found to be nested with multiple layers of single structures that changed while drawing a wavy gradation in the course of the road connecting the central business district terminal and the large-scale suburban terminal.

Keywords: Big Data Archive, Remote sensing, Hierarchical cluster analysis, Urban landscape, Urban green environment

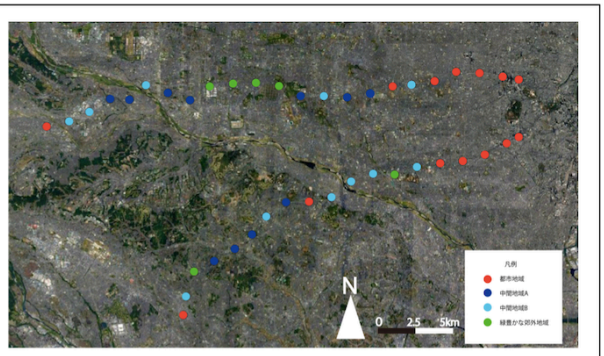

図１　分析対象地点

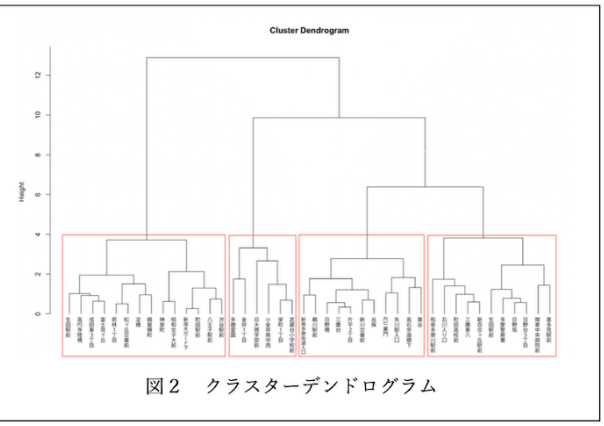

図２　クラスターデンドログラム

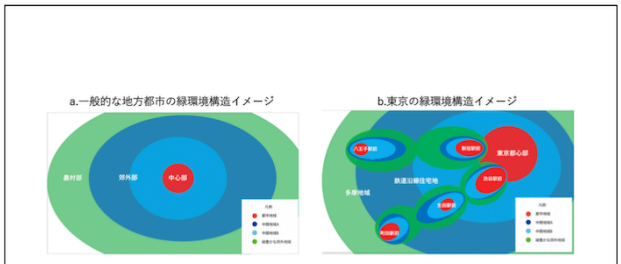

図３　緑環境構造イメージ

