

EVALUATION OF VEGETATION PATCH CONNECTIVITY USING REMOTE SENSING AND GIS

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ABSTRACT

The UN Conference on Environment and Development (UNCED) Agenda 21 issue for sustainable development emphasizes on an integrated approach for the maintenance and management of land resources. Conservation of biodiversity has become an important environmental issue after the UNCED. Habitat fragmentation caused by the sprawl of urban development is becoming one of the major environmental problems in the Metropolitan suburbs in Japan. The conservation of vegetation areas from urban development as well as creating more such areas has become an essential thought for today for preserving the biodiversity since vegetation area is the remaining habitat for wild-animals and wild-plants. In landscape ecological point of view, the size and distribution pattern of the vegetation patches that has become wildlife habitat and especially the strength of connectivity between such patches are important factors.

Study of connectivity was preformed for remaining vegetation patches and their network within central Tokyo region. This research was carried out by applying the techniques of remote sensing to extract the vegetation patches for the study area where as evaluation of the network connectivity was done using GIS. The ranking map for the vegetation patch was generated by considering the relationship between vegetation patches and number of networks.

The condition of the vegetation distribution was established based on source and sink habitat in landscape ecology. The quantitative analysis for vegetation distribution patches became possible due to generated networks of the extracted vegetation patches from the satellite data.

1 INTRODUCTION

The importance of biodiversity conservation was highly recognized after the UN Conference on Environment and Development (UNCED) in June 1992. In Japan, the environmental impact assessment law has come into force in June 1999 and a new framework was adopted considering the ecosystem and attention for the environmental protection has become paid to wildlife. It was realized to care about the ecosystem and dependency of wildlife on the nature, and to understand the importance of man-made developments for wildlife conservation.

The concept of landscape ecology considers landscape elements as “patch”, “corridor” and “matrix”. In landscape ecological point of view, the size and distribution pattern of the vegetation patches that has become wildlife habitat and especially the strength of connectivity between such patches are important factors. In order to preserve the biodiversity, the conservation of vegetation areas has become essential thought in the present days. Therefore, a thorough knowledge of land cover condition, specially on vegetation covered areas, is a crucial factor. Further, a methodology to evaluate habitat depending on the movement of wildlife and vegetation distribution has become necessary. In landscape ecology, two types of patches can be recognized: a source habitat that is more dispersed than immigration of individuals; a sink habitat that has immigrated exceeding dispersal (Forman & Godron,1986 ; Forman,1995).

The connectivity of habitats is crucial for the migration of wild-animals between habitats. It is important to emphasize the relationship of the connectivity between habitats rather than considering only large area.

The main objectives of the present study are to examine the distribution of the wildlife habitats in a wide area and to evaluate each vegetation patch as wildlife habitat. Satellite image was utilized to extract vegetation patches and connectivity network was generated. Concept of landscape ecology was adopted for discussing the relationship between source and sink habitats.

2 METHODOLOGY

2.1 STUDY AREA

The Tokyo Metropolitan City was selected as the study area. Vegetation areas are found along riversides as well as city parks scattered in the region. To understand an outline of the connectivity of vegetation patches, LANDSAT satellite Thematic Mapper (TM) data were resampled at 250m of ground level resolution. The location of the study area and its image of LANDSAT TM data are shown in Figure 1.

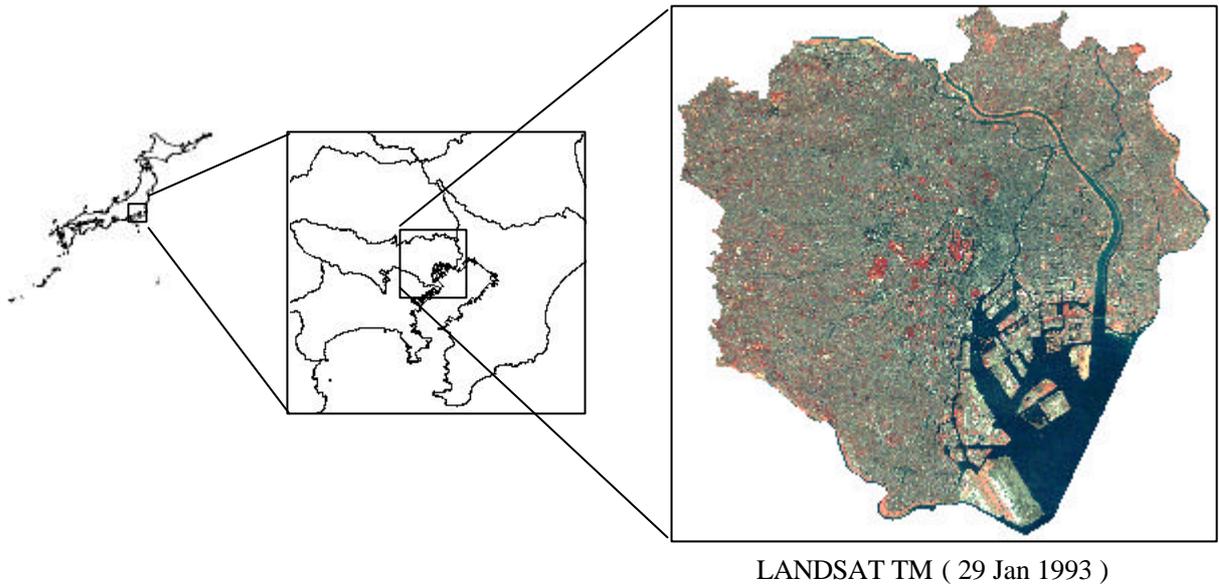


Figure 1. Study Area

2.2 DATA PROCESSING

The integrated remote sensing and GIS techniques were utilized to analyze the connectivity among vegetation patches. The flow of data processing is shown in Figure 2.

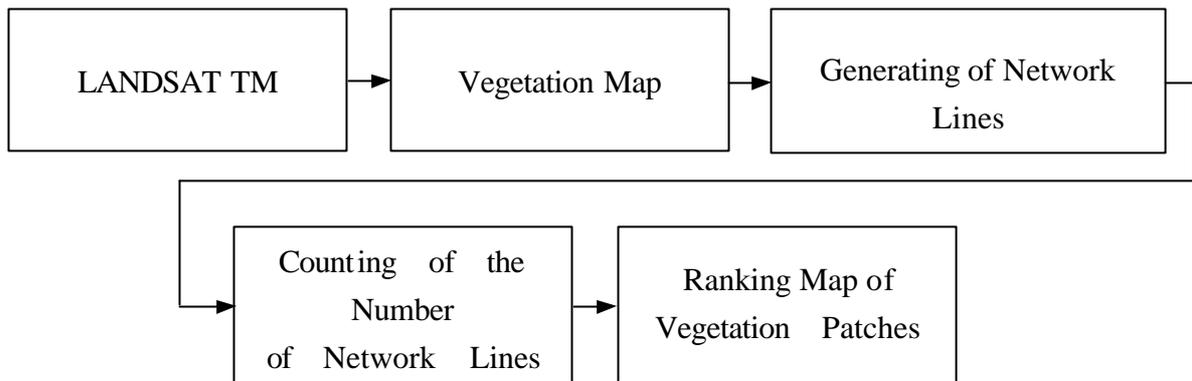


Figure 2. The flow of data processing

2.2.1 EXTRACTION OF VEGETATION PATCHES

The Normalized Difference Vegetation Index (NDVI) was used for the extraction of vegetation patches from the 250m resampled TM data. The extracted Vegetation patch is shown in Figure 3.

$$NDVI = (band4 - band3) / (band4 + band3)$$



Figure 3. Extracted vegetation map

2.2.2 GENERATING OF NETWORK LINES

Network lines were generated to obtain the information about the vegetation connectivity. The raster data of the vegetation patch was converted into the polygon data to generate the vector network. Network lines were connected from each point of a polygon to each point of surrounding polygon within 2,500m radius with straight line based on vertex coordinate (XY) of the polygons (Figure 4). Finally the shortest line between vegetation patches was selected for examination of the connectivity (Figure 5).

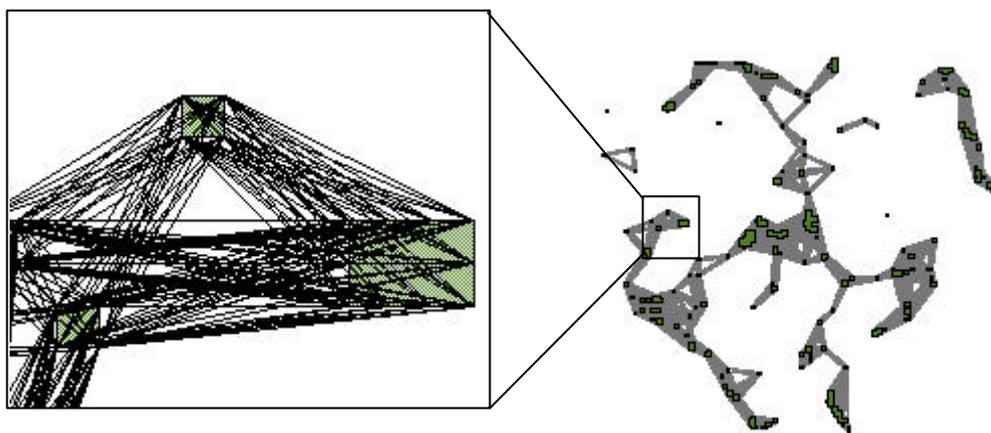


Figure 4. Network among vegetation patches

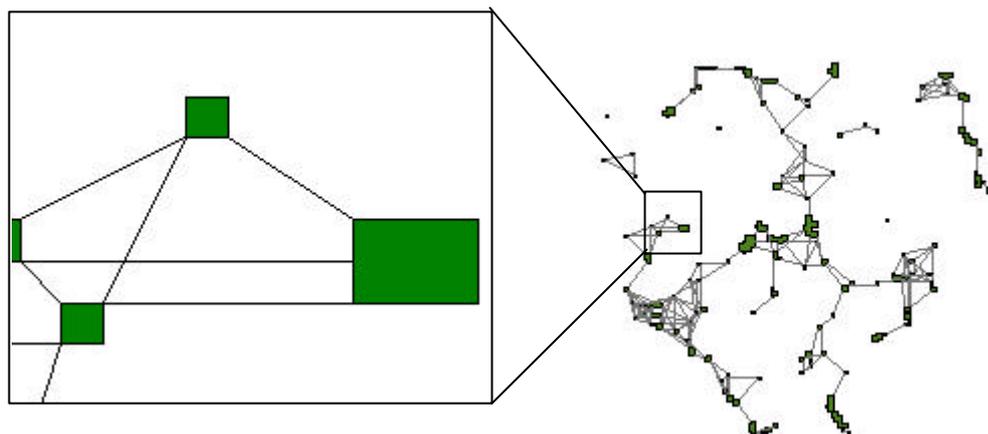


Figure 5. Final selection of network line by shortest distance

2.2.3 RANKING OF THE VEGETATION PATCH

The evaluation criteria for each patch were established based on the size and network connectivity. The ranking map of the vegetation patch was generated by considering the relationship among vegetation patches and the number of network lines.

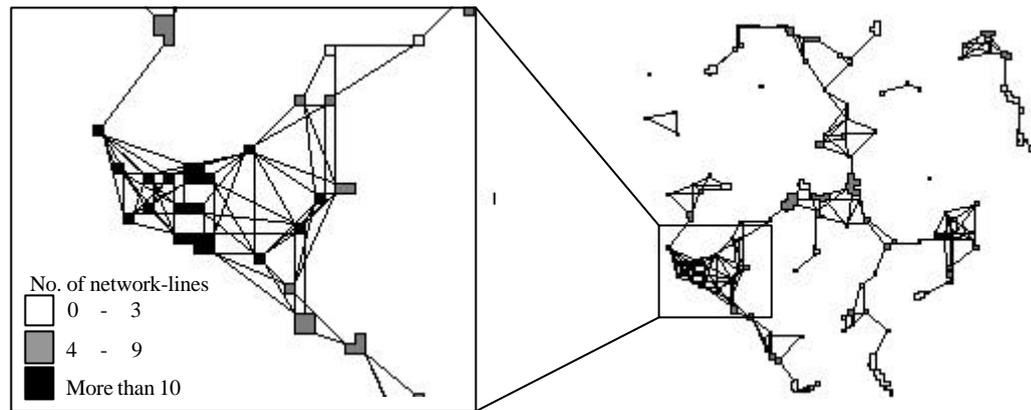


Figure 6. Ranking map for vegetation patches

3 RESULTS

The relationship between the number of network lines and distance of vegetation patches is shown in the ranking map for the networks (Figure 6). A large area of vegetation patches did not always contain numerous network lines. In landscape ecological point of view, the vegetation patches that cover more than 20ha and consist of 10 network lines were defined as the source habitat in this study. Hence the vegetation patches as source habitat were selected according to this definition. Two clusters of vegetation patches fulfilling the above criteria were recognized as source habitat (Figure 7). These habitats were evaluated as vegetation patch to be preserved, and it was considered that these habitats needed to be preserved for future and their habitat was necessary to be improved from now onwards.

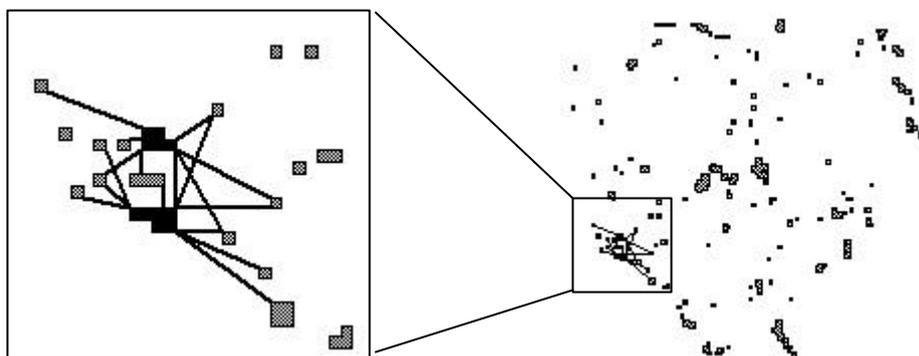


Figure 7. Selected source habitat fulfilling the criteria

4 DISCUSSION

The ranking map of vegetation patches evaluated by the quality as habitat provided the useful information to understand the relationship between source and sink habitats. The ranking map shows that some small vegetation patches can consist numerous network lines and it can be assumed that these vegetation patches in a group may function as source habitat as well. Wild-animals migrate from one place to other. The characteristics of vegetation patches, i.e., the size and shape of habitat and the connectivity of habitat, affect their movement. In case of wild-animals' migration, it is considered a favorable condition where distribution of vegetation patches allow an animal have more routes, as detour, to avoid predators or disturbance.

The sprawl of urban development is causing the fragmentation of the wildlife habitat. In order to preserve the biodiversity, conservation of vegetation areas from development as well as creating more such areas has become an essential thought for today, since vegetation areas in an urban area is the remaining habitat for wild-animals and wild-plants. In landscape ecological point of view, the size and distribution pattern of the vegetation patches, especially the strength of connectivity between such patches are important factors.

5 CONCLUSIONS

Satellite data was utilized in the present study to extract the vegetation patch and GIS was applied to evaluate the connectivity of vegetation patch. Based on the source - sink relationship in landscape ecological point of view, the condition of the vegetation distribution was examined. The quantitative analysis for vegetation distribution patches became possible due to generated networks of the extracted vegetation patches from the satellite data.

Establishment of this kind of methodology to evaluate vegetation patch should be helpful to understand the wildlife habitat distribution in the present situation and to produce a useful information about priorities in conservation of vegetation patches.

In future studies, it is important to include: the concept of network-connectivity, network-loops for wildlife migration to evaluate of wildlife habitats in landscape ecological point of view.

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