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The Application of Satellite Remote Sensing on Habitat Management

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Abstract. In recent year, habitat of wild animals decreases rapidly due to urban development which leads to decrease in biodiversity. The urban development has not taken a comprehensive planning and design, but instead it develops separately. Nonetheless, this urbanization phenomenon has resulted in insufficient greenery and inability to improve green coverage rate. This study attempts to understand distribution of greenery resources at Taichung Tatu area during spring and winter time by using Satellite Remote Sensing, thus conducts analysis of normalized difference vegetation index (NDVI) to explore changes in different seasons so we can identify habitat management strategies in more complicated forest vegetation area.

Keywords: habitat management, satellite remote Sensing, NDVI.

1. Introduction

1.1. Characteristics and significance of habitat management

One of global crucial issues is development of land resources and conservation of ecological habitat, of which restoration of biodiversity is what we focus on. Due to urbanization, road construction and other human factors, habitats are disturbed, interregional species are unable to communicate, and may lead to descending biodiversity and extinction of species. Maintaining demographic is important to species and reducing or erasing early-successional forests, shrublands, or old-field habitats are prohibited [1]. Relationship of animals and its habitats is important and its temporal consistency model is essential for conservation management [2]. Construction of habitats can provide opportunity of shelter, migrate, food, mating and genetic exchange for species, hence enrich the environment and improve biodiversity.

1.2. Application of satellite images in habitat management

Remote Sensing (RS) is the science of obtaining and analyzing information about objects, areas or phenomena without making physical contacts from satellites or aircraft. It is widely used in land-use surveys through satellite images which have large scales and real time features. Due to integration of space technology that can monitor a large area at a large scale, it also widely used in agricultural production, environmental monitoring, disaster prevention, geographic terrain exploration, resource exploration, weather broadcast, oceanographic and other aspects. Goatz et. al (2007) used laser remote sensing to predict bird species richness by exploring the efficacy of lidar metrics of structural diversity of canopy in the temperate forests of Maryland, USA [3]. McDermida et. al used RS to observed migration pattern of grizzly bears in the forest [4].

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There are Supervised Classification algorithms (SC) and Unsupervised Classification algorithms (UC), however, we use UC to carry our study. UC is classification based on the number set by the user, by using the calculation method of cluster gathering and then checks pixels of each image for spectral separation of the generic cluster analysis. Its advantage is without prior knowledge of the land cover situation it can reduce the time to screen area by using statistical methods for classification.

On the contrast, UC only can determine the quantity of classification but not the category, and due to complexity of terrain, it caused inconsistency in term of accuracy. NDVI is one of UC, is extensively used in researches related to topography, plant physiology and transition. Coakley and Bretherton observed the radiation intensity of the views of skies and overcasts by using the infrared satellite images which detect the temperature differences of ocean and cloud top, so that the distribution of oceans and clouds can be determined, and this clearly shows that this research method is Unsupervised Classification algorithms (UC) [5]. The application of Gaussian MaximumLikelihood Classifier and unsupervised ISODATA classification on multi-temporal satellite images is suitable for research based on land-use change in the island [6].

2. Method

2.1. Study area

Our study area located at Taichung Tatu area, as shown in Fig. 1. Tatu area is located at the west part of Taichung city and is connected urban and suburban area. Both side of Tatu area has highways and Taichung Airport at its north part. Government establishes Taichung Industrial Park, Central Taiwan Science Park, Taichung Harbour Related Industrial Park and world′s largest power plants to develop the economy and announced will plans Taichung Harbour as one of the Free Economic Pilot Zones in March. Southwest of Tatu area has low altitude of primeval forest which is important for ecological conservation thus it is protected land. Notwithstanding, because of rapid development in recent years, the forest land had reduced seriously, so our study chosen this particular area as a determination for the degree of changes of seasonal vegetation.

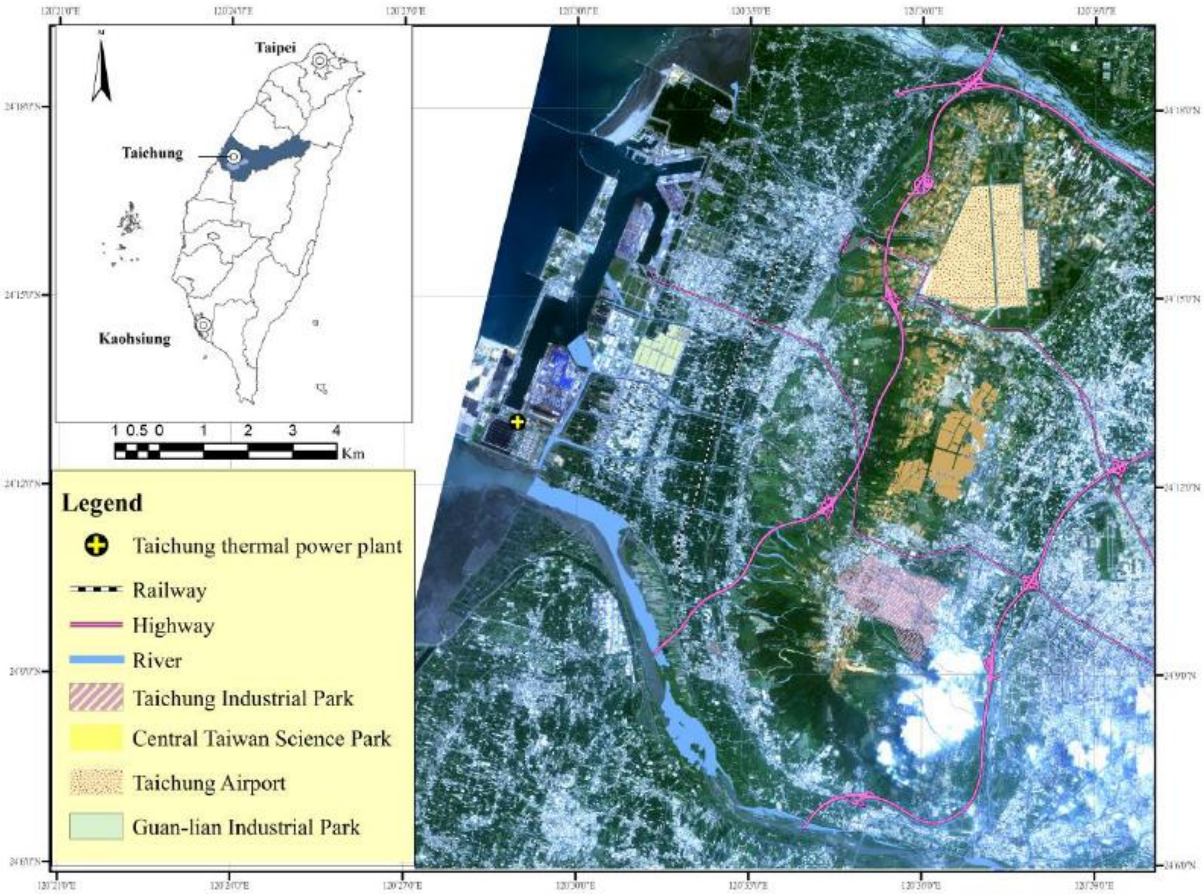

Fig. 1: Research background.

2.2. Analysis of habitat health

2.2.1. Image Acquisition

The images captured by FORMOSAT-2 satellite are used in this study. FORMOSAT-2 belongs to sun-synchronous satellite with shooting ability of 45° each side and has fixed orbit. It orbits the Earth 14 times a day and passes over Taiwan Strait twice. It also can shoot 8 minutes-data a time. Multispectral has 4 bands which are blue, green, red and near-infrared bands, has resolution of 8m and scanning width is 24km. The shooting mode of FORMOSAT-2 is body rotation synchronous sampling method that can observe forward and backward for 3-D photography to further obtain data of Digital Terrain Model (DTM).

2.2.2. Normalized Difference Vegetation Index, NDVI

Every object has the ability to reflect spectrum, and by analyze its spectral characteristics, we can determine the surface of the object. Leaves reflect green band but absorb blue and red bands to carry photosynthesis. Furthermore, green leaves have strong characteristic of reflected infrared, therefore, red light and infrared are often used to identify or predict the structure and changes of forest ecosystem. NDVI uses this characteristic for calculation as in Equation (1).

$$\text{NDVI} = \frac{IR - R}{IR + R} \tag{1}$$

From equation (1), IR: Near-infrared radiation value; R: infrared radiation value

As shown in Table 1, the NDVI value is between -1 to 1, which less than zero pixel value is usually a non-vegetated pixel. Therefore, the greater the value, the more the green plants is. NDVI is highly useful in distinguish the surface features of the visible area which are extremely beneficial for urban planning and management. The vegetation analysis provides humanitarian aid, damage assessment and new protection strategies in situation of unfortunate natural disasters [7].

Table 1: Relationship between NDVI value and vegetation.

NDVI	Vegetation
Less than 0.0	Non-vegetation of clouds, water, roads, buildings and etc.
0.01~0.6	The smaller the index, the more sparse the covered green plants
0.61~1.0	The larger the index, the more flourish the greenery grow

3. Conclusions

Our study uses NDVI to analyse vegetation coverage of satellite images during spring and winter time (Fig. 2). The yellow area is non-vegetation; light green area is sparse vegetation whereas dark green area is flourish vegetation. Winter lush vegetation classification is undetectable because its value is below the defined NDVI value. The area ratio of each category during spring and winter time is shown in Table 2.

Table 2: Area ratio of each identified category during spring and winter time.

Type		Spring	Winter
Non-vegetation		37%	71%
Sparse vegetation		46%	29%
Flourish vegetation		17%	0%

Table 3: The compiled chart of transition degree.

Types	Transition degree	NDVI (Spring)	Note
A	Low	Low	Non-vegetation of clouds, water, roads, buildings and etc.
B	Medium	Medium	Grassland, forest land and etc.
C	High	High	Paddy fields and other agricultural crops

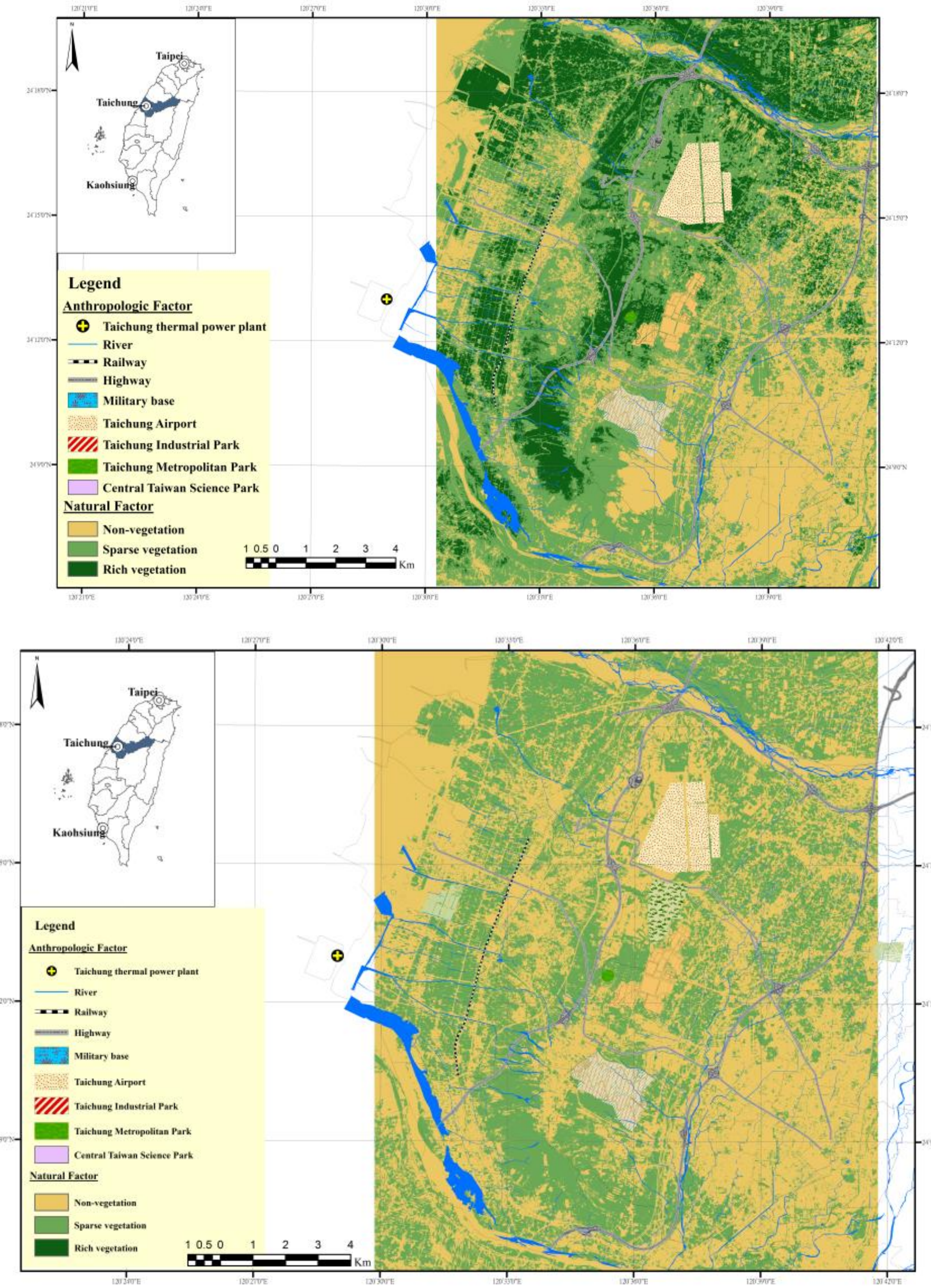

Fig. 2: NDVI schematic diagram during (a) spring time (May) and (b) winter time (November).

The combination of NDVI of spring and winter leads to understanding the transition degree of the study area, as shown in Fig. 3. The darker area in the figure indicates larger transition degree. In this study, transition degree is divided into 3 parts for discussion (Table 3). Type A has the least transition during different season, and judging from NDVI, we can indicate that land uses of type A mainly are non-vegetation of roads and buildings; but there is mostly developed land subsequent to limited area can be developed. Type B is classified as grassland and forest, its lush level changes slightly with seasonal change. Type C changes at greatest degree because it is located at the bulwark and surrounding of river. Although there is vegetation, but paddy field fallow with the seasons, so it causes significant change. According to comparison of NDVI and transition degree, thus study is expected to further identify region which may use as ecological corridor so that we can carry out habitat management.

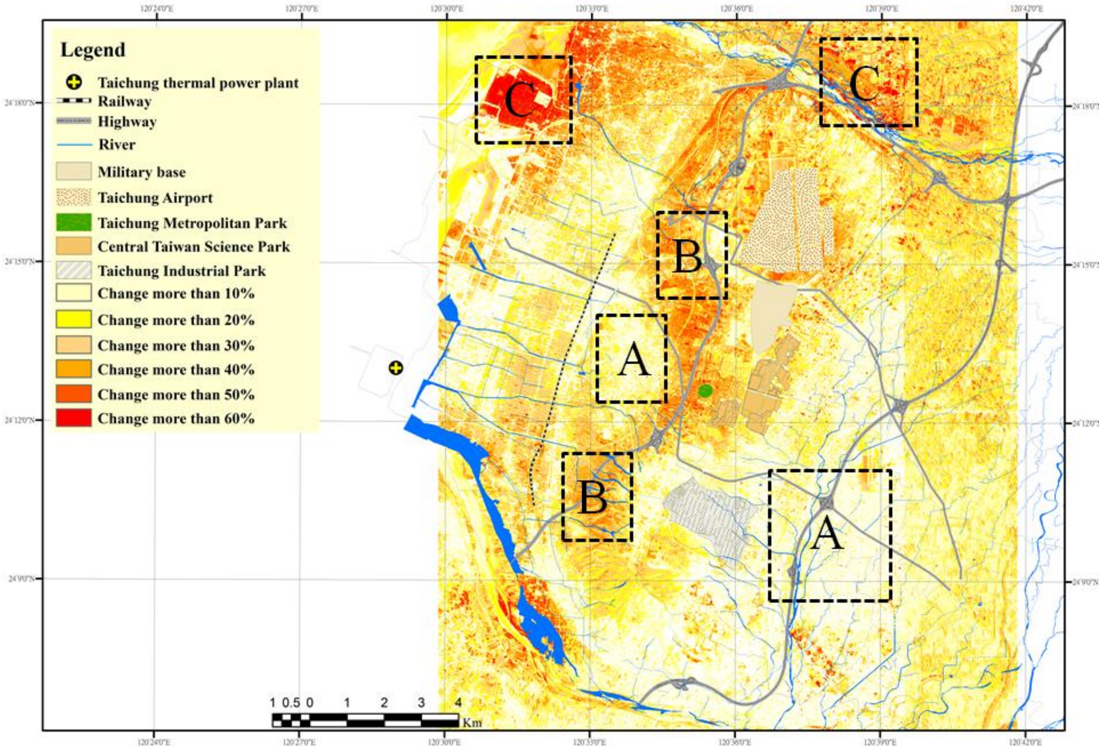

Fig. 3: Spring and winter overlay schematic diagram.

4. Acknowledgements

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