The Application of Unmanned Aerial Vehicle (UAV) for Biotope Monitoring Program

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Nature conservation is carried out at Miyagase Dam area, Kanagawa Prefecture since 1996. Construction work is held in 1992-1994 period for nature restoration works, and its effect is monitored by biotope mapping survey. Observation of living organisms and region temperature at study area are done during 1996-2014 period. In 2014, UAV aerial imaging has been deployed for additional 2D/3D data analysis. The observation used three cameras, e.g. optical camera (Canon S100), Near Infra-Red (NIR) camera (Canon S110 Yubaflex) and a thermal camera (Thermo Shot F30S) board on a Multicopter, which flew with flight altitude of 100m. The 2D/3D mapping products from optical images were derived using Structure from Motion (SfM) method and its results are used for spatial distribution of vegetation and habitat mapping (Fig.1a). Ground moisture and thermal mapping using NIR camera and thermal camera are used in thermal habitat study (Fig.1b, Fig.4). This observation method can be used for monitoring of biotope's environment on the finest scale. In this study, to observe the effect of local temperature changes, we observed the population and habitat of *Poikilotherm*, organisms which have body temperature that can be affected by the surrounding temperature, such as dragonflies.

The observation result shows that the combination of UAV data and field survey data of biotope give a new perspective and good accuracy on 2D/3D data analysis, i.e. 5-31 cm resolution on vegetation and habitat mapping. Normalized Difference Vegetation Index (NDVI) map derived from optical image shows spatial distribution of chlorophyll content which correlates with tree canopy structure (Fig. 2). High NDVI index shows spatial vegetation distribution of Japanese cedar (*Cryptomeria japonica*). Whereas, the distribution of autumn leaves (e.g. konara oak (*Quercus serrata*), etc.) is shown as high normalized index of band red and green ((b2-b3)/(b2+b3)) retrieved from NIR image (Fig. 3a). The analysis of ground moisture level of study area is derived using the normalized difference of green and red band of NIR image. On Fig. 3b, red area shows high moisture level which is habitat preference of dragonfly. Since band math calculation can be affected by tree shade, masking is suggested on preprocessing. Thermal camera captured optical and thermal images simultaneously. Field temperature measurement was held during flight time and its result shows good correlation with thermal map. Although thermal mapping with 31 cm resolution can provide good temperature distribution on observed area, the development of thermal camera sensor is needed for higher accuracy, enable image metadata (Exif) modification for GPS recording to provide 2D/3D thermal mapping using SfM method.

Long term monitoring is useful to detect changes in biotope presence and structure. We observed population increase of species which has strong adaption to high temperature, e.g. Ito Tombo *(Coenagrionidae)*. This species usually lives in or near pond and waterbody without streams, where temperature is warmer during spring to fall compare to the river area. Although few literatures addressed about the change of dragonfly population due to temperature, we conclude that the increase of dragonfly population possibly affected by the increase of temperature at observed area about 1.5℃ during 1996-2014.

Keywords: UAV imaging application, biotope monitoring, optical image, nir image, ndwi/ndvi, temperature rise effect

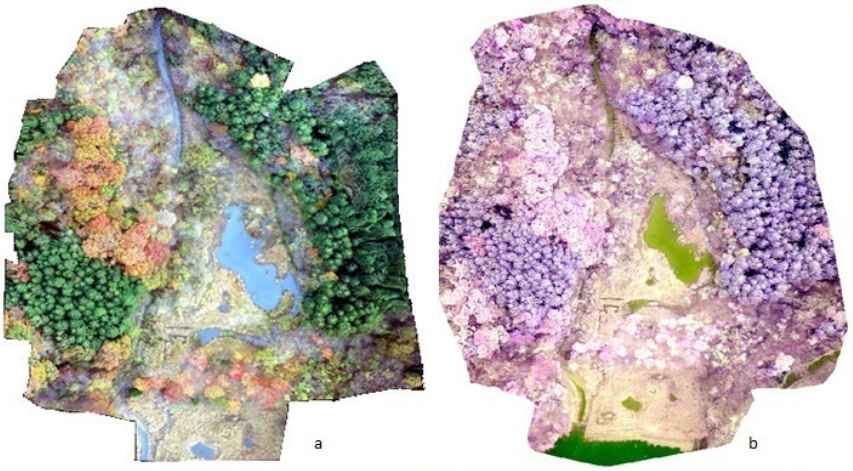

Fig.1 UAV photo result; a) optical image (RGB=123) and b) NIR image (RGB=NIR\R\G). Cooperation with Sagami River Water System Wide Area Dam Administration Office, Ministry of Land, Infrastructure, Transport and Tourism.

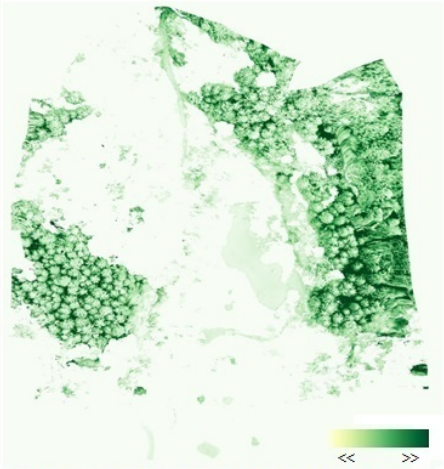

Fig. 2 Chlorophyll distribution of NDVI map (optical image)

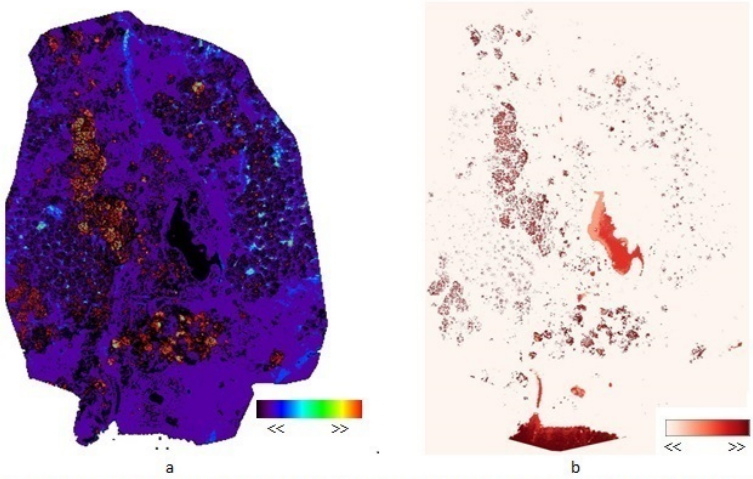

Fig.3 a) Autum leaves map (konara oak, etc.) and b) ground moisture level map (red is habitat preference of dragonfly) derived from normal difference index of green and red band of NIR image.

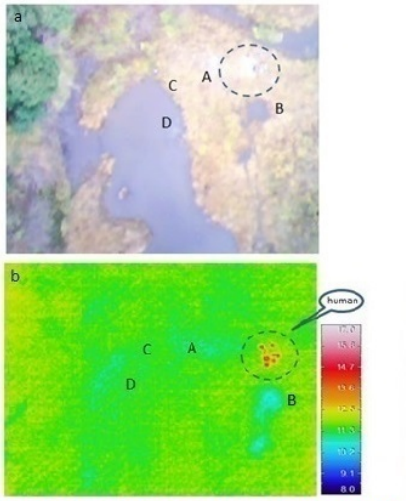

Fig.4 Thermal camera imaging result: a) optical image and b) thermal map. Field temperature measurement (2014/11/28) of A (soil): 10.8 °C, B (grass): 12.3°C, C (near pond): 11°C, and D (pond): 11.5-11.8°C, show good correlation with thermal map.

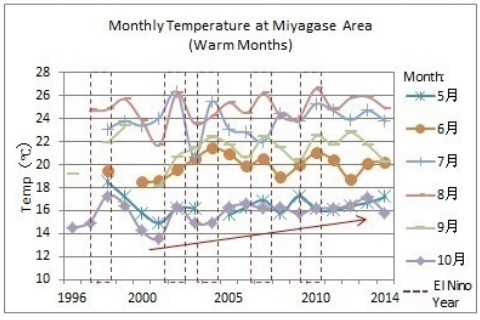

Fig. 5 Monthly temperature at Miyagase area during 1996-2014 period

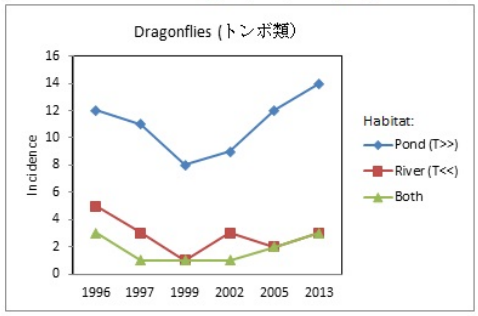

Fig. 6 The incidence index of dragonflies in various habitats during 1996-2013 period

