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【論文の内容の要旨】

Phenology is the study of the timing of recurrent biological events, the causes of the timing with regard to biotic and abiotic forces, and the interrelation among phases of the same or different species. Plant reproductive phenology such as flowering and fruiting is closely related to nature-based tourism. For example, cherry blossom viewing during spring season is able to provide great amounts of social and economic benefits in Japan. On the other hand, plant reproductive phenology is one of indicators to monitor climate change since the trend of spring phenology is able to reflect effects of climate change. It is well known that reproductive phenology of plants in urban areas has changed due to urban and global temperature increment in recent years. Therefore, monitoring reproductive phenology is crucial not only to identify biological and physiological status of cherry blossoms, but also to understand potential risk of nature-based tourism. However, monitoring reproductive phenology at high heterogeneous urban area is a challenge at landscape level as the spectral signal of flower generally weak. Utilizing remotely sensed technique could provide spatial and temporal extend datasets of plant reproductive phenology in heterogeneous environment. Therefore, this study aimed to develop remote sensing technology to monitor spring phenology in urban area.

Firstly, the ability to identify flowering cherry trees at landscape level was

investigated to explore the existing remote sensing technique ability in identifying cherry blossoms in urban park. To test the ability of remote sensing technique, hard and soft classifications were employed to IKONOS image in identification of flowering cherry trees in urban park has been investigated. Results of this study indicate that soft classifier employed on IKONOS image performed better than hard classifier in identifying flowering cherry trees in urban park. Results also suggest that both methods are able to classify cherry blossoms in an urban landscape, but soft classifier classified cherry blossoms is more accurate than hard classifier. Therefore, I conclude that the accuracy of soft classifier could decrease due to the limited number of available bands (four for IKONOS) and the existence of endmembers, such as dry grass in this study, with stronger signals than flowers. Therefore to overcome misclassification problem in order to improve soft classification accuracy, spectral characteristics and its properties exploration must be carried out.

Secondly, spectral properties of flowering cherry were explored to develop spectral library at petal and branch levels, and effects of morphological characteristics were investigated. Effects of morphological characteristics was evaluated using established vegetation indices. The properties of flowering cherry at petal and branch levels varied at visible wavelength. The spectral properties variation at petal and branch levels may be due to morphological effects. In addition, pink, green and yellow elements were consistence at petal level. Meanwhile, those colours are inconsistence since spectral reflectance are depending on the morphological characteristics at branch level for example amount of leaves, amount of flowers and other effect. As a conclusion, information obtained at petal level can be used as endmember to upscale at branch level. However, spectral response from other plant organs may affects the upscaling at branch level. Despite that, flowering cherries phylogenetic characteristics may also effects spectral properties of flowering cherries at branch level due to different morphological characteristics. In future study, it is recommended to identify effects of phylogenetic and morphological characteristics towards spectral properties of flower at branch level to improve upscaling technique. By exploring spectral properties of cherry blossoms cultivars, spectral library developed can be used to improve soft classification accuracy in identifying cherry blossoms cultivars. Besides that, the spectral library can be used to identify cherry blossoms biological and physiological status.

Based on the results obtained in this thesis, I strongly suggest that remote sensing techniques may have potential to monitor urban flowering plant spring phenological event even the urban landscape was highly heterogeneous. By using remote sensing approach, cherry blossoms spring phenological event can be monitor frequently and

could improve the cherry blossoms management as cherry blossoms provides economic and social benefits.