学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Detecting the mechanisms of spatio-temporal changes in land use and endangered ecosystems induced by urban growth
（都市成長に伴う土地利用と絶滅危惧生態系の時空的変化機構の検出）

To detect the mechanisms of the effects of urbanization on land use change and endangered ecosystems, the following researches were conducted in the urbanizing area of Bangladesh: 1) detecting land use changes at fine scale, 2) finding out the potential distribution of endangered and umbrella species, *Shorea robusta*, and 3) investigating the structure and function of ecosystems by using plant functional types.

Fine-scaled analysis is required to detect land use changes induced by urban growth, such as the construction of road networks, although the accuracy of land use classification at fine scale has not been examined well. Various vegetation indices (VIs) have been proposed for land use classification while each of the VIs has advantages and disadvantages on the classification. A hierarchical land use classification with a decision tree (DT) was used with four popular VIs to solve these issues (Chapter 1). The four examined VIs were normalized difference VI (NDVI), green-red VI (GRVI), enhanced VI (EVI) and two-band EVI (EVI2). The spectral reflectance data were obtained from fine-resolution sensors on two satellites, IKONOS and WorldView-2, before and after the urban growth. The leading classification of land use used all of the VIs and showed 96-98% accuracy. These results indicated that each VI exhibits unique advantages. In addition, the DT was the best classifier of land use types, particularly for native ecosystems represented by *Shorea* forests and homestead vegetation, at the fine scale. Since the conservation of these native ecosystems is of prime importance, DTs based on hierarchical classifications should be used more widely. Based on these land use maps, I confirmed that *S. robusta* forests were reduced mostly by the urban growth, particularly by the construction of road networks.

Detecting the determinants of spatio-temporal distribution of species is prerequisite for ecological conservation and restoration. Therefore, I investigated the potential distribution of this species by using Maximum entropy (Maxent) model (Chapter 2). The model was constructed by 165 location records that cover the whole distributional range of *S. robusta* in the study area. Eight environmental variables in relation to climate, geography and soil were included in the model. The model confirms that the potential distributional areas of this tree are determined mostly by

precipitation and soil nitrogen and are larger than the present one, indicating that the urban growth reduced the distribution. The future distributions in 2046-2065 and 2081-2100 were also investigated by the model under global warming scenarios, RCP4.5 (representative concentration pathways 4.5) and RCP8.5 proposed by IPCC were used for the prediction of distribution altered by global warming. The high accuracy of model prediction was confirmed by the binomial test of omission and area under the curve analysis. The results suggested that the distribution will be unchanged or slightly increased when the temperature increase is moderate and will be decreased when it is severe.

Since the leaf spectral reflectance is determined by photosynthesis and its related factors, the relationships between plant functional group (PFG) are expected. However, the relationships have not been examined well. To confirm the relationships, I developed species groups by Ward cluster analysis with Euclidean distance between leaf reflectance spectra of 112 species in the study area (Chapter 3). Four species groups (groups A to D) were recognized and showed significant differences in eight of the 48 examined species attributes, i.e., growth form, vegetative reproduction, phenology, structural properties and leaf morphology. These results indicated that these species groups reflected PFGs. In particular, PFGs were represented by growth forms, i.e., group A = sub-canopy plant, B = herb, C = slim-stemmed tree and D = large tree. These results suggested that the leaf spectral reflectance was associated with ecosystem structures and functions determined by the growth forms.

Based on these results, I concluded that urban growth observed at small scale was a trigger of *S. robusta* deforestation and changed the landscapes and ecosystems. Although the *S. robusta* forest has been at risk of deterioration induced by urban growth and global warming, the preservation of endangered forests is possible by detecting the potentially-suitable regions. The PFGs suggested that the structures and functions of endangered ecosystems should be considered for the conservation and restoration.