B: Remote sensing and GIS

Estimation of Forest Biomass using Remotely-sensed Data and k-Nearest Neighbor Algorithm
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This study purposed to estimate the forest biomass using k-Nearest Neighbor (kNN) algorithm. Multiple data sources were used for the analysis such as 5th forest type map, field survey data and Landsat TM data. Forest biomass accuracy was evaluated with the forest stratification, horizontal reference area (HRA) and modal filtering. Forests were divided into 3 types such as conifers, hardwoods and Pinus koraiensis. The applied radii of HRA were 3 km, 4 km, 5 km and 10 km, respectively. The estimated forest biomass of coniferous forest was 255 ton/ha when the value of k was 9, the radius of HRA was 4 km, and 5 by 5 modal was filtered. The estimated biomass of hardwoods was 210 ton/ha when the value of k was 6, the radius of HRA was 4 km, radius and 3 by 3 modal was filtered. The estimated forest biomass of Pinus koraiensis was 276 ton/ha when the value of k was 3, the radius of HRA was 11 km. The estimated total carbon stock by kNN method was 234 ton/ha. The estimated total biomass by kNN method was about 20 ton/ha less than that of filed survey data. This study was carried out with the support of ‘Forest Science & Technology Projects (Project No. S120911L010110)’ provided by Korea Forest Service.
Additional keywords: forest biomass, k-nearest neighbor algorithm, Landsat TM

Vegetation Map using Object-oriented Image Classification with Ensemble Learning
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Vegetation map is the basic information for forest management. In the remote sensing, creation of the accurate vegetation map is an important subject. Recently, the research using the object-oriented image classification technique or hyper spectral data have increased in the image classification by remote sensing data. Therefore, classifying image with the feature of multi-dimension is an important subject. In particular, in a linear model such as the maximum likelihood method in a pixel base classification, the pattern or relation of multi-dimension data are not characterized. In the classification of multi-dimension data, data mining and ensemble learning is effective. Ensemble learning is the method of raising accuracy and flexibility by combining two or more results. In this study, the object-oriented image classification using Random Forest (RF) advocated by Breiman was employed. Moreover, Nearest Neighbor (NN) method and Classification and Regression Tree (CART) were used as the candidate for comparison of classification accuracy. Our study area is Sado Island in Niigata Prefecture, Japan. SPOT/HRG imagery (June, 2007) was used for vegetation mapping. Our classification target was broad-leaved deciduous forest, coniferous forest, Japanese red pine, and bamboo forest. As the result, the accuracy of the vegetation map using RF and NN was high. Especially RF method was the most accurate within three techniques of image classification. We propose the effective classification technique in vegetation map creation using multi-dimensional data.
Additional keywords: image classification, random forest, Nearest Neighbor, CART, remote sensing

Development of Method to Estimate Understory Vegetation Coverage using Two Digital Cameras
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In Japan, conifer plantations were established for timber production after intensive clear-cutting of natural forests, particularly from the 1950s through the 1970s. However, these plantations have become overstocked during the past decades mainly due to lack of adequate management resulting from high labor costs and low wood value in the country. Presently, from the increasing interest in public benefit such as soil and water conservation brought by forest, the unsoundness of these overstocked forests poses a social problem with rapid increase of the belated thinning forest. Although thinning would open the canopy and lead to increased species diversity and understory vegetation coverage in these overstocked forest, the evaluation of the effects obtained by thinning have required significant time and labor. In this study, we therefore presented a method to estimate understory vegetation coverage using two digital cameras for investigating recovery of understory vegetation after the thinning of conifer plantation. For evaluating the accuracy of the method presented in this study, we established the 27 plots of 5 m × 5 m in size within the three hinoki cypress forests. We then compared the understory vegetation coverage directly measured in the field (UVCo: %) and that estimated using the method presented in this study (UVCe: %). The UVCe was significantly correlated with UVCo and the root mean square error of regression line of UVCo against UVCe was approximately 8%. Thus, the method presented in this study would be a useful method for measuring the understory vegetation coverage easily.

A Comparison of Stem Density Estimation Techniques using Very High Resolution Imagery
Tetsuji OTA, Nobuya MizOUE and Shigejiro YoshIdA (Kyushu University, Japan)
For sustainable forest management, we need precise forest information from periodic and systematic measurements. Remote sensing could be a powerful tool for getting forest information for sustainable forest management. Several techniques for retrieving forest information from very high resolution imagery (VHRI) now exist. In this study, we compared stem density estimation techniques using VHRI. We used QuickBird imagery as VHRI. The study site consisted of even-aged plantations of Japanese cedar (Cryptomeria japonica) and hinoki cypress (Chamaecyparis obtusa). Two techniques using regression analysis and two techniques using individual tree counting were compared. RMSE was between 377 and 409, regression analysis methods being used. RMSE was between 450 and 1242, individual tree counting methods being used. RMSE of individual tree counting methods were strongly influenced by window size. Additionally, one reason suggested for individual tree counting error is the
Factors Causing the Expansion of Japanese Oak Wilt Disease on the Outskirts of Kyoto City
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Japanese oak wilt disease (JOW), associated with Platypus quercivorus, an ambrosia beetle, is widespread in Japan. To prevent JOW, it is essential to locate all killed trees without exception. An aerial helicopter survey to locate killed trees has been ongoing in Kyoto City since 2005. To learn where JOW tends to occur, we analyzed topographic conditions in places where JOW occurred using the helicopter survey data. The analysis used geographic information system (GIS) technology. The probability of JOW occurring was calculated using Jacob’s index. In particular, to understand where JOW tends to occur first, we focused on trees that developed damage earlier, at least 6 km from trees killed the previous year. Our results indicate that although JOW occurred frequently at altitudes of 100 to 300 m each year, trees that developed damage earlier were found at lower altitudes. Although a clear tendency was not observed for the angle of inclination, trees that developed damage earlier were less likely to occur in steep areas. Aspect analysis indicated that in 2005-2006, JOW occurred frequently on the southwest-facing slope of Mt. Higashiyama, in the east part of Kyoto City. JOW then occurred at all aspects as the damage expanded. We also classified landforms into five classes and analyzed their relationship with JOW. The results show that trees that developed damage earlier were less likely to occur in steep valleys and on steep ridges. Moreover, we analyzed whether solar radiation, power pylons, and lightning strikes had an influence on JOW.

Additional keywords: JOW, Platypus quercivorus, helicopter survey, GIS

The Development of Risk Assessment Model for Snow Damage using GIS
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Serious snow damage occurred in Miyama-cho, Kyoto Prefecture in January 2009. We identified that some trees that had survived being damaged by wind during Typhoon 23 in 2004 had cracked along their annual rings. Trees weakened in this way later suffered snow damage. Similar damage will occur frequently in Japan in the future, because strong typhoons and heavy damp snow are likely to increase with climate change. In this study, we predicted where snow damage tends to occur by adopting topographical features (altitude, angle of inclination, water flow accumulation, and so on) and wind speed as factors influencing snow damage. In this prediction, we used wind flow simulation software (RIAM-COMPACT) to compute the wind speed in a given location during Typhoon 23. We divided Miyama-cho into 13,070 cells (10 m in every direction), randomly extracted training data from these cells, then predicted snow damage using three models: logistic regression, classification and regression tree (CART), and random forest analysis. To determine which of these three was the optimal model, we randomly extracted 6,535 cells for verification from different training data, then computed the discriminant hitting ratio (the number of cells in which predictions and actual conditions agree divided by the total number of cells used for verification). The results showed random forest to be the optimal model, as it had the highest discriminant hitting ratio (92.6%). We conclude that the random forest model can predict snow damage, because the hazard map based on this model agrees with actual conditions.

Additional keywords: snow damage, wind damage, GIS, RIAM-COMPACT, random forest

Extraction of Suitable Sites for Japanese Cypress (Chamaecyparis obtusa) Plantation in Odai-cho, Mie Prefecture: The Growth and Insect Damage Tendency by Site Condition
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This study aims to examining the relationship of site conditions and the growth of Japanese cypress (Chamaecyparis obtusa) at abandoned plantation sites of Odai-cho in Mie Prefecture for clarifying sites suitable or unsuitable for cypress plantation. The relationship between site conditions and the damage by Anaglyptus subfuscatus was also interpreted and used for evaluating the site suitability. Sixty-six plots were established for field survey and the site conditions were interpreted based on their parent material, types of deposition (residual/creeping/colluvial), slope angle, slope type, and soil particle size at each plot. The data of tree height, diameter at breast height (DBH), and insect damage were also investigated. Cluster analysis was conducted by using the data of tree height and DBH in order to divide the site conditions into several location groups with the same growth tendency. Using the insect damage data, site conditions were also divided into several location groups with the same damage tendency. The whole abandoned plantation area was then divided based on each location groups by using GIS. As a result, concave sites with colluvial deposits were fast-growing but tended to show serious insect damage. Convex sites with residual deposits and clay were slow-growing sites but showed little insect damage. As the insect damage is the main factor influencing the timber value, we concluded the latter sites as suitable sites for cypress plantation. Other sites might be better to convert to other forest types such as broad-leaved forest which might contribute to diversify the forests in the region.

Additional keywords: site condition, GIS, Chamaecyparis obtusa, suitable sites