Environmental Monitoring in East Asia: Remote Sensing and Forests

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第４章　東アジア生態学国際会議(EAFES)

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– Ecological esearch and Monitoring in Environmental Changes –

Session: Friday(October 22)

Utilization of remote sensing for monitoring of vegetation change

Time: 14:00~17:00

Room: A102

Organizers

- Ken-ichiro Muramoto, Kanazawa University (muramoto@t.kanazawa-u.ac.jp)
- Kyu-Sung Lee, Inha University (ksung@inha.ac.kr)
- Dafang Zhuang, Chinese Academy of Sciences (zhuangdf@lreis.ac.cn)
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1. Ecological Research and Monitoring in Environmental Changes in China

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Terrestrial ecosystem is a key component of our planet, but it has been changing by the natural and anthropoic effects, such as desertification, urbanization and global climate change. It becomes more and more important to acquire the Terrestrial ecosystem status and its change information. To understand such issues relating with the ecosystem and its change, a system to monitor the ecological system was founded in IGSNRR, CAS, which including CERN, Chinese Resources and Environment database, remote sensing receiver and processing system and ecological simulation model library. The Chinese Ecosystem Research Network (CERN), one of the founding members of the International Long Term Ecosystem Research Network (ILTER), and Global Terrestrial Observation System (GTOS), was established in 1988. CERN consists of 36 field research stations for various ecosystems, including agriculture, forestry, grassland and water body, five disciplinary centers and one synthesis center. The CERN stations equipped various instruments to acquire different ecosystem parameters, such as realtime flux data, meteorological data and vegetation growth parameters. These data, some are realtime, were collected and quality control in its synthesis center. Chinese Resources and Environment database was constructed from 1990's, now has included different resolution geospatial data that contributed to ecological research. These data include the multitemporal land cover data, ecological settings data and fields sample data. The remote sensing data receiver and processing system can receive MODIS data and process these data to extract ecological parameters. The model library has collected various methods related with ecological simulation. The four components integration will improve us in understanding the Chinese terrestrial ecosystem and its change.

2. Effectiveness of various vegetation indices for the estimation of forest canopy structure

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Several vegetation indices, obtained from multi-spectral remote sensing data, have been widely used to indirectly estimate canopy structure parameters across different biomes. Although vegetation indices have shown certain relationship with several biophysical variables of vegetation canopy, such as leaf area index, biomass, and vegetation coverage, their effectiveness has not been fully confirmed over the very dense temperate forest vegetation. Further, some of vegetation indices have limitation to describe forest canopy structure due to the influence of background soil and atmospheric attenuation. In this study, we are attempting to analyze the effectiveness of various vegetation indices over the forest ecosystem having rather close canopy condition.

Two vegetation indices, including normalized differential vegetation index (NDVI), simple ratio (SR), and enhanced vegetation index (EVI), were compared in relation to the leaf area index (LAI) over the study area near the Seoul metropolitan area. The Kyongan watershed covers a total area of 561km^2 of coniferous plantation and natural stands of mixed deciduous species. During the growing season of 2003, field survey was conducted over 30 ground sample plots to measure LAI, stand density, and stand height were measured. Each plot has an area of 20 x 20 m^2 and includes five subplots for LAI measurement within it. Plot locations were determined using a differential global positioning system (GPS). Field measured LAI values were then compared with vegetation indices that were extracted from satellite remote sensing data, which were obtained about the same season with the field survey. Capability of various vegetation indices to estimate LAI over the close canopy forest ecosystem are discussed.

3. Use of time series MODIS Leaf Area Index data to monitor temperate forest

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As one the primary EOS sensors, MODIS has provided not only radiant-flux image data but also several biophysical variables, including leaf area index (LAI), fraction of photosynthetically radiation (FPAR), and net primary production (NPP), that can be valuable source of information for ecological studies in range of time and spatial scales. Since 2000, MODIS LAI data (every eight-days composite) have been available for whole land areas of the earth. The objectives of this study are to analyze the potential of time series MODIS LAI product to monitor the regional scale forest cover changes over the temperate forests in the Korean peninsula.

Time series MODIS LAI data over the study region were obtained for the period of 2000 to 2003. As an initial approach to assess the quality of the data, we analyzed those reference data that are delivered with LAI data and include the LAI estimation algorithm used and cloud coverage for every pixel. Mean LAI value over the Korean peninsula showed very unusual pattern from June to August for every year, which was caused by the high cloud coverage during the summer season. Those LAI values estimated by the backup algorithm of using NDVI showed rather low quality. Therefore, it is strongly advised to use only those LAI values estimated by the main algorithm using the canopy radiative transfer model and not affected by cloud cover.

LAI of North Korea showed lower LAI than South Korea for spring, fall and winter, but similar mean LAI (4.5 LAI) during growing season of summer, which implies the short growing period due to the climate pattern between north and south Korea. Time-series MODIS LAI data have shown the possibility of detecting and monitoring of fire damaged forests. Comparison among three years MODIS LAI product, we were able to see high LAI value for a certain year when the precipitation and temperature were better than the other years. Time series MODIS LAI product can be useful to monitor several biotic and abiotic changes of temperate forest in regional scale.

4. Mapping Leaf Area Index using MODIS data in China

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Leaf area index (LAI) is one of the surface parameters that has importance in climate, weather, and ecological studies. It has been extensively investigated to estimate the LAI from remote sensing measurements, but it is still a challenge to map LAI in a large regional scale. There are mainly two methods to estimate LAI from satellite data, one is based on the statistical relationship between LAI and remote sensing bands which is only suitable to local regional scale, and another is from the inversion of physical canopy radiation transfer model which is more optimistic for large scale LAI estimation. In this presentation, a new LAI estimation method from MODIS data is proposed. Since LAI is a key parameter in description of vegetation structure, the satellite bands data may be different for same LAI from different view and sensor angles. The couple of view and sensor angle with satellite bands data may improve the accuracy of LAI estimation. The method is based on the 5-Scale model developed by Jing. M. Chen. MODIS bands radiance were firstly simulated to create lookup table using the 5-Scale model with input of LAI, view angle, sensor angle and landcover-related parameters. Then the LAI was retrieved from MODIS bands data using simulation lookup table. The algorithm was applied to produce LAI maps covering all China using 16-days cloud-free MODIS data. To validate the algorithm and these products, four sites, including Changbaishan, Heihe, Liping and Xingguo, were selected for validation under the support of CIDA projects in 2003. The field measurements use the commercial Tracing Radiation and Architecture of Canopies (TRAC). Landsat Thematic Mapper (TM) scenes at 30-m resolution at the same period were used to locate ground sites and to facilitate spatial scaling to 1-km pixels. It is shown that the accuracy of LAI values of MODIS was more than 80%. Random and bias errors were both considerable. Bias was mostly caused by the prior knowledge data such as the landcover and model predefined parameters error, but the uncertainties in atmospheric correction of remote sensing data were also contributed to MODIS LAI estimation. And, these LAI data were compared with NASA MODIS LAI product. The seasonal LAI changes are also analyzed from 2000 to 2003.

5. Landcover Classification and Forest Area Change Detection for DMZ using Remotely Sensed Images

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This study aims to characterize present land cover and to detect its change over time for the Demilitarized Zone (DMZ) and its vicinity of Korea using remotely sensed images. DMZ, a 4 km wide (N-S), 248 km long (W-E) corridor shaped area along the stalemate line has been free from human access for over the last 50 years. The DMZ, however, partly well conserved has been witnessing periodical disturbance continuously due to the army operations and artificial fire clearing the sight. The area surrounding the DMZ has been under the pressure for urbanization and the expansion of cropland. Land cover changes in DMZ and its surrounding area were mapped by comparing past and present Landsat TM 5 and 7 satellite images. And land cover maps showing 7 categories of present land cover and its change were developed using supervised classification techniques including calculation of NDVI and GIS overlay between 1987-1989 and 2001. The main category of quite a big change is 'Forest 1 class' of which the stem density and viability are relatively high. The 'Forest 1 Class' area decreased from 640,716 ha to 526,970 ha. The area of changes was larger in North Korea than in South Korea due to the conversion of forests into cropland and barren land for food production and supply of fuel wood. And what is worse, most of the croplands developed on the mountain slopes in North Korea are known to be experiencing increased erosion and decreased soil fertility. Apart from the quality, forests inside the DMZ showed better connectivity than the surrounding area. The results will help decision makers detecting where changes in the ecosystem of DMZ and its vicinity have occurred and determining where to conserve and restore for maintaining the structure and function of DMZ ecosystem.

6. Incidence of Japanese Oak Wilt in Relation to Topography and Sunshine

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Japanese oak wilt (JOW), caused by an ambrosia fungus *Raffaelea quercivora* and vectored by a symbiotic ambrosia beetle *Platypus quercivorus* (Murayama), has been prevalent in Japan for the last fifteen years. In Ishikawa Prefecture, incidence of JOW was first found in the western portion of the prefecture in 1997. In this study, we investigated the relationship between historical JOW incidence with topographical features, including slope, aspecct and exposure to solar radiation. The study area consisted of 1520 m x 1380 m region in Ishikawa and Fukui prefectures. The site was a mountainous region including Mt. Kariyasu and was nearly uniformly covered by forest stands dominated by *Quercus crispula*. Killed trees were identified by their red coloration in aerial photographs taken before natural fall color change in middle of October. The slope and aspect were calculated from a digital elevation model (DEM). Solar angle from 6 AM to 8AM on 1st August were calculated and relative amounts of solar radiation at each position was also calculated using the DEM. All data were compiled using a geographic information system (GIS). The incidence of JOW was higher in east-facing slopes than that in west-facing slopes. *P. quercivorus* adults are positively phototactic. The east-facing slopes receive more solar radiation in the morning, when adult flights occur. Incidence of JOW tended to be greater in locations that received more solar radiation in the morning.

7. Japanese Oak Wilt Spread analyzed with GIS and Multi-spatial-scale Data

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Japanese oak wilt (JOW) has been known to exist in Japan since the 1930s. The most early outbreask of this disease recorded were only a few years in duration and were confined to a few areas on the Japan Sea (western) coast of Japan, but in the last ten years epidemics have intensified and spread to the island's western coastal areas. The symbiotic ambrosia fungus *Raffaelea quercivora* is the causal agent of oak dieback associated with the disease, and it is vectored by *Platypus quercivorus* (Murayama). This is the first example of an ambrosia beetle fungus that kills vigorous trees. Previous studies have documented the historical spread of concurrencies of JOW at the regional scale level and it was recognized that JOW spreadbut trends of this expansion have not been analyzed statistically. In this study, statistical analysis of the spread of the oak dieback was conducted using GIS tools and expansion behavior was quantified atdifferent spatial scalew. There appear to be at least three different scales at which expansion of foci operate. These results suggest that adult beetles have cababilities of moving over various spatial scales.

8. Study on Land–use/Land-cover Change and Terrestrial Carbon Cycle in China

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The interest in the terrestrial carbon cycle at national levels has been increasing since the agreement of Kyoto Protocol was reached. Carbon cycle links human, biological, geochemical and atmospheric process. The change of the magnitude and spatial distribution of net carbon fluxes between ecosystems and the atmosphere is controlled mainly by prior disturbance and land-use/land cover change. To address the scientific issues such as temporal and spatial pattern of terrestrial ecosystem carbon sink, and driving mechanism and scenarios of carbon cycle, etc., a method of geo-information science for studying carbon cycle of terrestrial ecosystems is proposed. Bottom-up approach and top-down approach are combined by means of scaling models. The bottom-up approach is based on observations of comprehensive network of carbon storage and carbon cycle process of terrestrial ecosystems, adaptive experiments of biological processes, and researches on carbon transportation processes of rivers. The top-down approach is based on detecting land cover change and retrieving ecological parameters by using satellite. Retrieval models of carbon budgets are developed by means of the capacity of satellite remote sensing that can frequently supply surface information of geological processes and ecological processes. On the basis of analyzing data-at-points collected by observation stations of Chinese Ecosystem Research Network, stations of Chinese Forest Ecosystem Research Network, and stations of ChinaFLUX, combined with the retrieval models, a numerical simulation model of terrestrial ecosystem carbon cycle is constructed by means of surface theorem, grid generation method and grid computing technique. Pattern and process of carbon cycle are to be simulated; natural and human impacts on carbon cycle of terrestrial ecosystems are to be analyzed; and evolution trends of carbon cycle process of terrestrial ecosystems are to be discussed under the condition of global climate change.