VOLUME ESTIMATION AND FOREST FIRE DETECTION WITH GIS

Japanese Forest Monitoring

Forest fires, illegal logging, rehabilitation of degraded land and watershed management are worldwide problems, monitoring being aided by modern technology including earth observation from space, image processing software, GIS and general IT. The author provides an overview of Japanese initiatives in forest volume estimation and forest fire detection.

This article is a translated and modified version of an article earlier published in the July 2004 issue of The Journal of Survey.

The sustainable supply of natural, coniferous wood, important for local communities in Japan, requires information on structural forest parameters. However, the Japan Forestry Agency record agency contains such limited information. Airborne imagery requires labour-intensive interpretation. Therefore satellite imagery (Landsat TM and ETM) combined with ground survey has been applied to estimate volumes of natural forest in three areas in Japan: Aomori, Kiso and Akita, which are most famous for their beautiful natural coniferous forests. These play an important role in supporting local industry.

Forest Volume Estimation
Distribution of forest volume can be derived from satellite imagery by using the statistical Pattern Decomposition Method (PDM). This is able to provide precise information on forest structure; it assumes that each pixel covers various forest components the ratio of which can be estimated. In coniferous areas these components include conifer trees, broadleaf tree, soil and shadow. PDM is able to reduce the influence of terrain characteristics, even in the complex mountainous forests of Japan. The forest volume of each pixel is estimated by comparing the parameters of PDM with ground truth obtained by ground surveys. In this way a forest-volume distribution diagram was created. The accuracy increases proportionally to available ground surveys. The images recorded during springtime showed the best accuracy.
GIS is important for making this method operational in practice. GIS enables:

- extraction of natural forest boundaries from forest management map
- estimation of actual capacity of wood supply by combining slope angles, distances from road and other GIS information with regulations for forest management
- estimation of available tree volume for each district forest office.

Both GIS and integration of the PDM method into a remote-sensing image processing software package is thus key to success.

Fire Monitoring
Forest fire, especially related to El Nino and atypically long dry seasons, is an important issue in sustainable forest management in Asia. The big forest fires of 1997 and 1998 in South East Asia not only affected the forest ecosystem but also caused health risk. Smoke from these fires was so extensive that even people in surrounding countries were at risk. The aspects of fire risk may be divided into three categories:

- fire beginning risk
- fire spread risk
- fire control.

Fire beginning risk results mostly from human action, whilst fire control depends much on accessibility. GIS is able to provide the necessary information for both. Fire spread risk requires information on vegetation conditions (dry/wet); remote sensing can provide this information. Fire spread risk assessment gives important information on priorities for fire control once fires have begun. During the big forest fires in 1997 and 1998, the prioritising of fire control operations was difficult because hundreds of fires occurred in one day.

Fire Detection System
In 1996 we started the development of a near real-time forest fire detection system in Bogor, Indonesia for the Forest Fire Prevention Management Project of the Japan International Cooperation Agency (JICA). As basic data sources we used that from NOAA-AVHRR, Japanese Geostationary Meteorological Satellite (GMS) and the DMSP (Defense Meteorological Satellite Program). The system was designed in the morning to send to fire control offices information on uncontrolled fire recorded during the night. Image generation, system noise reduction and geometrical rectification are applied to the received data. Hotspots are identified as fire plots on NOAA-AVHRR data

and new lights are detected on DMSP images by excluding stable light spots caused by, for example, cities. There are few errors in identification of fires on NOAA-AVHRR images because of the use of the thermal band recorded during the night. Both hotspots and new lights are plotted on a map, which is automatically sent to the web-site (www.affrc.go.jp/ANDES/); their locations are automatically emailed to fire fighters in the form of latitude and longitude.

High-capacity Network

The availability of a high-capacity network is important for, among other things, obtaining raw remote-sensing data from other countries. We got permission from the Asia Pacific Advanced Network (APAN) consortium to transfer large amounts of remote-sensing data through their network. The Computer Centre for Agriculture, Forestry and Fisheries (CCAFF) set up a MODIS direct receiving system in Tsukuba in 1999, as well as a linkage system to the MODIS data server at the Asian Institute of Technology (AIT) in Thailand. MODIS, with a ground resolution of 250m, is useful for monitoring both global and regional forest conditions every eight to sixteen days.