

## ABSTRACT

*Eucalyptus* plantations cover an area of approximately 500 000 ha in Spain, which comprise the 25% of the total harvested wood each year in Spain. *Eucalyptus globulus* Labill. is the most important species, based upon extent and utility for pulp production. The most representative area for *Eucalyptus globulus* plantations in Spain is Galicia (NW Spain), considering both stocks and extension, with 178 000 ha of pure *Eucalyptus globulus* stands and 429 000 ha if mixed stands where *Eucalyptus globulus* is the primary species are also considered. These plantations are the most productive forest stands in Spain and their wood production is nearly the 28% of the total in Galicia.

The high productivity of *Eucalyptus globulus* plantations in Galicia has been threatened by the outbreaks of *Eucalyptus* snout beetle, *Gonipterus scutellatus* Gyll. (Coleoptera, Curculionidae) since 1991, whose outbreaks have affected nearly every eucalypt plantation in the last 15 years. Despite the adversity of its attack, damages produced by this defoliator did not cause tree death but a growth reduction.

Damage monitoring programs in Galicia are based on field surveys based on a plot network; therefore, are costly and require a large amount of resources from the administration. The gathered data are typically not timely or spatially accurate, and the defoliation assessment is observer dependent.

This research developed an objective, accurate, timely, and efficient prototype *Eucalyptus* Health Monitoring System (EHMS) for *Eucalyptus globulus* stands where *Gonipterus scutellatus* outbreaks affect health status and productivity, in Galicia, by means of remote sensing techniques and geographic information systems, in order to aid in forest management and planning. This goal was reached by (i) establishing a conceptual framework for a *Eucalyptus globulus* health monitoring system for eucalypt stands in Galicia, where required outputs, inputs and processes are settled, (ii) mapping *Eucalyptus globulus* stands by means of satellite imagery, in order to get an updated cartography, and (iii) detecting and mapping damaged *Eucalyptus globulus* using remotely sensed and available GIS data.

This study has demonstrated that the combined use of process based forest growth models, remote sensing and GIS data allows monitoring eucalypt stands in Galicia in a cost-affordable approach.

*Eucalyptus globulus* stands have been mapped by means of high and medium spatial resolution imagery, object oriented and pixel based classifications, hard and soft classifiers. It has been demonstrated that it is possible to map accurately and timely *Eucalyptus globulus* stands using 30-m multispectral Landsat-5 TM data through object-oriented classification (1 m scale parameter for the segmentation), achieving a producer's accuracy of 95.56% and a commission error of 27.22%. Results were better than high spatial resolution data (IKONOS) when cost-acquisition, cost-processing and cost-effective criteria were considered.

The application of the EHMS depends on the availability of climatic, soil and forest stand data, as far as the validation of some relationships between radiometric information and forest parameters for eucalypt stands in Galicia. Nevertheless, despite the lack of these data the EHMS can be applied because stand mapping just needs one Landsat-5 TM image and damage detection only requires spectral data from Landsat-5 TM imagery (Band 2), a digital elevation model (diffuse radiation), and data regarding stand density. Discriminant analysis allowed identifying damaged *Eucalyptus globulus* stands (leaf loss > 25%) with a true positive accuracy of 72.31% and user's accuracy of 95.92%.

The success of the prototype EHMS for *Eucalyptus globulus* stands depends on the combined use of appropriate remotely sensed and GIS data. Each dataset has to fulfill the data quality requirements, and follow a metadata/lineage standard, in order to know its accuracy and its suitability and limitations for the proposed analyses. Moreover, the use of the standards developed by the Open GeoSpatial Consortium Inc. (OGC) is recommended, so that forest administration, forest industry and forest managers can take advantage of outputs of the EHMS in an open environment, maximizing the value investments in GIS and data.