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Building a Time Series of Pan-European Forest Type Maps Based on Data Fusion of Multispectral and Multitemporal MODIS data

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Forest monitoring at continental and global scale has become more important, due to a need for carbon accounting, climate change modelling, forest management and biodiversity monitoring. In 2007, the Joint Research Centre (JRC) of the European Commission has produced a pan-European forest/nonforest map at 25 m spatial resolution for the year 2000. Recently, a forest type map (including broadleaved and coniferous forest) was added for the year 2006 (FTYP2006). Both products are available to the public for download. Due to limited data availability, data cost and required effort, such fine spatial resolution land cover maps can not be produced every year. In addition, they are released only years after their actual dates (seven and five years respectively in the case of the JRC forest maps). Yet, timely and regular forest type maps are crucial to assess impacts of climate change and monitor recent trends. Increasing the number of maps in a given time frame can also indicate if changes are actually trends or just temporary oscillations. This work presents five pan-European forest type maps (2006-2010) that were produced within only a month after the acquisition date of the last satellite data.

To reduce production time and cost, the focus was moved from fine to moderate spatial resolution satellite data. The MODerate Resolution Imaging Spectroradiometer (MODIS) instrument is viewing the entire Earth's surface every one to two days, acquiring data in 36 spectral bands at different spatial resolutions (250-1000 m). Only bands 1-7 at 250 and 500 m were selected, as a trade-off between spectral and spatial resolution. Based on the expertise that was built during the development of the fine spatial resolution forest maps of 2000 and 2006, a supervised classification approach was aimed for.However, availability of reliable training data is one of the main obstacles for this approach. A first objective of this study was to check if a classification method could be developed for producing time series of pan-European forest type maps, using a single date land cover map for training. Even though forest changes are relatively small in many areas in Europe, large differences can occur locally (e.g., clear cuts). Therefore, the classification method had to show some robustness for these "errors" in the training data. An Artificial Neural Network (ANN) was chosen, in particular a multilayer perceptron using backpropagation for training. A bootstrap aggregation (bagging) was also added. The robustness was tested by creating two forest type maps for the year of 2006. The maps were produced with two different training sets: one with an up to date land cover map (Corine 2006), and the second with an outdated land cover map (Corine 2000). The results were then compared to FTYP2006 (aggregated from 25 to 500 m), which served as a reference.

A second objective of this study was to search for a method that could best exploit the multitemporal and multispectral information provided by the MODIS instrument. The multitemporal information was obtained by first combining the daily images to monthly cloud free composites. The multispectral information consisted of the first seven spectral bands of MODIS from the visible to medium infrared part of the electromagnetic spectrum. Several approaches were tested how to fuse the multispectral and multitemporal data. Best results were obtained by classifying the multispectral information in each monthly product. In a decision fusion approach, the individual classification results for each month were then combined to reach a final class decision. Results show the ability of the proposed method to build a reliable time series of forest type maps shortly after the final acquisition date.

Keywords: forest type land cover mapping, multitemporal data, data fusion