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An estimation of tree cover from medium spatial resolution remote sensing data using an orthogonal vegetation index and Kalman filter

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Earth observation remote sensing data has the potential to retrieve up to date environmental information over large areas. Existing medium resolution sensors already offer time series of nearly 10 years of consistent remote sensing data. The combination of the temporal and spatial information components has the potential to provide unique capabilities to monitor land cover dynamics and understand ecological and socioeconomic processes.
In this study we retrieve annual estimations of tree cover at pan-European level for the period 2004-2010. Tree cover is a relevant variable for fields such as forest management, landscape ecology and biodiversity and carbon sequestration. We estimate tree cover through a vegetation index (VI). Vegetation Indices have been widely applied for vegetation studies. Despite of their limitations they offer a simple empirical proxy to vegetation related parameters. In this study the scaled difference vegetation index (SDVI) is applied to estimate tree cover. The SDVI is an orthogonal vegetation index based on the difference vegetation index (DVI), and scales DVI values between those of dense vegetation and bare soil. Previous studies showed SDVI is a direct estimate of vegetation fraction for mixed pixels (Jiang et al., 2006). Furthermore SDVI has proved to be scale invariant and nearly not affected by soil background.
For each year, a wall to wall tree cover for Europe was produced based on MODIS data at 250 m resolution from the summer months. Corine Land Cover and the JRC forest Type Map 2006 were used as ancillary data for the calibration of the SDVI. The calculation was implemented by blocks using a sliding window. As a result several estimations were available for each pixel.
However annual estimations can be affected by factors such as interannual variations or image quality. In order to reduce the uncertainty of annual tree cover estimations a Kalman filter algorithm (KF) was applied. KF uses measurements observed over time that contain noise and other inaccuracies. These measurements and their accuracies are integrated with retrievals from previous years and their respective uncertainties to produce a more robust estimate that tend to be closer to the true values of the measurements. The result is a robust time series of pan-European tree cover maps. This time series has the potential to provide relevant information about the evolution of forest cover in Europe over the past decade. It also proposes a simple but solid approach for time series analysis of medium resolution remote sensing data over large areas.

keywords: tree cover mapping, time series, Kalman filter