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Land Cover and Vegetation Seasonality – Lessons from time-series satellite data analysis

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In this study, information extracted from medium spatial resolution satellite data has offered considerable insight into spatio-temporal patterns in vegetation seasonality and land cover change across the island of Ireland from 2003 to 2009.

The most recent detailed land cover map of Ireland is CORINE Land Cover (CLC) 2006. However, there are concerns with regard to its use for national scale studies in Ireland. The CORINE classification is based on only one, or at most two, satellite image acquisitions within the year which can result in some vegetation types potentially being misclassified due to spectral similarities in the vegetation cover at certain periods of the growing season. Furthermore, the CORINE nomenclature is not the most appropriate to represent the diversity in Irish land cover and the 25Ha minimum mapping unit can lead to incorrect representation of heterogonous landscapes. These shortcomings have prompted an investigation of a land cover characterisation method that integrates vegetation seasonality with classification methods.

This method, based on time series analysis, was first used to explore the potential of 1.2 km spatial resolution MERIS Global Vegetation Index (MGVI) data to monitor the Start Of the growing Season (SOS) across the island of Ireland. Time series analysis allows full reconstructions of surface spectral changes, even in the presence of data gaps due to cloud and signal noise, using model curve fits from which seasonality metrics can be extracted.

Time series analysis of 10-day MGVI composites from 2003 to 2009 showed spatial patterns in the SOS across the island consistent with the distribution of CLC 2006 vegetation classes. Exploring differences in SOS per CLC class in 2006, based on the non-parametric Kruskal-Wallis test, revealed three significantly different ($p<0.05$) groups of classes. The first group consisted of agricultural land cover types with forests, the second group consisted of peat bogs and the third group consisted of both natural and semi-natural vegetation types. The relevance of these findings lies in the ability to detect statistically significant differences between CLC classes which appear to be related to land cover.

The same approach was then applied to the full seasonal profile of MODIS Enhanced Vegetation Index (EVI) data to characterise Irish landcover at an equivalent spatial resolution to CLC 2006. Time series analysis of a single year (2006) of 250m spatial resolution 16 day composites of the product yielded 38 landcover clusters of spectrally separable land cover types. The Jeffries Matusita index was then used to identify the degree of difference and similarity between clusters. Five statistically unique seasonality clusters were identified across the island, as well as five statistically distinct groups of clusters.

Interestingly, clusters which exhibited a distinctive double growing season were found to coincide with some CORINE "pasture" class areas. This suggests that a specific spectral change arising from land management practices such as silage cutting, a feature of intensive grassland systems in some areas, are detectable using this method. However, this would need to be verified by ground-based studies of land use in areas where such clusters are found.

This work has highlighted the value of multi-temporal satellite imagery compared to existing methods of land cover classification and studies of vegetation phenology. Further work will attempt to verify the content of land clusters using high spatial resolution satellite imagery. Findings will be of interest to natural resource and agriculture development agencies in mapping the intensity of grassland management in Ireland.