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Relation of MODIS EVI and LAI across time, vegetation types and hydrological regimes

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Estimation of the Leaf Area Index (LAI) of a landscape is considered important to describe the ecosystems activity and is used as an important input parameter in hydrological and biogeochemical models related to water and carbon cycle, desertification risk, etc. The measurement of LAI in the field is a laborious and costly process and is mainly done by indirect methods, such as hemispherical photographs that are processed by specialized software. For this reason there have been several attempts to estimate LAI with multispectral satellite images, using theoretical biomass development models, or empirical equations using vegetation indices and land cover maps. The aim of this work is to study the relation of MODIS EVI and LAI across time, vegetation type, and hydrological regime. This was achieved by studying 120 maps of EVI and LAI which cover a hydrological year and five hydrologically diverse areas: river Nestos in Greece, Queimados catchment in Brazil, Rijnland catchment in The Netherlands, river Tamega in Portugal, and river Umbeluzi in Mozambique.

The following Terra MODIS composite datasets were downloaded for the hydrological year 2012-2013: MOD13A2 "Vegetation Indices" and MCD15A2 "LAI and FPAR", as well as the equivalent quality information layers (QA). All the pixels that fall in a vegetation land cover (according to the MERIS GLOBCOVER map) were sampled for the analysis, with the exception of those that fell at the border between two vegetation or other land cover categories, to avoid the influence of mixed pixels. Using linear regression analysis, the relationship between EVI and LAI was identified per date, vegetation type and study area.

Results show that vegetation type has the highest influence in the variation of the relationship between EVI and LAI in each study area. The coefficient of determination (R2) is high and statistically significant (ranging from 0.41 to 0.83 in 90% of the cases). When plotting the EVI factor from the regression equation across time, there is an evident temporal change in all test sites. The sensitivity of EVI to LAI is smaller in periods of high biomass production. The range of fluctuation is different across sites, and is related to biomass quantity and type. Higher fluctuation is noted in the winter season in Tamega, possibly due to cloud infected pixels that the QA and compositing algorithms did not successfully detect. Finally, there was no significant difference in the R2 and EVI factor when including in the analyses pixels indicated as "low and marginal quality" by the QA layers, thus suggesting that the use of low quality pixels can be justified when good quality pixels are not enough. Future work will study the transferability of these relations across scales and sensors.

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