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NDVI (Normalized Difference Vegetation Index) signatures of transient ecohydrological systems: The case of post-mining landscapes

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Assessing ecohydrological systems that undergo state transitions due to environmental change is becoming increasingly important. One system that can be used to study severe disturbances are post-mining landscapes as they usually are associated with complete removal of vegetation and afterwards subsequent ecosystem restoration or spontaneous rehabilitation in line with natural succession.
Within this context it is of interest, whether and how (fast) the land cover in these areas returns to conditions comparable to those in the undisturbed surrounding or those prior mining. Many aspects of mine site rehabilitation depend on climatic, geomorphic and ecological settings, which determine at which rate vegetation may be re-established. In order to identify general patterns of vegetation establishment, we propose to use NDVI (Normalized Difference Vegetation Index) time series for mine affected land to estimate rate of recovery across climate regions and ecoregions.
In this study we analysed the MODIS Terra Satellite 8 day-composite NDVI for areas influenced by surface mining in different climates from 2001 to 2015. The locations have been chosen based on their extent and the data availability of mining and rehabilitation activities. We selected coal extraction as a case study as strip mining generates well-defined chronosequences of disturbance. The selected mining areas are located in equatorial, arid, warm temperate or snow climates with different precipitation and temperature conditions according to the Köppen-Geiger classification.
We analysed the NDVI time series regarding significant characteristics of the re-vegetation phase. We applied hierarchical cluster analysis to capture the spatial heterogeneity between different pixels (ca. 250 * 250 m^2 each) in and around each open cast mine. We disentangled seasonality, trend and residual components in the NDVI time series by Seasonal and Trend decomposition using LOESS.
As expected the time of the removal of vegetation can be clearly identified from the NDVI time series and provides the starting point of disturbance. The cluster analysis allowed us to distinguish between the non-mining land, the mine and the restored land of different ages. Based on these clusters, the time series decomposition revealed the dominance of the trend of increasing NDVI in areas undergoing the restoration process as well as the prevailing seasonality of the oldest restored sites. The determined phase of a dominant trend component, lasting until the NDVI is in the range of the surrounding landscape or the pre-mining conditions, is in the scale of a decade.
The impacts of different hydroclimatic regimes and different rehabilitation strategies on long term NDVI development are currently being investigated. Furthermore, coherence analysis will be applied to quantify short term influences of hydrometeorological variables on vegetation development.