

Identifying potential critical transitions in a forest ecosystem using satellite data

Ecosystems can undergo changes that are slow and gradual, or an abrupt change - a sudden nonlinear dynamics that can bring catastrophic changes and ultimately leads to the change in the structure and functioning. Non-linear and discontinuous changes sometimes may cause the system to shift into another undesirable state, called 'regime shifts' or 'critical transition'. Recent model based and simulation studies have identified indicators of impending regime shifts that can be used to provide early warning signals of a critical transition or tipping points. However, these studies lack an empirical base and studies in real world ecosystems are largely missing. Therefore, this study attempted to identify potential critical transitions and tipping points in a Mediterranean type forest ecosystem. In this study, we argue that time series of enhanced vegetation index (EVI) derived from MODIS satellite images can help to identify potential tipping points and critical transitions. The long term increasing trend and changes in the statistical properties of the observed time series of metric-based early warning indicators of critical transition and tipping points - autocorrelation-at-lag-1, standard deviation and skewness are used to identify the potential transitions and tipping points. The study quantified early warning indicators for the Northern Jarrah Forest (NJF) ecosystem, but the strongest signals did not flag any forest that showed any signs of an impending shift. In contrast, it largely identified the areas that were mined in the past and are susceptible to human interference and land use change. Some forest pixels are identified but it did not show any collapse while monitored using imagery from Google Earth at different time. There might be several possible reasons why the results indicated a non-tipping forest. The possible false indication of tipping points could be possibly due to the environmental and climatic variability that might have triggered the rise in indicators to act as a source of false alarm of impending critical transition or tipping point. On the other hand, it could also be that the NJF forest ecosystem is not yet close to tipping points. This study shows that detecting critical transitions and tipping points in real world ecosystems remains challenging and may not be as promising and straightforward as suggested by simulation studies. The gaps in evidences of tipping points in real world examples could be filled by analyzing high resolution and high frequency data, integrating remote sensing with process based approach dynamic vegetation models and validate the results with ground observations.

Keywords: critical transition, tipping point, early warning, EVI, time series

Advisor: **Petter Pilesjö** (Lund University), **Thomas A. Groen** (University of Twente)
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Department of Physical Geography and Ecosystem Science, Lund University.
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