Monitoring Forest Stability

Background

Degradation of forests has serious implications in terms of biodiversity, productivity and carbon storage. Due to the close canopy that most forests have, applying classical remote sensing based on visible- and near infrared broad band sensors does not give satisfactory results to detect degradation. At the same time, this is the kind of satellite imagery of which we have built up data archives containing over several decades of observations.

Non Linearity

New developments into ecosystem dynamics and their responses to stress might contain a key to use these archives. Several recent studies have indicated that many ecosystems, including forests, display non-linear dynamics. This means that a forest can show (apparently) very little change when stress conditions increase (e.g., increasing drought), although the inherent conditions do deteriorate (Figure 1). When these conditions pass a critical threshold, a sudden and often irreversible change occurs (Forest collapse). By now it is clear that these apparent stable systems actually do provide information on whether they are likely to tip. This information is hidden in the natural fluctuations that occur in ecosystems. These fluctuations slow down (so called “critical slowing down”) when the system is likely to change. There are several relevant statistical indicators that can be derived from time series of these ecosystems to determine the imminent collapse of a forest, and with that it’s degradation status.

Use of Remote Sensing

These fluctuations can be reconstructed and analyzed using satellite time series. This requires that the revisit time is frequent enough, and the sensors capture the correct forest parameters. Normalized Difference Vegetation Index is a usual suspect in this regard (Figure 2). But many other indices could be tested for their appropriateness. Potential remote sensing sources could be NOAA-AVHRR, MODIS, SPOT or MeteoSat data and many others (Figure 3).

Possible topics

* Compare various stability indicators across landscapes (Figure 4)
* Sensitivity of these indicators over time
* Case studies in Kalimantan (Indonesia), Pleistocene savanna remnants (Gabon), Collapsed forests in Western Australia or other relevant cases that a student can come with.

Requirements

* Programming skills in R or IDL
* Statistical aptitude
* Knowledge of vegetation indices
* Affinity with plant ecology
* Good RS and GIS skills