LANDSAT IMAGE TIME SERIES FOR MONITORING CHANGE IN VEGETATION PHENOLOGY AND DISTURBANCE IN QUEENSLAND, AUSTRALIA

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ABSTRACT:

Knowledge of extent and type of vegetation change at specific spatial and temporal scales is critical for resource management, policy making and ecosystem research. Information on change due to phenological cycles, inter-annual climatic variability, and long term trends cannot be derived from bi-temporal remote sensing change detection methods. Time series analysis techniques can produce such information, but require dense temporal observations, which compel the use of data from lower spatial resolution sensors, e.g. MODIS and AVHRR. However, many ecosystem processes operate at scale below the spatial resolution of those sensors and could be detected at the Landsat Thematic Mapper's scale. While Landsat TM images have spatial and spectral characteristics suited for mapping vegetation properties, its 16 days revisit cycle combined with cloud cover problems, limit the availability of images in desired time interval and duration for time series analysis. The availability of USGS archived Landsat imagery for free and the possibility of using MODIS imagery to fill gaps in Landsat acquisition by means of data fusion technique like Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM), provides an opportunity to create a Landsat image time series (LITS). We define a LITS here as a sequence of Landsat images with best possible level of geometric and radiometric consistency and temporal resolution capable of capturing vegetation phenology. A LITS was produced with observations every 16 days for five years from July 2003, for a Eucalyptus woodland area in Queensland, Australia. Synthetic Landsat TM images were created using STARFM algorithm for all dates when Landsat images were either unavailable or cloudy. Cloud free Landsat TM scenes of closest available dates and MODIS Nadir-BRDF adjusted reflectance (NBAR) collection five were used to create the synthetic images. The synthetic images were used either to fill the cloud gap in the respective images, or directly to be a part of the LITS. A per pixel based analysis of synthetic and original reflectance values of all bands for three different dates showed that the predicted and original reflectance were closely related (mean r2=0.61, 0.78, 0.86, 0.81, 0.90, 0.90 for band 1-5 and 7 respectively). Similar comparison of spectral indices derived from synthetic images and original images for all major vegetation communities also showed a strong relationship (mean r2=0.80). Examination of synthetic images with the original images of earlier and later acquisition dates and comparison of the mean NDVI of original and synthetic images for different vegetation communities across time series demonstrated that synthetic images were able to capture the phenological change. The comparison of the trend and seasonal parameters generated from LITS NDVI with that of MODIS NDVI (MOD13Q1) representing different forest communities showed that LITS NDVI time series were equally capable of capturing the trend and seasonality of vegetation.