

# Tree Stress Study in 2011 and 2014

by Prof. Timothy Warner, Ph.D., West Virginia University

2014 False Color Image Banyan trees (canopy clumps)

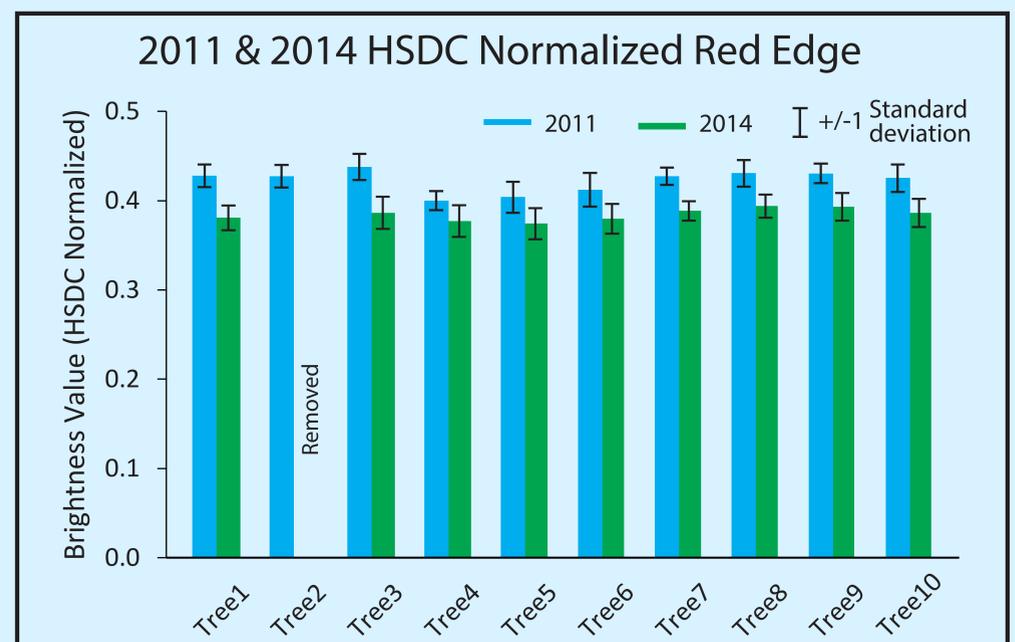
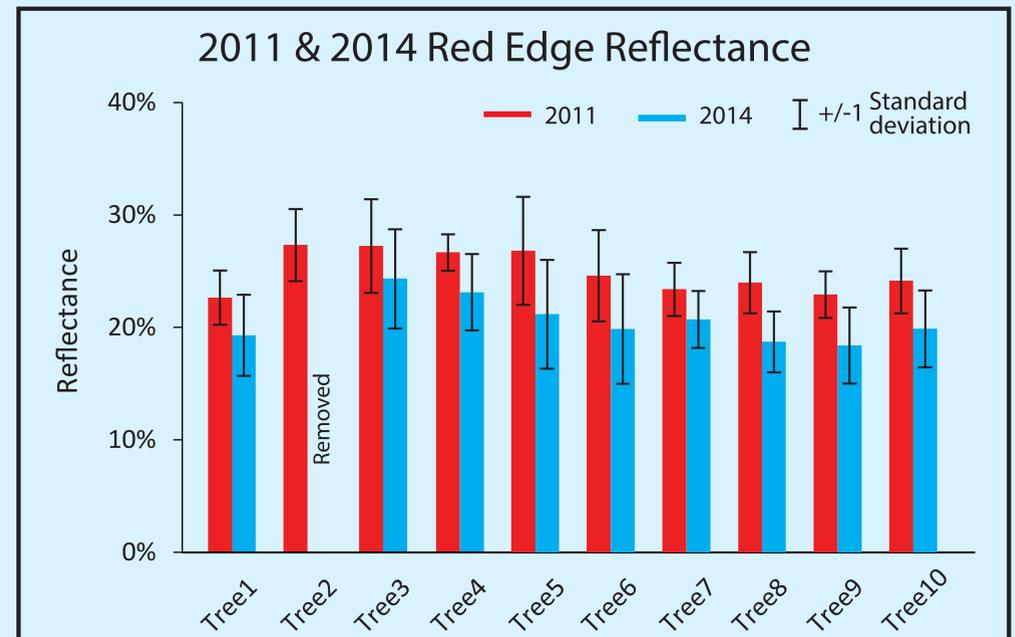


Kowloon Park

2014 Natural Colour Image



Kowloon Park



## Red edge spectral reflectance

The red edge spectral band encompasses a spectral region where vegetation appears to be particularly sensitive to environmental stresses. For example, spectral reflectance in the red edge region has been correlated with elevated levels of heavy metal contamination in urban trees, water stress, and damage from plant pathogens.

One challenge in using any single band, such as the red edge, as a measure of stress, is that the spectral changes due to the stress are likely small. The small changes associated with stress are typically overwhelmed by changes in solar illumination and the incident surface slope-angle effects, including changes due to variations in the angle of the leaves, and varying amounts of self-shadowing due to shade cast by other leaves.

A spectral ratio is an effective way to normalize for effects due to varying illumination conditions. The hyperspherical direction cosine (HSDC) transformation is simply a special type of spectral ratio designed specifically to normalize for illumination variations. Specifically, HSDC is a ratio of a single band (in this case the red edge) with an index that is a combination of all the other bands. Because the HSDC ratio is designed to normalize for illumination variations, the standard deviation of the HSDC brightness values should be smaller than that of the original reflectance values. In summary, the HSDC ratio is an attempt to minimize the illumination signal (which is not of interest) in order to enhance spectral variation, which is assumed to be of interest.

The graphs indicate that with the reflectance data, the range of red edge values for all trees for 2011 and 2014 overlap greatly, as indicated by the +/- 1 standard deviation ranges. In contrast, for the HSDC brightness values, the differences between 2011 and 2014 are much greater, and for 6 of the trees do not overlap at all with the +/- 1 standard deviation ranges.