UNIVERSITY OF TWENTE.

RETRIEVAL OF LEAF AREA INDEX FROM REMOTE SENSING DATA

STATISTICAL APPROACH - PART II: RED EDGE POSITION

TMT Bangladesh

Roshanak Darvishzadeh

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ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

CONTENT

- Red edge definition
- REIP techniques
- 1st derivative
- Linear interpolation
- Gaussian
- Linear extrapolation

RED-EDGE

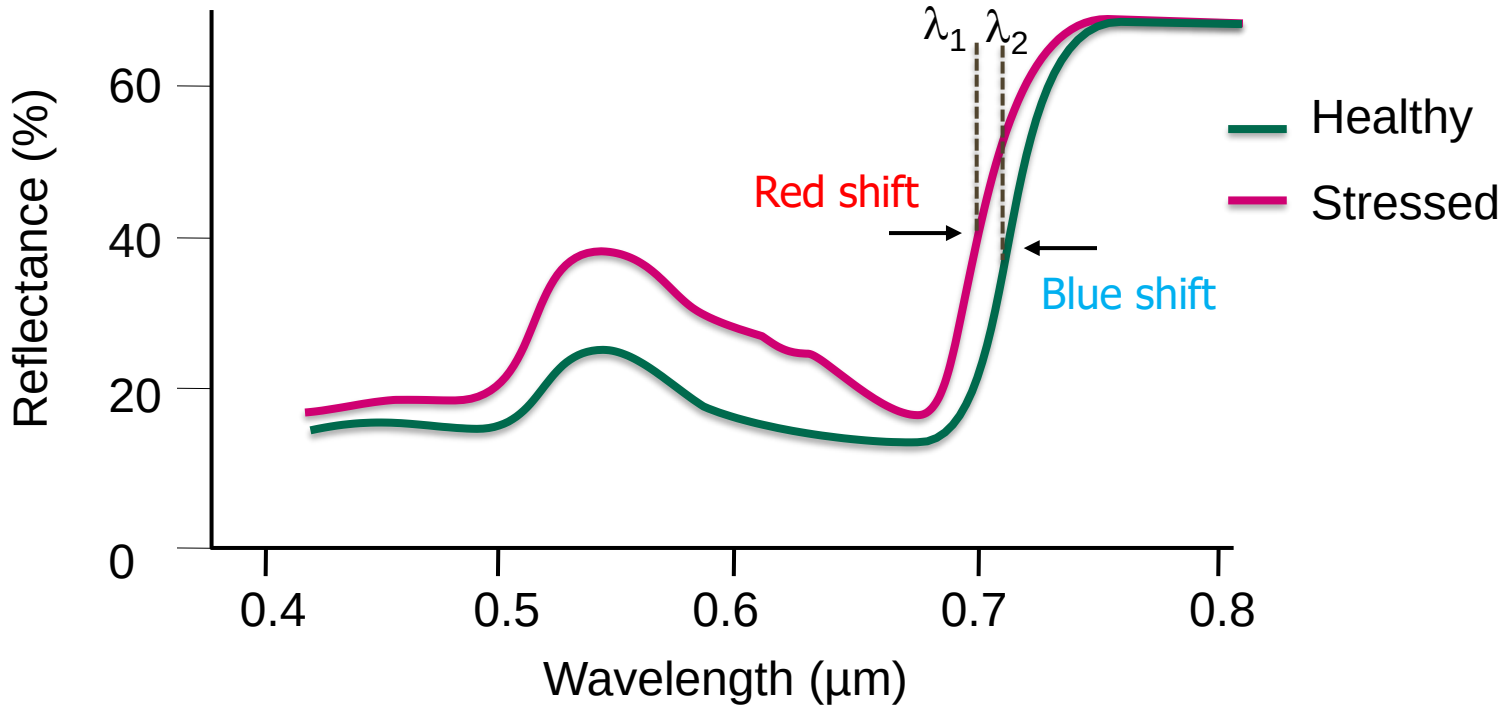
- Red edge of the vegetation spectrum is the sharp slope between the low reflectance in the visible region and the higher reflectance in the near infrared region, around 670-780 nm
- The wavelength which has maximal slope in the red edge (red edge inflection point (REIP), - the shape of the red edge
- Good correlation with biophysical parameters, less sensitive to spectral noise

RED EDGE INFLECTION POINT (REIP)

- The blue and red shift of REIP has been related to plant growth conditions
- REIP highly depends on the amount of chlorophyll, while has been related to many other variables such biomass
- Sensitive indicator of vegetation stress

PRINCIPLE

- REIP shit over time is indicator of stress
- REIP perform better than VI for chlorophyll and many other biochemical components



Based on van der Meer, de Jong, Skidmore

REIP TECHNIQUES

- First derivative (Dawson and Curran 1998)
- Linear interpolation (Guyot and Baret 1988)
- Inverted Gaussian model (Bonham-Carter 1988)
- *The linear extrapolation method* (Cho and Skidmore, 2006)

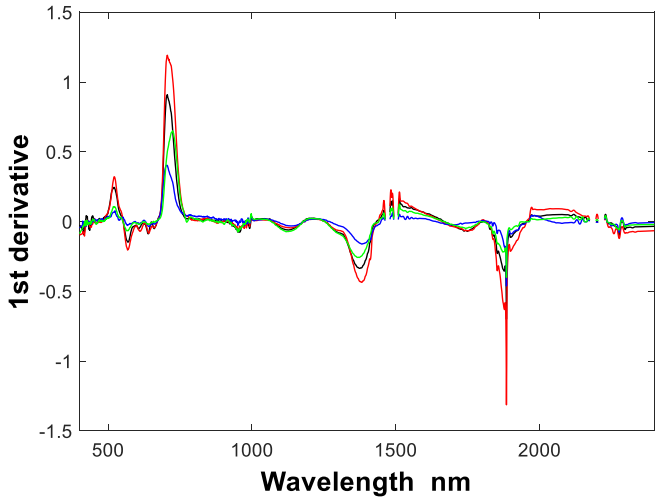
FRIST DIFFERENCE TRANSFORMATION METHOD

- REIP is the wavelength with the greatest first difference

$$FDiff_{\lambda(i)} = \left(R_{\lambda(j+1)} - R_{\lambda(j)}\right) / \Delta_{\lambda}$$

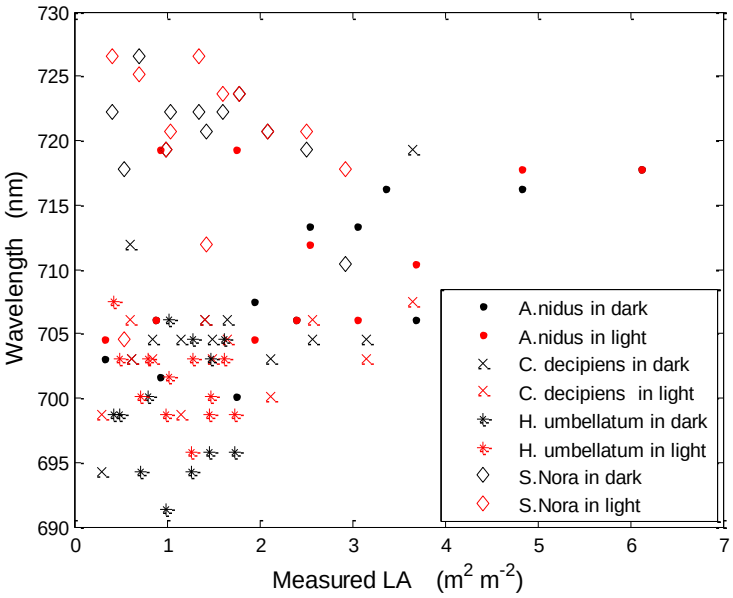
Dawson and Curran 1998)

$$REIP_{FDiff} = \lambda_{\max(FDiff)}$$

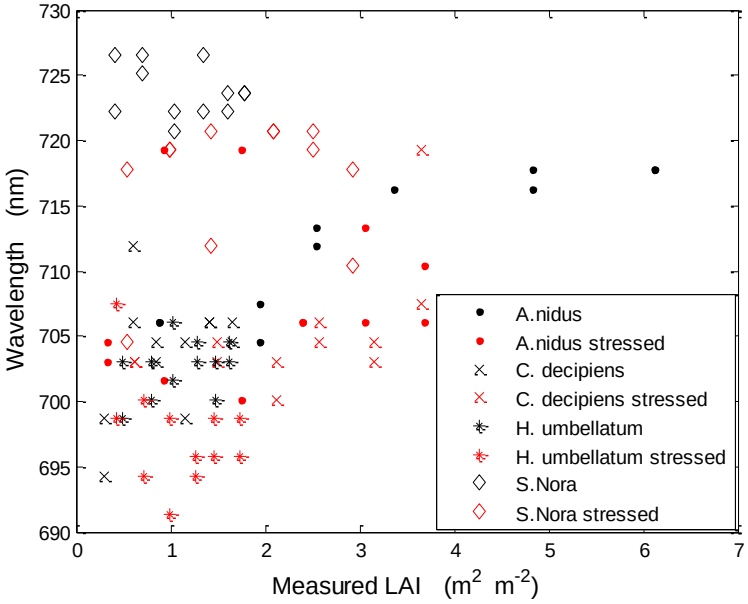


- *FDiff* is the first derivative reflectance at a wavelength i- midpoint between wavebands j and j + 1, R_{λ} is the reflectance, *j* is waveband and Δ_{λ} is the difference in wavelengths between j and j + 1

REIP FROM FRIST DERIVATIVE AND LAI



Different soil backgrounds



Different nutrient status

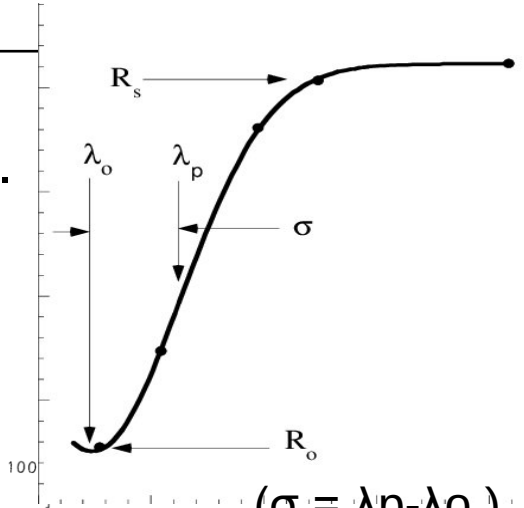
INVERTED GAUSSIAN METHOD

- Fits a Gaussian normal function to the measured reflectance data points between 670 and 800 nm.

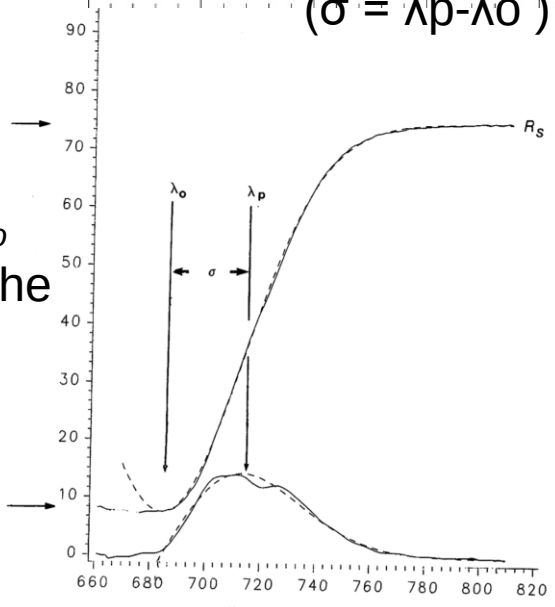
$$R_{estimated}(\lambda) = R_s - (R_s - R_O)\exp\left(\frac{-(\lambda_o - \lambda)^2}{(2\sigma)^2}\right)$$

$$REIP_{IGM} = \lambda_O + \sigma$$ (Bonham-Carter 1988)

- σ is the Gaussian shape width parameter, R_s and R_o are the maximum and minimum reflectance. λ_o is the wavelength with minimum reflectance.



(σ = λp-λo)



Quantitative characterization of the vegetation red edge reflectance 1. An inverted-Gaussian reflectance model, MILLER, et al. 1990 IJRS

LINEAR INTERPOLATION METHOD

- The REP is determined using following equations

$$R_{red-edge} = \left(R_{670} - R_{780}\right)/2$$

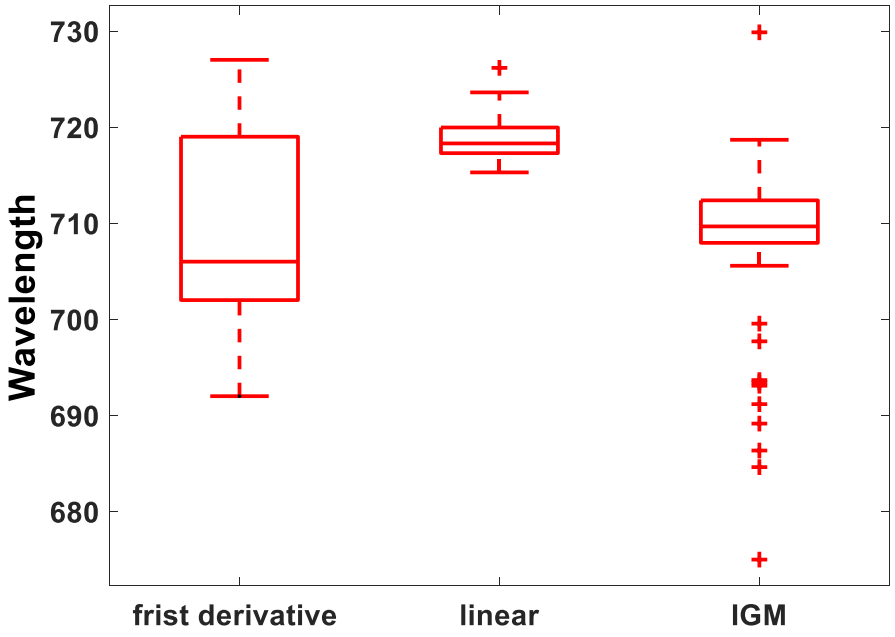
(Guyot and Baret,1988)

$$REIP_{linear} = 700 + 40\left[\frac{R_{red-edge} - R_{700}}{R_{740} - R_{700}}\right]$$

- Constants of 700 and 40 result from interpolation between the 700 -740 nm intervals, and R_{670}, R_{700}, R_{740} and R_{780} are, respectively, the reflectance values at 670, 700, 740 and 780 nm.

REIP CALCULATED FROM DIFFERENT METHODS

- Box plots showing the median, lower and upper quartile values, and extent of the rest of the red edge position (REIP) calculated using three different methods.



LINEAR EXTRAPOLATION METHOD

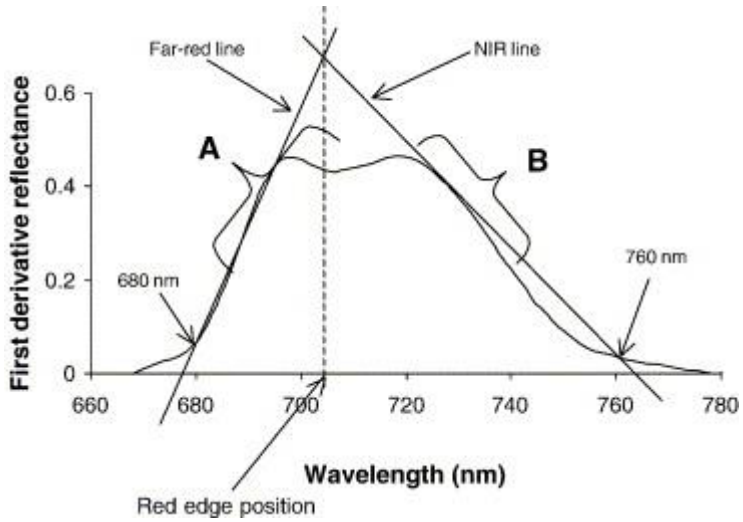
- *Far-red line*: D= $m_1.\lambda+c_1$

(Cho and Skidmore, 2006)

- *NIR line*: D= $m_2.\lambda+c_2$

- *m* and *c* are the slope and intercept of the straight lines. REIP, is the wavelength at the intersection, is given by:

$$RIEP_{LEM} = \frac{-(c_1 - c_2)}{(m_1 - m_2)}$$



REIP AND LAI RELATION IN MEDITERRANEAN GRASSLAND

	Cross-validation for pooled data sets (n=191)*		Training data set (n=127)**		Independent test set (n=64)***	
REIP method	R^2_{cv}	$RRMSE_{cv}$	R^2_t	$RRMSE_t$	R^2_p	**$RRMSE_p$**
Linear interpolation	0.49	0.39	0.52	0.37	0.45	**0.41**
Gaussian	0.52	0.38	0.54	0.36	0.49	**0.39**
Linear Extrapolation	0.51	0.38	0.55	0.36	0.44	**0.41**

SUMMARY

- Different methods for calculation of REIP.
- The REIP calculated from different methods may yield dissimilar results and highly dependent on the choice of methodology.
- RIEP has a good relation with foliar chlorophyll, however, the relation with LAI is poor, especially if several contrasting species are pooled together or a heterogeneous canopy is being investigated, this needs further studies.
- Accuracy in quantitative estimation of a parameter is a factor of measured *in situ* data.