Vegetation Index

Note : Healthy vegetation
Reflects strongly in NIR
Absorpts strongly in RED

Purposes :

(1) Discrimate Vegetation against other land covers, such as soil & water

(2) Discrimate healthy against ill vegetation

Commonly Used Vegetation Index

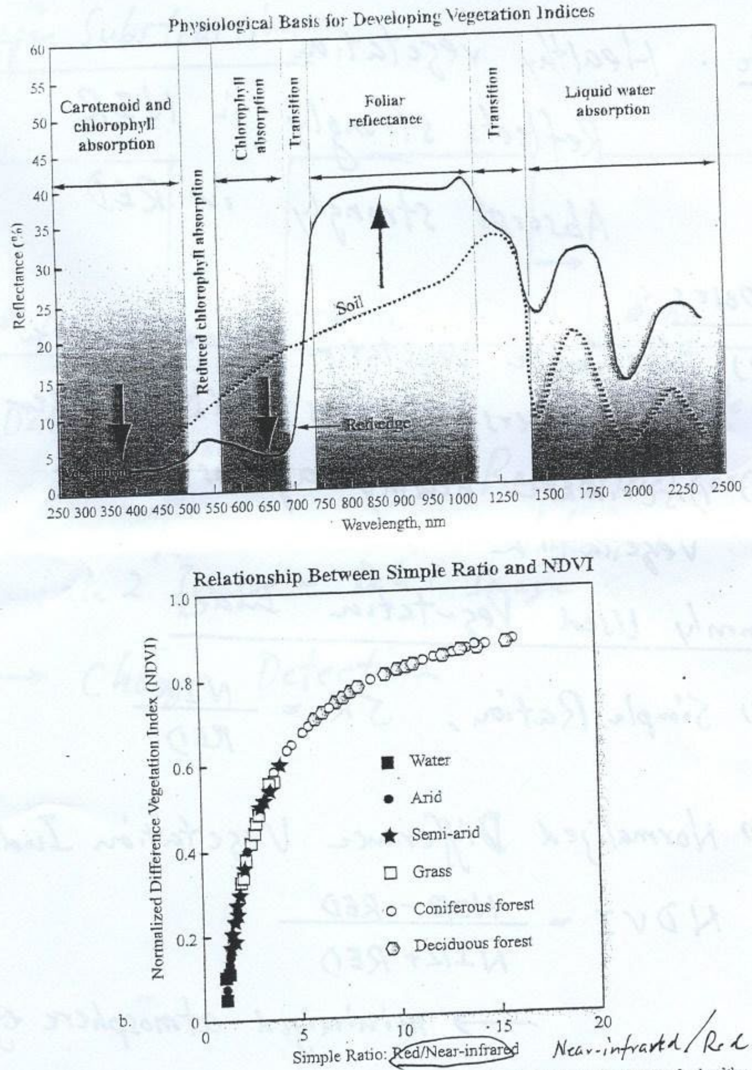
(1) Simple Ration, $SR = \frac{NIR}{RED}$

(2) Normalized Difference Vegetation Index

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

$\longrightarrow$ minimized atmosphere effect

7.6.12



Near-infrared/Red

Figure 11-21 a) Physiological basis for developing vegetation indices. Typical spectral reflectance characteristics for healthy green grass and bare dry soil for the wavelength interval from 250 to 1,000 nm. b) The NDVI is a normalized ratio of the near-infrared and red bands. The NDVI is functionally equivalent to and is a nonlinear transform of the simple ratio (adapted from Huete et al., 2002b).

4.6.2'

4.6.3

Principle Component Analysis (PCA)

I. Some correlations between pairs of spectral bands, i.e., redundant information contents between bands

II. Objectives

(1) Find a new set of components, such that no correlation between pairs of component

(2) Reduce the numbers of bands in the data

(3) Image enhancement (~~see next section~~)

Original N bands → First 3 Principal Component → Color Image (enhanced)

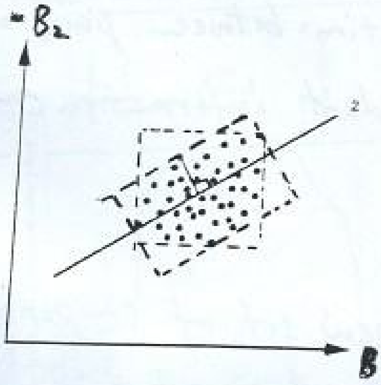


Figure 10.8.1 Example of principal component analysis

Scatter Plot

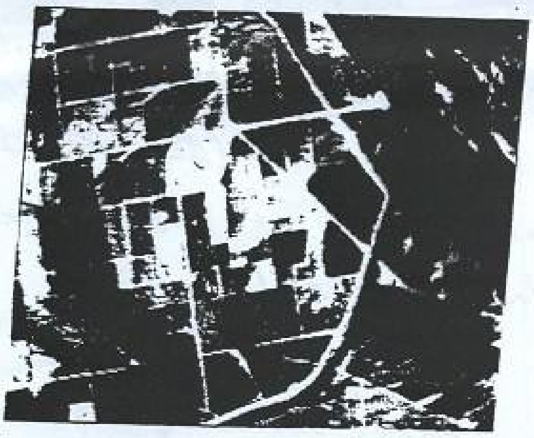


Figure 10.8.2 principal components and their color composite of LANDSAT TM

(Murai)

PCA Procedures

Given: No. of Bands = L

Image Size : M pixels × N lines

I. Covariance Matrix

Mean $\bar{X}_i = \dfrac{\sum_m^M \sum_n^N DN_i(m,n)}{M \cdot N} \quad i = 1, L$

Variance $\sigma_{ii}^2 = \sum_m^M \sum_n^N (DN_i(m,n) - \bar{X}_i)^2 / MN, \quad i = 1, L$

Covariance $\sigma_{ij}^2 = \dfrac{\sum_m^M \sum_n^N (DN_i(m,n) - \bar{X}_i)(DN_j(m,n) - \bar{X}_j)}{MN} \quad i = 1, L$

$\sigma_{ij}^2 = \sigma_{ji}^2$

Covariance Matrix $\underline{\sigma} = \begin{bmatrix} \sigma_{11}^2 & \sigma_{21}^2 & \cdots & \sigma_{L1}^2 \\ \sigma_{12}^2 & \sigma_{22}^2 & \cdots & \sigma_{L2}^2 \\ \vdots & & & \\ \sigma_{1L}^2 & \sigma_{2L}^2 & \cdots & \sigma_{LL}^2 \end{bmatrix}$

$\sigma_{ij}^2 \neq 0 \rightarrow$ Corelation between Band i & j

II. Find Eigen-value

$\text{Det}[\underline{\sigma} - \lambda] = 0, \rightarrow \lambda_1 > \lambda_2 \cdots > \lambda_L$

Principal Components $\sigma_{pc1}^2 = \lambda_1 \cdots \sigma_{pcL}^2 = \lambda_L$

III Information Content

$= \sum_{i=1}^{L} \sigma_{ii}^2 = \sum_{i=1}^{L} \sigma_{pci}^2$

4.6.6

Ⅳ PCA Transformation

$$\begin{bmatrix} PC_1 \\ PC_2 \\ \vdots \\ PC_L \end{bmatrix} = \begin{bmatrix} a_{11} & a_{21} & \cdots & a_{L1} \\ a_{12} & a_{22} & \cdots & a_{L2} \\ \vdots & & & \\ a_{1L} & a_{2L} & \cdots & a_{LL} \end{bmatrix} \begin{bmatrix} DN_1 \\ DN_2 \\ \vdots \\ DN_L \end{bmatrix}$$

⟹ Covariance Matrix becomes "Diagonal"

i.e. $\begin{bmatrix} \lambda_1^2 & 0 & 0 & \cdots \\ 0 & \lambda_2^2 & 0 & \\ \vdots & & \ddots & \\ & & & \lambda_L^2 \end{bmatrix}$

Transformation Matrix $\underline{\underline{P}}$

$\underline{P} \cdot \underline{\sigma} \cdot \underline{P}' =$

(Transpose)

Accuracy Assessment

Error (Confusion) Matrix

Randomly Sampled Test
~~Training~~ Set Data (Known Cover Types)

Classification Data

	W	S	F	U	C	H	Row Total	C.E.
W	480	0	5	0	0	0	485	1%
S	0	52	0	20	0	0	72	28%
F	0	0	313	40	0	0	353	11%
U	0	16	0	126	0	0	142	11%
C	0	0	0	38	342	79	459	25%
H	0	0	38	24	60	359	481	25%
Column Total	480	68	356	248	402	438	$\boxed{1992}$	
O.E.	0%	24%	12%	49%	15%	18%		84%

↑
O.A.

Cover Types: W, Water ; S, Sand ; F, Forest ;
U, Urban ; C, Corn ; H, Hay

C.E. : Commission Error, O.E. : Omission Error

x_{i+} = Row Total in Class i

x_{+i} = Colum Total in Class i

$C.E(i) = (1 - x_{ii} / x_{i+}) \times 100\%$

$O.E(i) = (1 - x_{ii} / x_{+i}) \times 100\%$

Overall Accuracy $= (\sum_{i=1}^{r} (x_{ii}) / \text{Total Pixels}) \times 100\%$

4.7.1