REMOTE SENSING AND GIS

C2 ASSIGNMENT-2

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1. **Explain the logic and concept behind the formulation of a spectral index. Also discuss the role of spectral indices in Remote Sensing.**

Solution :

Spectral Index

Concept: Combinations of spectral reflectance from two or more wavelengths that show the relative abundance of features of interest are known as spectral indices.

Spectral index: A mathematical equation that is applied on the various spectral bands of an image per pixel[1] is known as spectral index.

An image that shows an area of 100km X 100km translates to approximately 10 X 10 pixels for a band having 10m spatial resolution. Half by half for the bands that have 20 meters spatial resolution, etc.

If the number of spectral bands is n, each pixel is described by n numbers. A spectral index is calculated using some of these values (depends on the specific index) in a mathematical formula.

Normalized difference formula: ***(Bx - By)/(Bx + By)***

Normalized difference is practically the difference between two selected bands normalized by their sum. This type of calculus is very useful to minimize (as much as possible) the effects of illumination (shadows in mountainous regions, cloud shadows, etc) and enhance spectral features that are not visible initially.

Following are numerous different equations that can be applied on the spectral to produce a

spectral index.

I. Normalized Difference Vegetation Index (NDVI)

This enhances the vegetation and more specifically the healthy vegetation. The spectral response of vegetation (crops, forests, bushes, etc) shows a huge increase of the reflection percentage from 700nm to 1000nm.

The main ingredient for this increase in reflection is the chlorophyll mostly located in the plant leaves. On the contrary, land (soil, urban structures) without vegetation, according to the type of surface, has a continuous linear behaviour. Beside the determination between the vegetation and other objects it allows to detect the vitality of the vegetation.

NDVI calculation: ***NDVI = (Bnear_IR - Bred) / (Bnear_IR + Bred)***

where Bnear_Ir is the value of the pixel at the near infrared band and Bred is the value of the pixel located at the red part of the spectrum.

Range(NDVI) = [-1, 1], where

NDVI closer to -1 corresponds to water, 0 corresponds to barren areas of rock, sand or snow. NDVI > 0.2 implies vegetation.

II. Normalized Difference Water Index (NDWI)

This index is highly related to water bodies. It is highly correlated to being a measure of liquid water molecules in vegetation canopies that interacted with the incoming solar radiation. NDWI is sensitive to changes in liquid water content of vegetation canopies. It is less sensitive to atmospheric effects than NDVI. NDWI does not completely remove the underlying effects of soil.

NDWI is considered to be complentary to NDVI and usually they are both used in order to extract conclusions.

NDWI calculation: ***NDWI = (Bnear_IR - Bmiddle_IR) / (Bnear_IR + Bmiddle_IR)***

where Bnear_Ir is the value of the pixel at the near infrared band and Bmiddle_IR is the value of the pixel located at the mid infrared part of the spectrum.

Range(NDWI) = [-1, 1], where
NDWI > 0.2 are considered either water saturated soils, flooded areas or water bodies. NDWI can be used to quickly detect water presence by just applying a threshold[2].

Role in Remote Sensing

Spectral Indices in Remote Sensing are used for:

- Water Stress Levels Detection
- Chlorophyll Content Measurement
- Variance Detection of Green Percentage of crops
- Crop Types Discrimination
- Detection of Moisture Levels
- Extraction of biochemical variables like nitrogen and lignin
- Variation on pigmentations leaves
- Improvement in vegetation changes detection

All this happens without any contact with the above mentioned objects.

Different Vegetation Indices are used in different environments since they have their own variable characteristics. Some of the spectral indices used to analyse vegetation accurately are:

1. **Normalized Burn Ratio (NBR) :** Use NBR index for agriculture and forestry is detection of active fires, analysis of burn severity, and monitoring of vegetation survival after the burn[3].
2. **Enhanced Vegetation Index (EVI)[5] :** EVI is used for analyzing areas of Earth with large amounts of chlorophyll (such as rainforests), and with minimum topographic effects.
3. **Soil-Adjusted Vegetation Index (SAVI) :** Uses of SAVI consist of analysis of young or early sown crops, for arid regions with sparse vegetation and exposed soil surfaces.
4. **Chlorophyll Index (CI) :** CI is used in identification and addressing of nutrient deficiencies in-season, Informing early yield predictions in row crops, identification of plant stress and nutrients deficiencies.
5. **Modified Soil-adjusted Vegetation Index (MSAVI) :** In the fields where plants have just been sown, it allows farmers to monitor the crop conditions at their earliest developmental stages and help them with early opportunities to apply fertilizers only

REFERENCES

[1] https://www.l3harrisgeospatial.com/docs/spectralindices.html

[2]https://www.geo.university/pages/spectral-indices-in-remote-sensing-and-how-to-interpret-them

[3]http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S1909-836720190002000051

[4]https://www.satpalda.com/blogs/significance-of-spectral-indexes-in-accurate-vegetation-analysis

[5]https://en.wikipedia.org/wiki/Enhanced_vegetation_index