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Development of Spectral Index for Discriminating Degraded Lands

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A study was conducted to characterize the spectral variability of degraded lands in Agro Ecological Zone 4.1 of Tamil Nadu uplands and to develop spectral indices to distinguish stages of land degradation. In this study, Spectroradiometer GER 1500 was used for recording the spectral reflectance values of degraded lands from 400 to 1050 nm in various locations representing different types of degraded lands in the study area. A spectral index was identified for discriminating different levels of land degradation. Among the locations, the degraded status of lands was found to be of four different categories, *viz*., waste lands – open scrub, dense scrub, and slightly salt affected and moderately salt affected. It was observed that there is a difference between spectral reflectance values and various levels of degraded lands. It was also observed that the ratio of reflectance at 760 and 675 nm has given a better difference in the determination of various types of degraded lands.

Key words: Spectral reflectance, Degraded lands, Spectroradiometer

Land degradation is an ever-increasing problem in our mother earth. Land degradation is increasing in severity and extent in many parts of the world, with more than 20% of all cultivated areas, 30% of forests and 10% of grasslands undergoing degradation (Bai *et al*., 2008).

Soil physical degradation is a major environmental problem throughout the world due to its negative impact on biomass and economic production. Identification, delineation and classification of various environmental features through remote sensing data visually require an understanding of their spectral response in different parts of the electromagnetic spectrum. Moreover, study and compilation of spectral signatures provides with the choice of selecting the spectral bands for differentiating various land features. Hence, there is a grave need to understand the problems of land degradation in a better manner and to use remote sensing technology to study the reasons leading to land degradation, and categorize various types of land degradation, so as to provide suitable management solutions. There are a number of studies conducted in relation to the usage of remote sensing technology for land degradation assessment. Pramila Raina *et. al.* (1993) mapped the kind, extent, and severity of degradation processes using remote sensing in medium textured alluvial plain soils of arid regions in Rajasthan. Rao *et.al.* (1995) studied the spectral behavior of few typical salt-affected soils of the Indo-Gangetic alluvial plains of India. The study was conducted with ground-based spectral measurements with the field radiometer. The observations revealed that salt-affected soils had showed relatively greater spectral response in the visible and near-infrared regions of the spectrum as compared to normal cultivated soils.

Haboudane *et. al.* (2002) used remote sensing techniques to characterize land degradation and concluded that the spatial distribution of regional patterns of land degradation can be reliably mapped by using spectral indices describing the spectrum shape and spectral unmixing.

Shrestha *et. al.* (2005) conducted a study in which, imaging spectrometer data was used to detect and map desert-like surface features. Absorption feature parameters in the spectral region between 0.4 and 2.5 ìm wavelengths were analysed and correlated with soil properties such as soil colour, soil salinity, gypsum content, *etc*. Soil groupings were made based on their similarities and their spectral reflectance curves were studied. Distinct differences in the reflectance curves throughout the spectrum were exhibited between groups. Remotely sensed imagery is good at revealing the land that has been affected by degradation to various degrees (Gao and Liu, 2008). Spectral indices have been used to monitor a variety of land change processes. Keeping these points in mind a study was attempted to discriminate degraded lands with the help of ground based spectro-radiometer.

Materials and Methods

In this study, Spectroradiometer GER 1500 was used for obtaining the spectral reflectance values of

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degraded lands from 400 to 1050 nm in various locations representing different types of degraded lands in the study area. GER 1500 is field portable spectroradiometer covering ultra violet, visible and near infrared wavelengths from 350 to 1050 nm. A reflectance measurement takes the scan of a reference (white plate) and ratios the target scan to that reference. Multiple measurements were taken and averaged to provide a true picture of the spectral variability over a fixed point in space. Reflectance readings were measured when the sun reached the peak in the sky to minimize the effects of shadowing and solar zenith changes. Two hours on either side of solar noon was preferred.

Using Spectroradiometer GER 1500, spectral reflectance values of degraded lands was collected at different locations of AEZ 4.1 of Tamil Nadu uplands. Totally 23 locations were observed in this study and the types of these locations is provided in Table 1. Fig. 1 shows the locations where the spectral reflectance data was observed.

The spectral reflectance values at various bands were compared to evolve a suitable index to differentiate the degraded lands in the study area.

Results and Discussion

Spectral reflectance curves of different degraded lands were plotted for observing the differences among them. The curves behaved almost similarly except for steepness found in the moderately

Table 1. Location with their types of land degradation

Location	Land Degradation Type
Bolampatti	Wastelands - Scrub land - Open scrub
Bolampatti	Wastelands - Scrub land - Open scrub
Bolampatti	Wastelands - Scrub land - Open scrub
Anuvavi	Wastelands - Scrub land - Open scrub
Anuvavi	Wastelands - Scrub land - Open scrub
Anuvavi	Wastelands - Scrub land - Open scrub
PN Palayam	Wastelands - Scrub land - Dense scrub
SS Kulam	Wastelands - Scrub land - Dense scrub
Maruthamalai	Wastelands - Scrub land - Dense scrub
Maruthamalai	Wastelands - Scrub land - Open scrub
Maruthamalai	Wastelands - Scrub land - Open scrub
Palladam	Wastelands - Scrub land - Open scrub
Palladam	Wastelands - Scrub land - Open scrub
Palladam	Wastelands - Scrub land - Dense scrub
Kamanaicken palayam	Wastelands - Scrub land - Open scrub
Kamanaicken palayam	Wastelands - Scrub land - Open scrub
Maluchampatti	Wastelands - Scrub land - Open scrub
Maluchampatti	Wastelands - Salt affected land - Moderate
Maluchampatti	Wastelands - Salt affected land - Moderate
Karacheri	Wastelands - Salt affected land - Moderate
Vadasithur	Wastelands - Salt affected land - Moderate
Senjerimedu	Wastelands - Salt affected land - Slight
Maluchampatti	Wastelands - Salt affected land - Slight

degraded lands.Hence, an attempt was made to derive an index for the spectral reflectance values collected at two different wavelengths.

After observing various ratios of spectral

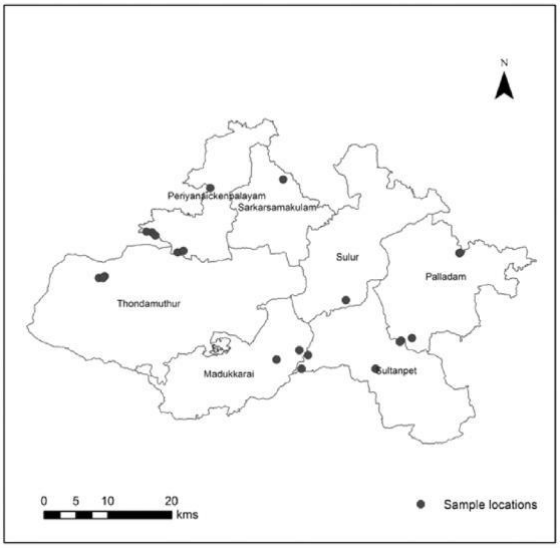

Fig. 1. Locations of spectral reflectance data observations

reflectance values at different wavelengths, it was found that (as shown in Table 1) the ratio of

Table 2. Mean and standard deviation of ratio of reflectance at 760 and 675 nm for various degraded lands

Degraded land	Mean	SD
Wastelands - Scrub land - Open scrub	1.275439	0.334124
Wastelands - Scrub land - Dense scrub	1.374712	0.404478
Wastelands - Salt affected land - Moderate	1.472739	0.509982
Wastelands - Salt affected land - Slight	1.235058	0.017151

reflectance at 760 and 675 nm has given a better difference in the various types of degraded lands. Hence, this ratio can be used for differentiating slight and moderately degraded lands.

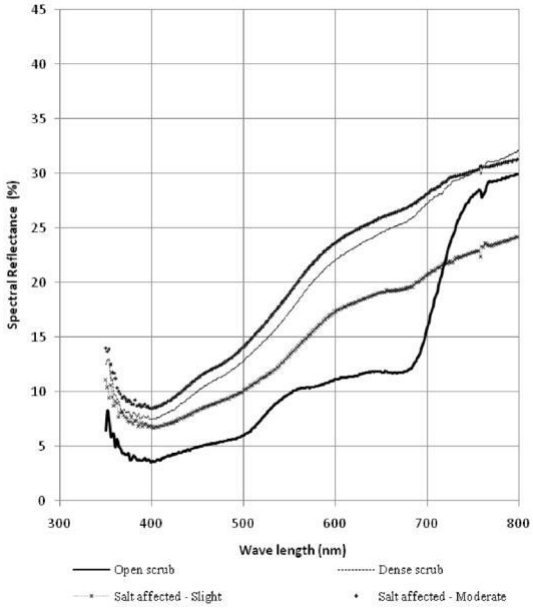

Fig. 2 Spectral reflectance curves for different types of degraded lands

Conclusion

Spectral indices have been used to monitor a variety of land change processes. A spectral index was identified for discriminating different levels of land degradation. Among the locations, the degraded status of lands was found to be of four different categories, *viz*., waste lands – open scrub, dense scrub, slightly salt affected and moderately salt affected. It was observed that there is a difference between the spectral reflectance values and various levels of degraded lands. It was also observed that the ratio of reflectance at 760 and 675 nm has given a better difference in the various types of degraded lands. This ratio could be used for differentiating slight and moderately degraded lands.

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