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COMPARITIVE ANALYSIS OF DIFFERENT VEGETATION INDICIES FOR THE ASSESSMENT OF TEA GARDENS

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Abstract—*Principle objective of Image Enhancement is to process an image so that the result is more suitable then original image for specific application. Digital image enhancement techniques provide a multitude of choices for improving the visual quality of images. This paper will provide a comparative analysis of different existing vegetation enhancement indices with respect to the visual interpretation and analysis of Tea Gardens of Assam (Barak Valley). Different vegetation indices used in present study are Normalized Differential Vegetation Index (NDVI), Infrared by Red Ratio (IR/R), Difference Vegetation Index (DVI), Soil and Atmospherically Resistant Vegetation Index (SARVI), Soil-Adjusted Vegetation Index (SAVI), Transformed Normalised Vegetation Index (TNDVI), and Randomised Differential Vegetation Index (RDVI). Each index is analysed quantitatively and visually. On the basis of statistical analysis, Transformed Normalised Difference Vegetation Index (TNDVI) with the lowest RMSE (0.224) is proposed as most efficient index for the study of Tea garden biomass estimation.*

Keywords: *Image Enhancement, Vegetation Indices, RMSE, Tea Garden.*

1. INTRODUCTION

Hallada and Cox (1983) applied Brovey transformation for image sharpening for mixed spatial and spectral resolution satellite data. Carper *et al.* used intensity-hue-saturation transformations for merging SPOT panchromatic and multispectral image data [4]. Shettigara applied component substitution technique for spatial enhancement of multispectral images using a higher resolution data set [28]. Sohn & Downman applied data fusion techniques of high resolution satellite images [30]. Gurjar & Padmanabhan have used various re-sampling techniques on high-resolution remote sensing images for enhancement of features [14]. Ranchin & Wald, Shetty *et al.*, & Franklin demonstrated multi-resolution data fusion techniques emerging as key visualization tools as well as providing improvement in classification accuracy [25, 31 10]. Amolins *et al.* applied wavelet based image fusion technique [1]. Ranchin & Wald have fused high spatial and spectral resolution images [26]. Zhang & Hong used IHS wavelet integrated approach to improve visual quality of PAN sharpening of natural color IKONOS and Quick Bird images [38]. Coskum & Musaoglu have stated that Intensity-Hue-Saturation transformation model is one of most often used in merging multi-sensor/ multi-resolution data [6]. Chavez *et al*. found that the IHS and HPF data fusion methods produced some of best results [5].Maul & Qualset & Gilliispe demonstrated image enhancement and their advantage and limitations [22, 12]. Duda & Hart, Lee, Frost *et al.* & Schowengerdt applied spatial filtering for image enhancement [8, 19, 10]. Vegetation indices have advantage of reducing effect of solar irradiance, atmospheric influence and spectral contribution of soils to vegetation [13]. Knipling, Viollier *et al*., Rouse *et al.,* Tucker and Perry and Lautenschlager applied physical and physiological based ratio for the reflectance of visible and near infrared radiation from vegetation [18, 36, 28, 35, 24]. Vegetation indices have been applied for crop yield estimation and modeling by Singh *et al.* Ray *et al*., Manjunath and Potdar, Deosthali and Akmanchi, Mukherjee and Sastri and Badarinath *et al.* [32, 27, 21, 7, 23, 3]. Geerkeen *et al* .classified rangeland vegetation type coverage using NDVI [11]. Comparison of vegetation indices has been done by Jaishanker *et al.* [16].

Digital enhancement of an image is essentially improving the analysis and interprets- ability of images for viewers. It plays an imperative part in digital image processing [34]. Accurate identification & verification of objects are frequently needed in day-to-day life, with high precision [2], image enhancement plays a vital role in it. Image enhancement aims at modifying attributes of an image to make it more suitable for a given task and for specific observer [20]. The enhancement techniques can extensively be partitioned into the accompanying two classifications: spatial domain and frequency domain techniques. In spatial domain, we specifically manage the image pixels values by manipulating, to accomplish desired enhancement. While during frequency domain method, orthogonal transform of an image is manipulated instead of the image itself [17].

The paper focuses on the comparison between different vegetation indices of spatial domain propounded by different scientists. In spatial domain techniques (2), we directly deal with image pixels. The pixel values are manipulated to achieve desired enhancement. In this paper six different types of vegetation indices i.e. NDVI (Normalized difference vegetation index), SAVI (Soil and adjusted vegetation index), SARVI (Soil and Atmospherically resistant vegetation index), Infrared by Red Ratio (IR/R), DVI (Difference vegetation Index), TNDVI (Transformed Normalised difference vegetation index) and RDVI (Randomised differential vegetation index) are compared based on objective image quality measure, RMSE (Root mean square error). Such a measure will be useful in determining the best suited vegetation indices for Tea garden.

2. MATERIAL AND METHODS

2.1 Study Area

Barak Valley is located in the southern region of the Indian state of Assam. The main city of the valley is Silchar. The region is named after the Barak River. The Barak valley mainly consists of three administrative districts of Assam State - namely Cachar, Karimganj, and Hailakandi. The Barak Valley region is located between longitude 92° 15/E and 90° 15/ E and 24° 8/N and 25° 8/ N & covers an area of 6922 Sq.Km. The valley has very gentle slope of average height of 20 meters above mean sea level & is a heterogeneous land of high hills, low lands and level plains. The general climate of Barak Valley is neither too hot nor too cold, it is rather humid during summers, in which the minimum temperature reads somewhere around 22° C and maximum temperature goes up to 35° C. The Barak Valley is mainly agriculture oriented and about 66% of the working population depends on agriculture for maintaining their livelihood amongst which tea gardens are main source. In 2005 it was noted that there were 198 tea gardens with 31894 hectares area under tea cultivation. Hence, our study area entirely focuses on these tea gardens.

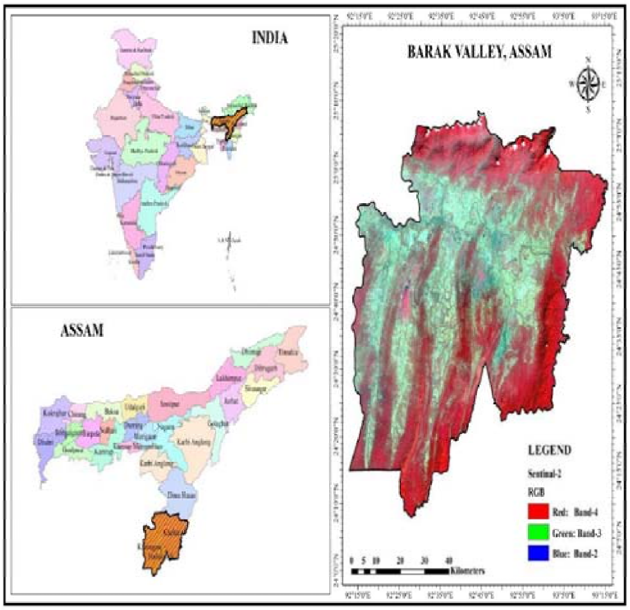

Fig.No. 1 Study Area

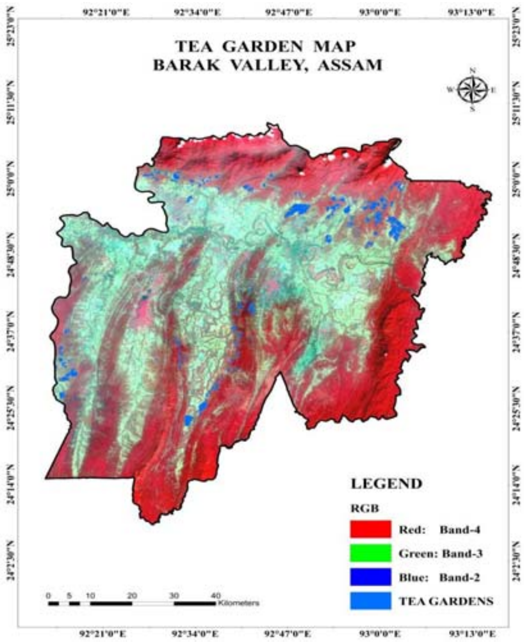

Fig. No. 2 Satellite Image of Tea Garden

2.2 Satellite Data

The Sentinel 2A satellite's multispectral imager covers 13 spectral bands with a swath width of 290 km and spatial resolutions of 10 m and 60 m. The Satellite images used in this study were acquired on 30th March 2018 which was obtained from Land viewer (a cloud service developed by EOS Data Analytics) for the analysis of vegetation indices.

Table No. 1 Bands of Sentinal-2A Satellite

Sentinel-2 Bands	Sentinel-2A		
	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
Band 1 – Coastal aerosol	442.7	21	60
Band 2 – Blue	492.4	66	10
Band 3 – Green	559.8	36	10
Band 4 – Red	664.6	31	10
Band 5 – Vegetation red edge	704.1	15	20
Band 6 – Vegetation red edge	740.5	15	20
Band 7 – Vegetation red edge	782.8	20	20
Band 8 – NIR	832.8	106	10
Band 8A – Narrow NIR	864.7	21	20
Band 9 – Water vapor	945.1	20	60
Band 10 –SWIR – Cirrus	1373.5	31	60
Band 11 –SWIR	1613.7	91	20
Band 12 –SWIR	2202.4	175	20

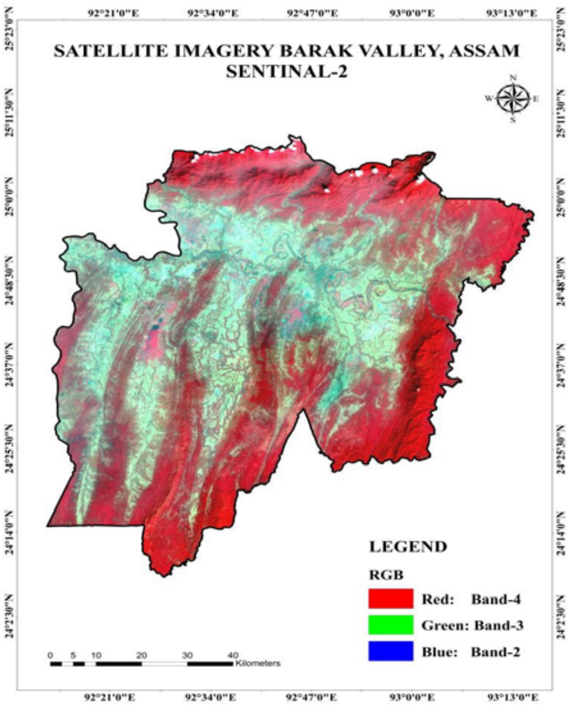

Fig. No. 3 Satellite Image of Barak Valley, Assam via Sentinal-2

2.3 Vegetation Indices

The reason for using vegetation index is to highlight vegetation cover detail in image and making image more visually appealing. In the present study to find out the best vegetation index based on image quality measure for the mountain ecosystem following 6 types of indices were performed:

Table No. 2 Formulas Various Vegitation Indices used

INDICES	FORMULA
Difference Vegetative Index (DVI)	NIR - R
Randomised Difference Vegetation Index (RDVI)	(NIR - R)/ SQRT(NIR+R)
Infrared Divide By Red (IR/R)	IR/R
Soil Adjusted Vegetation Index (SAVI)	(NIR – R) * (1+L)/ (NIR+R) * (3+L)
Soil & Atmospherically Resistant Vegetation Index (SARVI)	(NIR – RB) * (1+L)/ (NIR+RB+L) RB=Red – Gamma * (Blue - Red
Transformed Normalised Difference Vegetation (TNDVI)	SQRT ((NIR – R)/(NIR+R) + 0.5)
Normalised Difference Vegetation Index	(NIR – R)/ (NIR+R)

2.4 Image Quality Measure

Image quality measure is essential for most image processing application. It is the characteristic of an image that measures the perceived image degradation compared to an ideal or perfect image. There are two types of image quality measure subjective & objective quality measure. Objective measurements are performed with mathematical algorithms. The simplest and most widely used full reference quality metric is the root mean square error (RMSE).

Root Mean Square Error (RMSE)

Root mean square error (RMSE) is also known as those root mean square deviation (RMSD). Every now and again utilized measure of the distinction the middle of values predicted eventually the values are really watched from nature that is constantly modeled. RMSE measures the extent to which slip there is the middle of two datasets. RMSE typically compares a predicted quality and as well as observed value. The most important aspect in RMSE is that Lower RMSE values provide higher quality of image.

3. RESULTS

Indices :

Seven different indices with respect to vegetation were prepared during the study. The spectral variables were extracted using ARCGIS. Images of all the indices are presented below.

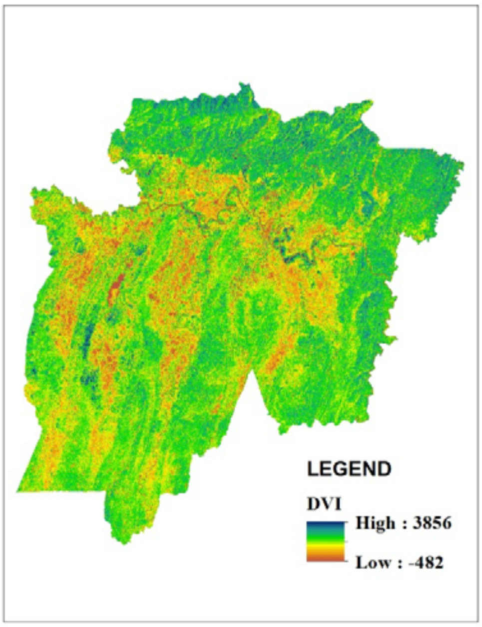

Fig No.4 Difference Vegetative Index (DVI)

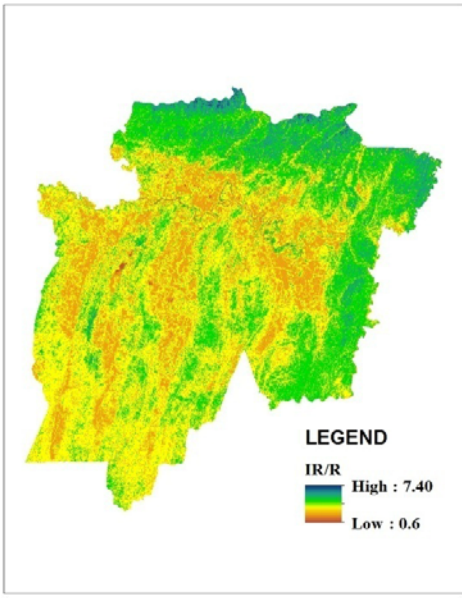

Fig No.5 Infrared Divide by Red (IR/R)

Minimum and maximum values of each indices are as shown in table no. 3. All the vegetation indices were compared on the basis of Root Mean Square Error (RMSE), as shown in figure no. 11. TNDVI is the most adequate index for the assessment of tea gardens with the RMSE value of 0.224.

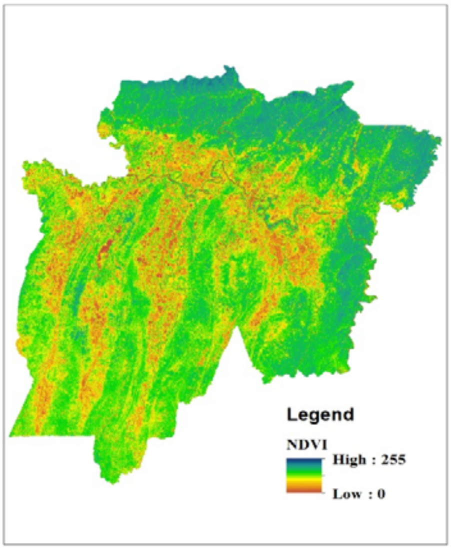

Fig No. 6 Normalised Difference Vegetation Index (NDVI)

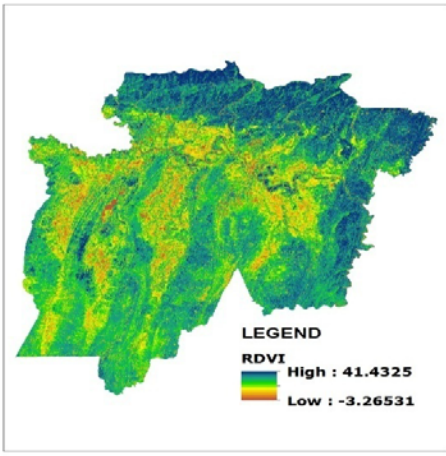

Fig No. 7 Randomised Difference Vegetation Index

Table No. 3 Min and Max Values of Each Indices.

INDICES	Min	Max
Difference Vegetative Index (DVI)	-482	3856
Randomised Difference Vegetation Index (RDVI)	-3.26	41.43
Infrared Divide By Red (IR/R)	0.6	7.40
Soil Adjusted Vegetation Index (SAVI)	-0.79	4.01
Soil & Atmospherically Resistant Vegetation Index (SARVI)	-0.27	1.63
Transformed Normalised Difference Vegetation (TNDVI)	0.5	0.51
Normalised Difference Vegetation Index	0	255

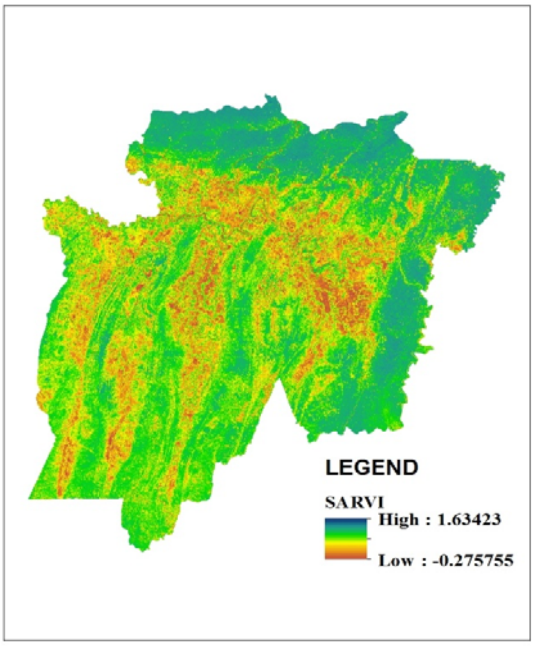

Fig No. 8 Soil & Atmospherically Resistant Vegetation Index (ARVI)

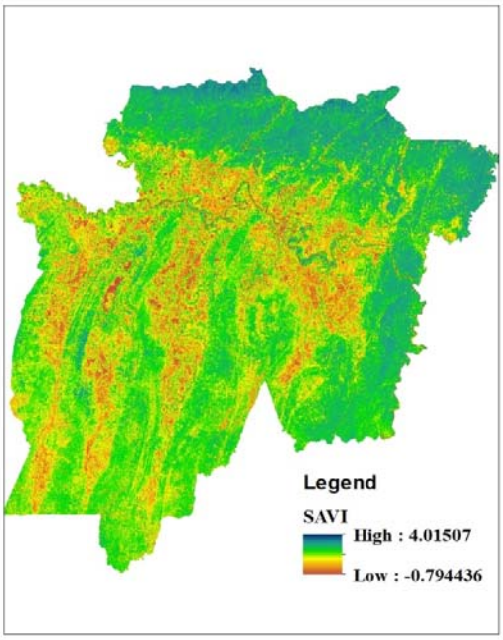

Fig No. 10 Soil Adjusted Vegetation Index (SAVI)

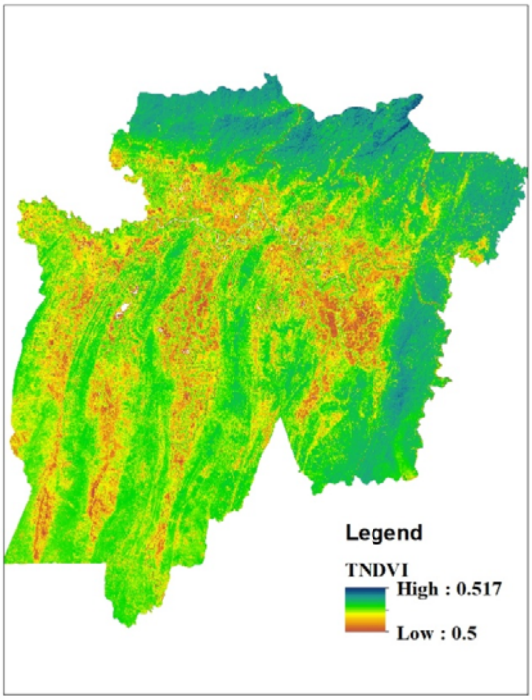

Fig No. 9 Transformed Normalised Difference Vegetation Index (TNDVI)

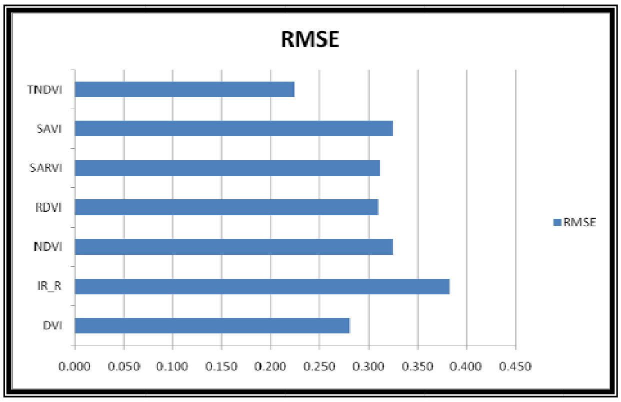

Fig No. 11 Root Mean Square Error (RMSE) Values for each Indices

4. CONCLUSION

We studied and analyzed six vegetation indices, NDVI (Normalized difference vegetation index), SAVI (Soil and adjusted vegetation index), SARVI (Soil and Atmospherically resistant vegetation index), Infrared by Red Ratio (IR/R), DVI (Difference vegetation Index), TNDVI (Transformed Normalised difference vegetation index) and RDVI

(Randomised differential vegetation index) further we computed the RMSE of all the six indices in which the lowest was 0.224 of TNDVI. Since, we have concluded that TNDVI has the least amount of errors as per the results of RMSE, therefore it standouts the best among the other vegetation indices.

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