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A Detailed Study on Vegetation Indices - Towards Agriculture Degradation Monitoring In Madurai Region, South India

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Abstract:- **The appetite for up-to-date information about earth's surface is ever increasing, as such information pro- vides a base for a large number of applications, including local, regional and global resources monitoring, land-cover and land-use change monitoring, and environmental studies. The data from remote sensing satellites provide opportunities to acquire information about land at varying resolutions and has been widely used for change detection studies. Change detection is a technology ascertaining the changes of specific features within a certain time interval. It provides the spatial distribution of features and qualitative and quantitative information of features changes. The main aims are to determine whether vegetation composition, structure and condition are changing over time or in response to a management intervention. . Remote sensing refers to the detection and recording of values of emitted or reflected electromagnetic radiation with sensors in aircrafts or satellites. The remote sensing datasets, such as satellite imageries and aerial photographs, would be a useful tool for monitoring purposes. This paper gives with comparing the performance of various vegetation indices parameters on semi arid region Madurai, Tamilnadu. There are forty index parameters calculated for this purpose. These parameters are grouped into first generation indices and second generation indices. The classified vegetation indices are further grouped into two main categories: indices created from the combination of two spectral bands, notably the red and near infrared , and indices created from the combinations of three or four bands. Some of the popular indices calculated are NDVI, SAVI, TVI, EVI, and PVI computed for the Resourcesat (IRS- P6) satellite imagery and the results are compared. From the vegetation classified output maps, the change map is computed. The change map is a measure of extent to which vegetation has been degraded in the study area during the two dcades.. In this paper, a method is proposed for vegetation cover estimation from multi spectral satellite data based on vegetation index. The timely difference between the vegetation cover of Madurai region, Tamilnadu during different time periods have been computed using post classification change detection comparison. The results show the extent of vegetation degradation during the concerned time periods and it is evident that the vegetation cover has been constantly decreasing in the Madurai region during the past two decades.**

Key Words: Vegetation Index, Post Classification Change Detection, Vegetation Cover

I. INTRODUCTION

In remote sensing (RS) applications, changes are considered as surface component alterations with varying rates. Land-cover (LC) and land-use (LU) change information is important because of its practical uses in various applications, including deforestation, damage assessment, disasters monitoring, urban expansion, planning, and land management. Timely and accurate change detection of the earth's surface features is extremely important for monitoring environmental changes and resource management. The change detection frameworks use multi-temporal datasets to qualitatively analyze the temporal effects of phenomena and quantify the changes. Vegetation monitoring methods are designed primarily to detect changes in vegetation over time in order to determine whether vegetation composition, structure and condition are changing over time or in response to a management intervention. NDVI is one of the most successful of many attempts to simply and quickly identify vegetated areas and their condition and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data.

In this paper, a vegetation index based change detection method have been proposed for vegetation monitoring from multispectral remotely sensed data. The proposed method consists three main stages namely, image preprocessing, vegetation index computation and post classification change detection.

II. STUDY AREA AND DATA USED

The study area chosen for the project is Madurai region, Tamil Nadu. Madurai is the second largest city of the state Tamil Nadu and one of the oldest continuously inhabited cities. It is known as the Athens of the East, and is one of

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the ancient historic cities in the world. The municipal corporation of Madurai has an area of 52 square kilometers, with an overall population of 18,28,869. The archeological findings clearly suggest that the city is more than 2500 years old. Madurai lies between 78° 04’ 47” E and 78 11’ 23” E longitude and 9° 50’ 59” N and 9° 57’36”N latitude. It is approximately 101 meters above the sea level. Madurai lies in the 44^{th} UTM (Universal Transverse Mercator) zone.
Multi spectral images of Madurai region captured by different satellites during different time periods have been used as the input data. Table 1 shows the details of satellite data used for this paper. Input images used for the paper are shown in fig.1 and fig.2.

Table 1. Details of the input satellite data used

	Date of Acquisition	Satellite / Sensor	Resolution
Image 1	23^{rd} April, 1990	Landsat / TM	30 Meter
Image 2	15^{th} May, 2001	Landsat / TM	30 Meter

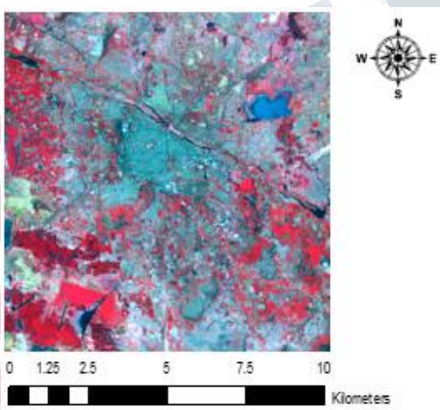

Fig. 1. 1990 Landsat TM Image

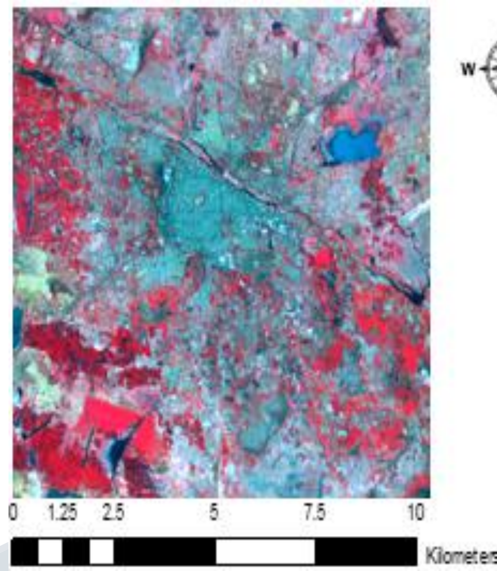

Fig. 2. 2001 Landsat TM Image

III. VEGETATION INDICES

Vegetation Indices (VI) are combinations of the visible red and the near infrared bands and are widely used to quantify vegetation. Their values indicate both the state and abundance of green vegetation cover and biomass. classified vegetation indices into two main categories: indices created from the combination of two spectral bands, notably the red and the near infrared, and indices created from the combination of three or four bands.

First Generation Index
Second Generation Index

FIRST GENERATION INDICES
RATIO=NIR/Red$\frac{PNIR}{PRED}$
SAVI = ((NIR-RED)/(NIR+red+L)) *(1+L)
CTVI= $\frac{NDVI+0..5}{Abs(NDVI+0.5}*\sqrt{Abs(NDVI+0.5)}$
TTVI= $\sqrt{Abs(NDVI+0.5)}$
RVI=$\frac{PRED}{PNIR}$

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NRVI = $\frac{(RVI-1)}{(RVI+1)}$
EVI= $\frac{(NIR-\mathrm{Re}\,d)}{(NIR+c1*\mathrm{Re}\,d-c2Blue+L)}*G$
$VIN = NIR/R$
$GVI = -0.283MSS4-0.660MSS5+0.577MSS6+0.3888MSS7$
$SBI = 0.332MSS4+0.603MSS5+0.675MSS6+0.262MSS7$
$YVI = -0.899MSS4-0.428MSS5+0..076MSS6-0.041MSS7$
$NSI = -0..016MSS4-0.131MSS5-0.425MSS6-0.882MSS7$
$SBL = MSS7-2.4MSS5$
$DVI = 2.4MSS7-MSS5$
$MSBI = -0.406MSS4-0.600MSS5-0.645MSS6-0..243MSS7$
$MGVI = 0.723MSS4-0.5131MSS5-00.530MSS6-0.532MSS7$
$MYVI = 0.723MSS4-0.597MSS5-0..206MSS6-0..278MSS7$
$MNSI = 0.404MSS4-0.039MSS5-0.505MSS6+0.762MSS7$
AVI=2.0MSSS7-MSS5s
GRABS=GVI-0.0917SBI+5.58959
GVSB=GVI/SBI
AGVI=GVI-(1+0.018GVI)YUVI-NSI/2
DVI=(NIR-RED)
NDGI=(G-R)/(G+R)
RI=(R-G)/(R+G)
NDI=(NIR-MIR)/(NIR+MIR)

SECOND GENERATION INDICES:

1	NDVI = $\frac{(\rho NIR-\rho RED)}{(\rho NIR+\rho RED)}$	2	TVI= $\sqrt{\frac{(\rho NIR-\rho RED)}{(\rho NIR+\rho RED)}}+0.5$
3	$PVI = (\frac{NIR-aR-b}{\sqrt{a^2+1}})$	4	ARVI=(NIR-RB)/(NIR+RB)
5	IPVI=(NDVI+1)/2	6	GOSAVI=(NIR-GREEN)/(NIR+G+Y)
7	IVI=(NIR-b)/(a*red)	8	NGDI=(G-R)/(G+R)
9	MNDVI=(NIR-MidNIR)/(NIR+MidNIR)	10	BWDRV=(0.1NIR-blue)/(0.1NIR+blue)
11	CVI=(Red-Blue)/(Red)	12	CI=NIR-Green
13	GDVI=NIR-Green	15	GLI=(2*G-R-B)/2*(G+R=B)
15	GVRI=(NIR-(GREEN-BLUE-RED))/(NIR-(GREEN+BLUE-RED)	16	ASBI=2.0YVI

The Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not. NDVI can be computed from the given relation

NDVI = $(\rho_{NIR}-\rho_{RED}) / (\rho_{NIR}+\rho_{RED})$

Where, ρNIR and ρRED being the reflectance values of the terrain features in the Near Infra-Red and Visible Red bands respectively. To measure and map the density of green vegetation across the Earth's landscapes, scientists use

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satellite sensors that observe the distinct wavelengths of visible and near-infrared sunlight that is absorbed and reflected by the plants. A NDVI value of zero means no green vegetation (barren areas of rock, sand or snow), Moderate NDVI values (0.2 to 0.3) represent shrub and grassland, values close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves (temperate and tropical rainforests).

In areas where vegetative cover is low (i.e., < 40%) and the soil surface is exposed, the reflectance of light in the red and near-infrared spectra can influence vegetation index values. In such cases, Soil Adjusted Vegetation Index (SAVI) can be used. The SAVI is structured similar to the NDVI but with the addition of a "soil brightness correction factor."

$$\mathbf{SAVI = ((\rho_{NIR}-\rho_{RED}) / ((\rho_{NIR}+\rho_{RED}) + L))*(1+L)}$$

Where ρNIR is the reflectance value of the near infrared band, ρRED is reflectance of the red band, and L is the soil brightness correction factor. The value of L varies by the amount or cover of green vegetation: in very high vegetation regions, L=0; and in areas with no green vegetation, L=1. Generally, an L=0.5 works well in most situations and is the default value used.

The Enhanced Vegetation Index (EVI) is an 'optimized' index designed to enhance the vegetation signal with improved sensitivity in high biomass regions and improved vegetation monitoring through a de-coupling of the canopy background signal and a reduction in atmosphere influences. EVI is computed by following equation,

$$\mathbf{EVI = ((\rho_{NIR}-\rho_{Red})/(\rho_{NIR}+C1*\rho_{Red}-C2\ \rho_{Blue}+L))*G}$$

where ρNIR, ρRed, ρBlue are atmospherically-corrected or partially atmosphere corrected (Rayleigh and ozone absorption) surface reflectance values of NIR band, Red band and Blue band respectively, L is the canopy background adjustment that addresses non-linear, differential NIR and red radiant transfer through a canopy, and C1, C2 are the coefficients of the aerosol resistance term, which uses the blue band to correct for aerosol influences in the red band. The coefficients adopted in the MODIS-EVI algorithm are L=1, C1=6, C2=7.5 and G (gainfactor) =2.5.

A Transformed Vegetation Index (TVI) has been applied to biomass estimation for rangelands (Richardson and Wigand, 1977). TVI is modified version of NDVI to avoid operating with negative NDVI values. It can be given by the formula,

$$\mathbf{TVI = \sqrt{((\rho_{NIR} - \rho_{RED}) / (\rho_{NIR} + \rho_{RED}))} + 0.5}$$

Where, ρNIR and ρRED being the intensity values in the Near IR and Visible Red bands respectively.

IV. METHODOLOGY

The proposed method consists three main stages namely, image preprocessing, vegetation index computation and post classification change detection. Multi-temporal dataset containing two images of Madurai region, taken on two different dates is used as input data. The input multi temporal images are initially subjected to image enhancement and geo-referencing. The goal of image enhancement is to improve the visual interpretability of an image by increasing the apparent distinction between the features. Geo-referencing involves assigning real world coordinates to a number of reference points on the image.

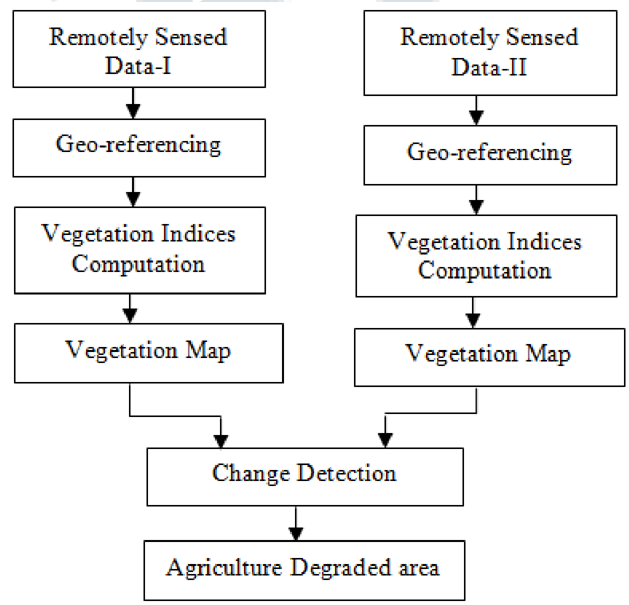

Fig. 3. Methodology

Then Normalized Difference Vegetation Index (NDVI) is computed for the preprocessed image. Using an appropriate threshold, the vegetation regions are extracted from the NDVI output image. Finally, the change map is computed by applying the post classification change detection technique. The change map is a measure of vegetation degradation in the Madurai region during the concerned period.

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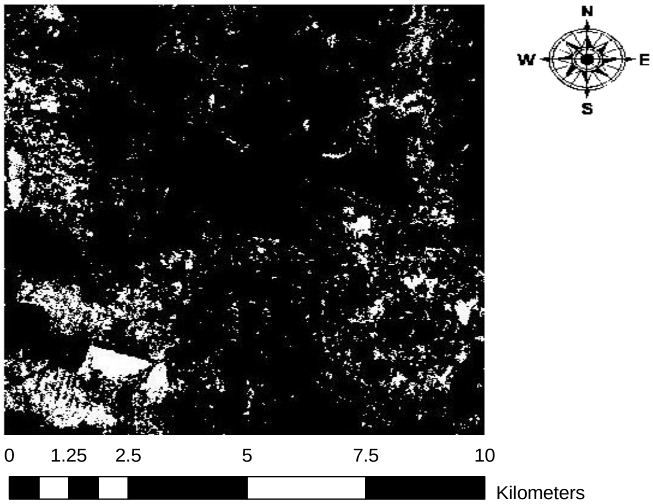

Fig. 4. Extracted Vegetation Regions – 1990 Data

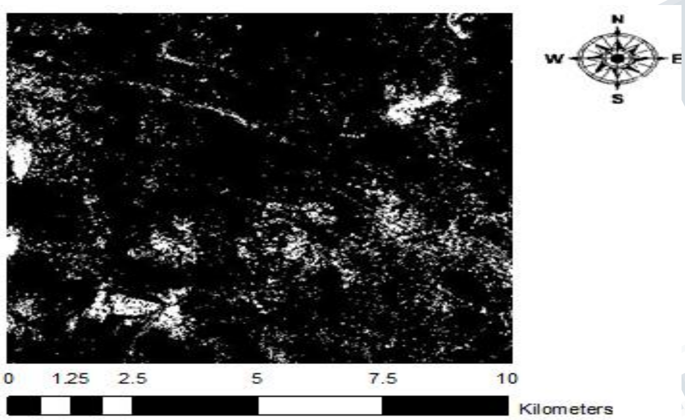

Fig. 5 .Extracted Vegetation Regions – 2001 Data

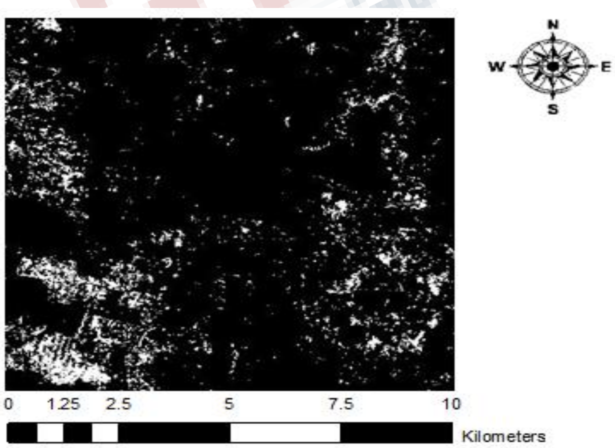

Fig. 6. Change Map – Agriculture Degraded Areas

V. RESULTS AND DISCUSSIONS

NDVI has been computed for the input multi-temporal images with a threshold value of 0.5. The results are shown below. The white color regions in the output images indicate the vegetation pixels of the input image. Then finally post classification change detection comparison is applied to the resultant images which is a measure of vegetation degradation of the Madurai region in the time period. The results show that the vegetation content of Madurai region has undergone severe degradation during the period 1990 to 2001. Table 2 represents the statistics of vegetation degradation.

VI. ACCURACY ASSESSMENT

Accuracy of the obtained results have been assessed using the ground truth points collected from google earth. The change map is compared with the reference points in ArcGIS 10.2 software. The change and no-change ares in the change map is plotted against the ground truth points interms of confusion matrix.

NDVI		Reference Data	
		Change	No Change
Change Detection Output	Change	61	38
	No Change	22	31

Table 2: NDVI Accuracy Assessment Table

VII. CONCLUSION

In this paper, a vegetation indices based agricultural monitoring has been performed. It is concluded that NDVI performs better than other vegetation index parameters in extracting vegetation regions from Landsat Multispectral images. Vegetation degradation between the time periods 1990 to 2001 has been computed using change detection technique.

REFERENCES

[1] Arizona, Tucson. A, . "A review of vegetation indices", Department of Soil and Water Science, University of Arizona, Tucson, AZ, USA.

[2] Opha Pauline Dube, "Remote Sensing, Climate Change and Land-Use Impacts in Semiarid Lands of Southern

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International Journal of Science, Engineering and Management (IJSEM)
Vol 3, Issue 4, April 2018

Africa", Department of Environmental Science,University of Botswana, Private Bag UB 00704, Gaborone, Botswana.

[3] .G.Fang." Fusing Landsat and MODIS Data for Vegetation Monitoring", USDA-ARS, Hydrology and Remote Sensing Laboratory, Beltsville, MD 20705, USA IEEE JOURNELS selected Topic in Remote Sensing. 2016

[4] . Wen Wang, Hai-Xu Hu, Juan Hu, "Land Cover Change Detection Based on MODIS 250m Vegetation Index Time Series Data", State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Hohai University Nanjing, 210098, China. 2015

[5] Nikolaos G. Silleos a , Thomas K. Alexandridis b , Ioannis Z. Gitas "Vegetation Indices: Advances Made in Biomass Estimation and Vegetation Monitoring in the Last 30 Years" Lab of Remote Sensing and GIS, Faculty of Agronomy , Aristotle University of Thessaloniki , G.R. 54124, 2014

[6] .Abdolreza Ansari Amoli, Abbas Alimohammadi "Utilization of Maximum and Minimum based Multi-temporal NDVI data for Agricultural Landcover Mapping in Gilan Province, North of Iran" Department of GIS K.N. University of Technology

[7] G.Csornai, Cs. Wirnhardt, Zs. Suba, P. Somogyi, G. Nádor,L. Martinovich, L. Tikász, A. Kocsis, Gy. Zelei, M. Lelkes(2009)." Crop Monitoring By Remote Sensing"Remote Sensing Centre,Institute of Geodesy, Cartography and Remote Sensing. 2012

[8] Andrew J. Elmore, John F. Mustard, Sara J. Manningand David B. Lobell"Quantifying Vegetation Change in Semiarid Environments: Precision and Accuracy of Spectral Mixture Analysis and the Normalized Difference Vegetation Index" Department of Geological Sciences, Brown University. 2011

[9] .M. Marek , A.Sobieraj "Comparison of several vegetation indices calculated on the basis of a seasonal spot xs time series, and their suitability for land cover and agricultur crop identificatio Department of Photogrammetry and Remote Sensing University of Warmia and Mazury in Olsztyn.

[10] Bannari, A., Huete, A. R., Morin, D. and Zagolski, F. (1995) Effets de la couleur et de la brilliance du slur les indices de végétation. 17th Canadian Symposium on Remote Sensing, Saskatoon, Saskatchewan, Canada IEEE Journel paper 2011

[11] Kaufman, Y. J. (1984) "Atmospheric effects on remote sensing of surface reflectance." SPIE Remote Sensing 475: 20-33. ELSEVIER, 2011

[12] Kauth, R. J. and Thomas, G. S. (1976) "The tasselled cap—a graphic description of the spectral temporal development of agricultural crops as seen by Landsat. Procs." Symposium on Machine Processing of Remotely Sensed Data, Purdue University, West Lafayette, Indiana, 41-51.

[13] Jackson, R. D., Slater, P. N. and Pinter, P. J. (1983a) "Discrimination of growth and water stress in wheat by various vegetation indices through clear and turbid atmospheres." Remote Sensing of Environment 13: 187-208. 2004

[14] Perry, C. R. and Lautenschlager, L. F. (1984) "Functional equivalence of spectral vegetation indices." Remote Sensing of Environment 14: 169-182. ELSEVIER, 20000

[15] Pearson, R. L. and Miller, L. D. (1972) Remote mapping of standing crop biomass for estimation of the productivity of the shortgrass prairie, Pawnee National Grasslands, Colorado. Proceedings of the 8th International Symposium on Remote Sensing of the Environment II: 1355-1379