NDVI-based vegetation changes and Seasonal variation In Semi Arid region

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Abstract:

Arid part of Rajasthan shows vast variation in climate and vegetation during last two decade. In the present study vegetation types and water bodies of western Rajasthan were mapped using Landsat data and Normalized Difference Vegetation Index (NDVI) technique. The Vegetation and water body in the semi-arid regions experiences a phenomenal change in its growth pattern and is highly dynamic. NDVI, an indicator of vegetation expansion, has been used to detect land use-land cover (LULC) features. ENVI and ArcGIS image processing software are used to evaluate and monitor the vegetation and waterbody changes using multi temporal landsat satellite data for the pre-monsson (April- 2017) and post-monsoon (Oct-2017) seasons. Three classes were identified, vegetation, waterbody and other area for classification analysis and preparation of vegetation density and land use maps of the respective periods. The LULC assessment based on NDVI and supervised classification for two seasons has resulted that vegetation coverage and water has been increased by 7.209% and 0.134% respectively in post monsoon season and fallow land (other area) has been decreased. Results showing significant changes in vegetation and water body of the area during the study period. This temporal study of vegetation and waterbody can help in examined the pattern and distribution across study area for achieving sustainability of natural environment. Enormous changes were observed during pre and post monsoon temporal analysis.

Keywords: Landsat, NDVI, Vegetation, Remote Sensing, Seasonal Variations.

Introduction:

Availability of vegetation in the arid part of Rajasthan is a valuable, natural resources and its mapping distribution is important for resource management and planning. GIS today involves sophisticated software and can be integrated with Remote Sensing (RS) technologies to provide monitoring of vegetation (Lambin et al 2001). The key element of GIS is that attributes are related spatial and some system is utilized to process and analyze these relationships (Lillesand et al 2009). Urban growth and its associated population increase is a major factor which has altered natural vegetation cover (Borana et al., 2013). This has resulted in a significant effect on local weather and climate. The use of remote sensing data in recent times has been of immense help in monitoring the changing pattern of vegetation. Change detection, as defined is the temporal effects as variation in spectral response involves situations where the spectral characteristics of the vegetation or other cover type in a given location change over time (Agone & Bhamare, 2012) The vegetation is one of the invaluable natural resources which changes spatio- temporally in its extent and distribution. Hence, reliable information on the extent and distribution of vegetation types is pre-requisite for natural resource management and planning. As the vegetation types in tropical part of India represents diverse formations, on screen visual image interpretation approach was found to be suitable to delineate various vegetation types.

Normalized Difference Vegetation Index (NDVI) : Vegetation indices have been generally used to monitor changes associated to vegetation. Many vegetation indices have been derived based on numerical combinations of red and near-infrared values of remotely sensed data. In NDVI corresponding cell values in the two bands are first subtracted, and this difference is then "normalized" by dividing the sum of two brightness values. The formula for NDVI is:

$$\textbf{NDVI} = (\textbf{Near-infrared} - \textbf{Red}) / (\textbf{Near-infrared} + \textbf{Red})$$

NDVI values range from –1 to +1 making interpretation and scaling easy. Positive values represent active vegetation, and near-zero or negative values represent other types of materials (Gulcan Sarp, 2012). In the present study, Landsat OLI data having spatial resolution 30 m was used to generate baseline information of vegetation types of Jodhpur city and surrounding area. The objective of the present study was to develop detailed vegetation type map using visual image interpretation technique and information collected from Ground Truth surveys.

Study Area:

Jodhpur study area is located at a latitude of 26º 8' 30" to 26º 23' 28" North and longitude of 72º 52' 46" to 73º 10' 52" East (Fig.1) with total coverage area of 830 sqkm. Its general topography is characterized by the hills located in the North and North-west and altitude of 241 m above Mean Sea Level. The study area has a natural drainage slope from North-North East to South-South East towards Jojari River.

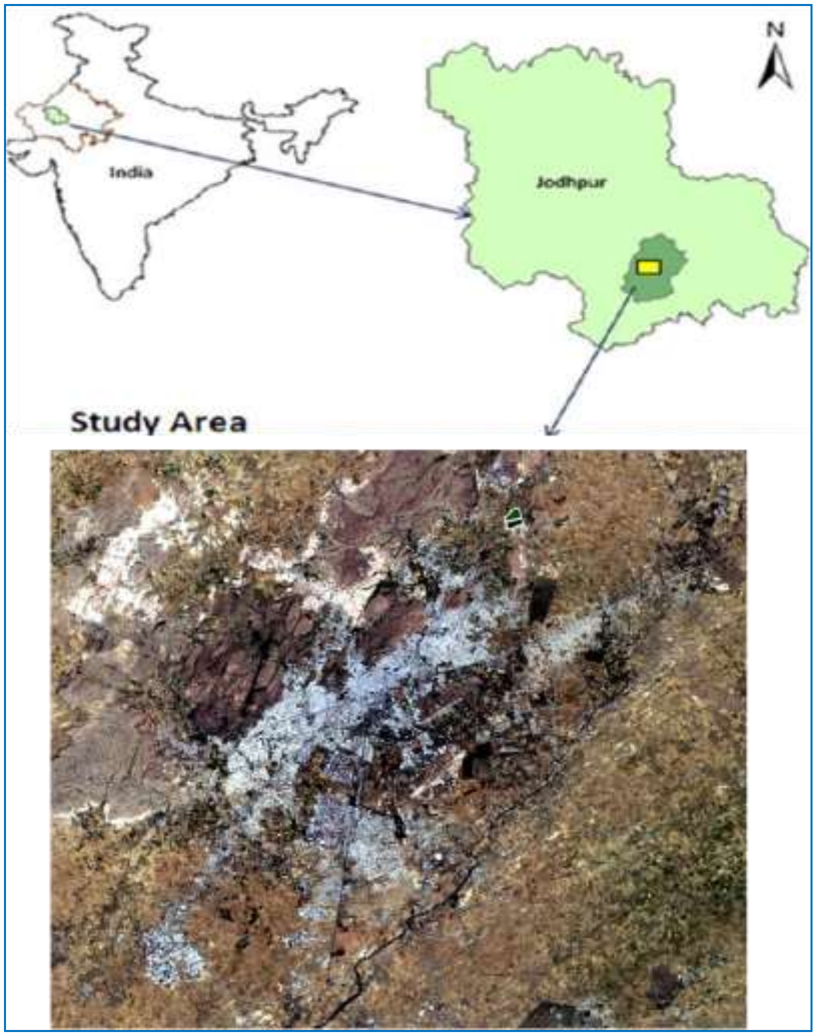

Fig.1. Location Map of the Study Area.

Data Used and Methodology

The aim of this paper is to detect the seasonal vegetation and water body changes and LU/LC mapping from April-2017 and Oct-2017 landsat OLI satellite data(Fig.2). False Colour Images of LANDSAT data on scale 1:50,000 with Survey of India (SoI) maps are used in the present study (Table-1). The LANDSAT satellite data is used to image processing for estimation of NDVI. ENVI and ArcGIS software are used for data interpretation, subseting and classification analysis. Three classes were identified, vegetation, waterbody and other area for classification analysis and preparation of vegetation density and land use maps. Jodhpur study area was selected for a supervised classification. Region of interest (ROIs) were manually drawn in pre and post monsoon season images to be used as training sites. For both season, the Maximum Likelihood classification scheme was selected in ENVI software, which gives the better accuracy for both season. A change detection between the two images was performed using change detection method in ArcGIS software. The NDVI data estimated (Table-2) and classified in a spatial environment to prepare NDVI map for both the years.

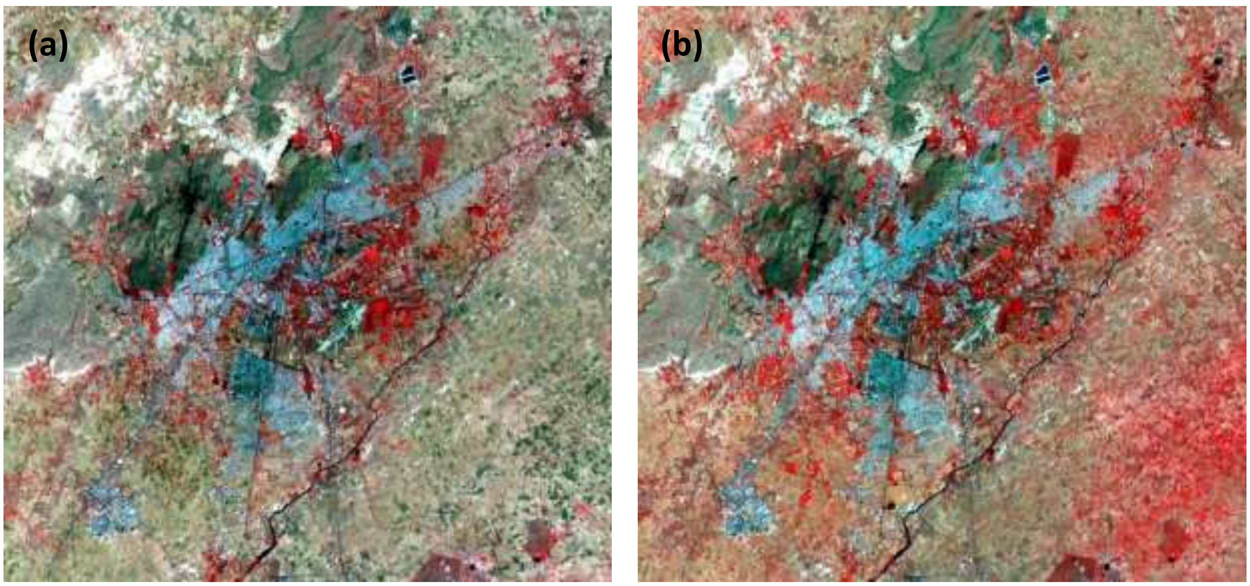

Fig.2: Landsat satellite imagery (a)Apr-2017, (b) Oct-2017

Table-1 The Satellite Data used in the Study Area.

RS Data	Resolution	Path/Row	Date of Acquisition
Landsat OLI	30 m	149/42	04-10- 2017
Landsat OLI	30m	149/42	11-04-2017

Table 2. Band Combination

Landsat OLI Data	Band Combination		
	Blue	Green	Red
True Colour Composite	Band 2	Band 3	Band 4
False Colour Composite	Band 3	Band 4	Band 5
NDVI Data	(Band 5- Band 4)/ (Band 5+ Band 4)		
NDVI Diff.	(NDVI)t – (NDVI)t-1		

Results and Discussion

The objective of present study was to generate a LU/LC features and change detection using remote sensing and Geological Information System (GIS). The observation for the seasonal changes of vegetation cover and limited availability is reported. The NDVI maps of Jodhpur area for both the season reveal three classes viz- water bodies, vegetation/ forest and other land. NDVI values for each class of vegetation cover are detected (Table 3).

NDVI Mapping and Image Differencing Analysis:

The NDVI values for study area varied mostly from -0.11 to 0.55. As it can be seen clearly the vegetation cover area has maximum NDVI values then comes the habitation, mines and finally water body shows the least. From Fig.3, it is clear that in post monsoon season (Oct-2017), there are increased vegetation and waterbody. The area occupied by the mines and settlements has low NDVI values nearer to zero (Yadav & Borana, 2017). Table-3 shows the variation of NDVI values for different classes in the pre and post monsoon season.

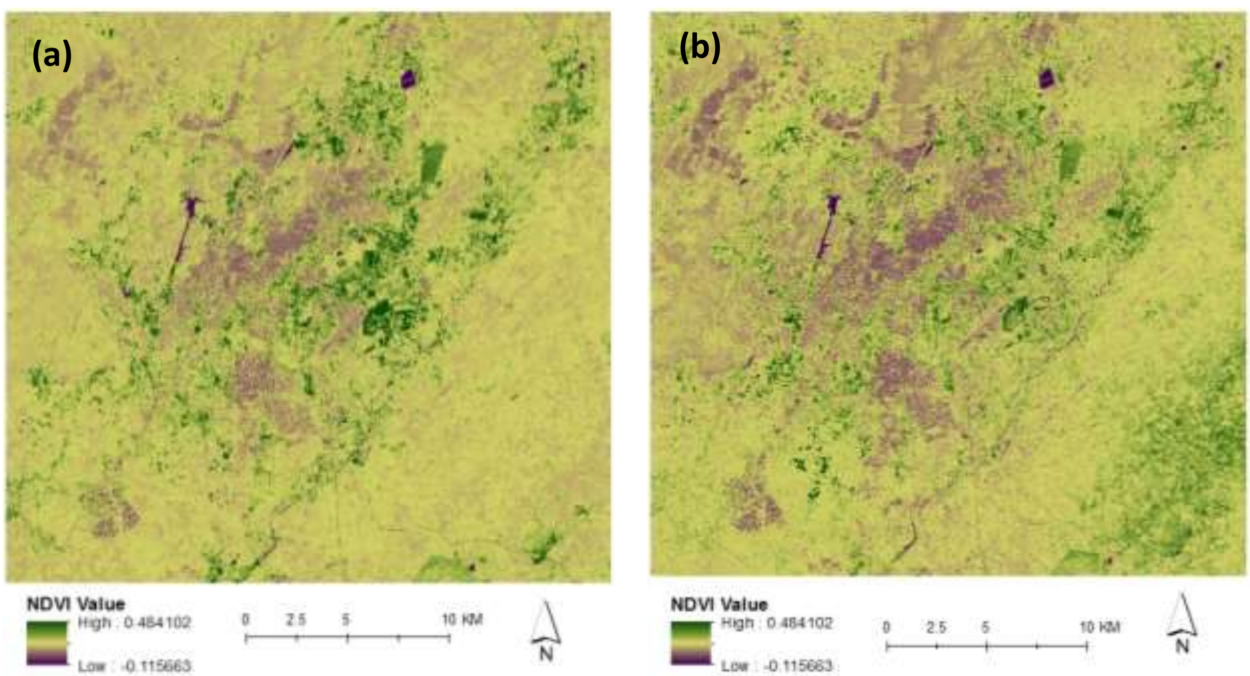

Fig. 3. The NDVI vegetation indices applied to the satellite image (a) 11-Apr-17 (b) 4-Oct-17

Table 3. Statistics of NDVI images

	NDVI (11-04-2017)	NDVI (04-10-2017)
Minimum	-0.115663	-0.163011
Maximum	0.484102	0.555144
Mean	0.133527	0.193734
Standard Deviation	0.041448	0.061611

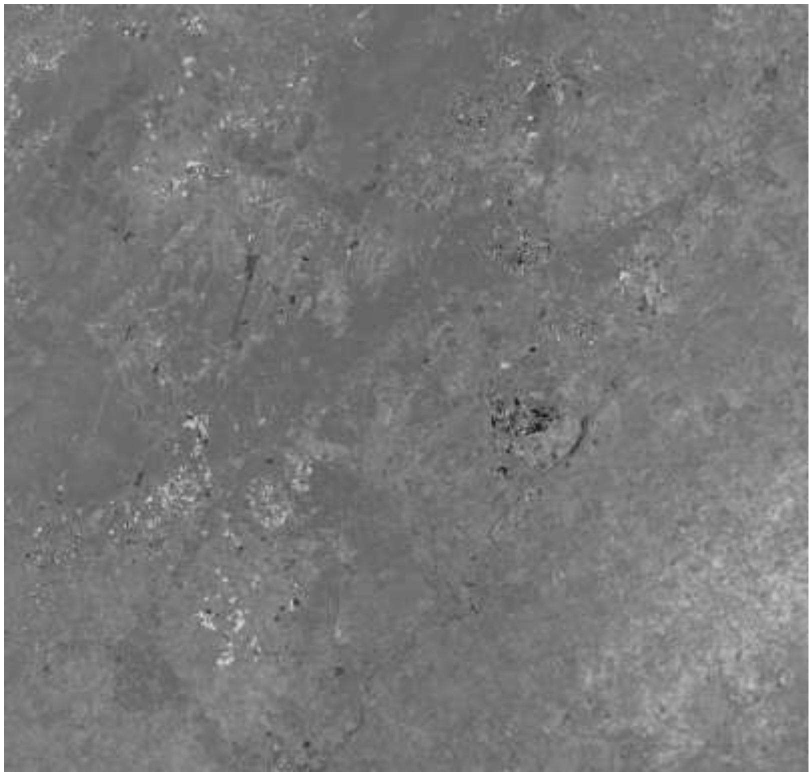

Fig. 4. NDVI Difference Image of the Study Area.

The table-3 shows the statistics of NDVI images and table-4 reflects the NDVI value is between -0.1156 and +0. 0.5551 during Apr-Oct-2017. The lower most NDVI value is –0.1156, indicates for no vegetation. The NDVI value above zero to one indicates the terrestrial vegetation with increase in their maximum proportion. The maximum NDVI value is 0.5551 indicates comparative dense vegetation cover. The maximum area of the Jodhpur area belongs to the scrub and grasslands and the minimum area lies under water bodies. The NDVI is unable to separate cropland from forest area. However, overall change of vegetation may be detected from substring NDVI map of Apr-2017 from Oct-2017 (Fig.4). The study area experience considerable spatial and temporal change in vegetation cover and water bodies. The supervised classified thematic maps of the study area is shown in Fig.5. The vegetation cover and water body increases by 7.209% and 0.134% respectively from pre to post monsoon season(Table-4).

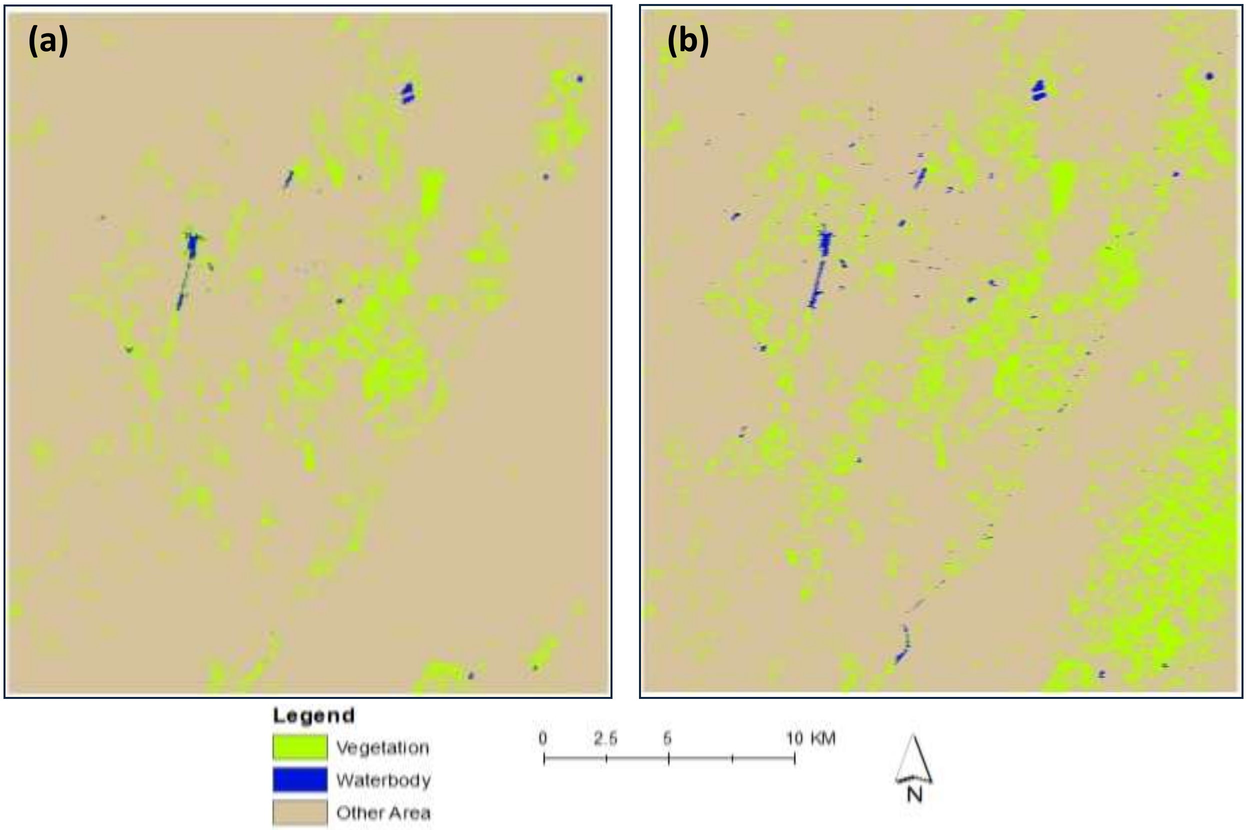

Fig. 5. Supervised Classification Images (a) 11-Apr-17 (b) 4-Oct-17

Table-4. NDVI values and Supervised classified LULC features

LULC Classes	NDVI Values	% Area (11-04-2017)	% Area (04-10-2017)	Change %
Vegetation	0.24 to 0.55	7.564	14.773	7.209
Waterbody	-0. 11 to -0.44	0.154	0.288	0.134
Other Area	0.10 to 0.24	92.282	84.939	7.343

Table 5. Vegetation Changes Using NDVI difference

Change (%)	April -2017 to Oct-2017
Positive change	6.887
No change	90.609
Negative change	2.504

From NDVI difference map, vegetation and water body change maps (pre to post monsoon season) were generated using ArcGIS software (Fig.5), 6.887% positive and 2.504% negative vegetation change was observed in the study area (Table-5).

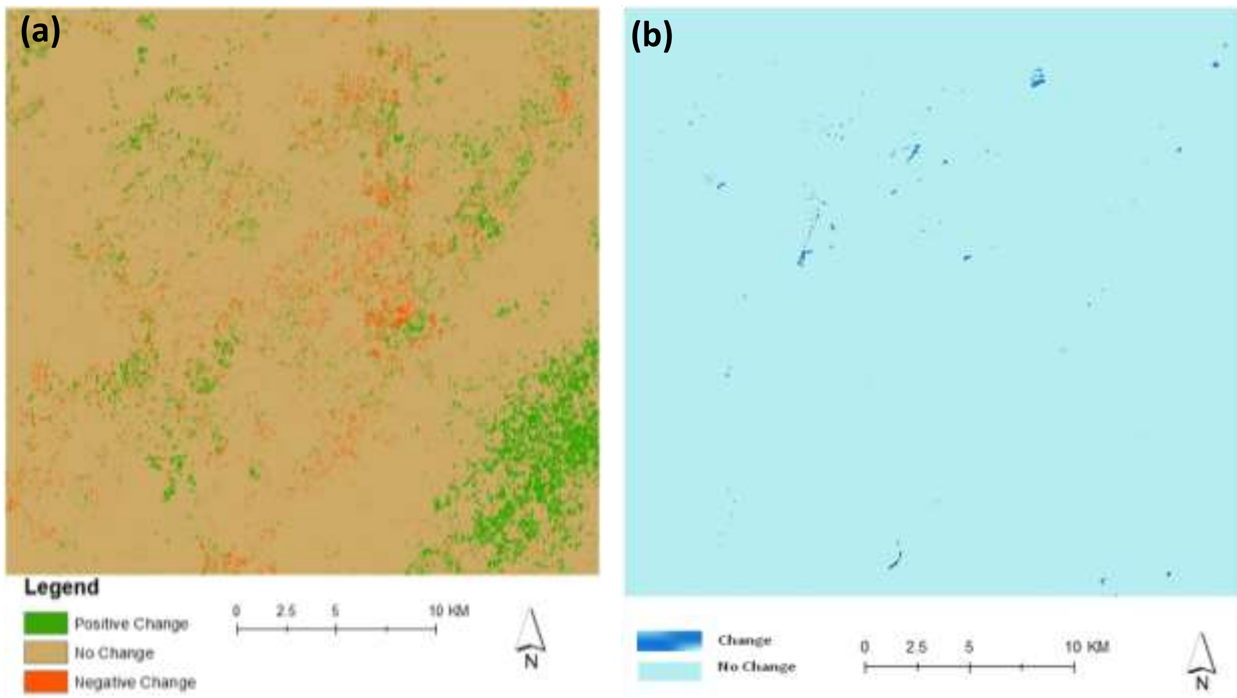

Fig. 5. Evolution of the (a) Vegetation and (b) Waterbody changes in Study area (Apr-17 - Oct-17)

Conclusion:

NDVI is an emerging technique from Remote Sensing and GIS technology to detect spatio-temporal change of vegetation cover. The NDVI method gives superior results for vegetation varying in densities and also for scattered vegetation from a multispectral remote sensing image. The change detection of vegetation cover is determined by comparing different date NDVI images using change detection method. Differencing NDVI images facilitated to easily identify areas where vegetation and waterbody are increased or decreased. Both the NDVI and the supervised classification change detection analyses indicate that there was a significant increases in vegetation cover and water bodies in post monsoon season.

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BIOGRAPHY

Dr S.L Borana received ME (Electronics & Communication) and PhD from JNV University, Jodhpur. Presently he is working in Defence Laboratory, Jodhpur and has experience of 14 years the area of remote sensing and GIS. His research interests include: Remote Sensing & GIS, Mgt, Image Processing.

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