

Where, NIR = near infrared, R = red and L = Soil adjustment factor

In the case of Himachal Pradesh a time series of NDVI, SAVI and TVI imagery had been analyzed. First of all the three vegetation indices were analyzed for the entire State. For each vegetation the statistical data was extracted and interpreted. Several changes were observed directly from the three seasons. Those included forest to snow cover.

5. Results and Discussion

5.1 Normalized Difference Vegetation Indices (NDVI)

Three different time-period NDVI images have been shown representative for seasonal changes (Figure 2). The NDVI images show the foliage cover in the respective time-period. The bounded values of NDVI range from -0.39 to 0.52 (March), -0.37 to 0.49 (August) and -0.43 to 0.52 (October).

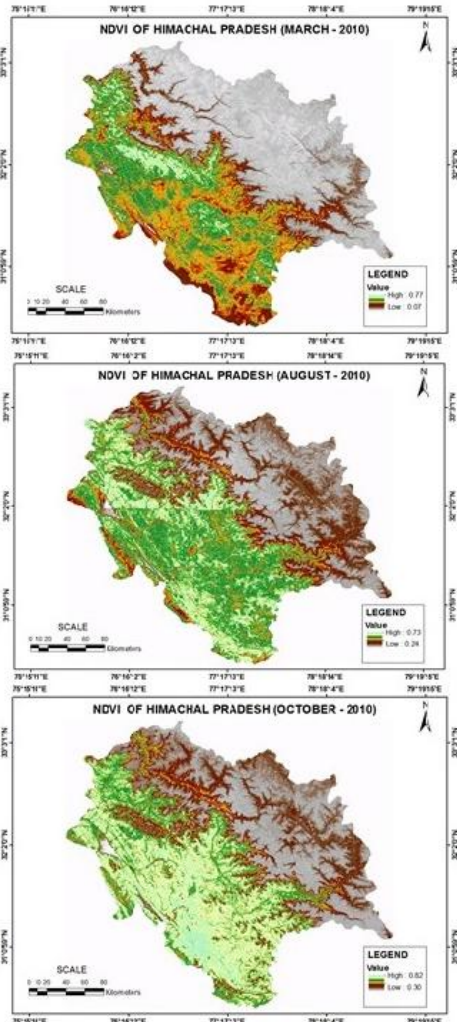


Figure 2: NDVI of March, August and October 2010

5.2 Soil Adjusted Vegetation Indices (SAVI)

The SAVI was performed on the same dataset. SAVI ranged between 0.07 to 0.79 , 0.24 to 0.75 , and 0.31 to 0.84 for March, August and October respectively. SAVI map of study area of different season is given in Figure 3.

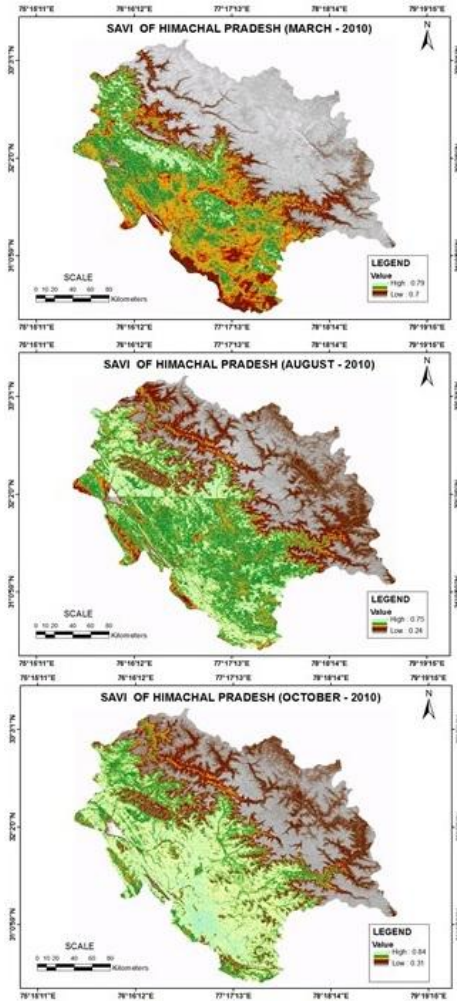


Figure 3: SAVI of March, August and October 2010

5.3 Transformed Vegetation Indices (TVI)

In the present study the TVI of the October month showed some data gap in some water body. The study showed that the value of range of TVI was in between 0.31 to 1.14 , 0.56 to 1.10 and 0.60 to 1.13 for March, August and October respectively. TVI map of study area of different season is given in (Figure 4) respectively.

The quantitative criteria which was used in this study, is the statistical variance with respect to mean, median, mode and standard deviation of the image of each vegetation index.

The TVI vegetation index produces images with a strong contrast. The vegetation areas appear in very clear tones. On the other hand, the spatial variation of the tonality of the NDVI image is stronger than that of the TVI and the SAVI. The signal to noise ratio of the NDVI, SAVI and TVI images increased with the ratio near infrared reflectance to red reflectance.

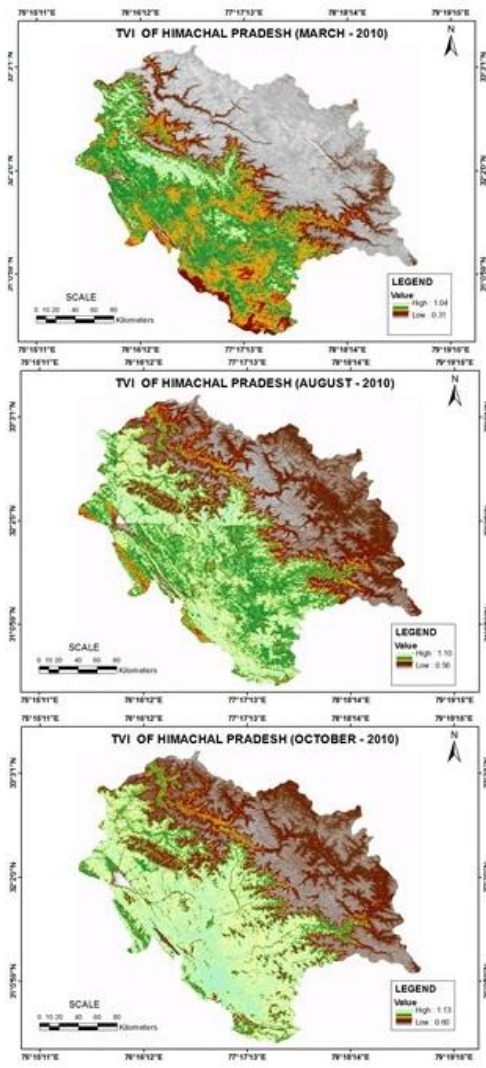


Figure 4: TVI of March, August and October 2010

5.4 Comparison among NDVI, SAVI and TVI

So far, previously a number of vegetation indices had been introduced for the study of the conditions of quality and quantity specifications of plant cover, but the selection of the best index for quantitative analysis of plant cover was one of the important problems for the users. The Operational method for this study could be suggested for integration of remote sensing data for the estimation of vegetation pattern. The features extracted from the satellite image was correlated by means of vegetation pattern with statistical analysis between mean, median, mode and standard deviation.

In the current study, there was no technical difference between NDVI and TVI. These two indices had drawbacks of light scattering due to presence of aerosols in the atmosphere, which directly affected the results obtained through vegetation indices. Light reflected from the soil also had significant effect on NDVI values. Another problem of TVI was the observed value of indices ranged from 0 to slightly more than 1.

The study also showed, SAVI was outperformed than the other two indices. It minimized the soil background effect (a major limiting factor in statistical analysis geared towards the quantitative assessment of above ground biomass in spectral

vegetation indices) using red and near infrared band. But it couldn't solve the problem of atmospheric scattering due to the presence of aerosol (Table 2, 3 and 4).

Table 2: Comparison among Statistical Data of NDVI

MARCH_2010_NDVI					
Minimum	Maximum	Mean	SD	Median	Mode
0.07	0.77	0.267	0.2	-1	-1
AUGUST_2010_NDVI					
Minimum	Maximum	Mean	SD	Median	Mode
0.24	0.73	0.274	0.2	-1	-1
OCTOBER_2010_NDVI					
Minimum	Maximum	Mean	SD	Median	Mode
0.30	0.82	0.297	0.2	0.3201	0.002

Table 3: Comparison among Statistical Data of SAVI

MARCH_2010_SAVI					
Minimum	Maximum	Mean	SD	Median	Mode
0.7	0.79	0.284	0.2	-1	-1
AUGUST_2010_SAVI					
Minimum	Maximum	Mean	SD	Median	Mode
0.24	0.75	0.312	0.2	-1	-1
OCTOBER_2010_SAVI					
Minimum	Maximum	Mean	SD	Median	Mode
0.31	0.84	0.342	0.2	0.3201	0.002

Table 4: Comparison among Statistical Data of TVI

MARCH_2010_TV I					
Minimum	Maximum	Mean	SD	Median	Mode
0.31	1.04	0.267	0.2	-1	-1
AUGUST_2010_TV I					
Minimum	Maximum	Mean	SD	Median	Mode
0.56	1.10	0.267	0.2	-1	-1
OCTOBER_2010_TV I					
Minimum	Maximum	Mean	SD	Median	Mode
0.60	1.13	0.297	0.2	0.3201	0.002

The spatial distribution of NDVI, SAVI and TVI values had been dominated by the high values in October followed by august and march. The comparative analysis revealed the influence of seasonal variation on the vegetation. During March, the vegetation showed a constant growing trend. During senescence period from March to September, the rapid increase in NDVI, SAVI and TVI values was seen in the study area, due to improvement in vegetation health, which was observed on the basis of pixel values. The influence of monsoon is very much dominated in August and October. Again the cyclic reduction in NDVI values has been analysed and decline in foliage cover has been observed in March season. The maximum NDVI image has been computed to represent the maximum foliage cover in the time period of October.

6. Conclusion

The remarkable developments in remote sensing technology have made efficient management of environment and forestry

and assessment for better characterization of vegetation at regional scales with frequent intervals. Remote sensing data help policy and decision makers to assess the current situation, judge long-term trends and help to manage forest resources sustainably. In this context, IRS P6 AWiFS has emerged as the most optimal means for monitoring and management of forest resources on a regional scale with a resolution of 56m. The repetitive coverage helps in selecting the required season period data for phenological states of vegetation, phytogeographical region, and land use practice. Each pixel provides a wide range of ground information and conditions, which may create complexity in interpretation. With automated classification, studies carried out using AWiFS data recommended for annual forest cover mapping, save time and money while providing equally efficient forest cover data

6.1 Scope for further studies

More research can be done in future towards the selection of better vegetation indices which can help the estimation biomass more precisely. Other vegetation indices such as Atmosphere Resistant Vegetation Indices (ARVI), Soil Atmosphere Resistant Vegetation indices (SARVI) can be also used for the study of biomass and carbon stock estimation.

6.2 Recommendations

The pre-calibration of satellite image influences in extracting spectral indices for the study. The degradation of sensor calibration also effect the spectral indices. Thus an improve method of sensor calibration of satellite images can be found which will enhance the spectral indices better. And also the use of high resolution satellite images may result better vegetation indices which ultimately will help in vegetation monitoring and estimating biomass and carbon stock in the desired study area with more precision.

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