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RESEARCH ARTICLE

# ANALYSIS OF DIFFERENT INDICES FOR MONITORING VEGETATION COVER USING REMOTE SENSING DATA: A CASE STUDY OF BARAMULLA DISTRICT, KASHMIR VALLEY, INDIA

**Mudasir Majid Malik* Asima Nusrath and Mahalingam B**

[1]Dos In Geography, University of Mysore, Mgm- 570006
[2]Dos In Geography, University of Mysore
[3]Department of Geography, University of Madras

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**ABSTRACT**

The present study has been conducted to analysis the accuracy in different indices to measure the vegetation cover. For the study three decadal remote sensing data have been selected such as, 1992, 2001 and 2012. These satellite images are belong to Lands at series, in which 1992 and 2012 are belong to TM and 2001 is belong to ETM+. To analyze the accuracy of different indices, the study have been conducted the vegetation cover of Baramulla district using NDVI, SAVI and MSI indices. The result of analysis represents that the indices SAVI is better than other two methods.



## INTRODUCTION

The vegetation on the earth surface is important phenomena, which makes the equilibrium of surrounding environment. All countries on the earth are concentrating to protect and develop the flora to make peaceful livelihood. As per the World Health Organization report, 33 per cent of total area of land should be covered by forest land to maintain the good ecosystem. The several studies (Jiang *et al*., 2007, Biniam, I., 2005) conducted to find out the vegetation cover represents that, the vegetation cover on the total area is not sufficient to build a balance environment, and also the studies conducted by (Coppin, *et al*., 2004; Mas, J. F., 1999; Lu, D., *et al*., 2004) shows that, the rapid growth of population in recent decades destroyed the vegetation covers without any concern. Therefore the study of vegetation cover and its changes between times to time is important to understand any region to make a better decision to conserve the valuable resources like vegetation for sustainable development of future.

The analysis of vegetation has been done in various ways among those using indices in the satellite imageries are popular one (Huete, 1988; Gilabert, *et al*., 2002; Jensen, 2007). There are several indices have been used like SR, NDVI, SAVI, ARVI, EVI, NVI, VARI, MSI etc. The result obtain through these techniques have been proved the accuracy of prediction and it has been widely used by the scientific community to analysis the vegetation.

### *Normalized Difference Vegetation Index – NDVI*

General NDVI has developed by Rouse *et al*. in 1974. It is an important vegetation index because of monitoring seasonal and inter-annual changes in vegetation growth (Jensen, 2007). Almost three decades, NDVI has been utilized for satellite assessment of the earth's vegetation cover ( Huete and Liu, 1994; Ramsey *et al*., 1995). The formula for NDVI has given bellow:

$$\text{NDVI} = \frac{NIR - R}{NIR + R}$$

Where NIR is Near Infrared Band (band 4) and R is the Red Band (band 3), (Rouse *et al*. 1974).

From the equation it clearly indicates that the information regarding the vegetation contained in the Red (R) and Near Infrared (NIR) spectral bands.

**Corresponding author:* **Mudasir Majid Malik**
Dos In Geography, University Of Mysore, Mgm- 570006

***Soil Adjusted Vegetation Index – SAVI***

Although the NDVI has been shown a great effort in monitoring vegetation cover or estimating vegetation properties, but many internal and external influences restrict its global utility. The influence like soil background conditions exerts on vegetation properties, which restricts the NDVI to some extent. To come up with this influence of soil background, the important vegetation index has been developed by (Heute, 1988) namely Soil Adjusted Vegetation Index (SAVI). He proposed soil adjustment factor L to the NDVI which reduces the soil background, backscattering and soil variations to obtain soil adjusted vegetation index, the formula for SAVI is given bellow:

$$\mathrm{SAVI} = \frac{\mathrm{NIR} - \mathrm{R}}{\mathrm{NIR} + \mathrm{R} + \mathrm{L}}(1 + \mathrm{L})$$

Where L is a Canopy background adjustment factor, NIR and R are the Near Infrared (NIR) and Red bands (R) (Huete, 1988; Huete *et al*., 1992; Karnieli, *et al*., 2001). The value of L is 0.5, which minimize the soil brightness variations and eliminates the need for additional calibration for different soils (Huete and Liu, 1994: Qi *et al.,* 1995).

***Moisture Stress Index – MSI***

The anther vegetation index method Moisture Stress Index was utilized by Rock *et al*., 1986 to quantify the effect of soil moisture conditions on vegetation and also it is used to assess the moisture stress on vegetation (NOAA, 2001). As in MSI, the increasing values shows the decrease in vegetation cover also decreasing the value shows the increase in vegetation cover. Here in this Index the two spectral bands Middle-Infrared (band 5) and Near Infrared (band 4) are to be used for assess the moisture stress on vegetation. It is not used for the sensors which are having 4 bands because it needs Mid-Infrared (band 5) to assess the moisture stress on vegetation. The formula is given bellow:

$$\mathrm{MSI} = \frac{\mathrm{MidIR}}{\mathrm{NIR}}$$

Where MidIR is Middle-Infrared (band 5) and NIR is Near Infrared (band 4). Even though there are several indices of vegetation cover analysis, the present study has been concentrated on NDVI, SAVI and MSI, because these techniques have been used widely by the researchers than any other methods and these methods also proved the accuracy of its prediction. Therefore the present study used to analysis the vegetation cover and its temporal changes of Baramulla district using these three. The results of each Indices have been compared with another and finally the suitable indices results have been suggested from the study.

***Study Area***

The Baramulla district is bounded by Kupwara and Muzzafarabad (POK) in the North and North West, Budgam and Poonch in the South, Bandipore District in the North East as shown in the figure 1. The Baramulla district extends from 33°58’ to 34°22’ North Latitudes and 73°54’ to 74°42’ East Longitudes. The average elevation of the district is 1593 meters (5226 feet) above sea level. The geographical area of the district is 2077.5 sq. km, with eight tehsils, namely, Baramulla, Boniyar, Kreeri, Pattan, Rafiabad, Sopore, Tangmarg, and Uri. As per 2011 census, the district has a population of 1,015,503, (53.4%). The district has distinction of having geographical diversity as it has in its jurisdiction, sub-temperate / sub-tropical areas apart from vast area falling in temperate zone. It has severe cold climate in winter and a pleasant weather in summer. Almost all parts of the district experience snowfall during winter.

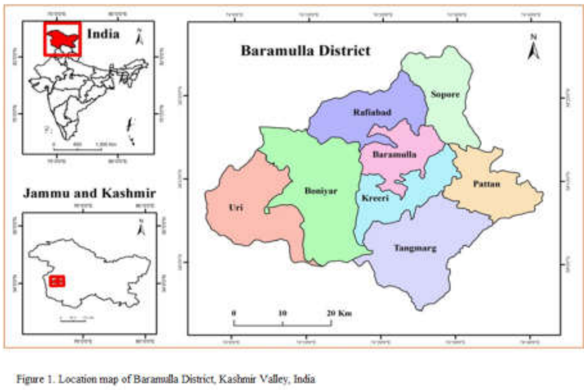


**Figure 1** Location Map of the Baramulla District

## MATERIALS AND METHODS

The NDVI, SAVI and MSI are one of the most widespread methods to assess the vegetation cover of earth surface. The calculation of vegetation has been found through the manipulation of reflected energy of an object in the red, infra-red and mid-infrared regions. The study of vegetation assessment using NDVI, SAVI and MSI technique has been carried out by several researchers (Huete, *et al*., 2002; Jensen, 2007; Huete and Liu, 1994; Ramsey *et al*., 1995: Qi *et al*., 1995), and these people have confirmed that, this method is suitable for vegetation analysis. The present study also adopted the NDVI, SAVI and MSI technique to find out the vegetation cover of Baramulla district based on the suggestion given by the previous research.

To assess the vegetation cover of study area, the freely available landsat satellite imageries have been downloaded for the years 1992, 2000 and 2012 from the USGS website. The downloaded data have been corrected and confirmed the accuracy of geometric, radiometric and atmospheric accuracy before the calculation of Indices. The popularly used remote sensing software’s ERDAS Imagine and ArcGIS has been used to analysis the satellite data and numerical results have been manipulated in MS-Excel to prepare the changes between years and represent the result in graph form. The result of NDVI varies from - 1 to + 1, in which negative values are represents the other than vegetation while the positive values of represents the vegetation surface. The positive values near to 0 portray the scattered or low vegetation area while positive values near to 1 represents the dense vegetation (John, W and David, H., 2000; NOAA satellites and LANDSAT).

## RESULTS AND DISCUSSION

## RESULTS OF NORMALIZED DIFFERENCE VEGETATION INDEX- NDVI

The NDVI is one of the popular methods to assess the vegetation cover of earth surface. The calculation of vegetation has been found through the manipulation of reflected energy of an object in the red and infra-red region. The study of vegetation assessment using NDVI technique has been carried out by several researchers (Ramsey, *et al*., 1995; John, *et al*., 2000; Huete *et al*., 1992; Huete and Liu, 1994; Rouse *et al*., 1974), and these people have confirmed that, this method is suitable for vegetation analysis. The present study also adopted the NDVI technique to find out the vegetation cover of Baramulla district based on the suggestion given by the previous research. To assess the vegetation cover of study area, the freely available Landsat satellite imageries have been downloaded for the years 1992, 2000 and 2012 from the USGS website. The downloaded data have been corrected and confirmed the accuracy of geometric, radiometric and atmospheric accuracy before the calculation of NDVI.

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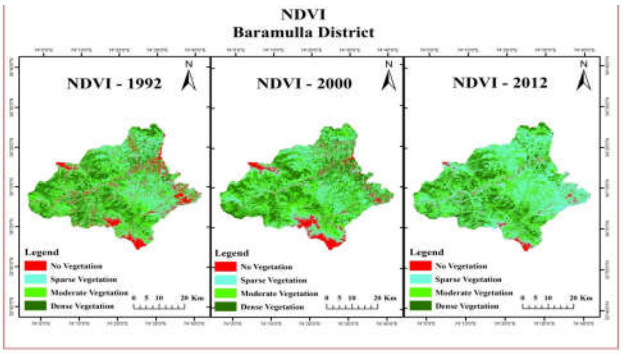


**Figure 2** NDVI-Spatial distribution of Vegetation cover between the selected years.

The analysis result of year 1992 shows that, 230.64 $Km^2$ areas were not having vegetation, 591.89 $Km^2$ areas were having sparse vegetation, 725.17 $Km^2$ areas were having moderate vegetation, and 525.22 $Km^2$ areas were having dense vegetation as shown in table1.

The result shows decrease in no vegetation class during the year 2000 having an area of 168.15 $Km^2$. Sparse vegetation class having an area of 569.05 $Km^2$, moderate vegetation class is having an area of 768.18 $Km^2$ and dense vegetation class having an area of 567.53 $Km^2$, which shows increase as compared to previous selected year. The analysis result of year 2012 shows that, 64.97 $Km^2$ areas were not having vegetation, 847.04 $Km^2$ areas were having sparse vegetation, 720.00 $Km^2$ areas were having moderate vegetation and 440.90$Km^2$ areas were having dense vegetation.

**Table 1** Results of NDVI Analysis

| Classification | Area in (Km2) 1992 | 2000 | 2012 | Change in (%) 1992 - 2000 | 2000 - 2012 | 1992 - 2012 |
|---|---|---|---|---|---|---|
| No Vegetation | 230.647 | 168.158 | 64.974 | -27.093 | -61.361 | -71.830 |
| Sparse Vegetation | 591.897 | 569.051 | 847.049 | -3.860 | 48.853 | 43.107 |
| Moderate Vegetation | 725.178 | 768.185 | 720.005 | 5.930 | -6.272 | -0.713 |
| Dense Vegetation | 525.225 | 567.534 | 440.900 | 8.055 | -22.313 | -16.055 |

Source: Analysis Result

The analysis result of changes between the years 1992 to 2000 shows that, the no vegetation class and sparse vegetation class has decreased 27.09 percent and 3.86 respectively, while the moderate vegetation class and dense vegetation class has been increased 5.93 percent and 8.05 percent respectively.

The study result shows the changes between the years 2000 to 2012. The no vegetation class has decreased 61.36 percent, while the sparse vegetation class has increased 48.85 percent. The moderate vegetation class has decreased 6.27 percent, while the dense vegetation class has also been decreased 22.31 percent.

During the years 1992 to 2012 the results show that, no vegetation class has decreased 71.83 percent, while the sparse vegetation class has increased 43.10 percent. The moderate vegetation class has decreased 0.71 percent, while the dense vegetation class has also been decreased 16.05 percent.

## RESULTS OF SOIL ADJUSTED VEGETATION INDEX – SAVI

The analysis of SAVI for each same year values have been classified as same as in NDVI, such as No Vegetation (values less than 0), Sparse Vegetation (0 to 0.2), Moderate Vegetation (0.2 to 0.4) and Dense Vegetation (more than 0.4). Figure 3 shows the distribution of vegetation in the study area using SAVI method.

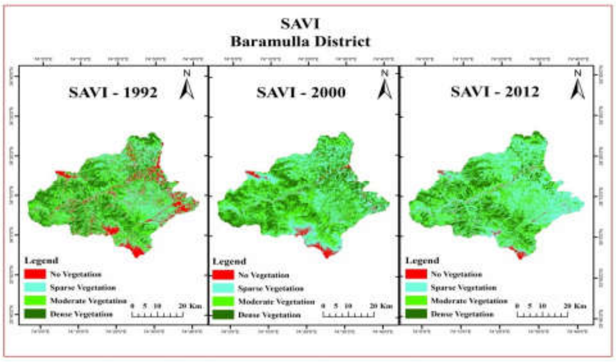


**Figure 3** SAVI-Spatial distribution of Vegetation cover between the selected years.

The analysis result of year 1992 shows that, 249.94 $Km^2$ areas were not having vegetation, 606.02 $Km^2$ areas were having sparse vegetation, 701.66 $Km^2$ areas were having moderate vegetation, and 515.30 $Km^2$ areas were having dense vegetation.

The result shows decrease in no vegetation class during the year 2000 having an area of 66.64 $Km^2$. Sparse vegetation class having an area of 659.52 $Km^2$, moderate vegetation class has an area of 759.24 $Km^2$ and dense vegetation class having an area of 587.51 $Km^2$.

The analysis result of year 2012 shows that, 45.11 $Km^2$ areas were having no vegetation, 858.97 $Km^2$ areas were having sparse vegetation, 723.67 $Km^2$ areas were having moderate vegetation and 445.16 $Km^2$ areas were having dense vegetation as shown in table 2.

**Table 2** Results of SAVI Analysis

| Result of SAVI Analysis | | | | | | |
|---|---|---|---|---|---|---|
| **Classification** | **Area in (Km2)** | | | **Change in (%)** | | |
| | **1992** | **2000** | **2012** | **1992 - 2000** | **2000 - 2012** | **1992 - 2012** |
| No Vegetation | 249.945 | 66.648 | 45.117 | -73.335 | -32.305 | -81.949 |
| Sparse Vegetation | 606.025 | 659.521 | 858.971 | 8.827 | 30.242 | 41.739 |
| Moderate Vegetation | 701.669 | 759.244 | 723.673 | 8.205 | -4.685 | 3.136 |
| Dense Vegetation | 515.309 | 587.515 | 445.167 | 14.012 | -24.229 | -13.612 |

Source: Analysis Result

The analysis result of changes between the years 1992 to 2000 shows that, the no vegetation class has decreased 73.33 percent, while the sparse vegetation class has increased 8.82 percent. The moderate vegetation class has also increased 8.20 percent, while the dense vegetation class has also been increased 14.01 percent.

The study result shows the changes between the years 2000 to 2012. The no vegetation class has decreased 32.30 percent, while the low vegetation class has increased 30.24 percent. The moderate vegetation class has decreased 4.68 percent, while the dense vegetation class has also been decreased 24.22 percent.

During the years 1992 to 2012 the results show that, no vegetation class has decreased 81.94 percent, while the low vegetation class has increased 41.73 percent. The moderate vegetation class has increased 3.13 percent, while the dense vegetation class has been decreased 13.61 percent.

## RESULTS OF MOISTURE STRESS INDEX – MSI

The analysis of MSI for the years 1992, 2000 and 2012, where the values have been classified into 4 classes based on values such as Dense Vegetation having (below than 0), Moderate Vegetation (0-0.5), Sparse Vegetation (0.5-1), and No Vegetation (more than 1) values. Figure 4 clearly shows the vegetation distribution in the present study area using the vegetation Index MSI.

The study result of the year 1992 shows that, 534.22 $Km^2$ areas were having dense vegetation, 565.08 $Km^2$ areas were having moderate vegetation, 774.28 $Km^2$ areas were having sparse vegetation, and 199.35 $Km^2$ areas were having no vegetation.

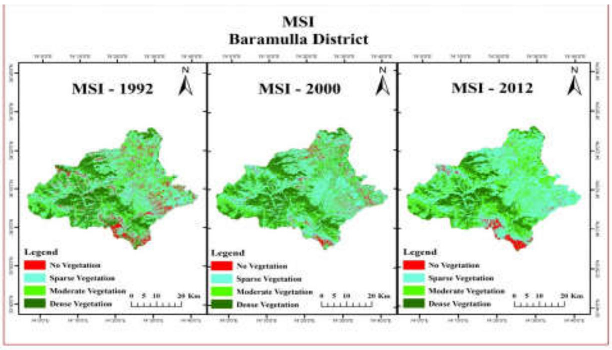


**Figure 4** MSI-Spatial distribution of Vegetation cover between the selected years.

In the year 2000, result shows that, 569.04 $Km^2$ areas were having dense vegetation, 562.19 $Km^2$ areas were having moderate vegetation, 840.41 $Km^2$ areas were having sparse vegetation and 101.26 $Km^2$ areas were having no vegetation.
The result of the year 2012 shows that, 445.19 $Km^2$ areas were having dense vegetation, 714.29 $Km^2$ areas were having moderate vegetation, 848.67 $Km^2$ areas were having sparse vegetation and 64.75 $Km^2$ areas were having no vegetationas shown in table 3.

**Table 3** Results of MSI Analysis

| Result of MSI Analysis | | | | | | |
|---|---|---|---|---|---|---|
| **Classification** | **Area in (Km2)** | | | **Change in (%)** | | |
| | **1992** | **2000** | **2012** | **1992 - 2000** | **2000 - 2012** | **1992 - 2012** |
| Dense Vegetation | 534.227 | 569.041 | 445.193 | 6.517 | -21.764 | -16.666 |
| Moderate Vegetation | 565.082 | 562.195 | 714.299 | -0.511 | 27.056 | 26.406 |
| Sparse Vegetation | 774.281 | 840.417 | 848.678 | 8.542 | 0.983 | 9.609 |
| No Vegetation | 199.359 | 101.269 | 64.757 | -49.202 | -36.055 | -67.517 |

Source: Analysis Result

During the years 1992 to 2000 the results show that, dense vegetation class has increased 6.51 percent, while the moderate vegetation class has also decreased 0.51 percent. The sparse vegetation class has increased 8.54 percent, while the novegetation class has been decreased 49.20 percent.

The study result shows the changes between the years 2000 to 2012. The dense vegetation class has decreased 21.76 percent, while the moderate vegetation class has been increased 27.05 percent. The sparse vegetation class has also increased 0.98 percent, while the novegetation class has been decreased 36.05 percent.

During the years 1992 to 2012 the result shows that, dense vegetation class has decreased 16.66 percent, while the moderate vegetation class has increased 26.40 percent. The sparse vegetation class has also been increased 9.60 percent, while the no vegetation class has been decreased 67.51 percent.

## CONCLUSION

The present study carried out to assess the evaluation of vegetation cover in Baramulla district during the years 1992, 2000 and 2012. The results showed that there was an overall decrease in classes like no vegetation, and dense vegetation of indices (NDVI and SAVI), while in classes like moderate vegetation and sparse vegetation shown increasing trend. So in MSI, classes like no vegetation and dense vegetation showed decrease, while in sparse vegetation and moderate vegetation classes showed increase in vegetation cover. The change in vegetation cover had an effect of climatic conditions like disruption of seasonal rainfall and temperature directly and anthropogenic impact indirectly. Besides the effect of climatic conditions and anthropogenic impacts, the other factors like, topography, presence of river systems and difference in acquisition dates of satellite images may have had an effect on vegetation cover change.

The result of analysis represents that the indices SAVI is better than other two methods. That is because of L parameter having value of 0.5, which minimizes the soil influence, (Heute, 1988). This index could be quite useful for comprehensive purpose vegetation classification.

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