The Andhra Agric. J 61(3):658-664, 2014

Normalized Difference Vegetation Index (NDVI) Changes around Godavari River Basin in Andhra Pradesh

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ABSTRACT

Extracting and identifying vegetation from satellite images plays a major role in Remote Sensing. Estimating land cover by interpretation of remote sensing imagery involves Normalized Difference Vegetation Index (NDVI), an indicator that shows vegetation cover. The aim of the present research work is to detect the vegetation changes around Godavri River Basin in Andhra Pradesh from 1992 to 2007. For the present study, two satellite images of Landsat-4 (TM) and Landsat-7 (ETM+) with spatial resolutions of 28m and 15m were used to prepare the land use land cover changes. The satellite images were classified into four classes namely water bodies, barren rock, moderate vegetation and dense forest. The study revealed that, moderate vegetation was increased from 50 to 55% and dense forest was decreased from 31 to 27%.

Key words : Change Detection,Godavari River Basin, NDVI, Remote Sensing.

Remote sensing techniques play vital role in solving many human and natural problems. These techniques have several advantages which lead to the understanding of these issues, their causes and how to overcome them. Remote Sensing (RS) is defined as the science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation (Lillesand et al. 2004). The idea is based on the fact that each object has its ownspectral signature that facilitates its clear distinction from another object.

Change detection analysis is one of the main applications of Remote Sensing (RS) techniques. It is to be applied to several applications such as urban growth, land use land cover changes, vegetation change etc. Several change detection methods have been developed worldwide to extract the information from remote-sensing imageries such as post classification comparison using supervised classification or unsupervised classification, Normalized Difference Vegetation Index (NDVI), Change Vector Analysis (CVA), visual interpretation and manual digitizing and differencing and rationing image. These techniques are useful tools to improve the decision processes in many applications which are to be utilized by planners, engineers, managers etc. The Normalized Difference Vegetation Index (NDVI) is an index of plant "greenness" or photosynthetic activity, and is one of the most commonly used vegetation indices. Vegetation indices are based on the observation that different surfaces reflect different types of light differently (Congalton, 1999). Photo synthetically active vegetation, in particular, absorbs most of the red light that hits it while reflecting much of the near infrared light. Vegetation that is dead or stressed reflects more red lights and less near infrared light. Likewise, non-vegetated surfaces have a much more even reflectance across the light spectrum (Congalton, 1999).

Higher NDVI values typically indicate a larger fraction of vegetation in a pixel. The amount of vegetation determines Land Surface Temperature (LST) by the latent heat flux from the surface to atmosphere via evapotranspiration. Lower LSTs usually are found in areas with high NDVI. The negative correlation between NDVI and LST is valuable for urban climate studies (Yuan and Bauer, 2007). Long term series of NDVI data generated from coarse spatial resolution sensors,

Table 1. The details of four NDVI classes.

Type of Class	Remarks
I	Water bodies, settlement with reflecting roofs, pakka roads and others
II	Settlements, barren land or rock surface, kaccha roads
III	Low vegetations, agricultural lands and others
IV	High vegetation, dense forest and others

are valuable tools for the detection of both temporally discrete changes, like forest clearing, as well as gradual changes such as long term precipitation decline (Hansen and DeFries, 2004). The present study aims to detect the vegetation changes around Godavari River Basin in Andhra Pradesh using Normalized Difference Vegetation Index (NDVI), from years 1992 to 2007.

MATERIAL AND METHODS

This study has been conducted at Godavari River basin in Andhra Pradesh. The basin lies between north latitudes of 17^0 072 to 19^0 142 and east longitudes of 78^0 442 to 81^0 572 . Godavari originates near Trimbak in Nashik District of Maharashtra state and flows east across the Deccan Plateau into the Bay of Bengal near Narasapuram in West Godavari district of Andhra Pradesh. The main tributaries of the River Godavari are Penganga River, Pranahita River, Indravati River, Manjira, Sabari River and Manair. The study area is located in the state of Andhra Pradesh (India) covering the parts of Adilabad, Karimnagar, Warangal, Khammam, and East Godavari districts. The Godavari River is the only river in India that flows from western to southern India and is considered to be one of the big river basins in India, with a length of 1465 km. Agriculture is the main occupation of the people live around the Godavari River.

Remote sensing techniques are employed for monitoring and mapping condition of ecosystems of any part of the earth. Vegetation indices allow us to delineate the distribution of vegetation and soil based on the characteristic reflectance patterns of green vegetation. The Normalized Difference Vegetation Index (NDVI) measures the amount of green vegetation and the vegetation cover is to be estimated using vegetation indices derived from satellite images. For NDVI classification, two satellite images have been obtained from the online archive of the Global Land Cover Facility (GLCF); one is Landsat- 4 Thematic Mapper (TM) imageries with spatial resolution of 28.5 m for the year 1992 and second one is Landsat-7 Enhanced Thematic Mapper plus (ETM+) imageries with spatial resolution of 28.5 m for the year 2007. Four classes such as water bodies, barren rock, dense forest and moderate vegetation are taken for NDVI classification. The spectral reflectance difference between Near Infrared (NIR) and red is used to calculate NDVI. The formula for NDVI is expressed as (Jensen, 2000);

$$NDVI = \frac{NIR - \mathrm{Re}\, d}{NIR + \mathrm{Re}\, d} \qquad (1)$$

The NDVI has been used widely in remote sensing studies since its development (Jensen, 2005). NDVI values range from -1.0 to 1.0, where higher values are for green vegetation and low values for other common surface materials. Bare soil is represented with NDVI values which are closest to 0 and water bodies are represented with negative NDVI values (Lillesand et al., 2004: Jasinski, 1990; Sader and Winne, 1992). Since NDVI provides useful information for detecting and interpreting vegetation land cover it and has been widely used in remote sensing studies (Gao, 1996: Myneni and Asrar, 1994; Sesnie et al., 2008).

RESULTS AND DISCUSSION

3.1 NDVI classification for Landsat- TM (1992)

Normalized Difference Vegetation Index (NDVI) classification for Landsat-4 (TM) is shown in the Figure 1. NDVI provides an accurate estimation of vegetation health and a means of monitoring

Figure 1. Normalized Difference Vegetation Index (NDVI) for Landsat-4 (TM) – 1992.

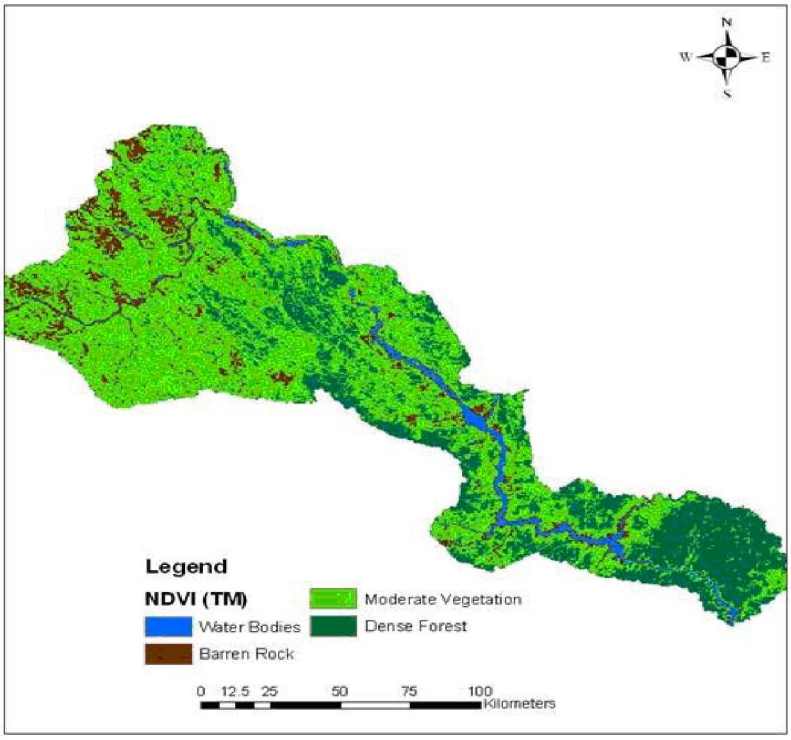


Figure 2. NDVI classification of Godavari River Basin with respect to area for Landsat-4 (TM).

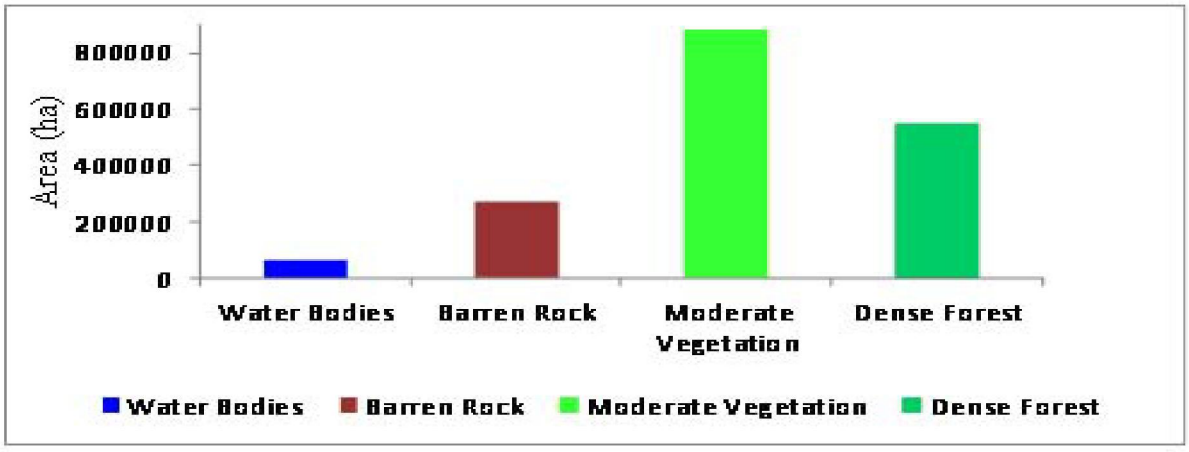
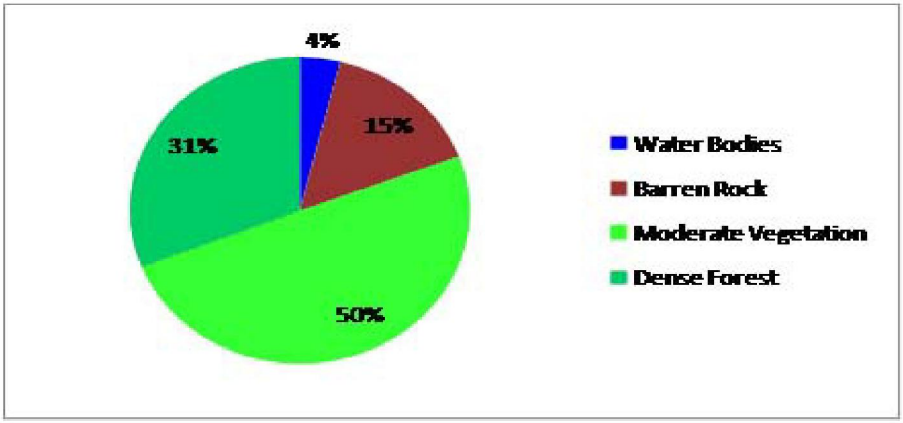


Figure 3: Percent NDVI classification of Gadavari Basin for Landsat-4 (TM).



changes in vegetation over time. The possible range of values is between -1 and 1. In this study, NDVI is divided into four groups and these are expressed in Table 1. Forthis study, NDVI value for Landsat-4 (TM) is ranges between -0.492958 to 0.742755. The status of different NDVI classes of Godavari Basin with respect to area is shown in the Figure 2. It is noticed that highest and lowest area occupied by NDVI classes are moderate vegetation and water bodies respectively. The percentage of each NDVI class viz. water bodies, barren rock, moderate vegetation and dense forest is depicted by pi-chart (Figure 3). It can be seen that 50% of the total study area covered by moderate vegetation followed by dense forest, (31%), barren rock (15%) and water bodies (4%) respectively. Water bodies, barren rock, moderate vegetation and dense forest occupied 67930. 25, 273113.54, 878976.66, and 546762.51 ha respectively as shown in Table 2.

3.2 NDVI classification for Landsat- ETM+ (2007)

The Normalized Vegetation Index map of study area of Landsat-7 (ETM+) during the year 2007 is shown in the Figure 4. The dominated NDVI class in the Godavari Basin is moderate vegetation followed by dense forest, barren rock and water bodies respectively as shown in Figure 5. The pi-chart as shown in Figure 6 gives the percentage NDVI classes of the study area. The Godavari River Basin consists of 55% moderate vegetation, 27% dense forest, 12% barren rock and 6% water bodies during the year 2007. Water bodies, barren rock, moderate vegetation and dense forest occupied 105127.23, 209136.47, 971664.41, and 480854.85 ha respectively as shown in the Table 3.For this study, NDVI value for Landsat- 7 (ETM+) is ranges between -0.726563 to 0.554688.

Table 2: Details of NDVI classification for Landsat-4 (TM)

Name of NDVI class	Landsat-4 (TM) Area in ha
Water bodies	67930.25
Barren rock	273113.54
Moderate Vegetation	878976.66
Dense forest	546762.51

Figure 4. Normalized Difference Vegetation Index (NDVI) for Landsat-7 (ETM+)-2007.

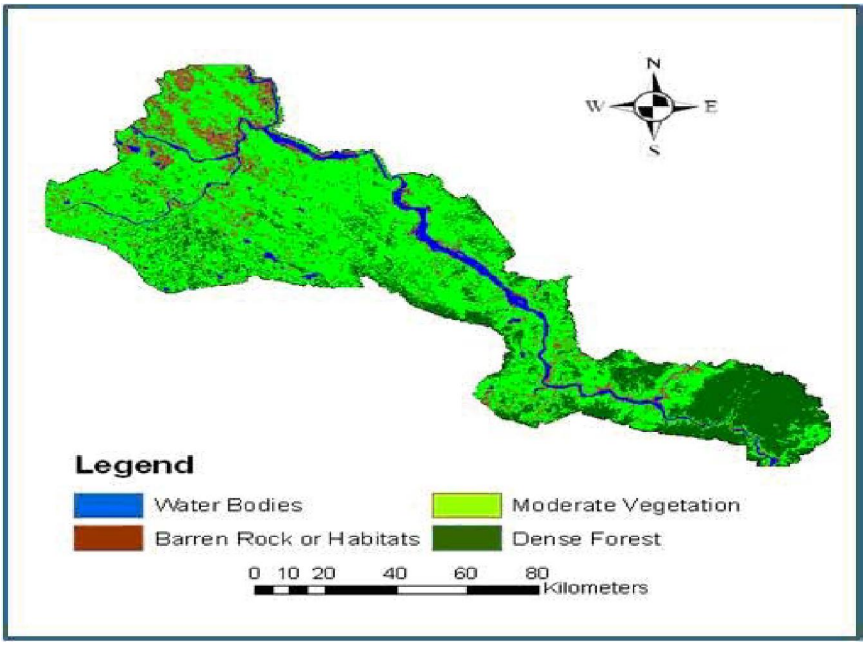


Figure 5. NDVI classification of Godavari River Basinwith respect to area for Landsat-7 (ETM+).

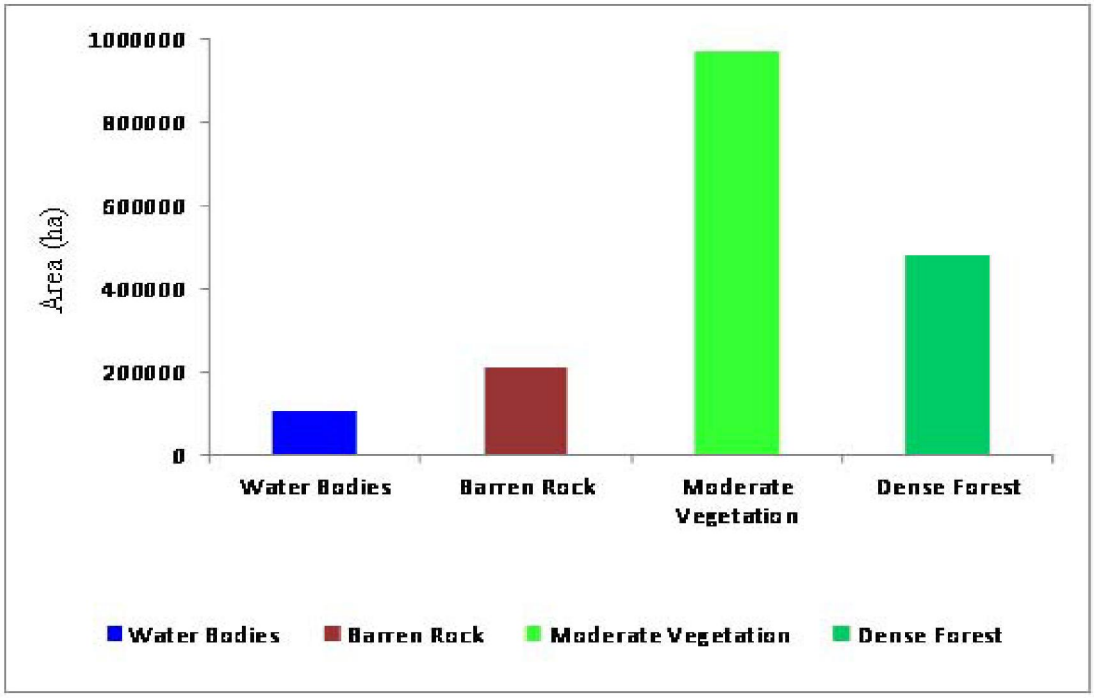


Figure 6. Percent NDVI classes of Godavari River basin for Landsat-7 (ETM+).

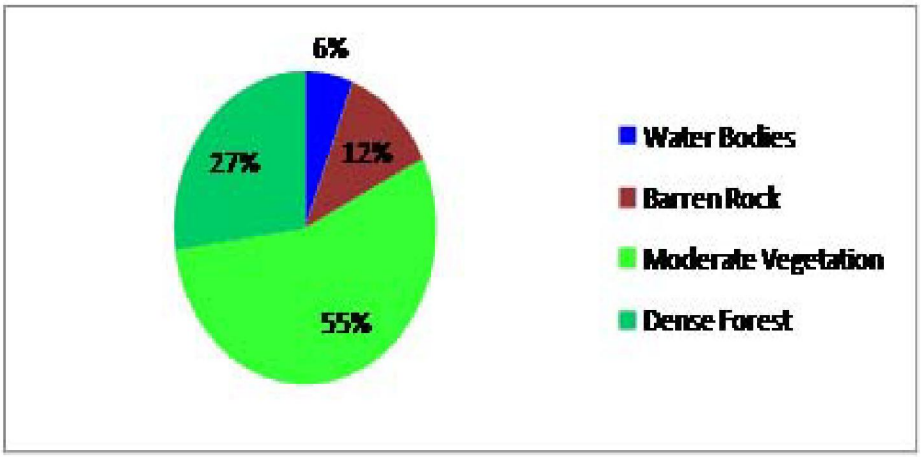


Table 3. Details of NDVI classification for Landsat-7 (ETM+).

Name of NDVI class	Landsat-7 (ETM+) Area in ha
Water bodies	105127.23
Barren rock	209136.47
Moderate Vegetation	971664.41
Dense forest	480854.85

3.3 NDVI Changes

The NDVI change detection analysis with respect to area between Landsat-4 (TM) and Landsat -7 (ETM+) images are performed for the years 1992 and 2007 are shown in Figure 7. The percent change in Normalized Vegetation Index of Godavari basin from 1992 to 2007 as shown in Figure 8. Table 3 displays the percent change of NDVI classes from 1992 to 2007. Finally, this study revealed that the water bodies slightly increased to 2% which is due to the widening of river reaches. Moderate vegetation increased to 5%, the reason is the conversion waste land/ barren rock to agriculture land. Barren rock and dense forest decreased to 3% and 4% respectively. Due to urbanization, barren rock and dense forest converted into habitats, agriculture land etc.

Figure 7. Comparison of NDVI classes with respect to area for two years 1992 and 2007.

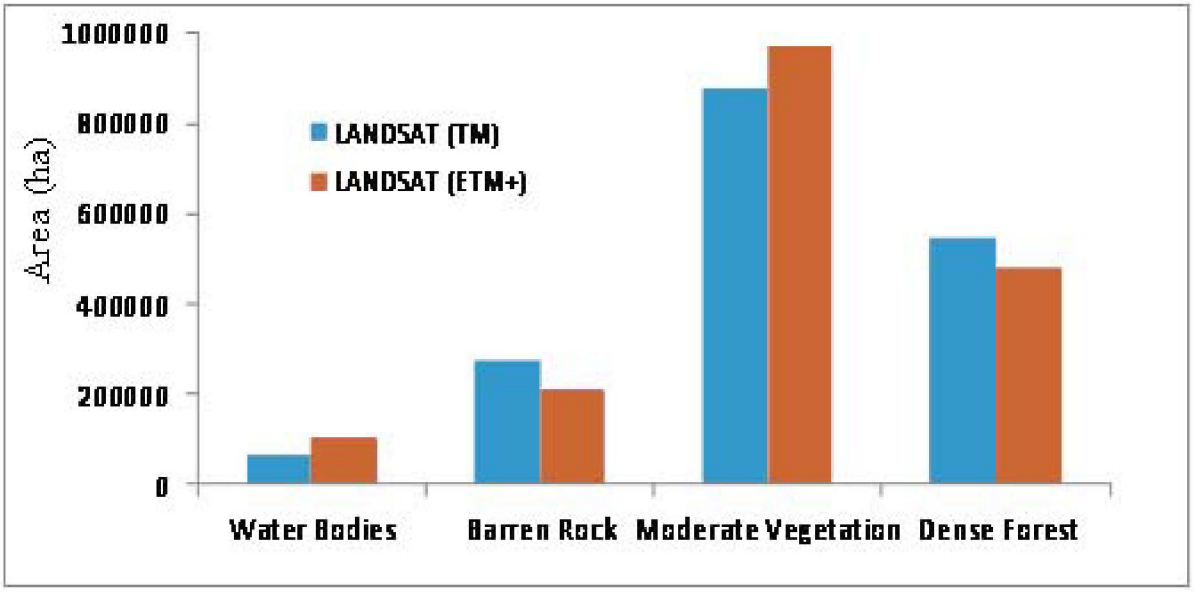


Figure 8. Percent change of NDVI classes from the year 1992 to 2007.

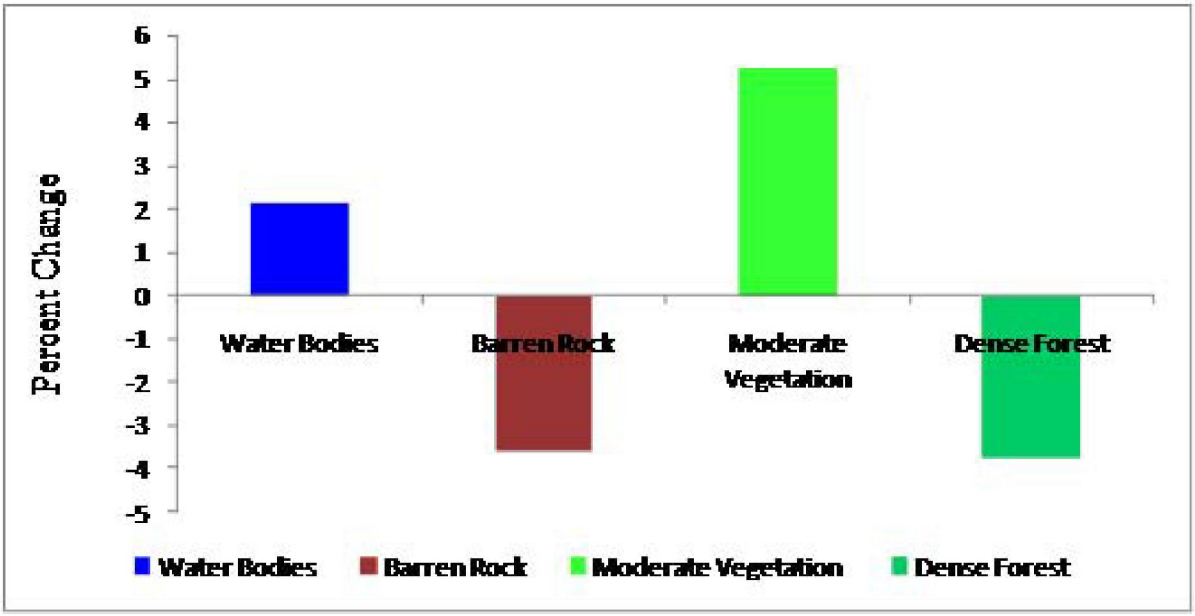


Table 4. Percent change of NDVI classes from 1992 to 2007.

Name of the NDVI class	Percent area for Landsat-4 (TM)	Percent area for Landsat-7 (ETM+)	Percent change
Water Bodies	4	6	2
Barren Rock	15	12	-3
Moderate Vegetation	50	55	5
Dense Forest	31	27	-4

4. Conclusions

NDVI changes were conducted for the Godavari basin, Andhra Pradesh using the satellite images of Landsat-4 (TM) and Landsat -7 (ETM+) for the years 1992 and 2007. The study reveals that, water bodies, barren rock, moderate vegetation, and dense forest occupied an area of 67930.25 ha, 273113.54 ha, 878976.66 ha, and 546762.51 ha respectively for Landsat-4 (TM). Landsat-7 (ETM+) covers in the geographical area of 6%, 12%, 55%, and 27% of water bodies, barren rock, moderate vegetation and dense forest respectively. Apart from the NDVI classification, NDVI change detection analysis was also performed. The NDVI change detection analysis revealed that form 1992 to 2007, the water bodies have been increased to 2%, barren rock decreased by 3%, moderate vegetation increased by 5% and dense forest decreased by 4%. Present research work suggested that more concentration is to be required and management practices are to be suggested to improve the forest area.

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(Received on 11.06.2012 and revised on 08.11.2012)