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THE RELATIONSHIP BETWEEN RAINFALL AND VEGETATION IN THE PUNE DIVISION (MAHARASHTRA)

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Abstract

Pune division is a large region with a complex topography and concentration of urban environment, encroachment of human activities that respond to variations in weather and pattern of land cover, land use. The complex physiographic condition of the Pune division shows the complexity of the distribution of rainfall. To examine dynamic changing vegetation, cover Normalized Difference Vegetation Index (NDVI) method and Landsat satellite images (TM, ETM+, TIRS sensor) are used. For the calculation of NDVI 0.20 value is used. Rainfall data was measured over the study region by different stations. Kriging operation and statistical analysis were used for the study of rainfall variability. To attain the exact relationship between rainfall and vegetation used Karl Pearson's correlation coefficient. The finding indicates that in the last two decades 7870.19 sq. km. vegetation cover wipes out from the Pune division. Sudden fall in rainfall distribution affects the loss of vegetation cover. The study reveals that alarming change in vegetation cover as well as rainfall distribution.

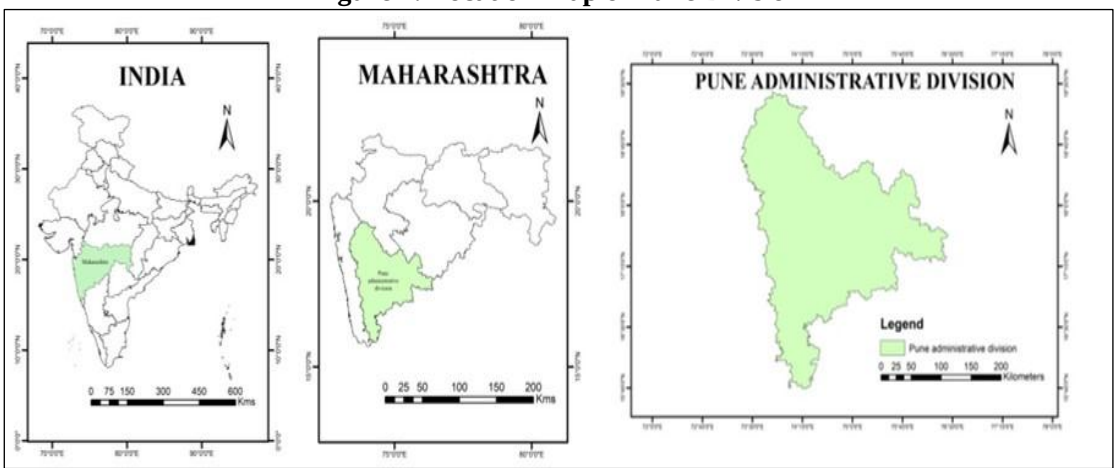
Key Words: *Encroachment, NDVI, Kriging, Sensor, Correlation Coefficient*

Introduction

With the influence of the complicated topography of the Deccan plateau, Sahyadri ranges, and South-West Monsoon, the Pune division is typical and representative of Western Maharashtra. The complex physiographic condition which leads to regional disparity in rainfall distribution, agriculture, urbanization, and demographic pressure shows the change in vegetation cover patterns in the Pune Division. Vegetation is a vital part of land cover that contributes to the ecosystem in many ways. 'No matter physical or cultivated vegetation, their growth processes are all affected by temperature, precipitation, etc.' (Nicholson et al. 1990, Li et al. 2000, Zhang et al. 2003). The rainfall regime is characterized by wide variation from year to year in the study region. The region faced droughts nine times since 1998. Therefore, an attempt will be made in this study, to map out the changing status of vegetation cover and the relationship between vegetation cover and rainfall.

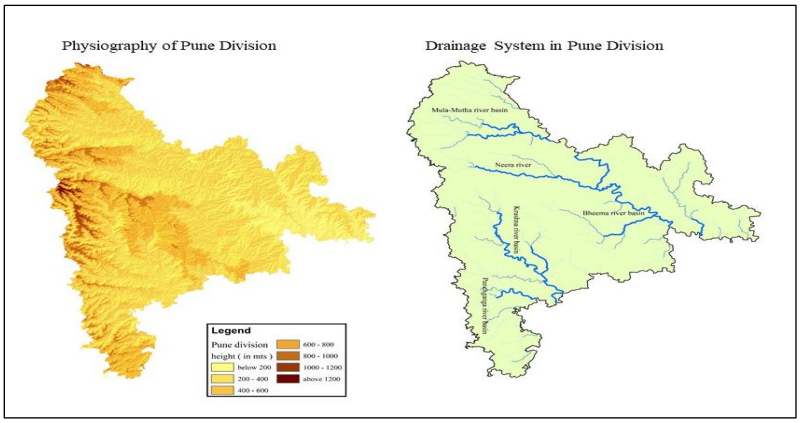
Study Area

Figure 1: Location Map of Pune Division



Source: Compiled by the author based on SOI Toposheet

Figure 2: Physiography and Drainage System of Pune Division



Source: Compiled by the author based on Landsat Data

Pune division is located in the western part of Maharashtra state of India. The extension of the Pune division is $15^0$44'30" to $19^0$24'7" North latitude and $73^0$20'52" to $76^0$25'23" East longitude. The area of the Pune division is 57090.97 sq. km. The average height of the study area is 560 mts above mean sea level. Pune division includes six administrative divisions namely Pune, Satara, Sangli, Solapur, and Kolhapur. The region may be divided into four physiographic divisions i.e., the Western hilly region, the Central undulating region, the Eastern highland plateau region & river basins of Bhima & Krishna. The climate of the region is essential for a tropical monsoon type. There are many river basins such as Mula-Mutha, Krishna, Panchganga, and Bhima. The region is diversifiable with plateaus such as Saswad (Pune district), Aundh (Satara district), Panchgani (Satara district), and Khanapur (Sangli district). Ridges like Harishchandra, Ambala (Pune), Mahadev (Satara), Chokodi (Kolhapur), Aashta (Sangli), and Balaghat (Solapur). It makes a region with physiographic importance.

Objectives: To examine the relationship between rainfall and vegetation cover in Pune Division.

Database And Methodology

The data required for vegetation cover mapping is collected from the Landsat series. Rainfall-related data is acquired from the maharain.gov website.

Table 1: Specification of Sensors of Landsat Series

Band	Wavelength (in mm)	Resolution (in m)
Sensor of Landsat 5 Thematic Mapper (TM)		
Band-3 Red	0.63 - 0.69	30
Band-4 NIR	0.76 - 0.90	30
The sensor of Landsat 7 Enhanced Thematic Mapper Plus (ETM+)		
Band-3 Red	0.63 - 0.69	30
Band-4 NIR	0.77 - 0.90	30
The sensor of Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)		
Band-4 Red	0.636 - 0.673	30
Band-5 NIR	0.851-0.879	30

Source: Compiled through USGS Earth Explorer Handbook

For the calculation of the distribution of vegetation in the study, the region used Normalized Difference Vegetation Index (NDVI). NDVI is a simple numerical indicator that can be used to analyze the remote sensing measurement, from a remote platform and assess whether the target or object being observed contains live green vegetation or not.

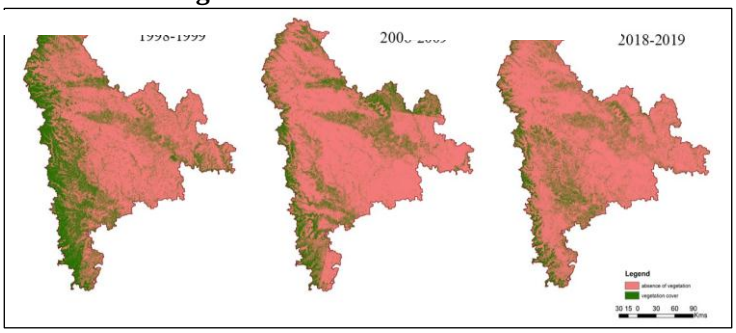
$$NDVI = (NIR - R)/ (NIR + R)$$

NIR is the reflectance in the Near-Infrared Band (760-900nm), and R is the reflectance in the Red Band (630-690nm) NDVI method is applied according to the characteristics of the vegetation at different NDVI threshold values. We used a 0.20 value for the calculation. **Kriging interpolation** is mathematical assuming closer values are more related than further values with its function which is useful for the rainfall dispersion mapping.To find out the relationship between vegetation cover and rainfall used Karl Pearson's Correlation Coefficient formula.

Analysis : According to NDVI 1999, 32.14 percent of the Pune division is covered with vegetation. The western boundary of the region has a luxuriant place for vegetation growth. The Sahyadri range and Krishna river basin are covered with more vegetation cover. The river

basin of Mula-Mutha and the bank of Neera river has enough vegetation cover. On the contrary, the rain shadow area of Satara and the middle part of the Krishna, Bhima river basin has thin vegetation growth. Kolhapur district shows the highest NDVI followed by Satara, Pune, Sangli, and Solapur.

Figure 3: Distribution of Vegetation Cover in the Pune Division



Source: Compiled by the author based on Landsat Data

According to NDVI 2009, 21.13 percent of the region is covered with vegetation. This year, western the region has compacted vegetation but the proportion of vegetation cover is decreased. The vegetation cover in the Krishna river basin and Mula-Mutha river basin is constant. The northeast part of the Pune division has more vegetation compared to the NDVI of 1999. According to NDVI 2018, 10483.08 sq. km areas out of the total area of the Pune division have been covered with vegetation. This is only 18.36 percent compare to the area of the Pune division. Vegetation cover in the study region is decreasing rapidly. The western boundary of the Pune division only has ample heavy vegetation cover. An exception for the western boundary, all area of the study region has rarified vegetation cover. Kolhapur has more vegetation cover in twenty years but the Solapur district has minimum vegetation cover throughout the study time. The graph of vegetation cover area is going fall from 1999 to2018. Vegetation cover is slump by 13.78 percent in the past twenty years and the downward rate graph is grave

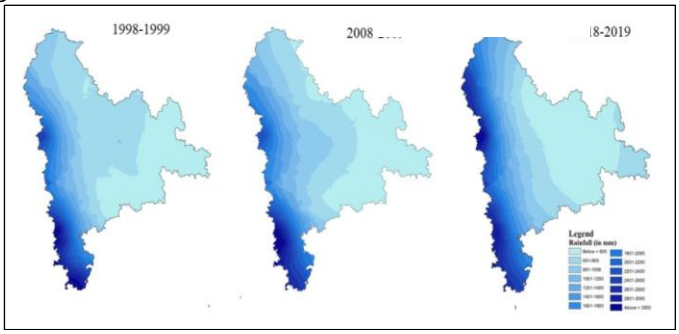
.**Table 2: Distribution of annual rainfall in the Pune Division**

Rainfall (in mm) / District	Pune	Solapur	Satara	Sangli	Kolhapur
1998-99	**884.6**	**648.7**	**1335.5**	**642.5**	**2125.6**
2008-09	**971.5**	**706.5**	**1405.6**	**745.4**	**2036.1**
2018-19	**775.2**	**263**	**959**	**485.6**	**1421.5**

Source: Compiled by the author based on the Maharain.gov.in website

Pune Division received 5636.9 mm of annual rainfall in 1999. The highest rainfall was recorded in Kolhapur followed by Satara, Pune, Solapur, and Sangli. Sangli received only one-third part of the rainfall of Kolhapur record. The annual rainfall of the Pune division is 5865.1 mm in the year 2009. As we go from the southern part of the Pune division to the northern part and east parts, rainfall goes decreasing. In 2018, the annual rainfall of the Pune division is about 3904.3 mm. Solapur district receives only 263 mm of rainfall throughout the year. Sangli, Pune, and Satara have rainfall between 480 mm to 1000 mm. Kolhapur recorded the highest rainfall i.e., 1421.5 mm which is less than 700 mm compared to the annual rainfall of Kolhapur district in 2009.

Figure 4: Distribution of Annual Rainfall in the Pune Division



Source: Compiled by the author based on the Maharain.gov.in website

Comparing three years of study, Karl Pearson's correlation coefficient is 0.57. It shows a moderate positive relationship between vegetation cover and rainfall. If the rainfall will increase the vegetation augmentation is definite. The year 2018 received minimum rainfall. In 2018 the vegetation cover is the lowest. In twenty years, rainfall decreased by 1732.6 mm and vegetation cover decreased by 7870.5 sq. km. When we look toward the NDVI and district-wise rainfall distribution of 1999, we can see that Kolhapur district has maximum rainfall and highest NDVI value, and Solapur district has minimum rainfall and lowest NDVI value. As we see from west to east, the rainfall and NDVI value goes decreasing.

Conclusion

It is found that the NDVI value reaches a maximum in the year 1998-99 and a minimum in the year 2018-19. Vegetation cover in the study area is slump by 13.78 percent in the last twenty years. The rate of rainfall distribution since 1999 is not constant. The year 2018 recorded minimum annual rainfall. In twenty years, annual rainfall decreased by 1732.6 mm. Rainfall is an important constraint to the vegetation cover in the Pune division. Sudden fall in rainfall distribution affects vegetation cover.

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