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Climatic, Geomorphic and Environmental Characteristics of Savanna Morphogenetic Region: A Case Study of Maharashtra State, India

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Abstract The present study focuses on assessing climatic, geomorphic, and environmental factors at the regional scale. Peltier's model, combined with RS data and GIS techniques, is employed to accomplish this study's goal and find out the characterization of the morphogenetic region. The climatic data of mean annual rainfall and temperature (last 63 years) are used to delineate the morphogenetic areas. Different thematic maps from various sources such as Geomorphology of India; Geological Survey of India (GSI), Geology and mineral map of Maharashtra (GSI), Soil region map of India; National Atlas of India, Soil map of Maharashtra; National Bureau of Soil Survey and Land Use Planning (NBSS) are used for analysing the characteristics of Savanna morphogenetic regions. Relative relief, slope, wind speed and humidity were used for the characterization. Maximum rainfall is received 861.14 mm, minimum occur 611.75 mm rainfall. The average annual temperature of the region is 26.27°C with a maximum 27.75°C and minimum 20.26°C temperature. The relative humidity is high during the southwest monsoon months and mostly dry during the rest of the year. The maximum humidity is recorded in SW part of the region (47.50%), whereas the lowest in NE direction (69.5%). The mean annual humidity is 54.75 % and the range of humidity is 22%. The maximum wind speed is 12.31 km/ph and a minimum 6.20 km/ph. The mean annual wind speed is 10.25 km/ph and range from 6.11 km/ph. The slope aspects of the area affect the denudation processes of the hilly tracts. The entire region is dominated by moderate chemical weathering. The whole region is dominated by maximum to moderate wind action. Maximum pluvial erosion and moderate weathering processes show in the study region. The study region covers different slope units with undissected and dissected. Undissected elements cover 1571.90 km^2 (1.84%), and dissected cover the area 30670.80 km^2 (35.95%).

Keywords: *geomorphic, morphogenetic, region, savanna, Maharashtra, NDVI*

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1. Introduction

The morphogenetic characteristics of different regions provide essential inputs for the assessment and interpretation of planning and management. Such kind of morphogenetic investigation may assist in perceptive any allocation of natural resources and provides detailed information about the landforms and processes of regions. First of all the morphogenetic classification was proposed by Budel (German Geographer) [1]. The concept of morphogenetic regions do describes a set of specific climatic conditions and dominates geomorphic processes. Therefore, it establishes regional morphogenetic characteristics to the landscape, which set it off from those other regions developed under dissimilar climatic situation [2]. The study of Peltier's (1950) is presently considered as the best source for explaining various geomorphic processes [3]. Most researchers in geology, geomorphology, and other relevant subjects still apply his study to describe the complex processes continually happening on the earth's surface. Therefore, climatic, geomorphic, and environmental characteristics have been studied for the Savanna Morphogenetic Region of Maharashtra State in the present investigation.

The present day's data sources are improved such as topographical maps, aerial photographs and satellite images. Modern techniques help the quantitative analysis of slopes using data driven methods. Relief is commonly regarded as the range in altitude [4]. Penck [5] emphasis to work on slope. The technique of slope analysis is suggested by many geomorphologists like [6,7,8,9,10,11], and they have contributed in slope analysis and physiographic investigation on earth surface.

Measurement of slope angles in the field and instrumentation of process (weathering, mass wasting, and

movement and erosion) acting on the hill slopes. The significant contribution in slope studies have been made by [12,13,14,15,16,17,18,19,20,21,22,23,24]. The region is classified in different slope angle categories i.e. very gentle slope, gentle slope, moderate slope, moderately steep slope, steep slope, very steep slope.

The slope aspect is defined as the gradient vector's directional component and is the direction of the maximum gradient of the surface at a given point. As with slope, aspect is calculated from estimates of the partial derivative. NDVI was first used by Rouse et al. (1973) from the Remote Sensing Centre of Texas A&M University [25]. The Normalized Difference Vegetation Index (NDVI) is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum and is adopted to analyze remote sensing measurements and assess whether the target being observed contains live green vegetation present or absent [26,27]. Generally, healthy vegetation will absorb most of the visible light that falls on it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation reflects more visible light and less near-infrared light. Bare soils, on the other hand, reflect moderately in both the red and infrared portion of the electromagnetic spectrum [28]. Therefore, NDVI was used for the determination of vegetation cover in the study region. The present study's main objective is to study the geomorphic and climatic characteristics of the study area.

2. Study Area

Maharashtra state is located in the central-western part of India, confined in 15° 44′–22° 06′ N latitudes and 74° 52′– 78° 53′ E longitudes (Figure 1). This region covers the area of 85324 km^{2,} which comprises 27.74% to the total area of Maharashtra (Figure 1). Savanna region is located in the centre of Maharashtra and also situated eastern site of western Ghat. The climatic conditions in the study region vary deeply. This morphogenetic region extends over the area having mean annual rainfall between 635 to 1270 mm (millimetres), and temperature varies from 12.22 to 29.44 degrees Celsius. The climatic conditions in the study region vary deeply. It is observed that the rainfall and temperature vary from west to east. Maximum pluvial erosion and moderate weathering processes show in the study region. The western site of Maharashtra experiences heavy rain due to the Arabian branch of monsoon as Western Ghat stays as a barrier. It prevents the cloud from entering the continental part of Maharashtra. The study area shows semi-arid dry climatic conditions throughout the year and severe water resource scarcity [29].

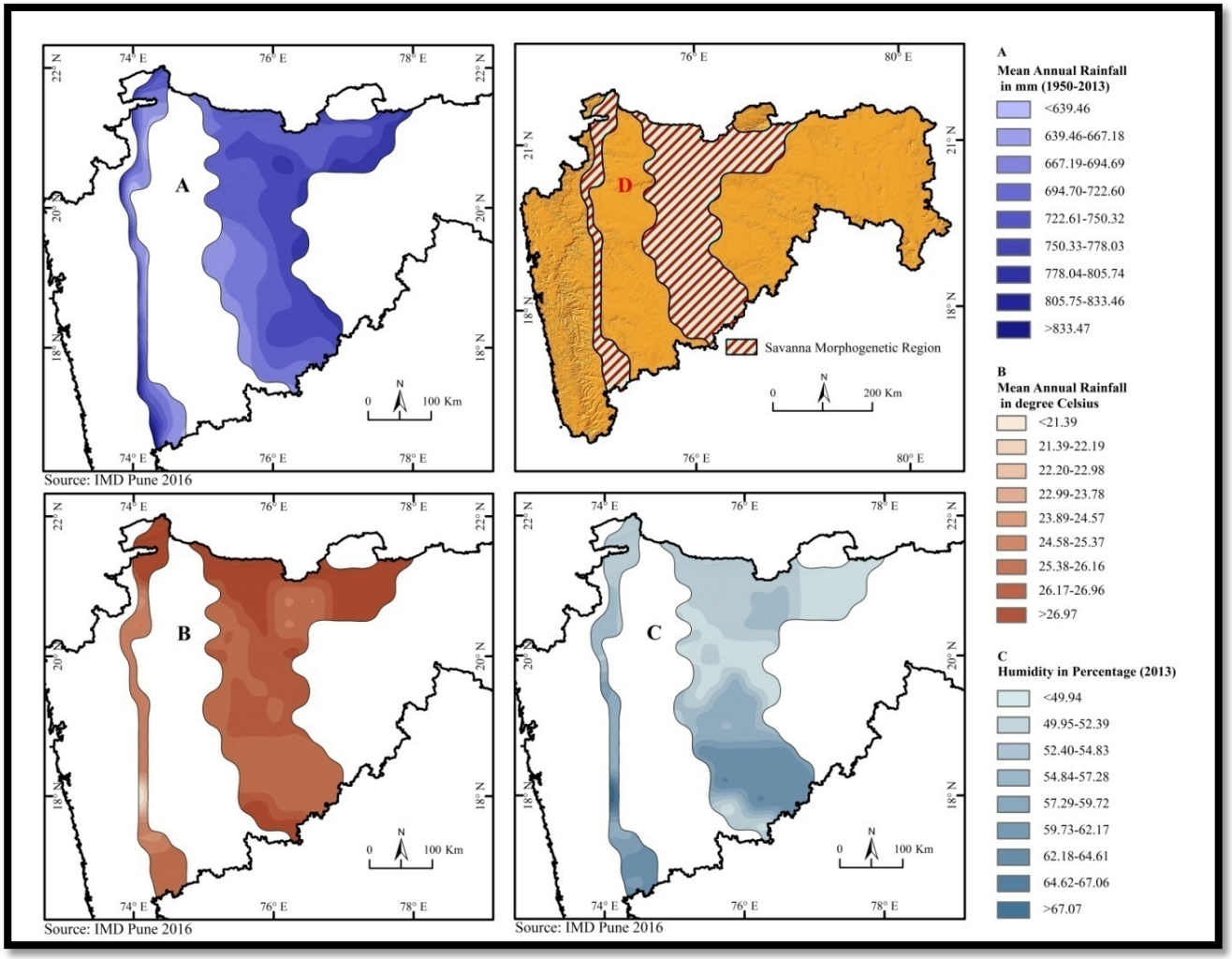

Figure 1. Rainfall (A), Temperature (B) and Humidity (C) distribution map of Savanna morphogenetic region and (D) Location of the region

3. Materials and Methods

Grid-based (0.25° × 0.25°) daily rainfall and temperature data are procured from India Meteorological Department (IMD) for a time span of 1951-2018.

Drainage density, a geomorphologic concept, was first instructed by Horton in 1932. Drainage density is the ratio of total length of all stream segments of in a given drainage basin to the total area of that basin. On the basis of drainage network and drainage, density maps have been prepared (Horton 1932) using ArcMap 10.3 software.

$$D_d = \frac{\sum L_K}{A_K}$$

D_d = Drainage density
$\sum L_K$ = Total length of all stream segments
A_K = Total area of the basin.

The SRTM DEM data are converted in hill shed, the linear features are digitized and verified on Google Earth. Geological lineament density map was generated in ArcMap 10.3 software. The direction and lineament statistics are produces using the Rockworks16 software. The purpose of the lineament density analysis is to calculate the frequency of the lineaments per unit area. This is also known as lineament-frequency [30]. Based on the analysis, a map is produced, showing concentrations of the lineaments over the area. Analysis of lineament density is performed by counting the number of lineaments contained in the specified area.

Various thematic maps from various sources such as Geomorphology of India; Geological Survey of India (GSI), Geology and mineral map of Maharashtra, Soil region map of India; National Atlas of India, Soil map of Maharashtra; National Bureau of Soil Survey and Land Use Planning (NBSS) are used for analysing the characteristics of morphogenetic regions.

A vegetation index can be defined as a parameter calculated from reflectance values at different wavelengths and is particularly sensitive to vegetation cover, according to Gilabert et al. (2002).

$$NDVI = \frac{NIR - Red}{NIR + RED}$$

NDVI= Normalized Differential Vegetation Index
IR= Reflectivity in the near infrared
R= Reflectivity in the red.

Advanced wide field sensor (AWiFS) onboard Resourcesat-1 with 56m spatial resolution; 5 days receptivity and 740km swath has enabled the prospects of near-real-time monitoring of dynamic natural resources. Resourcesat-1data downloaded from Bhuvan special bands B2, B3, B4 and B5. Each module covers a swath of 370 Km providing a combined swath of 740 Km with a side lap between them for the vegetation cover analysis of study area. Entire region is classified into three category including dense vegetation, Water body and no class. All data plates are the download of the same year and same month for analysis (Figure 2).

The NDWI was developed by McFeeters (1996). The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features. The reflectance of water is higher in the green band and lower in NIR band, but the reflectance of vegetation is higher in NIR band than the green band. The subtraction of NIR band from green band in the numerator of NDWI will result in positive values of water features and negative values of vegetation. It has been found that water features may not be accurately extracted using NDWI due to the spectral confusion of built-up land with water bodies because built-up land may also have positive values in the NDWI-derived image. The water bodies are also extracted from satellite images.

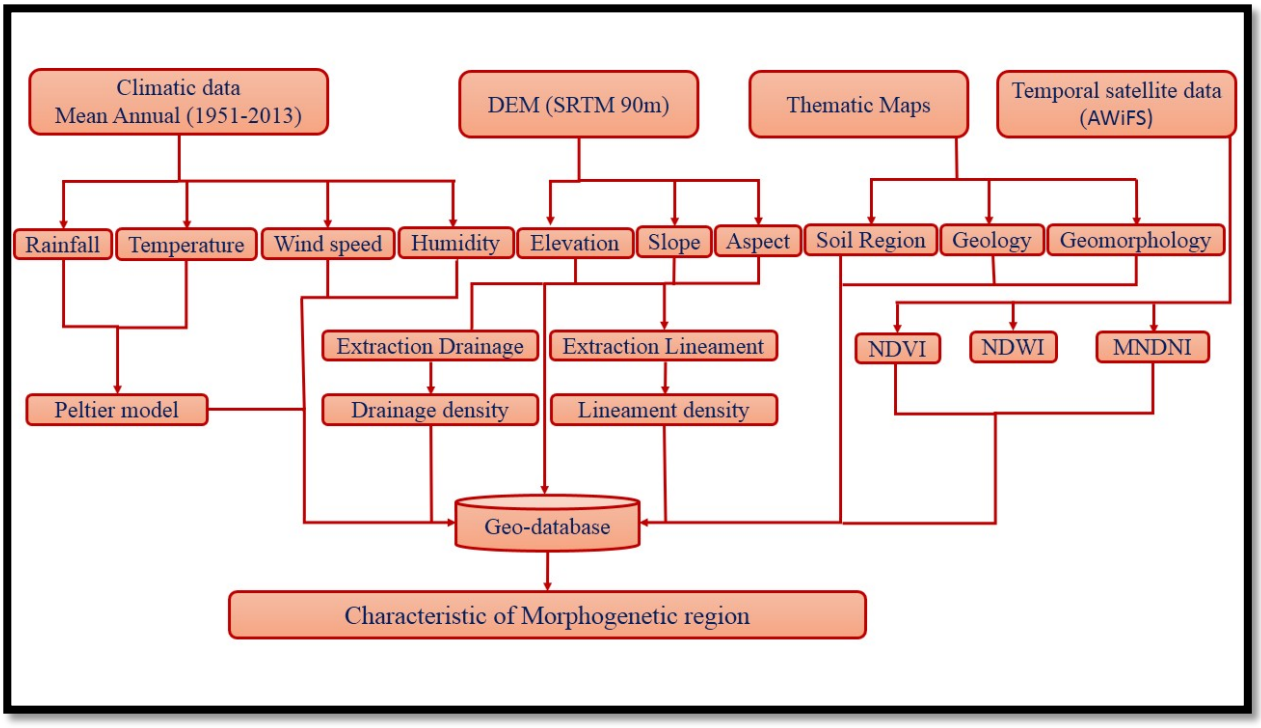

Figure 2. Schematic diagram of methodology (Characteristic of the region)

The high contrast in the reflectance of water in the green spectral range with respect to the NIR and SWIR region is an important characteristic. These characteristics were used to automatically delineate water feature using Normalized Difference Water Index (NDWI). The NDWI was subsequently refined as Modified Normalized Difference Water Index (MNDWI). The definitions of these spectral indices are:

$$NDWI = \frac{Green - NIR}{Green + NIR}$$

$$MNDWI = \frac{Green - SWIR}{Green + SWIR}$$

Where Green represents the reflectance of the green band (band 2 of AWiFS), NIR represents the reflectance of the near-infrared band (band 4 of AWiFS), and SWIR represents the reflectance of the short wave Infrared band (band 5 of AWiFS).

4. Result and Discussion

4.1. Rainfall Characteristics of Savanna Morphogenetic Region

The region lies mostly in the rain shadow zone situated to the east of Western Ghats. The average of 63 years annual rainfall in the region is 745.58 mm. Maximum rainfall is received in SW area having 861.14 mm, and minimum occur in the south region having 611.75 mm. The range of rainfall is 249.39 mm. About 70% of the annual rainfall in the region is received during the southwest monsoon season, September being the rainiest month. About 20 % of the annual rainfall in the region isreceived in the post monsoon months of October and November. The variation in theannual rainfall from year to year is not much significant (Figure 1-A).

The temperature varies through the region, the lowest temperature recorded in the region's SW direction and highest in NE part. The average annual temperature of the region is 26.27°C with a maximum 27.75°C and minimum 20.26°C temperature in NE parts and SW part of the region respectively with the range of temperature of about 7.15°C (Figure 1-B). The relative humidity is high during the southwest monsoon months and mostly dry during the rest of the year. The maximum humidity is recorded in SW part of the region (47.50%), whereas the lowest in NE direction (69.5%). The mean annual humidity is 54.75 %, and the range of humidity is 22% (Figure 1 C). The maximum wind speed is 12.31 km/ph and a minimum 6.20 km/ph. The mean annual wind speed is 10.25 km/ph and range 6.11 km/ph.

4.2. Physiography of Savanna Region

The northern part of the Tapi River shows the lowest elevation of about 55 m ASL and highest in NW direction 1392 m ASL with range elevation of 1337 m (Figure 3).

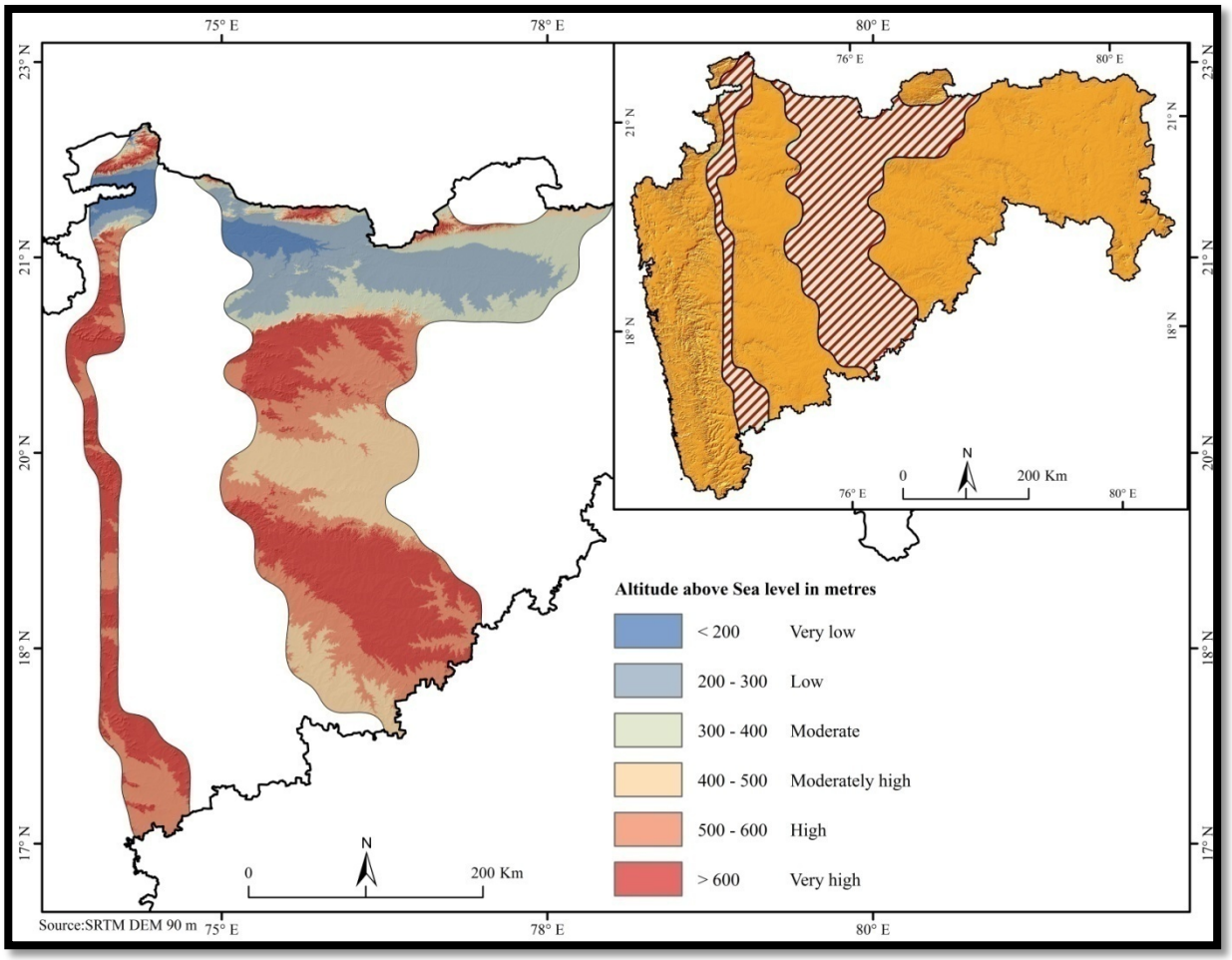

Figure 3. Elevation map of Savanna region

Table 1. Physical division of Savanna region

*Relative Relief (m)	Remark	#Area (km^2)	Area (%)
>200	Very low (Almost flat)	3059	3.59
200-300	Low	12350	14.47
300-400	Moderate	8830	10.35
400-500	Moderately high	14300	16.76
500-600	High	20073	23.53
>600	Very high	26712	31.31
	Total	85324	100.00

*SRTM DEM 90m, *Area calculated by the author with the nearest approximation.

More than 71% of the total area falls under moderately high zone to very high zone, (>400 m) ASL and only 28.4% area in below 400 m ASL. The west side of the region has a higher elevation as compared to the east side (Table 1). Plain areas dominate the almost entire region with varying slope gradient and aspect (Table 2). Over 92.95% of the area has slope angles less than 6°, whereas only 10 km^{2}area is covered by steep slopes (>45°) (Figure 3). The slope aspect map shows the relative position of slope facets with respect to the north direction. Slope aspects of the area affect the denudation processes of the hilly tracts (Figure 5).

Table 2. Slope division of Savanna region

*Angle class	Remarks	*Area (km^2)	Area (%)
≤ 6	Very Gentle slope	79312	92.95
6-12	Gentle slope	3552	4.16
12-22	Moderate slope	1921	2.25
22-31	Moderately steep slope	438	0.51
31-45	Steep slope	90	0.11
> 45	Very steep slope	10	0.01
	Total	85324	100.00

*SRTM DEM 90m, *Area calculated by the author with the nearest approximation.

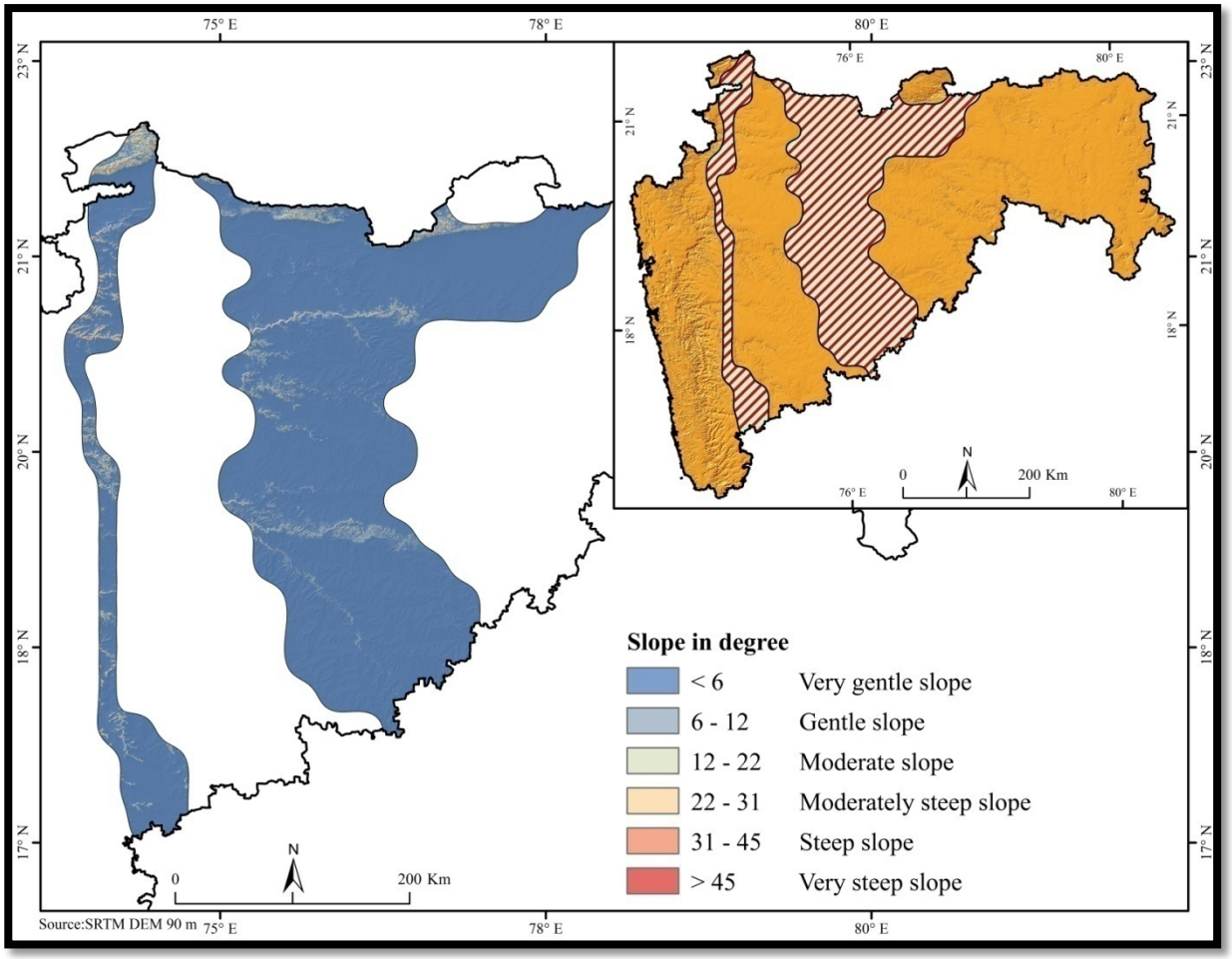

Figure 4. Slope map of Savanna region

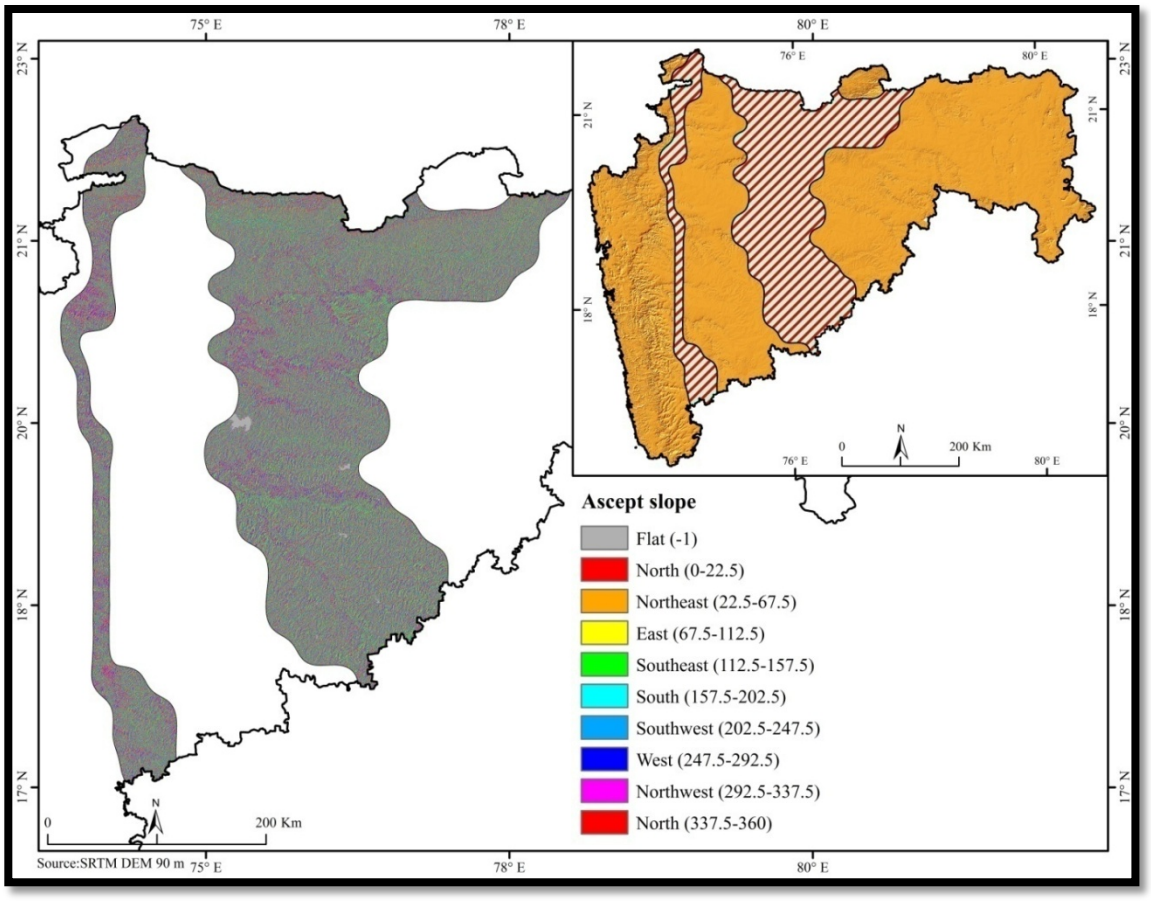

Figure 5. Slops aspect map of Savanna region

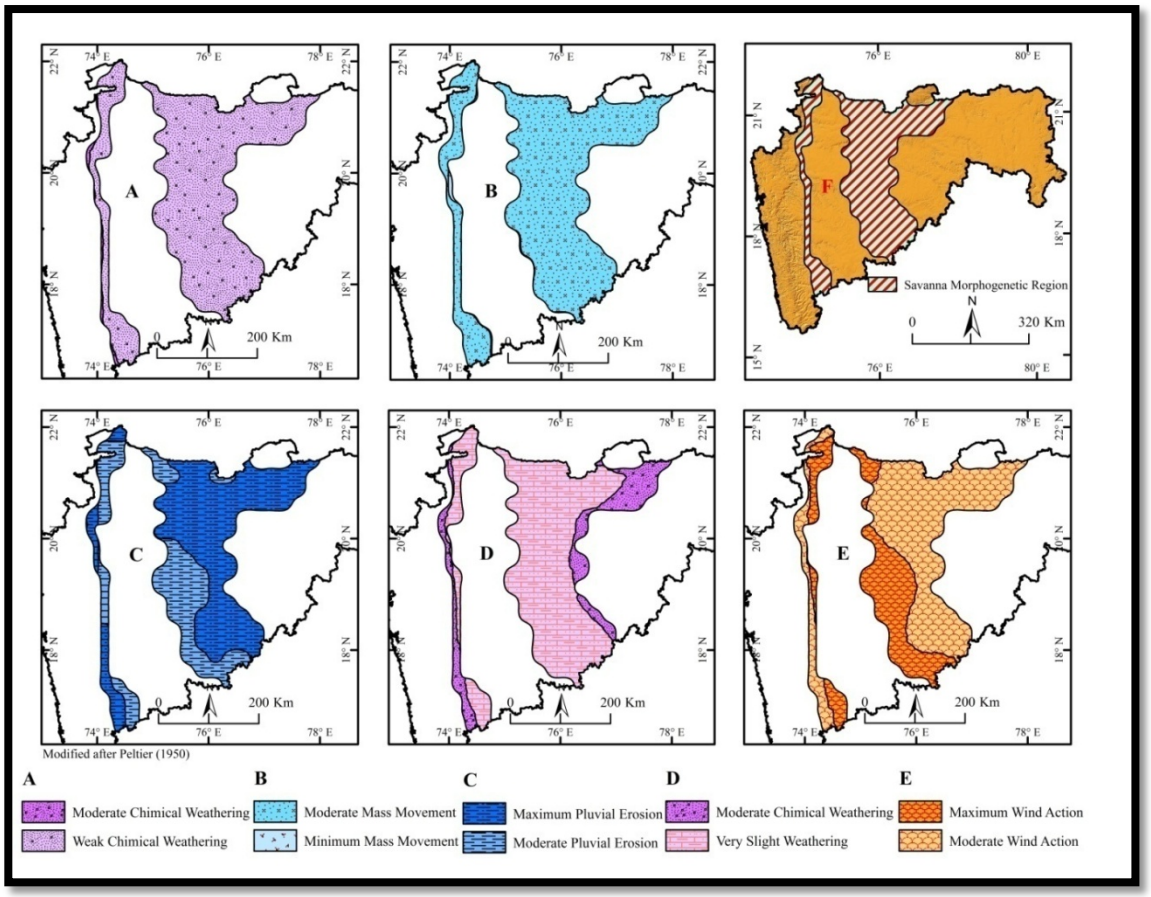

Figure 6. Morphogenetic processes in Savanna region: Chemical weathering (A), Mass movement (B), Pluvial erosion (C), Weathering region (D), Wind action (E) Location of the region (F)

4.3. Morphogenetic Processes in Savanna Region

The weathering characteristics of the region are described in Figure 6. The entire region is dominated by moderate chemical weathering due to low rainfall and humidity (Figure 6-A), very slight to moderate weathering (Figure 6-D), moderate mass movement (Figure 6-B), maximum to moderate pluvial erosion (Figure 6-C) because of lack of vegetation. The entire region is dominated by maximum to moderate wind action (Figure 6-E).

4.4. Geology of Savanna region

Deccan trap covers the highest area of the Savanna region (75437.59 km^2) i.e., 88.41% of the total area (Table 3). On the only north side of the Savanna region we can see the 'Alluvium' in the river Tapi basin, which is a recent formation, covers 9886.36 km^2area (11.59%). Adyalkar (1975) studied alluvial deposits of this area and has described the basement topography of Tapi valley [31]. Based on bore log data, it is estimated that the alluvial deposits are as deep as 200 m in Tapi valley and even deeper, up to about 400 m, in Purna valley (Figure 7).

4.5. Geomorphology of Savanna region

The Savanna region may be divided in different geomorphic units and the various tropical weathering landforms. The area covers ridges or hills with intervening broad undulating plains coves 577.11 km^2 (0.68%) area. Table 4 presents the area and percentage of area covers for different geomorphological units. The entire region covers different slope units with undissected and dissected. Undissected elements cover 1571.90 km^2 (1.84%), and dissected cover the area 30670.80 km^2 (35.95%).

Geologically, the almost entire region is covered by the Deccan trap with inter trappean beds, whereas lava plateaus cover the second largest area of the Savanna region, Undissected and dissected plateaus cover 20,306.75 km^2 (23.80%) and 1,101.36 km^2 (1.29%) area respectively. Rocky terraces cover 132.55 km^2 area (0.16%). Low lying plains 1,465.70 km^2 area (1.72%).

Table 3. Area wise distribution of the Geological units in the Savanna region with Geological time scale

Sr. No.	Geology	Geological period	Area (km^2)	Area (%)
1	Alluvium	Recent	9886.36	11.59
2	Deccantrap with inter Trappean Beds	Cretaceous-Eocene	75437.59	88.41

Source: Geology and mineral mop of Maharashtra (Geological Survey of India), *Area calculated by the author with the nearest approximation.

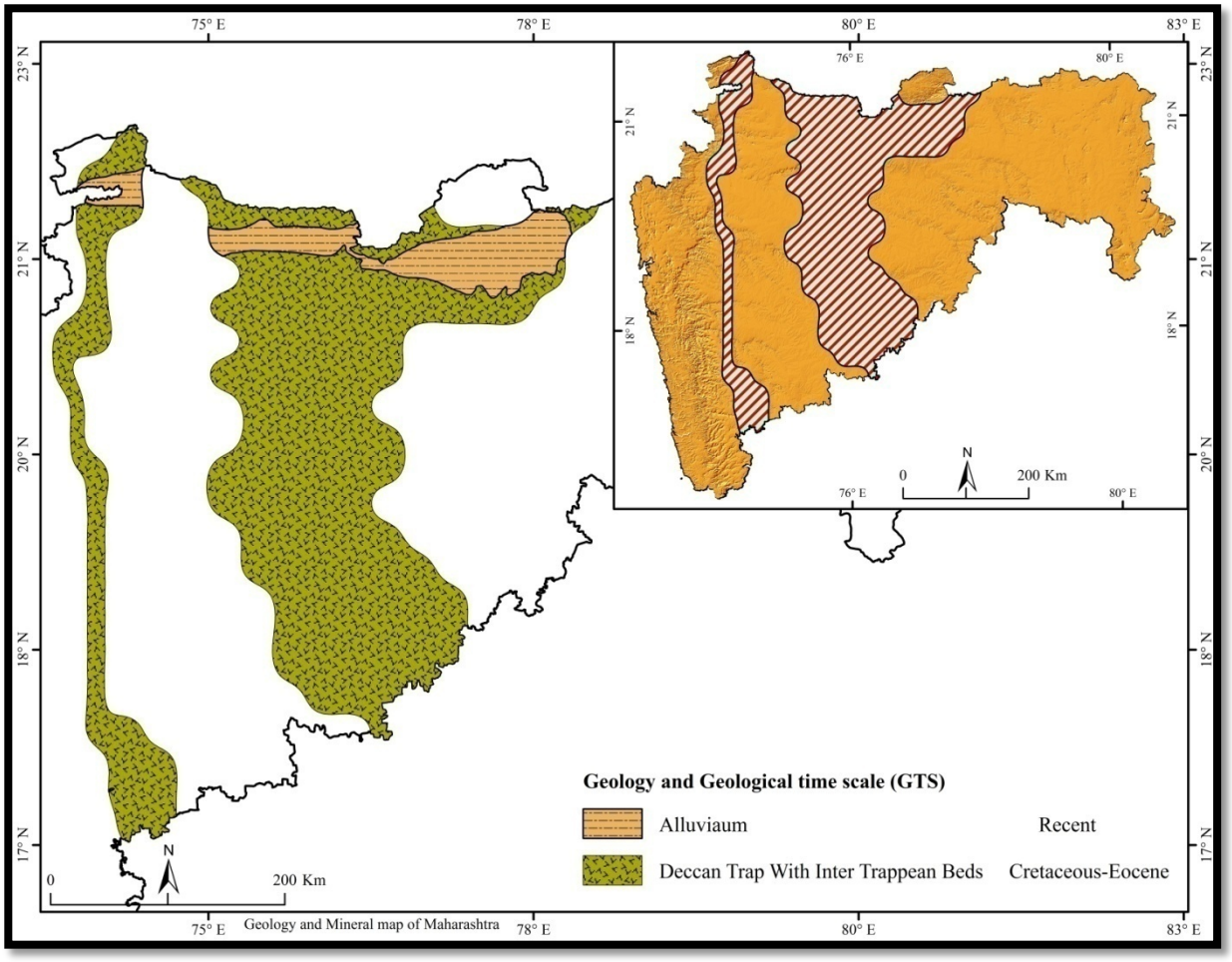

Figure 7. Geological map of Savanna region

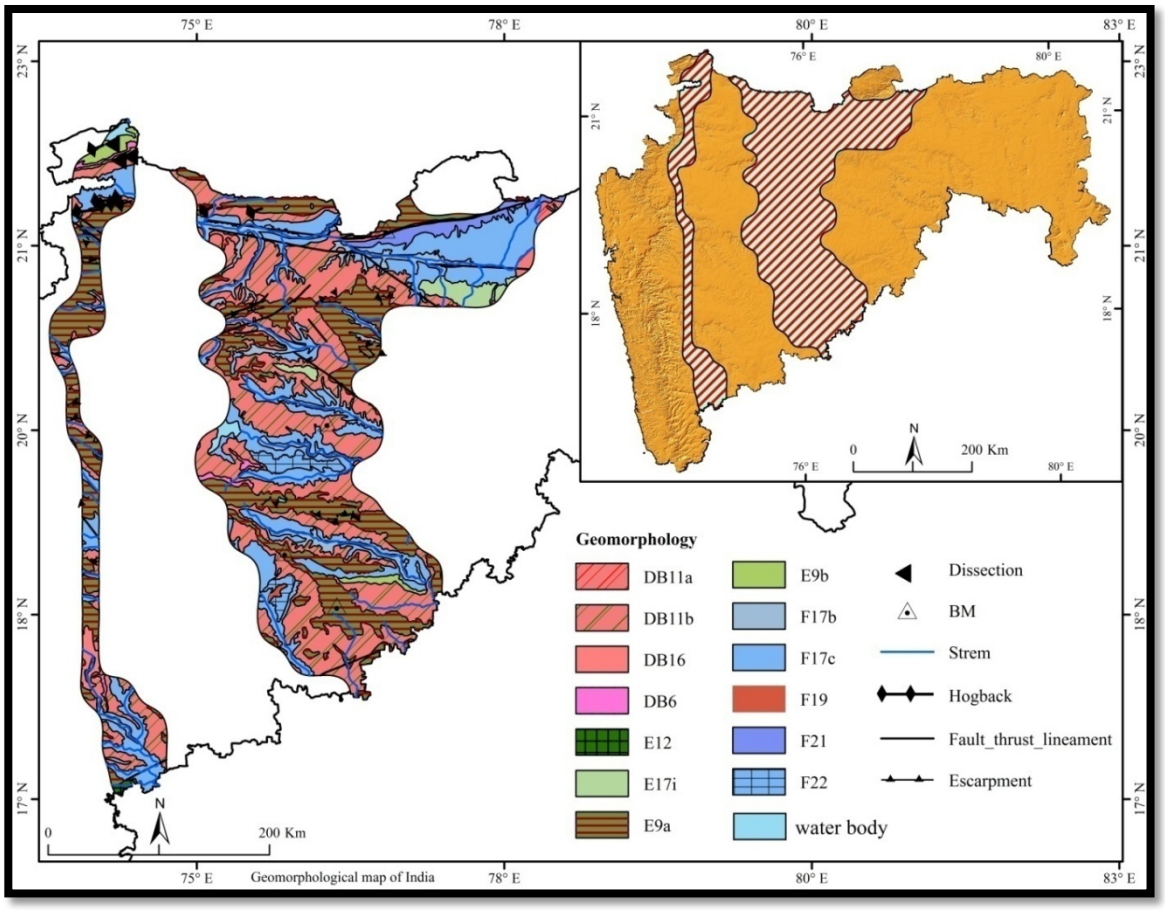

Figure 8. Geomorphological map of Savanna region

Figure 8 represents the geomorphology of the Savanna region. The area is characterized by low rainfall and high-temperature range and its impact on denudation processes. The whole area is characterized by slight to moderate chemical weathering due to which very small pockets cover deeply weathered plains.

In rives of Tapi, Godavari, and Bhima basin, low lying plains are formatted. Present floodplains and older alluvial plains covers 5,715.13 km^2 (6.70%) and 19,732.26 km^2 (23.13). Infilled valleys with or without alluvial ridges cover 95.94 km^2 (0.11%) area. Colluvial foot slopes cover the area of 1,545.43 km^2 (1.81%) followed by riverine terraces 1,349.26 km^2 area (1.58%) and water bodies (major dams, ponds, and water in river channel) 519.48 km^2 area (0.61%).

Table 4. Geomorphological units in the Savanna region

D	Unit of Denudational Origin (D)				*Area (km^2)	Area (%)
	DB	Denudation with minimalcontrol of Structure (DB)				
		DB6	Ridges/Hills with intervening broad undulating Plains		577.11	0.68
		DB11	Slope facets/elements			
			DB11a	Undissected	1571.90	1.84
			DB11b	Dissected	30670.80	35.95
	DB16	Deeply weathered plains/Duricrusts			533.73	0.63
E	Unit of Extrusive Origin (E)					
	E9	Lava plateaus				
		E9a	Undissected		20306.75	23.80
		E9b	Dissected		1101.36	1.29
	E12	Rocky benches/Rocky terraces			132.55	0.16
	E17	Lowlyingplains/flats				
		E17i	Lowlying Plains		1465.70	1.72
F	Unit of Fluvial and Lacustrine origin (F)					
	F17	Lowlyingplains/flats				
		F17b	Present floodplains		5715.13	6.70
		F17c	Older alluvial plains		19732.26	23.13
	F19	Infilledvalleys with or without alluvial ridges			95.94	0.11
	F21	Colluvialfoot slopes			1545.43	1.81
	F22	Riverine terraces			1349.26	1.58
W	Water bodies				519.48	0.61
Source: Geological Survey of India, Geomorphology of India. *Area calculated by the author with the nearest approximation						

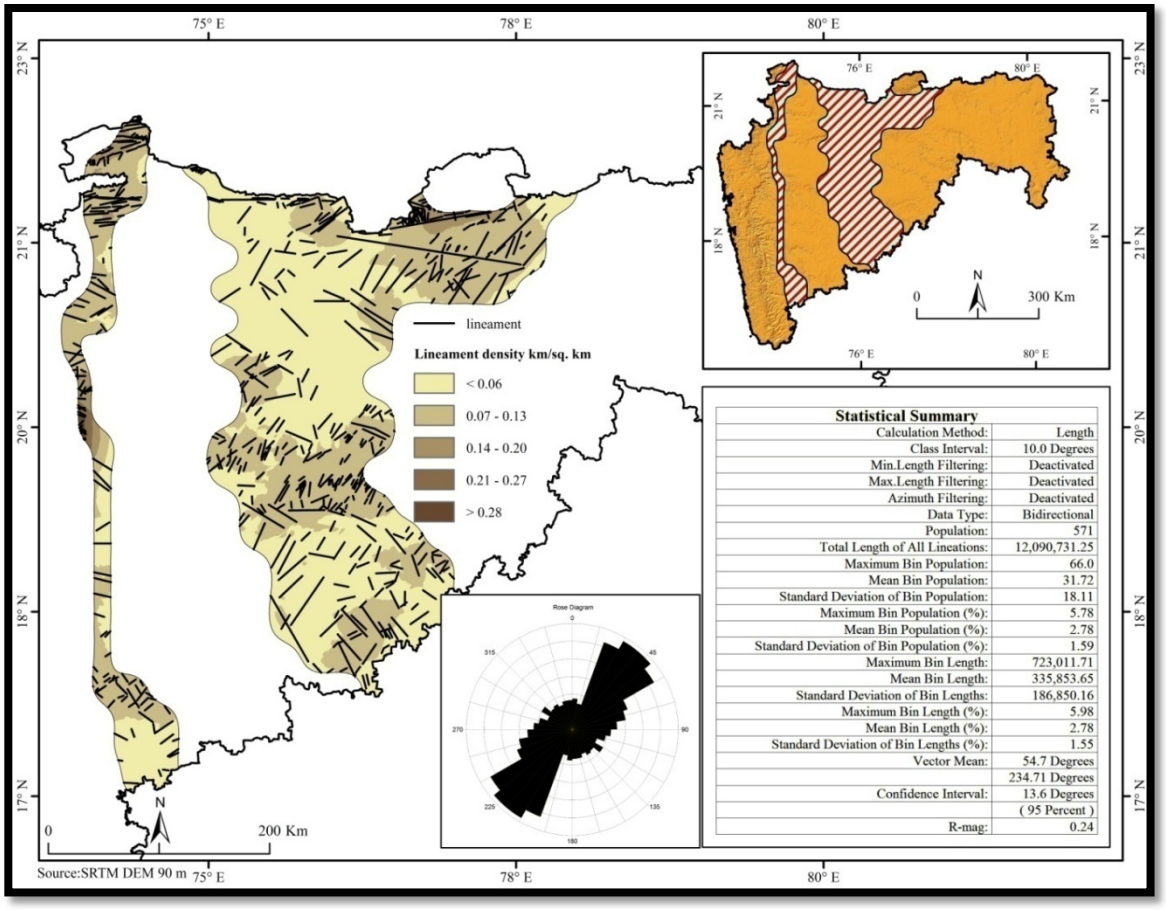

Figure 9. Statistic of lineament and density distribution in Savanna region

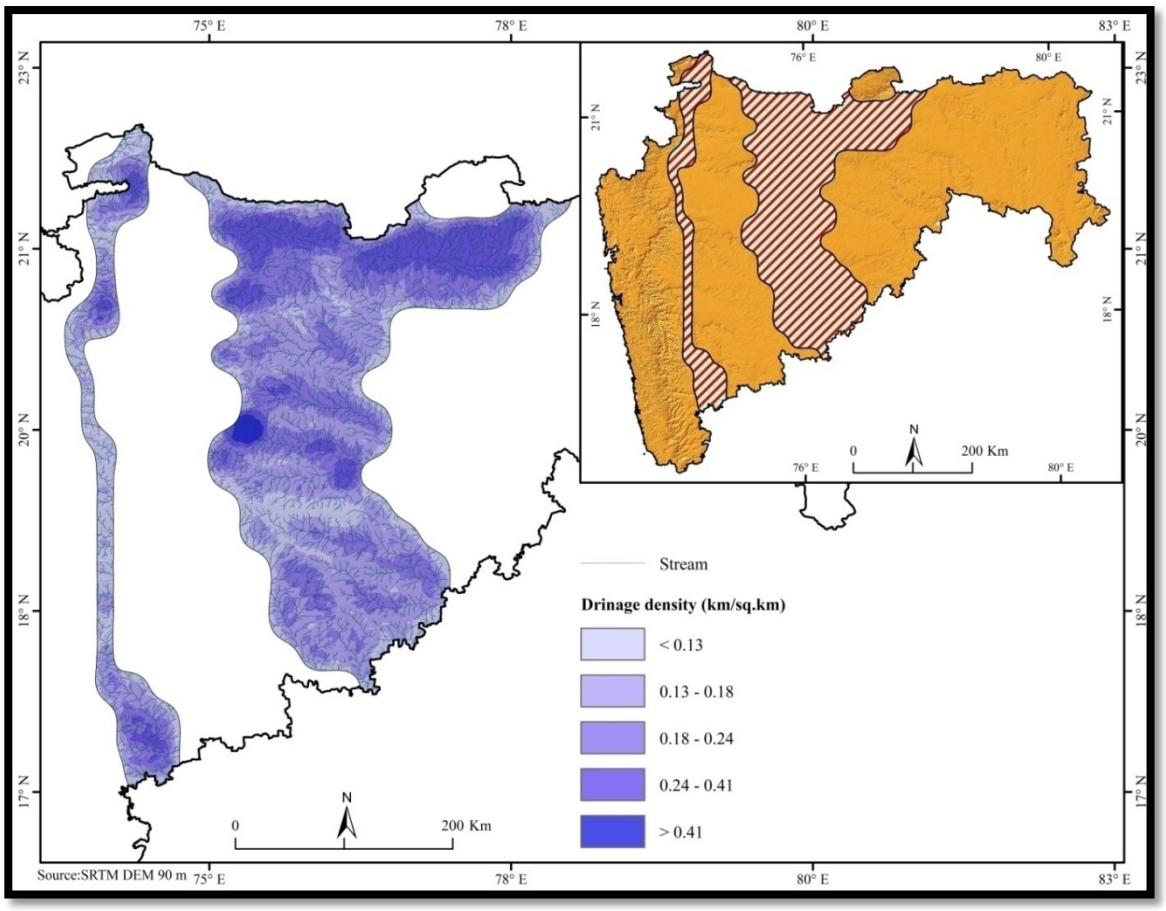

Figure 10. Drainage density distributions in Savanna region

4.6. Lineament and Drainage Density

The area having maximum lineament density of 0.35 km/sq.km and minimum is 0.003 km/sq.km with range of 0.347 km/sq.km (Figure 9). The total number of lineaments is 571, and the length is 12,090.73 km; the statistics of lineament and density distribution are presented in Figure 9 and Figure 10. The direction of lineament in the Savanna region SW-NE. The Savanna region area having moderate rainfall characteristics having a drainage density is low 0.65 km/sq.km (5.21). The drainage density is varies from 0.13 to 0.41 km/sq.km.

4.7. Soil in Savanna Region

There is less variation in soils of this area. Figure 11 shows the soil types in the Savanna region. The small patches in NW covers Haplaquents, Paleustalfs, Rhodustalfs (red sandy) soil, which acquires 1,329.18 km^2 (1.56%) area. Parallel to the river channel Pelluderts, Pellusterts, Chromusterts (deep black) soils are common, which cover 14,286.26 km^2 (16.74%) of the area. Pelluderts, Chromusterts (medium black) covers a large area, spread over 50,292.34 km^2 (58.94%) area of Savanna regions. Hilly area slopes covers Ustochrepts (shallow black) soil, which acquires 19,201.76 km^{2}area (22.65%), (Table 5). The small areas in SW are dominated by Plinthaqualts, Plinthustults, Plinthudults (Laterite) soils covering the area of 218.28 km^2 (0.26%).

4.8. Soil Depth in Savanna Region

In Savanna, soils are deep near to the river channel and shallow is the mountainous area. Whole region is divided in six categories which are; extra shallow, shallow, moderately shallow, moderately deep, deep and very deep (Figure 12). Extra shallow or rock outcrop covers the lowest area of 5 km^2 (0.01%), (Table 6). Shallow area covers 345.40 km^2 (0.42%) area. Moderately shallow soils cover a larger area of about 43954.06 km^2 (51.13%). Moderately deep and deep soil covers 8191.60 km^2 (9.53%) and 5834.99 km^2 (6.79%) area, respectively. Very deep soil covers the second-largest area of 27012.02 km^2 (31.42%) of the region. The water bodies also cover 616.83 km^2 (0.72%) area.

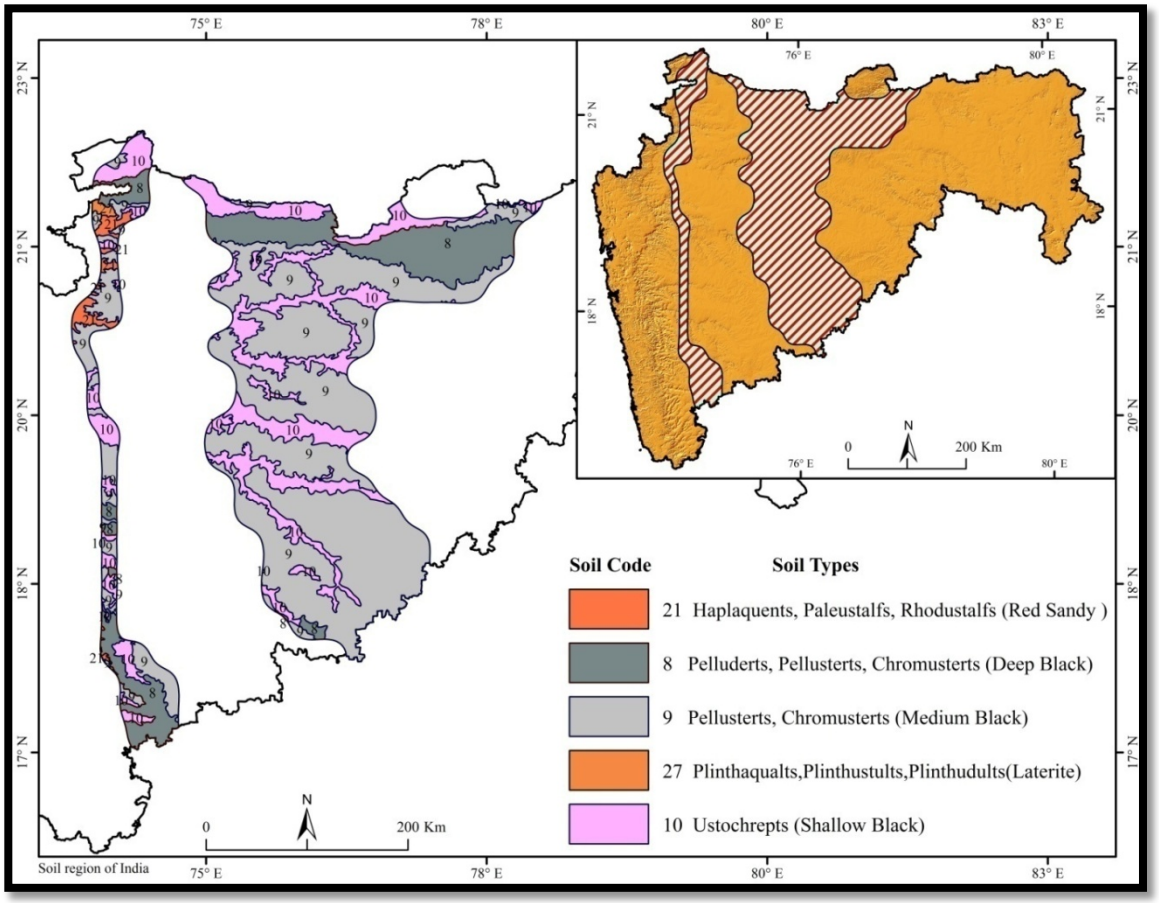

Figure 11. Soil types with soil code in Savanna region

Table 5. Soil regions in Savanna region with soil code

Soil Code	Name of Soil Region	Area (km^2)	Area (%)
8	Pelluderts, Pellusterts, Chromusterts (Deep Black)	14286.26	16.74
9	Pellusterts, Chromusterts (Medium Black)	50292.34	58.94
10	Ustochrepts (Shallow Black)	19201.76	22.50
21	Haplaquents, Paleustalfs, Rhodustalfs (Red Sandy)	1329.18	1.56
27	Plinthaqualts, Plinthustults, Plinthudults (Laterite)	218.28	0.26

Source: Soil region map (National Atlas of India), *Area calculated by the author with the nearest approximation.

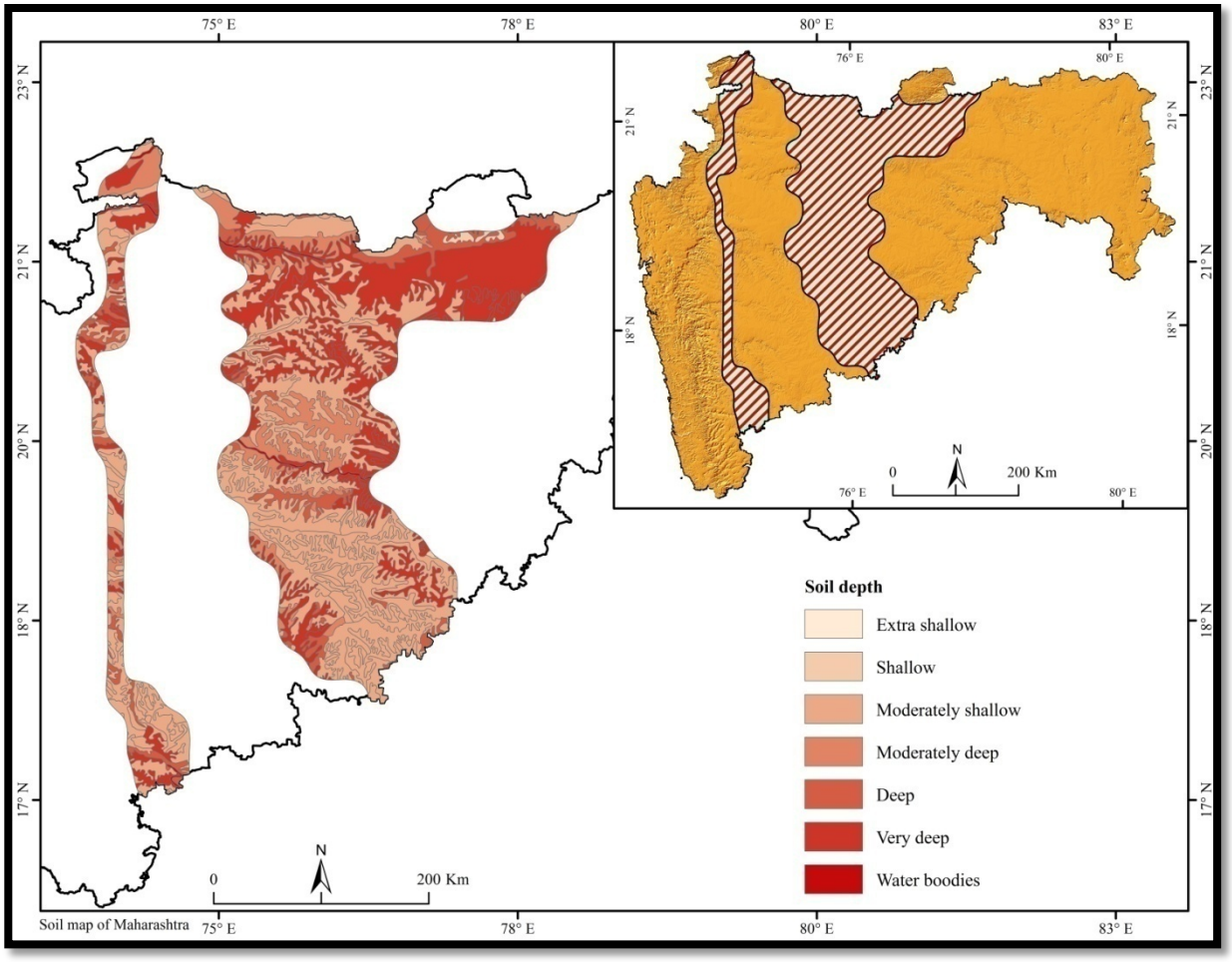

Figure 12. Soil depth in Savanna region

Table 6. Soil depth in Savanna region

Sr. No.	Soil class	*Area (km^2)	Area (%)
1	Extra shallow	5.00	0.01
2	Shallow	345.40	0.40
3	Moderately shallow	43954.06	51.13
4	Moderately deep	8191.60	9.53
5	Deep	5834.99	6.79
6	Very deep	27012.02	31.42

Source: Soil map of Maharashtra (NBSS), *Area calculated by the author with the nearest approximation.

4.9. Vegetation in Savanna Region

The area covered dry deciduous forest and are further divided into two types, Dry teak forests, and dry mixed deciduous forests. In the first category, species like teak, Ougeinia Dalbergioides (tiwas), Acacia Catechu (Khair), Gmelina Arborea (Shivan), and Anogeissus Latifolia (dhavda) are found. The mixed deciduous forests on the other hand, include Boswellia Serrata (salai), Anogeissuslatifolia (dhavda), Lanneagrandis (moin), Cleistanthuscollinus (garari), Soymidafebrinfuga (rohan) and Terminaliatomentosa (ain). The timber derived from these forests is of inferior quality and is used as domestic fuel. The area coverage of healthy vegetation in the Savanna region is 47527 km^2 (55.70%), and water bodies cover 769 km^{2}area (Table 7). Figure 13 portray vegetation distribution in the Savanna region.

Table 7. Vegetation distribution with area in Savanna region

Sr. No.	Land cover Class	*Area (km^2)	Area (%)
1	Water Bodies	769	0.90
2	No Class	37027	43.40
3	Health Vegetation	47527	55.70
Total		18654	85324
Source: Resourcesat-1: AWiFS, * Area calculated by the author with the nearest approximation			

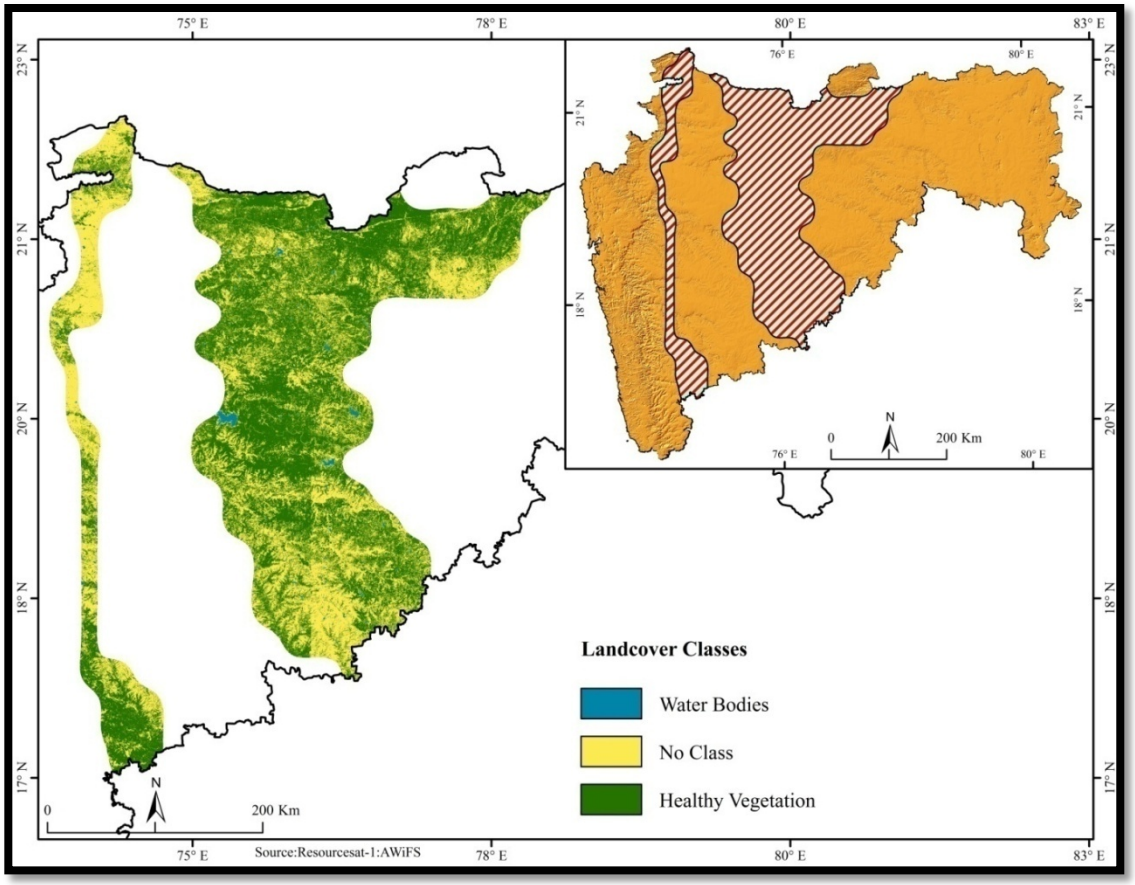

Figure 13. Vegetation distribution in Savanna region

Table 8 (a). Morphogenetic characteristics of Savanna region

Morphogenetic Region	*Climatic Elements				Geology	Geomorphology	#Lineament Density and Direction (km/sq.km)
	Rainfall (mm)	Temperature (°C)	Humidity (%)	Wind Speed (km/ph)			
1	2	3	4	5	6	7	8
Savanna	Max. 861.14 Min. 611.75 Arithmetic Mean 745.58 Range 249.39	Max. 27.75 Min. 20.60 Arithmetic Mean 26.27 Range 7.15	Max. 69.5 Min. 47.5 Arithmetic Mean 54.75 Range 22	Max. 12.31 Min. 6.20 Arithmetic Mean 10.25 Range 6.11	Alluvium Deccan Trap with inter Trappean Beds	(Denudation with minimalcontrol of Structure (DB), Ridges/Hills with intervening broad undulating Plains, Slope facets/elements (Undissected and Dissected), Deeply weathered plains/Duricrusts), (Unit of Extrusive Origin (E), Lava plateaus (Undissected and Dissected), Rocky benches/Rocky terraces, Lowlyingplains/flats, Lowlying Plains), (Unit of Fluvial and Lacustrine origin (F), Lowlyingplains/flats, Present floodplains, Older alluvial plains, Infilledvalleys with or without alluvial ridges, Colluvialfootslopes, Riverine terraces (Water bodies (W))	Max. 0.35 Min. 0.003 Range 0.347 Direction SW-NE Total no of Lineament 571 Total length of Lineament 12090.73 km

*Mean Annual (1951-2013);*Grid Point-126, # SRTM DEM 90m.

5. Conclusion

Table 8 (a) and Table 8 (b) represent the summarized characterization of the Savanna Morphogenetic region. Twenty characteristic studies in the present work. Rainfall (mm), temperature (°C), humidity (%), and wind speed (km/ph) with maximum, minimum, arithmetic mean, and range. Geology, geomorphology, Lineament Density, and Direction (km/sq.km) are studded in the present work. Different dominant processes also characterize this morphogenetic region. In the case of weathering processes, it is found that the maximum pluvial erosion and moderate chemical weathering. The Savanna region is characterized by a moderate leaching environment with moderate mass movement. The wind action is moderate in savanna regions. Maximum rainfall is received 861.14 mm, minimum occur 611.75 mm rainfall. The region's average annual temperature is 26.27°C with a maximum 27.75°C and a minimum 20.26°C temperature. The relative humidity is high during the southwest monsoon months and mostly dry during the rest of the year. The maximum humidity is recorded in SW part of the region (47.50%), whereas the lowest in NE direction (69.5%). The mean annual humidity is 54.75 % and the range of

humidity is 22%. The maximum wind speed is 12.31 km/ph and a minimum 6.20 km/ph. The mean annual wind speed is 10.25 km/ph and range from 6.11 km/ph.

Table 8 (b). Morphogenetic characteristics of Savanna region

Morphogenetic processes					Approximate area (km^2) and (%)	Soil region and Vegetation area (km^2)	Morphological processes and Landscape (characteristics)	#Slope (degrees)	#Elevation (Meters)	#Drainage density (km/sq.km)	*Weathering Depth (m)
Weathering Region	Chemical Weathering	Mass movement	Wind action	Pluvial							
9	10	11	12	13	14	15	16	17	18	19	20
Moderate Chemical Weathering to Very Slight Weathering	Moderate Chemical Weathering	Moderate	Maximum to Moderate	Maximum to Moderate	85324 27.74 Center part of Nandurbar, Nashik, Pune, Satara, Sangli, W and NW Dhule, E (Jalgaon, Aurangabad; Ahmednagar) Center part of Amravati, All most (Akola, Buldhana; Jalna; Bid; Osmanabad)W Latur	Pelluderts, Pellusterts, Chromusterts (Deep Black) Pellusterts, Chromusterts (Medium Black) Ustochrepts (Shallow Black) Haplaquents, Paleustalfs, Rhodustalfs (Red Sandy) Plinthaqualts, Plinthustults, Plinthudults (Laterite) Area of Healthy Vegetation 47527 (55.70%)	Exfoliation and core stone formation, Mass movement activity likes Fall; slide; flow and creep activity in western Ghats section.	Max. 63.16 Min. 0 Range 63.16	Max. 1392 Min. 55 Range 1337	0.65	Max. 54 Min. 2 Mean 13 Range 32 SD 8.75

#SRTM DEM 90m, *Litho-log station 330.

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