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Geomorphological characteristics of Mahendragarh district using remote sensing and GIS techniques

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Abstract

The study of geomorphological characteristics involves demarcation of different units from satellite data and these units are classified based on their nature of genesis, extent and their processes. The study has been done through Remote Sensing approach using Survey of India (SOI) map of Mahendragarh District. The aims of this study are to find out the geomorphological characteristics of Mahendragarh District using satellite images LISS-III and digital SOI topographic maps. Geomorphologically, the area of Mahendragarh can be divided into four different geomorphic regions characterized by different geomorphic elements and relief characteristics. These are plain area, Sand dunes, Hilly area and Seasonal Rivers. Slope analysis has been done with the help of contours which has been taken from topo-sheets 2007. The slope of Mahendragarh district is reverse in comparison to rest of Haryana. The Sahibi, the Dohan and the Kasaunti or Krishnawati are the main seasonal streams of the district. Narnaul branch and Mahendragarh distributaries of the Jawaharlal Nehru canal command system makes the chief canal network in the region.

Keywords: GIS and Remote Sensing, geomorphology, slope, seasonal streams

Introduction

Geomorphology is defined as the science of landforms with an emphasis on their origin, evolution, form and distribution across the physical landscape. The geomorphological analysis involves delineation of distinct units from satellite data and classification of these units based on their nature of genesis, extent and their processes (Reddy *et al.*, 2002) ^[9]. Geomorphology is important for the understanding of Earth surface processes, geochronology, natural resources, natural hazards and landscape evolution. It involves the partition of the particular area based on morphology, genetics, composition, structure, land cover, soil, ecology as well as landforms. Geomorphological studies in India has received great fill up by the works of geologist and geographers. There has been an emphasis on various aspects of geomorphology from regional to coastal, structural, fluvial, climatic and Applied Geomorphology (Sharma HS, 1982) ^[10]. Most of the surface area of Haryana is constituted of the Late Quaternary deposits. The structural and denudational hills can also be subdivided into, the West North West-East North East (WNW-ENE) trending series of parallel ridges of Siwalik rocks in the northern part and widely spaced North North East-South South West (NNE-SSW) ranges and isolated hills of Delhi super group in southern part (Geology and Mineral Resources of Haryana, 2012) ^[6]. The Mahendragarh district has dry-land topography as there are present sandy plain inland stream shifting sand dune and devoid of vegetation dissected upland tract fixed or fossil sand dune and rarely denuded barren rocky hills ranges which is a group of terrain whose features truly connected with semi-arid to arid environment. The two well-known sandy plain are present in Mahendragarh district. The first sandy plain is generally present in western and eastern parts of Aravali ranges mostly found in Mahendragarh district. The natural drainage system of district consist of mainly three seasonal streams, the Sahibi, the Dohan and the Krishnawati seasonal streams.

Remote Sensing identifies the locations of geomorphological features and natural resource. The advancement in Remote Sensing and GIS has revolutionized the field of Geomorphology. These Remote Sensing and GIS techniques allowing geomorphologists to identify vegetation and geomorphological patterns present within the imagery.

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Thus, the GIS environment can be used to add further detection process through visualisation, analysis and modelling techniques and to correct Remote Sensing imagery for topographic effects (Smith RG, *et al.*, 1996) ^[12].

Study Area

Mahendragarh district, located in South-Western part of Haryana and the geographically area covered is 1944 Km². It is located between 27°48' N to 28°28' N latitudes and 75°54' E to 76°22' E longitudes. It is surrounded by Bhiwani

district in North, Rewari district in East, Alwar, Jaipur and Sikar in South and in West by Sikar and Jhunjhunu districts of Rajasthan State. Landscape of the district comprises of undulating plains, sand dunes and baring rocky surface. Topography of the district is peculiar. The residuals of the Aravali are spreading in the district giving the rocky outlook. Climate of the district is hot and semi-arid in nature. The location map of the study area is shown in Figure 1.

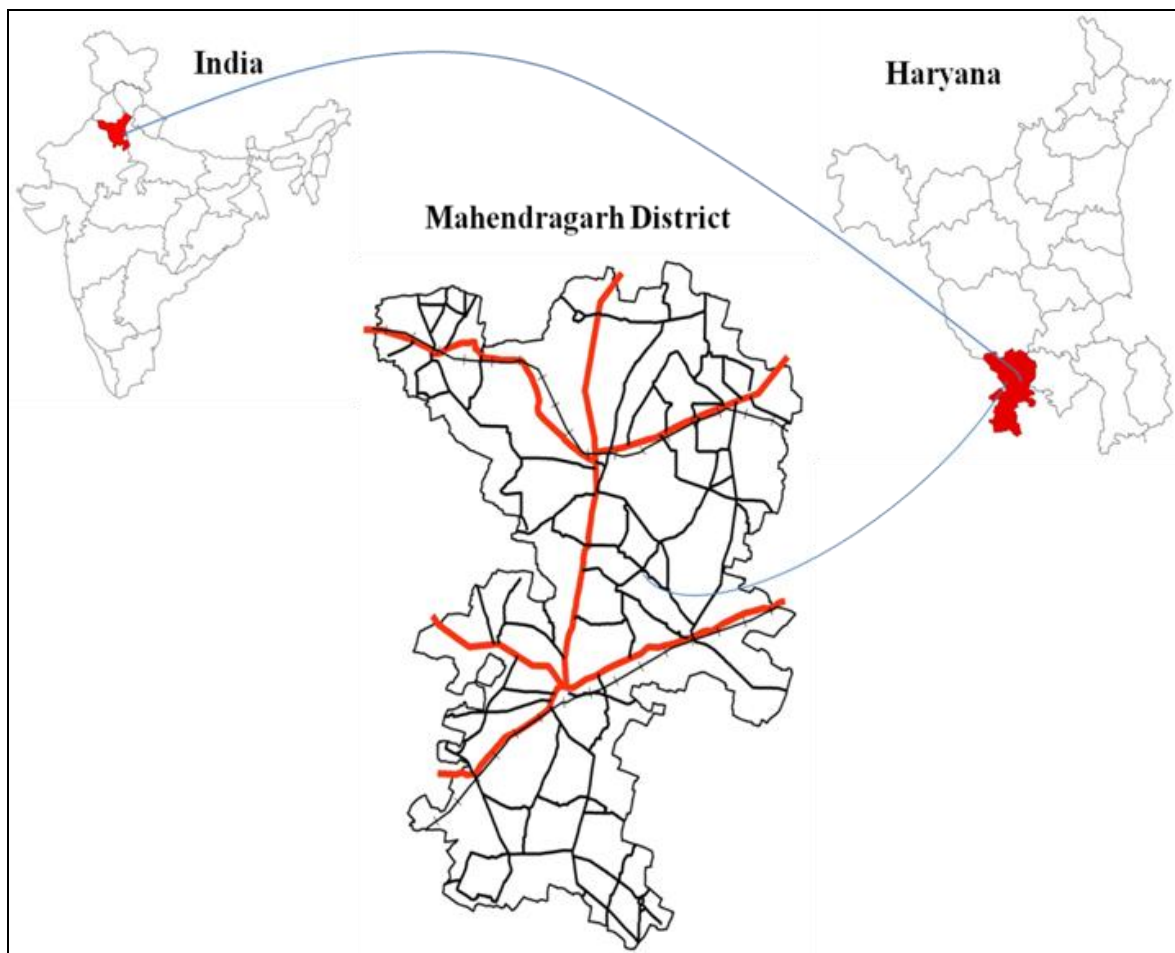


Fig 1: Location map of study area

Objective

The purpose of present study is to analyze the Geomorphological features of Mahendragarh district.

Data Sources and Methodology

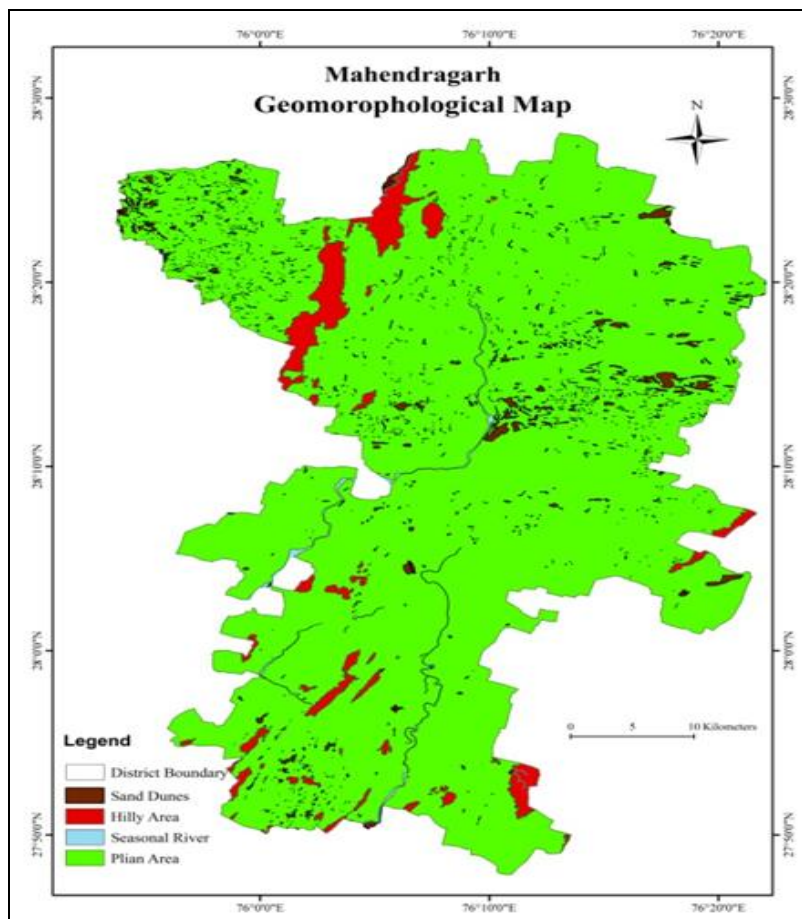
Data in this study are used digital topographic maps Survey of India (SOI). We have taken Topo-sheets no 43V_15, H 43V_16, H 43W_3, H 43W_4, H 43W_7, H 43W_8, G 43_D13 and G 43 E_1 of 2007 with a 1:50000 scale. A mosaic has created from all toposheet using Erdas 9.0 software. Then, contours are digitized with the help of Arc GIS 9.3 software. These contours are utilised for the study of Geomorphology of Mahendragarh district. Digital Elevation Model was prepared in Arc GIS 9.3 software using topo-sheets to raster tool with the help of contours. Slope map has been prepared by using Digital Elevation

Model (DEM) similarly aspect map is also prepared by using Digital Elevation Model (DEM). With the help of topo-sheets, we digitized the canal distribution and seasonal rivers.

Geomorphology

Geomorphologically, the area of Mahendragarh district can be divided into four different geomorphic regions characterized by different geomorphic elements and relief characteristics. These are Plain area, Sand dunes, Hilly area and Seasonal Rivers. This is shown in Figure 2 and explained with the help of Table 1.

S and dunes is one of category or class having an area of 51 Km² and cover about 26 per cent of total area. Sand dunes are mostly present in North-West and South-West and near Mahendragarh block of Mahendragarh district.



Source: Based on Survey of India (SOI) Topo-sheets no. 43V_15, H 43V_16, H 43W_3, H 43W_4, H 43W_7, H 43W_8, G 43_D13 and G 43 E_1 of 2007

Fig 2: Mahendragarh Geomorphological Map

Table 1: Area under different geomorphological feature

Categories	Area in Km ²	Area in Par cent
Sand Dunes	51	2.6
Hilly Area	83.6	4.3
Seasonal River	9.4	0.5
Plain Area	1801.2	92.7
Total Area	1944	100

Source: Calculated on the basis of Fig. 5.1

Hilly area covers some Aravalli range and some ridges, Dhosi hills, they cover area of 83.6 Km² and which is about 4.3 per cent of total area. A large range of hilly area is present along in the Satnali block and some parts of hilly area is also present in South and South-West of District. Seasonal rivers cover area only 9.4 Km² and Which about 0.5 per cent. The largest area is under plain area. Plain covers area of 1801.2 Km² out of geographical area 1944 Km² which is 92.7 per cent of total area of Mahendragarh district. Plain area is present mostly in North and central part of Mahendragarh district.

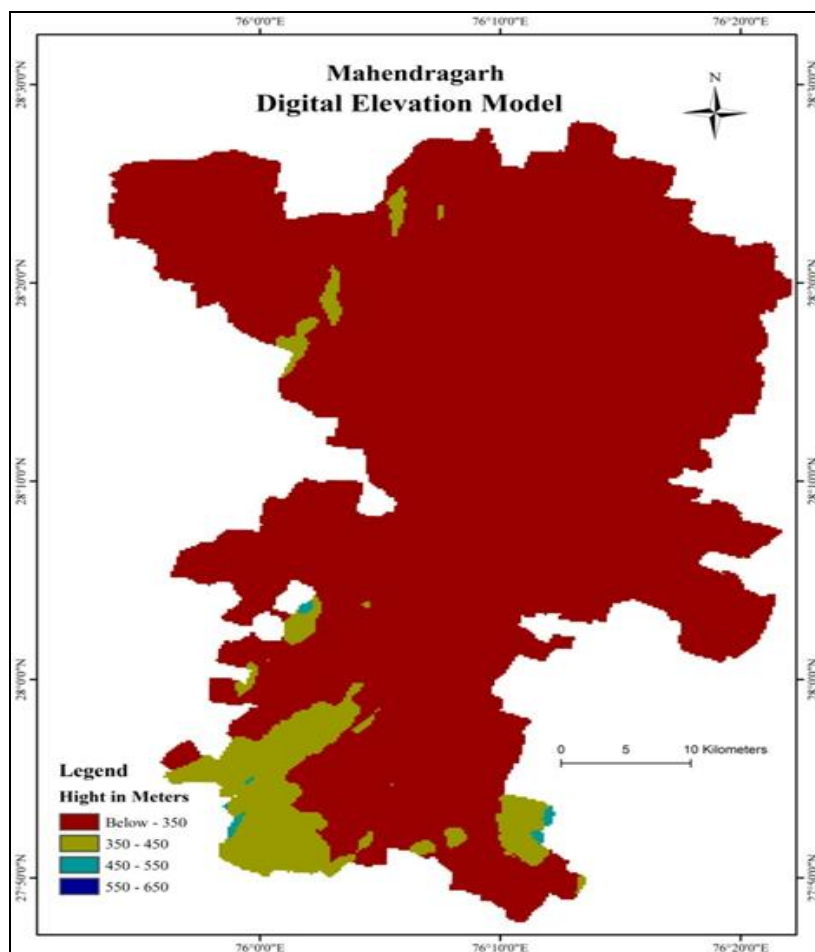
Digital Elevation Model (DEM)

Digital Elevation Model (DEM) provides the description about three dimensional surfaces and data foundation for impressive three dimensional visualisation of geographical data, but also sets the foundation for deriving other surface morphological parameters such as slope, aspect, curvature, slope profile and catchment area. Using DEMs topographic attributes (elevation, slope, aspect etc.) are easily calculated and can be shown as output image called DEM derived surfaces. With help of these images DEMs show the relationship between topography and geology. DEM was classified into four categories; i.e. low, medium, high, and very high. These categories are shown in Fig 3 and are explained in Table 1. In the first category i.e. low category relief zone which height is below 350 meters. In this category the area occupied of the study area i.e. Narnaul block, some part of Nangal Chaudhary block, Ateli block, Mahendragarh block and Satnali block. In the medium category of relief zone height lies between 350 to 450 meters. This zone exists in South-West, some part of South-East and few parts of North-West part of the study area.

Table 2: Area under different relief zones

Sr. No.	Altitudinal Zone in Meters	Category of Relief Zones
1	Below 350	Low
2	350-450	Medium
3	450-550	High
4	550-650	Very High

Source: Calculated on the basis on Figure 2



Source: Based on Survey of India (SOI) Topo-sheets no. 43V_15, H 43V_16, H 43W_3, H 43W_4, H 43W_7, H 43W_8, G 43_D13 and G 43 E_1 of 2007

Fig 3: Mahendragarh digital elevation model

The third category is high category relief zone height varies from 450 to 550 meters. High relief zone is present in Nangal Choudhary block, near Dhosi hills, lower part of Satnali block. The fourth category is very high category relief zone and its height varies between 550 to 650 meters. This relief zone lies in very few part of South-West as a continuous range of the study area.

Slope

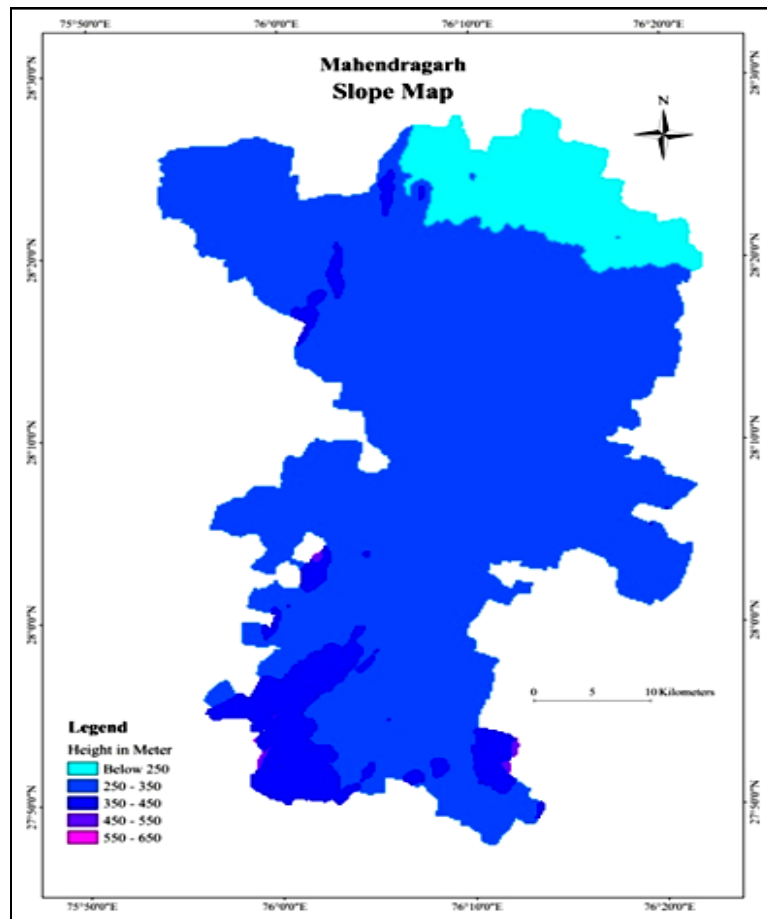
The term slope has two commonly used meanings, one referring to the angle of inclination of the surface, express in degrees or a percent, and the other is the inclined surface itself. Slope displays the grade of steepness expressed in degree or as per cent slope (Cires J, *et al.*, 1994) [2]. DEM slope is generated for a fixed slope length which is related to the sampling intervals. The study of slope is not only of academic, but also of practical, significance. Slope map for the Mahendragarh has been prepared by using Digital Elevation Model (DEM). Figure 4 and table 2 is showing the surface slope in the study area in meters. It varies from 240 to 650 meters. Slope is classified into five categories i.e.

very low, low, moderate, high and very high. The slope of Mahendragarh district is reverse in comparison to rest of Haryana. The first category is very low slope and it is in below 250 meters. It exists mainly in North and North-East part of Mahendragarh district. The low slope category has interval of 250 to 350 meters. It lies in Narnaul block, some part of Nangal Chaudhary block, Ateli block, Mahendragarh block and Satnali block. The area occupied by this category is very large part of the district. The moderate slope category is from 350 to 450 meters. In present it is in South-West, some part of South-East and few parts of North-West part of the study area.

Table 3: Area under different slope categories

Sr. No.	Slope Group in Meters	Categories
1	Below 250	Very Low Slope
2	250-350	Low Slope
3	350-450	Moderate Slope
4	450-550	High Slope
5	550-650	Very High Slope

Source: Calculated on the basis of Figure 5



Source: Based on Survey of India (SOI) Topo-sheets no. 43V_15, H 43V_16, H 43W_3, H 43W_4, H 43W_7, H 43W_8, G 43_D13 and G 43 E_1 of 2007

Fig 4: Mahendragarh Slope Map

High slope category is from 450 to 550 meters. It is present in South, South-East and South-West, some part of Satnali block and near hilly range. Very high slope is from 550 to 650 meters. It occupies mainly in South-West in Aravalli range and South-East part of the Mahendragarh district.

Aspect

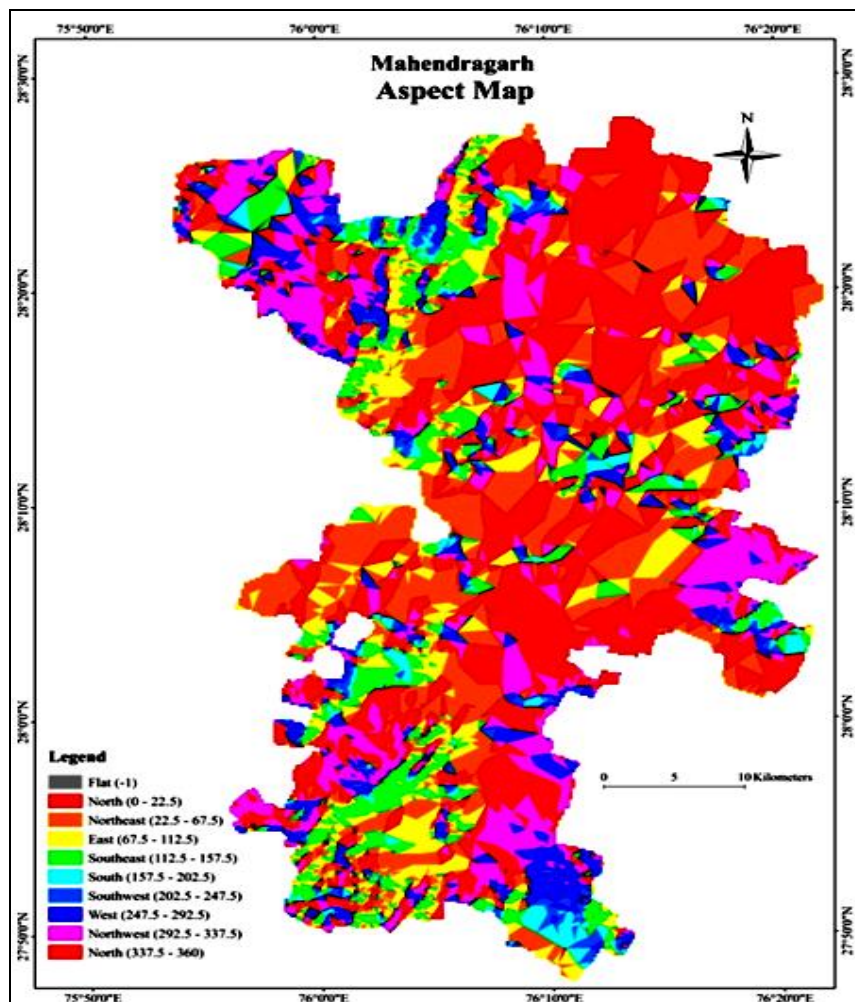
Aspect identifies the down-slope direction. Aspect images may enhance landforms such as fluvial network, alluvial

fans, faceted fault related scarps etc. (Cires J, *et al.*, 1994) [2]. Aspect usually known to the horizontal direction to which a mountain slope faces. Fig 5 describes the distribution of aspect within the study area. Aspect is measured clockwise in degrees from 0° North to 360° North coming full circle. The area of Mahendragarh district divided into ten different aspect categories. A full description of the aspect categories in showing Table 4.

Table 4: Areas under different categories of aspect

Sr. No	Aspect Name	Area in °C
1	F(Flat)	-1
2	North	0-22.5
3	North-East	22.5-67.5
4	East	67.5-112.5
5	South-East	112.5-157.5
6	South	157.5-202.5
7	South-West	202.5-247.5
8	West	247.5-292.5
9	North-West	292.5-337.5
10	North	337.5-360

Source: Calculated on the basis on Figure 5



Source: Based on Survey of India (SOI) Topo-sheets no. 43V_15, H 43V_16, H 43W_3, H 43W_4, H 43W_7, H 43W_8, G 43_D13 and G 43 E_1 of 2007

Fig 5: Mahendragarh Aspect Map

Distribution of Seasonal Rivers and Canals

Rivers are important part of any Country, State, and District. It is necessary for drinking purpose, washing irrigation etc. As Mahendragarh district is quite dry area, so there are only few seasonal rivers. The Sahibi, the Dohan and the Kasaunti or Krishnawati are the main seasonal streams of the district. Sahibi is a chief central stream of southern Haryana enters first time in district near its South-eastern tip, about 1 Km from Paoti village. Along with these seasonal rivers, there are also some canals in the district. Narnaul branch and

Mahendragarh distributaries of the Jawaharlal Nehru canal command system makes the chief canal network in the region. The natural slope of surface is from South to North in the canal command area but the direction of flow of water in canal is from North to South by lifting systems. This canal system is better only in the Mahendragarh block. These are the main source of drinking, irrigation and recharge the ground water. Seasonal rivers and canal distribution of Mahendragarh district is shown in Figure 6, and described in Table 5.

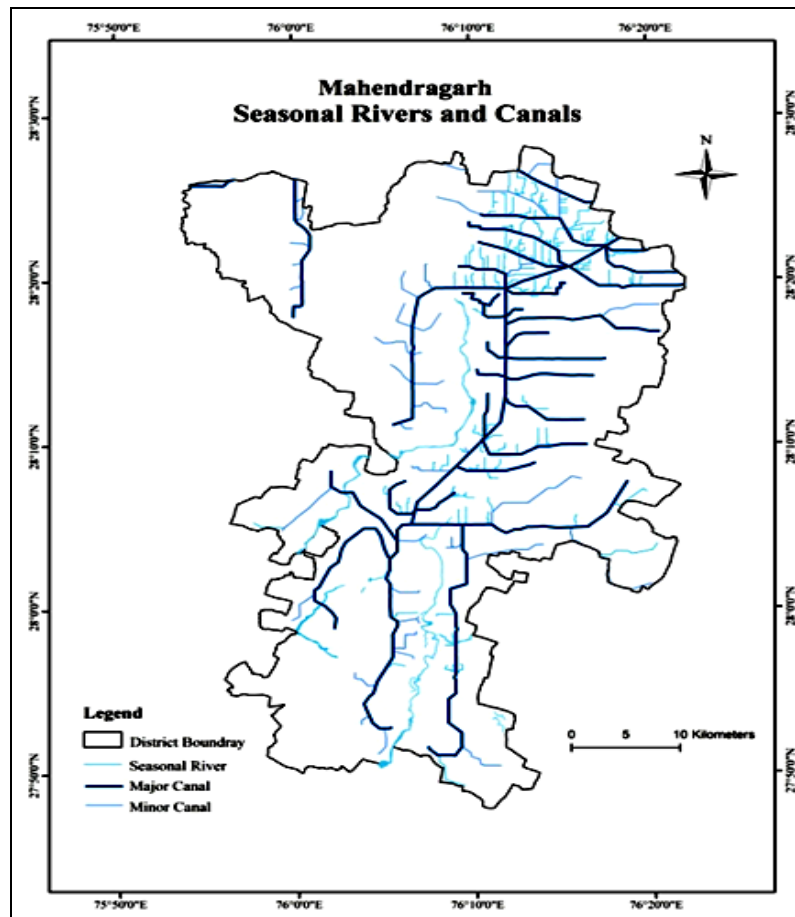
Table 5: Area and length under different categories of seasonal rivers and canals

Categories	Area in Km ²	Length in Km
Seasonal River	9.44	121.8
Major Canal	1.42	376
Minor Canal	0.29	150
Total	11.2	661.6

Source: Calculated on the basis on Figure 6

The seasonal river in Mahendragarh district covers 9.44 Km² area and length of 121.8 Km. The major canals are also made for distribution of water. Major canal system covers

area of 1.42 Km² and length of 376 Km whereas minor canals have area of 0.29 Km² and length of 150 Km.



Source: Based on Survey of India (SOI) Topo-sheets no. 43V_15, H 43V_16, H 43W_3, H 43W_4, H 43W_7, H 43W_8, G 43_D13 and G 43 E_1 of 2007

Fig 6: Mahendragarh Seasonal Rivers and Canals

Conclusions

Geomorphology is a systematic and organised description and study of landforms of the Earth. It is important for the understanding Earth surface processes, geochronology, natural resources, natural hazards and landscape evolution. Geomorphologically, the area of Mahendragarh can be divided into four different geomorphic regions characterized by different geomorphic elements and relief characteristics. The plain area is 1801.2 Km², sand dunes are 51 Km², hilly area is 83.6 Km² and the area occupied by seasonal river is 9.44 Km². Slope analysis has been done with the help of contours which has been taken from topo-sheets 2007. The contour of minimum height is 240 meters and maximum height is 650 meters. Slope is derived by Digital Elevation Model (DEM) and further Aspect has been used for finding the direction of slope. The lowest part of slope exist in mainly in North and North-East of Mahendragarh district while the highest slope occurs mainly in South-West and in Aravalli range of Mahendragarh district. The slope of Mahendragarh district is reverse in comparison to rest of Haryana. The Sahibi, the Dohan and the Kasaunti or Krishnawati are the main seasonal streams of the district and the area of seasonal rivers is 9.44 Km², major and minor canals have area of 1.42 Km² and 0.29 Km² respectively.

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