INVESTIGATING STATISTICAL ANALYSIS OF CANAL DENSITY & CANAL NETWORK ANALYSIS OF HISAR DISTRICT (HARYANA) – USING REMOTE SENSING & GIS

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Abstract

Drainage density defined as the total length of channels per unit area, is a fundamental property of terrain that reflects local climate, relief, geology, and other factors. Accurate measurement of is important for numerous geomorphic and hydrologic applications, yet it is a surprisingly difficult quantity to measure, particularly over large areas. Like this in this paper we calculate canal density of Hisar district and used a consistent and efficient method of Horton (1945) for generating choropleth maps of canal density. This yields a theoretically sound tool for estimating spatial variability of canal density.

This paper demonstrates a feasibility of automated canal density mapping on regional scales and using LISS III satellite data in GIS environment. Such maps offer affordable means of surveying large regions for variability in spatially extended features, which themselves are difficult to sense remotely, but are expressed by the canal density.

Keywords: Canal Density, LISS III Satellite Data, Canal Network Analysis, Hydrology, Stream.

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Introduction:

Drainage density, since first used by Horton has been extensively utilized in many hydrological studies. "*Drainage density is defined as the total length of stream channels per unit area may be used to describe a particular stream network.*" Many geographer like Horton (1932-1945), Melton (1957), Chorley and Morgan (1962), Gray (1965), Wooding (1966), and Arthur N. Strahler, A. H. Strahler (1964) worked on drainage density. Drainage density is the length of streams per unit area. It is expressed in units like km/km^2 or mi/mi^2. Such units are not dimensionless, and the value of the number depends on units.

Canal density reflects the signature of how irrigation systems of canal network are working on the topography. In this article, Potential drainage density index also calculated. Canal density values for per unit area shows how much land is under irrigation.

Study Area:

The study area is Hisar district of Haryana. It is a part of Indo- Gangetic alluvial plain and located between 28 °53'45" N to 29 °49'15"N latitudes and 75 °13'15"E to 76 °18'15"E longitudes. It occupies an area of 4170.51 sq. km. and is bordered on the east by Rohtak district, on the west by Fatehabad district & Rajasthan state, on the south by Bhiwani district and on the north by Jind district. The location of the district in the state is shown in Figure -1.

The average rainfall in the district as a whole is 276.2 mm during 2002-06. It generally increases from south or south-west to east or north-east. Over 64% of the annual rainfall is received during the months July to September. Maximum rainfall received during monsoon season that starts from June and extends up to September. Some rainfall is also received during the winter months of December to February. The area is nearly level, with imperceptible slopes, except for the regions in and around the sand dunes. The general gradient of the terrain is from north –east to south-west and then west.

Drainage:

The surveyed terrain forms regionally a water-divide between Ghaggar and old Drishdawati. Drishdawati (Chautang) river tract is extinct and its vast filled channel course is occupied by the

Hansi branch of the Western Jamuna canal. During the monsoons, many seasonal streams flood the adjoining portions of the lateral shifting Ghaggar flood-plain.

Most of the total irrigated area in the district is covered by canals because of brackish under- ground water. But in some areas, the underground water is fresh and irrigation is given by tube-wells.

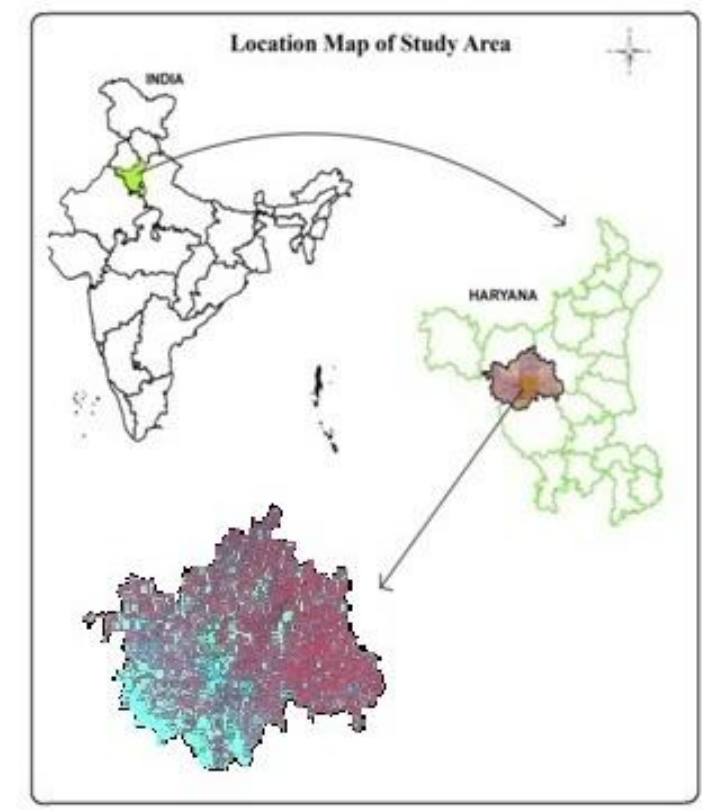

Figure-1

Materials and Methodology:

IRS-P6 satellite LISS-III data is used for the study area downloaded from National Remote Sensing Centre (NRSC), Hyderabad website through Bhuvan. The project is also referenced by topographic sheet provided by 'Survey of India' The classification of satellite data was carried out by using on-screen interpretation and digitization technique. . The datum and projection system of

the satellite data was taken as WGS 84 and UTM respectively. Satellite or sensor specifications and acquisition dates for the data used for the analysis are given in Table-1

Table -1

Sr. No.	Satellite	Sensor	Resolution	Date of acquisition
1.	IRS-P6	LISS-III	25M	18October,2008

Survey of India Topographical Sheets:

44O/06,44O/07,44O/08,44O/10,44O/11,44O/12,44O/14,44O/15,44O/16,44P/05,44P/09,44P/13,53C/02,53C/03,53C/04,53C/06,53C/07,53C/08,53D/01 and 53D/05.

Scale 1:50,000

Software's used:

ARC/MAP .9.2, ERDAS IMAGINE 9.2, Microsoft Office 2007

In the present study, for calculation of drainage density per unit area Horton's method was used. 2 X 2 km. grid was generated for the study area and total length of all canals in per unit area was calculated in GIS environment. Canal density is the ratio between total length (L) of all canals in per unit area and a unit size of area (A).

This is shown in formula as:

$$\textit{Canal Density}\ (CD) = \frac{\text{Total Length of all canals per unit area (L)}}{\text{Per unit area (A)}}$$

The Potential Canal Density of whole district is calculated by below formula:

$$\textit{Canal Density}\ (CD) = \sum_{\frac{I}{A}}^{n} L$$

Here "L" is the length, "n" is the numbers of canals and "A" is the total area of district.

With the help of Canal density values per unit area, a choropleth map was created using minimum and maximum value for Hisar district.

Result and Discussion:

Total number of 2 X 2 km. length's grid is 1184. Each grid contains 4 sq. km. area. Total length of all canals in Hisar district is 1413.63 km. Canal density for whole district is 0.338 km per unit area. This statistical analysis for canal length and canal density is shown in Table -2. Canal network map with grids and per unit area or grid canal length is presented in Figure -2.

Sr. No.	Measurement	Canal Length	Canal Density
1	Minimum	0.000038	0.00001
2	Maximum	7.24	1.81
3	Mean	1.68	0.42
4	Standard Deviation	1.18	0.29
5	Sum	1413.63	353.40

Table -2

Sr. No	Canal Density Classes (Per Unit Area)	Description	Area in Sq. km.	Area in %
1	0	No Canal Density	324.29	7.78
2	0 - 0.4	Canal Density very poor	2337.77	56.05
3	0.4 - 0.8	Canal Density poor	1322.53	31.71
4	0.8 – 1.2	Canal Density Moderate	164.74	3.95
5	1.2 – 1.6	Canal Density High	20.02	0.48
6	Above 1.6	Canal Density Very High	1.15	0.03
Total			4170.5	100.00

Table-3

The canal density of study area can be categories into six groups on the basis of minimum and maximum values. The class group 0 - 0.4 takes highest area 2337.77 sq. km. and above 1.6 class takes lowest area 1.15 sq. km. Canal density classes group 0-0.4 and 0.4-0.8 takes 87.76 % of total study area. 7.785 of study area have no canal. These classes and their area is described in Table -3 and area under different classes of canal density is presented in Chart-1.

The choropleth map of canal density is shown in Figure – 3. This map provides a simple and straight forward way to analyze canal density statistically and density variation in study area. Map shows area under different classes of canal density and their catchment area under irrigation. South –western and eastern part of district contain poor canal density.

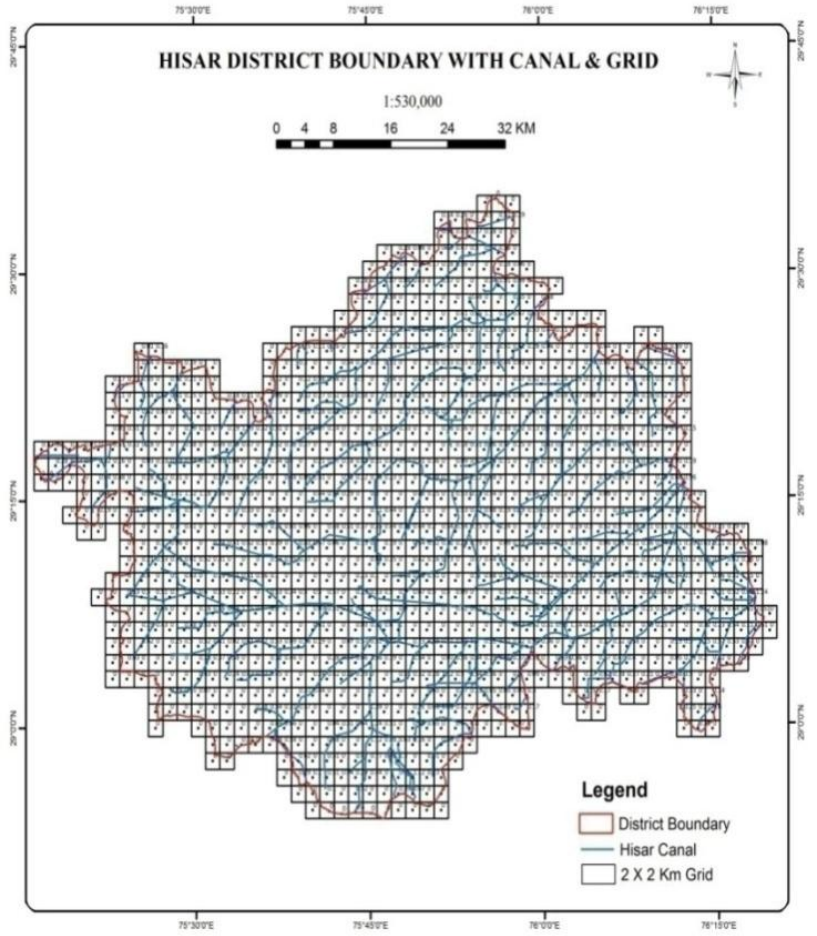

Figure- 2

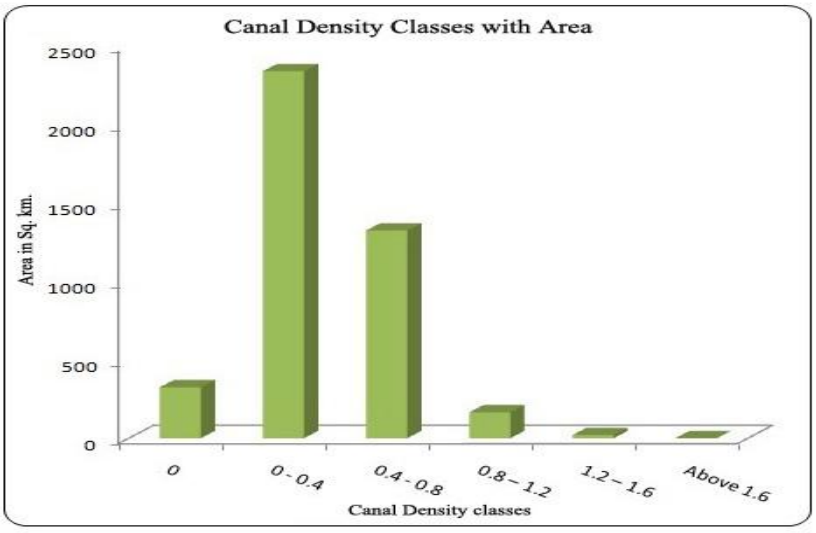

Chart – 1

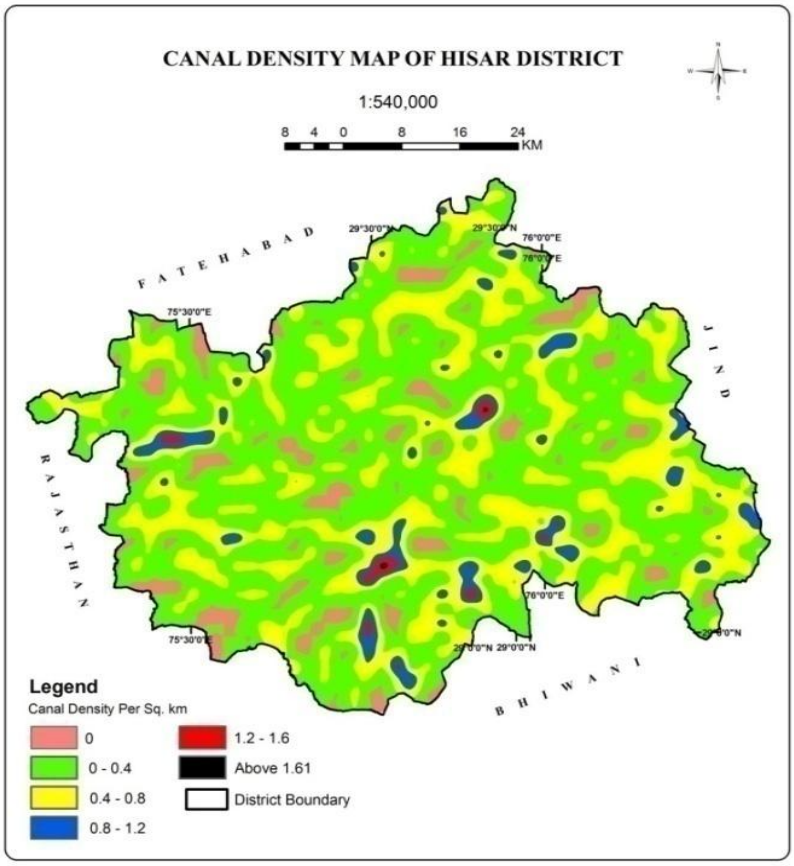

Figure -3

Conclusion:

This paper suggests simple summaries concerning Canal density and area relation. Canal density presents very useful index for network characteristics. Average canal density of Hisar district is 0.34 per km. 2126.29 sq. km area is less than average canal density. It is 50.98 % of study area.

It was observed that satellite data proved to be very useful in the interpretation of canals networks. It is also no doubt that the precise tool like GIS will form part of Management Information System for implementing the canal network, their statically analysis and mapping. This information is useful for irrigation department.

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