"Watershed Management of Chandwad Taluka, Using GIS & Remote Sensing Data"

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Abstract

In the present study, groundwater prospect of Chandwad area has been delineated using remotely sensing data, base map of Geological Survey of India(GSI), ground truth data, and geographic information system. Based on these integrated studies, it has been noticed that the lithology of the area mainly consist vesicular/weathered basalt, massive and hard compact basalt belonging to cretaceous to early Eocene period. Based on hydro-geomorphological, geological and lineament mapping the Chand wad area can be qualitatively categorized into three groundwater potential units, viz. good, moderate and poor . The remotely sensed data provides synoptic viewing and repetitive coverage for thematic mapping of natural resources. In the present study hydro geomorphological mapping can be carried out in Chandwad for delineating groundwater potential zones. SRTM data in conjunction with Survey of India toposheet (1:50000 scale) and field inputs were used for thematic mapping. Geomorphic units identified through visual interpretation of FCC include: alluvial plain, plateau, valley fills, intermountain valleys, burried pediment, residual hills, and linear ridges. In addition, lineaments were mapped since they act as conduit for groundwater recharge.

Keywords;- *Watershed Management, SRTDA, Remote Sensing & GIS, Ground water etc.*

»Introduction

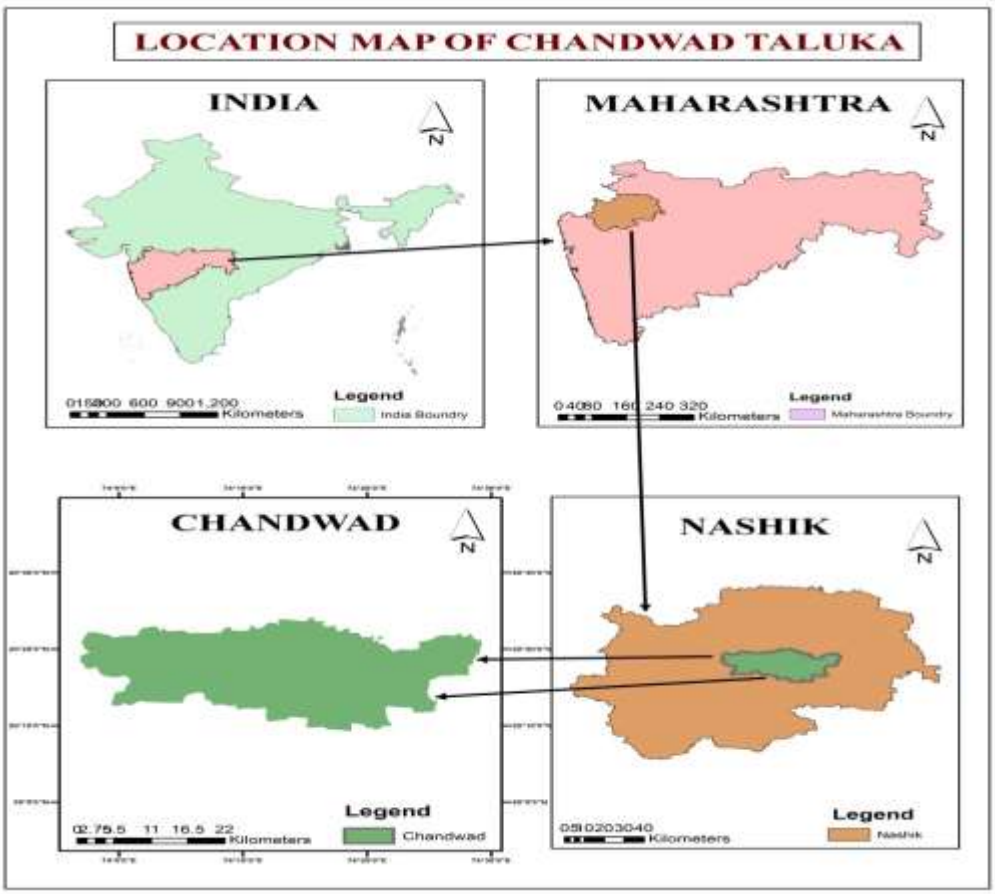
Integration of remote sensing data and the geographical information system (GIS) for the exploration of groundwater resources has become a breakthrough in the field of groundwater research, which assists in assessing, monitoring, and conserving groundwater resources. In the present paper, various groundwater potential zones for the assessment of groundwater availability in then district have been delineated using remote sensing and GIS techniques. Survey of India top sheets and IRS-1C satellite imageries are used to prepare various thematic layers viz. lithology, slope, land-use, lineament, drainage, soil, and rainfall were transformed to raster data using feature to raster converter tool in ArcGIS.

Objective National Aquifer Mapping (NAQUIM) has been introduced in XII five year plans to carry out detailed hydrogeological investigation on a scale of 1:50,000. The activities under study includes The study also include quality monitoring (intensive inventory of wells), Hydrological and Hydro meteorological studies, Infiltration Tests, Geophysical Surveys, Water Quality Analysis, Isotope Study, Specific Yield determination, Slug Test, GIS data integration & analysis, Preparation of Aquifer map, compilation and Printing of reports etc. Under the NAQUIM study Chand wad Talukas of Nasik district has been taken up and Toposheet -wise micro level hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 200 meters have been carried out. Aquifer mapping itself is an improved form of groundwater management – recharge, conservation, harvesting and protocols of managing groundwater.

Groundwater is a vital natural resource for the reliable and economic provision of potable water supply in both urban and rural environment. Hence it plays a fundamental role in human well-beings, as well as that of some aquatic and terrestrial ecosystems. At present, groundwater contributes around 34% of the total annual water supply and important fresh water resource. So, an assessment for this resource is extremely significant for the sustainable management of groundwater systems. GIS and remote sensing tools are widely used for the management of various natural resources. In recent years, extensive use of satellite data along with conventional maps and rectified ground truth data has made it easier to establish the base line information for groundwater potential zones (Tiwari and Rai, 1996; Das et al., 1997; Thomas et al., 1999; Harinarayana et al., 2000; Muralidhar et al., 2000; Chaudhary et al., 2010). Remote sensing not only provides a wide-range scale of the space-time distribution of observations, but also saves time and money (Murthy, 2000; Leblanc et al., 2003; Tweed et al., 2007). In addition it is widely used to characterize the earth surface (such as lineaments, drainage patterns and lithology) as well as to examine the groundwater recharge zones (Sener et al., 2005).

»Study area

Chandwad is the Taluka in Nashik District of Maharashtra State, India. Chandwad Taluka Head Quarters is Chandwad town. It belongs to Khandesh and Northern Maharashtra region. It belongs to Nashik Division. chandwad located at $20^{0}19'37"$N lat and $74^{0}14'50"$E long extent It is located 63 KM towards East from District headquarters Nashik. 233 KM from State capital Mumbai towards west. Chandwad Taluka is bounded by by Deola Taluka towards North, Niphad Taluka towards South, Kalwan Taluka towards west, Yeola Taluka towards East. Manmad City, Satana City, Ozar City, Yeola City are the nearby Cities to Chandwad. It consist of 204 Villages and 91 Panchayats. Indraiwadi is the smallest Village and Chandwad is biggest Village. It is in the 632 m elevation (altitude). Nasik (Nashik), Shirdi, Saputara, Trimbakeshwar, Dhule are the nearby Important tourist destinations to see. Chandwad taluka location in Nashik district 60 km away from Nashik. The surrounding of chandwad taluka in the north side The Central Ground Water Board in view of the current and futuristic requirement of water and its availability has initiated the National Aquifer Mapping Programme (NAQUIM) in India during XII five year plan, with a priority to study over-exploited, critical and semicritical talukas The Central Ground Water Board in consultation of Groundwater Surveys and Development agency, Govt. of Maharashtra, Pune has selected Chandwad Talukas of Nashik district on priority for the detailed hydrogeological investigation under NAQUIM. The Chandwad talukas are situated in the central part of Nashik district Thus, the total area of Chandwad is 953.06 sq.km These Taluka have been categorized as semi critical, as per Ground Water Resources Estimation.



» Objective

- To Understand the Geology, Geomorphology & Recharge Structure in Chandwad Taluka Area.
- To create DEM based Thematic Mapping of the Study Area.

»Methodology

Data Used

DEM Images- SRTM the ASTER data of 30m resolution from http://edu.usgs.gov/

Toposheet- 46H/15, 46H/16, 46L/3,46L/4,46L/7,46L/8

Software Used

ARC GIS, QGIS ,google Earth pro

The data were used for preparing thematic map by DEM data watershed map collected from Groundwater survey Department Agency (GSDA) Nasik collector office ,data was used to get the maximum possible information or various earth features on 1:2,50000 scale. To create drainage map on the basis of SOI toposheet 1:50000 scale.

» Rainfall and Climate

The climate of Nasik district is characterized, by general dryness throughout the year except during the south-west monsoon season. The winter season is from December to about the middle of February followed by summer season which last up to May. From June to September is the south-west monsoon season, whereas October and November are the post-monsoon season. The maximum temperature in summer is 42.5°C and minimum temperature in winter is less than 5.0°C. Relative humidity ranges from 43% to 62%. The normal annual rainfall in the district varies from about 500 mm to 3400 mm. It is minimum in the north eastern part of the district and increases towards west and reaches a maximum around Igatpuri in the western ghat.

»Soil

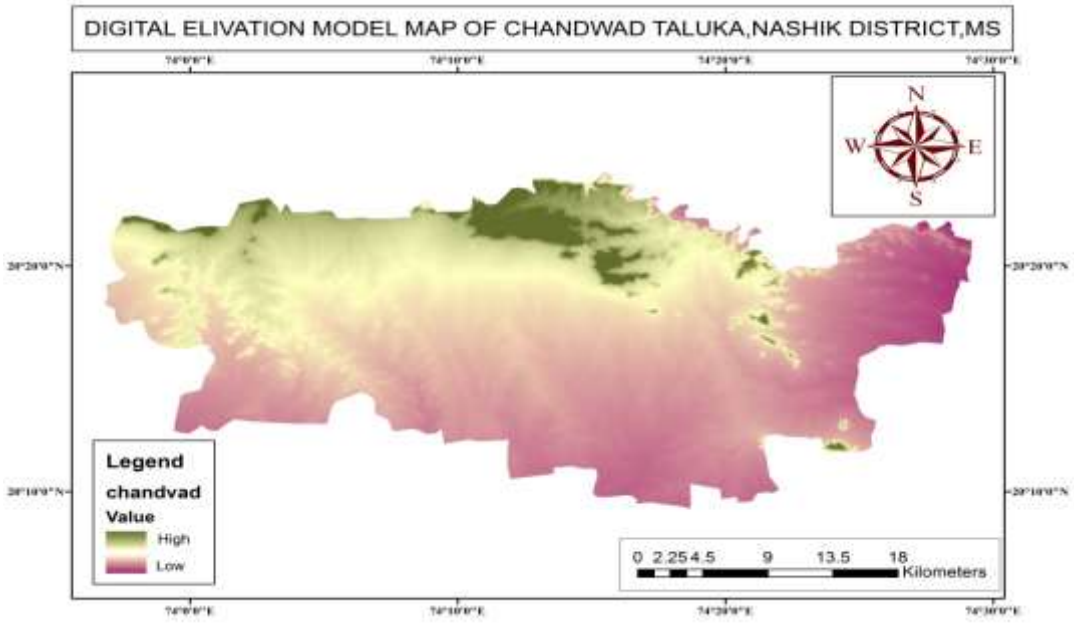
The soils of the district are the weathering products of Basalt and have various shades from gray to black, red and pink color. The soils occurring in the district are classified in the four categories namely lateritic black soil (Kali), reddish brown soil (Mal), coarse shallow reddish black soil (Koral), medium light brownish black soil (Barad). In general the soils are very fertile and suitable for growing cereal and pulses. The black soil contains high alumina and carbonates of calcium and magnesium with variable amounts of potash, low nitrogen and phosphorus. The red soil is less common and is suitable for cultivation under a heavy and consistent rainfall.

» Geology

Deccan traps Deccan traps are a thick pile of basaltic lava flows, horizontally disposed and apparently more or less uniform in composition. Deccan Trap comprising of pahoehoe and a type of basaltic lava flows. Thin beds of volcanic tufts are found between the flows along the contact at few places. Each individual flow is a typical section, which varies from porous

Weathered base to a massive middle unit, becoming increasingly vesicular towards the top. The rocks are fine to medium grained, hard compact and physic. The Upper Chandwad formation containing Phenocryst of plagioclase ranging in size form 3-7mm marks the upper contact of this Ratangarh formation. The formation is exposed north east and southern part of the district and comprises ten compound pahoehoe /Aa flow containing olivine phenocrysts. This formation show a maximum exposed thickness of 530 m in the areas south west of Nandgaon. The thickness of thin beds of tuft varying from 0.2 to 1m found at places at the flow contacts. The tuft is reddish brown to dark brown, fine grained and contains angular fragment of basalts and laths of plagioclase feldspar.

» Analysis of DEM using ArcGIS:-

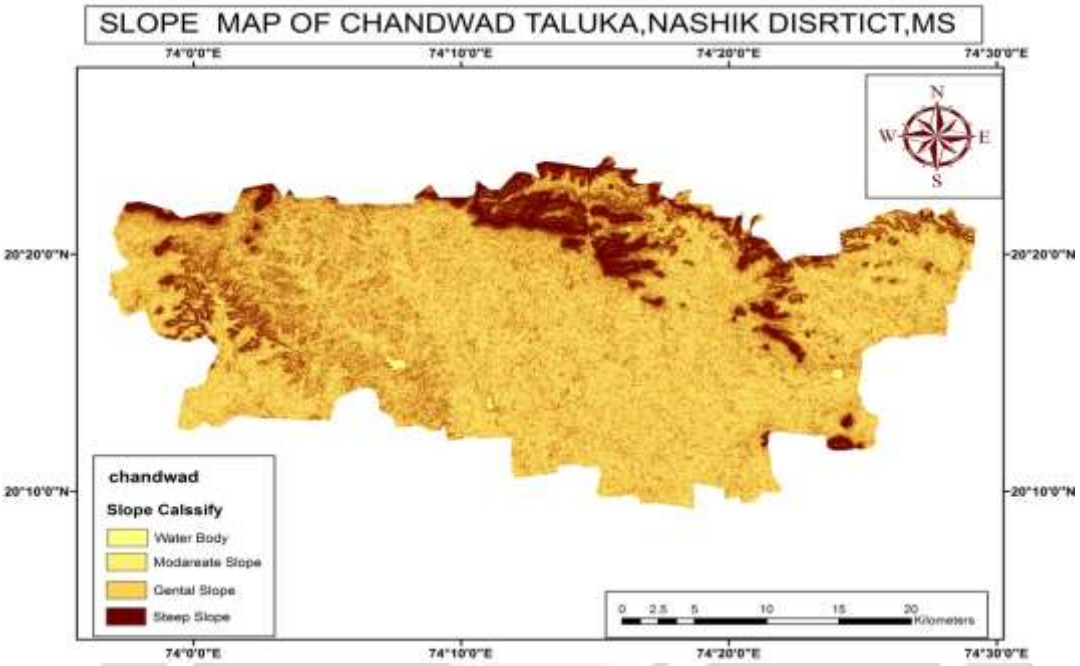


Details about the maps which have been prepared are being given below:-

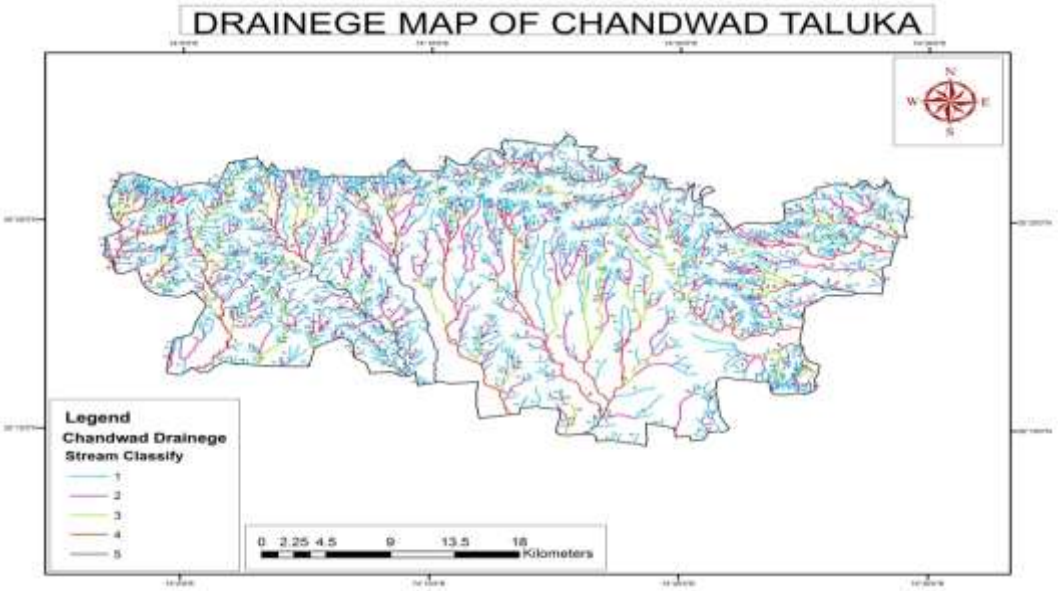
Slope map: - Slope can be defined as the maximum change in elevation over the distance. Slope map is made to know the local and regional slope variation of the terrain which helps encounter the structural disturbances. Slope

map is prepared by using surface tool which is present in spatial analyst tool which can be achieved by following steps.

Process – Arc Tool Box > Spatial Analyst Tool > Surface > Slop

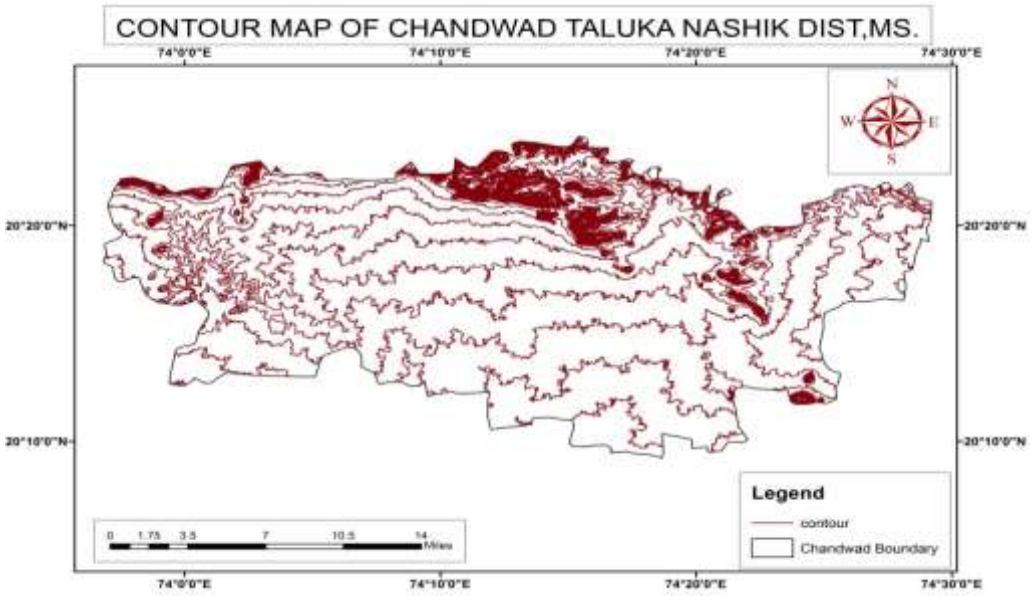


Drainage Map: - The term "**drainage** area" is defined as the land area where precipitation falls off into creeks, streams, rivers, lakes, and reservoirs. It is a land feature that can be identified by tracing a line along the highest elevation between two areas on a **map**, often a ridge.



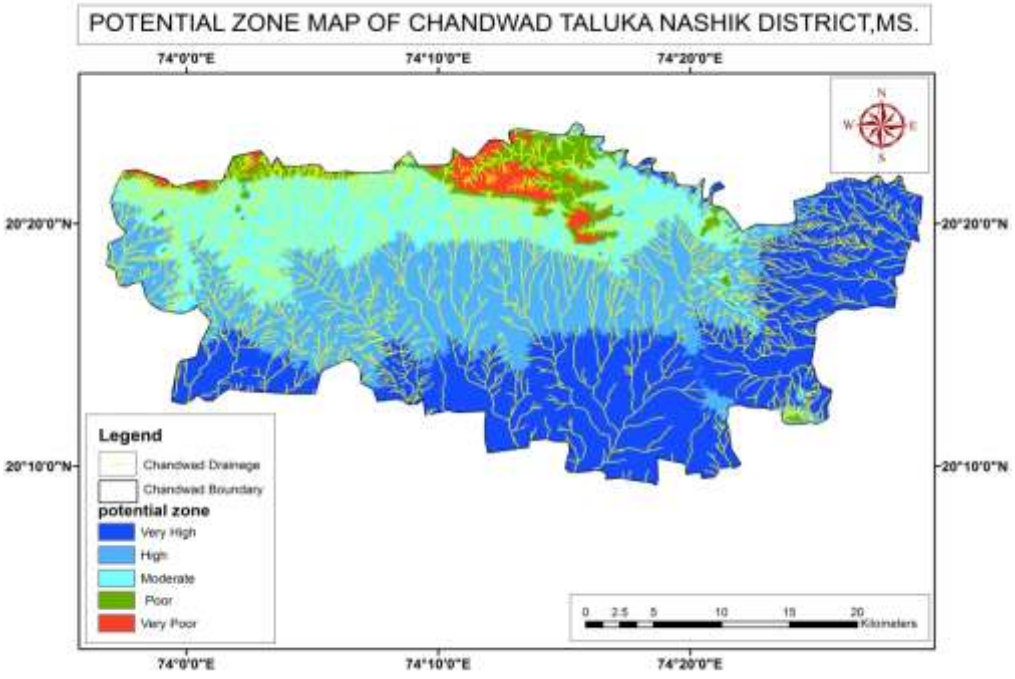
Contour Map: - Contours are lines that connect points of equal value (such as elevation, temperature, precipitation, pollution, or atmospheric pressure). The distribution of the lines shows how values change across a surface. Where there is little change in a value, the lines are spaced farther apart. Where the values rise or fall rapidly, the lines are closer together. Contour map is prepared by using surface tool which is present in Spatial analyst tool which can be achieved by following steps.

Process – Arc Tool Box > Spatial Analyst Tool > Surface > Contour



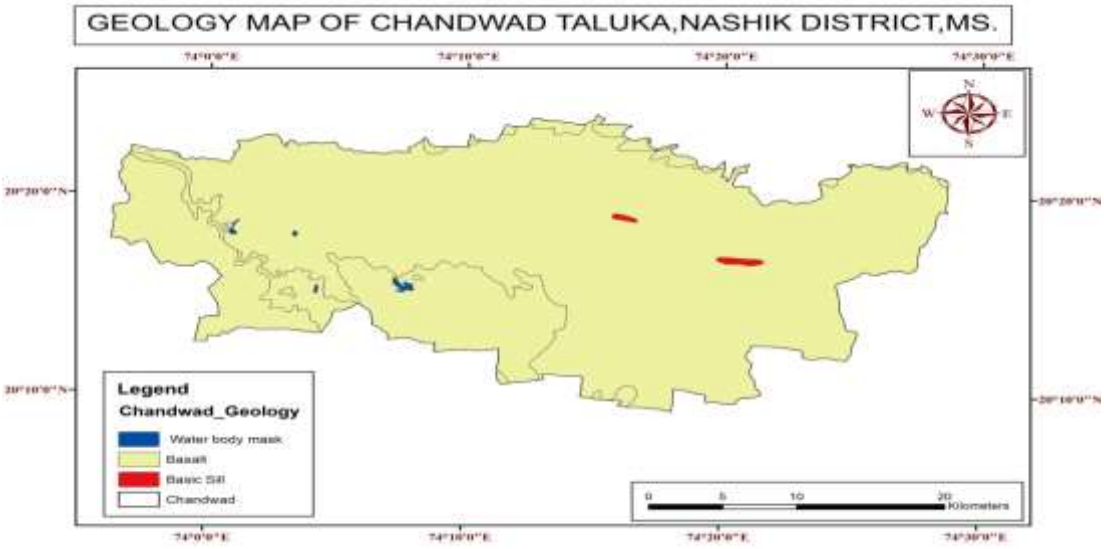
Ground Water Potential Map:- Groundwater potential is measured by recharge rate and mechanism, aquifer storage and transmission properties, and suitability of the water from water quality point of view and the response of the aquifer to changes such as climate, seasonality, artificial withdrawal and pollution.

Process - Create a shape file > Digitize the Features (lineaments).



Geological Map: - Identification of Rock type or lithology from visual and digital interpretation from image is also a systematic integrated approach. In which Image elements like tone/ color ,texture, pattern, shape ,size ,shadow ,association and Terrain elements like landforms ,drainage pattern and drainage density are studied. At first one shape file was created with line geometry. Lithological contacts boundaries have been digitized .After digitization the line shape file was polygonised.

Process - Create a shape file > Digitize the Features (contacts) > Data management Tool > Features > Features to Polygon



Drainage Extraction:-

Using Arc GIS Tools.

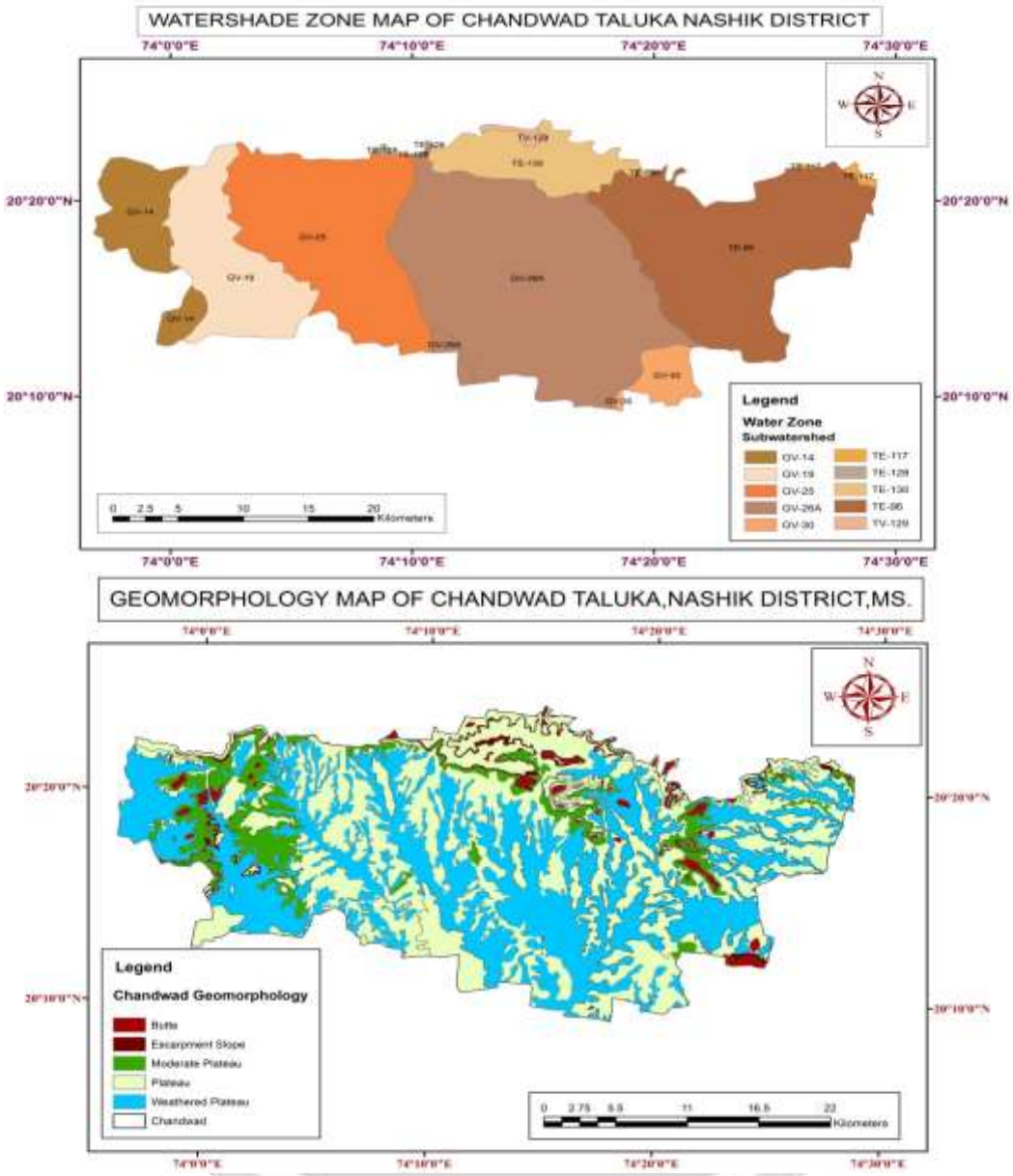
Sr. No.	Function	Process
1	**Fill**	Arc Tool Box > Spatial Analyst Tool > Hydrology > Fill
2	**Flow Direction**	Arc Tool Box > Spatial Analyst Tool > Hydrology > Flow Direction
3	**Flow Accumulation**	Arc Tool Box > Spatial Analyst Tool > Hydrology > Flow Accumulation
4	**Conditional Map**	Arc Tool Box > Spatial Analyst Tool > Map Algebra> Raster Calculator > Con (‘Flow Acc ‘ >250’1)
5	**Stream Order**	Arc Tool Box > Spatial Analyst Tool > Hydrology > Stream Order> Using (Strahler’s Scheme)
6	**Stream To Feature**	Arc Tool Box > Spatial Analyst Tool > Hydrology > Stream to Feature

Drainage pattern:- The study area displays a variety of drainage patterns which is governed by the spatial arrangement of lithological boundaries, landforms, drainage networks and distribution of linear structures, fault, lineament and fractures. Dendritic Drainage pattern is present in the Jalna taluka.

Aspect Map:-It is graphical representation of the down slope direction of the maximum rate of change in value from each cell to its neighbors. It can be thought of as the slope direction. The values of each cell in the output raster indicate the compass direction that the surface faces at that location.

Structural Map: - Structural map generally comprises faults, lineaments, trendlines and thrusts. Lineament is a linear topographic feature that is thought to reflect crustal Structure, e.g Fault Line, Straight Stream courses etc. Mapping of lineament is first and foremost step which directly or indirectly tells about the tectonic sensitivity of

tectonic area. First a shape file, with the line geometry was created and linear features which are considered lineaments are digitized.



Geography of Chandwad Taluka

Nashik District, located in Maharashtra, India, is noted for the mountains and hills occupying the north and north-east of its territory. These hill ranges are eastward spurs of the Western Ghats and form prominent landmarks in the district, some noted for the shrines they harbor while others for the trekking adventures which can be undertaken while ascending the peaks. Broadly categorized, the hills can be segregated into 3 noteworthy ranges:

- Selbari Range which may be inclusive of the Dholbari range, alternately called Selbari-Dholbari range.
- Satmala Range also called the Satmala-Ajanta range.
- Trimbakeshwar Range constituting the Trimbak-Anjaneri hills.
- 1Selbari-Dolbari Range
- 2Satmala Range
- 3Trimbakeshwar

Geomorphology of the Study Area

The district forms part of Western Ghats and Deccan Plateau. Physiographical Nasik district comprises varied topography. The main system of hills is Sahyadri and its offshoots viz., Satmala, Selbari and Dolbari hill ranges. These hill ranges along with eastern and southern plains and Godavari valley are the distinct physiographic units. The northern part of the district falls under Tapi basin and is drained by easterly flowing Girna River along with its tributaries, whereas the southern part of the district falls under Godavari basin and is drained by Godavari River and its tributaries. The available data of the exploratory wells, Geophysical survey, Ground water level monitoring stations and ground water quality monitoring stations of Central Ground Water Board were compiled. In addition to these the data on ground water monitoring stations and ground water quality stations of the State Govt. (GSDA) was also utilized for same. The district is further subdivided in to 15 taluka wise, Nasik, Igatpuri, Dindori, Peint, Surgana, Deola, Satana, Kalwan, Chandwad, Niphad, Sinner, Yeola, Malegaon, Nandgaon and Trimbakeshwar.

As per 2001 census, the population of the district is 49.94 lakhs. The district has 18 towns and 1931 villages. Nasik district has a reputation of holiest pilgrimage district of Maharashtra state. Nasik district is highly diversified district in terms of physiography. It has a main river Godavari which is called as 'Ganga' of Maharashtra. Because of this main river along with river Girna and Mosam provide high resources of water for irrigation therefore we find this district with high and rich agricultural resources. Nasik district has made its name in the global export market because of grapes. It is necessary for us to understand a brief profile of this district which is now establishing itself into one of the leading agricultural and industrial district of Maharashtra state.

The larger eastern portion of the district, which lies on the Deccan Plateau, is open, fertile, and well cultivated. The Chander Range, which runs east and west, forms the chief divide of the plateau region. The Godavari River originates in the district and drains east towards the Bay of Bengal, and all the streams to the south of the Chander Range, including the Kadwa and Darna, are tributaries of the Godavari. To the north of the Chander Range, the Girna River and its tributary, the Mosam, flow westward through fertile valleys into the Tapti River.

CONCLUSION

We have used number of techniques to study the area before visit such as Toposheet (Survey of India), Remote Sensing, satellite images & GIS software to develop map of proposed watershed region for proper understanding based on this data some thematic maps of study area were prepared. The integrated use of remote sensing and GIS for development of watershed and for evolution of its hydrologic response, to various land use and management changes. The spatial analysis of thematic information, which can be derived from remote sensing helps in the assessment of development plans before they are implemented of Watershed management.

The groundwater potential unit revels and gives an idea about development and management plan of groundwater recourses. The three type of groundwater potential units has been observed such that good, moderate and poor potential zones. These units have been demarcated by the different lithologic and geological conditions. The good groundwater potential units consist of valley fills, flood plain and thick alluvium deposits geomorphologic features. The lithologies of this unit are mainly alluvium and lineaments present in the area cut to each other.

In the case of moderate groundwater potential unit the geomorphological condition is buried pediment, older alluvium plains. The lithology is vesicular/weathered basalt having secondary porosity in rocks. Lineament having cut and parallel structured to each other. Poor groundwater potential units a lithology of massive compact basalt devoid of porosity, and absence of water conducting lineament.

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