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Process of Delineation of Watershed Boundary

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ABSTRACT: For making the digitized map of “PROCESS OF DELINEATION OF WATERSHED BOUNDARY” first we learned some pre-requisite technical aspects like ARCGIS. After getting the image from Google maps boundaries are determined according to the requirements of the work then we import the information to the ARCGIS software where we digitize watershed boundary by creating DEM, Flow direction grid, creating pour points and finally Delineating Watershed boundary. Watershed refers to the area or ridge of land that separates water flowing to different rivers, basins, or seas from higher level to lower level topography. This network of watershed boundaries can help indesigning of Storage tanks and efficient installation of this tanks.

The vector map of “Streams Network and Contours map of Peddapalli District. All streams of selected boundary was shown by thematic layer”. All the features were represented on the map with labels and symbols and finally the analysis was done. The stream lines and water bodies were said to be water storage reservoir for the sake of irrigation or other purposes. The result founded was flow direction and water storage using stream lines and Contours were created to find the lower areas. The final results were explained with the clear data.

I. INTRODUCTION

Water is a transparent and nearly colourless chemical substance that is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms.

Watershed

A watershed is an area of land that catches rain and snow and drains or seeps into a marsh, stream, river, lake or groundwater. Homes, farms, cottages, forests, small towns, big cities and more can make up watersheds. Some cross municipal, provincial and even international borders. They come in all shapes and sizes and can vary from millions of acres, like the land that drains into the Great lakes, to a few acres that drain into a pond. Watershed consists of highpoints and ridgelines that descend into lower elevations and stream valleys. A watershed carries water "shed" from the land after rain falls and snow melts. Drop by drop, water is channelled into soils, groundwater, creeks, and streams, making its way to larger rivers and eventually the sea. Water is a universal solvent, affected by all that it comes in contact with: the land it traverses, and the soils through which it travels. The important thing about watersheds is: what we do on the land affects water quality for all communities living

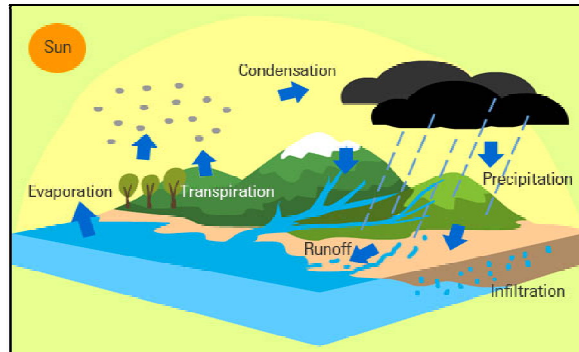
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Hydrological cycle:



A watershed is a precipitation collector:

Most of the precipitation that falls within the drainage area of a stream's monitoring site collects in the stream and eventually flows by the monitoring site. Many factors, some listed below, determine how much of the stream flow will flow by the monitoring site. Imagine that the whole basin is covered with a big plastic sheet. Then if it rained one inch, all of that rain would fall on the plastic, run down slope into gully and small creeks and then drain into main stream. Ignoring evaporation and any other losses, and using a 1-square mile example watershed, then all of the approximately 17,378,560 gallons of water that fell as rainfall would eventually flow by the watershed-outflow point.

To picture a watershed as a plastic-covered area of land that collects precipitation is overly simplistic and not at all like a real-world watershed. A career could be built on trying to model a watershed water budget (correlating water coming into a watershed to water leaving a watershed). There are many factors that determine how much water flows in a stream (these factors are universal in nature and not particular to a single stream):

Precipitation: The greatest factor controlling stream flow, by far, is the amount of precipitation that falls in the watershed as rain or snow. However, not all precipitation that falls in a watershed flows out, and a stream will often continue to flow where there is no direct runoff from recent precipitation.

Infiltration: When rain falls on dry ground, some of the water soaks in, or infiltrates the soil. Some water that infiltrates will remain in the shallow soil layer, where it will gradually move downhill, through the soil, and eventually enters the stream by seepage into the stream bank. Some of the water may infiltrate much deeper, recharging groundwater aquifers. Water may travel long distances or remain in storage for long periods before returning to the surface. The amount of water that will soak in overtime depends on several characteristics of the watershed:

Soil characteristics: In Georgia, clayey and rocky soils of the northern areas absorb less water at a slower rate than sandy soils, such as in Georgia's Coastal Plain. Soils absorbing less water results in more runoff overland into streams.

Soil saturation: Like a wet sponge, soil already saturated from previous rainfall can't absorb much more ... thus more rainfall will become surface runoff.

Land cover: Some land covers have a great impact on infiltration and rainfall runoff. Impervious surfaces, such as parking lots, roads, and developments, act as a "fast lane" for rainfall - right into storm drains that drain directly into streams. Flooding becomes more prevalent as the area of impervious surfaces increase.

Slope of the land: Water falling on steeply-sloped land runs off more quickly than water falling on flat land.

Evaporation: Water from rainfall returns to the atmosphere largely through evaporation. The amount of evaporation depends on temperature, solar radiation, wind, atmospheric pressure, and other factors.

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Transpiration: The root systems of plants absorb water from the surrounding soil in various amounts. Most of this water moves through the plant and escapes into the atmosphere through the leaves. Transpiration is controlled by the same factors as evaporation, and by the characteristics and density of the vegetation. Vegetation slows runoff and allows water to seep into the ground.

Storage: Reservoirs store water and increase the amount of water that evaporates and infiltrates. The storage and release of water in reservoirs can have a significant effect on the stream flow patterns of the river below the dam.

Water use by people: Uses of a stream might range from a few homeowners and businesses pumping small amounts of water to irrigate their lawns to large amounts of water withdrawals for irrigation, industries, mining, and to supply populations with drinking water.

Water around earth:

Water covers 71% of the Earth's surface. It is vital for all known forms of life. On Earth, 96.5% of the planet's crust water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapour, clouds (formed of ice and liquid water suspended in air), and precipitation. Only 2.5% of this water is freshwater, and 98.8% of that water is in ice (excepting ice in clouds) and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies

Climate of India:

Geographic scale and varied topography, making generalisations difficult. Based on the climate of India comprises a wide range of weather conditions across a vast Köppen system, India hosts six major climatic subtypes, ranging from arid desert in the west, alpine tundra and glaciers in the north, and humid tropical regions supporting rainforests in the southwest and the island territories. Many regions have starkly different micro-climates. The nation has four seasons: winter (December, January and February), summer (March, April and May), a monsoon rainy season (June to September), and a post-monsoon period (October to November).

General Overview

Land is real estate or property, minus buildings and equipment, which does not occur in a natural way. Land ownership may offer the title holder the right to natural resources on the land. The traditional school of economics dictates that land is a factor of production, along with capital and labor. The sale of land results in capital gain or loss; under IRS tax laws, land is not a depreciable asset.

Land, sometimes referred to as dry land, is the solid surface of the Earth that is not permanently covered by water. The vast majority of human activity throughout history has occurred in land areas that support agriculture, habitat, and various natural resources. Some life forms (including terrestrial plants and terrestrial animals) have developed from predecessor species that lived in bodies of water.

Areas where land meets large bodies of water are called coastal zones. The division between land and water is a fundamental concept to humans. The demarcation between land and water can vary by local jurisdiction and other factors. A maritime boundary is one example of a political demarcation. A variety of natural boundaries exist to help clearly define where water meets land. Solid rock landforms are easier to demarcate than marshy or swampy boundaries, where there is no clear point at which the land ends and a body of water has begun. Demarcation can further vary due to tides and weather.

LAND COVER is what covers the surface of the earth. Examples of land cover classes include: water, snow, grassland, deciduous forest, and bare soil.

LAND USE describes how the land is used. Land use examples include: wildlife management area, agricultural land, urban, recreation area etc.

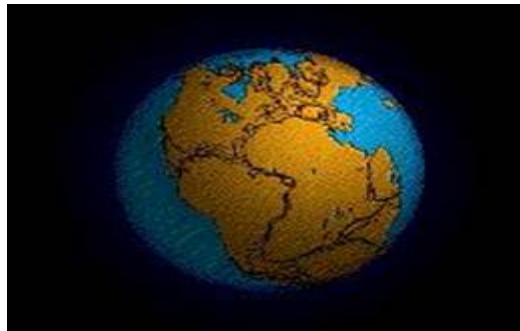
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History of land on Earth



Earth Surface

The earliest material found in the Solar System is dated to 4.5672 ± 0.0006 bya (billion years ago) therefore, the Earth itself must have been formed by accretion around this time. By 4.54 ± 0.04 bya, the primordial Earth had formed. The formation and evolution of the Solar System bodies occurred in tandem with the Sun. In theory, a solar nebula partitions a volume out of a molecular cloud by gravitational collapse, which begins to spin and flatten into a circumstellar disk, which the planets then grow out of in tandem with the star. A nebula contains gas, ice grains and dust (including primordial nuclides). In nebular theory, planetsimals commence forming as particulate matter accrues by cohesive clumping and then by gravity. The assembly of the primordial Earth proceeded for 10–20 million year

Earth's atmosphere and oceans were formed by volcanic activity and outgassing that included water vapor. The origin of the world's oceans was condensation augmented by water and ice delivered by asteroids, proto-planets, and comets. In this model, atmospheric "greenhouse gases" kept the oceans from freezing while the newly forming Sun was only at 70% luminosity. By 3.5 bya, the Earth's magnetic field was established, which helped prevent the atmosphere from being stripped away by the solar wind. The atmosphere and oceans of the Earth continuously shape the land by eroding and transporting solids on the surface.

Land mass

"Land mass" refers to the total surface area of the land of a geographical region or country (which may include discontinuous pieces of land such as islands). It is written as two words to distinguish it from the usage "landmass", the contiguous area of land surrounded by ocean. The Earth's total land mass is $148,939,063.133 \text{ km}^2$ ($57,505,693.767 \text{ sq mi}$) which is about 29.2% of its total surface. Water covers approximately 70.8% of the Earth's surface, mostly in the form of oceans and ice formations.

Land and climate

The land of the Earth interacts with and influences climate heavily since the surface of the land heats up and cools down faster than air or water. Latitude, elevation, topography, reflectivity, and land use all have varying effects. The latitude of the land will influence how much solar radiation reaches the surface. High latitudes receive less solar radiation than low latitudes. The height of the land is important in creating and transforming airflow and precipitation on Earth. Large landforms, such as mountain ranges, divert wind energy and make the air parcel less dense and able to hold less heat. As air rises, this cooling effect causes condensation and precipitation. Reflectivity of the earth is called planetary albedo and the type of land cover that receives energy from the sun affects the amount of energy that is reflected or transferred to Earth. Vegetation has a relatively low albedo meaning that vegetated surfaces are good absorbers of the sun's energy. Forests have an albedo of 10-15% while grasslands have an albedo of 15-20%. In comparison, sandy deserts have an albedo of 25-40%. Land use by humans also plays a role in the regional and global climate. Densely populated cities are warmer and create urban heat islands that have effects on the precipitation, cloud cover, and temperature of the region.

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Type of Lands:

India is one of the largest countries of the world. It ranks seventh in respect of size, and second in respect of population. The total land area of India is 32 lakh 87 thousand square kilometers. Three major types of lands are found in India in respect of its relief, such as, mountains, plateaus and plains. About 29% of our total land areas are mountains, 28% plateaus and 43% plains.

The mountains include the high Himalayan mountains in the north, the Aravalli ranges and the Western Ghats in the west, the Vindhyas and the Sapura range at the centre, the Eastern Ghats in the east, the Agro, Khaki and Jacinta range in the north east. The plateaus include the Chhotnagpur Plateau, the Amarkantaka, Malawi, Karnataka and the Deccan plateaus. The plains include the Gang etic plains in the north, the Brahmaputra valley, the east and the west coastal plains and the flood plains of different river valleys of India.

About 80% of the total land area of India is utilized by man. This land utilisation of man is influenced by the relief, climate, soil as well as man's social and economic conditions.

According to use, lands in India are utilized as forest-lands, pasture and grazing lands, agricultural or farm lands, settlement and other such purposes.

Forest Lands:

India was covered with dense forests in primitive ages. More and more lands were needed for agriculture, settlement industry, roads etc. with the growth of population. So man utilized land by cutting down and cleaning the forests in order to fulfill his growing needs. Now only about 22% of the total land area of our country is covered with forests.

The National Forest Policy formulated in the year 1952 proclaims that about 33% of the country's total land area should be covered with forests in order to maintain ecological balance in our environment. It will control the country's climate and the country will be saved to a great extent from the ravages of flood, drought and cyclones. Therefore, there should be forests in about 60% of lands in hilly areas and 20% of lands in the plains.

According to law, these forests are of three categories; such as, reserved forests, protected forests and unclassified forests. Valuable forests are taken as the reserved forests, for which about half of the total lands under forests have been conserved. Man gets many useful forest products from the forests.

Forests play vital role in checking soil erosion, controlling flood, increasing the amount of rainfall and creating favourable conditions in the local climate. That is why forests are an important natural wealth of the country. Forests of India are being destroyed owing to various natural as well as man-made causes. So the extent of forests is gradually diminishing.

In some hilly areas of the country, the Advises adopt shifting cultivation by clearing forests. Such type of farming is known as "pod" on "tail" cultivation in Orissa. At some places forests are cut down to raise farm lands, settlements, industries, roads etc. Cattle also treat forests as their grazing ground thereby the seedlings and finally the forests are destroyed.

Only 2% of the total forest land of the world is in India. But 15% of the total world population and 13% of the total cattle population depend on forests. It is known as biotic pressure. Such enormous pressure is an important reason of deforestation. Besides, floods, cyclones and land erosion etc. also diminish the forest areas of our country.

Various projects like afforestation, social forestry, farm forestry etc. are being worked out in order to increase the forest area and efforts are being made to bring more land under forests. Artificial forests are being raised on waste lands in village and town areas under the social forestry scheme.

Plantations are likewise in progress on bunds and plots dividing boundaries under the farm forestry scheme. By means of afforestation, the destroyed forests of hills, mountains and plateaus are being developed and thereby the extent and density of forests are increasing.

Land for Agriculture or Farm Lands:

India is primarily an agricultural country. About 55% of the total land areas are used for growing food-crops, vegetables, cash crops and fruit. Food-crops are grown on about 45% of land out of the total 55% under cultivation. Vegetables and fruit are grown on the rest of the lands and some lands are left without any cultivation occasionally.

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India has more farm lands according to its land area as compared with the other countries of the world; but it is strange that the agricultural products are less. Plains, river-valleys, flood-plains and delta areas are mostly used for agriculture. Very limited farming is done on the plateaus and mountain-slopes. Shifting cultivation or pod cultivation is carried on by clearing the forest areas.

Only paddy is cultivated on about three-fourths of the total land under food-crop cultivation, as rice is the staple food of the people in most parts of India. Wheat is grown on less amount of land than this; the area of farm lands is increasing year after year as more people depend on agriculture. The area of land under food-crop production in 1951 has by now increased by one and a half times; but the per capita holding of arable land has been decreasing gradually because of rapid growth of population.

These are the general uses of land:

Agriculture and horticulture

Housing

Laying of roads and railway lines

Industries

Mining of mineral resources

A container for holding water

For fodder, cattle grazing, forest wealth for timber, fuel, etc.

The above flow gives an over-view of India's land classification.

Particular areas of land can be utilized by humans in diverse ways. These can include residential, institutional, business, industrial, agricultural, forestry, park, and other relatively natural land uses. Each of these broader categories can be further subdivided, based on the nature and intensity of the activities that are undertaken.

Residential land uses, for example, can involve single-family dwellings on large or small lots, or aggregations of multiple-unit dwellings of various sorts. The most intensive residential land-uses are associated with clusters of apartment buildings, which can support extremely large densities of human populations.

Institutional land uses are mostly associated with land that is occupied by public buildings such as schools, universities, government office buildings, art galleries, and museums. These facilities are most commonly located in urban or suburban areas. Business land uses are rather similar in many respects, and are mostly associated with land that is appropriated to retail facilities of various types, and with office buildings.

Industrial land uses are extremely varied, depending on the nature of the industry being considered. Urban-industrial land usage generally refers to the siting of factories or petroleum refineries, and of utilities such as electricity generating stations, and water- and sewage-treatment facilities. Industrial land use in rural areas can include mines, smelters, and mills for the production of ores and metals; mines and well fields for the production of fossil fuels such as coal, oil, and natural gas; and large water-holding reservoirs for the production of hydroelectricity.

Land uses for agriculture and forestry are also types of industrial land uses, in this case involved with the production of food or tree-fiber as renewable resources. The nature of agricultural land uses depends on the types of crops and agronomic systems, which can vary from intensively managed monocultures, to more organic systems involving annual or perennial crops and little use of fertilizers or pesticides. Similarly, the intensity of land use in forestry varies from systems involving clear-cutting and the establishment of short-rotation plantations, to selection-harvesting systems with long-spaced interventions.

Some land uses associated with parks and golf courses also represent intensive modifications of the natural landscape. The management practices required to maintain these lawn-dominated ecosystems are similar to those utilized in some types of mono-cultural agricultural systems

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II. METHODOLOGY

Study Area:

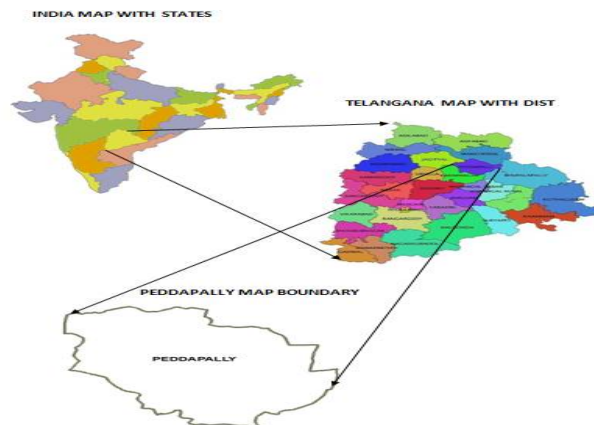
Peddapalli district is a district located in the northern region of the Indian state of Telangana. Peddapalli city is a educational and business hub for the Ramagundam and Manthaniareas .Peddapalli city is well known for its Multi cultural and linguistic diversity. Ramagundam is the largest city in this district.

The district is spread over an area of 4,614.74 square kilometres (1,781.76 sq mi).

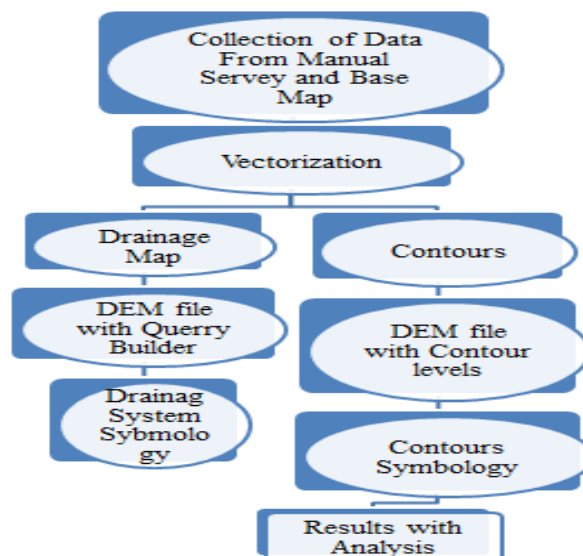
List of mandals: Peddapalli, Odela, Sulthanabad, Julapalli, Eligaid, Dharmaram, Ramagundam, Anthergaon, Palakurthy, Srirampur, Kamanpur, Ramagiri, Manthani, Mutharam (MNT)

Latitude and longitudes: Coordinates are: 18.6162°N 79.3832°E

LOCATION MAP



Flow Chart



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Procedure:

FILL: The Fill tool uses the equivalents of several tools, such as Focal Flow, Flow Direction, Sink, Watershed, and Zonal Fill, to locate and fill sinks. The tool iterates until all sinks within the specified z limit are filled

As sinks are filled, others can be created at the boundaries of the filled areas, which are removed in the next iteration. The tool can also be used to remove peaks, which are spurious cells with elevation greater than would be expected given the trend of the surrounding surface. This surface also looks same as above.

Flow Direction: This tool takes a surface as input and outputs a raster showing the direction of flow out of each cell. If the Output drop raster option is chosen, an output raster is created showing a ratio of the maximum change in elevation from each cell along the direction of flow to the path length between centers of cells and is expressed in percentages. If the Force all edge cells to flow outward option is chosen, all cells at the edge of the surface raster will flow outward from the surface raster.

Flow Accumulation: The Flow Accumulation tool calculates accumulated flow as the accumulated weight of all cells flowing into each down-slope cell in the output raster. If no weight raster is provided, a weight of 1 is applied to each cell, and the value of cells in the output raster is the number of cells that flow into each cell.

In the graphic below, the top left image shows the direction of travel from each cell and the top right the number of cells that flow into each cell.

Conditional: The Conditional tools allow you to control the output values based on the conditions placed on the input values. The conditions that can be applied are of two types, those being either queries on the attributes or a condition based on the position of the conditional statement in a list.

Stream Order: Stream ordering is a method of assigning a numeric order to links in a stream network. This order is a method for identifying and classifying types of streams based on their numbers of tributaries. Some characteristics of streams can be inferred by simply knowing their order. For example, first-order streams are dominated by overland flow of water; they have no upstream concentrated flow. Because of this, they are most susceptible to non-point source pollution problems and can derive more benefit from wide riparian buffers than other areas of the watershed

Stream Feature Class: The algorithm used by the Stream to Feature tool is designed primarily for vectorization of stream networks or any other raster representing a raster linear network for which directionality is known. The vector data below shows the all possibility stream lines, from this the necessary data will be kept and the remaining stream lines will be removed by using query builder tool.

CONTOURS MAP:

Contours are the lines joining the points of equal elevation (height) which are above Datum (Mean sea level). A contour map is a map illustrated with contour lines, for example a topographic map, which thus shows valleys and hills, and the steepness or gentleness of slopes.

To create the required contour data we use DEM file and 3D Analyst tools from the Arc Tool box. These tools will be accessed if we select in the customize – extensions.

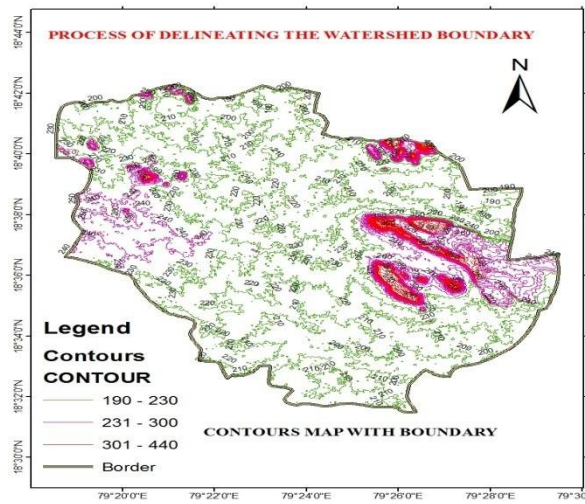
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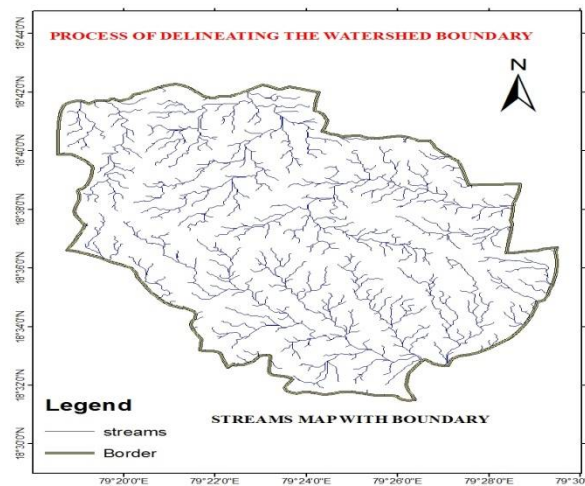
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III. RESULTS AND ANALYSIS



From the above contours map the highest level contours are showed with red color, the medium level contours were shown with pink color and the lowest contours were shown with green color. In this the contour intervells are taken as 10 units each.



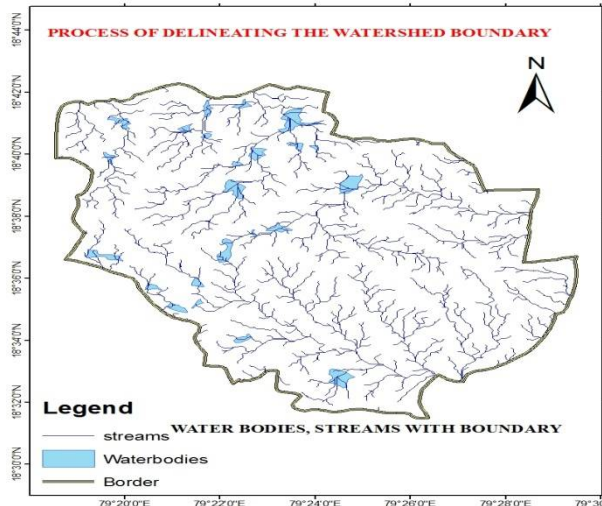
From the above network we found that the water flows from high level to low level so based on the flow direction water will be stored for the utilization. The storage reservoirs will be constructed. All streams are shown with branches and sub branches as their source of water from there we can collect the water as stream

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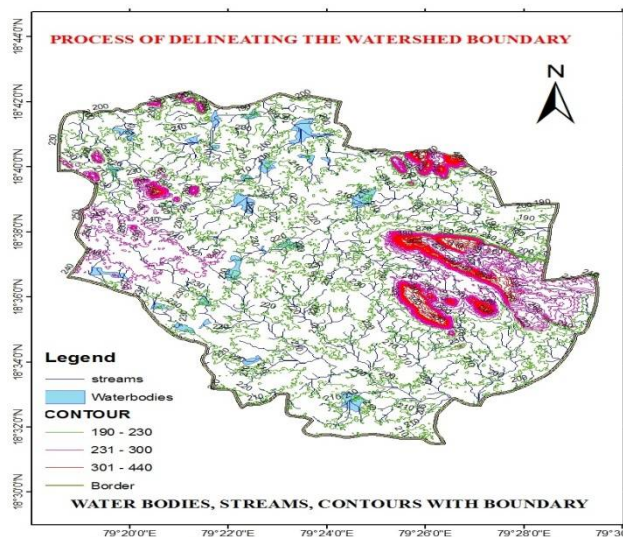
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From the above network we found that the water flows from high level to low level and the storage reservoirs were shown with blue colour. All streams are shown with branches and sub branches as their source of water from there we can collect the water as stream



Above map shows the contours, Water bodies and Water bodies. This shows all the features with different color for easy understanding. And the flow direction also identified easily with the help of branches.

IV. CONCLUSION

From the above results we can say that the Geographical Information Technology was very useful in the collection, management, maintenance, manipulation and presentation of geographic data and information. By the use of these technologies is known to simplify decision making to a non technical level. For making the vector map of “Drainage Network and Contours” were shown with thematic layer”. In this we used DEM image from the opentopography, it was converted into vector data with required features as contours and stream lines.

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All the features are represented on the map with labels and symbols and finally the analysis was done. These stream lines and water bodies were said to be water storage reservoir for the sake of irrigation or other purposes. The result founded was flow direction and water storage using stream lines and contours map was done to find the lower height areas. In this GIS technology played the vital role to estimate the required data.

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