INTEGRATED STUDIES FOR WATERSHED DEVELOPMENT USING GIS: A CASE STUDY IN BASUHI RIVER WATERSHED

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ABSTRACT: With the study we are trying to get to know how GIS can be used in multiple applications and help us to rejuvenate and conserve the watershed. GIS proves to be a driving resource for the development and the management of the watersheds which is now not only restricted to mapping but also plays a very crucial role in analytical process and also provides us with much more organized way of looking and dealing with the problems we face for the development and conservation of watersheds quiet efficiently. With Integrated studies we can get a great approach and a better visualization for planning, conserving and modelling watershed properly with accuracy.

Making use of the technology like Remote Sensing and GIS lets us assess the changing Rainfall patterns over a period of time, the erosivity caused due to rainfall, the land use land cover patterns, drainage density, soil and other natural resources. Integration of all these assessments give us with the ways in which we can develop the watershed, protect and manage them accordingly. This in turn can also help us to gather information about how to plan the development of infrastructure for the future which also serves multiple purpose from the study.

KEYWORDS: Basuhi River Basin, Micro Watersheds, GIS, Watershed Development, Management, Priority.

INTRODUCTION

GIS is a very useful and powerful tool these days when it comes for the development and management of the watershed. GIS tools and techniques help us figure out about the current situation as well as plan how we can maintain the watershed in the coming future for sustainable living and sustainable environment. With Watershed Development we can rejuvenate the natural resources be it water, soil, land, vegetation etc. In order to get the development activities done in a correct manner we need to see the topography of that area be it water, soil, land, vegetation etc. which lets us to adopt an integrated management approach which evolves the development of the watershed.

With the growing degradation of the environment, we need to effectively put efforts for the development of the watershed as with this we can also let other natural resources to revive and get regeneration and conservation of all the other natural habitats. We basically need to protect and conserve and improve the quality of all the natural resources within a watershed. With the help of watershed management, we can create a balance between what are the availabilities and what are the demands that needs to get fulfilled. The approach to be used should be curative and progressive.

With the development and management of watersheds the ability of land to hold water also gets improved, also the ground water also needs to get recharged. We are in need to use the integrated studies for generating environment indicators, and generating variety of the maps based on certain important factors. With the help of Remote Sensing and GIS we would receive the timely and accurate information of the natural resources which we are going to take as multiple factors and will let us know about the how the rainfall is distributed over the study area, how rainfall led to the erosion of soil and over which area is most affected by rain. The distribution of the type of land within the study area would be known by LULC map whether it is cropland, scrub land, land with settlements etc. Also, we will figure about certain other parameters which will guide us through the steps needed to be taken for the development of the watershed in the study area.

STUDY AREA

Basuhi River is the longest tributary of Varuna River. Although Basuhi River Basin covers five districts of Uttar Pradesh named Jaunpur, St. Ravidas Nagar, Pratapgarh, Prayagraj, Varanasi but the major region the river covers is in Jaunpur district of Uttar Pradesh. It is considered as a very prominent river of Jaunpur. The latitude of Basuhi River is 25° 23' 38" north and the longitude of Basuhi River is 82° 41' 36" east. The Basuhi River is around 40 feet's deep. The Basuhi river along with river

Gomti divides the Jaunpur district into four equal landmasses. The soil near the Basuhi river is generally Loamy. The river also overflows during rainy season. The study area has flat terrain. Basuhi River feds nearby villages, one can also do fishing in the river. Uttar Pradesh State Bridge Corporation Limited has floated a tender for Construction of Approach Across River Basuhi on Lumbani Dudhi Road Near Jamalapur in Jaunpur District. It covers a very prominent space in Varuna River Basin.

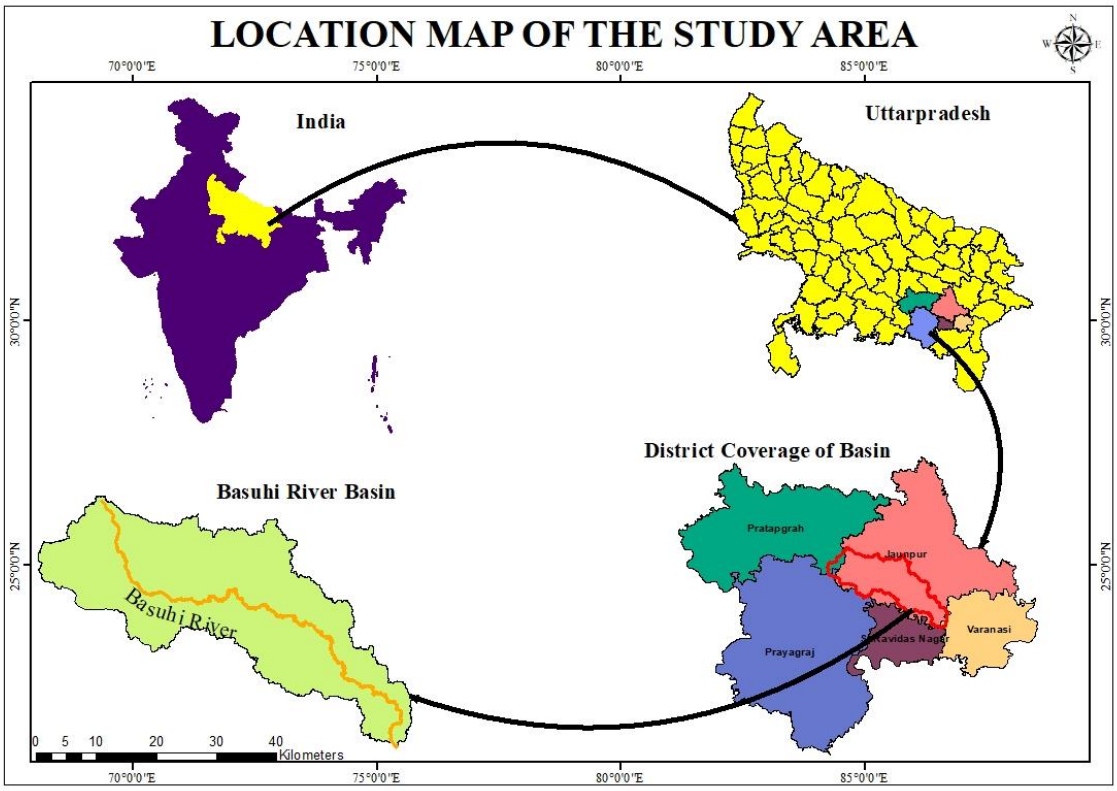


Fig. 1 LOCATION MAP OF BASUHI RIVER BASIN

DATA USED AND METHODOLOGY

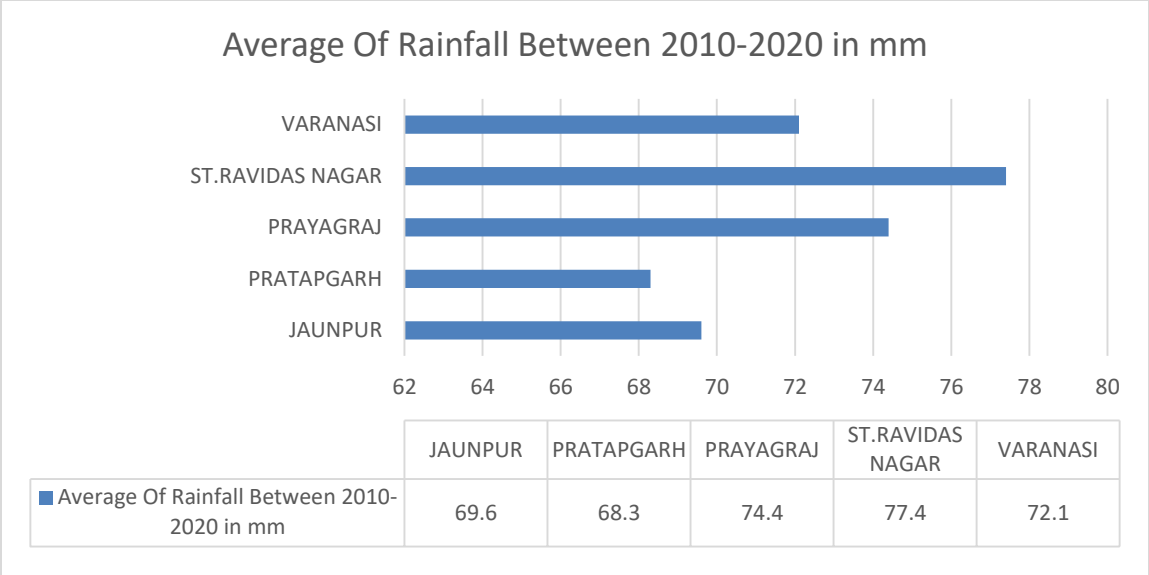
For conducting the present study, we have made various maps using ArcGIS 10.8 and used the inbuilt tools of the software to get the result. For delineating Basuhi River Watershed we have made use of toposheets of scale 1:50000 and DEM data. We have made Spatial Distribution map of rain for Basuhi River Basin over a period of 10 years from 2010-2020, we have also made a rainfall erosivity map using inverse distance weighted interpolation technique by gathering the reliable rainfall data. Land use land cover map is also prepared by using SENTINEL-2B data for taking ahead the essential study for the development of watershed. We made use of supervised classification for the generation of Land Use Land Cover map. The slope map is also prepared using ArcGIS software by taking the soil data from NBSS. A map for the micro watersheds along with the streams present in the Basuhi River Basin is also created automatically by making use of Arc Hydro tool of Arc GIS software by using DEM data from BHUVAN portal. A Drainage Density map is also prepared using GIS tools.

RESULT AND DISCUSSION

Rainfall Distribution

When it comes to add importance to the hydrological data, rainfall is most important factor. The graph (Fig. 2) generated shows us the average value of the rainfall between 2010-2020 in the five districts through which Basuhi River flows with the help of which we have made the spatial distribution of rain map.

We have prepared the spatial distribution map of rainfall (Fig. 3) for a period of ten years from 2010 to 2020 with the help of Inverse Distance Weighted interpolation technique using ArcGIS.



	JAUNPUR	PRATAPGARH	PRAYAGRAJ	ST.RAVIDAS NAGAR	VARANASI
Average Of Rainfall Between 2010-2020 in mm	69.6	68.3	74.4	77.4	72.1

Fig. 2 AVERAGE RAINFALL BETWEEN (2010-2020) IN BASUHI RIVER BASIN

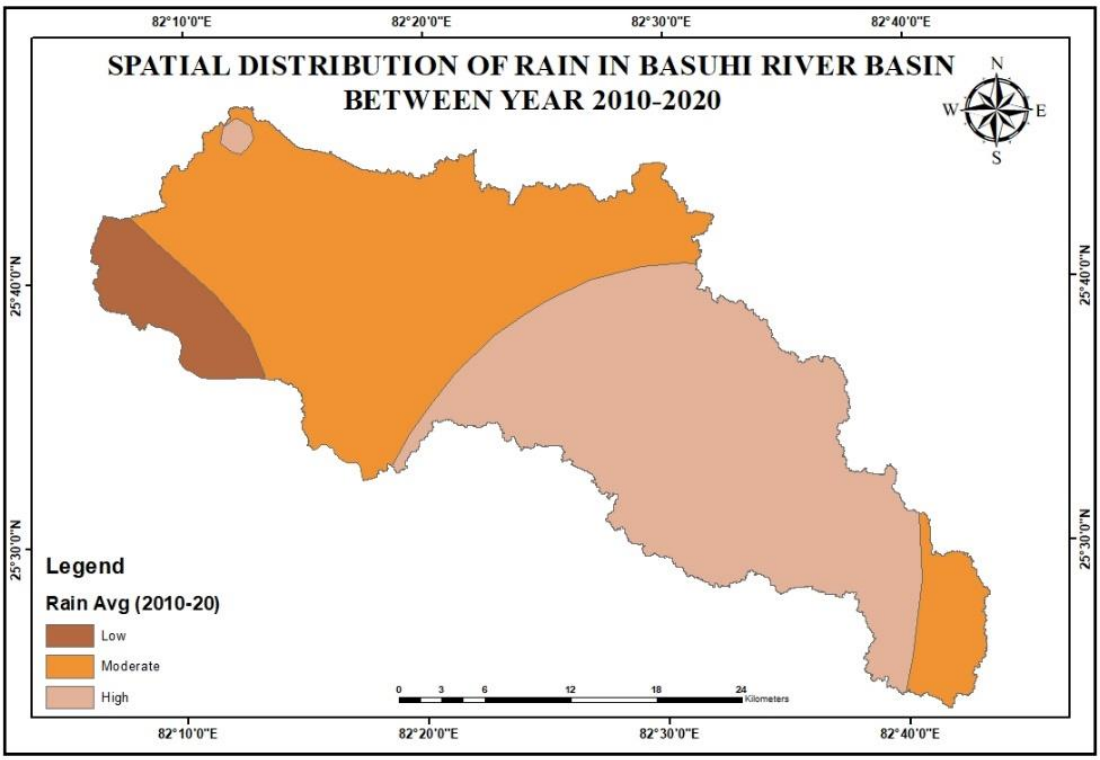


Fig. 3 SPATIAL DISTRIBUTION OF RAIN IN BASUHI RIVER BASIN

Rainfall Erosivity

Rainfall erosivity implies the soil loss due to rainfall. Heavy rainfall in the area would cause higher loss in the soil as compared to less rainfall which will not turn much loss in the soil. Rainfall erosivity is calculated using ArcGIS tools. This factor will let us know about the area which is most needed for the development of the watershed which has been deteriorated most from the erosion caused due to rainfall. In the map that we have made we have divided the categories among the Low Erosivity, Moderate Erosivity and High Erosivity. The area coming under high erosivity will be needed to treated well for the development of the watershed and its management.

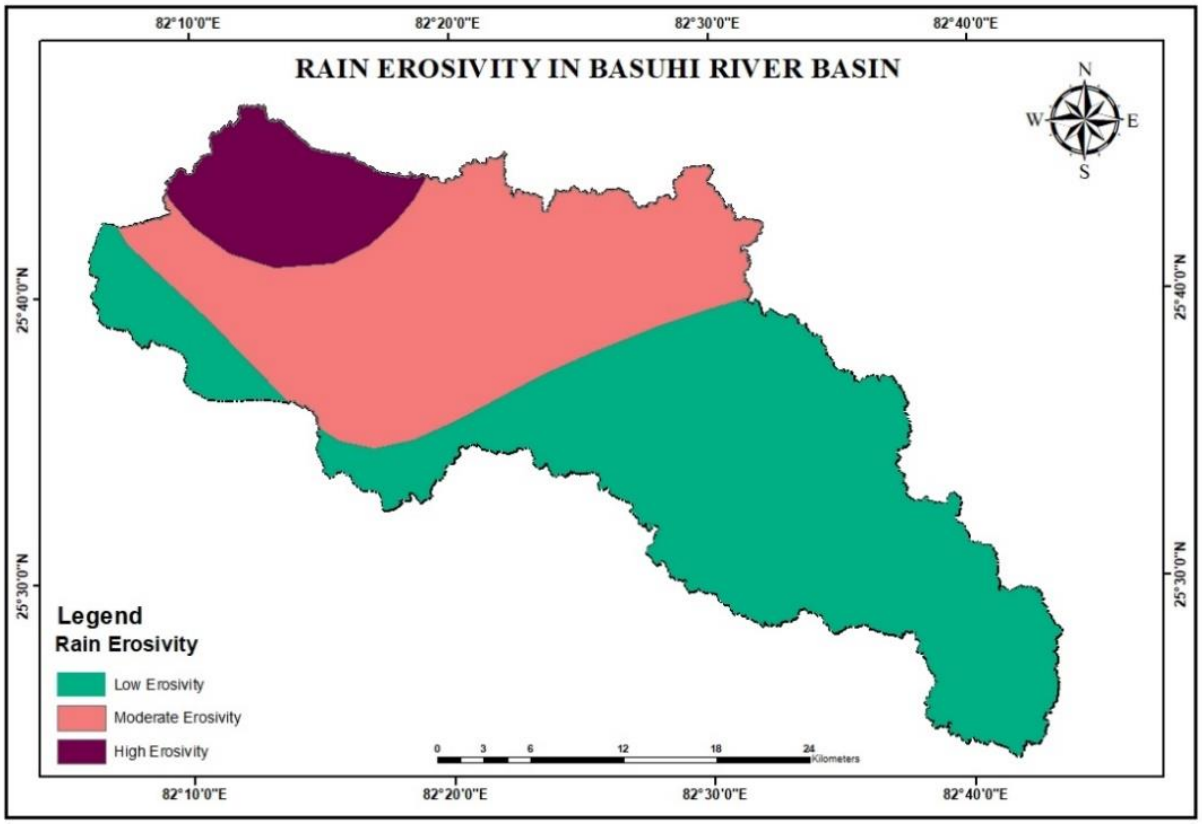


Fig. 4 RAINFALL EROSIVITY MAP OF BASUHI RIVER BASIN

Land Use Land Cover (LULC)

Land Use Land Cover maps (Fig. 5) are very important in determining the kind of entities the land is covered with. We can determine the area which is covered under various categories like Crop Land, Plantation, Scrub Land, Barren Land, Settlements, Waterbodies etc. LULC Maps helps in the present and the future developments. LULC Maps helps in determining the landscape. Delineating and mapping land cover is very crucial and important for studies that relates with the global monitoring, management of the resources and the activities involved in the planning and the management of the land. Various kinds of classification is done in order to get LULC maps. We have prepared the current LULC maps with the help of supervised classification with the help of the satellite images downloaded from SENTINEL-2B.

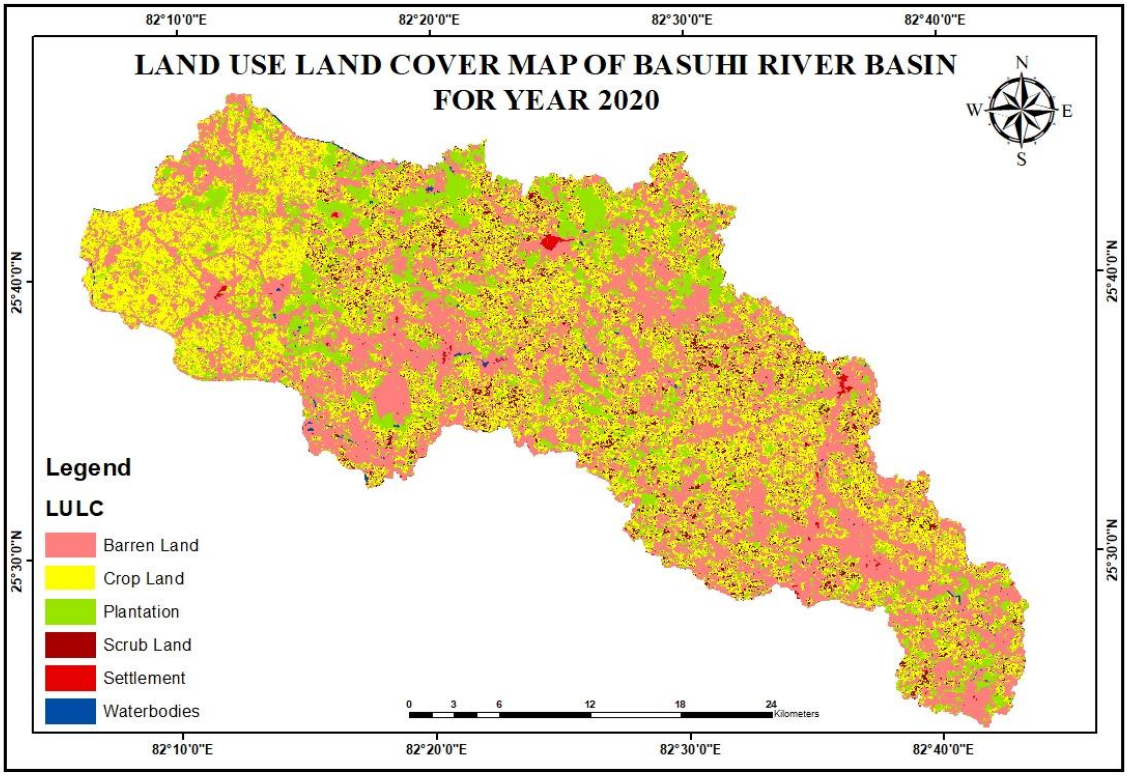


Fig. 5 LAND USE LAND COVER MAP OF BASUHI RIVER BASIN

Slope

With slope many factors are related which gives us massive information about the area under the study. It is extremely important to have knowledge about the slope of the region we are studying. Slope has an inverse relation with the infiltration. More slope leads to less infiltration and less slope has higher capacity of infiltration. On the other hand, slope is directly proportional to the drainage density which refers more is the slope more is the drainage density and lesser is the slope lesser is the drainage density. The study area has been classified into two forms of slope, one is very gentle slope and the other is near level to level slope (Fig.6). This tells us that the slope is less in the study area which is either very gentle or near level to level and this depicts that the study area is a plain region which in turn has slow run off. Slope also let us know about the direction of the runoff and as we know here that the slope is not on the steeper side it could also cause water to get logged as various places and hence a reduced runoff.

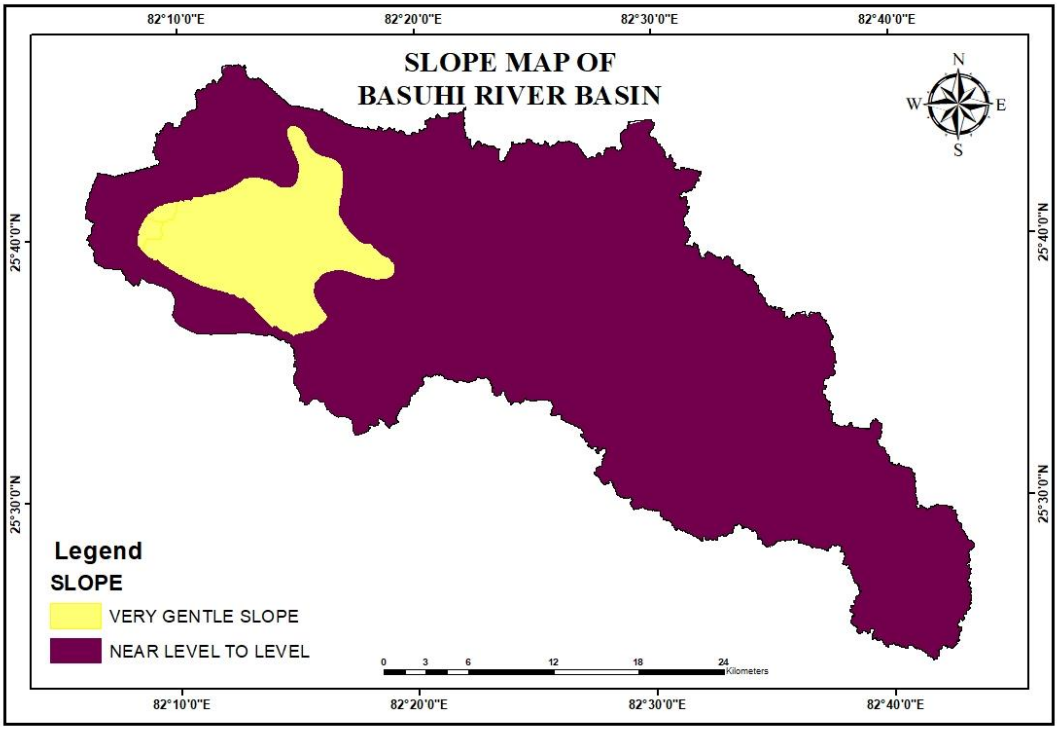


Fig. 6 SLOPE MAP OF BASUHI RIVER BASIN

Drainage Density

Drainage Density tells us about the characteristics of the river basin. We have made the streams with the help of Arc Hydro tool and then made drainage density map with Arc GIS software. The difficulty in the infiltration affects the runoff in a watershed. If the ground will not allow the water to pass through it then there will be increase in the surface runoff. For taking the study further we have prepared a drainage density map using ArcGIS software and we have classified the drainage density in three categories with value (0.00-0.75) as low, (0.76-1.89) as moderate, (1.90-3.00) Km/Km^2 as high (Fig. 8). The area having drainage density high will allow the water to percolate inside the ground and will not clog the water on the surface. The area having drainage density between (0.00-0.75) which is less, this will create surface runoff.

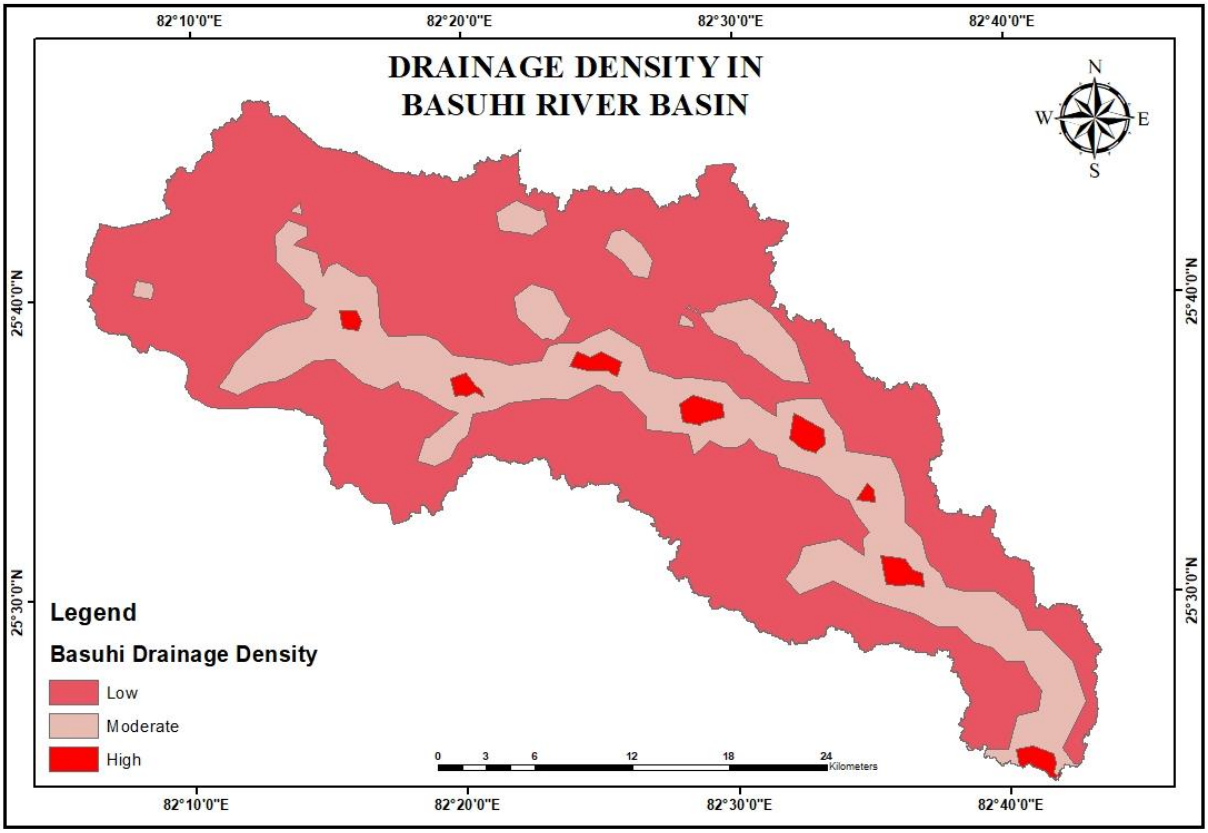


Fig. 8 DRAINAGE DENSITY MAP OF BASUHI RIVER BASIN

Micro Watersheds with Streams

In Basuhi River Basin we have a total of 23 Micro Watersheds named from SW1 to SW23 which are formed with the help of Arc Hydro tool of Arc GIS software (Fig. 7). We have also shown the streams present in the Basuhi river basin which are also made with the help of Arc Hydro tool. The streams in this basin have the highest order 4 (Fig. 7). All the orders are differentiated with the help of different types of colors given to each order respectively. With the help of this we would be able to know that within which micro watershed development is needed to be at priority within the Basuhi river basin so that even if we do not have resources to develop the entire watershed at a single time, we can easily treat the micro watershed which is at the highest risk.

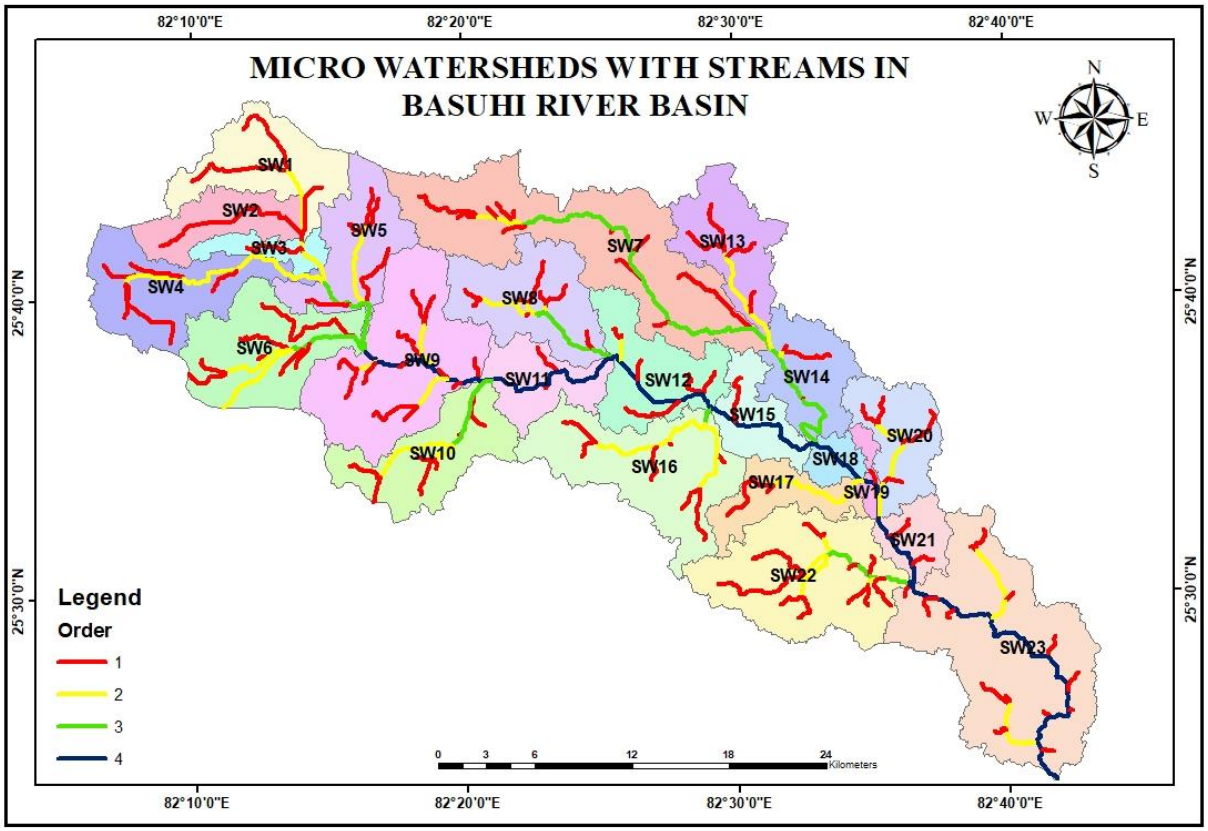


Fig. 7 MICRO WATERSHEDS WITH STREAMS IN BASUHI RIVER BASIN

PRIORITY

Priority is given to all the micro watersheds (Fig. 9) on the basis of all the above parameters that we have discussed. Total of 23 watersheds are present in the study area along with which the order of the stream is also marked over the micro watersheds. So, with this we can see that micro watersheds SW1, SW2, SW3, SW4, SW5, SW6 and SW9 having very gentle slope are covered mostly with barren land and faces high erosivity due to large amount of the rain distribution over that area so we need to develop and manage the watershed in this area at our priority therefore priority given to them is high (Table 1). Also, SW13 and SW23 micro watersheds have high rainfall and lower to moderate drainage density giving it high priority for watershed management. We have given low priority to micro watersheds SW12, SW14, SW15, SW16, SW17, SW18, SW19, SW20, SW21, SW22 less erosivity due to rain and also drainage density lies between moderate to high in which most of the water will infiltrate (Table 1).

Micro Watersheds	Rainfall Distribution	Rainfall Erosivity	LULC	Slope	Drainage Density	Priority
SW1	High, Moderate	High	Barren land, Crop Land, Plantation	Very Gentle Slope	Low	High
SW2	Moderate	High, Moderate	Barren land, Crop Land, Plantation	Very Gentle Slope	Low, Moderate	High

SW3	Moderate	High, Moderate	Barren land, Crop Land, Plantation	Very Gentle Slope	Low, Moderate	High
SW4	Low, Moderate	Low, Moderate	Barren land, Crop Land, Plantation	Very Gentle Slope	Low, Moderate	High
SW5	Moderate	High, Moderate	Barren land, Crop Land, Plantation	Very Gentle Slope	Low, Moderate	High
SW6	Low, Moderate	Low, Moderate	Barren land, Crop Land, Plantation, Waterbody, Settlement	Very Gentle Slope	Low, Moderate, High	High
SW7	High, Moderate	Low, Moderate	Barren land, Crop Land, Plantation, Waterbody, Settlement, Scrub Land	Near Level to Level	Low, Moderate	Moderate
SW8	High, Moderate	Moderate	Barren land, Crop Land, Plantation, Waterbody, Scrub Land, Settlement	Near Level to Level	Low, Moderate, High	Moderate
SW9	Moderate	Moderate	Barren land, Crop Land, Plantation, Settlement, Scrub Land	Very Gentle Slope	Low, Moderate, High	High
SW10	High, Moderate	Low, Moderate	Barren land, Crop Land, Plantation, Waterbody, Scrub Land, Settlement	Near Level to Level	Low, Moderate, High	Moderate
SW11	High, Moderate	Low, Moderate	Barren land, Crop Land, Plantation, Waterbody, Scrub Land, Settlement	Near Level to Level	Low, Moderate	Moderate

SW12	High, Moderate	Low, Moderate	Barren land, Crop Land, Plantation, Waterbody,	Near Level to Level	Low, Moderate, High	Moderate
SW13	High, Moderate	Low, Moderate	Barren land, Crop Land, Plantation, Waterbody, Scrub Land,	Near Level to Level	Low, Moderate	High
SW14	High	Low	Barren land, Crop Land, Plantation, Waterbody, Scrub Land, Settlement	Near Level to Level	Low, Moderate, High	Low
SW15	High	Low	Barren land, Crop Land, Plantation, Waterbody, Scrub Land,	Near Level to Level	Low, Moderate, High	Low
SW16	High	Low	Barren land, Crop Land, Plantation, Waterbody, Scrub Land,	Near Level to Level	Low, Moderate, High	Low
SW17	High	Low	Barren land, Crop Land, Plantation, Scrub Land,	Near Level to Level	Low	Low
SW18	High	Low	Barren land, Crop Land, Plantation, Scrub Land,	Near Level to Level	Moderate	Low
SW19	High	Low	Barren land, Crop Land, Plantation, Waterbody, Scrub Land, Settlement	Near Level to Level	Moderate, High	Low
SW20	High	Low	Barren land, Crop Land, Plantation, Waterbody, Scrub Land, Settlement	Near Level to Level	Low, Moderate	Low

SW21	High	Low	Barren land, Crop Land, Plantation	Near Level to Level	Low, Moderate, High	Low
SW22	High	Low	Barren land, Crop Land, Plantation, Waterbody, Scrub Land,	Near Level to Level	Low, Moderate	Low
SW23	High, Moderate	Low	Barren land, Crop Land, Plantation, Waterbody, Scrub Land, Settlement	Near Level to Level	Low, Moderate, High	High

Table 1- PRIORITY TABLE OF BASUHI RIVER BASIN

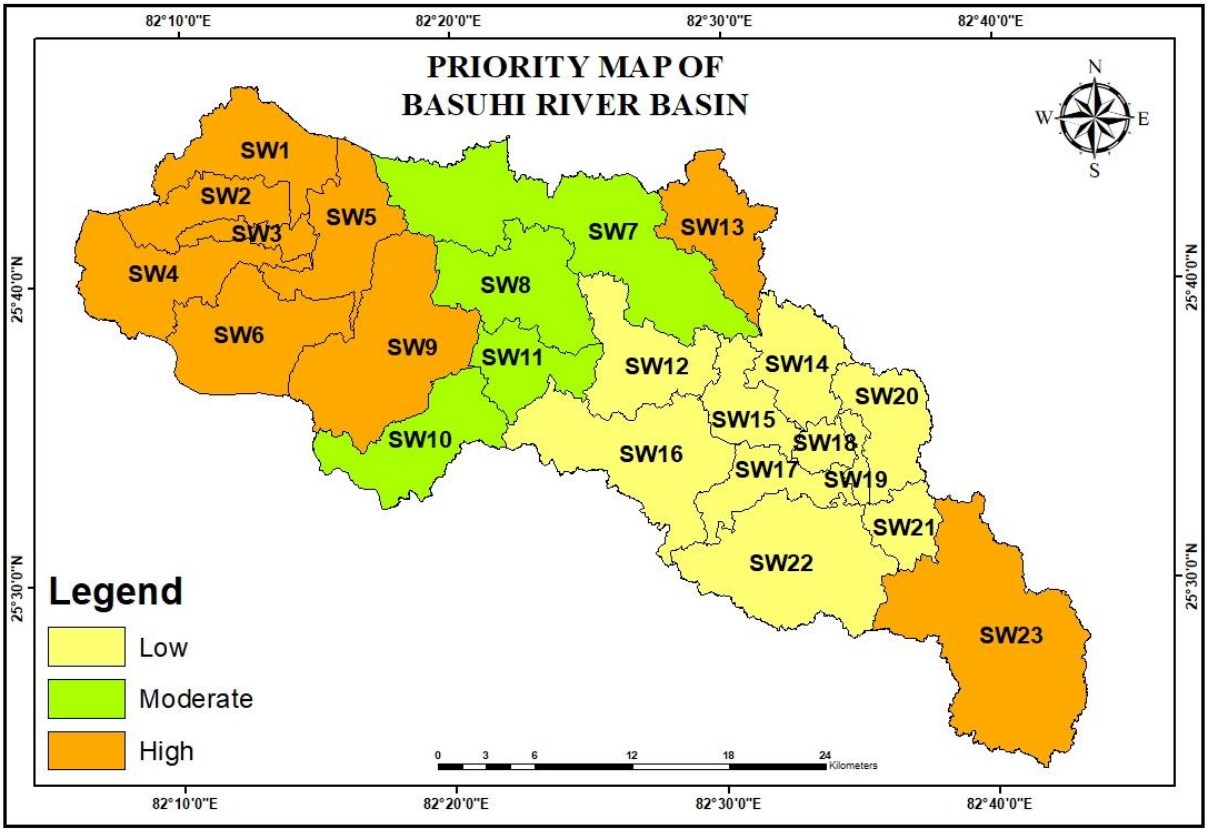


Fig. 9 PRIORITY MAP OF BASUHI RIVER BASIN

CONCLUSION

With the help of GIS, we are able to delineate micro watersheds within the study area, with the help of which it gets easy for us to know that which is the place needed more for the development within the watershed. In the study as we can see in (Fig. 9) that 9 out of 23 micro watersheds have high priority. SW1, SW2, SW3, SW4, SW5, SW6 and SW9 having very gentle slope are covered mostly with barren land and faces high erosivity due to large amount of the rain distribution over that area so we need to develop and manage the watershed in this area at our priority, therefore priority given to them is high (Table 1). So, we need to put more focus in rejuvenating and developing the micro watersheds which are at high priority. GIS has been very effective in finding the priority of micro watersheds with integrated studies of various important parameters. With the help of GIS technology, we can even spread the development of watersheds to other areas effectively and efficiently through which water can be easily conserved for present and future use.

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