ISSN: 0974-5823 Vol. 7 No. 4 April, 2022

International Journal of Mechanical Engineering

"WATERSHED MANAGEMENT OF MURGUD VILLAGE BY USING GIS"

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ABSTRACT

The watershed is a natural hydrological entity that covers a specific aerial expanse of land surface from which the rainfall runoff flows to a defined drain, channel, stream or river at any particular point. It is a general phenomenon governed by topography of the terrain. Based on the size, the hydrological unit is termed as water resource region, basin, catchment, sub-catchment, watershed, sub-watershed and micro-watershed respectively. The smallest hydrologic unit in the hierarchal system is termed as Micro watershed having size of 500-1000 ha. In India emphasis is being placed on making the local-level users participate in the management of natural resources at the watershed level. Therefore, it is imperative that local-level organizations be strengthened by providing the integrated watershed management tools which are user-friendly, but still use all the scientific knowledge to arrive at the appropriate decisions. Hence the Murgud Municipal Council (Nagar parishad) has been approached for this CASE STUDY. It is planned to use GIS-based overlay method for local-level planning, incorporating the sustainability aspects of watershed development for MURGUD Village to delineate priority areas for watershed management plan.The main water source for drinking and farming is Sarpirajirao Lake, also called Ghatge Lake. It is situated to the east of Murgud. The major crop in Murgud area is sugarcane.In order to implement the next criterion of taking up watersheds which are covered by maximum part of the Village, the overlay of all the sub watersheds with the village boundaries will be performed.The next action is to conduct detailed survey to generate a reasonably accurate DEM for making use of the latest technologies of GIS to help in handling the water resources development at the local level. This DEM will be used to generate the local drainage, which in turn will be used to identify the possible locations of the water-harvesting structures.

1. INTODUCTION:

WATERSHED

The watershed is a natural hydrological entity that covers a specific aerial expanse of land surface from which the rainfall runoff flows to a defined drain, channel, stream or river at any particular point. It is a general phenomenon governed by topography of the terrain.

Watershed management means the process of creating and implementing plans, programs and projects to sustain and enhance watershed functions that affect the plant, animal and human communities within a watershed boundary. Watershed management is not so much about managing natural resources, but about managing human activity as it affects these resources. The drainage area of the river provides the natural boundary for managing and mitigating human and environmental interactions. Because human activity includes actions by governments, municipalities, industries, and landowners, watershed management must be a co-operative effort. Effective watershed management can prevent community water shortages, poor water quality, flooding and erosion.

The expense of undertaking watershed management is far less than the cost of future remediation. For development of agriculture and drinking water resources the basic elements required are land and water. Because of tremendous rise in population, urbanization, industrialization and agriculture area, resulting in steep incline water demand line. Indian agriculture sector is lot more depend upon the monsoon. But last 3-4 years due to inadequate rainfall, people are looking towards the underground water as alternative sources without regarding to its recharge resulting in deepening of ground water table 100-200mbelow the ground surface.

NECESSITY

In India emphasis is being placed on making the local-level users participate in the management of natural resources at the watershed level. Therefore, it is imperative that local-level organizations be strengthened by providing the integrated watershed management tools which are user-friendly, but still use all the scientific knowledge to arrive at the appropriate decisions. Hence the Murgud Municipal Council (Nagar parishad) has been approached for this CASE STUDY. It is planned to use GIS-based overlay method for local-level planning, incorporating the sustainability aspects of watershed development for MURGUD Village to delineate priority areas for watershed management plan.

LOCATION AND AREA

Murgud village is situated at the southern boundry of Kolhapur Dist established in the year 1921. In Maharashtra state. Murgud is on $16^{\circ} 24' 28.94''$ North latitude and $74^{\circ} 10' 342''$ East longitude. Murgud is about 610.82m above m.s.l. Total area of Murgud is 884.86 Ha in which congested area is 19.58 Ha and non- congested area is 865.28 Ha. Population of Murgud village is 11188 as per 2011 survey. It is divided into 17 Municiple wards. Total number of houses in murgud are 2325.

TOPOGRAPHY AND LANDSCALE

Murgud is surrounded by Vedganga river nearly at its two sides ie. on West, North side. The main water source for drinking and farming is Sarpirajirao Lake, also called Ghatge Lake. It is situated to the east of Murgud. The general slope of town is towards river side. The major crop in Murgud area is sugarcane.

CLIMATOLOGY

Climate is hot in summer, but due to good surrounding agriculture lands with green cover, summer is pleasant. The average annual rainfall is about 1000mm. The rainy season is between June and October, July being the month of maximum precipitation.

WIND- Wind direction is generally from West.

SOURCES OF WATER SUPPLY

The main water supply to the town is from Sir Pirajirao lake by gravity. It is about 1.5 kms. from Murgud gaothan. The Municipal Council has constructed a purification plant. The capacity of purification plant is of 0.328 MLD and the purification process contains all the required stages of purification. At present, the domestic supply of water per capita per day is at 100 litres. Therefore, looking at the standard requirement of 135 litres per day per capita and the increased area due to inclusion of additional area in Municipal limit, there is a need in future to increase the capacity of purification plant.

There are in all 21 numbers of public taps made available in the Municipal limit and 1994 numbers of private connections are also provided. The total households within the town are 2325 numbers. Municipal Council has provided 2 ESR having total capacity of 5 lakhs. Sufficient water is available for the daily needs of the people at present.

DRAINAGE

There is no underground drainage system provided by Municipal Council. All the area within the Municipal limit is having individual septic tanks. The Municipal Council has to plan for establishing a new drainage system. At present, the Municipal Council maintains road side opens gutters for sullage water. These gutters also serve as storm water drains. The work of larger section of storm water drain on one road is under construction by the Municipal Council.

PROJECT PROBLEM

In murgud, there is lack of water supply in summer season and also Silting of existing water resources like Lake. Hence there is need to increase the water quantity by increasing water level of sarpirajirao lake by using various techniques.

To improve, harness and increase the quantitative water requirement for the population present and future of Murgud which is presently having water supply only for half hour in a day.

OBJECTIVE

1. To survey the existing water supply of the village and asses the water requirements- needs for human, agriculture and cattle.
2. Apply GIS techniques of watershed for defining geographical extent of water bodies, streams and also potentials for introducing various interventions for watershed management .
3. Prepare GIS maps for water basin and stream decide on various interventions such as check dams, CCT, ENB, CNB, Loose boulder structure etc. and other practical solutions for increase lake recharge capacity.
4. Provide a holistic solution for the village administration for decision making of water supply to fulfill needs of the villagers/stakeholders

STUDY AREA

Murgud village is situated at the southern boundry of Kolhapur Dist. In Maharashtra state. Murgud is on $16^{\circ} 24' 28.94''$ North latitude and $74^{\circ} 10' 342''$ East longitude. Murgud is about 610.82m above m.s.l. Total area of Murgud is 884.86 Ha. Population of Murgud village is 11188 as per 2011 survey.

Murgud is surrounded by Vedganga river nearly at its two sides ie. on West, North side. The main water source for drinking and farming is Sarpirajirao Lake, also called Ghatge Lake. It is situated to the east of Murgud.

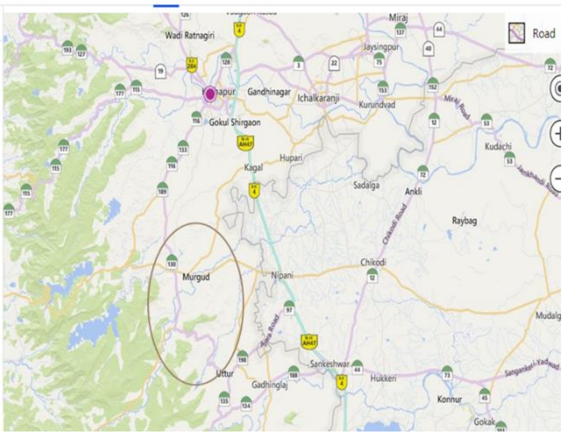

Fig.1 Study Area

DATA ANALYSIS AND METHODOLOGY

FIELD VISIT FOR DATA COLLECTION

We have done field visit on 24th July 2017. On that day, we meeted with Murgud Nagaradhyaksh and discussed the problems about water availability and water supply and also future requirements of Murgud.

After meeting with Murgud Nagaradhyaksha, we did the reconnainance survey of Sarpirajirao lake. In that,we captured the data of way points by using GPS essential tool. And also collected the water sample of Sarpirajirao lake at point source and nonpoint source to know the potability of Ghadge lake.

I. Data capture of waypoints by using GPS essential

We have taken some Way points at different water sources i.e river, well, lake etc. and other important points of MURGUD village.

Fig.2 Wavepoints

We have traced the path along the boundary of Sarpirajirao lake and taken the way points at various locations and also taken latitude and longitude of that points.

From that information we get an idea about actual boundary of Sarpirajirao lake and boundary of Sarpirajirao lake on google earth.

II. Water samples of lake.

During the field survey of murgud we have visited the sarpirajirao lake. At the sarpirajirao lake we took the water sample of ghatge lake at point source and non-point source to know the potability of water.

HOUSEHOLD VISIT FOR QUESTIONNAIRE SURVEY

To know the problems about water quantity, water supply and requirement of water, we have done the survey of 60-70 houses of murgud village.

According to this survey we know the existing water supply of village and asses the water requirement needs for human, agriculture and cattle.

WATER GAP ANALYSIS

At present the domestic supply of water per capita per day is at 100 lit. Therefore looking at the standard reqirement of 135 litres per capita per day, there is need to increase the quantity of water.

- Present water supply –
  11188 X 100 = 1118800 lit.
- Computed water requirement –
  Present – 11188 X 135
  =1510380 lit.
  (Approx. 15.5 Lakh lit.)

For present population of 11188 as per 2011, there is requirement of 15.5 lakh lit. (Approx.) water supply as per standard requirement of per capita per day.

GROWTH OF POPULATION:

Table no.3

YEAR	POPULATION	VARIATION INCREASE IN DECADE
1951	5637	-
1961	6067	+430
1971	7480	+1413
1981	8613	+1133
1991	8945	+332
2001	9766	+821
2001	11188	+1422
Average	8242	+925

It is seen from the above table that the rate of growth of population in the decade 1961 to 1971 was 23.28% and that in the decade between 1971-1981 was 15.14%. But after the year 1981, the rate of growth has dropped down to 3.85% for the decade 1981-1991 and has come up to 9.17% in the decade 1991-2001. Further, there is seen an increase in population in the last decade. The last decade of 2011 shows an increase of 14.56%. So, it seems to be a natural growth without migration and is now necessary to consider for estimating the projected population.

- Computed water requirement
  After 20 years – 19 lakh lit. (Approx.)

By using Arithmetic mean method, water requirement after 20 years is computed as 19 lakh lit. (Approx.)

TESTING OF WATER SAMPLE

During the field visit to sarpirajirao lake of murgud we have taken the water sample of sarpirajirao lake and did the various tests of that sample to know whether the sample is potable or not.

We did the tests like PH, Chloride content, Hardness, TDS (Total dissolved solid)

And result of these tests are as follows –

Table no.4

SR NO.	TEST	POINT SOURCE	NONPOINT SOURCE
1.	PH	7.90	7.60
2.	Hardness	88 mg/lit	79 mg/lit
3.	Chloride content	39.76 mg/lit	41.18 mg/lit
4.	TDS (Total Dissolved Solid)	315 ppm	475 ppm

MAPPING

For deriving various maps of watershed we have considered murgud munciple boundary and village boundary extraction from google earth.

VILLAGE MAP:

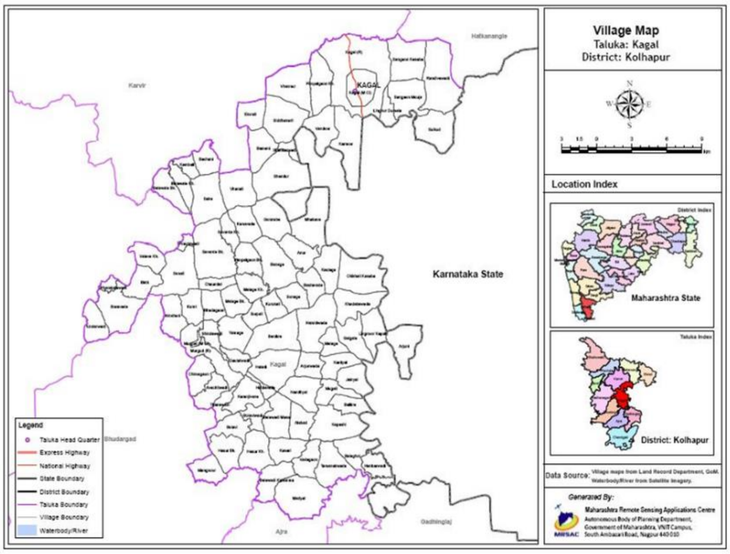

Fig 3 Village Map

This is the map of kagal downloaded from MRSAC (MAHARASHTRA REMOTE SENSING APPLICATION CENTER). In kagal there are 84 villages and Murgud is one of them.

VILLAGE BOUNDRY EXRACTION FROM GOOGLE EARTH CONSIDERING WATERSHED

On google earth by using polygon we traced the watershed boundary of the Murgud village. We also traced the boundary Sarpirajirao lake (Ghatage lake).

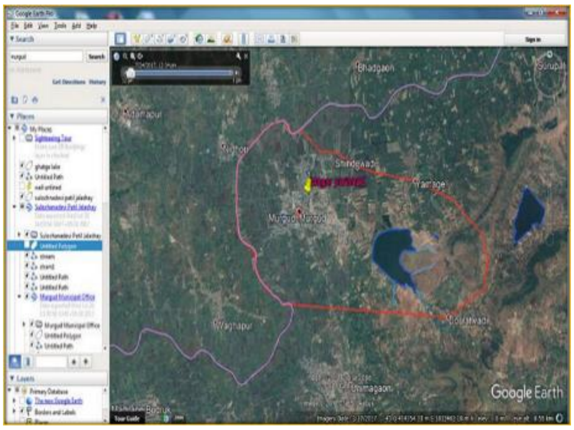

Fig.4 Village boundry

DOWNLOADING OF DEM FROM SATELLITE DATA CENTRE

To download the DEM for Murgud area we gone to satellite data centre site. After that by giving inputs as latitude and longitude of Murgud, we downloaded the DEM for Murgud area.

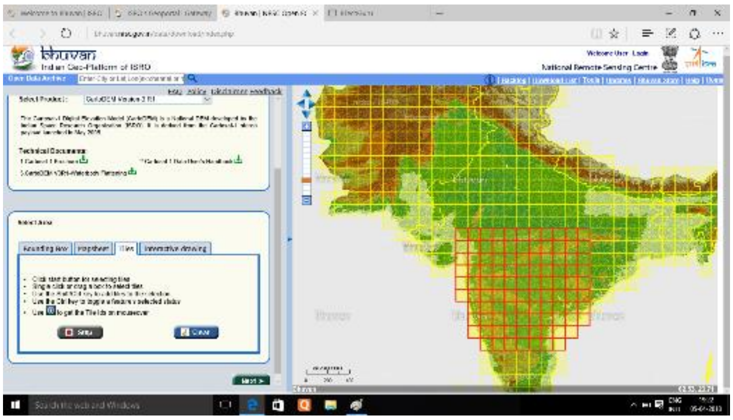

Fig 5.DEM

EXTRACTION

Village map of MURGUD is taken into Q-GIS Environment . After that georeferenced it by using georeferencing tool. After that we downloaded the DEM (DIGITAL ELEVATION MODEL) for Murgud area (latitude, longitude) from satellite data center.

After downloading the DEM, that DEM is taken into Q-GIS Environment by using Raster. After taking that DEM into QGIS Environment, by using Extraction then clipper we clipped that DEM to murgud boundary.

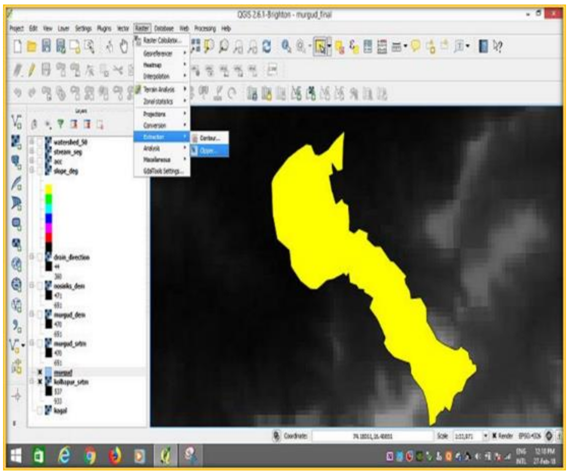

Fig 6.Extraction

NEW MAPSET

After the extraction of murgud boundary we have to create the new mapset for that we go on grass tools in GIS environment in that we go to new mapset and created the new mapset. After creating new mapset by using various plugins in grass tool we created various map like

- Stream map
- Contour map
- Slope map
- Watershed map

For creating this map firstly we have to create the no_sinks dem map for that map we go on plugins and by giving input as r.gdal we created the map of drainage density then we give the input as r.fill in grass tools and we get the required map of nosinks_dem.

CONTOUR MAP FOR VILLAGE ADMINISTRATIVE BOUNDARY

After creating the map of nosinks_dem we created the map of contour for the map of contour first we have to give input to plugins as r.contour then one window will open in that by giving input map as nosinks_dem and output map as contour we get the contour _map

Plugins $\longrightarrow$ r.contour $\longrightarrow$ nosinks_dem $\longrightarrow$ contour map

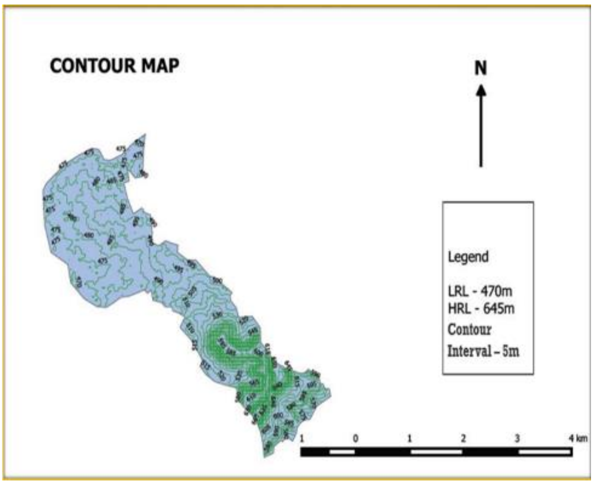

Fig.7 Contour map

CONTOUR MAP OF MURGUD WATERSHED BOUNDARY

As mentioned above by using that same steps we crated this map of contour for the area of murgud considering watershed boundary.

Plugins → r.contour → nosinks_dem → Contour map

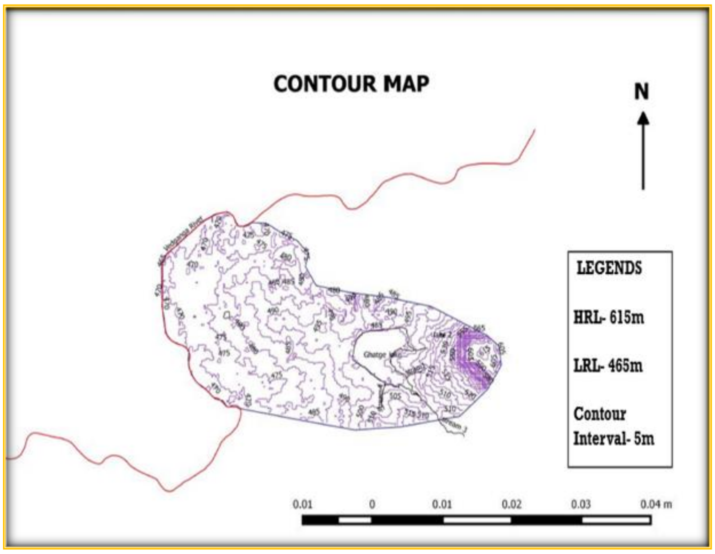

Fig.8 Contoue map

SLOPE MAP FOR MURGUD ADMINISTRATIVE BOUNDARY

After creating the contour map, again by going on plugin and giving the input as r.slope the new window will open in that window we give input map as nosinks_dem and output map as slope_map we get the map for the slope of mugud municipal boundary.

Plugins → r.slope → nosinks_dem → solpe_map

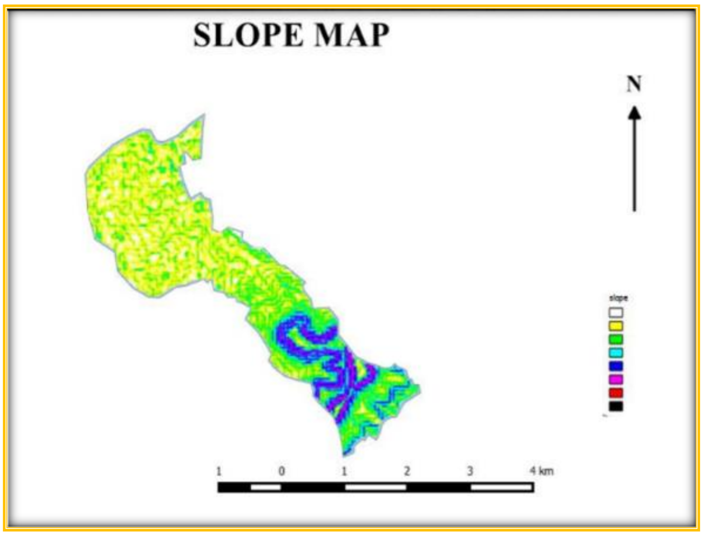

Fig.9 Slope map

SLOPE MAP FOR MURGUD CONSIDERING WATERSHED BOUNDARY

By applying same steps mentioned above we created the map of slope for the murgud by considering watershed boundary.

Plugins → r.slope → nosinks_dem → slope_map

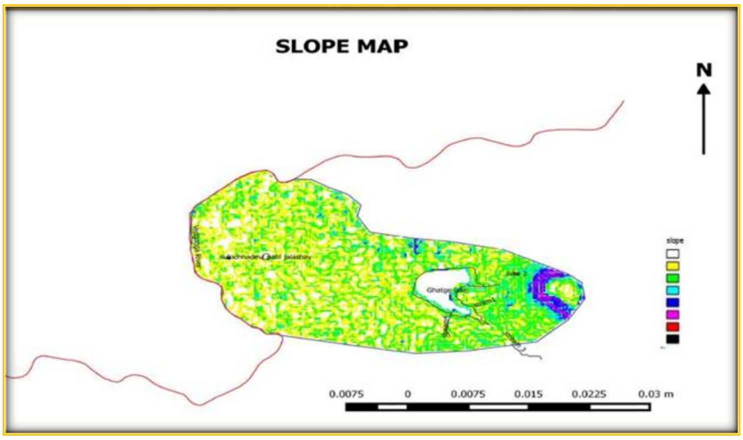

Fig.9Slope map

STREAM MAP FOR VILLAGE ADMINISTRATIVE BOUNDARY

Stream map is created automatically at the time of creating the watershed map. For the stream map we give the input as r.watershed in the grass tools after that window will open in that window we give the input for the stream map in that way we get the stream map.

Open grass tools → r.watershed → nosinks_dem → ws_50 → stream_map → watershed_map

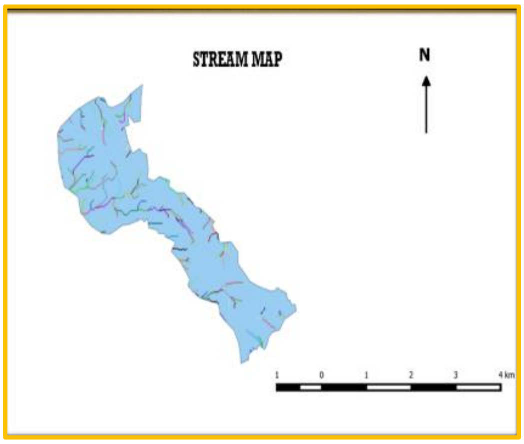

Fig.10 Stream map

STREAM MAP OF MURGUD BY CONSIDERING WATERSHED BOUNDARY

Stream map of murgud by considering watershed boundry is created by using the same steps mentioned above for the murgud administrative boundry.

Open grass tools → r.watershed → nosinks_dem → ws_5000 → stream_map → watershed_map 5

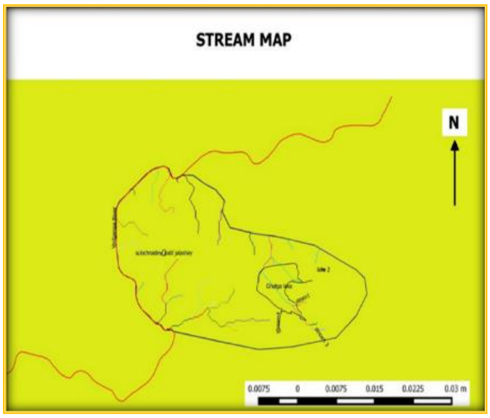

Fig.11 Stream map

WATERSHED MAP FOR MURGUD ADMINISTRATIVE BOUNDRY

After creating all the maps like contour map, slope map we have to create map of watershed. For creating watershed map, in GIS environment we go on open grass tools in that by giving input as r. watershed new window will open in that giving input map as nosinks-dem basin size as ws_50 and ouput map as watershed_map final watershed map is obtained.

Open grass tools → r.watershed nosinks_dem → ws_50 → stream_map watershed_map →

While creating the watershed map stream map also created.

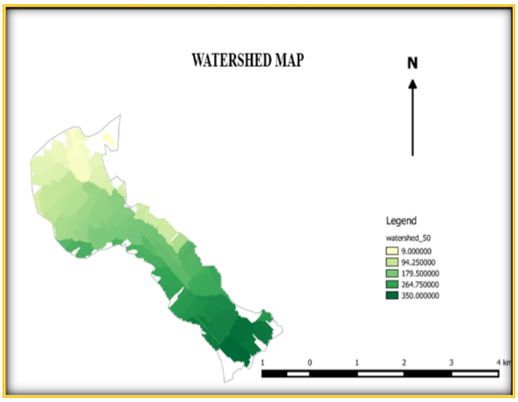

Fig.12 Watershed map

WATERSHED MAP OF MURGUD WATERSHED BOUNDARY

Watershed map for murgud watershed boundary is created as same as watershed map of murgud village administrative boundary.

Open grass tool → r.watershed → nosinks_dem → ws_5000 → stream_map → watershed_map →

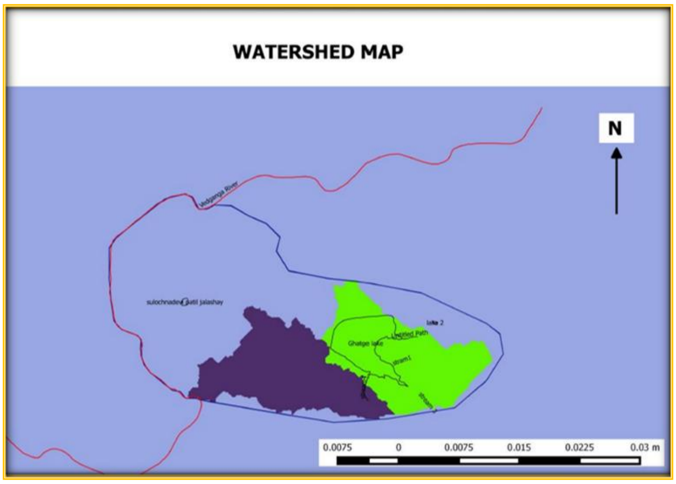

Fig.13 Watershed map

FINAL WATERSHED MAP

Following map is the final watershed map of murgud watershed boundary. This map is overlapping map of-

- Contour map
- Slope map
- Stream map
- Watershed map

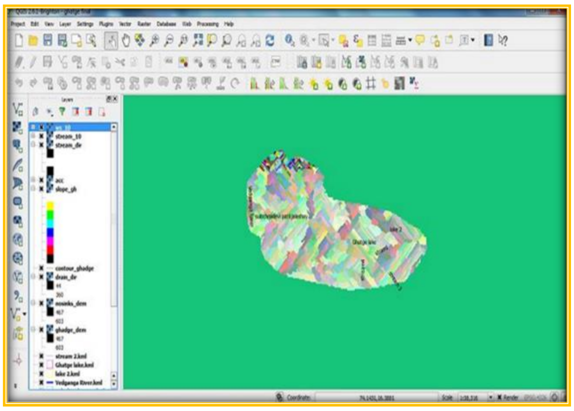

Fig.14Final watershed map

LAND USE LAND COVER MAP (LULC)

For creating land use land cover map first we have to download LULC from the satellite data center i.e. from bhuvan. For downloading first we have to visit the site of bhuvan and giving input for search as LAND USE LAND COVER and geography as Maharashtra then by clicking on view key we get the LULC map after that we have to copy the URL from the bhuvan .

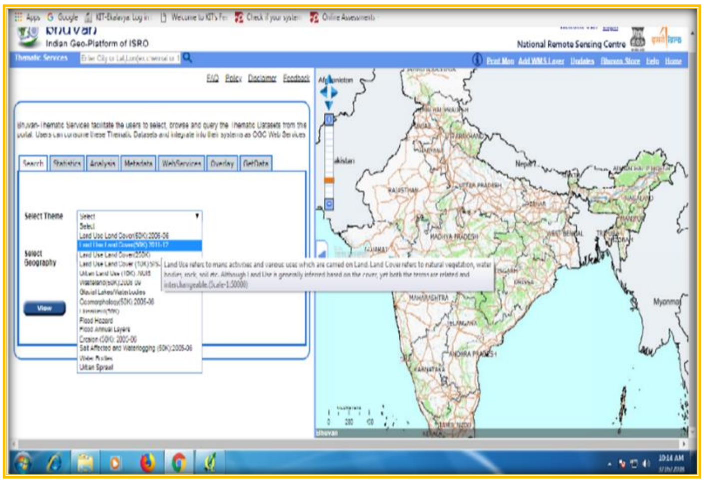

Fig.15 LULC

COPYING OF URL IN GIS ENVIRONMENT

After copying the URL from bhuvan go in GIS environment. After going in GIS environment open the add layer option in that selecting WMS layer one window will open in that window by copying the URL and connecting it we get the LULC map.

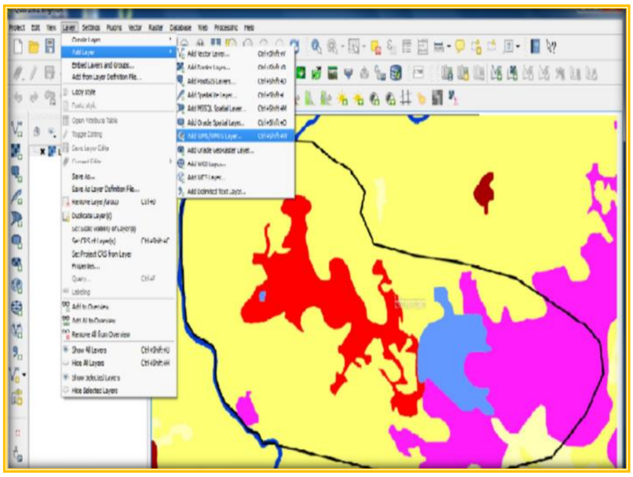

Fig.16 Copying of url in GIS environment

FINAL LAND USE LAND COVER MAP

After copying and connecting the URL we get the final map of the land use land cover map

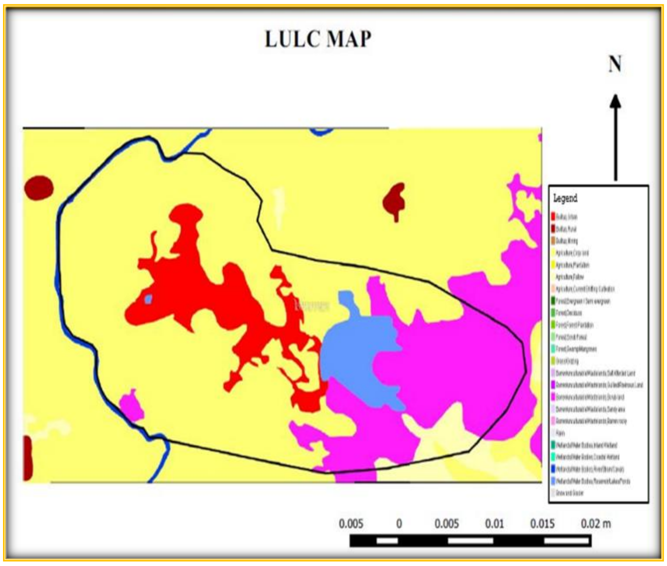

Fig.17 LULC

SOIL MAP

Go to Mahabhujalvedh website (http://mrsac.maharashtra.gov.in/gsda/)

Zoom in at village location

Layers

Soil

Texture –click check box

Uncheck other check boxses

Take a screentshot and save it

FINAL SOIL MAP

After taking screenshot by opening GIS environment and taking the screenshot in GIS environment by georefrencing it we get the final soil

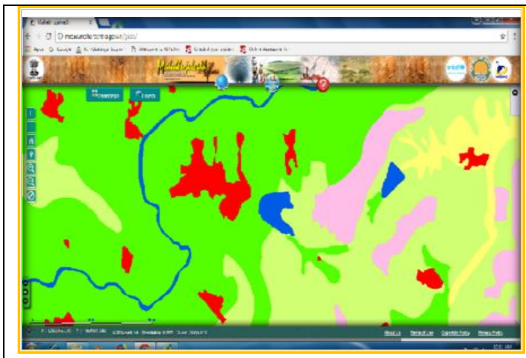

Fig.17 Soil map

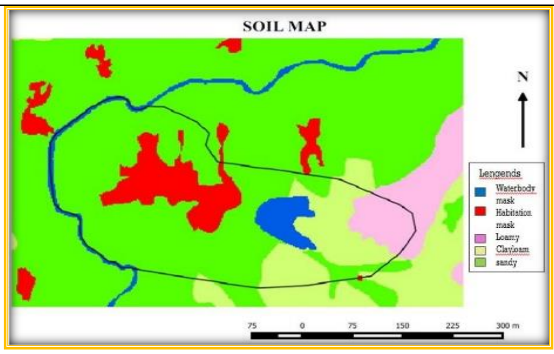

Fig. Final soil map

SUGGESTIONS

From the household survey and meeting with village administration it is seen that there is no water taxation which is very much necessary to avoid water exploitation for that village.

Administration can provide water meter and water ATM machine for purified drinking water.

As per the suitability for Murgud village following are the suggestions for interventions-

1. Continuous Contour Trenching.
2. Loose boulder structure.
3. Earthen nala bund.
4. Concrete nala bund.
5. Lake dredging.

RESULT

After obtaining all above maps we studied all that maps and also studied household survey and other methodology adopted above. And considering requirement of local administrative and stakeholder we come to know that murgud village has requirement of the following interventions.

Interventions -

1. Continuos Contour Trenches
2. Loose Boulder Structure
3. Lake Dredging

CONTINUOUS CONTOUR TRENCHES –

Trenches are artificially dug along the contour lines .water flowing down from hills is retained by the trench is infiltrating the soil below.

Continuous trenches are done on the land where no farming is done or the land which is not used for the purpose of farming or residential. And the CCTs are done where the slope is less than 33%.

Advantages of Continuous contour trenches.

- The rain water does not immediately run off the hill.
- Water does not evaporate uselessly.
- Crops does not suffer later on from water shortage.
- Fertile soil particles are not lost by water and wind erosion.

DESIGN PARAMETERS FOR CONTINUES CONTOUR TRENCHES

Slope between 0-33%

1. Width - 0.60m
2. Depth – 0.60m

and

1. Width- 0.60m
2. Depth -0.45m

➢ Depending upon slope of the hill, length of the trenches are 833m – 2174m.
➢ In per 1000 running meter 0.30m deep trenches contain 180 cu.m water.
➢ And in per 1000 running meter 0.45 m deep trenches contain 270 cu.m water.
➢ Ht of the CCT should not be greater that 2m.

o TRENCH SPACING INTERVAL BY HILL SLOPE

Slope (%)	Distance between trenches
0-4	10-12m
4-8	8m
8-15	6m
15-33	4m

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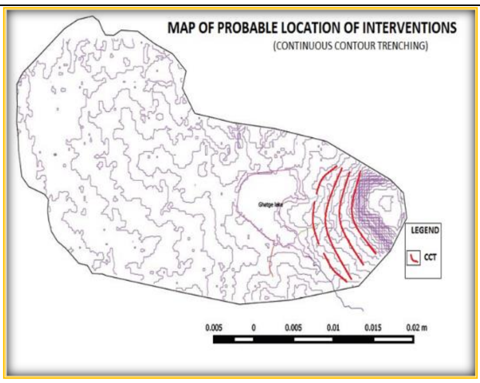

</td><td>

</td></tr>
<tr><td>Fig.19 MAP OF PROBABLE LOCATION OF INTERVENTIONS (CONTINUES CONTOUR TRENCHES)</td><td>Fig.19 CONTINUES CONTOUR TRENCHES</td></tr>
</table>

LOOSE BOULDER STRUCTURE-

A loose boulder structure is a small barrier constructed of rock, gravel bags, sand bags, fiber rolls or reusable products , placed across constructed swale drainage ditch.

These structures reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion and can provide a 'drought-proof' water supply. It reduces the runoff of water.

- Design parameters for the loose boulder structure

Type	drainage basin	Ht. of structure
Small loose boulder structure	5 Ha	0.75m
Large loose boulder structure	5-10 Ha	v

MAP OF PROBABLE COCATION OF INTERVENTION (LOOSE BOULDER STRUCTURE)

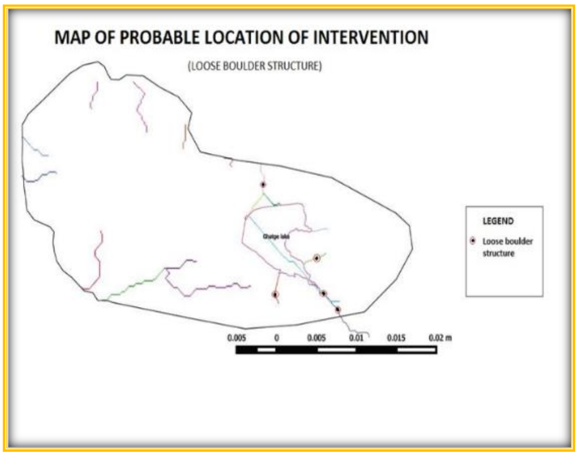

Fig.21

LOOSE BOULDER STRUCTURE

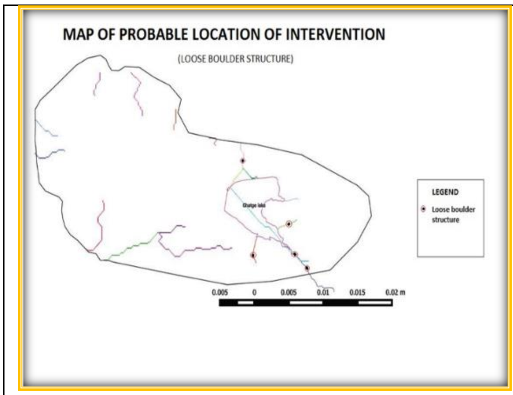	
Fig.22 **MAP OF PROBABLE COCATION OF INTERVENTION (LOOSE BOULDER STRUCTURE)**	Fig.22 **CONCRETE NALA BUND**
	
Fig.22 Loose boulder structure	

CONCLUSION :

From the above study and results we conclude that above structure are very economical and easy for construct or implement. This interventions require very less manpower and it takes less cost for the whole work. The material required for this interventions are easily available.

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