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GPS Technology for Finding Suitable Place for Water Harvesting

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Abstract: ***Groundwater is a precious and scarce natural resource on the earth. Though Ranchi is blessed with prominent monsoon with an average rainfall of around 1430 mm; it experiences water scarcity in off monsoon seasons. Artificial recharge technique such as rainwater harvesting is essential to increase the groundwater level and to maintain the quality of water. The technique can be used effectively to trap the unutilized surface runoff and thereby increase the groundwater level. The present study has been conducted in the campus of a technical college in Ranchi, the capital city of Jharkhand state of India. The objective of this study is to demonstrate a simple but generally applicable water-harvesting model with finding pore points. Global positioning system was used for the survey, and ArcMap 10.1 software was used for the spatial analysis. The prominent sites were located by overlaying thematic maps of land use, soil, slope, runoff potential, soil permeability and stream order. Further, the role and scope of advertisement in bringing awareness of rainwater harvesting technology have been analysed. It has been found during the survey that people residing in the study area are hardly aware of such technology. Thus, the study helps depict the need for advertisement to promote rainwater harvesting technology.***

Keywords: ***Water scarcity, Rainwater harvesting model, GIS, Recharge pit, Advertisement and promotion***

I. INTRODUCTION

The Study is an attempt to find and evaluate the benefits of rainwater harvesting technology to maintain the level of groundwater. Water is the most basic necessity for humans and groundwater is the most important water resource on earth [1].However, 71% of the land area is covered by water; out of which only 2.5% is fresh water. Human population is increasing day by day; society is facing serious issues related to water quantity and quality. Groundwater vulnerability maps give information about the area where water can be stored. It also evaluates water quality in changing land use pattern [2],[3],[4].Groundwater recharge is the governing factor
for water level and depends on the selection of proper place, rainfall intensity, and amount of surface runoff. It is to be noticed that Ranchi is a hilly place and the land pattern of this place is rocks, so the surface runoff varies from 38% to 41 %[5].

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Thus, recharge is not so good in Ranchi; rocks are metamorphic that serve as poor aquifers and hence despite getting heavy rainfall every year (1200 mm to 1430 mm every year), rainwater is unable to percolate. In Jharkhand, most of the land is covered by rock, so these lands are drought prone. Jharkhand has good minerals resource but there are no big rivers, and the groundwater level is also not good because rainwater runoff quantity is very high. Many factors have affected the groundwater level of Ranchi badly, and this city of Chotanagpur district is facing acute water crisis (shortage of drinking as well as general water).) The water crisis and Groundwater depletion, in turn, have many bad impacts on almost every field viz. agriculture, mines, industries and domestic use. The UN has declared 2005 to 2015 the decade of water and also many of the Millennium Development is based on water. In India the population is 1,337,221,378 (1.33 billion)[6] i.e. approx 17.85% of the world's population lives in India. Jharkhand population is 32,966,238[7] groundwater accounts for over 80% of domestic water use in rural areas, and 60 – 64% of the population dependents on groundwater. Since day by day, the use of groundwater increases, the groundwater exploitation and degradation of groundwater quality are serious issues in Ranchi. Groundwater level is rapidly decreasing in many states [8]. Rainwater harvesting technology is a feasible solution for sustaining groundwater. Groundwater vulnerability categories different land pattern [9]. Groundwater vulnerability is essential to analyse for town planner, as day by day the population is increasing. It is expected that in India by 2025,60% of the population will live in the town area[10].In the city area, open space is used for construction, due to the use of open space rainwater cannot be harvested naturally. Groundwater is used for household purposes, and rainwater harvesting is a technology through which groundwater is recharged.

II. ROLE OF SOCIAL ADVERTISING

Considering the issue of low rainfall and depleting groundwater label, the social advertising strategy was thought to be applied to increase the groundwater label by promoting water harvesting technique in the Ranchi District. Social advertising aims to change people's behaviour to become healthier or to improve society or the world [11]. Behavioural change is achieved by two phenomena education, which uses rational facts to persuade awareness in people to change their behaviours and coercion [12], which forces people to adopt a certain behaviour. Somewhere in between education and coercion lies the social advertising use of social advertising and marketing principles to persuade people to change their behaviours.

The objective of social advertising in our case is too aware and promotes water harvesting techniques. Water harvesting techniques should recharge groundwater and increase water availability for domestic use in the long term [13]. Water harvesting techniques can be achieved or promoted through training programmes, method demonstrations in institutes, exhibitions and visit sites and should be done by the urban development department, Municipal Corporation, groundwater resource department and local NGOs. The intended beneficiaries (public) should be the people of Ranchi district. The beneficiaries should avail the subsidies (policy) offered by the state government for constructing water harvesting structures [14]. However, they should work out the benefit, cost analysis and take care of their budgetary constraints too. This kind of positive impacts should be communicated and advertise to the people living in the city through an appropriate communication channel. Interpersonal channels like N.G.O, Urban Department officer, subject matter specialist from Water resource departments, method demonstration and training programmes should be utilised. Further, depending upon the intensity of the problem, mass media channels like a local television channel, hoarding, radio and newspapers should be used.

III. AWARENESS CAMPAIGN:

Some of the awareness campaign in India for rainwater harvesting as follows: public awareness: Conducting public awareness programmes on Rainwater Harvesting and Artificial Recharge of ground water throughout the country involving educational institutions, government departments, NGOs, resident welfare organisations, industries and individuals.

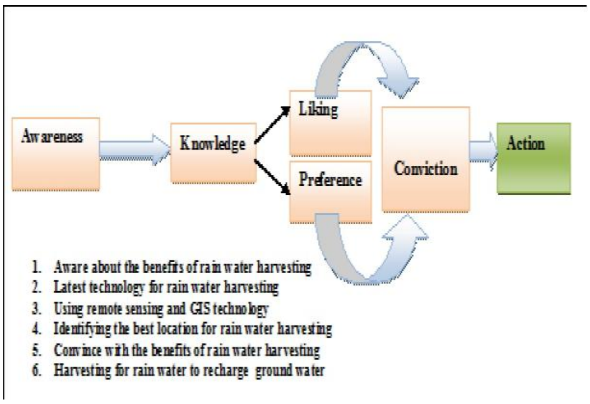


Fig-1

Technical Guidance for Rainwater Harvesting Techniques: In various part of the country in both urban and rural area provide technical guidance for rainwater harvesting structure and place, how and where to harvest rainwater.

Training Programmes and Exhibitions: conducting training programmes on focusing on various target groups like youth and children, women, farmers and villagers, policy and opinion makers. Display working models and their benefits in exhibitions and stalls.

Water Conservation Campaign: On selected area water conservation campaign was launched in the off monsoon session. Different publicity measures like the broadcasting message on radio, telecasting on the television, print media, holding of seminars, workshops and conferences.

Production of Ad Films: Small ad films were produced on Rainwater harvesting and its benefits, Groundwater quality. How to improve groundwater qualities were shown in these films. These films were shown in various mass awareness campaign and training programmes in schools, colleges and seminars.

IV. STUDY AREA

We have selected the Ranchi district for the proposed study. Ranchi is situated at 651m above from the mean sea level [15]. This district is surrounded by Lohardaga, Gumla, West Singhbhum, East Singhbhum, and Hazaribagh, Ranchi district has a total area of 4,912 km^2 and is located between 22°45′–23°45′ North latitude to 84°45′–84°50′ East longitude

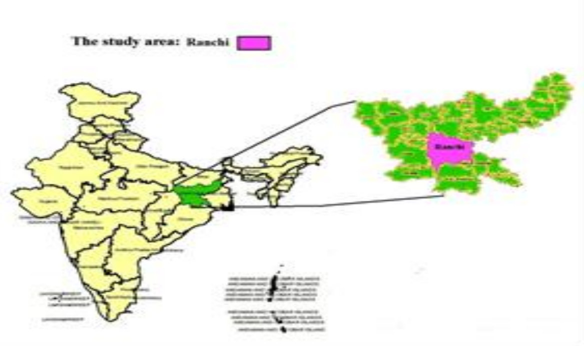


Fig-2

There are 14 blocks in district namely Ormanjhi, Kanke, Ratu, Bero, Burmu, Lapung, Chanho, Mandar, Bundu, Tamar, Angara, Sonahatu, Silli, Namkum shown in fig-2. The climate of Jharkhand affects the level of groundwater. The observed and projected climate change is mainly due to a change in temperature. Increase in population & other factors has resulted in a decrease of freshwater availability (depletion of groundwater) for the people of Ranchi. Analysis of data from 40 years showing a trend that rainfall increase from 1250.5 mm to 1623.5 mm (2000 -2009).However, this increasing trend of rainfall is not showing from the last eight years (2010-2017).

V. CAUSES OF WATER DEPLETION

A Land use pattern changes

Jharkhand became a separate state in 2000, and Ranchi is the capital of this state. After becoming capital in Ranchi house have been built in an open place, so the natural recharge area is covered.

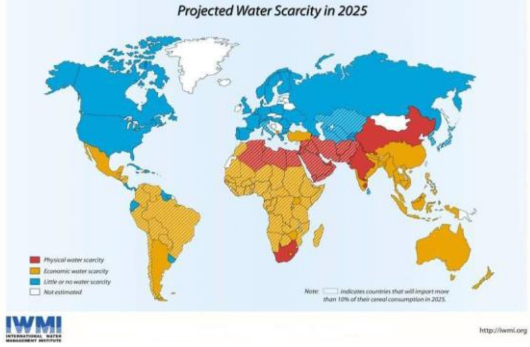


Fig-3

Evidence of water depletion in Ranchi is shown in Fig-3. An unconfined aquifer is one in which a water table varies, depending on the areas of recharge and discharge and pumping from the wells**.** Besides, the deep borings in Ranchi have also played a big role in decreasing the water label.

B. *Effects of water depletion*

Jharkhand state is blessed with minerals, but there is no rich source of water is available [16]. This city is based on the hill most of the area is occupied by the hard rock, these areas have less water absorbing capacity. As we saw earlier, many factors have affected the groundwater level of Ranchi badly, and this city of Chotanagpur district is facing acute water crisis (shortage of drinking as well as general water). These water crisis and Groundwater depletion, in turn, have many bad impacts on almost every field viz .agriculture, mines, industries and domestic use. The rainwater received an entire year for a particular place is known as an endowment. The amount of water that is harvested is water harvesting potential.

VI. RAINWATER HARVESTING AS A TOOL & SOLUTION FOR WATER CRISIS

There are lots of bad impacts of climate change on earth. Though all are a matter of great concern but in the present study, we have focused on the groundwater depletion, its causes and possible solution through rainwater harvest. Although there is rain water runoff, there is surface runoff harvesting model [17]. It is a system of catching rainwater that flows over the earth surface. This runoff water can be stored by technology for recharge of the ground. Rainwater can be stored on the roof of a house in the tank, or it can be diverted to an artificial recharge system. This method is very effective and if implemented properly helps in augmenting the ground water level of the area. All rainwater falling in the area cannot effectively be harvested, because of runoff and evaporation.

Table I: Area wise downfall in water level in Different Place of Ranchi

Name of colony	Year 2008/ Meter	Year 2017/ Meter
Hinoo	1.20	10
Hatiya	3.36	10
Tipudana	1.72	07
Namkum	6.83	09
Tiril Kokar	7.25	11
Ashok Nagar	1.03	3.5
Hotwar	7.02	12.50
Murabadi	6.96	12
Sukarhutu	1.77	07
Ratu	7.91	13
ITI	8.05	09

Water harvesting potential =Rainfall (mm)*collection efficiency

The following is illustrative theoretical calculations that highlight the enormous potential of rainwater harvesting.

Area of the plot = 100 sq.Kms
Height of the rainfall = 2.2m (2200mm)
The volume of rainfall = Area of plot x-height of rainfall
Over the plot = 100 sq.Kms x 2.2m
= 220cu.m (2, 20,000 litres)

Only 60% of the total amount of the rainfall is assumed to be stored, the volume of water harvested is 1, 32,000 litres. It means it is approx seven times the annual domestic requirement of water by a family which is more than an average. Due to less use of artificial recharge facility, rainwater runoff quantity is very high. Along with this, Groundwater facility is also insufficient, availability of water resource is only 287810 lac m^3, out of which 237890 lacs m^3 cube is from surface water and rest 49920 lacs meter cube is from groundwater. In irrigation, both surface and groundwater are used only 47360 lacs meter cube out of which 39640 lacs meter cube is surface water & 7720 lacs meter cube is groundwater. Earlier the climate of Ranchi was cool and pleasant in the summer season too.

Before 2000 the temperature of Ranchi rarely rose up to 35 degrees in the day time, and regularly there was evening rainfall. Regularly rainfalls recharge groundwater, but from last few years, the weather condition changed. It is clear from the Table-2.

Table II: Data collect from place of study

Name of building	Perimeter of catchment in m	Area of catchment in sq.m	Average annual rainfall in mm	Runoff coefficient	Annual water harvesting from the roof in cu.m	In litres
Staff quarter1	71.29	262.95	1391.9	0.7	256.2	256200
Faculty quarter	96.36	434.3	1391.9	0.7	423.151	423151
Girls hostel	153.16	771.85	1391.9	0.7	752.036	752036
Parking1	40.21	75.08	1391.9	0.8	83.603	83603
Sabina house	40.95	84.59	1391.9	0.7	82.418	82418
Faculty parking2	31.58	59.1	1391.9	0.8	65.781	65781
Staff quarter2	91.89	300.33	1391.9	0.8	334.279	334279
Mahila helpline	50.02	92.65	1391.9	0.7	90.271	90271
Staff quarter3	89.9	357.22	1391.9	0.7	348.05	348050
Staff quarter4	38.2	65.03	1391.9	0.7	63.36	63360
THMC Shop	37.56	80.98	1391.9	0.7	78.901	78901

That maximum temperature is showing a clear increase, and this has resulted in excessive heat due to which ponds, lakes & rivers of Ranchi are drying slowly.

Water Available From Roof

Annual rainfall (in mm) x roof area (in sq. m) x coefficient of runoff for roof

Co-efficient of run off

GI sheet 0.9
Asbestos 0.8
Tiled 0.75
Plaster on bricks/ Concrete 0.7

(Source: K. M. Henry & W. E. Smith, 1964)

Longitude, latitude and elevation of the study area were found through the Digital Elevation Model. This model finds the DEM point with the help of satellite image and GPS technology. We find the flow direction of the water with the DEM points. Which denotes pore area, these areas can be developed as recharge pit**.** The groundwater is mainly used for agriculture and home use, the main source of lifting groundwater is boring and wells. Ranchi district is divided into three groups-Kanke blocks having 112% stage of development, Ratu block having 72% of development and rest 16 blocks having less than 9-69%. The low development of groundwater is mainly attributed to lithology of the area. Were quantitative and were confined to monsoon period only. According to the Action Plan for Jharkhand State, the state receives good rainfall of range 1200-1600 mm per year. As per estimation 50% of the rain flow as surface runoff, 30% soaks into the ground, and 20 % is lost in the atmosphere. Through, the state has a very good amount of rainfall, but water is scarce for agriculture and industries.

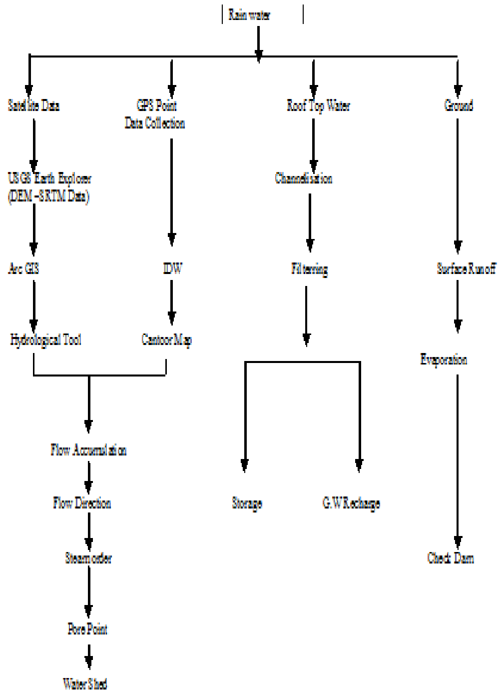
VII. GPS TECHNOLOGY FOR SURVEY

There is some places in Ranchi which is identified as deeper aquifers, through GIS technology Ratu Road, Kutchery, Kanke, Morabadi, Bariatu, Doranda, Hinoo, Harmu are find a suitable place for artificial recharge and the process of recharge is shown in Fig-4. Rainwater harvesting is a technology of collecting surface runoff water and storing these water in surface or sub surface area. Water harvesting is a technology for recharging groundwater and maintaining the quality and level of water.

VIII. METHODOLOGY

GIS Maps based on Observation and Analysis was conducted

Table III: Process of water harvesting



A Study Area Image: B.I.T Campus

The study area was selected due to the water crisis in off monsoon season and declining trend of the water table from the previous few years. The root cause of the present scenario occurs due to inappropriate rainfall recorded during 2016-17. To combat this alarming situation, Rain Water Harvesting considered being a remedial solution. The digitizing and georeferencing of the operational area was performed in the Arc Gis 10.1software. The Image of the operational area was collected from goggle map.

The images show the different steps of GIS and

Fig-4

RemoteSensing Processes to determine the location of a recharge pit in the operational area .

B.DEM Points

DEM (Digital Elevation Model) is an important data source to perform the landform analysis. Nowadays, using DEMs data applied in many fields, such as urban planning, water harvesting, disaster prevention and engineering.

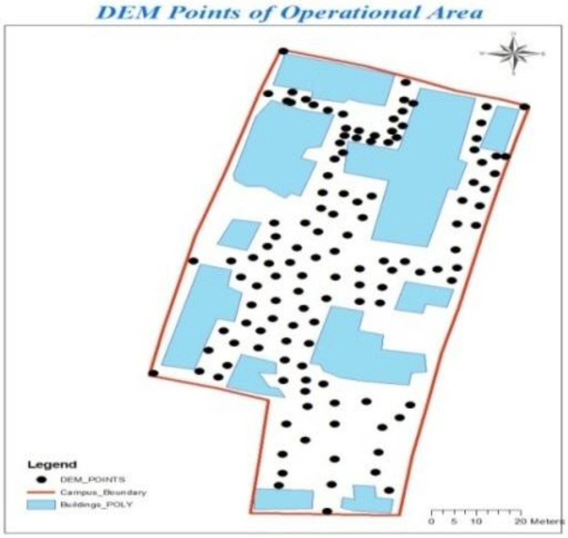


Fig-5

DEM points are created by using a GPS device which co-ordinates along with elevation values This data was first compiled and added on ArcGIS by adding X; Y data on ArcMap. A raster gets generated in each cell has an elevation value. Hence this raster (IDW raster) is equivalent to DEM raster

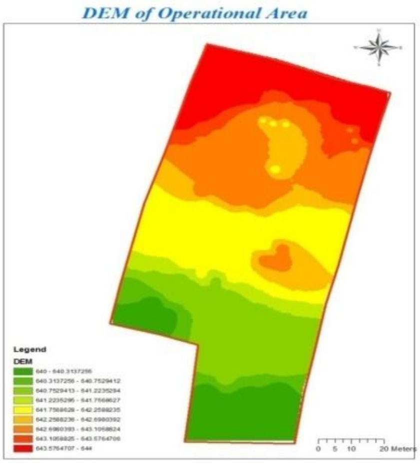


Fig-6

C Flow Direction of Operational Area

The direction of water flow is an important parameter for the place selection of water harvesting structures [18].The water runoff, recharge, and movement of surface water depend on the flow of the area. Through spatial analyst tools flow map is generated from DEM (Fig-8). The flow direction raster finds the

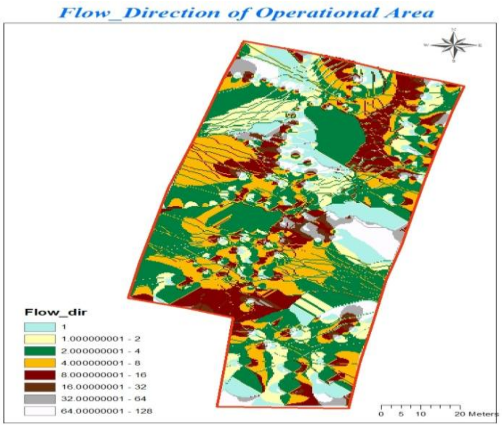


Fig-7

hydrological characteristics of the surface it provides the detail about descent in elevation. This raster shows the direction of water in a specific cell. Since there are8 adjacent cells to any raster layer (including cells in the corners/edges). There can be eight possible directions of flow. This approach is also known as the eight direction flow model (D8) originally presented by [19].

D Pour Point of Operational Area

The exact locations on the surface which will collectively have the highest amount of water accumulation capacity have to determine a practical location to collect this water [20]. Since water is getting collected or getting poured at that point. Another convenience is that we have the stream order raster now we know the route of natural channel of flow of water; we can also channelize the natural channels as per our convenience. There may be constructions/ blockages present in between, so in order to avoid complete manual channelisation for the whole area, small channelisation should be done, such that the natural channel remains intact and useful and the pour point can be adjusted by channelising the stream of the highest order as per need.

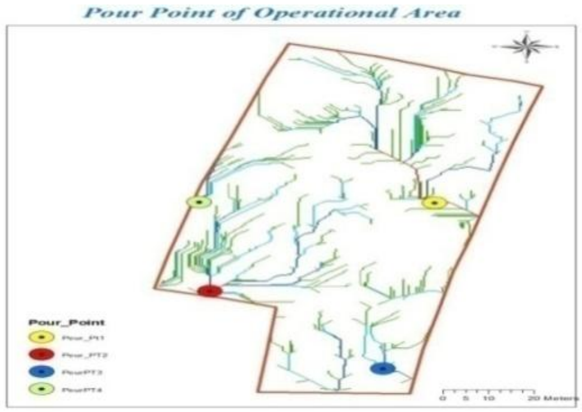


Fig-8

IX. RESULT AND DISCUSSION

Calculation of annual water harvesting potential of B.I.T staff campus

The study was conducted in B.I.T staff campus, and calculation of annual water harvesting was shown in Table-3

Total perimeter of the campus= 413.55m

Total area of the campus= 8035.30sq.m

Total constructed area= 2584.08sq.m

Surface area (excluding the constructed area) = 5451.22sq.m

The slope is an important parameter in the development of a watershed. It gives information, more than the profile, on the more or less great ability to run off the land. This parameter has a very strong influence on the hydrograph, the concentration-time will be lower the higher the slope, the slope conditions the drainage and affects directly by its intensity, the phenomena of infiltration, runoff and erosion, its form, and the length on which it acts [21]. Usually, the mean value of this parameter is used in watershed management. Given the heterogeneous nature of this parameter, it is often recommended to have information on the different slope values. Such information coupled with others such as land tenure may assist the manager in determining areas of priority interventions. With the GIS processes, we can obtain in a short time an image containing the value of all the slopes of the watershed. The average slope of a basin is a parameter that has an important and complex relationship with infiltration, surface runoff and water saturation of the soil. It controls the run-off time and the concentration of rainwater in the drainage arteries

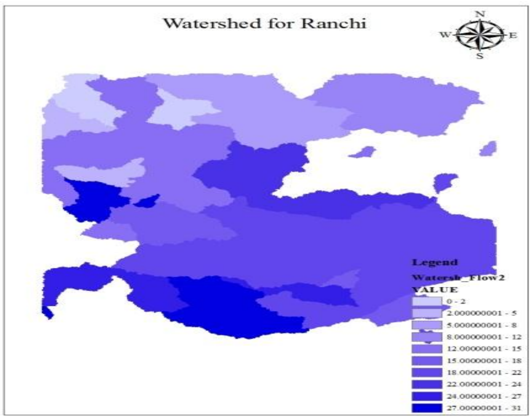


Fig-9

The deepest blue colure is showing the possibility of maximum water, as the deepness of colour decreases the possibility of groundwater decreases showing in (fig-9).

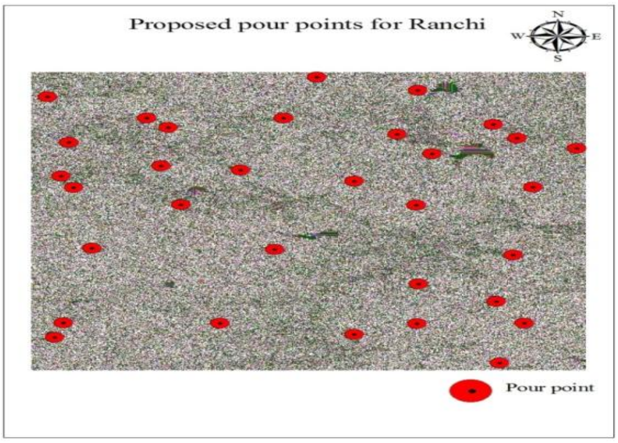


Fig-10

In (fig-10) the deep red marks are showing the possible pore points for harvesting rainwater in entire Ranchi district.

X. CONCLUSION

The groundwater level in Ranchi is now a matter of great concern. Natural recharge of groundwater is not sufficient. Artificial recharge techniques are must for this city as the population growth rate is high. Rainwater harvesting can prove to be a lifeline for groundwater as the city receives a very good amount of rainwater every year. Rainwater harvesting is a process to store runoff water for reuse. The in our study we found that recharge pits can accumulate a good amount of water after the runoff if proper advertising did for the promotion of rainwater harvesting technique, the groundwater table could be uplifted, and the issue of water scarcity can be minimised in future. There is a requirement of aggressive awareness campaign towards rainwater harvesting and promotion of GIS technology.

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22. achievements, with photo that will be maximum 200-400 words.

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