iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VII **Month of publication:** July 2023

DOI: https://doi.org/10.22214/ijraset.2023.55083

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VII Jul 2023- Available at www.ijraset.com

Planning, Design and Site Suitability for Artificial Recharge Structure using GIS at Sarayu River Uttar Pradesh

Rishabh Singh
M.Tech Student, Department of Civil Engineering, Madan Mohan Malviya University of Technology, Gorakhpur, Uttar Pradesh.

Abstract: Due to its widespread occurrence, ease of availability, and dependability, ground water has recently become a significant source of water in India for the household, industrial, and agricultural sectors. Due to the lack of recharging options, this trait had led to its uncontrolled abuse in some regions of the nation. This has caused significant ground water table loss in some locations, raising questions about long-term sustainability. Utilizing GIS is necessary for the development of the scarce ground water resources.

I. INTRODUCTION

Terrain influences ground water's spatial and temporal variations. Construction of water collecting structures can help to lessen water shortage because it has an impact on an area's environmental and developmental activities. The possible sites call for an artificial recharging system that uses GIS and remote sensing methods.

In order to improve the availability of soil moisture during sporadic rainfall and to raise the water table in water sheds, appropriate structures are neededA manmade ground water recharge well is developed inside the provinces of home to recharge the groundwater table close to the location of the Sarayu River as groundwater levels are falling across the country as our withdrawals surpass the rate of aquifers to naturally replenish themselves.

Artificial groundwater recharge is one strategy for managing eroding water levels. The method of boosting water entering an aquifer through human-controlled ways is known as artificial recharge. For instance, by rerouting water across the land surface through canals, infiltration basins, or ponds, groundwater can be artificially refilled.

II. PLANNING

Sarayu/Ghaghra, It flows from Nepal through the Himalayas to India's Brahmaghat, where it merges with the Sharda River. They combine to create the Ghaghra River. It is the longest river in Nepal, measuring 507 kilometers in length. The Ghaghara River runs 1,080 kilometers in total before meeting the Ganges near Revelganj in Bihar.

The Karnali (or Ghaghara) and Mahakali (or Sharda) meet at a point in Bahraich District at 27°40′27″N 81°16′39″E where they merge to form the Sarayu river of India. Before getting the Rapti from its left at 26°16′34.05″N 83°37′49.51″E, Tanda and Barhalganj.

As it enters the Ganges close to Chhapra, which is located at 25°44′36″N 84°40′01″E. Installations for artificial recharge could have multiple uses. For instance, in some places, artificial recharge serves as both a storm water disposal method and a way to supplement the groundwater supply.

A. *Data Collection*

Sarayu/Ghaghra, It flows from Nepal through the Himalayas to India's Brahmaghat, where it merges with the Sharda River. They combine to create the Ghaghra River. It is the longest river in Nepal, measuring 507 kilometers in length. The Ghaghara River runs through Bihar for 1,080 kilometers before joining the Ganges near Revelganj. The Karnali (or Ghaghara) and Mahakali (or Sharda) meet at a point in Bahraich District at 27°40′27″N 81°16′39″E where they merge to form the Sarayu river of India. Before getting the Rapti from its left at 26°16′34.05″N 83°37′49.51″E, Tanda and Barhalganj. It enters the Ganges close to Chhapra at 25°44′36″N 84°40′01″E.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VII Jul 2023- Available at www.ijraset.com

1) Status of Pre and Post Monsoon Water Level

Table 1

Sl. No.	Well Name	Pre – Monsoon (mbgl)	Post – Monsoon (mbgl)	Fluctuation (m)
1	Chaure Bazar	7.80	4.00	+3.80
2	Naokua	4.30	2.20	2.10
3	Sakhupura	3.00	2.08	0.92
4	Bakarganj	2.45	2.52	-0.07
5	Meethagao n	5.60	5.51	0.09
6	Milkipur	4.85	3.78	1.07
7	Rudauli	-	2.79	_

2) Geological Map

A geologic map depicts the distribution of geologic characteristics, such as different types of rocks and surficial deposits, faults that shift the rocks and can be seen as scarps in surficial deposits, and folds that demonstrate the rocks have been bent.

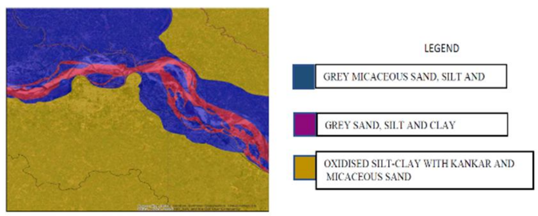


Fig 1 Geological Map

3) Ground Water Level Map

The process of characterizing the quantity, quality, and sustainability of ground water in aquifers using geologic, geophysical, hydrologic, and chemical field and laboratory tests is known as aquifer mapping.

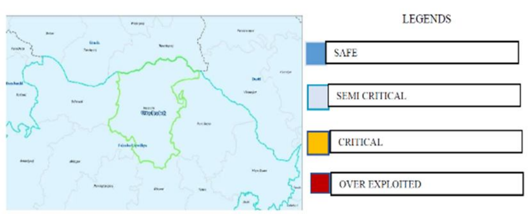


Fig 2 Ground water level mao

4) Land Cover Land Use

The National Institute of Hydrology has mapped the country's different land use zones to show the percentage of land that is covered by forests, non-agricultural, plantations, and grasslands.

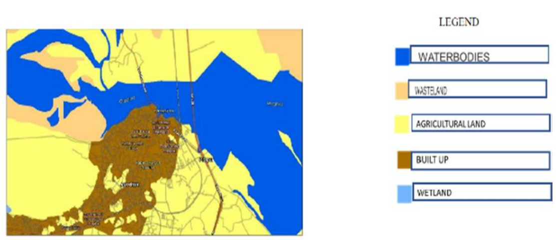


Fig 3 Land cover land use

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VII Jul 2023- Available at www.ijraset.com

5) Soil Map

This survey may result in thematic maps on various soil and land parameters that will be useful for macro level watershed development planning.

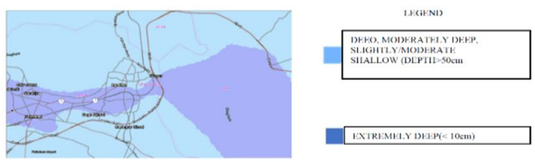


Fig 4 Soil map

6) Artificial Recharging Structure (Rechargewell)

The term "artificial recharge" describes the human-induced transport of surface water to the aquifer. The percolation of surface water that is either stored or flowing and would not otherwise percolate into the aquifers speeds up the natural process of recharging the aquifers. The method by which ground water is increased at a rate greater than that under natural replenishment conditions is known as artificial recharge. As a result, any man-made structure that augments an aquifer with water may be referred to as artificial recharge (CGWB, 1994). The goal of artificial recharge is to increase the natural replenishment of ground water storage through construction, water dispersion, or man-made changes to the environment. It helps to decrease overdraft, conserve surface runoff, and expand the amount of groundwater that is accessible. Depending on whether or not recharge results from routine water use, it may be accidental or intentional. Another definition of artificial recharge is the process of inducing replenishment of the groundwater reservoir through human activity. The process of supplementing may be deliberate, such as when water is stored in pits, tanks, or other structures for the purpose of feeding the aquifer, or unplanned and incidental to human activity, such as when irrigation is used, when pipelines burst, etc.

B. Analysis

Artificial recharge initiatives are site-specific, and even emulating tactics from comparable locations requires taking into account regional hydrogeological and hydrological conditions. Setting up the recharge area is the first step in project planning. If a hydrologic unit like a watershed is chosen for implementation, the project can be carried out gradually. However, there are also regional programs utilized to boost ground water storage. Groundwater is frequently artificially recharged in the sites listed below:

a) Regions where ground water levels are consistently dropping.
b) Regions where a significant portion of the aquifer has already become desaturated.
c) Locations where the groundwater supply is insufficient during dry months.
d) Locations where salinity incursion is occurring.

1) Hydro-Meteorological Studies

These are carried out to understand climatological characteristics, evaporation losses, and rainfall patterns. When designing storages of a given capacity with the intention of having low evaporation losses, these can show the extent of post-monsoon evaporation losses. By this time, the water that was kept in storage should have percolated into the ground water reservoir because evaporation losses in semi-arid areas of India rise after January. The structure's capacity and design are determined using data on rainfall quantity, intensity, and number of rainy days.

2) Hydrological Studies

Finding a supply of water to use for refilling the ground water reservoir is a fundamental requirement before beginning any artificial recharge operation. Hydrological studies must be conducted in the watershed/sub-basin/basin where the planned artificial recharge systems are located to determine the source water availability for artificial recharge. Four different source water types may be available for artificial recharge, including

a) in-situ precipitation on the watershed.
b) Surface (canal) supply from sizable basin-based reservoirs.
c) Surface supply via water transfer across basins
d) Wastewater from treated municipal and industrial sources.

3) Soil Infiltration Studies

The soil and land use variables that regulate the rate of infiltration and downward percolation of the water applied on the soil's surface take particular significance in the case of artificial replenishment by water spreading technologies. The definition of infiltration in the strictest sense is "The action of allowing water to penetrate a soil through the soil surface." Even though infiltration and percolation (the movement of water within the soil) are separate phenomena, the two are closely associated because infiltration is prevented by percolation until infiltrated water has been removed from the surface soil.

4) Geophysical Studies

a) The primary goal of using geophysical methods to determine the best location for artificial recharge studies is to aid in and provide an accurate, adequate, and cost-effective assessment of the subsurface hydrogeological conditions. The primary objective is often to supplement the exploratory program. It is used primarily to focus the target area, identify potential locations for artificial recharge structures, and determine the best designs for these structures.

b) The surface expression of these structures, the subsurface litho environment, and their relation to the hydrogeological setting are all still seen using geophysical methods

c) It may also detect the brackish/fresh ground water interface, the contaminated zone (saline), and the region vulnerable to seawater intrusion in addition to defining the subsurface structure and lithology.

5) Chemical Quality Of Source Water

a) Chemicals and Salts

The biggest issue with ground water recharge is the quality of the raw fluids that are available for it and that typically need to be treated before being used in recharge systems.

Additionally, they are connected to the modifications made to the environment's conditions as well as the biological phenomena and changes in soil structure that occur when infiltration starts. Therefore, it is crucial to perform a chemical and bacterial investigation on source water in addition to ground water.

b) Sediment Load

The absence of silt is a key condition for waters that will be used in recharge operations. Silt is defined as the amount of undissolved solid matter, often measured in mg/l, that settles in still water or water moving at speeds under 0.1 m/h.

6) Clogging Of Soil Pores

This is a crucial factor to take into account while designing a system for artificial recharge. The typical techniques to reduce clogging include:

a) Surface installation of a filter with a lower permeability than the surface's natural stratum •Periodic removal of the mud-cake and dicing or scraping of the top layer (the filter needs to be taken out and replaced on a regular basis)

b) Adding chemicals or organic substances to the topmost layer

c) Growing certain plant-covers, particularly specific grass varieties

d) Including a bottom-mounted inverted filter with fine, coarse, and gravel sand.

For infiltration, ditches and pits are very effective.

The water and basin floor's organic and mineralogical makeup, as well as its permeability and grain size, all affect clogging caused by biological activity. The sole workable treatment strategy created so far entails completely drying the land beneath the basin.

7) Assessment of sub-surface Potential

The thickness of the potential unsaturated zone for recharging should be calculated based on hydrogeological and geophysical investigations in order to assess the likelihood of artificial recharge in terms of the volume of water that can be accommodated in this zone in comparison to the availability of the source water. The potential of the unsaturated zone in terms of the total volume that can be filled should be emphasized in the inquiry.

8) Finalisation Of Physical Plan

The following actions are required to complete the physical strategy for artificial recharge.

a) Creating a layout design of the project area to a size that is acceptable, indicating where the proposed structures and source water conveyance systems would be placed.
b) Calculating the quantity of structures needed for recharge.
c) Identification of the potential locations for the planned constructions, step iii
d) Making design drawings and requirements.

9) Analysis Impact Assessment

In general, the following impacts of artificial recharge schemes can be listed:

a) Preserving and collecting extra monsoon runoff that would typically be squandered beyond the watershed/basin and into the sea in underground reservoirs.
b) An increase in ground water levels brought on by more recharge. If there had been a steady fall in ground water levels, this would have been checked, and/or the rate of decline would have diminished. The amount of energy needed to lift the water is likewise lessened.
c) Wells feed water during the dry months when these buildings were about to run dry. Groundwater structures in the zone where artificial structures are favorable establish sustainability. Domestic wells will last longer, and tankers won't be needed in many locations.
d) As a result of the additionality of ground water, the cropping pattern in the benefited zone will noticeably shift, and cash crops will begin to grow. It is possible to restore orchards that previously dried up because of a lack of groundwater and grow new plantations.
e) Because of the benefit zone's improved soil moisture availability, there may be more green vegetation along structures and in the benefit zone overall.
f) Dilution may result in an improvement in the quality of ground water.
g) The artificial recharge plans will have immediate, obvious effects, but they will also have indirect advantages, such a reduction in soil erosion, an enhancement in the fauna and flora, a rise in migrating bird populations, etc.

C. Design

Groundwater can be artificially refilled by rerouting water through the land's surface using canals, ponds, or infiltration basins; by constructing irrigation furrows or sprinkler systems; or by simply injecting water directly into the ground through injection well.

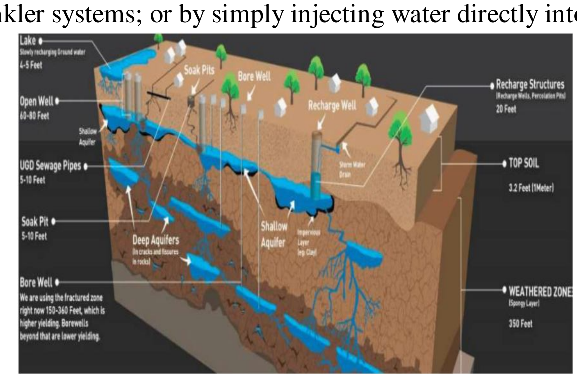


Fig 5 Artificial ground water recharge system

- *Step 1:* The communities have struggled with a lack of water during the summer as their borewells have dried up and supplies from private tankers has decreased. They can build a recharge well in their neighborhood to collect storm water and send it directly to the ground water table to remedy the condition.
- *Step 2:* A recharging well is being built, Rainwater percolates into the soil and replenishes aquifers thanks to recharge wells. You require a recharge well with a minimum diameter of 1.5 meters and a minimum depth of 16 meters to prevent water logging and flooding.
- *Step 3:* Final constructed recharge well with RCC cover plate

1) AutoCAD Design

Rainwater percolates into the soil and replenishes aquifers thanks to recharge wells. You require a recharge well with a minimum diameter of 1.5 meters and a minimum depth of 16 meters to mitigate water-logging and flooding. Using AutoCAD 2020, the artificial recharge well's plan and elevation were created.

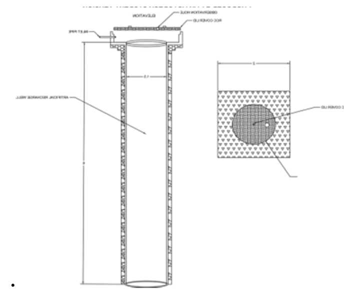


Fig 6 AutoCAD design of recharge well

2) Recharge Well

Recharge wells are designed with the idea that water collected in the well will seep into the soil and replenish shallow aquifers. Water-bearing structures known as shallow aquifers are found 10 to 100 feet beneath and are typically refilled during rainy seasons. However, percolation and recharge levels are poor in urban built-up areas. Rainwater can be directed into shallow aquifers via recharge wells, raising groundwater levels, according to the theory.

3) Porous Concrete

There is a unique kind of concrete called pervious concrete that is highly porous and is used for concrete flatwork applications. Pervious concrete allows water to travel through it directly from precipitation and other sources. restricting the area's discharge as much as possible. By enabling storm water to permeate the soil over a large area, pervious concrete serves the same function as a storm water infiltration basin and aids in the local replenishment of irreplaceable groundwater resources. Pervious concrete is made of cement, coarse aggregate (which should have a size between 9.5 and 12.5 mm), and a little amount of water. Low water to cement ratios will increase the strength of concrete, but too little water may cause surface failure.

4) Porous Concrete Sample –Contents

a) 12mm coarse aggregate = 3 Portion
b) Cement = 1 Portion
c) Water = 33% of total volume

5) Porous Concrete Sample- Real Sample

Fig 7 Porous concrete real sample

III. CONCLUSION

This approach provided me with a fantastic opportunity to learn about various GIS features and potential applications, and it was a tremendous learning experience. This gave me the chance to learn a lot of practical information, gain experience in the field, and become familiar with the numerous technical jargon used in engineering geology and GIS mapping. Choosing a suitable place utilizing a geographic information system (GIS) and remote sensing. used ArcGIS to create theme maps such as runoff potential maps, landcover maps, soil maps, and drainage maps. The artificial recharge well was planned and created using AutoCAD software. casting and curing of a sample of porous concrete.

REFERENCES

[1] Chowdhury, A. Jha, M.K. Chowdary, V.M. (2009), Delineation of groundwater recharge zones and identification of artificial recharge sites in West Medinipur district, West Bengal, using RS, GIS and MCDM techniques, Environmental Earth Sciences, Vol. No. 59, Issue No. 6, page. 1209 – 1222

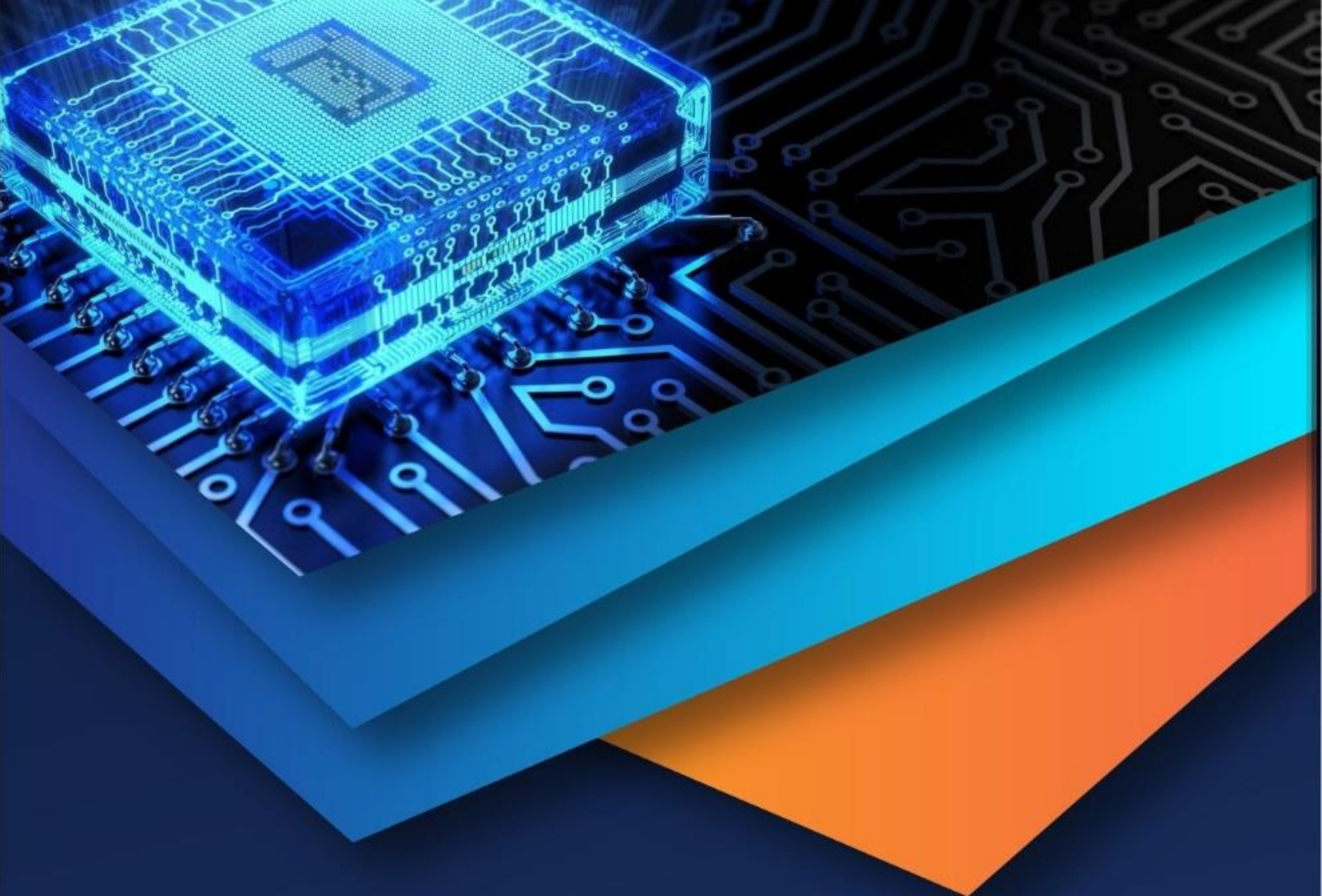
[2] Ramakrishnan, D. Durga Rao, K.H.V. Tiwari, K.C. (2008), Delineation of potential sites for water harvesting structures through remote sensing and GIS techniques: A case study of Kali watershed, Gujarat, India, Geocarto International, Vol. No. 23, Issue No. 2, page. 95 - 108.K

[3] Kumar, M.G. Agarwal, A.K. Bali, R. (2008), Delineation of potential sites for water harvesting structures using remote sensing and GIS, Journal of the Indian Society of Remote Sensing, Vol. No. 36, Issue No. 4, page. 323 - 334.

[4] Krishnamurthy, J. Mani, A. Jayaraman, V. Manivel, M. (2000), Groundwater resources development in hard rock terrain - An approach using remote sensing and GIS techniques, International Journal of Applied Earth Observation and Geoinformation, Vol. No. 2000, Issue No. 43528, page. 204 - 215.

[5] Kumar, T. & Jhariya,, D. C. (2017), Identification of rainwater harvesting sites using SCS-CN methodology, remote sensing and Geographical Information System techniques. Geocarto international, Vol. No. 32, Issue No. 12, page. 1367-1388.

[6] Saha, A. Patil, M. Karwariya,S. Pingale, S.M. Azmi, S. Goyal ,V.C. Rathore ,D.S. (2018), Identification of potential sites for water harvesting structures using geospatial techniques and multi-criteria decision analysis, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, Vol. No. 42, Issue No. 5, page. 329 - 334.



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY