Artificial Groundwater Recharge of Gandhinagar district

Naishadkumar Jagdishbhai Sutariya[1], Mr. Jitendrasinh Raol
[1] PG Student, of M.E. (Civil Infrastructure Engineering), L.D.R.P. Institute of Technology & Research, Gandhinagar, Gujarat, India.
[2]Professor, L.D.R.P. Institute of Technology & Research, Gandhinagar, Gujarat, India.

Abstract- **Water is essential for the existence of all forms of life for human consumption, agriculture and industrial. This is the reason why the man has moved and settled only in areas of rich water resources. As the population has started growing and unregulated usage of surface water resources has been initiated in multiple fronts the available water is not able to cope up to human needs. So, the man has aggressively and competitively started mining the ground water reservoirs all over the world using all the possible and available modern technologies. Water resources of the world in general and in India are under heavy stress due to increased demand and limitation of available quantity. Since urbanization, the demand for water is increasing day by day and the sources of fresh water are depleting rapidly. Groundwater is not only an important component of the hydrological cycle but also the most important source of water for drinking, domestic, industrial and agricultural uses. In a densely populated country like India, ground water resource is of extreme importance. Gujarat Government announced that the Gandhinagar district is under the heavy stress of water availability. all four talukas are over exploited due to the excessive withdrawal of groundwater. So, it's necessary to takes steps against this problem in these study artificial groundwater recharge process is applied on Gandhinagar district.**

Artificial groundwater recharge is a process by which the groundwater reservoir is reduced at a rate exceeding the augmentation rate under natural conditions of replenishment. The work aims to understand the ground water scenario from the geological point of view as geology of the area concerned is the main control of ground water recharge, and potentiality.

This study aims that recharging the groundwater of and tries to overcome the scarcity of water in Gandhinagar district.

Index Terms- **Water scarcity, Groundwater, artificial recharge, techniques, Runoff, Site selection**

I. INTRODUCTION

India is now facing a water situation that is significantly worse than any that previous generations have had to face. All Indian water bodies within and near population centres are now grossly polluted with organic and hazardous pollutants. Interstate disputes over river waters are becoming increasingly intense and widespread. Not a single Indian city can provide clean water that can be consumed from the tap on a 24×7 basis. In India, groundwater has come to occupy an enviable position in terms of meeting 55% of irrigation, 85% of rural and 50% of urban and industrial needs. Almost 90%of drinking water needs are met from groundwater.

Surface water conditions are bad. However, the groundwater situation is even worse.

Groundwater extraction is growing and has become increasingly unsustainable. Consequently, in many parts of the country, groundwater levels are declining steadily. In some parts, the levels are declining by more than one meter per year. A lack of proper wastewater treatment from domestic, industrial, and mining sources has meant that groundwater is being progressively contaminated by known and unknown pollutants, increasing the potential health risks to humans and ecosystems.

The Gujarat government has declared 14 districts and 152 talukas of the state as "scarcity hit" due to deficient rains and announced a stimulus package with fodder subsidies and out-of-turn power connections among other measures. Every taluka in districts of Kutch, Surendranagar, Rajkot, Jamnagar, Junagadh, Amreli, Porbandar, Bhavnagar, Ahmedabad, Gandhinagar, Patan, Banaskantha, Mehsana and Bharuch falls under this category.

Need of study

- In Gandhinagar net annual groundwater availability is 45300.05 ha.m and Existing Gross

Ground Water Draft for irrigation is 51272.00 ha.m, Existing Gross Ground Water Draft for All uses is 54384.00Ha.m. on the other side, Allocation for domestic and industrial requirement supply upto next 25 years is 4257.00 Ha.m . Net Ground Water Availability for future irrigation development is Zero.

- For confined aquifers, In the year 1995-2000 water level of Gandhinagar is nearer to 80 m, in present condition it is reaches to the 93 m.
- For unconfined aquifers, water level is 12m in 1995 and in present time it's reached upto 18m. Based on the present scenario groundwater water levels of Gandhinagar are depleting rapidly at the Gandhinagar can cause heavy stress of water in future.

Objectives:

- To maximize long-term & seasonal storage of water under the ground surface.
- Maintaining declining ground water levels.
- To demarcate the area and depth of groundwater recharged by different recharge methods.
- To suggest measures to enhance recharging rate of groundwater level.

Scope of study

The information given by the data of Gandhinagar district, the most suitable areas for the recharge has been found and the rise of groundwater level by the various groundwater recharge methods, like direct methods, indirect methods and combination methods. Due to the successive analysis of data and implementation of the recharge methods, groundwater is rise and that water is used for the various purpose.

Study Area

Gandhinagar District is an administrative division of Gujarat, India, whose headquarters are at Gandhinagar, the state capital. It was organized in 1964.

It has an area of 649 km², and a population of 1,334,455 of which 35.02% were urban (2001 census). The district includes Gandhinagar with three Suburbs - Chandkheda, Motera, Adalaj. The four tehsils are - Gandhinagar, Kalol INA, Dahegam and Mansa - and 216 villages.

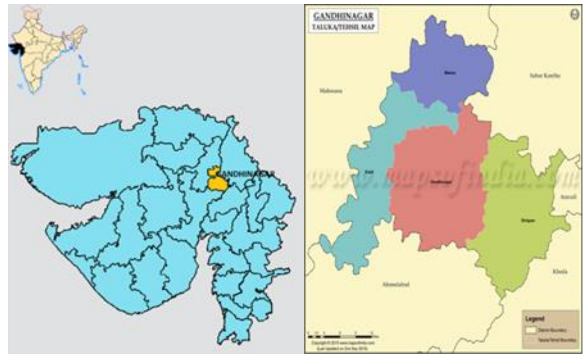
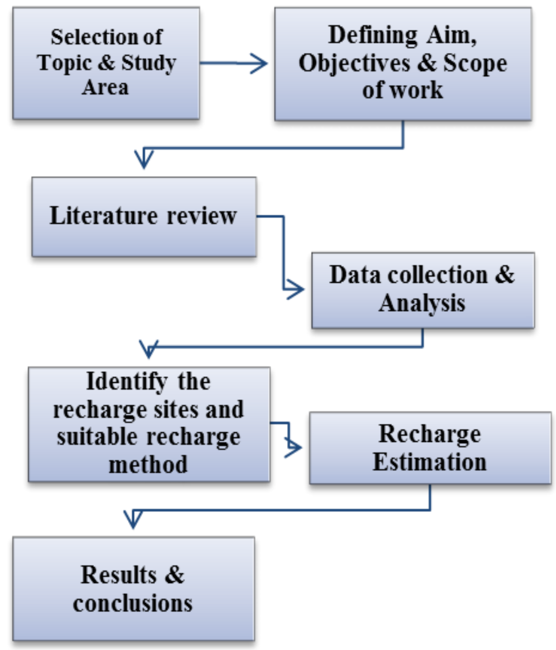


Fig.1 Location of Gandhinagar District



Flowchart of Methodology

II. : DATA COLLCTION

Data required for the implementation of the project are following:

- Rainfall Data
- Existing & past groundwater level(pre-monsoon/post-monsoon data)
- Aquifer system
- Available water resources
- Groundwater withdrawal

Thematic Maps

Certain thematic maps were made by using GIS, where data is available from BISAG.

A thematic map shows the spatial distribution of one or more specific data themes for standard geographic areas.

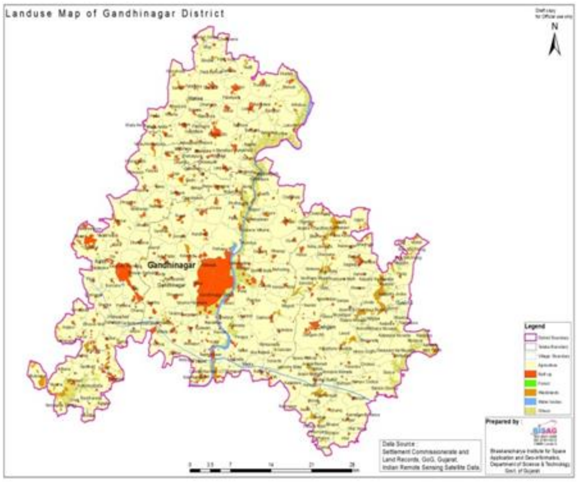
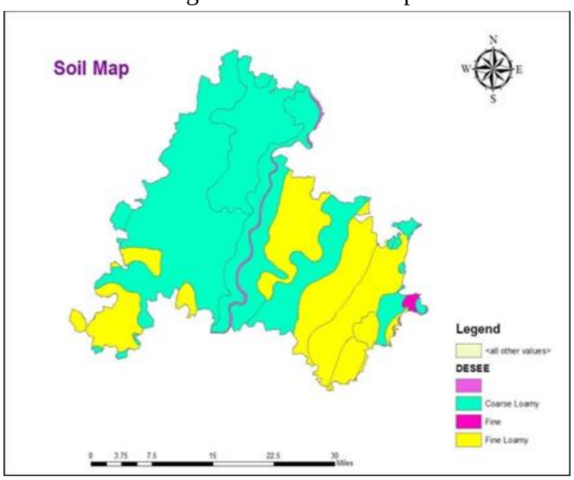
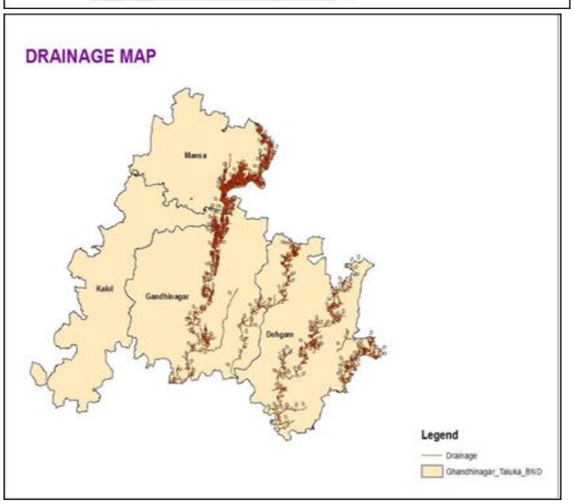


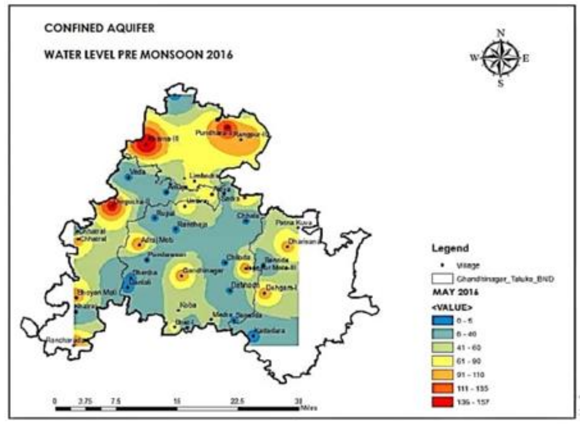
Figure 1 : Landuse map

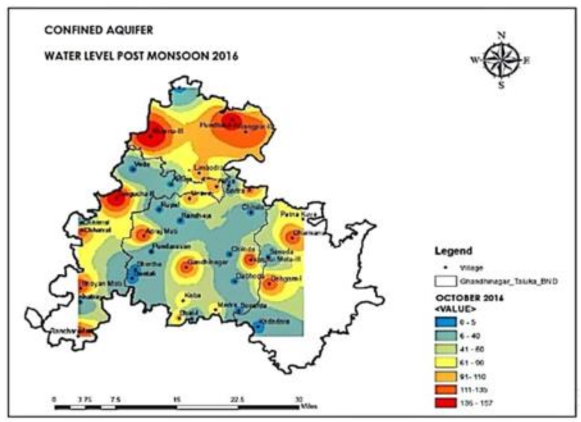




Groundwater level Maps

Water level study has been done for both confined and unconfined aquifer. Rises and falls in the water table correspond to changes in the volume of water in storage within an aquifer. The contour maps and profiles of the water table can be prepared from elevations of water in wells that tap the aquifer to determine the quantities of water available.





CALCULATION

Runoff :

Runoff is defined as the part of the water cycle that flows over land as surface water instead of being absorbed into groundwater or evaporation. The amount of rainfall directly affects the amount of runoff. If a large amount of snow melting in short period, there will be large amount of runoff.

SCS Curve Number Method

- The runoff curve number is an empirical parameter used in hydrology for predicting direct runoff or infiltration from rainfall excess. The curve number method is established by USDA Natural Resources Conservation Service, which is called the Soil Conservation Service – the number is still known as “SCS runoff curve number”.
- The runoff curve number is based on the area’s hydrologic soil group, land use, treatment and hydrologic situation. The runoff equation is as follows:

- Q = 0 for P ≤ Ia
- $Q = \frac{(P-Ia)2}{P-Ia+S}$ for P >Ia

Where Q = Runoff (mm)
P = Rainfall (mm/year)
S = Potential maximum soil moisture retention after runoff begins
Ia is the initial abstraction or the amount of water before runoff
The runoff curve number CN is then related

$$S = \frac{1000}{CN} - 10$$

Natural Recharge Estimation
Estimation of groundwater recharge of the study area was conducted for tropical regions based on water level fluctuation and rainfall depth
The equation is given as:

$$R = 1.35(P - 14)^{0.5}$$

where R is the net recharge due to precipitation in inches, and P is the precipitation in inches. These can be converted to millimeters (mm).

Table 1 : Runoff (mm)

Year	Kalol	Dahegam	Mansa	Gandhinagar
2000	424.43	538	703	831
2001	773	595	454	994
2002	603	588	567	736
2003	1027	901	1066	1050
2004	954	578	444	746
2005	766	613	840	884
2006	849	504	990	1061
2007	899	710	1006	1116
2008	97	807	731	802
2009	1027	584	623	510
2010	669	987	1181	889
2011	717	672	1117	718
2012	906	1065	657	707
2013	1028	593	977	786
2014	669	654	749	646
2015	683	895	819	871
2016	873	787	785	902

Table 2 : Natural Recharge Estimation

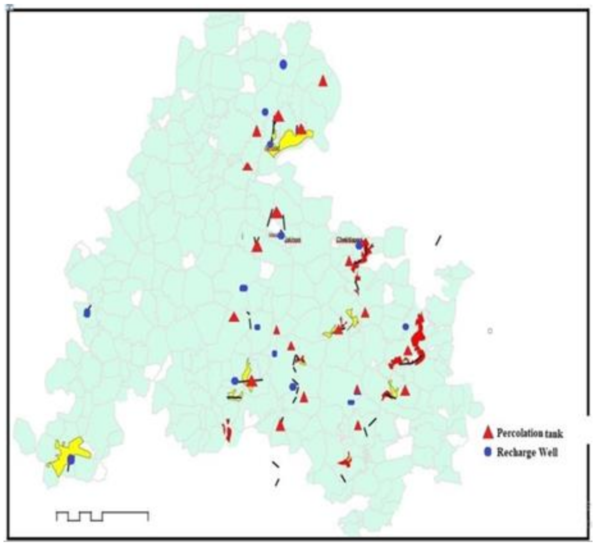
Year	Gandhinagar	Kalol	Dahegam	Mansa
2000	150	58	93	127
2001	173	140	106	69
2002	135	108	105	100
2003	180	176	160	182
2004	136	167	102	65
2005	158	138	110	150
2006	182	152	84	172
2007	188	159	129	174
2008	145	127	145	132
2009	87	176	103	112
2010	157	121	171	196
2011	131	130	121	188
2012	129	161	181	118
2013	185	177	105	170
2014	117	121	118	135
2015	156	124	158	147
2016	160	155	141	141

SITE SELECTION
The preliminary artificial recharge zones map prepared through the remote sensing and GIS techniques were verified in the field for correctness, the artificial recharge zones demarcated were in agreement with the conditions in the field. The selection of the artificial recharge sites was based on logic and conditional methods were used. The most suitable class of the result of the weighted index overlay was combined with other binary weight maps.

Table 3 : Score Assigned to theme

Sr.No	Evidential theme	Class	Weight	Score
1	Land use/land cover	River bed	5	4
		Settlement		10
		Valley fill		7
		Agriculture field		9
		Dense Forest		6
		Open forest		5
		Hilly area		2
2	Geomorphology	Active flood plain	6	4
		River terrace (t0)		5
		River terrace (t1)		7
		Older alluvial plain		6
		Piedmont alluvial plain		8
3	Lithology	River/ stream	7	3
		Younger alluvium		9
		Older alluvium		7
		Boulder conglomerates		10
		Nagrota formation		6
4	Hydrologic soil texture	Recent river	4	4
		Coarse loamy soil		10
		Fine loamy soil		7
		Fine silty soil		6
5	Slope	0-2	5	8
		2-5		10
		5-10		6
		10-15		4
		15-35		2
		>35		1
6	Pre-monsoon depth to water table	<3.5	8	6
		3.5-6.5		7
		6.5-9.5		8
		>9.5		10
		Runoff Zone		1
7	Post-monsoon depth to water table	<2.5	8	6
		2.5-5.5		7
		5.5-7.5		8
		>7.5		10
		Runoff Zone		1
8	Permeability	<5	10	2
		5-10		2
		10-20		4
		20-35		7
		>35		10

Most of part of Gandhinagar is covered by Alluvial plain and some part is aeoline plain. There are only percolation pond and recharge well method is suitable on alluvial plain.



Recharge Potential of Some Artificial Recharge Structures

Various artificial recharge experiments carried out by different organizations in India have established the feasibility of the methods in unconfined, semi-confined and confined aquifer systems. However, economic considerations make some particular methods viable in a particular area or for a particular aquifer. Consequently, it is possible to estimate upper limits of quantities of recharge through each artificial recharge structure based on studies carried out in different hydrogeological set-ups. typical recharge estimates are given below in general form with field examples from alluvial unconfined/semi confined aquifer systems.

1) Percolation Tank

i) Average water spread area = 'a' Hectares

ii) Seepage Rate = 'b' Cu m/sec/million sq m of wetted perimeter

iii) Inflow and storage period = 'c' Days

iv) Quantity of induced recharge in MCM

$$= \frac{a * 10 * b * 3600 * 24 * c}{10^6 * 10^6} = 'P'MCM$$

2) Recharge Tube well

i. Injection recharge rate = 'a' lps

ii. Number of days of recharge = 'b' days

iii. Quantity of recharge in MCM

$$= \frac{a * 86.4 * b}{10^6} =' R'MCM$$

CONCLUSION

In present study, the data collected of study area and analyzed as per requirement. It help to select suitable recharge site and recharge method. As per the guidelines given in manual of artificial recharge to groundwater site selection for artificial recharge is selected. mostly all area of Gandhinagar is under water stress but At that location ,where levels of groundwater is high are most suitable for recharge. Study area covers mostly alluvial plain landform so, the suitable recharge methods in Gandhinagar district are percolation tanks, Recharge wells.

Location of recharge structures are based on the site selection criteria. after that runoff is measured by empirical formula and natural recharge is estimated. Then recharge potential is measured for selected structure by formula given is manual of artificial groundwater recharge.

As per the formula, approx. recharge by percolation tank is 2.25 MCM and recharge well can recharge 0.15MCM. total recharge is estimated as per numbers of recharge structures.

So the more quantity of water can store in aquifers.

REFERENCES

[1] A. K. Saraf & P. R. Choudhury (Nov 2010), ‘Integrated remote sensing and GIS for groundwater exploration and identification of artificial recharge sites.”

[2] Government of India, “Ministry of water resources (2013) Master plan for artificial recharge to ground water in India.”

[3] Satish A. Bhalerao and Tushar S. Kelkar,(june,2013) “Artificial recharge of ground water: A novel technique for replenishment of an aquifer with water from the land surface.”

[4] State water data centre, Unit-2, Kherva, Mehsana

[5] State water data centre, Sector-8, Gandhinagar