Assessment of Ground Water Recharge through Canal - A Case Study of Patan and Mehsana District, Gujarat

Rutvik H. Oza[1] R.M.Jadav[2] Indra Prakash[3] Khalid Mehmood[4]
[1]M.E Student [2]Associate Professor [3,4]Faculty
[1,2]L.D College of Engineering, Ahmedabad 380015, Gujarat [3,4]Faculty of BISAG, Gandhinagar, Gujarat

Abstract— The study represent an analysis of artificial ground water recharge through Sujalam-sufalam canal and same has been modeled in GIS Platform. Here Patan and Mehsana district of Gujarat considered in order to measure the recharge. Numbers of wells are identify in the study region in order to measure water table and based on lithologs confined and unconfined aquifers are identify. Based on rainfall data, estimate the ground water recharge due to rain is calculated using an equation derived by United states geological survey. This rainfall recharge data is deducted from total recharge in the well in order to estimate the recharge through Sujalam Sufalam canal. all this analytical things are modelled in to gis platform in order to generate ground water contour on the topography of study region. This study can guide to the decision making authorities to construct suitable infrastructure for the better utility of Sujalam Sufalam canal.

Key words: Ground Water Recharge, Canal, Sujalam Sufalam canal

I. INTRODUCTION

Ground water constitutes about two thirds of the freshwater resources of the world. In India it is a major source for all purposes of water requirements. It plays a vital role in the country's economic development and in ensuring its food security. More than 90% of rural and nearly 30% of urban population depend on ground water for drinking water. It also accounts for nearly 60% of the total irrigation potential in the country (NRSA, 2008). The demand for ground water is increasing due to rapid growth in population, industrial development, urbanization and increase in agricultural activities. As per the Central Ground Water Board, 2009 report the Annual Replenishable Ground Water Resource for the entire country is 431 billion cubic meter (bcm), Net Annual Ground Water availability is 396 billion cubic meter whereas the Annual Ground Water draft for irrigation, domestic and Industrial is 243 billion cubic meter and the stage of Ground water Development for the country as a whole is 61%. The occurrence and distribution of ground water in the country varies significantly depending on geology, rainfall and geomorphology. In regions like North West India ground water resources are depleting whereas the eastern part of the country have plenty of ground water ground water resources are depleting whereas the eastern parts of the country have plenty of ground water resources which remained unexploited. The distribution of rainfall also varies widely both in time and space. Most of rainfall (about 76%) occurs during the Monsoon months resulting into eight comparatively dry months. Similarly, the Meteorological subdivisions like North east India, coastal Karnataka and Goa receives more than 250cm of rainfall annually while West Rajasthan gets only about 30cm (IMD, 2011).

Although the ground water available in the country, in general, is potable and suitable for various uses, localized occurrence of ground water having various chemical constituents in excess of the limits prescribed for drinking water use have been reported in many states. Increasing incidence of fluoride concentrations (above permissible levels of 1.5 ppm) have been reported from 69 districts in 14 Indian states (e.g. Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh,Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal). It is estimated that about 65% of Indian villages are exposed to fluoride risk.

The annual replenishable groundwater resources have been assessed as 431 BCM. Keeping an allocation for natural discharge, the net annual groundwater availability is 396 BCM. The annual groundwater draft (as on 31st March, 2009) is 243 BCM. The stage of groundwater development works out to be about 61%. The development of groundwater in different areas of the country has not been uniform. Out of 5842 assessment units (Blocks/ Mandals/ Talukas) in the country, 802 units in various states have been categorized as "Over-exploited" i.e. the annual groundwater extraction exceeds the net annual groundwater availability and significant decline in long term groundwater level trend has been observed either in pre monsoon or post-monsoon or both. In addition, 169 units are Critical i.e. the stage of groundwater development is above 90% and within 100% of net annual groundwater availability and significant decline is observed in the long term water level trend in both premonsoon and postmonsoon periods. There are 523 Semi-critical units, where the stage of groundwater development is between 70% and 100% and significant decline in long term water level trend has been recorded in either pre-monsoon or post-monsoon. 4277 assessment units are Safe where there is no decline in long term groundwater level trend. Apart from this, there are 71 blocks completely underlain by saline ground water.

Over-exploitation of groundwater resource (stage of groundwater development being more than 100%) refers to the development of groundwater resource which is available below the active recharge zone or zone of fluctuation that is sometimes referred as static or in–storage groundwater reserve. The quantum of water available for development is usually restricted to long term average recharge or in other words to "dynamic resource".

A. Study Area

The works of 332 K.M. long Sujalam Sufalam Spreading Canal, navigating through seven District from Mahi to Banas stream which incorporates preoccupation of surplus surge water of Kadana Reservoir and Narmada to the water shortfall ranges, crosses 21 waterways, 2 National Highways, 7 Railway lines and other 564 structures for little depletes/nallas are finished with the exception of some extra intersection/delta structures. The work has begun yielding outcomes, as the agriculturists have flooded their properties through lift and ground water energize. An expense of Rs. 2938.23 lakh is proposed for the year 2013-14.From this 332km long canal, study area is Mehsana and patan in which The canal has length 85km is taken for the study of groundwater. Elevation of the mehsana and Patan is 81m and 76m respectively. The co-ordinate of the Mehsana is lying between 23.6N to 72.4E and the co-ordinate of patan is lying between 23.85N to 72.61E.

B. TOPOGRAPHY

A major part of Mehsana and patan district is monotonously flat on account of a thick cover of alluvium and windblown sand. In some of the part of Kheralu and satlasana there is mountainous area in Mehsana district.

C. CLIMATE

Mehsana and patan falls in semi-arid region as the tropic of cancer passes through the districts. The rainfall is also very less, varying from 600 mm to 700 mm and the district has extreme climate. The average rainfall in the district is about 642 and 612 mm. About 96 % of the annual rainfall in the district is received during the south-west monsoon (months-June to September).

D. DRAINAGE

The entire area is drained by the Sabarmati and the Rupen. The river Sabarmati flowing on the boundary of the district is the third largest river in the state after Narmada and Tapi. The river Rupen rises from the western side of the Taranga hill in Satlasan taluka.

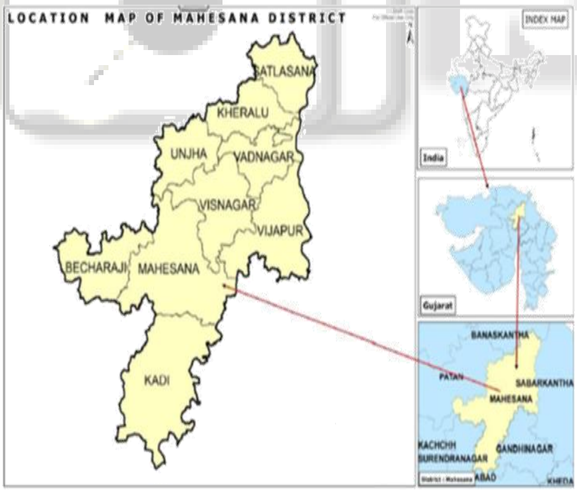

Fig. 1: index map of study area

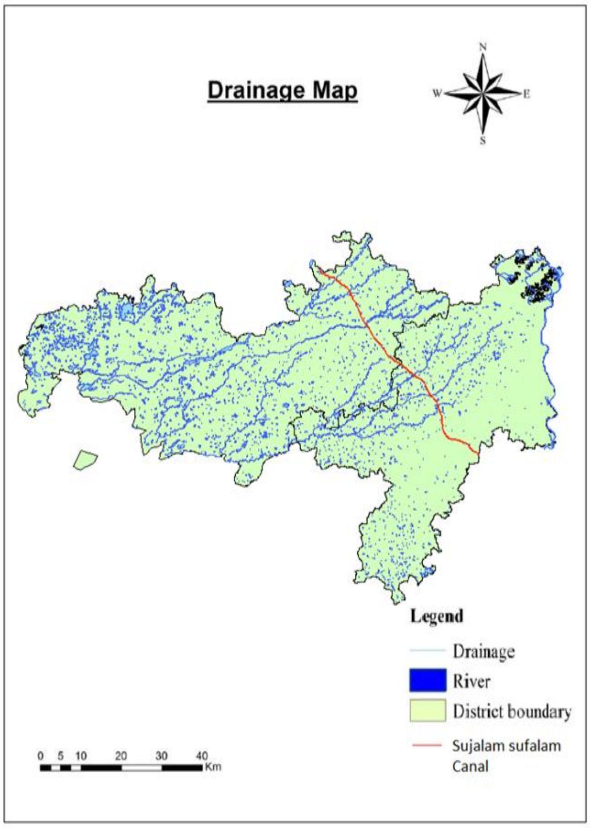

Fig. 2: Drainage map of study area

E. FOREST

The total area under Forest is 353.00 Sq.mile. The district is not having much major forest area and not mineral forest products. There are limited scopes for establishing forest based industries.

F. Availability of Minerals

The oil & Natural Gas commission of India had successfully explored many minerals oil and natural gas in Kadi and Mehsana taluka. Mehsana district is having a place in All India Minerals Map prepared by Ministry of Petroleum Govt. of India. Thereare other minerals like China Clay (crude), China Clay (impure), Bricks Clay, Granite, Sand, Limestone and Quartzite etc.

II. METHODOLOGY

This chapter deals with the data used and methodology adopted for carrying out experiment in the study area. It includes description of study area, extent, use of remote sensing and GIS for getting information of data set and GIS software used, methodology used for GIS incorporation, topography and hydrology of the study area. Methodology adopted for generating the thematic maps or thematic layers of Mehsana and Patan district using remote sensing and GIS techniques.

The step wise methodology is shown following:

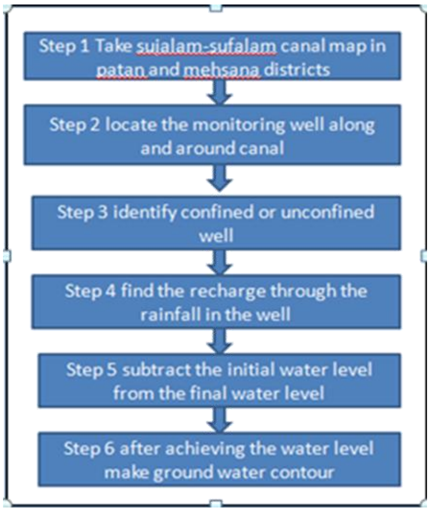

Fig. 3: Flow chart of methodology

A. Sujalam-sufalam canal map in patan and mehesana andMehsana districts

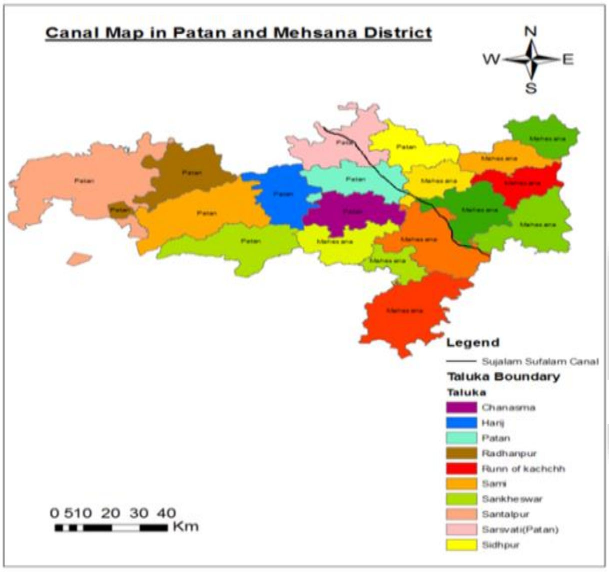

Fig. 4: Canal map in Patan and Mehsana district Monitoring Well along and around Canal.

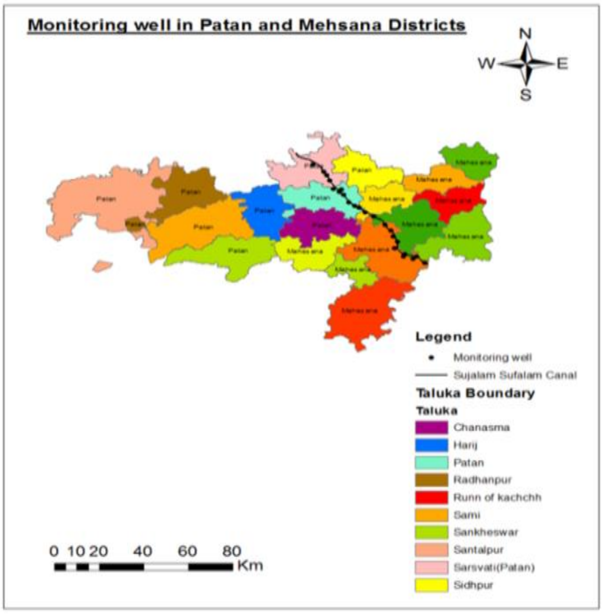

Fig. 5: Monitoring well along and around the canal

B. Identify Confined And Unconfined Aquifer Well Along And Around The Canal.

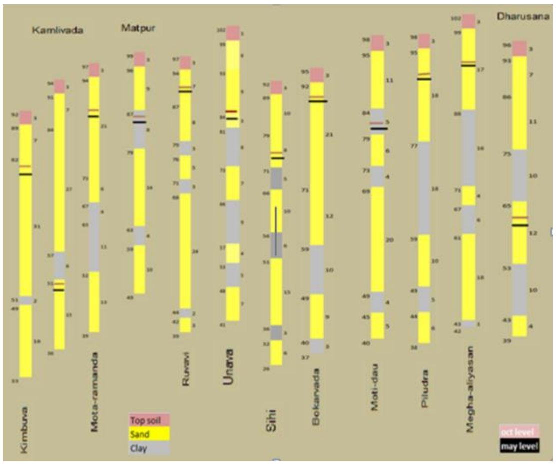

Fig. 6: Wells on left side of canal

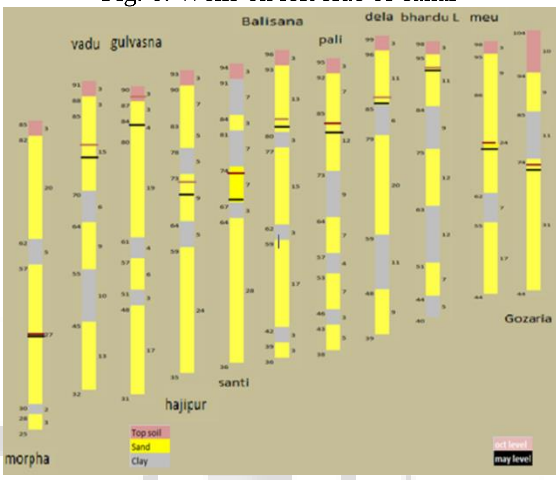

Fig. 7: Wells on right side of the canal

C. find the recharge through rainfall in the well from the following equation.

$$R(tj) = Sy * \Delta H(tj)$$

$R_{(tj)}$: recharge occurring between time t_0 and t_j.

S_y : Specific yield

ΔH_{tj} : peak water recharge attributed to the recharge period

Specific yield can be estimated by the following equation, This equation taken from the United states geological survey

$$s = \frac{Qt}{7.48V}$$

S = specific yield

t = time in days, since pumping began.

V = volume of water can be obtain from the following equation.

$$V = \frac{\pi r^2 e^{2ams}}{2am}$$

Where 'a' is

$$a = \frac{2\pi P}{Q}$$

- Q= discharge rate of pumped well (LPM)
- P = The field co-efficient of permeability of aquifer (m/Day)
- R = Horizontal distance from the axis of pumped well to a point on the cone of depression.
- S = Drawdown at distance 'r'

- Sw = Drawdown at outside the screen of the pumped well
- M = thickness of the zone of saturation before pumping of the height of the static water table above the aquifer bottom.
- T = Co-efficient 0f transmissibility of aquifer (m2 per day) subtract the Rain water recharge from the water level fluctuation in the well. it will give the amount of recharge through the canal.

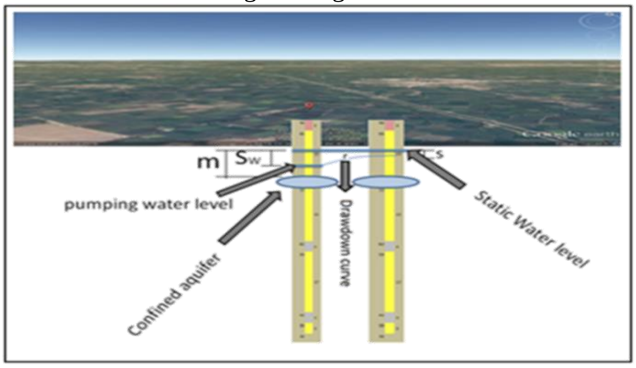

Fig. 8:

III. RESULT

The amount of recharge in the well can be seen through the following figure.

A. Two wells located at meu and padhiria (village name) on the cross-section of canal is as shown in fig. the rain water recharge and rise level can be plotted on graph. This will give the amount of recharge through canal.

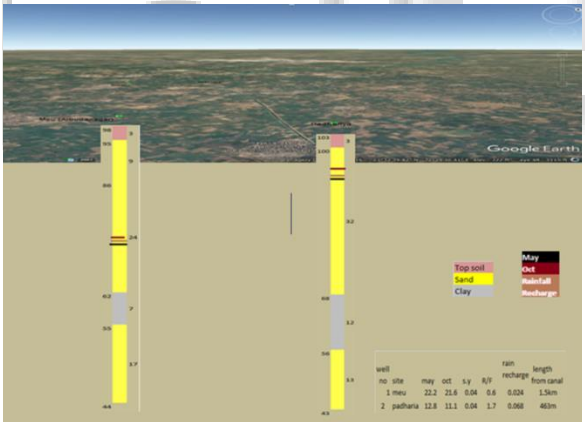

Fig. 9: Location of the well and water level in the well

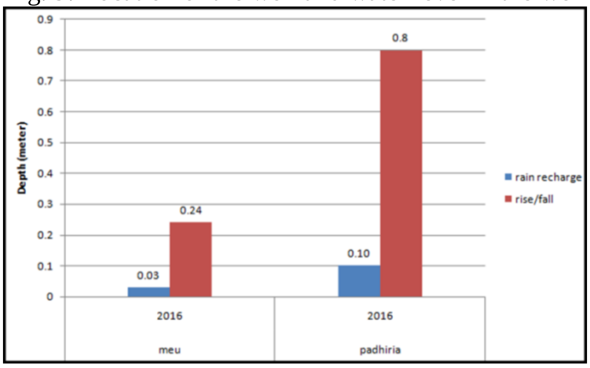

Fig. 10: Graphical representation of water table fluctuation and rain water recharge

B. Another two wells located at pali and unava (village name) on the cross section of the canal shown in fig.

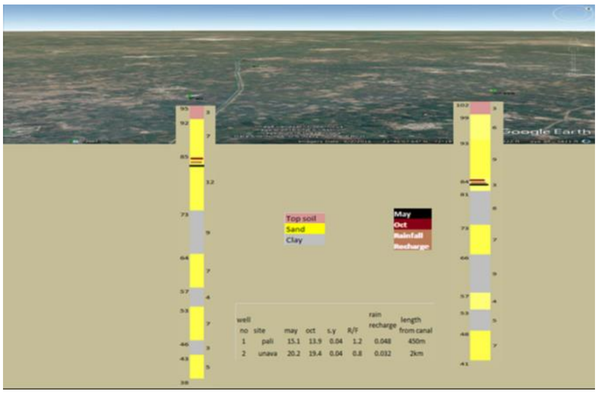

Fig. 11: Location of the well and water level in the well

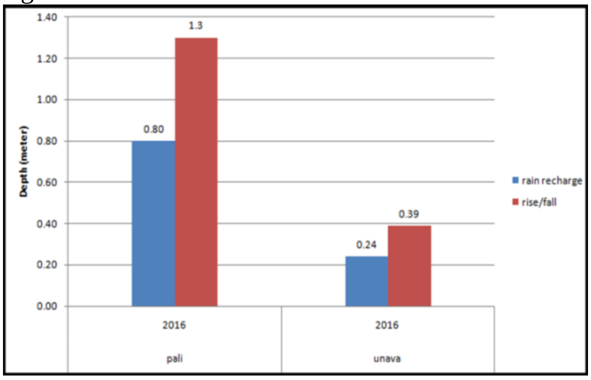

Fig. 12: Graphical representation of water level fluctuation in wells

C. Two wells located at balisana and sihi (village name) on the croos section of canal.

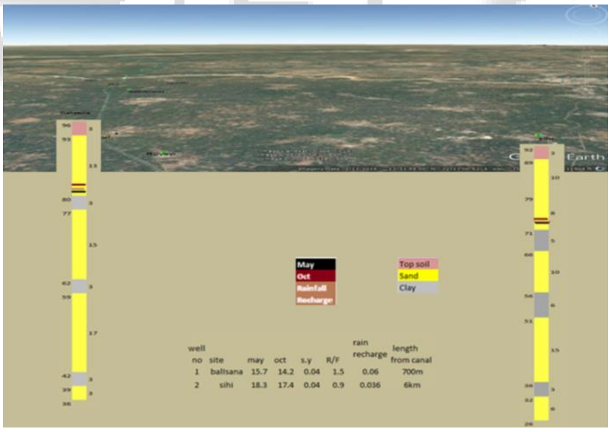

Fig. 13: location of the well and water level in the well

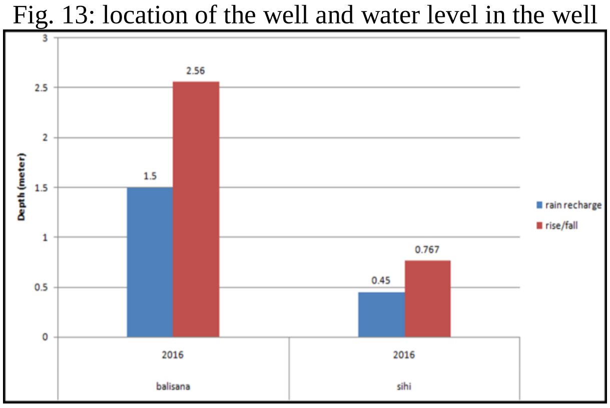

Fig. 13: graphical representation of water level fluctuation in well

IV. CONCLUSION

1) It will give the perfect amount of Recharge.
2) Potential locations with less ground water recharge are identified with the help of GIS modeling.
3) proper distribution of channels can be analysed.
4) Here, Thiessen polygon method has been implemented for modeling on GIS platform but with some more accurate method one can expect improved results.

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