GROUNDWATER MANAGEMENT THROUGH RECHARGE INTERVENTIONS : A CASE STUDY OF GUJARAT

Vivek P. Kapadia

Narmada, Water Resources, Water Supply and Kalpsar Department, Government of Gujarat, Block No - 9, New Sachivalaya, Gandhinagar, Gujarat, India

vivekpkapadia@gmail.com)

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ABSTRACT

India is a water stressed country. Regionwise scenario is different but in general surface water resources are not sufficient to fulfil the need of the country. Available sites for water storage are limited and are located in reach regions which makes it difficult to rationally distribute the available surplus water resources to the deprived regions. This compels the extraction of groundwater in the deprived regions. Even in the command areas of the dams the tail enders do not get water and hence they have to depend on groundwater. Cropping pattern has been continuously changing due to market variations and hence the regions which are not expected to grow water-intensive crops have started growing them by meeting the water demand from precious groundwater. Objective of agriculture has been changed from food production to profit-making. Urbanization and Industrialization have furthered the dependence on groundwater. The erratic rainfall sometime is the cause of depending on groundwater. In all, the reasons for dependence on groundwater are many and the overall dependence on groundwater has been at present between 50 % to 90 % in different parts of India. For last so many years that the dependence on groundwater has been on increase which has paused a serious threat of quantity and quality of water almost in the entire country and the present model of economy, agriculture and development as a whole has become a subject of reconsideration on the ground of sustainability and environmental change. The root cause of this situation is the unsustainable ways of resource management we have adopted. The paper underlines the need of paying attention at the groundwater quantity and quality of India and presents a case study of Gujarat showing the effectiveness of scientifically planned and implemented recharge interventions with detailed discussion of quantity and quality improvements in the groundwater scenario of the state. The objective of the paper is not limited to discussion on issues but underlining the significance of the efforts to address them and their results so that the future course could be corrective and is approached early to save the future of the entire country.

1. GROUNDWATER : INDIAN SCENARIO

World Bank has given in brief a real picture of groundwater scenario of India in its paper - "India Groundwater: a Valuable but Diminishing Resource" as following.

- If current trends continue, in 20 years about 60% of all India’s aquifers will be in a critical condition.
- India is the largest user of groundwater in the world. It uses an estimated 230 cubic kilometers of groundwater per year - over a quarter of the global total.
- More than 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater.

The World Bank suggests that a complex web of factors determines groundwater extraction: the size of landholdings, density of population, water-intensity of crops planted, water users’ behavior, legislation and administration of groundwater, power subsidies for pumping irrigation water, and economic policies.

India has been receiving good monsoons for last over 10 years with an exception of the year 2012 but somehow the groundwater scenario is becoming worse every year. If studied only one year i.e. 2014, the scenario for all the years in the near past being almost similar, the phenomenon could be well understood. Figure-1 shows the monsoon of the year 2014 which gives an idea that about 70% of the area of the country received average rainfall.

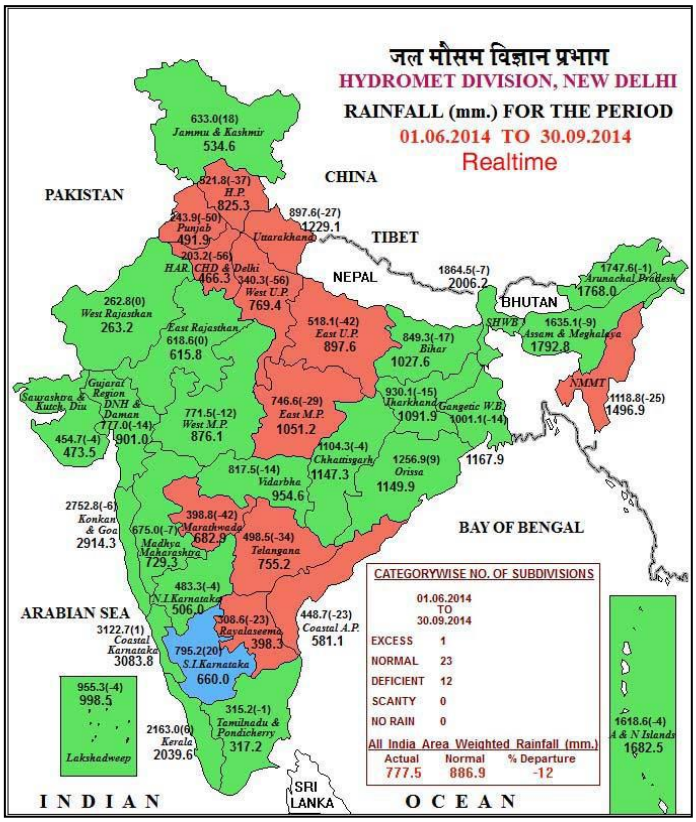

Figure 1. Monsoon of 2014

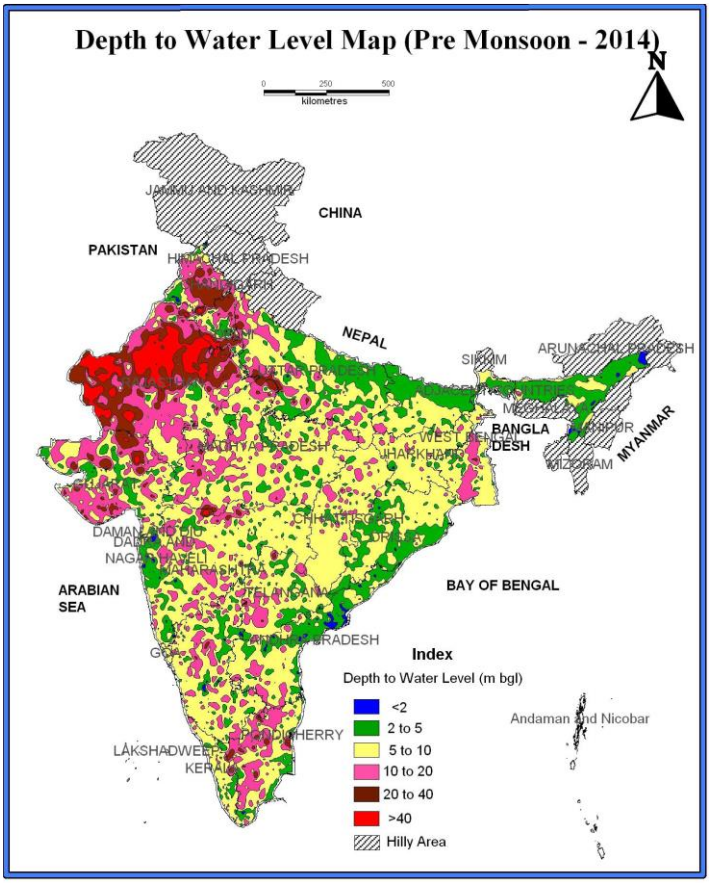

Figure 2. Depth of water levels - Pre-monsoon 2014

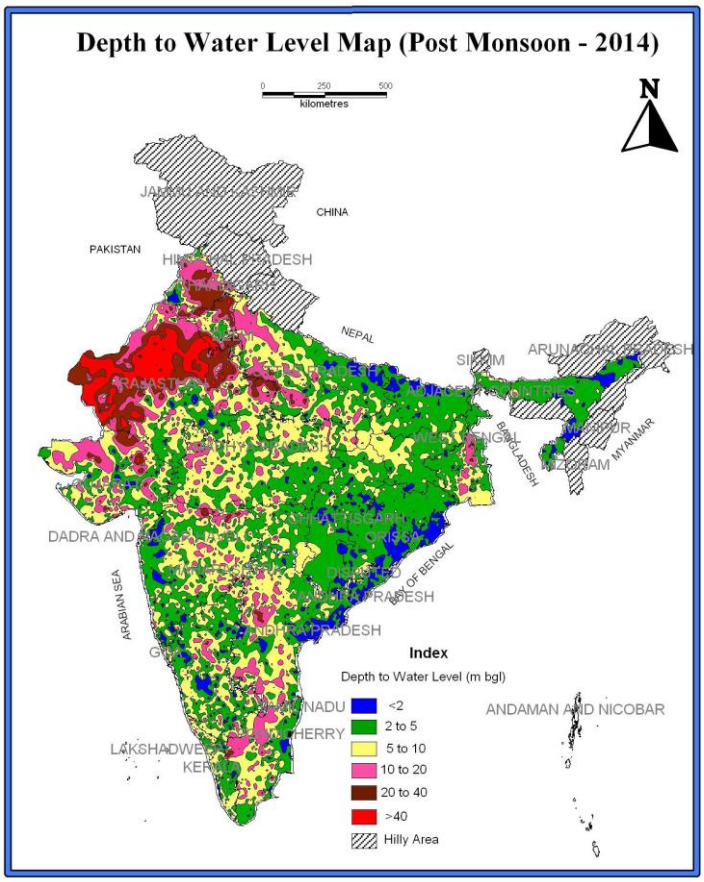

Figure 3. Depth of water levels - Post-monsoon 2014

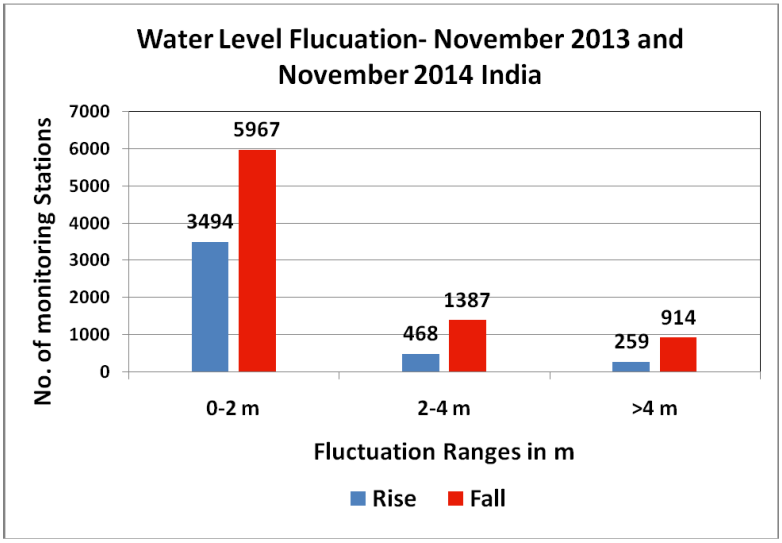

Figure 4. Water level fluctuations - Pre-monsoon and Post-monsoon 2014

Figure-2 and Figure-3 if compared, it could be understood that the areas where there was average rainfall during monsoon, the depth of groundwater could not improve much. Figure-4 suggests that rise in groundwater levels has been observed in less number of observation stations than those with fall. This means that the water level fell in a larger area than the area wherein it rose. Thus, more and more area comes under critical situation from groundwater point of view every year.

2. A PEEP IN TO OVERALL WATER PERSPECTIVE OF GUJARAT - NEED OF INTERVENTION

Gujarat is divided in to four regions - South Gujarat which also includes Central Gujarat, North Gujarat, Saurashtra and Kachchh as shown in Figure-5. South Gujarat is water reach and is also having clayey soil, North Gujarat is water stressed and having alluvial soil, Saurashtra is facing shortage of water and having a mix of black cotton soil with kankar whereas Kachchh is having sandy soil and a large area of dessert. Coastal length of Gujarat is the highest in India which is 1664 kilometers.

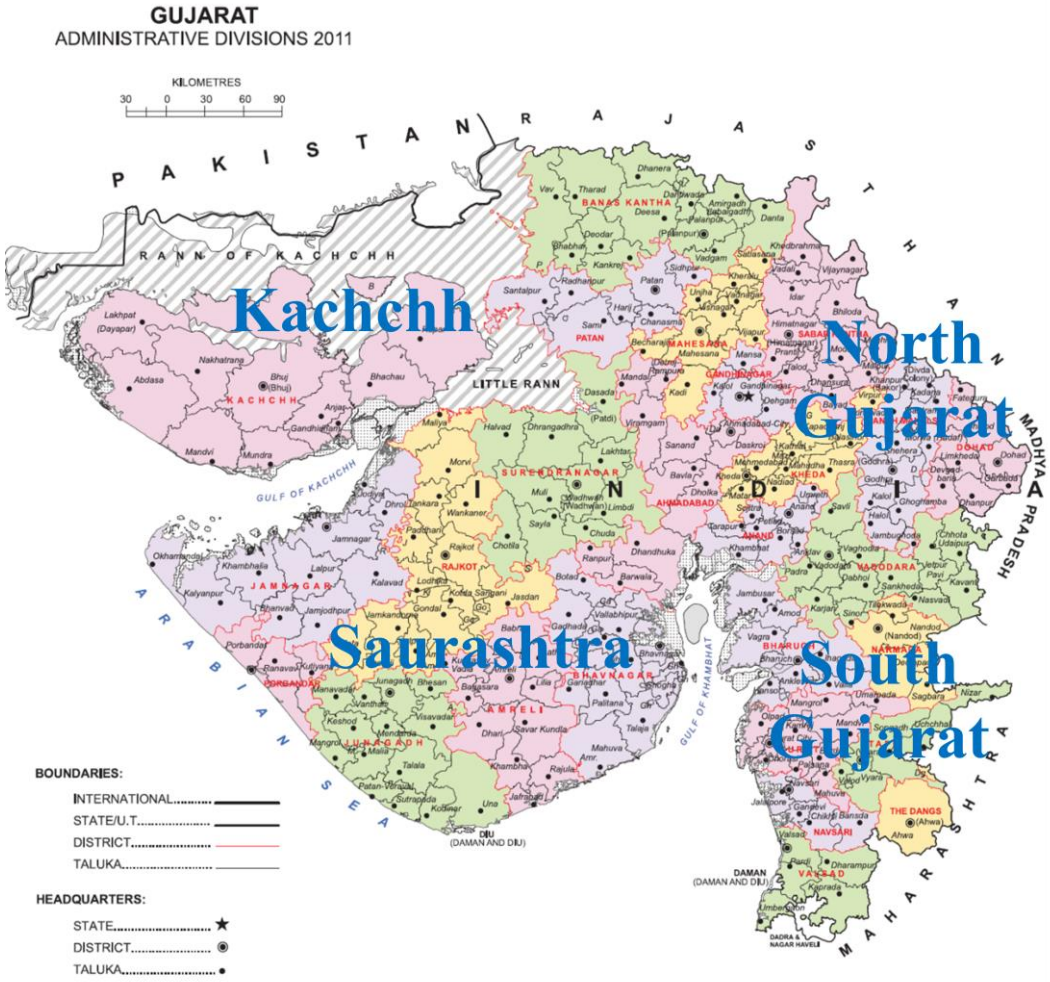

Figure 5. Regions of Gujarat

Gujarat was not much different in the groundwater scenario from other parts of the country till 2005. Even at present it has more than 11,18,000 wells to draw groundwater in 18,000 villages. This shows the level of dependence on groundwater. Overall scenario of Gujarat i.e. surface water and groundwater is shown in Table-1.

Table 1. Surface water scenario of Gujarat

REGION	AREA IN % OF GUJARAT	SURFACE WATER Mm^3	GROUND WATER Mm^3	TOTAL WATER Mm^3	PER CAPITA AVAILABILITY m^3 PER ANNUM
South and Central Gujarat	25	31750	3950	35700 (71 %)	1695 *(1880)
Saurashtra	33	3600	4300	7900 (16 %)	487 *(540)

North Gujarat	20	2100	3300	5400 (11 %)	309 *(343)
Kachchh	22	650	450	1100 (2 %)	658 *(730)
Total	**100**	**38100**	**12000**	**50100 (100 %)**	**893 *(990)**

* Indicates figures based on 2001

Except South and Central Gujarat there has been scanty water in the entire state. If compared the per capita water availability, it is clear that from 2001 onwards there is a significant reduction. This is because of population growth and development of industries. Quality of groundwater has also been an issue in Gujarat. Electrical conductivity, Chloride, Nitrate and Fluoride are the parameters on which the quality of groundwater is monitored regularly. When quantity and quality of groundwater were declining, some intervention became a must. Gujarat started from a very bad scenario and worked among many challenges.

3. RECHARGE INTERVENTION AND ITS EFFECTS

Saurashtra and North Gujarat are having acute shortage of water which can be seen from the per capita availability were selected for the intervention.

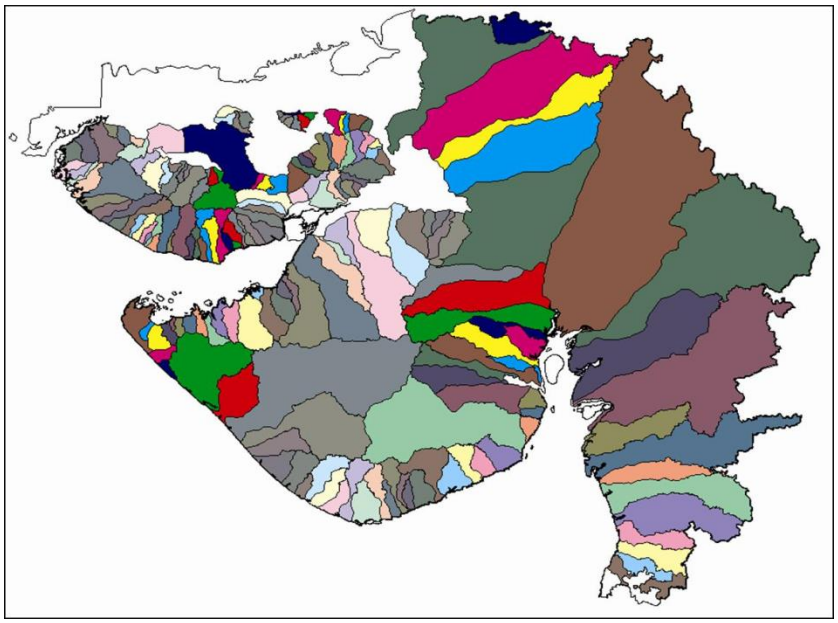

Figure 6. River Basin Map of Gujarat

Table 2. Surface water scenario of Gujarat

Name of Region	**Annual Rainfall in mm**	**No. of River Basins**
North, Central and South Gujarat	800 to 2000	17
Saurashtra	400 to 800	71
Kachchh	Less than 400	97

Figure-6 shows that in Saurashtra there are many river basins but small and in Kachchh they are very small. Table-2 shows that rainfall and number of river basins are inversely proportionate in Gujarat and therefore in Saurashtra and Kachchh rivers are many but small and non-perennial.

While working on the solution part, it was observed that Saurashtra had a rocky bedrock and semi-mountainous topography and therefore the rivers and their tributaries had a tendency to flow with high velocity and hence they used to become dry soon after the monsoon was over. The Government of Gujarat decided to construct small checkdams across the streams and big checkdams across the medium sized rivers. The main objective was to provide protective irrigation for Kharif and to plan the distributed resource management. Saradar Patel Participatory Water Conservation Programme was launched with 60:40 basis in which 60 % of the cost of each checkdam was to be borne by the Government of Gujarat and 40 % by the beneficiary farmers' group or Water Users' Association. The idea behind this arrangement was that generally 60% of the total cost was for the materials and the rest for the labour and hence the material cost would be supported by the Government and the labour was expected to be taken care of by the beneficiaries. This would instil a feeling of belongingness amongst the people. It was launched in 2001 and in 5 years, about 40,000 checkdams were constructed with people's participation. The industries were also approached to extend their support and spend their Social Responsibility Funds and they constructed 120 big checkdams across the medium sized rivers in 3 years. The checkdams were designed to ensure no encroachment on riparian rights of the people in the downstream. The design for each checkdam was given by the Government of Gujarat and the construction was done by the Water Users' Association or industry. In North Gujarat, ponds were deepened on large scale as the topography was flat and the soil alluvial.

Figure 7. Checkdam across a medium sized river

The results in the period after 2005 are worth studying. The monsoon of the year 2012 was really subnormal and hence studying the results of May 2013 that could provide the most reliable measure of effectiveness of the recharge interventions executed earlier. Following important points emerge from study of the Figure-8 to Figure-11.

- Most part of Saurashtra and North Gujarat had fresh or marginally brackish water even in a meagre recharge condition and that too in May which is the most critical part of the year. If Electrical Conductivity is less than 1500 µS/cm, it is considered as fresh and if between 1500 to 15000 µS/cm, brackish.
- More than 90 % of the area of Saurashtra and North Gujarat had Chloride within limit. Saurashtra is having so long the coast and still a good scenario is really praiseworthy. The limit of Chloride for drinking purpose is 250 mg/l which can be extended to 1000 mg/ l where no alternative source of water is available.
- Nitrate concentration was an issue only at a few places. The desired limit of it is 45 mg/l.
- In Saurshtra, only at few places fluoride was beyond limit but the North Gujarat was having a large scale issue of fluoride. An upper desirable limit for fluoride is 1.0 mg/l. Because of

the depth of groundwater in North Gujarat, i.e. more than 80 meter the issue of fluoride is critical.

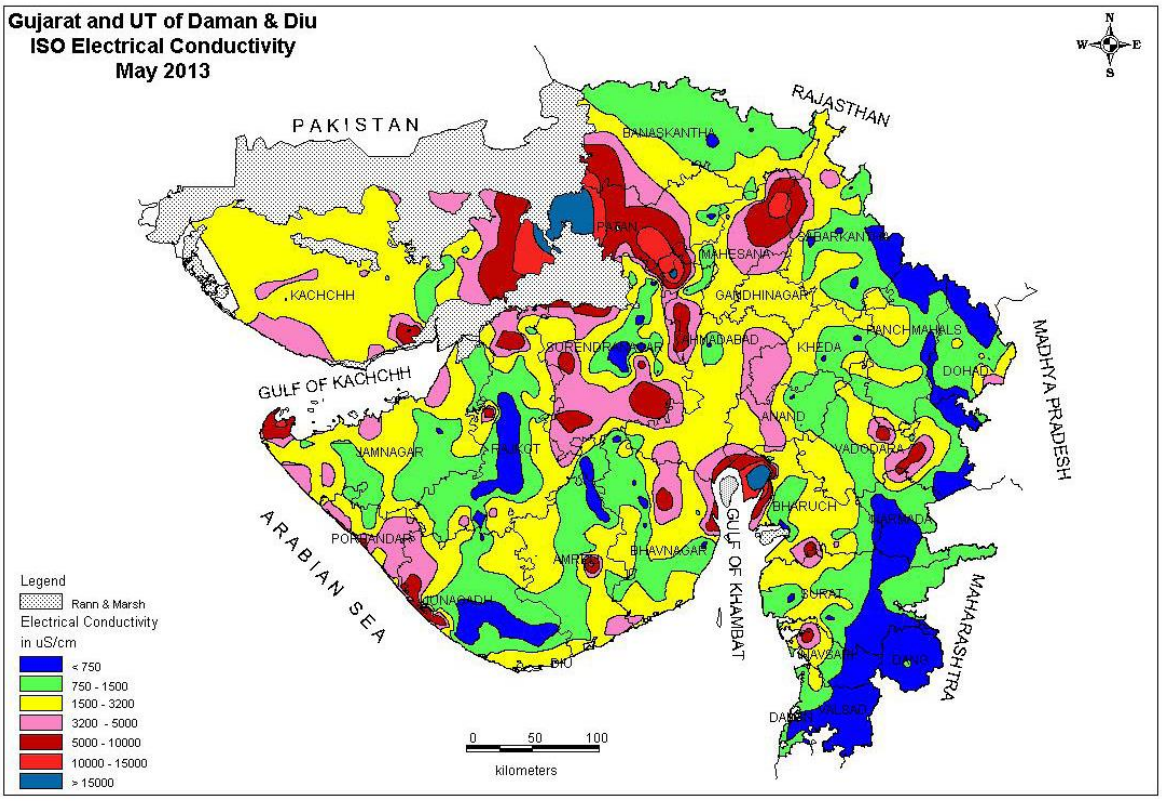

Figure 8. Electrical Conductivity in May 2013

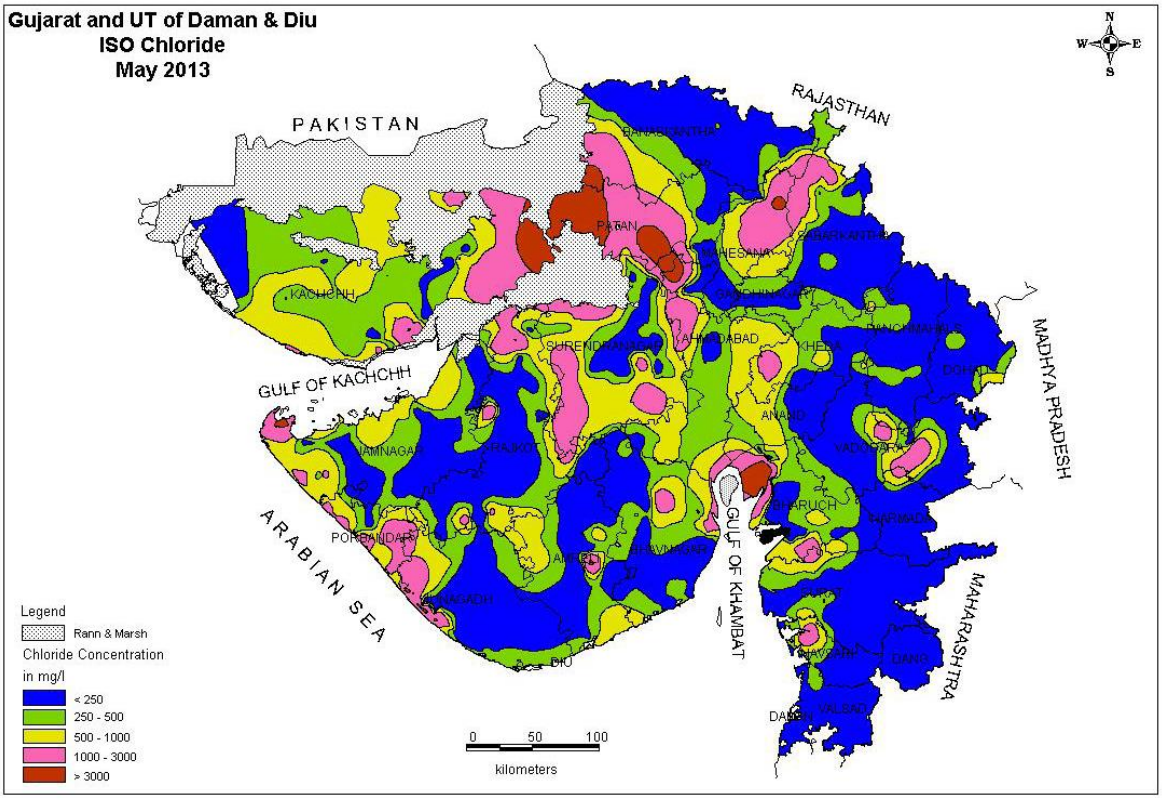

Figure 9. Chloride in May 2013

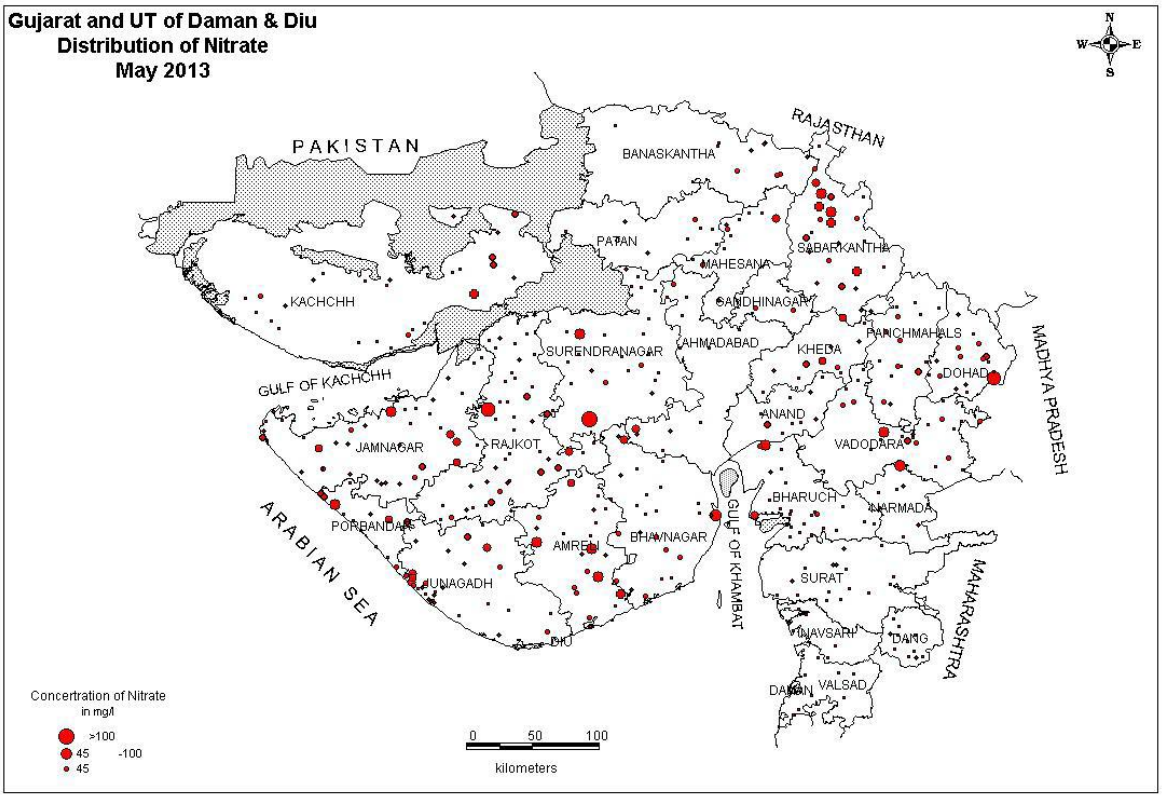

Figure 10. Nitrate in May 2013

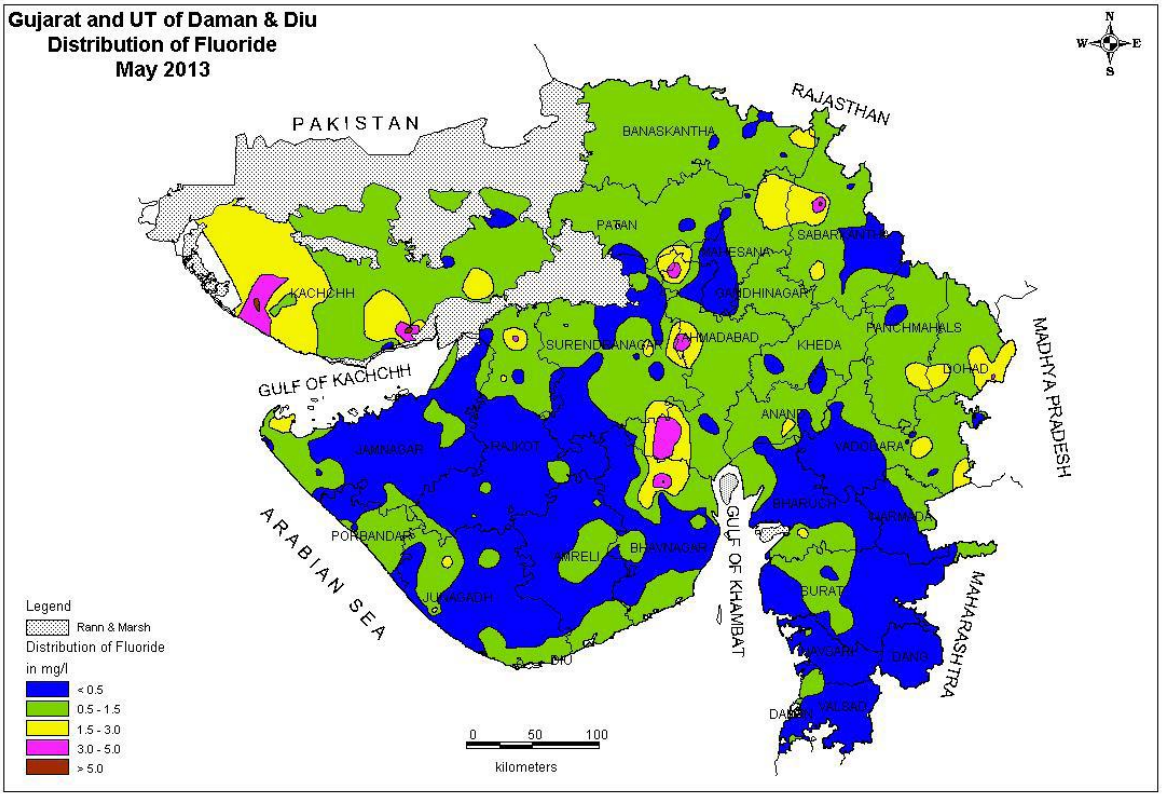

Figure 11. Fluoride 2013

Table-3 clealry shws that the demand-supply imbalance is gradually improving in Gujarat. Over-exploited blocks and critical blcoks are decreasing, saline blaocks are also decreasing and in contrast the safe blocks are increasing. This is the net results of the sensibly planned recharge interventions. The intense efforts from 2001 to 2005 have led to this effect.

Table 3. Enhancement in Groundwater Scenario

YEAR	Over Exploited Blocks (G.W. Development Above 100%)	Critical Blocks (G.W. Development Between90% and 100%)	Semi-Critical Blocks (G.W. Development Between 70% and 90%)	Safe Blocks (G.W. Development Below 70%)	Saline Blocks (G.W. T.D.S above 2500 ppm)
1997	35	13	45	122	9
2002	30	13	62	105	14
2007	26	8	51	125	14
2009	27	6	50	127	14
2011	24	5	13	172	10
2013	22	6	9	177	10

4. CONCLUSION

Recharge interventions have produced encouraging results in Saurashtra and North Gujarat. If sensibly designed interventions based on proper engineering are executed, they lead to success. However, in North Gujarat, high level of fluoride due to much depth of ground water level suggests further efforts for more recharge. If such efforts are designed considering the local situation in different parts of India, the situation can improve.

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