Dwindling Ground Water Sources & Deteriorated Water Quality the Major Menace of Sustainable Development of Rajasthan

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Abstract **- Ever increasing demands of water for domestic, irrigation as well as industrial sectors have created water crisis worldwide. Unfortunately, Rajasthan is the most water deficit state of our country, where each drop of water is as precious as diamond. Increased demographic pressure and societal advancement result in acute water shortage for drinking, agriculture and industrial purposes. Rajasthan is the largest state of India covering 10.4% of the total area of the entire nation. On the other hand, the State is having only 1.15% of total water resources of the country to cater the needs for about 5.5% of the nation's population. Ground water is the only dependent source in larger part of the state except a few district areas, where canal water or surface sources are also available. Deeper water levels and inferior quality of ground water (highly saline, enriched with high nitrate and fluoride) followed by periodic occurrence of droughts and famines further deteriorates the situation putting tremendous pressure on limited available fresh water aquifers. Though the state is endowed with lot of good cultivable land but inadequate rainfall and lack of water resources from other sources hamper good agriculture production. Industrial development also greatly suffers for want of water at suitable locations. As results of increase in hydro-chemical parameters, lives of human beings, flora and faunas have been adversely affected which inturn have affected their socio-economic status. Therefore, for sustainable development proper management efforts must be made viz. maximum utilization of rain water by reviving and strengthening traditional water harvesting structures, proper soil conservation measures by afforestation, watershed development, artificial recharge of ground water, Dry farming, drip and sprinkler irrigation techniques have to popularized to minimize use of water for irrigation, installation of reverse osmosis plants, De-fluoridation plants and above all it is exigence to educate and create mass awareness amongst consumers of water for its judicious use.**

I. INTRODUCTION

The largest state of the country, i.e. Rajasthan, is a state of geographical and climatic diversities. About two third area of the state is desert, lying in the world famous Thar Desert. Ground water is the major factor in the agricultural economy of Rajasthan as more than 70 percent of the irrigation demand is met by ground water at present as compared to only 52 percent in the early 1960s. The uncontrolled extraction of ground water and low ground water recharge due to changed rainfall pattern, shrinkage in rechargeable area and loss for surface run-off lead to a continuous decline in ground water table and changes in the natural geochemistry of ground water. This decline in water table has, inturn, led to the drying up of open wells and increasing well failures1 causing higher costs of installing new wells, deepening causing wells, pumping and other maintenance activities2. Competitive deepening of wells or installing deep tubewells makes the distribution of access to ground water increasingly skewed in favour of large and resource rich farmers leaving the resource poor farmers out of the race3.

The present drinking water scenario is also quite grim despite of the fact that both Central and State Governments are pumping the heavy financial resources. The overall stage of ground water development is presently 137.94%. Quality wise, more than 25% of the ground water sources have multiple problems, 16% have excessive fluorides, 15% have excess nitrates and over 9% have excess salinity, thus leaving merely 35% sources as potable. Overall it has 74% country's total habitations affected with two or more quality parameters. There are more than 16,550 fluorosis affected villages in the state out of 32, 211 in the whole country which is more than 50%. Similarly, there are, more than 14,415 salinity affected village out of 33,552 in the whole country which is 42%. Likewise, the situation for nitrate toxicity is also very formidable. Periodic occurrence of droughts and famines further aggravated the problem. Therefore, for sustainable future, judicious use of this nature's gift is mandatory. In the present communication status of ground water sources in the state, their quality problems and remedial measures are discussed comprehensively.

Ground Water Status of Rajasthan:

(A) Physiography, Drainage & Hydrogeology :

Ground water resources of the state are most precious although these form only 2.9% of the total ground water resources of the country. Ground water is the only dependable source of water in the larger area of the State. More than 90% drinking water schemes and 74% of irrigated area in the state is dependent on ground water. Inferior quality of ground water with high salinity, fluoride and nitrate contents further limits the availability of fresh water assets. Besides the ground water is being polluted in many areas due to indiscriminate disposal of industrial waste and urban wastewater and solid waste. Excess use of chemical fertilizers is also detrimental to water quality. These human activities have further reduced available limited ground water resources.

Rains are the main source of recharge to ground water body. The average annual rainfall in the state is varying from

140 mm (Ramgarh, district Jaisalmer) to 1571 mm (Mt. Abu). The rainfall in the state gradually decreases from South East towards North East. However rainfall pattern is very erratic with high variability, which leads to very frequent droughts affecting mass population as well as livestock for drinking water, food and fodder. Consecutive drought spells of 2 to 3 years often occur in the state. Cumulative effects of all these factors have made Rajasthan as the most water Crisis State of India. Annual Potential Evapotranspiration is also very high varying from 1263 (Banswara) to 2062 mm (Jaisalmer) with maximum temperature reaching upto 490 C in peak summer.

North East-South West trending Aravalli hill range serves as major watershed dividing western Thar Desert and eastern Rajasthan plains. The State occupies a wide spectrum of geomorphologic features of Aravalli hill range. Eastern plains, Vindhyan scarp land – Deccan plateau and western Thar Desert. General elevation of Aravalli ranges varies from 300 to 1722 m amsl.

Luni river is the only integrated ephemeral river system in Western Rajasthan whereas eastern Rajasthan is drained by the Chambal, Mahi (both perennial) and ephemeral rivers viz. Banganga, Barah, Sota, Sahibi, Banas etc. Indira Gandhi Nahar, and Gang canal have been constructed to bring Himalayan water to the desert areas of Western Rajasthan to create irrigation facilities and for drinking purpose. Other major canal commands in the State are Chambal command, Mahi command and Narmada command areas. A number of salt lakes like Sambhar, kuchaman, Pachpadra, Lunkaransar etc occur in the state. These are characteristic feature of arid area. Large areas of western Thar desert is the area of internal drainage called outside basin. Small rivers and streams originating in this area disappear after a short distance in sands or in depressions. As such no well-defined drainage exists in such areas due to low rainfall. The rare heavy continuous rainfall/cloudbursts often causes disaster like situation due to water stagnation.

The Geological framework of the state is comprised by oldest archaean rocks to recent alluvial sediments and Aeolian sand formations. Bhilwara supergroup, Aravalli, Delhi supergroup formations and igneous intrusive constitute main Aravalli ranges and terrain. The south eastern part of the state is occupied by Vindhyan sedimentary rocks. Marwar super group sedimentary formation occur in western part of the state. Further younger Mesozoic and tertiary formations comprising Sandstone, shales and clays occur in further western and Northern parts of the state. Mesozoic extrusives Deccan traps occur in south eastern margin of the state. Alluvial and wind blown sediments covers a large area in north eastern and western part of the state.

Rajasthan witness diversified hydro-geological conditions. Groundwater occurs in unconsolidated (Quaternaries), semi-consolidated (Tertiary sandstone, Lathi sandstone etc.) and consolidated rock formations. However, Quaternary alluvium, Lathi sandstone, Palana sandstone, Borunda limestone and Jodhpur sandstone at places are some of the prominent aquifer systems available in the State. Nearly 45 percent area of the state of Rajasthan is occupied by the hard rocks consisting of the Archaean crystallines (Bhilwara Super Group) and Proteorozoic rocks comprising of Aravalli and Delhi Super Groups, Erinpura granite, Malani Igneous suit of rocks and their equivalents along with Marwar & Vindhyan Super Groups of rocks and Deccan traps. The igneous and metamorphic rocks ranging in age from Archaean to Upper Proterozoic have negligible Primary porosity. Significant secondary porosity is introduced into them locally due to tectonic activities, weathering and fracturing. In the most part of crystalline formations of Archaean to Upper Proterozoic have negligible Primary porosity. Significant secondary porosity is introduced into them locally due to tectonic activities, weathering and fracturing. In the most part of crystalline formations of Archaean to Upper Proterozoic age, the yield of wells/tube wells are generally poor. Some of the Vindhyan sandstone and Limestone occupying parts of Kota, Jhalawar Bundi, Chittaurgarh, Jodhpur and Nagaur district (mainly Marwar and Vindhyan Super Groups of rocks) are found locally promising for tapping moderate to plentiful supplies of ground water due to their porous and permeable nature locally. The Deccan trap shows low permeability. Valley fill deposits along the river floodplain areas often contain highly productive alluvial aquifers although their potentiality and extension is limited. The yield of wells in hard rocks ranges from 5 m3/hr to about 25 m3/hr. Higher yields are obtained from wells tapping sandstone and limestone at places. The unconsolidated formations (both alluvium and wind born Aeolian sand) occupy the major part parts of the state. Semi consolidated sediments comprising the tertiary and Mesozoic formations occur only in parts of western Rajasthan. The alluvium contains the most productive aquifers in the state. The thickness of alluvium varies from 40 to 130 m in eastern Rajasthan whereas its thickness upto 330 m. is found in parts of western Rajasthan. Ground water occurs under unconfined to semiconfined conditions in alluvium. In parts of Bharatpur, Jalore and Barmer confining conditions also occur. The alluvial formations in parts of Jalore, Sikar, Hanumangarh and Bharatpur has high ground water potential of >40 m3/hour. Among the semi consolidated formations, the Lathi sand stone in Jaisalmer district, Palana sandstone in Bikaner Basin and Tertiary sandstone in parts of Barmer district are found to contain moderate to highly productive aquifers which is source of water supply in these desert areas.

Depth to water level in the State widely varies from water logging conditions to as deep as 130 m. In the eastern side of Aravallis, the depth to water table is comparatively shallower (20-50 m bgl generally) than that in the western side (30 to 90 m bgl generally). In southern and south eastern parts depth to water generally varies from 10 to 30 m bgl. In eastern Rajasthan due to over-exploitation the water levels have gone down even upto 60 m bgl. Water table is shallow in IGNP, Chambal and Mahi canal command areas. The Aravalli hill ranges serve as major water divide in the state. The water table in general slopes towards west in the western Rajasthan were as it slopes towards east and south in eastern part of the state. However, local variations are common both in the direction and movement of ground water. Over exploitation and excess use of ground water has led to substantial decline in water levels, which may ultimately result to drying up of aquifers in larger areas of the state. Deepest water table were observed in Bikaner and Jaisalmer districts.

(B) Ground Water Level Trends in Rajasthan:

Districtwise and blockwise long term water level trend in the state has been computed on the basis of water level fluctuation between the period pre-monsoon, 1984-2012 and short term trend has been computed on the basis of water level fluctuation between the period pre-monsoon 2011-2012 (observed from well distributed network of keywells comprising dugwells and piezometers). The districtwise change in water level between pre-monsoon 1984-2012 and pre-monsoon 2011-2012 are depicted in Table-1 & Table-2 respectively.

TABLE-1 : DISTRICTWISE CHANGE IN WATER LEVEL BETWEEN PRE-MONSOON 1984-2012

S. No.	District	Average Water Level (m)		Average Change in water level (m)
		Pre'84	**Pre'12**	**Pre'12 - Pre'13**
1	AJMER	7.91	16.62	-8.71
2	ALWAR	11.11	24.63	-13.52
3	BANSWARA	6.46	7.73	-1.28
4	BARAN	7.63	11.99	-4.36
5	BARMER	33.74	42.66	-8.92
6	BHARATPUR	6.92	11.48	-4.56
7	BHILWARA	9.81	14.85	-5.05
8	BIKANER	71.44	74.82	-3.38
9	BUNDI	9.04	13.28	-4.24
10	CHITTORGARH	11.11	16.09	-4.98
11	CHURU	49.18	54.26	-5.08
12	DAUSA	11.80	26.53	-14.73
13	DHOLPUR	8.71	13.66	-4.95
S. No.	**District**	**Average Water Level (m)**		**Average Change in water level (m)**
		Pre'84	**Pre'12**	**Pre'84 - Pre'12**
14	DUNGARPUR	7.45	11.54	-4.09
15	GANGANAGAR	16.51	10.56	5.95
16	HANUMANGARH	20.11	14.94	5.17
17	JAIPUR	11.69	30.66	-18.97
18	JAISALMER	60.13	61.97	-1.83
19	JALORE	13.02	31.02	-18.00
20	JHALAWAR	8.12	10.90	-2.79
21	JHUNJHUNU	30.50	45.86	-15.36
22	JODHPUR	31.44	42.37	-10.93
23	KARAULI	11.22	18.67	-7.45
24	KOTA	8.49	14.53	-6.04
25	NAGAUR.	27.93	45.92	-17.99
26	PALI	12.58	23.83	-11.25
27	RAJSAMAND	10.29	15.90	-5.62
28	SAWAI MADHOPUR	9.43	18.77	-9.34
29	SIKAR	27.85	41.23	-13.38
30	SIROHI	11.91	18.66	-6.75
31	TONK	7.12	13.65	-6.53
32	UDAIPUR	9.52	12.40	-2.88
Average		**18.13**	**25.37**	-7.24

TABLE-2 : DISTRICTWISE CHANGE IN WATER LEVEL BETWEEN
PRE-MONSOON 2011-2012

S. No.	District	Average Water Level (m)		Average Change in water level (m)
		Pre'11	Pre'12	Pre'11 - Pre'12
1	AJMER	15.68	16.62	-0.94
2	ALWAR	23.82	24.63	-0.81
3	BANSWARA	6.37	7.73	-1.36
4	BARAN	11.43	11.99	-0.56
5	BARMER	41.43	42.66	-1.23
6	BHARATPUR	11.74	11.48	0.25
7	BHILWARA	13.37	14.85	-1.48
8	BIKANER	73.52	74.82	-1.30
9	BUNDI	12.93	13.28	-0.34
10	CHITTORGARH	15.66	16.09	-0.42
11	CHURU	54.02	54.26	-0.24
12	DAUSA	25.70	26.53	-0.83
13	DHOLPUR	16.48	13.66	2.82
14	DUNGARPUR	8.54	11.54	-2.99
S. No.	District	Average Water Level (m)		Average Change in water level (m)
		Pre'11	Pre'12	Pre'11 - Pre'12
15	GANGANAGAR	11.01	10.56	0.44
16	HANUMANGARH	15.19	14.94	0.24
17	JAIPUR	29.90	30.66	-0.76
18	JAISALMER	61.26	61.97	-0.71
19	JALORE	28.24	31.02	-2.77
20	JHALAWAR	10.88	10.90	-0.02
21	JHUNJHUNU	43.95	45.86	-1.91
22	JODHPUR	41.75	42.37	-0.63
23	KARAULI	17.66	18.67	-1.01
24	KOTA	13.08	14.53	-1.45
25	NAGAUR.	44.90	45.92	-1.02
26	PALI	21.03	23.83	-2.80
27	RAJSAMAND	12.58	15.90	-3.32
28	SAWAI MADHOPUR	18.08	18.77	-0.70
29	SIKAR	40.24	41.23	-1.00
30	SIROHI	14.16	18.66	-4.51
31	TONK	13.58	13.65	-0.07
32	UDAIPUR	10.68	12.40	-1.72
Average		**24.34**	**25.37**	**-1.04**

The perusal of Table-1 & 2 reveals that depletion in ground water level is very significant in the state. 30 districts in the state shows depleting trend of ground water level. On the basis of average depletion these districts have been further classified as Most critical, Critical and Moderate. Their details are given below :

MOST CRITICAL – This category is indicative where average depletion is more than 10 m. 9 districts namely Alwar, Dausa, Jaipur, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali and Sikar districts fall in this category.

CRITICAL - The category is indicative where average depletion is between 5 to 10 m. 10 districts namely Ajmer, Barmer, Bhilwara, Churu, Karauli, Kota, Rajsamand, Sawai Madhopur, Sirohi and Tonk districts fall in this category.

MODERATE – In this category average depletion is between 0 to 5 m. 11 districts come under this category namely Banswara, Baran, Bharatpur, Bikaner, Bundi, Chittorgarh, Dholpur, Dungarpur, Jaisalmer, Jhalawar and Udaipur district.

The analyses of short term water level fluctuation between the period pre-monsoon 2008 – 2009 in various districts have been computed. It reveals that the 4 districts namely Dholpur, Bharatpur, Sri Ganganagar and Hanumangarh show rise in water level. In Dholpur district water level rise is due to heavy rainfall (1133.15 mm) during the year 2008 instead of Normal Annual Rainfall of 688.99 mm which was 64.46% higher than the Normal Rainfall, which causes recharging the ground water significantly so rise in water level is observed. In Bharatpur district there is marginal rise in water level in this period which is due to good rainfall (803.83 mm) during the year 2008 instead of Normal Annual Rainfall of 658.32 mm which was 22.11% higher than the Normal Annual Rainfall. However, rise in water level in Ganganagar and Hanumangarh district is due to seepage of canal system.

Remaining 28 districts shows depletion of water level in this period. (Table-2)

Analysis of the data indicates that the ground water level has depleted in the major part of the State. The impact of depletion has caused shrinkage of ground water resources potential in the State. More and more blocks have come under “Over-exploited” and “Critical” category with steep drop in number of “Safe” category.

The prime cause of depletion in ground water level is supposed to be the uncontrolled withdrawal of ground water to meet out every growing demand for agriculture, domestic sand industrial purposes through huge number of structures in potential areas. The sustainability of vagaries of rainfall has further given prey to the unplanned development. The ultimate consequence of this is the shrinking of ground water resources due to which the wells are getting dry, deterioration in chemical quality and increase in lifting cost. Highest depletion in ground water table was observed in Jalore district and lowest was in Banswara district.

As per Ground Water Resource Estimation the overall ground water resource position of the state is as under :

Net annual ground water availability	10,563.01mcm
Ground water Draft	14,570.40 mcm
Present ground water balance	-4007.48 mcm
Stage of ground water development	137.94%

Categorisation

a. Safe	30 blocks
b. Semi-critical	8
c. Critical	34
d. Over-exploited	164

(C) Quality of Ground Water Resources :

From developmental, environmental and health point of view quality of ground water is of immense importance. Ground Water Department, being an apex organization of the state for ground water studies has carried out systematic studies of ground water by periodically monitoring the quality of over 12,000 water samples per annum using latest analytical and instrumental techniques3.

Quality of ground water in many parts of arid Rajasthan and Bharatpur district in the eastern Rajasthan in particular, is largely saline. High fluoride hazard is found in pockets in almost all the districts with varying intensity. Problem of high nitrate and other constituents beyond permissible limits of drinking and irrigation standards also exists in some arid districts. Increased use of fertilizers and poor sewerage system in the urban agglomerate has caused high nitrates in aquifer water. Industrial pollution has also further caused deterioration in the quality of ground water.

Rajasthan is the most severely suffered state in the country wherein its habitants are affected by multiple quality problems with respect to drinking water standards. Nearly over 70% such existing villages and habitations of the country fall in Rajasthan. The percentage frequencies of various potability parameters in desert zone of Rajasthan is depicted in Table-3.

Table –3 : Percentage Frequencies of various potability parameters in ground water of desert zone of Rajasthan.

Constituents & their range	% Frequency								
	JOD	PLI	JSM	CHU	NGR	BMR	JLR	BKN	SKR
TDS (mg./l)									
0 – 1000	16.04	26.01	9.08	13.71	22.02	20.18	28.31	17.02	15.76
1000-2000	24.82	39.32	36.27	30.10	25.68	24.74	18.84	37.04	22.32
2001-5000	29.81	25.84	34.22	32.08	36.74	44.02	46.78	21.88	40.41
5001-10000	28.32	7.74	16.21	20.57	12.48	10.03	4.12	22.04	21.21
Above 10000	1.01	1.08	4.22	3.23	2.38	1.16	0.89	1.14	0.30
Nitrate (mg/l)									
0 – 20	18.92	24.32	31.81	5.14	10.64	21.27	18.72	26.02	20.08
21 – 45	23.56	31.41	26.73	9.14	20.28	10.82	19.15	19.34	12.47
45 – 100	20.63	23.69	30.22	9.71	15.32	13.25	20.85	19.04	27.22
Above 100	36.88	20.57	11.23	75.99	53.70	53.66	40.91	35.50	40.22
Fluoride (mg/l)									
0 1.0	38.88	36.12	39.72	30.29	21.01	17.72	17.87	17.01	29.87
1.01 – 1.50	30.92	33.04	40.26	30.57	25.23	35.56	15.74	26.04	38.11
1.51 – 10	29.08	29.72	19.00	37.71	49.07	46.01	63.23	55.01	30.40
Above 10	1.12	1.11	1.02	1.43	4.68	1.88	3.82	3.06	2.01

High salinity in ground water indicated by high TDS and chloride values occurs in ground water in many parts of Jaisalmer, Churu, Nagaur, Bikaner, Barmer, Bharatpur, Ganganagar & Hanumangarh districts. Highest TDS value of 29,140 mg/l was observed in ground water of Bikaner district. Generally ground water quality in hard formation areas and shallow alluvial areas is fresh in general.

Nitrate is an environmental and health hazard when nitrates are converted into nitrites which occurs generally, then toxic effects are encountered and may cause potential health hazards. The significant diseases caused by nitrate toxicity are as follows :

(a) Methaemoglobinaemia - It is a disease, which reduces capacity of blood to carry enough oxygen for proper functioning of human body. When nitrates are reduced to nitrite by microflora of intestine, nitrite reacts with haemoglobin leading to formation of methaemoglobin in which iron is in ferric (III) state, greatly lessening the capacity to carry oxygen and causing chemical suffocation. Very young children are susceptible for nitrite.

(b) Stomach Cancer – Off all the cancers, that of stomach causes the second largest number of deaths. Stomach cancer is a painful and debilitating way to die and a link to nitrate in water has been suggested. Nitrite produced from nitrate can react in the stomach with secondary anime coming from breakdown of protein to produce N-nitroso compound, which are carcinogenic so the reaction may result in stomach cancer.

(c) Effect on Livestocks - It has been observed that in many herbivorous animals excess of nitrate through fodder and drinking water causes severe ailments. Cases of abortion in cattles, sheeps and other animals have also been observed.

The extent of severity of nitrate toxicity was observed in ground water of Churu, Nagaur, Barmer, Bikaner, Jhunjhunu, Ganganagar and Hanumangarh district. Highest nitrate content of 4750 mg/l was observed in Nagaur district. Nitrate concentration in ground water is both Geogenic and due to manmade activities. Urban centres like Jaipur and Jodhpur have high nitrate problem due to pollution from unorganized sewerage and city waste disposal.

Rajasthan is an endemic state with respect to fluorosis. The ground waters of Ajmer, Alwar, Barmer, Bhilwara, Dungarpur, Dausa, Jalore, Jhunjhunu, Nagaur, Pali, Rajsamand, Sikar, Sawai Madhopur and Tonk district are enriched with high fluoride. Highest fluoride of 90 mg/l was observed in stagnant well of Nagaur district. The losses due to fluoride toxicities are enormous because excess quality of fluoride in drinking water is responsible for dental and skeletal fluorosis.

In skeletal fluorosis deformities are found in persons particularly in the limbs, flexion deformity of knee and hips. It may damages lungs, foetus and kidneys. In Didwana block of Nagaur and Rani block of Pali district, maximum fluorofic patients have been seen. Highest fluoride values in ground water of Rajasthan is given in Table-4.

Table – 4: Highest fluoride values in ground water of Rajasthan.

S. No.	District	Maximum value/ village/block
1.	Ajmer	17.4 Bharai (Kekri)
2.	Alwar	7.1 (Kishangarh)
3.	Baran	2.6 Bhaonra (Chhabra)
4.	Barmer	19.6 Nosar (Sindari)
5.	Banswara	3.8 Bilari (Sajjangarh)
6.	Bharatpur	17.0 Tilakpuri (Kaman)
7.	Bhilwara	8.1 Dhuliakhurd (Shahpura)
8.	Bikaner	16.0 Charanwala (Kolayat)
9.	Bundi	5.9
10.	Chittorgarh	7.4 Tana (Bhopalsagar)
11.	Churu	30.0 Bhimsar (Sujangarh)
12.	Dausa	10.0 Malema (Dausa)
13.	Dholpur	6.5 Bajna (Rajakhera)
14.	Dungarpur	6.2
15.	Ganganagar	9.2 Pipran (Sauratgarh)
16.	Hanumangarh	15.0 Raiko Ki Dhani (Nohar)
17.	Jaipur	9.8 Manoharpura (Shahpura)
18.	Jaisalmer	12.0 Satyaya (Jaisalmer)
19.	Jalore	14.0 Dhanpur (Jalore)
20.	Jhalawar	1.6 (Golana (Khanpur)
21.	Jhunjhunu	14.0 Nathasar (Alsisar)
22.	Jodhpur	22.0 Daikara (Mandore)
23.	Karauli	7.8 Mirzapur (Todabhim)
24.	Kota	4.8
25.	Nagaur	90 Datiad (Jayal)
26.	Pali	12.0 Gogra (Sumerpur)
27.	Rajsamand	5.9 Amratiya (Kumbhalgarh)
28.	Sawai Madhopur	6.4 Mitrapura (Bonli)
29.	Sikar	13.0 Dukia (Danta Ramgarh)
30.	Sirohi	11.6 Gola (Sheoganj)
31.	Tonk	10.0 Kareriya (Niwai)
32.	Udaipur	4.8

Socio-Economic losses : In fact the problem of fluoride has socio-economic implication as well. There are some villages in Rajasthan where no marriages have been taken place in the last several years as people from non-fluorotic villages are not ready to give their daughters to the grooms of endemic villages. In some cases wives have deserted their husbands, left the village and remarried elsewhere as they could not cope with problematic water. Generally skeletal fluorosis in villages directly affects the economy of villagers owing to health problems in man and livestocks. Consequently the affected families are facing acute financial crisis. Likewise, the dental fluorosis, not only causes delay of teeth but also adversely affect matrimonial aspect of an individual, which is also a great social problem.

II.MANAGEMENT OF PROBLEMS FOR SUSTAINABLE DEVELOPMENT

Following are some of the suggestive measures for sustainable development of arid state :

1. To overcome the load on exploitation of ground water, the practices and skills associated with traditional water harvesting devices must be encouraged. In the past, such structures were common in the district viz. Jodhpur, Nagaur, Jaisalmer, Jhalawar, Sikar and Chittorgarh, wherein the stored water was used for drinking purposes round the year.
2. Much emphasis should be given to periodic water quality monitoring and surveillance. Innovative approaches such as involving community in water quality surveillance, creating awareness about water quality must be encouraged.
3. Installation of desalination and defluoridationplants in an economically viable manner followed by their periodic maintenance.
4. Farmers should be encouraged for the use of green manure, organic manure, instead of nitrogenous fertilizer.
5. A detailed survey of water quality of all the sources should be undertaken. Potable sources should be painted with green colour and unpotable source may be painted red. The water quality status of all the sources of village should be available at panchayat samiti level.
6. Reduce the intake of fluoride by avoiding intake of fluoride rich water and food.
7. Adequate use of calcium and vitamin C in diet in fluorotic areas.
8. N.G.O.'s must be involved in such programmes for participation.
9. Awareness regarding water quality and sanitation must be enhanced through different IEC activities.
10. To combat the problem of saline or sodic water for irrigation, thin and frequent irrigation are suggested.
11. Augmentation of ground water through Roof Top Rain Water Harvesting, Artificial Recharge through S.S.B. be adopted.
12. Ground water legislation must be implemented to overcome the over exploitation of ground water.
13. Land and soil conservation measures shall have to undertaken by aforestation of clean shaved hills.
14. Adoption of dry farming, drips and sprinkler irrigation techniques to minimize use of water for irrigation.
15. Installing public tubewells, managed by village community institutions, to provide cheap irrigation water to the poor farmers, particularly in the desert region, will decrease water price and increase competition in the water market which will eventually be beneficial to the poor farmers of the state and will also help in sustainable use of scarce water because buyers have to pay by use, an hourly payment.
16. Immense need to change power policy from flat or fixed power tariff basis, as this encourages farmers to overuse their pumpsets because they do not pay by the quantity or time of electricity use, to the metered or variable power tariff basis which would strength the inducement to save on electricity bill by economizing on electricity use.

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