Irrigation Water Management in Scarcity Area of North Gujarat

[1]P. M. Joshi, [2]V. A. Patel, [3]S. K. Patel, [4]H. M. Rajgor, [5]A. R. Patel

[1, 2, 3, 4, 5] Assistant Professor,
[1, 2, 3, 4, 5] Civil Engineering Department,
[1, 2, 3, 4, 5] Sankalchand Patel College of Engineering, Visnagar, Gujarat, India.

Abstract : Water is important natural resources available for mankind. It is an essential content in every part of life on this earth. Everything is originated from water and everything is sustained by it. In north Gujarat water resources are less than the water requirement. The north Gujarat region has an average annual rainfall of 510 to 1020 mm with a high coefficient of variance over time and space and surface water is not available in sufficient quantity. Also in this region no perennial river exists. Hence ground water utilized as the main sources for agriculture, irrigation, industrial and domestic purposes. Ground water table is being reduced rate of 3 to 5 m per year, as the removal of water is more than recharge in these regions. In a view of above Gujarat faces quantity/quality contamination problem of salinity, fluoride and nitrates. North Gujarat is water scarcity region declare by the Government of Gujarat. However, scientific management of water resources with emphasis on artificial recharge or improvement in recharge system by various project of water conservation, water harvesting, cross drainage structures, linking of drains and tanks etc. in north Gujarat region by Government of Gujarat. Government of Gujarat has taken up rainwater harvesting and groundwater, recharge programs on a large scale in North Gujarat Region.

IndexTerms **- Water scarcity, Water Conservation, North Gujarat.**

I. INTRODUCTION

Groundwater has become the major source of water to meet the requirements of domestic, industrial and irrigation sectors in India in the last few decades on account of its ubiquitous occurrence, easy availability and reliability. These factors have led to its indiscriminate exploitation in some parts of the state without due regards to recharging options. This has resulted in considerable depletion of the groundwater table in some areas causing concerns for long-term sustainability. There is an urgent need for augmentation of the limited groundwater resources by taking appropriate measures including suitable management interventions. With rapid urbanization, lakes, ponds and green areas that contribute to recharge have reduced drastically. Catchment areas have been paved and reclaimed for construction. As a result, lesser and lesser percolation takes place as ground water recharge during rainfall. Each year, the area receives quite substantial amount of rainfall. But in some areas, this rainfall is unable to seep into the ground, because the land is sealed for miles with concrete buildings and network of roads. Instead, this precious rainwater rushes out through drains, nallas, and to the sea. Billions of litres of fresh water are lost unutilized each season this way. Artificial recharge to groundwater through scientifically designed structures has been proven as a viable option for augmentation of groundwater resources. It also provides an opportunity to utilize the surplus monsoon runoff which otherwise is lost to sea unutilized. The pioneering efforts of Government and NGO's have been instrumental in introducing cost-effective recharge augmentation techniques suitable for various hydrogeologic regions in the state. Gujarat has already implemented a number of pilot schemes for artificial recharge of groundwater. However, a lot remains to be done to implement cost effective and mass scale recharge augmentation structures across the length and breadth of the state.

Excessive drawl of ground water for irrigation, industrial and drinking water needs in the water scarce areas of Kachchh, Saurashtra and North Gujarat, has resulted in reduction of confined aquifer level at a rate of more than 5 meters per year. The declining ground water levels also have a serious impact on water quality as the water from deeper aquifers usually carries higher concentrations of minerals like Fluoride, Nitrates and Dissolved solids. Excessive fluoride in groundwater is already a major problem in large parts of Saurashtra and North Gujarat. High level of Total Dissolved Solids (TDS) is found in Kachchh and Mehsana district. In Mehsana districts almost half of the villages reported fluoride problems. The problem of high fluoride increased up in the North Gujarat region, particularly in Kheralu Taluka within the last few decades, its origin involved prevalence of a more arid climate and recent exploitation of groundwater recharged during the past and climatic phases. [7] Excessive Fluoride and high concentration of Total Dissolved Solids in groundwater has adverse impact on both agricultural productivity and community health. In this paper global, Indian and Gujarat State water scenario, pilot schemes for artificial recharge of groundwater in Mehsana Taluka is discussed.

II. GLOBAL WATER SCENARIO

As we know the world as a blue planet as 70 % of the earth's surface is covered with water. The reality, however, is that 97.3 % of the total water on earth is saline and only 2.7 % is available as fresh water out of which about 79 % of this fresh water is locked up in polar regions, glaciers and permanent snow. 20 % of the fresh water occurs as ground water of which 11 % is considered to occur at depths exceeding 800 m below the ground, which cannot be extracted economically with the technology presently available. About 9 percent of the resources are available as extractable ground water within 800 m depth and about 1 % is available as surface water in lakes and rivers. Thus, the easily accessible fresh water is only about 0.027 % of the total water available around us. Even this quantity of available fresh water would certainly be adequate to meet demand if supply were distributed equally across the world's population. There is considerable variation in availability of water from region to region and country to country. Out of the 113,000 BCM of rain and snow received on the earth, evaporation losses account for about 72,000 BCM, leaving a

balance of about 41,000 BCM, out of which about 9000-14000 BCM is considered utilizable. Percentage wise Distribution of Global Water shown in Fig. 1. [2]

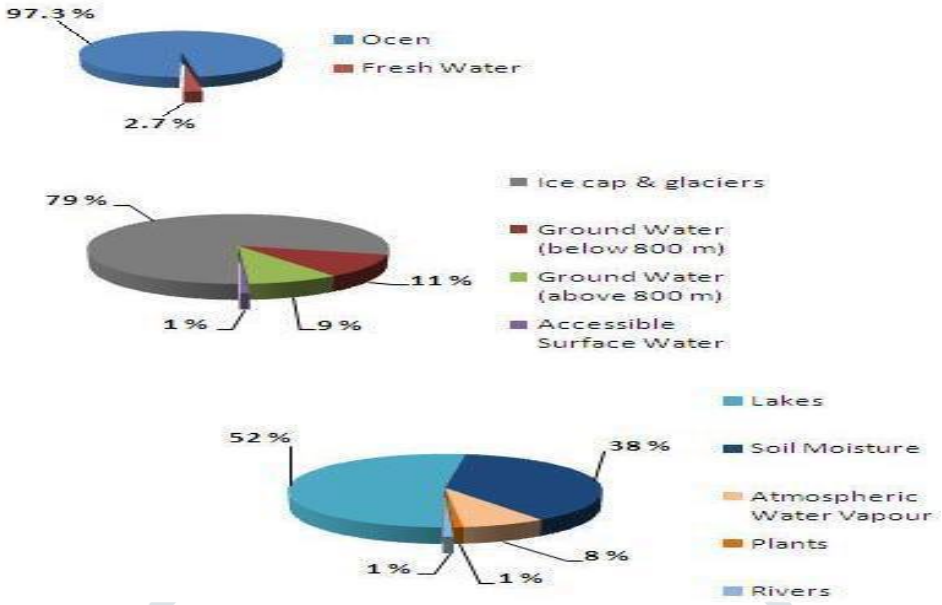

Fig. 1. Percentage wise Distribution of Global Water

Growing populations, changing diets, increased urban, agricultural and industrial water demands, and a growing understanding of nature's need for water require that we radically reform our attitude toward water and how it is managed globally. Water needs to be on the global political agenda not only in order to feed the projected 9 billion people that will inhabit the earth by 2050 with less agricultural water than is available today, but also in order to address the critical development challenge of doing so in a safe, sustainable way without compromising water resources that are essential to ecosystem services and functions.[1]

III. INDIAN WATER SCENARIO

The annual precipitation including snowfall in India is 1170 mm which is equivalent to about 4000 BCM and the natural runoff in the rivers is computed to be about 1869 BCM. The utilizable surface water and replenishable ground water resources are of the order of 690 BCM and 433 BCM respectively. Thus, the total water resources available for various uses, on an annual basis, are of the order of 1123 BCM.

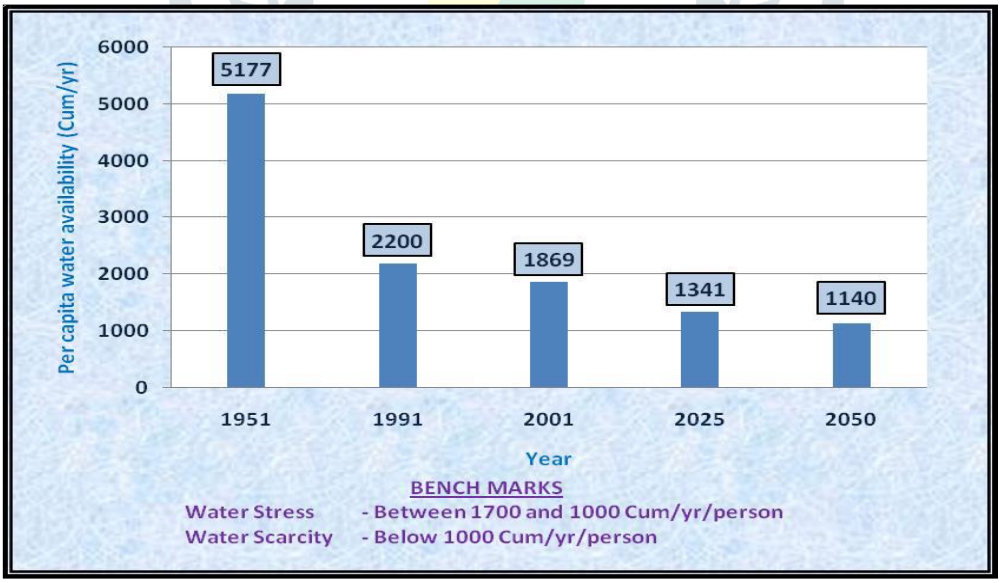

Fig. 2. Per capita surface water availability in India

Owing to high rate of population growth, the national per capita annual availability of water which was 5177 m3 in year 1951 has come down to 1869 m3 in 2001 and is projected to fall down to 1140 m3 in 2050. Although the per capita availability of water in India in year 2001 is about 1869 m3 against the benchmark value of 1700 m3 signifying "water-stress" condition as shown in Fig. 2, there is wide variability in basin-wise water availability due to uneven rainfall and varying population density in the country. The availability is as high as 14057 m3 per capita in Brahmaputra/Barak Basin and as low as 307 m3 in Sabarmati basin which is water scarce. It is evident from the following figure that per capita water availability in India which is near water stress condition at present would further go down and tend towards water scarce condition by year 2050.[2]

IV. WATER SCENARIO OF GUJARAT

Gujarat State is situated on the west coast of India, latitude 20°2' and 24° N and longitude 68°8' and 74°23' E. The boundary of the state extend to the Arabian Sea in the West, Pakistan in the North-West, Rajasthan in the North and North-East, Madhya Pradesh in the East, and Maharashtra in the South and South-East. The Geographical area of the state is about 196136 Km^2 (6 % of the total area of India). According to the 2001 census, the total population of Gujarat state is 50316585 (5 % of population of country). For administrative purpose, Gujarat state is divided into 25 districts and 226 talukas. Geographically, Gujarat state divides naturally into three regions namely: i) Gujarat region mainland, covering the central and eastern part of the state; ii) Saurashtra peninsular region in the western part; and iii) Kachchh region, covering mostly the arid area in the North-Western part of the state. Gujarat has a tropical monsoon climate. Annual rainfall ranges from less than 300 mm in the North-West to 2,000 mm in the South-East. Gujarat region receives an average rainfall of 650 to 800 mm while Saurashtra has an average rainfall of 280 to 500 mm. The annual rainfall in Kachchh is less than 380 mm. Most of the rain (90-95% of the annual total) falls during the period June to September only in a period of about 100 hours duration. In South Gujarat region, rainfall distribution is more or less uniform, with occasional heavy rainfall. The incident and distribution of rainfall, particularly in Saurashtra and Kachchh regions and in the northern parts of the Gujarat region, is highly erratic over space and time. Due to temporal and spatial variation of rainfall, these regions are very often subject to drought in one part and floods in another part of the State. Regional water endowment in the state is also at great variance. Surface Water resources of Gujarat are 38,500 Mcm against 18, 69,000 Mcm for the country. Thus Gujarat has 6 % of land, 5 % of population of country but only 2.06 % of surface water resource of the country and hence the state is less blessed in terms of availability of fresh water. Water shortage in Gujarat is becoming acute with every passing day. It is not only due to rapid population growth alone, but also on account of many factors such as rise in per capita water need owing to rising living standards, increased reliance on irrigated agriculture, rapid urbanization, massive industrialization and more importantly due to temporal and spatial variations of rainfall, resulting in drought and floods in one part of the state or the other.

The Irrigation Commission has identified about 36% of the state's total area as drought prone, where deficiency of water is a serious problem. To combat the problem, the State Government has given top priority to construction of water resources development projects. Out of the total 19.6 Mha area of the state, 12.5 Mha or two-third of the total area is cultivable based on the available water resources The Ultimate Irrigation Potential after implementation of major & medium projects is 1.8 Mha, Minor schemes is 0.36 Mha, Groundwater is 2.55 Mha & Sardar Sarovar Narmada Project is estimated at 1.79 Mha. The geographical, culturable area and ultimate irrigation potential of India and Gujarat are tabulated in Tabe. 4.1.[2]

Table. 4.1: Development of Ultimate Irrigation Potential

Particulars	**India**	**Gujarat**
Geographical Area (Mha)	328.7	19.6
Culturable Area (Mha)	182.5	12.5
Ultimate Irrigation Potential (Mha)	140	6.5
Ultimate IP to Culturable area (%)	77	52

Gujarat's water resources are concentrated primarily in the Southern and Central part of the mainland. North Gujarat, Saurashtra and Kachchh regions, with exceptionally high irrigation needs, have limited Surface and Ground water resources. Table.4.2 below shows the regional comparison of surface water resources in Gujarat State.

Table. 4.2: Surface Water Resources Availability in Different Regions of Gujarat State

Sr. No.	Region	Surface Water		Population (Census 2001)	Per capita surface water availability (population based)
		(Mcm)	(%)		
1	Gujarat State	38533	100.00	50316585	766
2	North Gujarat	2012	5.22	14708626	137
3	Central & South Gujarat	32260	83.72	20586874	1567
4	Saurashtra	3613	9.38	13437860	269
5	Kachchh	648	1.68	1583225	409

Gujarat's surface water resources are concentrated primarily in the Southern and Central part of the mainland. South-Central Gujarat with about 41% of the State"s population accounts for about 84% of total surface water resources of the State, where as Kachchh, Saurashtra and North Gujarat region together with 59% of the population account for only about 16% of the surface water resources. Comparing on basis of population, per capita surface water availability for the North Gujarat is 137 cum and which is less compare to other region of Gujarat State.

Groundwater is distributed more evenly but it is not sufficient for the needs of the regions with inadequate surface water resources. Saurashtra and Kachchh in the Northern Mainland with exceptionally high irrigation needs have limited Surface and Groundwater resources. The region wise groundwater resources of Gujarat State are shown in Table.3 as below.

Table.4.3: Groundwater Resources Availability in Different Regions of Gujarat

Sr. No.	Region	Ground Water (Mcm)	Ground Water Resources (%)	Population (Census 2001)	Per capita Ground water availability (population based) in m3
1	Gujarat State	15810.95	100.00	50316585	314
2	NG	3742.52	23.67	14708626	254
3	SG	5917.07	37.42	20586874	287
4	Saurashtra	5428.25	34.33	13437860	404
5	Kachchh	723.11	4.57	1583225	457

Unlike Surface water, Groundwater is distributed more evenly but it is not sufficient for the needs of the regions with inadequate surface water resources. Saurashtra and Kachchh in the Northern Mainland with exceptionally high irrigation needs have limited Surface and Groundwater resources. Because of the arid climatic conditions in Gujarat, characterized by erratic rainfall and successive drought years, groundwater constitutes a relatively reliable source of drinking water in addition to its use in the industrial and agricultural sectors.[2]

V. ARTIFICIAL RECHARGE PLANNING IN MEHSANA DISTRICT OF NORTH GUJARAT

The plan for artificial recharge has been prepared considering the hydrogeological parameters and hydrological data base. The following aspects were considered for preparation of the plan:

- Identification and prioritization of need based areas for artificial recharge to ground water.
- Estimation of sub surface storage space and quantity of water needed to saturate the unsaturated zone (up to 10 m below ground level).
- Estimation of storage space and quantity of water required to arrest the declining water levels.
- Quantification of surface water requirement and surplus annual run off availability as source water for artificial recharge in each basin/region.
- Areas of poor chemical quality of ground water and scope of improvement by suitable recharge measures

VI. WATER CONSERVATION IN THE MEHSANA DISTRICT REGION

The water conservation work carried out through Dharoi project, Sujlam Suflam Yojna, Chimnabai Sarovar, Thol tank, Sabarmati – Saraswati link Channel, Sipor loop canal and major cross drainage structure like as Lakroda weir and major check dam in Rupen, Pushpawati and Khari rivers in the region of Mehsana District. Water resources department decided to construct major check dam in river which is more effective than small check dam and which provide direct irrigation facility through surface water/ground water recharge. In the area where no feasibility of check dams then the deepening of tank/pond is carried out. In Dharoi command area 134 tanks/ponds are connected through canals which are filled by surplus water of Dharoi dam and other tanks/ponds out of Dharoi command area are filled through Narmada pipe line and Sujlam Suflam Canal. Water resources department constructed 1067 smaller check dams, 13 bigger check dam and 891 tanks/ponds deepening work in last 8 years. The Pond/Tank and Check Dam constructed up to date: 30-06-2016 in the region of Mehsana District as recharge structures is shown as below in Table. 6.1

Table.6.1: Tank/Pond and Check dam constructed up to date: 30-06-2016 in the region of Mehsana District

Taluka	Pond / Tank		Check Dam	
	Smaller	Bigger	Smaller	Bigger
Visnagar	95	18	65	1
Mehsana	131	39	49	4
Vadnagar	38	11	11	-
Unjaha	56	30	52	4
Becharaji	81	30	73	3
Kadi	102	9	1	1
Satlasana	24	-	321	1
Kheralu	108	7	148	-
Gojariya	-	1	-	-
Jotana	-	9	-	-
Vijapur	98	4	347	-
Total	733	158	1067	13
Total	891		1080	

VII. CONCLUSION

Thus water scarcity in the area of Mehsana district is balanced by surface water through water management by conservation structures like tanks/ponds and check dam in real aspect. Due to construction of 1067 smaller check dams, 13 bigger check dam and 891 tanks/ponds deepening work by Water resources department in the region of Mehsana District, around 68996 ha land area can be irrigated and water storage capacity is increase around 4190.37 ha.m.

I. ACKNOWLEDGMENT

Authors are grateful to all staff members of Narmada, Water Resources, Water Supply and Kalpsar Department, Gujarat for provisioning of helpful data and valuable information on relevant website.

REFERENCES

[1] Bigas, H. (Ed.), 2011-201, "The Global Water Crisis: Addressing an Urgent Security Issue. Papers for the Inter Action Council", ISBN: 92-808-6032-1, pp.-1 -127

[2] WAPCOS Ltd., Gandhinagar, 2014, "Final Master Plan Report for Ground Water Recharge Structures in all Taluka of Mehsana District"

[3] CGWB, GOI, New Delhi,2000, "Guide on Artificial Recharge to Ground Water, Prepared by Central Ground Water Board, Ministry of Water Resources",pp. 1-59,

[4] Nilu Khan, 2014, "Contribution of Rainwater Harvesting in Agriculture of Gujarat: A Case Study of Ahmadabad District", OSR-JEF, e-ISSN: 2321-5933, Volume 5, Issue 5, pp. 30-36

[5] CGWB, GOI, Gandhinagar, 2014, "Ground Water Brochure of Mehsana District Gujarat", pp. 1-26,

[6] A.K. Bhattacharya, 2010, "Artificial Ground Water Recharge with a Special Reference to India", IJRRAS, vol. 4 (2), pp.214-221,

[7] Patel, P., & Bhatt, S. A., 2007, "Fluoride: a major polluting component of ground water in North Gujarat region, India". In Proceedings of Taal 2007: The 12th World Lake Conference, pp 245-249).