Planning and Management of Water resources for North Gujarat

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***Abstract* - Water is a natural and scarce resource, livelihood, for food security and sustainable development depend on water [N.W.P.-2012].**

The rapid rise in urban population, heavy demand of land for commercial and residential development and the heavy dependence on ground water led to over exploitation. Rainfall is the main source of ground water recharge, and the water table normally rises in response to rainfall in particular period. This relation has been changing because of the reduction in the number of water bodies which led to rapid decline of ground water level and drying up of shallow wells/bore wells in many parts of north Gujarat.

The security of our water future depends on how we utilize & save our water resources today. This will require concerted effort on the legal, policy, regulatory and institutional front for better managements and efficient usage of water. Accurate data and information systems are key to effective planning and management of water. Appropriate valuation of water uses will be necessary to design and promote demand management, recycling of wastewater, rainwater harvesting and also to deter the polluting of water bodies. Extensive awareness and education program need to be undertaken in parallel. A mass awareness program supplemented by appropriate technologies, policies, institutional arrangements, and stake-holders participation would increase water productivity, accurate economic growth and assure safe and secure water in the present and in future.

***Index Terms* - Rainwater harvesting, Ground water resources, Surface water resources, National water policy, Effective Planning and Management of water, Accurate data and information system, Livelihood, Food security, Sustainable development, ground water, Recharge of ground water.**

INTRODUCTION

The Gujarat state can be divided in to four district units on the basis of water resources, endowment namely Kutch, North Gujarat, South & Central Gujarat, and Saurashtra. North Gujarat the northern part of Indian state of Gujarat includes the districts of Gandhinagar, Banaskantha, Sabarkantha, Aravalli, Mehsana, Patan and Ahmedabad. In which Ahmedabad facing less difficulty of water problem and quite developed district so this district not include in this study.

Urbanization is one of the biggest challenges. Right now, there is about, one third population and expected more than half of Indian population will live in cities. As per census 2011, In Gujarat 62,6% of total population was living in rural area and 37.4% was in the urban areas. Decadal growth of urban population in various districts of North Gujarat are Banaskantha districts shows 50.05%, Gandhinagar districts shows 53.48%, Sabarkantha districts shows 61.25%, Mehsana districts shows 24.86%, Patan districts shows 17.87% decadal growth of urban populations.

In past two decades, the Gujarat state has lost about 27% of its ground water resources, the loss being 50% in North Gujarat, total water availability quota for North Gujarat is 6342 MCM, in which 2100 MCM is of surface water resources and 4242 MCM is of underground water resources. In many parts of North Gujarat, the extraction of ground water is more than the recharge, so the resources are stressed, and we are depleting both in quality and quantity, inefficiency in water use and irresponsibility in the management of water resources pose a serious threat to our water security and sustainability.

Rapid development of Ground water resources for varied usage has contributed to expansion of irrigated agriculture, overall economic development and in improving the quality of life. Ground water which is the source for rural domestic water requirements, urban water requirements and irrigation requirements is depleting fast in many areas due to its large-scale withdrawal for various sectors. In last 40 years development has taken place due to availability of physical infrastructure like electricity and funding from various agencies. This is indirectly depleting ground water level. And due to depletion in Ground water level the ground water quality affected. Mostly all parts of North Gujarat villages found presence of chemical constituents like fluoride, salinity, and Nitrate more than permissible limit, The District like Mehsana and Patan issue of increasing instances of high fluoride. And increasing depth of tube wells also become problematic in this two Districts. Due to that incidence of diseases like jaundice, cholera, typhoid, gastro enteritis and other skin disease rises. Currently the water table of region is dropping 6 mt. every year.

APPROACHES AND METHODOLOGY

Approaching to data from Central Ground Water Board water yearbook, district Ground Water Brochure, for secondary data from current water supply provision by various Municipalities of North Gujarat areas.

OBJECTIVE OF THE STUDY

- To assess the reliability, affordability, financial, environmental, and social sustainability of existing water supply system.
- To focus on possible improvements in water supply system provisioning and governance.
- To analyze effective planning and management of water supply.
- To discuss Rainwater Harvesting traditional techniques, which is currently needed to increase storage of water.

URBANIZATION IN NORTH GUJARAT

Urbanization is one of the biggest challenges. Right now, there is about, one third population and expected more than half of Indian population will live in cities. As per census 2011, In Gujarat 62,6% of total population was living in rural area and 37.4% was in the urban areas. Decadal growth of urban population in various districts of North Gujarat are Banaskantha districts shows 50.05%, Gandhinagar districts shows 53.48%, Sabarkantha districts shows 61.25%, Mehsana districts shows 24.86%, Patan districts shows 17.87% decadal growth of urban populations. Urban development uses water resources in many ways. The growing urban population impose increasing demand on provision of water services including water supply, ground water loss, wastewater collection and management and finally leading to water pollution control at receiving end. Urbanization generally increases the impervious covers of ground to a large extent and thus discharge the surface runoff move quickly to the nearby areas. Which in turn contribute to urban flooding and its consequent damage to all inhabits a phenomenon which was not so prevalent time in earlier time.

MANAGEMENT OF WATER RESOURCES [ISSUES AND SOLUTIONS]

Water sources are very limited in North Gujarat, so it is the responsibility of every Citizens to save the water by proper use and increasing the storage capacity of water. Priority shall be allocated for utilization of water for various uses, so that the same way become a guideline for all actions for planning, development, and utilization of water resources.

a. Drinking water.
b. Irrigation.
c. Hydro power, and Thermal power.
d. Agro-industries and nonagricultural industries.
e. Ecology
f. Navigation, fisheries, and other uses.

AGRICULTURE

Public irrigation systems are losing their position of dominance. Yet despite poor performance of canal-based irrigation, water fee recovered from irrigators is less than 10% of working expenses and a key problem is poor maintenance and system management, especially below the outlet. It is rarely able to deliver water to more than half of the command area. As a result, farmers in the periphery started relying on ground water. The benefits of ground water irrigation, coupled with supportive policies of the government, led to an explosion in ground water tube wells, and tube wells become the predominant means of irrigation. Rampant use of ground water has, however brought about serious problems, lack of regulation and its indiscriminate extraction has led to a lowering of the water table and increasing salinity and water quality problems.

Suggestions: - Improving the performance of surface system to evolve public-private partnership between farmers and irrigation departments for efficient utilization of canal water. There are number of schemes where the irrigation department has constructed weir at regular intervals for lift irrigation schemes and pump and underground pipe system to distribute water to farms.

URBAN WATER SECTOR

The urban water sector is in a state of despair, inadequate access, poor quality, and poor reliability are major problems with urban water supply. Water utilities are operationally in efficient and financially weak similar to the experience of public irrigation system. ULBs are dependent on higher levels of government for funds, which undermines their motivation for effective asset management, service delivery, and cost recovery. The failure of the state in supplying adequate water to meet the needs of urban dwellers has led to the emergence of unorthodox supply systems.

Suggestions: - Several reforms are required to improve the performance of utilities . International experience suggests that effective leadership, political will, improvement in management practices, corporatization, measures for demand side management and wastewater reuse and full cost recovery have been necessary elements for the successful transformation of utilities.

RURAL DRINKING WATER

The major problems with rural drinking water are its adequacy and quality. Government programs such as Bharat Nirman have not been able supply adequate, good quality water to rural households, much of the rural drinking water needs are met by ground water. Declining water table and deteriorating quality of ground water has rendered government schemes untenable. Availability of water in rural areas is getting further strained due to urbanizations.
Fundamental changes are required in approach towards rural drinking water supply. Foremost amongst those is setting legally binding water quality norms and quality standards that are equitable, second local government institutions, the gram sabhas and gram panchayats must be given the necessary regulatory and fiscal powers to ensure effective implementation of the tasks that they have to perform, third the inconsistencies between binding legal principles and rural drinking water programs need to be addressed.

INDUSTRIAL WATER

Two concerns that dominate the industrial water sector are (i) rising demand and (ii) pollution caused by the discharge of wastewater by industries. As per an estimate each liter of discharged wastewater further pollutes 5-8 liters of water, in industries water productivity is low, one of the main reasons for inefficient use of water by industry is its poor pricing. Wastewater recycling offers immense potential for becoming a viable and practical solution for non-potable water uses. The cost of recycling has also reduced dramatically to make this option viable, particularly for industrial use.

DISTRICTS PROFILE OF NORTH GUJARAT

1. Gandhinagar district: - Geographical Area [Sq. km.] = 2137.62, Number of Towns = 15, Number of Villages = 252, Numbers of household = 2,88,540, Population [As per 2011 census] =13,87,478, Average Annual Rainfall [mm] = 823

2. Banaskantha district: - Geographical Area [Sq km] = 10,303, Number of Towns = 12, Number of Villages = 1249, Numbers of household = 5,59,243, Population [As per 2011 census] = 25,02843, Average Annual Rainfall [mm] = 578.8

3. Sabarkantha and Aravalli district: - Geographical area as per state territory/as per village papers [Sq km.] = 7390, Number of Towns = 15, Number of Village = 11389, Numbers of household = 4,79,339, Population [As per 2011 census] = 24,27346, Average Annual Rainfall [mm] = 886.6

4. Mehsana district: - Geographical area [sq km.] = 4371, Number of Towns = 10, Number of Villages = 593, Numbers of household = 4,23,463, Populations [As on 2011 census] = 20,27,727, Average Annual Rainfall [mm] = 827

5. Patan district: – Geographical area [sq km] =5740, Number of Talukas = 7, Number of Villages = 517, Numbers of household = 2,66,938, Populations [As on 2011 census] = 13,42,746, Average Annual Rainfall [mm] = 664.87

GROUND WATER STATUS AT NORTH GUJARAT

The monitoring of ground water levels has been carried out at ground water monitoring wells four times in a year simultaneously throughout the State during the following periods.

a. May-20th to 30th. [water level of pre-monsoon period].
b. August-20th to 30th. [peak monsoon water level].
c. November-1st to 10th [water level of post-monsoon period].
d. January- 1st to 10th [the recession stage of water level].

The data is analyzed for each set of measurement, and report prepared which include following maps to understand the groundwater regime in the state.

1. Depth to water level.
2. Seasonal fluctuation- water level fluctuation in comparison to pre-monsoon.
3. Annual fluctuation- water level fluctuation in comparison to same month in the previous year.
4. Decadal fluctuation- water level fluctuation in the month of measurement with reference to the decadal average for the same month.

65% of the wells have depth to water levels in the range of 5 to 20 mbgl (meter below ground level) during pre-monsoon 2015. The water levels were deeper in Banaskantha, Gandhinagar and Sabarkantha districts. Deeper water levels were observed mainly in the over exploited and Critical talukas. The water levels are declining at an average rate of 2m per year in deeper aquifers in north Gujarat. Steep declines have been observed during the last five years.

GROUND WATER QUALITY MONITORING

A systematic plan for conducting water quality monitoring is called Monitoring program, which includes monitoring network design, preliminary survey, resource estimation, sampling, analysis, data management and reporting. Central Ground Water Board [WCR], Ahmedabad has monitored a total number of 602 water samples collected during May 2015, for basic parameters determining PH, EC, TDS, CO3, HCO3, CL, NO3, SO4, F, Ca, Mg, TH, Alkalinity, Na, K, and SAR, involving use of instruments such as PH meter, EC meter, flame photometer, UV/Visible Spectrophotometer, and titrimetric methods. Further 602 water samples received during the same period were analyzed for as by colorimetric method using visible spectrophotometer. From the analytical results it has been observed that Pollution parameters like The Electrical conductivity [EC], Chloride [CL], Nitrate [NO3], Fluoride [F], Arsenic [As] shown in table, measured in various North Gujarat Districts.

*** District wise range distribution of pollution parameters observed during CGWB monitoring- 2015.

S. No.	District	Analysed for basic	No. of samples with EC>3200uS/cm	No. of samples with CL>1000mg/L	No. of samples with NO3>45mg/L	No. of samples with F>1.5mg/L	No. of samples with as> 50ug/L
1	Gandhinagar	2	0[max. 2677, Serthapara]	0[max. 284, Serthapara]	2[max. 140, Paliya]	0[max. 1.30 Serthapara]	---
			2[min. 1977, paliya]	2[min. 249, Paliya]	0[min. 70, Serthapara]	2[min. 1.12, Paliya]	---
2	Banaskantha	13	2[max.4028, khoda]	0[max.852, Amirgadh]	5[max.115, Amirgadh]	2[max.2.30, khoda]	---

			11[min.478, Dantiwada 1]	13[min.43, Bharol 1]	8[min.8, Bharol 1]	11[min.0.20 , Bharol 1]	---
3	Sabarkantha	38	3[max.4826, Silwad]	1[max.1250, Silwad]	24[max.190, Choriwad]	2[max.2.60, Idar]	1[max.0.78, Sabbalwad]
			35[min.524, Virpur 2]	37[min.57, Malpur]	14[min.0, Megraj]	36[min..00, Atarsuma]	16[min.0.00, Malpur]
4	Mehsana	15	3[max.8190, Unad 1]	1[max.1527, Unad 1]	1[max..185, Unjha]	2[max.1.90, Dasaj]	1[max.0.85, Asjol]
			12[min.385, Asjol]	14[min.21, Asjol]	14[min.0.00, Tarabh]	13[min.0.15 , Asjol]	11[min.0.00, Bhandupara]
5	Patan	8	3[max.29200, Motichander]	2[max.11132, Motichander]	3[max.245, Patan-2]	1[max.3.00, Piprala]	----
			7[min.778, Shankhari]	6[min.43, Sander]	5[min.4, Sander]	7[min.0.00, Dharmoda]	----

PRESENT SCENARIO OF WATER IN NORTH GUJARAT

Gujarat is one of the frequent drought prone states of India. Several consecutive droughts have been experienced during last 20 years. 1986-88 was the longest and the most severe drought period experienced in the past. For the North Gujarat region, the rainfall deficit is about 72 percent till date as on August 6, 2018 year. The Sardar Sarovar Dam on Narmada river as on August 6, 2018 year has only 37 percent water of its gross storage, which has triggered a wave of concern.

The bulk of the households depend on the municipal water supply for their daily needs [tap water and tankers]. North Gujarat mostly depends on various water resources like Dug wells, tube wells, bore wells, water conservation structure, canal, tanks, and ponds. Gujarat government made provisions to provide enough fresh drinking water to North Gujarat. Government initiates various water supply schemes. The Sujalam Suflam yojana is a water conservation scheme by the Gujarat government which focuses on deepening of water bodies before monsoons and increasing water storage for rainwater collection. Its inaugural run was from 1st May 2018 to 31st May 2018, the state set a target to increase water storage capacity by 11,000 lakh cubic feet through deepening of 13,000 lakes, check dams, and reservoirs, "which was achieved successfully by the state as per media reports". After the program's success in 2018, the second edition was launched in 2019. In which the state increased its financial contribution to 60% for Programme activities, requiring private entities to pay only the remaining 40%. In addition to participatory water management programmes being implemented across the country, states such as Madhya Pradesh have launched schemes to provide financial aid to farm owners for the construction of irrigation structures on private land. Further, Punjab has launched a scheme to incentivise farmers for efficient water use in irrigation through financial rewards.

At present Narmada based water grid covering 9490 villages and 173 towns of Kutch, Saurashtra and North Gujarat providing water to almost 75% of population of Gujarat. North Gujarat having 15 nos. of Dams [smaller, check dam, earthen dam, and gravity dam]. Total storage capacity of Dams is 1922.26 MCM. Majors are dharoi, dantiwada, sipu, majum and mukteshwar dams.

GWSSB- Gujarat Water Supply and Sewerage Board established for water management in Gujarat. GWSSB purchase water from SSNNL- Sardar Sarovar Narmada Nigam Limited and provide water to Urban Local Bodies, for rural areas. Rural Water Supply Schemes are implemented either as individual village piped water supply or regional piped water supply facility. In Gujarat there are nearly 7000 individual rural water schemes and 372 rural regional water supply schemes covering more than 4000 village/habitation. Individual village water supply schemes are ruin and maintained by the village Panchayat and Government provide grants for its all expenditure including electric bills also. The Pani samitis are formed at village level for wise water management taking care of operation and maintenance of infrastructure at villages and for creation of intra village water supply distribution. Up to 2007-08 year there were 11694 pani samitis formed in Gujarat.

WATER SUPPLY IN NORTH GUJARAT URBAN AND RURAL AREAS

North Gujarat average per capita water supply [LPCD].
Minimum = 10.81 LPCD, Maximum = 154.88 LPCD, Average = 75.31 LPCD

- Mehsana city getting 96 percent of water from Narmada water supply and 4 percent from tube well supply. Mehsana rural require 6 MLD and urban require 26 MLD.
- Patan city getting water from NMC pipeline from khorsam connecting to Saraswathi barrage and siddhi Sarovar. Total capacity of 27 MLD.
- Himmatnagar city getting water from Narmada canal, tube well and bore well. Total estimated consumption is 96.15 lakh liter/day.
- Modasa city getting water from water supply schemes based on 'Vatrak and Mazum' dam connected by Narmada pipelines, total estimated consumption quantity is 92.30 lakh liter/day.
- Gandhinagar city getting water from Narmada canal and tube well. Gandhinagar cities require 66 MLD water.

Palanpur city getting water from Bhadar dam, Narmada canal and tube well, total estimated water consumption quantity is 100 lakh litre/day.
Bhabhar, Chansma, Kalol, Mansa, Radhanpur, Thara, Tharad, Vijapur are getting water from Narmada Water Supply Scheme, while Vadali, Vadnagar, Visnagar, Siddhpur and Unjha are getting water from Dharoi water supply scheme, while other municipality like Kadi, Deesa, Idar, Prantij and Talod are getting water through bore wells and tube wells.

WATER MANAGEMENT TOOLS AND TECHNIQUES

By applying following some of tools and techniques we can increase the storage capacity of water for use. The water management systems show that the traditional knowledge of water management was efficient as well as eco-friendly (Paikra and Puntambekar, 2013). Various conventional water recharging systems and conservation structures like Kund (Kundi), Bawli (Stepwell), Phad and Bhandara, Haveli, Kare, etc.; are a few traditional Rainwater harvesting system and Zing, Guhal, Jobo, Ahar pyne, etc., are some of the water conservations used in different parts of India through history.

Sustaining Safe Sources: -
1, Looking for alternate water sources: Water harvesting: - Rainwater Harvesting and subsequent recharge of groundwater can help lower the concentration of minerals in aquifers. Setting up community-based water harvesting units will involve creating social mobilization, awareness, and confidence among all sections of the community.
a.Water Harvesting in Balisana village, Gujarat: - The village of balisana in Patan district of Gujarat was under the acute grip of fluoride pollution, six years back, the villagers started a community drive to solve the crisis, with help from the Ahmedabad-based non-government organization, UTTHAN. The villagers started to de-silt a 3.05 mt. long canal through which they diverted rainwater to a 300-year-old tank. About 82,000 cubic meters of silt was extracted from the tank at a cost of 52 lakh RS. Sixty percent of the cost came from the government, 40 percent was community shramdan. A 12-kilometer-long bond was reconstructed to hold the diverted rainwater. Adjacent to the tank was a 45 m. deep recharge well that was fitted with high density pipe. The horizontal pipe carries water from the tank to the recharge well, water from the well is pumped into a storage tank near the well. A 12 year dead well nearby has got water now that is also free from fluoride. This water is increasingly used by villagers for drinking purposes.

2. Dual water supply and wastewater treatment: - The success of this system lies in the fact that filtered purified water is used only for drinking purposes while other source of water may be used for purposes other than drinking. Wastewater treatment can also be another effective means of reducing the burden on freshwater sources. The treated wastewater can be used for purposes other than drinking. One example of effective wastewater treatment is in Mehsana district of Gujarat where wastewater from homes in villages is used for agriculture. The wastewater coming out of homes is collected in a pond which is then auctioned to farmers for use in an agriculture.

Another example in Gujarat depicts use of dual water supply, Magod Dungri village in Valsad district in Gujarat has a population of 4264. An old well served as a water source, but the water was saline and not potable in 2006, this village was brought under the Bigri Malwan group water supply scheme of the GWSSB and it started receiving safe drinking water, but in village distribution of water continued to pose a problem. Under the swajaldhara program, the village community decided to develop a system of household connections. The entire community made a 10 percent contribution towards capital costs and the responsibility of collecting the contribution was taken up by one individual in each habitation in the process a 5000 liter water tank in the village school, electricity connections, a 2208 m. distribution pipeline, a 318 m. gravity pipeline and 15 stand posts were made out of a total expenditure of 5,20,000 RS. The community contributed 80,000 RS. The foremost priority of the village was to get regular and safe water to meet their drinking water requirements. As far as water for other purposes was concerned this need could easily be met from the village well, for drinking water, the villagers make use of the treated water supplied through regional water supply scheme. This is accessed from the 15 stand posts constructed in the 15 habitations in the village. Thus, by making use of dual sources of water, the community has ensured that treated water is not wasted and is used only for drinking purposes.

3. Exploring simple, low-cost treatment technologies: Once contamination is detected in a water source, there is need for treatment. In case of rural areas, modern water purification technologies might not be viable. In villages, it is important that simple technologies that are easy to use and can be operated without much technical know-how be promoted. The use of traditional methods, however, should not be publicized unless its effectiveness has been proved through appropriate research.

Traditional methods of water purification: -

1. strychancs potatroum (kataka seeds) are natural coagulants used for the purification of moddy water.
2. Morenga olifers (drumstick) seeds are used as a coagulant. They also inhibit the growth of bacteria and fungi.
3. Vetiveria Zizanoides (khas) are laid in a clay jar which has a few tiny holes in its bottom, water filtered through this layer of roots is not only clear but also has a pleasant smell.
4. Dusting of water with plant ashes earth from termite hills, paddy husks or crushed seed coats from elaichi (Elettaria Cardamum) improves clarity of water.
5. Osimum Sanctumn (Tulsi) is a water purifier with antibacterial an insecticidal property.
6. water stored in copper or brass pots do not breed bacteria.

4. Community enterprise for water: - communities, civil societies, technology provider can form enterprise for delivery of water services. Each of the stakeholders play an important role in the operation and maintenance of water purification system and delivery. The example of Reverse Osmosis water enterprise system in Gujarat is an initiative where WASMO in collaboration with a technology provider has set up community managed reverse osmosis system in 71 villages across the state to address the problem of salinity. The communities contributed 10% of the capital cost and the rest was provided by the government. The technology provider assists in training of village youth for running the R.O. plant. This type of initiative not only solves the problem of providing safe drinking water but is also a source of employment for the village youth.

Check dams: - A check dam is generally constructed on small streams and long gullies formed by the erosive activity of water. The ideally a check dam is located in a narrow stream with high banks. A check dam serves many purposes. 1, It cuts off the runoff velocity and reduces erosive activity. 2, The water stored improves soil moisture of the adjoining areas and allows percolation to recharge the aquifers.

While constructing a series of check dams on along stream course, the spacing between two check dams should be beyond their water spread. The height of the check dam should such that even during the highest flood, water does not spill over the banks.

Rejuvenation of Ponds and Lakes: - During the past years there is a realization that these ponds/lakes have to be restored with a view to making them reliable source of fresh water all through the year. With increased urban activities and population, the need of potable water has diversified as well as gone up. The lakes help recharge groundwater, support livelihood by way of fishing and grazing and quench the thirst of the bovine population simply by harvesting rainwater, ensuring its storages, and making the overflow seep into ground the best insurance against water scarcity and water logging [Gowda and Sridhara, 2013].

Interlinking of Rivers in India: -

The interlinking of rivers has two components, the Himalayan component and a Peninsular one. All interlinking schemes are aimed at transferring of water from one river system to another or by lifting across natural basins. The project will build 30 links and some 3000 storages to connect 37 Himalayan and Peninsular rivers to form a gigantic South Asian water grid. The canals planned to be 50 to 100 meters wide and more than 6 meters deep, would facilitate navigation. The estimates of key projects variables-still in the nature of back –of-the-envelope calculations-suggest it will cost around 5,60,000 crores Indian rupees, at 2002 prices, handle 178 km of inter-basin water transfer/per year, build 12,500 km of canals, create 35 giga watt of hydropower capacity, add 35 million hectares to India's irrigated areas, and create an unknown volume of navigation and fishery benefits.

Geographical Information System: - Remote sensing coupled with the use of Geographical Information Systems [GIS] can be used to identify runoff potential zones and location of suitable sites for water harvesting. They can also be used to identify sites in watersheds that have not been gauged, and where, due to very steep slopes, the runoff drains out fast. This system was used to identify 18 suitable sites for rainwater harvesting structures in the watershed of the Song river at Bandal, Uttaranchal.

The methodology consisted of preparing various resource maps such as land use/land cover by using IRS-1C, LISS data by digital image processing techniques, coupled with ground truth data. Digital elevation model, slope map, aspect map, classified map, soil map, drainage and buffer maps for village and agriculture areas were created in a GIS environment. Input parameters deduced from the basic thematic maps were then integrated with field data to generate runoff potential zoning. This model uses rainfall data, temperature data, soils, land use and rooting depth of different types of vegetation for calculating the soil moisture deficit, soil moisture surplus, evapo-transportation, surface runoff and other parameters.

History of Rainwater Harvesting.

Civilizations in the Indus Valley were far more advanced than we may think nowadays. In many of the ancient cities that still remain, we can still find huge vats that were cut into the rock to collect water when there was torrential rainfall. These were used to keep the population and local vegetation going in hotter, dryer times and were fed by numerous stone gullies that weaved their way through the city. Some of these rock vats are still used today in parts of India.

During the time of the Roman Empire, rainwater collection became something of an art and science, with many new cities incorporating state of the art technology for the time. The Romans were masters at these new developments and great progress was made right up until the 6th Century AD and the rule of Emperor Caesar.

CALCULATING ANNUAL RAINWATER HARVESTING POTENTIAL [ARHP]

ARHP = R X Rf X A, where ARHP = Annual Rainwater Harvesting Potential [in cubic meters]

R = Annual rainfall [in mts.]

Rf = Run-off Co-efficient [% age]

A = Area [in sq. mts.]

The Run-off Co-efficient [Rf] is taken as.

- For Roof Catchments: - Tiles = 0.8 - 0.9, Corrugated Metal Sheet = 0.7 – 0.9
- For Ground Surface Covering: - Concrete = 0.6 – 0.8, Plastic Sheeting [Gravel covered] = 0.7 – 0.8, Butyl rubber = 0.8 – 0.9, Brick pavement = 0.5 – 0.6.
- For Treated Ground Catchments: - Compacted and Smoothened soil = 0.3 – 0.5, Clay/cow-dung threshing floors = 0.5 – 0.6, Silicone treated soil = 0.5 – 0.8.
- For Untreated Ground Catchments: - Soil on slope less than 10% = 0.0 – 0.3, Rocky = 0.2 – 0.5.

[The above averages are taken for the sake of simplicity. An intense rainfall generates more run-off than a light but prolonged rain. Also, the slope, surface hardness and lack of vegetation cover of the catchment contribute to increased run-off. An increase in slope and hardness of the hard catchment area will yield greater run-off].

EXAMPLE [FOR CAMPUS BUILDING]– Calculating Annual Rainwater Harvesting Potential.
Total Catchment Area = 5000 sq. m., Roof Area = 500 sq. m., Paved Area = 500 sq. m., Kuchha Area = 4000 sq. m., Average Annual Rainfall = 60 cm./ 0.60 m.
Annual Rainwater Harvesting Potential [ARHP] =
[500 X 0.8 X 0.60] + [500 X 0.70 X 0.60] + [4000 X 0.1 X 0.60] = 240 + 210 + 240 = 690 cubic meters/ 6,90,000 lts.

VARIOUS CONVENTIONAL WATER RECHARGING SYSTEMS AND CONSERVATION STRUCTURES


Jhalara


Talab/Bandhi


Ahar pynes


Bawari


Taanka


Johads


Flood irrigation


Panam keni


Khadin


Zing


Kuhls


Bhandara phad


Kund


Baoli


Ramtek Model


Nadi


Zabo


Jackwells

CONCLUSIONS

To frame an integrated strategy for urban water security is absolutely necessary today. There is no single solution that can be employed but rather a multitude of strategies can be used to achieve water security. There are so many technologies for water supply available in India. The major challenge is to select an appropriate technology considering the multifaceted issues including technical feasibility affordability, custom and practices, preferences, and institutional support available. Rainwater is the main source for ground water recharge. Artificial recharging of ground water by rainwater harvesting in paved and unpaved areas (open fields, parks, pavement landscapes, etc.) can fulfil around 25 percent demand of urban areas. Ground water recharging fulfils about 25 percent water demand. Roof top rainwater harvesting meets another 25 percent urban water demand. Water losses in pipeline supply can be used for ground water augmentation, which is about 25 percent of supplied water. The same water recharging structure trench can be used for recharging ground water by rainwater or storm water runoff.

RECOMMENDATIONS

With a growing population and rising needs of a fast-developing nation as well as the given indications of the impact of climate change, availability of utilize water will be under further strain in future with the possibility of deepening water conflicts among different user groups. It became necessary to take cognizance of the existing situation, to propose a framework for creation of a system of laws and institutions and for a plan of action with a unified national perspective. It is become necessary to avail water and utilization of rainwater through R.W.H. [Rainwater Harvesting] techniques.

REFERENCES

[1] Districts of North Gujarat – Indianetzone. http://www.indianetzone.com>districts_north_gujarat
[2] District Ground Water Brochure Mehsana District Gujarat compiled by A.K.Sinha, Asst. Hydrogeologist.
[3] District Ground Water Brochure Patan District Gujarat compiled by A.K.Sinha, Asst. Hydrogeologist.
[4] Efficient Water Management By- Dhimant Vyas.
[5] Groundwater Yearbook – 2015,16 – Gujarat State and UT. Of Daman & Diu.

[6] Ground Water Brochure Gandhinagar District Gujarat compiled by R.K. Verma
[7] Ground Water Brochure, Banaskantha district Gujarat compiled by B.K. Gupta.
[8] Ground Water Brochure Sabarkantha District Gujarat compiled by K.M.Nayak.
[9] Institute of Town Planners, India Journal 14x1, January-March 2017, Article- Critical issues and options for management of water in Indian urban sector. By- Prakash Chandra tamrakar and prof. Abir bandyopadhyay, Ph. D.
[10] North Gujarat- Wikipedia. http://en.wikipedia. org>wiki>North_Gujarat
[11] National Water Policy, 2012.
[12] Traditional water conservation systems of India. https://www.thebetterindia.com>traditional-water-conservation-systems-in...
[13] Water supply scenario in Gujarat-GIDB gidb.org/water-supply-scenario-in –Gujarat
[14] Water supply flow diagram catalogue for Municipalities of Gujarat, Vo2, 2012-13
[15] Pdf Review of Reforms in Urban Water Sector— By Pranjal Deehshit
[16] Rainwater harvesting, A basic manual for Urban Built-up Areas. http://www.frontdesk.co.i/forum /
[17] Pdf by amit dalal “COMPOSITE WATER MANAGEMENT INDEX in association with Ministry of Jal Shakti and Ministry of Rural Development”.