UNIVERSAL WATER REGISTRY

UWR Rainwater Offset Unit Standard

(UWR RoU Standard)

Concept & Design: Universal Water Registry

www.uwaterregistry.io

Project Concept Note & Monitoring Report (PCNMR)

Project Name: Ichchapor HK HUB Sarovar Artificial Lake- Ground water recharge by Hari Krishna Exports Pvt. Ltd / Dholakia Foundation, Surat, Gujarat

UWR RoU Scope: RoU Scope 3

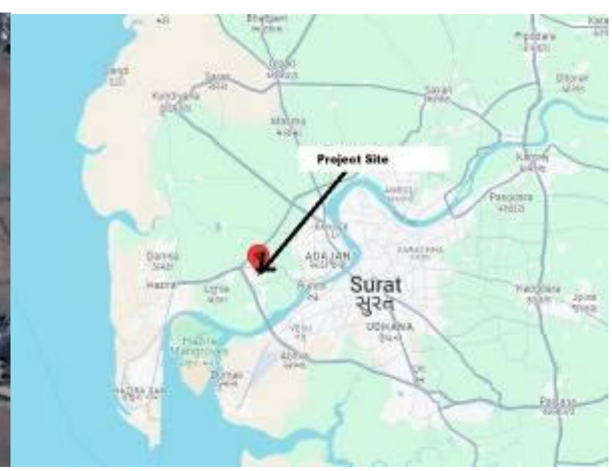
Monitoring Period: 01/01/2014-31/12/2023

Crediting Period: 2014-2023

UNDP Human Development Indicator: 2 (India)

A.1 Location of Project Activity

Address of the Project Activity	Gujarat Hira Bourse, Gem & Jewellery Park, ONGC Road, Village: Ichchapor Ichchapor HK HUB Sarovar (artificial Lake)
Project Proponent (PP)	Hari Krishna Exports Pvt. Ltd / Dholakia Foundation
State	Gujarat
District	Surat
Block Basin/Sub Basin/Watershed	Please refer to http://cgwb.gov.in/watershed/basinsindia.html
Lat. & Longitude	21°11'10"N 72°44'11"E
Area Extent	Groundwater Surface



A.2. Project owner information, key roles and responsibilites

Hari Krishna Exports Pvt. Ltd/ Dholakia Foundation (Project Proponent or PP)., is a prominent diamond industry player, who has transformed its industrial site located at Gujarat Hira Bourse, Gem & Jewellery Park, ONGC Road, Village: Ichchapor District: Surat, State: Gujarat, by constructing an artificial lake—"Ichchapor HK Hub Sarovar 1".

This project was designed to enhance environmental sustainability, improve employee well-being, and demonstrate corporate social responsibility. By addressing challenges such as water conservation and low biodiversity, the initiative has created a healthier ecosystem and a more pleasant working environment. The project has led to increased local flora and fauna, an improved microclimate, and greater employee satisfaction, while also fostering awareness of sustainable practices.

The PP launched a project with four key objectives: enhancing environmental sustainability by using artificial lake for water conservation and groundwater recharge; improving employee well-being through the creation of green spaces; demonstrating corporate social responsibility by showing commitment to environmental and community welfare; and raising awareness about water conservation to foster a culture of sustainability among employees and the local community. The company demonstrated corporate social responsibility by committing to environmental stewardship and community welfare. Additionally, they focused on raising awareness about water conservation to promote sustainable practices among employees and the local community.

The PP constructed an artificial lake as below mentioned:

Figure 1. 1. Ichchapor HK Hub Sarovar 1

A.2.1 Project RoU Scope

PROJECT NAME	Ichchapor HK HUB Sarovar Artificial Lake- Ground water recharge by Hari Krishna Exports Pvt. Ltd / Dholakia Foundation
UWR Scope: RoU Scope 3	Measures that improve the quality of existing ground water through dilution with rainwater runoff.
Date PCNMR Prepared	02/09/2024
Catchment Area	5773.50 SQ.MT
Total catchment Capacity	36175120 ltr water
Type of structure	Circular shape
Month and Year of Construction	15/01/2012
Month and Year of Commissioning Rwh's	01/01/2014
Average Rainfall	1400.00 mm
Run off Coefficient	0.9
Evaporation and absorption losses	20%
RoU Crediting Period	01/01/2014 - 31/12/2023 (7 years)
Total RoUs Generated For the Crediting Period	50919 RoUs

A.3. Land use and Drainage Pattern

A3.1 Urban and rural Residential

A3.1.1 Introduction

Surat district lies between 20°30: 21°30'N and 72°35: 75°20'E with a total geographical area of 4,378 sq.km. (District Census Handbook Surat 2011). River Tapi is a major river that flows downstream towards the Gulf of Cambay. This district has many industrial zones like Hazira in the west, Olpad in north-west and Surat city. These industries manufacture different types of chemicals, petrochemicals, polymers, fibers,etc. (GSIDS, 2016).

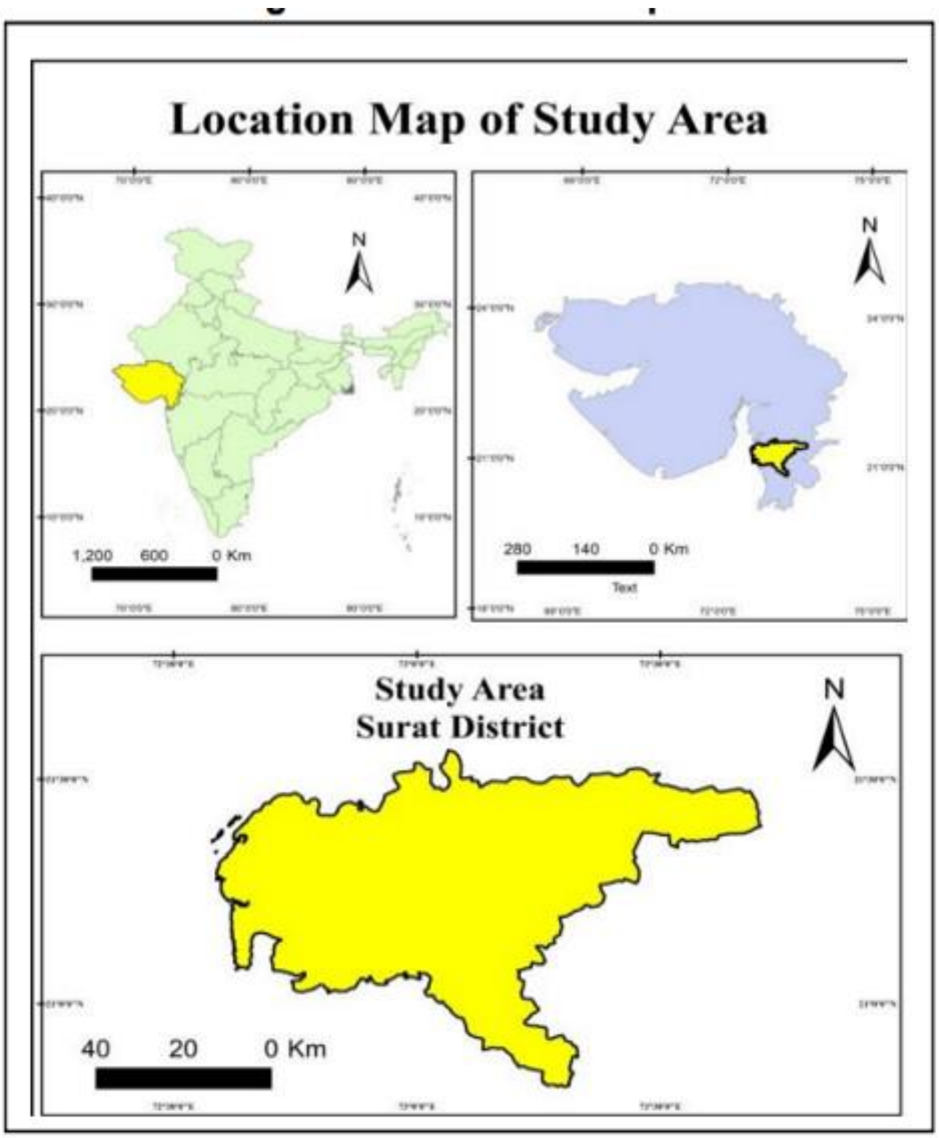


Figure 2. Location Map

Surat District is one of the fast industrializing regions of the State which has many industrial zones like Hazira in the west, Olpad in north-west and Surat city itself. These industries manufacture different types of chemicals, petrochemicals, polymers, fibres, etc. (GSIDS, 2016). The physico-chemical parameters study could help to determine the water quality. WQI calculation and Geographic Information System (GIS) has emerged as a powerful tool for storing, analysing and displaying spatial data and these data for decision making in several fields including environment, earth and engineering sciences, urban planning, agriculture, water resources etc. GIS is used as an effective tool for solution for water resources problem for assessing and mapping of groundwater quality.

https://www.isdesr.org/wp-content/uploads/2020/07/1.-Mukesh-Kumar-Bind-and-Rolee-Kanchan.pdf

A3.1.2 Physiography

Geographically, the district belongs to the western coastlands of the Deccan peninsula. The main Sahyadri scarp is a little outside the limits of the district towards east, but it gives the district its orientation, landscape features and drainage pattern. Distinct zones, viz., hilly areas, piedmont slopes, alluvial plains and coastal plains. Hilly areas: The north-eastern parts of the district fall in this category. Here the general elevations are more than 100m amsl. The topography is rugged with low to moderate high hills and steep hill slopes. These parts are poorly populated and are infested by dense jungle of teak and bamboo. Piedmont slopes: East-central parts of the district fall in this category. Here the elevations range between 60 and 100m.amsl. These parts show a gentle slope towards west. Topography is mainly plain with moderate to deep cutting river valleys and occasional hillocks.

Alluviual plains: Alluvial plains towards situated in the central parts of the district are characterized by flood plains of the Tapi, Kim and Purna rivers. Tapi has a meandering channel entrenched fairly deep and has cut deep terraces. The topography is generally plain with gentle slope towards west. The general elevations are below 60 m.amsl, the lowest elevation being 45m.amsl near Madhi. Coastal Plains: The alluvial plains towards west merge into a dry barren sandy coastal plain fringed by marshy shore line. All the rivers form estuarine mouths. There are sand bars and spits near the shore.

The basaltic lava flows are covered by black clayey to loamy soil. It is in general ranges in thickness up to one meter. The colour of the soil turns brown due to high iron content at places. In the piedmont slope area the soil is shallow to moderately deep, moderate to severely eroded and non-calcareous in nature. The texture is silt clay loam to clay loams. The clay content varies from 30 to 60%. The water holding capacity of the soil is moderate. In the midland and flood plain areas, the soil is deep to very deep, light greyish to yellowish brown in colour. The texture is fine clay loam to sandy loam. The clay content varies from 25 to 60%. In coastal region the soil is deep to very deep dark grey to black colour. The texture is clay loam to silty loam. The area is affected by tide as well as leaching of salts from up land forming saline alkali soils. The content of clay in this is high and permeability is low (mud flats).

https://www.cgwb.gov.in/old_website/District_Profile/Gujarat/Surat.pdf

A3.1.2 Geology

Geographically, the district lies on the western coastal land of the Deccan peninsula. The distinct zones viz. hilly area is dominant in the north-eastern part, piedmont slope in east-central and this part shows a gentle slope towards the west. The topography is mainly plain with moderate to the deep cutting river valley and occasional hillocks. The alluvial plain is situated in the central part of the district and is characterized by flood plains of Tapi, Kim, and Purna Rivers. The coastal plain towards west merges into dry barren sandy shorelines (CGWB 2013).

The geological formation of the district falls under the Deccan trap (Basalt rock), flood plain.

Geological Succession

Era	Period	Epoch /Series	Description
Cenozoic	Quaternary	Holocene	Soil, Younger alluvium Blown and Fluvio-marine deposits.
	Tertiary	Pleistocene	Older alluvium, conglomerate
		Miocene	Ferruginous sandstone (Gaj)
		Eocene	Numulitic limestone
		Palaeocene	Sub-Numulitic limestone, gypseous shale,Supra- Trappean sediments lateritised and having bauxite pockets.
Mesozoic	Lower Tertiary to Upper Cretaceous	Early Eocene To Upper	Deccan Trap basalt with dykes

S. No	Taluka	Geographical Area (Sq. Km.)
1	Bardoli	399.09
2	Choryasi	396.95
3	Kamrej	377.60
4	Mahuva	267.02
5	Mandvi	829.02
6	Mangrol	526.45
7	Olpad	598.09
8	Palsana	202.26
9	Umarpada	513.26
	Total	**4109.74**

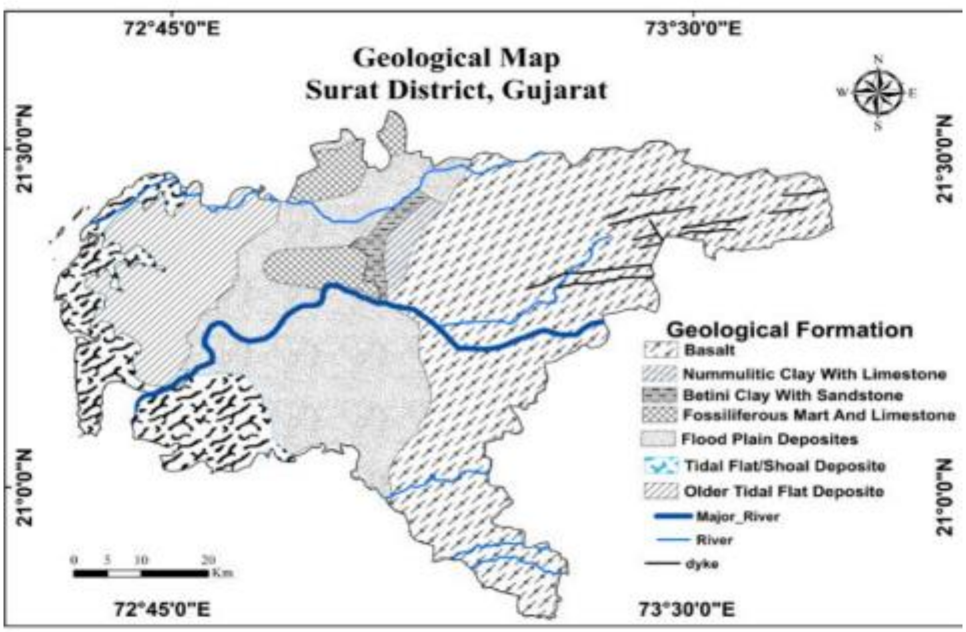


Figure 3. Geological Map Surat

https://www.isdesr.org/wp-content/uploads/2020/07/1.-Mukesh-Kumar-Bind-and-Rolee Kanchan.pdf

A3.1.3 Hydrogeology

The hydro-geological framework of the area is essentially governed by geological setting, Tapi River, distribution of rainfall fall and facilities of circulation and movement of water through interconnected primary and secondary porosity of the geological units forming the aquifers. The major aquifers in the district are formed by alluvium and Deccan trap basalt. The alluvium occurs in the western part of the district and along the streams whereas in eastern parts weathered and fractured basalt from aquifers.

Conclusion

The present study focused on the spatial pattern of groundwater quality in Surat District, Gujarat. Fluctuation was observed in each category of WQI in both seasons. The geological structure, urbanization and use of fertilizer in the agricultural field played a significant role in affecting water quality in the western part of the study area which is highly developed as compared to eastern part. It is very essential to sustain groundwater quality in poor quality zones in the district. For the improvement in groundwater quality, construction of concrete drainage lines, treating of industrial pollutant water before discharging into river, continuous monitoring of water quality, reframing the use of fertilizer limit for agricultural practices and reframing policy for discharging of industrial effluents are some of the means for improvising the water quality. In the overall study, the eastern part of the study area has good water quality which is suitable all purpose (viz. drinking, domestic, irrigation as well as industrial) because their geological structure is made up of basalt rock which helped in purifying water, absence of industries specifically chemical and urbanization This part is largely covered by forest and water bodies (UkaiDam)

https://www.isdesr.org/wp-content/uploads/2020/07/1.-Mukesh-Kumar-Bind-and-Rolee-Kanchan.pdf

A3.2 Land Use

Surat city experienced significant urban expansion due to rapid industrialization and population growth. The supervised classification of satellite images revealed that urban areas grew by 29.5% between 1993 and 2000, 31.3% from 2000 to 2010, and 47.7% by 2019. This urbanization led to a reduction in water bodies and cultivated land, particularly during a drought in 2000, which increased barren land. The classification results, with accuracy ranging from 84% to 93.3%, highlight the environmental impact of this rapid urbanization, resulting in a shift in land use patterns and an imbalanced environmental situation in Surat.

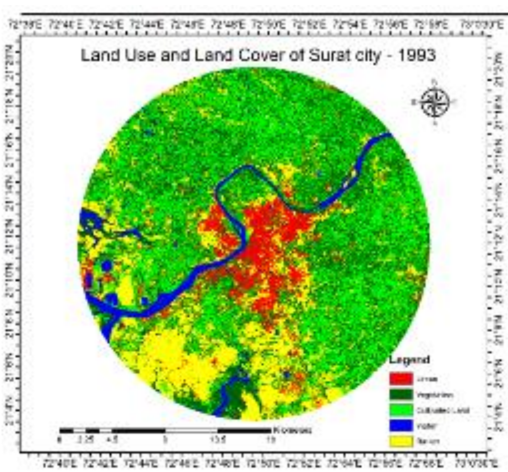
The Tapi basin's land cover and land use characteristics highlight the region's predominant reliance on agriculture, which occupies 66.19% of the area. Key crops include wheat, sugarcane, rice, and gram, with wheat being the most significant irrigated crop, covering 30.3% of the irrigated land. Dryland farming is prevalent, with groundnut, soybean, maize, and pulses as common kharif crops, and sorghum and gram as common rabi crops.

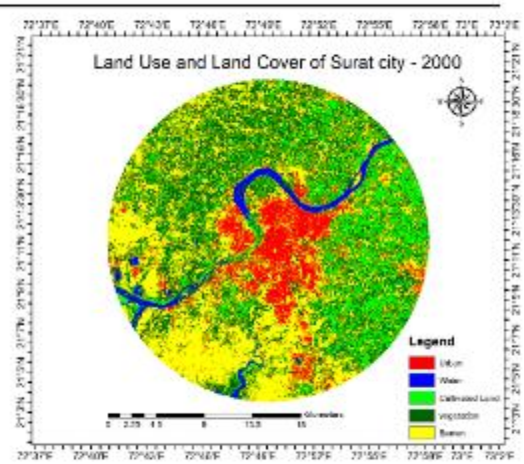
Forests cover 24.41% of the basin, primarily consisting of dry deciduous vegetation. The culturable area constitutes 68.1% of the total area. Built-up land is minimal, at only 1.26%, while water bodies, primarily contributed by the Tapi River and its tributaries, cover 2.99% of the basin. Wastelands, including scrublands and gullied lands, account for 5.16% of the area.

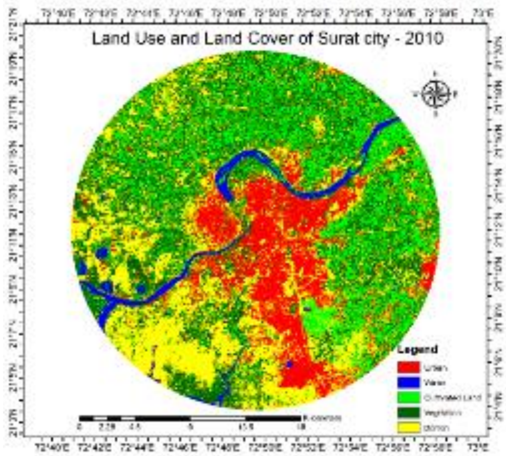
S.no.	Category	Area (Sq. km)	% of Total Area
1	Built Up Land	818.64	1.26
2	Agricultural	43117.34	66.19
3	Forest	15899.92	24.41
4	Grassland	1.47	0.00
5	Wasteland	3362.91	5.16
6	Waterbodies	1944.71	2.99

CLASS	1999 Area (km^2)	2000 Area (km^2)	2010 Area (km^2)	2019 Area (km^2)
URBAN	59.9157	77.571	112.993	164.923
WATER	29.709	21.0546	21.0357	17.6733
CULTIVATED LAND	239.953	99.7686	141.47	231.793
VEGETATION	228.562	227.209	215.748	95.3595
BARREN	148.736	281.272	215.628	197.126
TOTAL	706.875	706.875	706.875	706.875

Table: Land Use and Land Cover classification of Surat city







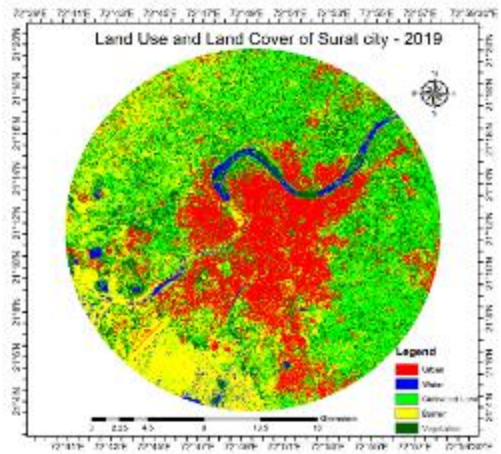


Figure: Land Use and Land Cover of Surat city

https://www.researchgate.net/figure/Land-Use-and-Land-Cover-classification-of-Surat-city_tbl3_344870260

In this study, overlay analysis is used to understand how urban land expansion has affected water bodies in Surat. First, polygons were drawn around water bodies from a topographic map of Surat from 2011 to create a vector map showing the location and shape of these water bodies. Next, data on urban land use from 2019 was extracted from a classified satellite image of Surat. By overlaying these two datasets, the study examines how much of the original water bodies from 2011 have been covered by urban development by 2019. This method helps visualize the impact of urban growth on water bodies in the city.

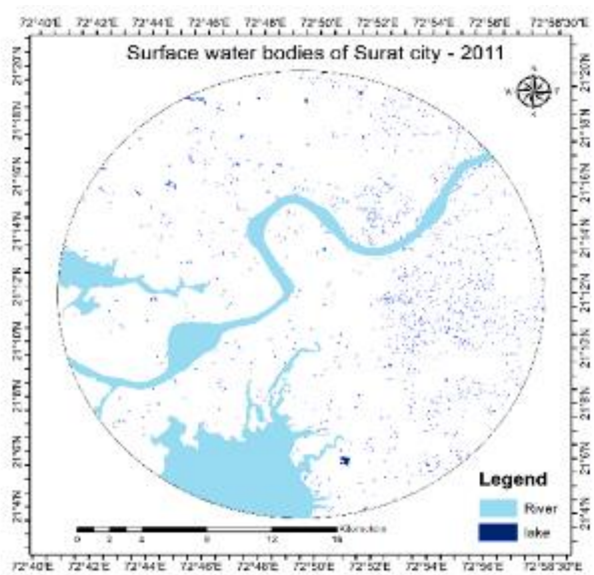


Figure: surface water bodies of Surat city

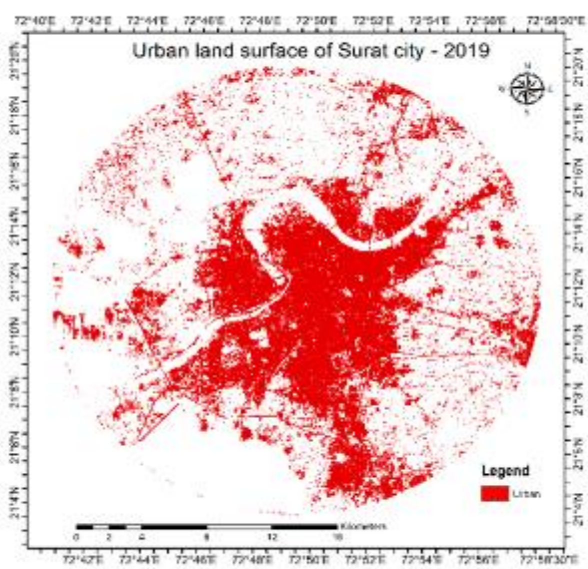


Figure: The urban land surface of Surat city

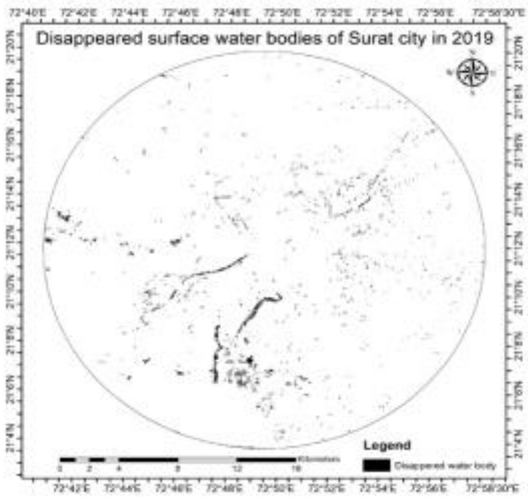


Figure: Disappeared surface water bodies of Surat city in 2019.

[**https://www.researchgate.net/figure/Land-Use-and-Land-Cover-classification-of-Surat-city_tbl3_344870260**](https://www.researchgate.net/figure/Land-Use-and-Land-Cover-classification-of-Surat-city_tbl3_344870260)

Conclusion

From 1993 to 2019, Surat's urban area expanded by 175.2%, significantly altering land use, especially in the city center and fringe areas. This rapid urbanization, often at the expense of agricultural land and water bodies, has led to environmental issues such as flooding, water scarcity, and loss of natural ecosystems. About 0.812 sq.km of water bodies were converted into urban areas between 2011 and 2019. To mitigate these negative impacts, better urban planning and conservation policies are needed to protect natural resources and ensure sustainable development.

A3.3 Drainage

The Tapi is the major river which passes through the central parts of the district and flows towards the west. The river is perennial in nature. It originates in Madhya Pradesh near Betul and has about 62225 sq. Km. of catchment area. The average width of the river in the upstream of Kathor bridge is about 500m. Downstream of the bridge the average width increases to 700m. Pickup weir was constructed on the Tapi river in 1954 at Kakarapar about 56km west of Surat. Ukai dam, constructed in 1965, is situated about 25km upstream of Kakarapar weir. Other prominent rivers draining the district are Kim, Ver, Mindola, Jhankhari and Purna. The Ver flows from north-east to south-west and flows parallel to Tapi and then it flows towards west. All other rivers are situated toward south of Tapi and flow towards west, parallel to Tapi.

A3.4 River Basin

The Tapi is the second largest westward draining interstate river basin. It covers a large area in the State of Maharashtra besides areas in the states of Madhya Pradesh and Gujarat. The Tapi Basin is the northern - most basin of the Deccan plateau and is situated between latitudes 200 N to 220 N approximately. The Satpura range forms its northern boundary whereas the Ajanta and Satmala hills form its southern extremity. Mahadeo hills form its eastern boundary. The basin finds its outlet in the

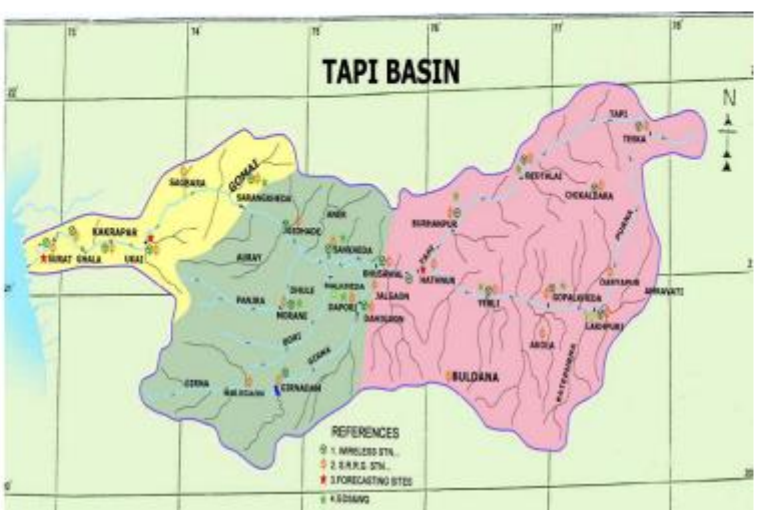
Arabian Sea in the west. Bounded on the three sides by the hill ranges, the river Tapi, along with its tributaries, more or less flows over the plains of Vidharbha, Khandesh and Gujarat. The Tapi River drains an area of 65145 Sq.Km. out of which nearly 80 percent lies in Maharashtra. The state wise distribution of the drainage area is shown in Table.

Sr. No.	Name of State	Drainage area[Sq. Km.]	Percentage of total
1	Madhya Pradesh	9,804	15.0
2	Maharashtra	51,504	79.1
3	Gujarat	3,837	5.9
	TOTAL:-	65,145	100.0

S.no.	Sub Basin	Area (Sq. Km.)	Size Range of Watershed (Sq. Km.)	No. of Watersheds
1	Tapi Lower Sub Basin	4108.90	427.18 - 781.84	7
2	Tapi Middle Sub Basin	31766.67	365.64 - 937.44	47
3	Tapi Upper Sub Basin	28047.34	322.12-937.28	46

Table: Sub-basin wise watersheds

Watershed Code	
Sub-Basin Name	**Watershed Code**
Tapi Lower	B13TAL01 to 07



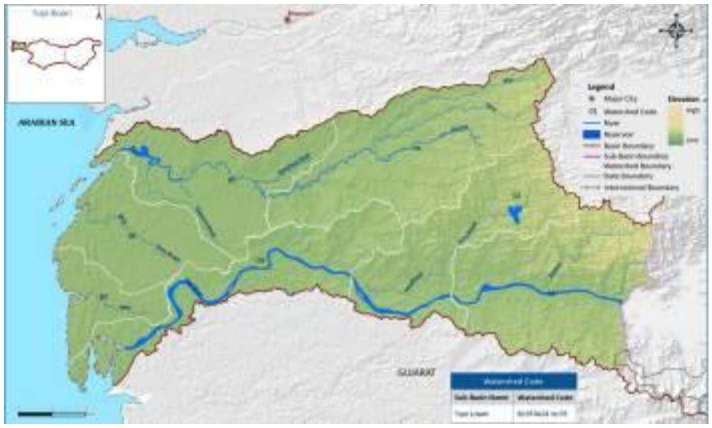


Figure: Tapi river Basin

(Source: India Water Resources Information System: www.india-wris.nrsc.gov.in.)

A3.5 Description of river system

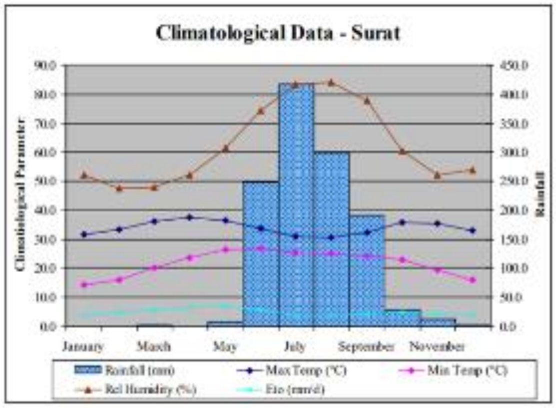
The Tapi River originates near Multai in Betul district at an elevation of 752 m above m.s.l. The total length of this west flowing river from its origin to its out fall into the sea is 724 Km. For the first 282 km the river flows in Madhya Pradesh, out of which 54 km forms the common boundary with Maharashtra State. It flows for 228 km in Maharashtra before entering Gujarat. Traversing a length of 214 km in Gujarat, the Tapi River joins Arabian Sea in the Gulf of Cambay after flowing past the Surat city. The river receives tidal influence for a length of about 25 Km upstream from the mouth. (Up to Singanpur weir causeway) The Tapi River receives several tributaries on both the banks. There are 14 major tributaries having a length more than 50 Km. on the right bank, 4 tributaries namely the Vaki, Gomai, Arunavati and Aner join the Tapi River. On the left bank, 10 important tributaries namely the Nesu, Amaravati, Buray, Panjhra, Bori, Girna, Waghur, Purna, Mona and Sipna drain into the main channel. The drainage system on the left bank of the Tapi river is, therefore, more extensive as compared to the right bank area.

A.4. Climate

(ι) Type of Climate

Agro-climatic Zones: is a land unit in terms of major climate, and growing period which is climatically suitable for a certain range of crops and cultivars. The climate of the area is characterized by hot and wet summers and dry winters. The region in general has an annual rainfall of over 100cm with some local variations. Major part of the Tapi Basin falls in the Western plateau and Hilly Agro climatic zone map of Tapi basin is shown in Map10. The uppermost part of the basin falls in the “Central Plateau and Hilly region” and the lowermost part fall in the “Gujarat Plateau and Hilly region”(Source: Agro-climatic Zone: Panning Commission,1989)

https://indiawris.gov.in/downloads/Tapi%20Basin.pdf



https://www.cgwb.gov.in/old_website/District_Profile/Gujarat/Surat.pdf

A.5. Rainfall

The South-west monsoon sets in by the middle of June and withdraws by the first week of October. June to September is the period of heaviest rain. During this season, the weather is somewhat sultry and oppressive, especially in areas adjoining the Tapi River. In the post-monsoon season, a few thunderstorms occur especially in October. Therefore, the weather clears up and it is dry and pleasant throughout the Tapi valley. The Tapi basin receives its maximum rainfall in the monsoon season. The normal rainfall near the coastal areas in the basin is highest going up to 1,000 mm. The normal annual rainfall in the Tapi basin up to is 820 mm, about 90% of which is received during the monsoon months only of which 50% is received during July and August In, the first week of October, 5.2% of the annual rainfall is received so rainfall is likely to produce a comparatively higher runoff so month of October has been included in the monsoon months. Source: (Water Year Book, 2010-2011 Central Water Commission, Ghandhinagar), Indian Meteorological Department). There are 17 districts (3-Gujarat, 4-Madhya Pradesh & 10-Maharashtra) falling in the basin which are drought prone. (Source: Drought Prone Areas Program, DPAP, MoRD, 2002).

The Upper Tapi basin had max rainfall in year 1990 is 1187.31mm while minimum annual rainfall in year 2000 is 592.4mm, The Middle Tapi basin had max annual rainfall in year of 1976 is 1427.45mm while minimum rainfall in 1991 574.94 while Lower Tapi basin had max annual rainfall of 1405mm in year of while minimum annual rainfall is recorded in year of 1991 is 578.94mm.

Surat District Rainfall Data - IMD Data	
Year	Total Rainfall (mm)
2014	849.6
2015	899.9
2016	1093.3
2017	1243.6
2018	1285.4
2019	1933.4
2020	2149.3
2021	1598.9
2022	1822.9
2023	1124
Total	14000.3

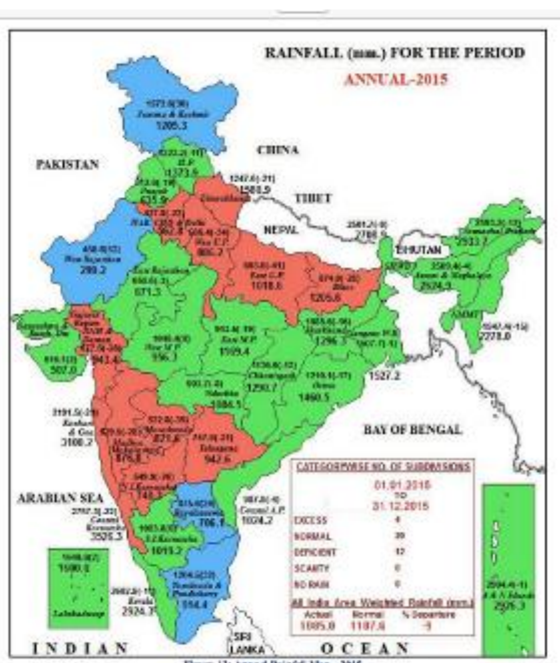


Figure 13: Annual Rainfall Map – 2015

Figure 24: Annual Rainfall Map – 2016

Figure 13: Annual Rainfall Map – 2017

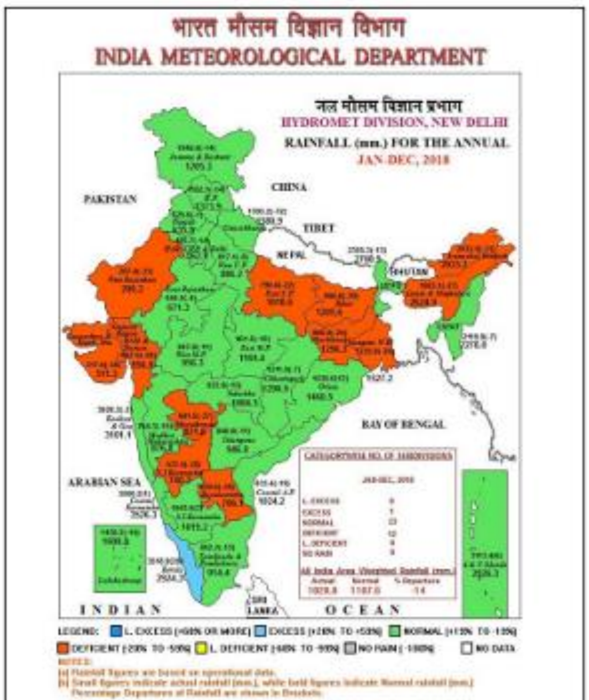


Figure 13: Annual Rainfall Map – 2018

Figure 13: Annual Rainfall Map

Figure 12: Annual Rainfall Map

Figure 12: Annual Rainfall Map

Figure 13: Annual Rainfall Map

https://environicsindia.in/wp-content/uploads/2018/09/Rainfall-Statistics-of-India-2014.pdf

Taluka Wise Ground Water Resources, Availability, Utilization and Stage of Ground Water Development- 2023																
DISTRICT- SURAT																
Sr No	Taluka	ANNUAL REPLENISHABLE GROUND WATER RESOURCES (Ham)				Total Annual Ground water Recharge (3+4+5+6)	Environmental Flows (ham) (5% of 7 for WTF & 10% of 7 for RIF)	Annual Extractable Ground water Resource (ham)	ANNUAL GROUND WATER DRAFT (Ham)				Allocation of Ground Water Resource for Domestic Utilisation for projected year 2025 (ham)	Net Annual Ground Water Availability for Future Use (ham)	Stage of Ground Water Extraction (%)	Categorization of Assessment Unit
		Monsoon		Non Monsoon												
		Recharge from Rainfall	Recharge from Other Sources	Recharge from Rainfall	Recharge from Other Sources				Irrigation	Industrial	Domestic	Total Draft (10+11+12)				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	BARDOLI	5796.8	1289.92	0	4561.71	11648.43	1164.84	10483.59	5234.10	5.35	517.66	5757.10	615.75	4628.40	54.92	safe
2	KAMREJ	9774.48	977.54	0	3365.32	14117.34	705.87	13411.47	5165.10	88.15	511.19	5764.44	608.04	7550.18	42.98	safe
3	MAHUVA	5144.86	1408.82	0	5005.87	11559.55	1155.96	10403.59	4613.80	4.46	93.72	4711.97	111.48	5673.86	45.29	safe
4	MANDVI	15216.1	1385.34	0	6741.13	23342.57	2334.25	21008.32	4751.50	41.43	583.66	5376.59	694.25	15521.14	25.59	safe
5	MANGROL	15108.39	1129.39	0	4106.60	20344.38	1017.22	19327.16	1835.40	137.80	515.75	2488.95	613.47	16740.49	12.88	safe
6	OLPAD	5405.27	1638.96	0	6896.38	13940.61	1394.06	12546.55	1235.00	54.27	0.00	1289.27	270.43	10986.85	10.28	safe
7	PALSANA	6990.26	1085.72	0	3831.06	11907.04	1190.71	10716.33	2804.10	3733.43	334.97	6872.50	398.44	3780.36	64.13	safe
8	SURAT CITY & CHORASI	4586.23	922.5	0	3665.09	9173.82	917.38	8256.44	3230.40	144.24	689.32	4063.97	819.93	4061.86	49.22	safe
9	SURAT URBAN	14073.49	0	0	0.00	14073.49	703.67	13369.82	0.00	329.94	15087.88	15417.82	17668.11	0.00	115.32	over_exploited
10	UMARPADA	13183.4	102.11	0	201.54	13487.05	674.36	12812.69	829.50	0.00	225.57	1055.07	268.31	11714.88	8.23	safe
	Surat Total	**95279.28**	**9940.30**	**0.00**	**38374.70**	**143594.28**	**11258.32**	**132335.96**	**29698.90**	**4539.06**	**18559.73**	**52797.68**	**22068.21**	**80658.02**	**39.90**	**safe**

A.6. Ground Water

Groundwater quality alludes to the state of the water that is arranged under the Earth's surface. Groundwater can accumulate in breaks in subsurface rocks and the centre of soil particles. Since various blends can break down in water and others can be suspended in water, there is a potential for pollution with harmful mixes including significant particles like Electrical Conductivity (EC), Total Dissolved Solids (TDS), and many others i.e. Ca, Cl, F, Mg, NO3, SO4, and Total Hardness. This study examines Groundwater Quality in the study area of the South-West zone of Surat city, Gujarat. The South-West zone of Surat city is situated on the shoreline, causes the groundwater of the concerned area highly affected by seawater intrusion. The present study determines the Ground Water Quality Index (GWQI) from the year 2006 to 2015. It also predicts the approximate ground water quality for the next 10 years. The outcome of this study suggests the need of certain improvement in ground water quality by an appropriate method such as Managed Aquifer Recharging (MAR). It will be beneficial for the people mainly dependent on the ground water, particularly living near the coastal region.

file:///C:/Users/user/Downloads/An_assessment_of_groundwater_quality_in_South-West.pdf

(i) Description of aquifer:

The level of Ground Water Development varies from 20.14% (Olpad Taluka) to 77.72% (Choriyasi Taluka.) and overall Level of Development for the district is 40.39 %. The overall category of the district is also "Safe"

(Refer Water Data Guide under Documents on https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/17084175271055872857file.pdf)

(ii) **Unconfined Aquifers:**

Potable: Generally, unconfined aquifers can have a mix of water quality. In Surat, potable water from unconfined aquifers can be found but may be limited in certain areas. Quality often depends on local contamination sources and management practices.

Brackish: Unconfined aquifers in Surat can contain brackish water, especially near coastal areas where seawater intrusion can impact groundwater quality.

Saline: Saline water in unconfined aquifers is also a concern, particularly in coastal zones where the intrusion of seawater can occur, leading to increased salinity in the groundwater.

Confined Aquifers:

Potable: Confined aquifers in Surat generally have better water quality compared to unconfined aquifers due to natural filtration processes through the confining layers. However, localized contamination can still affect water quality.

Brackish: The brackish water is less common in confined aquifers but can occur depending on the geological formations and proximity to saline water sources.

Saline: Saline water is less common in confined aquifers but can still be present in certain areas, particularly if there is a significant geological connection to saline water sources or if there is significant over-extraction leading to quality issues.

https://www.cgwb.gov.in/old_website/District_Profile/Gujarat/Surat.pdf

(iii) Any special quality problem, (Seawater intrusion, pollution, high fluoride etc.).

As of the latest reports from the Central Ground Water Board (CGWB), Surat District in Gujarat faces several water quality issues, including:

1. **Seawater Intrusion**: Surat, being a coastal district, is vulnerable to seawater intrusion, especially in areas where groundwater is over-exploited. This intrusion can lead to increased salinity in groundwater, affecting its potability and usability for irrigation.
2. **Fluoride Contamination**: Fluoride levels in groundwater can be a concern in some parts of Surat. Excessive fluoride can lead to health issues such as dental and skeletal fluorosis. Monitoring and managing fluoride concentrations is important to mitigate these risks.
3. **Pollution**: Industrial activities in Surat can contribute to pollution, including contamination from chemicals and heavy metals. This pollution can affect both surface and groundwater quality, making it essential to implement measures to prevent contamination and protect water sources.

file:///C:/Users/user/Downloads/An_assessment_of_groundwater_quality_in_South-West.pdf

http://jalshakti-dowr.gov.in/sites/default/files/MasterPlanForArtificialRechargeToGroundWater2020.pdf

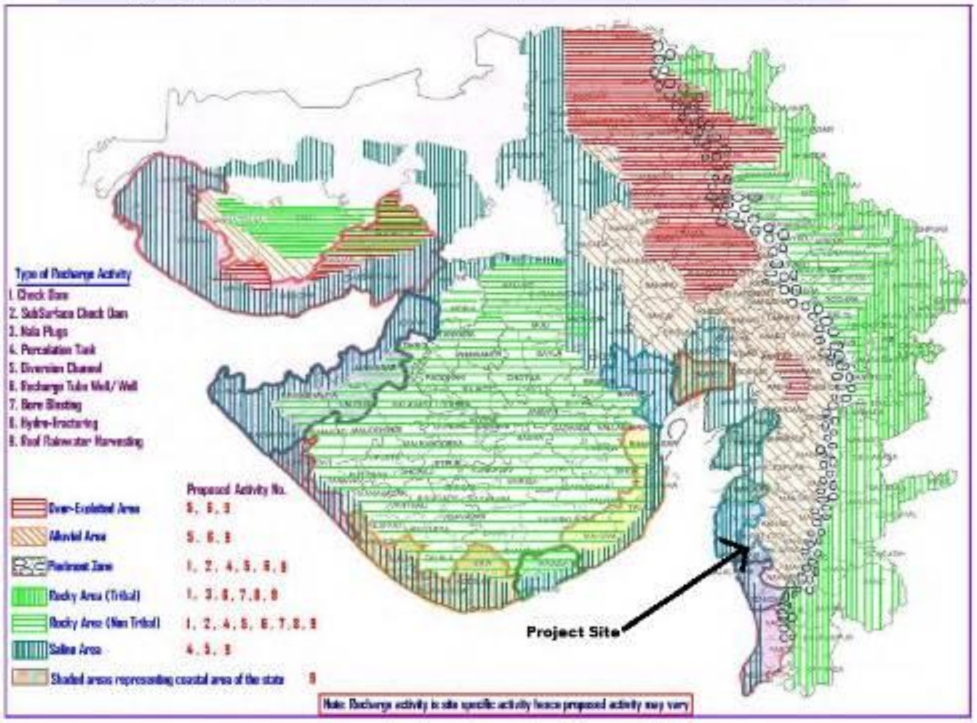
A.7. Alternate methods

Surat District, water management methods should be tailored to local conditions such as topography, rainfall, hydrogeology, and land source water availability. Current methods are likely chosen based on these factors, with a focus on sustainability and feasibility. For high rainfall areas, rainwater harvesting, and check dams are effective, while recharge pits and watershed management are beneficial for addressing groundwater depletion. In coastal regions facing saline intrusion, desalination and coastal aquifer management can be alternative solutions. A comprehensive approach considering these methods can enhance water resource management in Surat.

Table: Water Management Methods for Surat District

Condition	Recommended Methods	Rationale
High Rainfall Areas	-Rainwater Harvesting - Check Dams	Captures and stores excess rainfall for dry periods.
Groundwater Depletion	-Recharge Pits - Watershed Management	Enhances groundwater recharge and manages resources holistically.
Coastal Areas with Saline Intrusion	-Desalination -Coastal Aquifer Management	Mitigates the impact of saline water on freshwater resources.

https://www.cgwb.gov.in/old_website/District_Profile/Gujarat/Surat.pdf wasmows.gujarat.gov.in/web/public/content/cms.portal.document/164/document/Handbook_on_recharge.pdf



Number of natural and man-made water bodies including lakes in rural and urban areas in the State of Gujarat reported in the first Census of Water bodies

State	No. of water bodies including lakes 14.12.2023								
	Natural			Man made			Total		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Gujarat	16,166	800	16,966	36,990	113	37,103	53,156	913	54,069

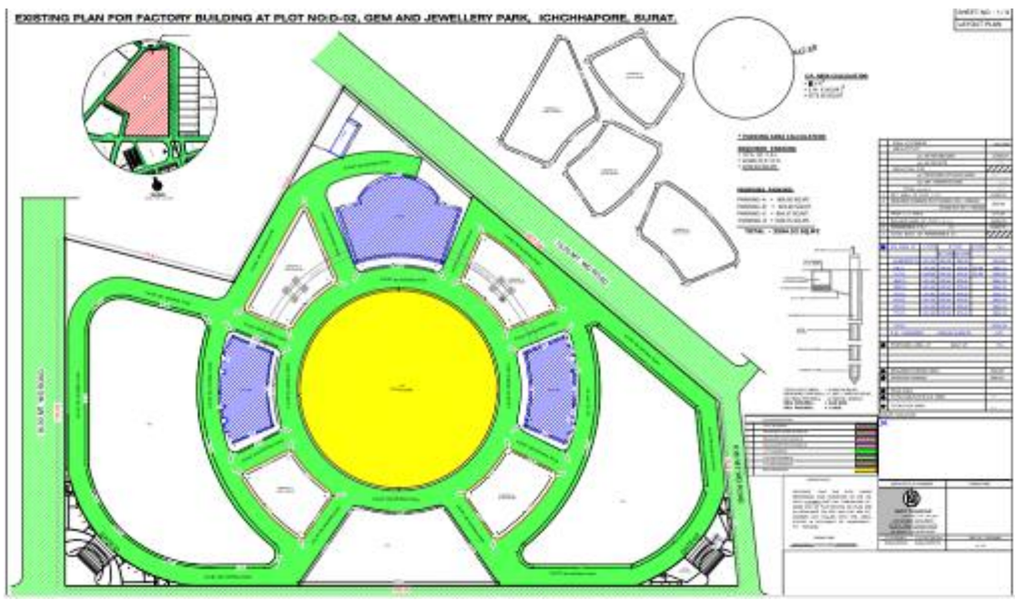
sansad.in/getFile/loksabhaquestions/annex/1714/AU2017.pdf?source=pqals

A.8. Design Specifications

Ichchapor HK HUB Sarovar 1 is an innovative artificial lake developed by the PP, designed specifically for rainwater harvesting and sustainable water resource management. This circular lake, with dimensions of 82 meters in both length and width and a depth of 5 meters, is engineered to capture and store substantial quantities of rainwater. The project exemplifies PP's commitment to environmental stewardship and responsible natural resource management, particularly in addressing local water needs.

The construction of the lake is carefully planned to ensure durability and functionality. The lake's foundation begins with precise excavation to the required depth, followed by grading and levelling to ensure uniformity, effective drainage, and structural stability. Special care is taken to promote percolation, allowing rainwater to naturally seep into the ground and recharge the local water table. Reinforcement measures, such as soil stabilization techniques, are integrated to enhance the lake's longevity and prevent erosion.

Beyond its primary function of rainwater harvesting, Ichchapor HK HUB Sarovar 1 plays a vital role in groundwater recharge through percolation. This process helps restore local water tables, contributing to the long-term availability of water resources in the area. The lake's design maximizes its capacity to collect rainwater and facilitates natural percolation, ensuring sustainable water management for the future.



Site Layout

A.9. Implementation Benefits to Water Security

The primary achievement of Ichchapor HK HUB Sarovar (artificial Lake) construction is its ability to enhance biodiversity by creating a habitat for a variety of plant and animal species. It also improves the microclimate, fostering a more stable and favorable local environment. Additionally, ponds add aesthetic and recreational value, offering visual appeal and opportunities for leisure activities. Furthermore, they serve as an educational resource, providing a hands-on learning environment for studying ecosystems and environmental science.

- **Increased Groundwater Recharge:** The artificial lakes captured and stored rainwater, allowing it to percolate into the ground, thereby replenishing local groundwater reserves and ensuring long-term water availability.

- **Reduced Surface Runoff:** The lakes and surrounding green areas absorbed rainwater, reducing surface runoff and minimizing soil erosion and flood risks.
- **Water Storage and Management:** the lakes served as reservoirs for excess rainwater, providing a controlled storage solution that ensured a steady water supply during dry periods and emergencies.
- **Promotion of Sustainable Water Use:** Educational programs promoted water conservation and sustainable practices, leading to more responsible water use among employees and the local community.
- **Enhanced Ecosystem Services:** The lakes supported local ecosystems, which in turn contributed to natural water filtration and hydrological processes, maintaining water quality and availability.
- **Reduction of Water Stress:** By increasing water storage and promoting efficient use, the project alleviated pressure on existing water resources, reducing the risk of water shortages.

A9.1 Objectives vs Outcomes

Objective of the Project Activity

Enhancing Environmental Sustainability: The primary aim of this objective was to enhance environmental sustainability through effective water management. The artificial lakes were designed to function as reservoirs, capturing and storing rainwater. This setup was intended to improve groundwater recharge, address water scarcity issues, and support local ecosystems by maintaining ecological balance. By transforming a barren, dry area into a water-rich environment, the project sought to create a more resilient and sustainable landscape.

Improving Employee Well-being: The project's objective was to foster a healthier and more enjoyable working environment. By integrating the lakes and surrounding green spaces, the aim was to provide employees with a serene and visually appealing setting. The addition of walking paths, gardens, and seating areas around the lakes was intended to offer relaxation and recreational opportunities. This change was expected to reduce workplace stress, boost morale, and enhance overall employee satisfaction and productivity.

Demonstrating Corporate Social Responsibility (CSR): This objective focused on highlighting PP's commitment to environmental and community welfare. The development of the lakes was intended to serve as a tangible example of the company's CSR initiatives. By investing in environmental improvements and showcasing these efforts, the company aimed to build a positive reputation, demonstrate its dedication to sustainability, and strengthen its relationship with both employees and the local community.

Raising Awareness on Water Conservation: The objective here was to educate employees and the local community about the importance of water conservation and sustainable practices. Through the introduction of guided tours and educational sessions around the lakes, the project aimed to raise awareness about effective water management. This initiative was designed to promote a culture of environmental consciousness and encourage sustainable behavior among stakeholders, thereby extending the impact of the project beyond its immediate surroundings.

Outcome of the Post-Project Activities:

Enhanced Biodiversity: The introduction of the lakes led to a notable increase in local biodiversity. The newly created water bodies attracted a variety of aquatic plants and provided habitat for numerous bird species. This resulted in a vibrant ecosystem, where the presence of flora and fauna contributed to a richer, more diverse natural environment. The enhanced biodiversity also supported ecological balance and improved the overall health of the area.

Improved Microclimate: The presence of the lakes had a significant impact on the local microclimate. The water bodies helped regulate temperature and humidity levels, creating a more comfortable and pleasant environment. This improvement in microclimate not only made the area more enjoyable for employees but also contributed to better air quality. The cooling effect of the lakes mitigated the extreme heat previously experienced, enhancing the overall working and living conditions.

Aesthetic and Recreational Value: The lakes and their surroundings were designed to enhance the aesthetic appeal of the industrial site. The addition of landscaped paths, gardens, and seating areas transformed the area into a visually appealing and relaxing space. This new recreational value provided employees with opportunities for leisure and relaxation, contributing to a more inviting and enjoyable environment. The improved aesthetics also positively influenced the overall ambience of the site.

Educational Opportunities: The project introduced educational programs and guided tours focused on water conservation and environmental sustainability. These initiatives provided valuable learning experiences for both employees and visitors. By offering insights into the importance of water management and sustainable practices, the project aimed to raise awareness and foster a deeper understanding of environmental issues. This educational component was intended to encourage proactive engagement with conservation efforts and promote sustainable practices among stakeholders.

A9.2 Interventions by Project Owner / Proponent / Seller

The project activity by the PP has achieved its objectives through meticulous planning, execution, and ongoing management. By conducting a thorough Environmental Impact Assessment and implementing a robust water management strategy, the project addressed potential environmental concerns and ensured a sustainable water supply. The design and construction phases focused on enhancing biodiversity, improving the aesthetic appeal of the premises, and creating recreational spaces that benefit both employees and the local community.

The project's success continued through effective ongoing management, including regular maintenance and monitoring, which supported a healthy ecosystem and provided educational opportunities to raise environmental awareness. Transparent reporting and impact assessments ensured that stakeholders were informed and engaged throughout the project's lifecycle.

The project activity has significantly improved the environmental quality of the area, fostered a positive and sustainable work environment, and exemplified strong corporate social responsibility. These outcomes demonstrate the project's success in creating a lasting, positive impact on both the local ecosystem and the community.

A.10. Feasibility Evaluation

The project activity has significantly enhanced local biodiversity by creating new habitats for aquatic life and bird species, while also improving the microclimate by regulating temperature and humidity. This artificial lake has transformed the area, adding aesthetic and recreational value, creating a more inviting environment for employees and visitors. Additionally, it serves as an educational resource, emphasizing the importance of environmental sustainability and water conservation.

A key feature of the project is its role in groundwater recharge through percolation. By allowing rainwater to slowly seep into the ground, the lake helps replenish local aquifers, promoting sustainable water management and reducing reliance on external water sources. This process is critical for maintaining the area's water table, ensuring long-term water availability for the community.

While the project involved substantial initial investment and ongoing maintenance costs, it offers far-reaching benefits—boosting property value, strengthening the company's environmental credentials, and fostering community engagement. Its long-term success will depend on effective water management practices and continuous ecological monitoring to ensure the health and sustainability of the system.

A.11. Ecological Aspects:

Gujarat heavily relies on surface water as its primary source of water. The state has 185 river basins and an available quota of 55,608 million cubic meters of water (Chengappa, 2021). However, only a small percentage (2%) of this quota, equivalent to 38,100 million cubic meters, constitutes surface water, which has resulted in unequal distribution across the region (Chengappa, 2021). In particular, the Saurashtra and Kutch areas are disproportionately affected despite their vast geographical extent, with access to merely 9% and 2% of the state's water resources, respectively. Contributing greatly to this imbalance are factors such as erratic rainfall patterns and challenging topography.

Various projects such as the Narmada canal have aimed to alleviate surface water shortages in drought-stricken areas like Saurashtra. However, the construction and maintenance of such infrastructure call for substantial investments and continuous efforts to ensure effective water distribution, which have been lacking thus far. Consequently, this has led to further reductions in surface water availability due to the prevalence of leaks and losses during transportation.

With the lake project of the PP, things have now started changing. Lack of infrastructure which was a big problem for the region in holding rainfall water is now being filled with the lakes constructed by the PP.

Lakes constructed are acting as natural or artificial reservoirs that can store large amounts of water. This stored water is then utilized during periods of water scarcity, such as droughts, or for various purposes like landscaping, water supply, and industrial use. The increased storage capacity is helping to ensure a more reliable water supply and mitigating the effects of seasonal variations in rainfall

Approximately three-fourths of Gujarat's area, including Saurashtra, consists of rocky terrain and coastal regions unsuitable for groundwater withdrawal. Lakes constructed are not only increasing the surface water but also helping in increasing the ground water levels.

Groundwater recharge refers to the process where water moves downward from surface water to replenish underground aquifers. Lakes are contributing to this process through following two mechanisms:

1. **Diffuse recharge:** As a hydrological process, diffuse recharge plays a vital role in maintaining the equilibrium of groundwater resources. This mechanism occurs when precipitation infiltrates and permeates through the soil layers, gradually traveling downward until it reaches the water table. In the context of water conservation efforts by organizations like the PP, the construction of lakes serves a dual purpose: not only do these bodies of water provide much-needed resources for local communities, but they also enable groundwater replenishment during rainfall events. As precipitation continues to saturate the earth surrounding these lakes, water naturally seeps into underground aquifers, ultimately enhancing the regional water supply.

2. **Focused recharge:** It represents a closely related yet distinct phenomenon. This particular mechanism involves water from existing lakes and rivers leaking and seeping directly into the ground, contributing substantially to localized groundwater recharge. Lakes constructed by the PP are also doing focused recharge and it becomes quite relevant specifically in arid regions where water sources are scarce, as it allows for efficient utilization of limited resources while concurrently mitigating the detrimental effects of drought conditions on both human populations and ecological systems alike.

Lakes, as crucial elements of the global hydrological cycle, serve as essential components in sustaining ecological systems, nurturing a wide array of aquatic and terrestrial life forms. Their prominent role as natural reservoirs enables them to store vast volumes of water and meticulously regulate its flow, gradually feeding downstream areas to enhance the availability of surface water. As a result, these bodies of water present a continuous and reliable supply during times of drought or low precipitation, which effectively counteracts the consequences of water scarcity. This inherent ability to provide dependable water resources caters to diverse applications such as agriculture, human consumption, industrial processes, and energy generation.

The Dholakia Foundation's lakes exemplify these qualities through their contributions to the region's overall water storage capacity. These man-made lakes capitalize on their strategic placement within natural depressions in the landscape to gather water from rivers and retain it during periods of heavy rainfall. In doing so, they impede the rapid runoff that would ordinarily occur on the land surface. Consequently, this storage capacity enables these lakes to accommodate vast quantities of water, generating a valuable reserve accessible during periods of limited precipitation and heightened demand for water resources. By functioning as efficient reservoirs, the lakes secure an excess of water otherwise lost as runoff – a versatile commodity now available for vital purposes such as drinking water supply and irrigation.

The storage capacity of lakes is influenced by their size and depth. Larger and deeper lakes have a higher water-holding capacity, enabling them to store larger volumes of water. This is the reason that the PP is not only constructing new lakes but is also increasing the depth and wideness of the existing lakes and river flow area.

Lakes are also going to play a crucial role in regulating the flow of water within river basins of Gagadiya river. They will act as natural buffers, absorbing excess water during periods of high flow and releasing it gradually during dry spells. This regulation of water flow will help to maintain a more consistent water supply in downstream areas, ensuring that surface water is available even during periods of low precipitation or drought. By dampening the effects of extreme hydrological events, lakes will contribute to a more stable and reliable water supply. This becomes even more important in recent times as flash floods are becoming more frequent in this region.

Moreover, lakes are going to interact with the surrounding landscape through various processes such as evaporation, seepage, and groundwater exchange. Evaporation from the lake surface will lead to the formation of atmospheric moisture, which can contribute to precipitation in nearby regions, thereby influencing the distribution of water resources. Additionally, lakes can also replenish groundwater resources through seepage and groundwater exchange processes, enhancing the availability of water in aquifers and maintaining baseflow in rivers and streams.

The presence of lakes will also have significant ecological benefits. They will provide habitat for a diverse array of plant and animal species, supporting aquatic ecosystems and promoting biodiversity. Healthy lake ecosystems are essential for maintaining water quality and functioning as nurseries for many species. By preserving these habitats, lakes will indirectly contribute to the overall health and availability of surface water resources.

Unfortunately, in the modern era, the age-old methodology of rainwater harvesting is greatly neglected. Years of negligence, and short-sighted water management policies that mostly rely on overexploitation of ground and river water, has once again brought rainwater harvesting to the fore because of its life-saving qualities. Rainwater harvesting and management hold tremendous potential for alleviating storm water runoff and reducing groundwater consumption, particularly in urban areas. Though the costs of installing modern rainwater harvesting systems, storing, and treatment of rainwater was an area of concern earlier, but now with the advent of new technologies, the investment has a positive return.

Today, rainwater harvesting systems are acting as incredible support systems in many Indian cities, providing a superb alternative to the main water supply, especially during dry seasons. Moreover, the advantages of storing rainwater are not only limited to a particular individual or a family, but it is coming off as a lifesaver for many urban communities as well. Widespread installation of these systems is also revitalizing the natural properties of land, helping to improve the quality of groundwater, raising its level, and preventing wells and tube wells from drying up. Additionally, efficient deployment of rainwater harvesting systems is limiting surface runoff of water, which is reducing soil erosion, and increasing its fertility.

The project activity of PP in Surat district of Gujarat complies with sustainability goals:

Sustainable Development Goals Targeted	Most relevant SDG Target / SDG Impact	Indicator (SDG Indicator)
SDG 3: Good Health and Well-being	**Target 3.4**: Reduce by one third premature mortality from non-communicable diseases through prevention, treatment, and promotion of mental health and well-being. **Target 3.9**: Reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination.	The report mentions improved employee well-being and productivity due to the creation of a serene environment, which aligns with this goal.
SDG 4: Quality Education	**Target 4.7**: Ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including through education for sustainable development and sustainable lifestyles	The project provides educational opportunities through guided tours and awareness programs about water conservation and environmental sustainability
SDG 6: Clean Water and Sanitation	**Target 6.4**: Increase water-use efficiency across all sectors to ensure sustainable water withdrawals and supply. **Target 6.6**: Protect and restore water-related ecosystems, such as rivers, wetlands, and lakes.	The project focuses on water conservation through the creation of artificial lakes, which serve as reservoirs and enhance groundwater recharge. This directly contributes to sustainable water management.

SDG 11: Sustainable Cities and Communities	**Target 11.3**: Enhance inclusive and sustainable urbanization and capacity for participatory, integrated, and sustainable human settlement planning and management. **Target 11.7**: Provide universal access to safe, inclusive, and accessible green and public spaces, in particular for women and children, older persons, and persons with disabilities	By transforming an industrial area into a more livable space with green areas and water bodies, the project contributes to making the community more sustainable and resilient.
SDG 12: Responsible Consumption and Production	**Target 12.2**: Achieve the sustainable management and efficient use of natural resources. **Target 12.8**: Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.	By promoting water conservation and sustainable use of natural resources, the project encourages responsible consumption patterns.
SDG 13: Climate Action	**Target 13.1**: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. **Target 13.2**: Integrate climate change measures into national policies, strategies, and planning	The improvement of the microclimate through the creation of water bodies helps in regulating temperatures and humidity levels, which can be seen as a local climate action initiative.
SDG 15: Life on Land	**Target 15.1**: Ensure the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems and their services. **Target 15.5**: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity, and protect and prevent the extinction of threatened species.	The project has significantly enhanced biodiversity by creating habitats for various flora and fauna, including migratory birds. This contributes to protecting and restoring terrestrial ecosystems.

SDG 17: Partnerships for the Goals	**Target 17.16**: Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology, and financial resources. **Target 17.17**: Encourage and promote effective public, public-private, and civil society partnerships, building on the experience and resourcing strategies of partnerships.	While not explicitly stated, the project demonstrates a form of partnership between the company and the local community in achieving sustainable development goals

A.12. Recharge Aspects:

Document efforts taken to ensure that the *Quality of Surplus Recharge water is clean, free from contamination and has compatibility with quality of native ground water in aquifers.*

A.12.1 Solving for Recharge

Ultimately, the volume of groundwater recharge benefit to the subbasin is the most critical aspect for such MAR activities. Groundwater recharge is quantified as the deep percolation of surface water applied during project implementation. Using a field-scale water budget, deep percolation can be calculated as the difference between all other inflows and outflows, per the equation below, with each other inflow and outflow being quantified:

Recharge = Rainfall + Surface Inflow – Evapotranspiration – Surface Outflow – Change in Storage

Evapotranspiration & Other Data: https://datameet-pune.github.io/open-water-data/docs/open-water-data-paper.pdf (or available under Documents Section- Water Data Guide)

Root Zone = the root zone is comprised of the upper portion of the soil where water extraction by roots occurs, above the depth at which water infiltrates to the groundwater system. The depth to the bottom of the root zone varies by crop, but typically extends up to seven feet.

Surface Inflow= Surface inflows can be either directly measured or calculated from measured values. In fields directly served by metered lift pumps or metered gates, the volume of surface inflows to the field can be directly measured or calculated from totalized measurements. Typical accuracies of pipe flow measurements range from 1-12 percent. In fields that are indirectly supplied with surface water, surface inflows may need to be calculated from upstream and downstream flow measurements, or through theoretical or empirical equations relating available data to field surface inflows. For example, fields served from canals measured using weirs, or fields served from canals that deliver water to multiple locations downstream of a measurement device may require site-specific calculations to quantify surface inflows to a specific field. Low-cost in-field measurements can also be made by setting up flashboards at the measurement location and correlating the “runup” of an unsubmerged weir overflow on a flat weir stick to the flow rate using standardized equations. Typical accuracies of “runup” or indirect flow measurements may exceed 10 percent, depending on site conditions and the accuracy of measurement data.

To monitor surface inflows, project owners may record flow data, maintain irrigation logs, and maintain logs of any other parameters required to calculate field deliveries, depending on the unique conditions of their field. Project owners may also consider using mobile flow monitoring equipment to measure or verify surface inflows.

Surface Outflows= *To monitor surface outflows, users may record flow data or water level data and maintain logs of any other parameters required to calculate outflows, depending on the unique conditions of their project activity. Pressure transducers and dataloggers may be used to automatically monitor water levels, or users may install wooden stakes to manually monitor water depths.*

Change in Storage *= the change in surface storage, or average ponded water depth, can be calculated from measured and observed changes in water surface levels at points throughout the project field.* Over the annual project implementation period, **the total change in surface storage is typically zero**, provided that the surface of a field is dry and free of ponded water at the start and end of the project.

While the uncertainty of each inflow and outflow will vary based on field conditions and measurement devices, typical uncertainties associated with each water budget component are summarized in the table below. The uncertainty of deep percolation (i.e., recharge) can then be calculated from these other uncertainties, for example following the process described by Clemmens and Burt (1997). Users can use the following table to eliminate uncertainty from their estimates.

Water Budget Component	Typical Estimated Uncertainty (%)	Description
Surface Inflow	2%	Typical range of accuracy from meters to minimum delivery accuracy requirements of delivery and diversion measurement devices. 2% would be consider for surface inflow
Precipitation	1%	Typical range of accuracy from field-level rain gauges to extrapolation of local weather station data.
Surface Outflow	2%	Typical range of accuracy from meters to estimated outflow relationships
Evapotranspiration	20.00%	Clemmens and Burt, 1997; typical accuracy based on free water surface evaporation coefficient.
Deep Percolation	5%	Typical range of calculated accuracy from field-scale water budget results (fields ranging from 56 to 125 acres). 5% would be considered for deep percolation.
Total	30%	

Uncertainty to consider when quantifying recharge are:

- Deep percolation does not immediately recharge the groundwater system. There is a time lag between when deep percolation occurs through the root zone and when that water reaches the saturated groundwater system.
- Subsurface inflows and outflows can occur through the groundwater system. While deep percolation may supply water to the groundwater system, that water may migrate away from the field along groundwater gradients.

Groundwater recharge can also be monitored and verified through groundwater level measurements at groundwater wells adjacent or near to the project activity. For instance, groundwater level measurements collected before, during, and after implementation can potentially help verify that net recharge is occurring, especially in well-positioned wells with continuous monitoring.

A.13. Quantification Tools

The baseline scenario is the situation where, in the absence of the project activity, unutilized rainwater flows uncollected into drains or is not conserved and harvested within the project boundary and hence remains unutilized. Baseline scenario, if not directly measurable, is calculated by using the UWR Standard. The PP has selected the following method from UWR standard

Harvesting potential or Volume of water utilized (m3) = Area of Catchment/Roof/Collection Zone (m2) X Amount of rainfall (m) X Runoff coefficient*uncertainty Factor (1-0.30= 0.70)

As per UWR Standard

Surface area	Runoff Coefficient (K)
Industrial (Asphaltic or concrete pavement)	0.9

Area of Catchment:

Annual Rainwater harvesting Potential

Annual rainwater harvesting potential is given by

V = K × I× A

Where, V=Volume of water that can be harvested annually in liters.

K = Runoff coefficient

I = Annual rainfall in (mm)

A = Catchment area in (m^2)

Ichchapor HK HUB Sarovar 1

Year	Area of Catchment	Annual Rainfall	Runoff coefficient	Uncertainty Factor	Total Volume of Water
2014	5773.5	849.6	0.9	0.7	3090254.328
2015	5773.5	899.9	0.9	0.7	3273210.77
2016	5773.5	1093.3	0.9	0.7	3976665.557
2017	5773.5	1243.6	0.9	0.7	4523352.498
2018	5773.5	1285.4	0.9	0.7	4675391.847
2019	5773.5	1933.4	0.9	0.7	7032365.487
2020	5773.5	2149.3	0.9	0.7	7817659.637
2021	5773.5	1598.9	0.9	0.7	5815686.965
2022	5773.5	1822.9	0.9	0.7	6630443.285
2023	5773.5	1124	0.9	0.7	4088330.82

Quantification of RoUs

Year	Crediting Period	RoUs (1000 Liters)/Year
2014	01/01/2014-31/12/2014	3090
2015	01/01/2015-31/12/2015	3273
2016	01/01/2016-31/12/2016	3976
2017	01/01/2017-31/12/2017	4523
2018	01/01/2018-31/12/2018	4675
2019	01/01/2019-31/12/2019	7032
2020	01/01/2020-31/12/2020	7817
2021	01/01/2021-31/12/2021	5815
2022	01/01/2022-31/12/2022	6630
2023	01/01/2023-31/12/2023	4088

A.14. UWR Rainwater Offset Do No Net Harm Principles

Describe how the project activity accomplishes the following:

- Increase the sustainable water yield in areas where over development has depleted the aquifer
- Implementing aquifer recharge techniques, such as check dams, percolation tanks, and recharge wells, is crucial for replenishing groundwater levels by capturing and storing rainwater, while recharge pits and trenches enhance water infiltration into aquifers. Concurrently, improving water conservation practices through water-efficient technologies, like drip irrigation, and public awareness campaigns can significantly reduce water wastage. Sustainable water management strategies, including regulating groundwater extraction and developing comprehensive management plans, are essential for preventing overexploitation. Exploring alternative water sources, such as seawater desalination and water recycling, can further ease reliance on groundwater. Data from the Central Ground Water Board (CGWB) report for Surat provides critical insights into groundwater levels, aquifer characteristics, and water quality, guiding targeted interventions to restore and sustain water yields, and addressing unutilized rainwater that might otherwise flow into storm drains or sewers.
- Conserve and store excess water for future use

  RWH is responsible for lessening the load on primary water sources, adding fresh and potable water availability for the masses. In the urban and areas, it is shown to be beneficial by increasing the efficiency of wastewater treatment plants since the need for clean water is compensated by the harvested rainwater, to a great extent. The project activity decreases the dependence on groundwater, thereby preventing excessive depletion.

A.15. Scaling Projects-Lessons Learned-Restarting Projects

Surat is actively addressing water scarcity through the development of artificial ponds and lakes, particularly in the context of cultural practices such as Ganesh idol immersion. The Surat Municipal Corporation (SMC) has initiated the construction of multiple artificial ponds to facilitate the immersion of Ganesha idols during the festival season. This approach not only provides a designated area for idol immersion—thereby reducing pollution in natural water bodies—but also helps manage the logistical challenges associated with large-scale immersions.

Artificial Ponds for Cultural Events

The SMC plans to develop **19 artificial ponds** specifically for the immersion of approximately **65,000 Ganesha idols**. This initiative is a response to environmental regulations that have restricted immersions in the Tapi River and coastal areas. By creating these ponds, the SMC aims to segregate immersion processions across different areas, which alleviates pressure on police resources and enhances community participation in the festivities.

Wastewater Management and Reuse

In addition to artificial ponds, Surat has implemented advanced wastewater management strategies. The city has established a **tertiary treatment plant** that recycles and treats wastewater for industrial use. This facility is part of a broader effort to conserve water and reduce reliance on freshwater sources, which are becoming increasingly scarce due to urbanization and climate change. Surat is recognized for its effective reuse of treated wastewater, with a significant portion being redirected for non-potable applications such as irrigation and industrial processes.

Community and Environmental Benefits

The development of artificial lakes and ponds serves multiple purposes:

- **Environmental Protection**: By providing designated immersion sites, the initiative reduces pollution in rivers and oceans, helping to maintain water quality.
- **Water Conservation**: The treatment and reuse of wastewater contribute to conserving freshwater resources, which is critical given the projected increase in water demand in urban areas.
- **Public Engagement**: These efforts foster community involvement in environmental stewardship, as local residents participate in the maintenance and use of these artificial water bodies.

Overall, Surat's innovative approach to managing water resources through artificial ponds and effective wastewater treatment exemplifies a proactive strategy to combat water scarcity while accommodating cultural practices.

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