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Effective Strategies for sustainable Water management in Butibori Town

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ABSTRACT

In this dissertation work an attempt has been made to quantifying the water supply facilities in Butibori town for both present & future population. This dissertation is aimed to prepare water resources management plan for Butibori town. The purpose of the water resource planning process is to ensure security of water supply now and in the long term, taking account of increasing pressures on water supply from factors such as increasing population, climate change and environmental requirements. The study aims to prepare strategic water resource management plan for Butibotri council for assessment of existing water resources present in the city and evolve a technical solution towards water conservation, distribution and maintenance of the system. In order to prepare a water resource management plan for urban areas, like Butibori city, few case studies were referred to understand the water resources characteristics and need for management of water resources in different time periods, from various Indian cities and cities from outside of India also. The reference Case Studies are selected based on the importance of water resources in the region, different possible management approach for improving water management strategies (Like NRW reduction, Usage of reclaimed water for non-drinking purposes, Sustainable water resource management techniques and various water augmentation measures) in that city.

Keywords-climate change, population growth, water demand, water supply, water resource management.

I.INTRODUCTION

India is facing challenges with its water future. The current way of developing and managing water supply systems isn't sustainable for the long term. Having a reliable water supply is essential for public health, society, and the economy, so managing water resources effectively is very important. The goal of planning for water resources is to ensure we have enough water now and in the future, especially with increasing pressures from population growth, climate change, and environmental needs.

Water is vital for life and is crucial for many development activities. Since independence, India has made significant progress in developing and managing water resources through various plans and schemes, leading to a

nearly fivefold increase in the country's growth. There have also been improvements in drinking water supply and other water uses. However, the rising population, urbanization, and industrialization have greatly increased the demand for water for domestic needs, industrial use, and more.

Given the overall shortage of freshwater and the actual scarcity and water stress in many arid and semi-arid regions of India, there is an urgent need for conservation and improved management. Effective strategies should focus on not only better managing the water supply but also managing water demand. Water resource management involves two main processes: managing water supply and managing water demand.

II. PROBLEM FORMULATION

If we consider to supply 135 lpcd to the current inhabitants, the Butibori Municipal Council needs 9.10 MLD of water, but due to absence and inappropriate management in the water supply, the Municipal Council not able to meet the requisite water demand in urban areas. Presently the Municipal Council supplies 34-45 LPCD of water at regular time interval i.e. intermittent once after 2-3days. There is a deficiency of supply in remaining days. The city has a 7.32 MLD water shortfall as a result of the unsuitable monsoon and urbanization, despite the fact that the current water delivery system and plans are intended to provide 10.92 MLD of water to the city. The majority of the population currently relies primarily on hand pumps and open wells, with MIDC providing water to the remaining population.

The existing water supply system and schemes are designed to supply 10.92 MLD of water to the city, but due for improper monsoon and growth in urban area, the city has a shortage of 7.32MLD of water. Presently, most of the population is majorly depends on Handpumps and open wells and the remaining population is served by water supplied by MIDC.

It shows that the population growth rate of the town is increasing over the decades. It is noticed that the overall growth rate for the town as a whole is more due to newly established industrial area which created major employment which increased in-migration in Butibori. The vicinity to Butibori MIDC, availability of good infrastructure, good educational facilities, good social life resulted in major in-migration during the decade 2001-2011. The trend has continued in the subsequent decade.

Although the city's current water supply infrastructure and plans are intended to provide 9.10MLD of water, the city is currently experiencing a 5.50MLD water shortfall as a result of an unsuitable monsoon and urbanization. Butibori is one of Nagpur's industrial centers, and as a result of its expansion and industries, it will require more water in the future. Because of the urbanization effect and industry in and around Butibori city, the population is growing quickly, making it extremely difficult to supply the public's needs for drinkable water. The Vena River serves as the primary source of water supply. However, the city's future needs will be beyond Vena River's capacity.Therefore, plans for the management of water resources must be developed.

II.OBJECTIVES

The goal is to provide a technical solution for water distribution and conservation while also creating a strategic water resource management plan for the town of Butibori based on an assessment of the town's current water resources.

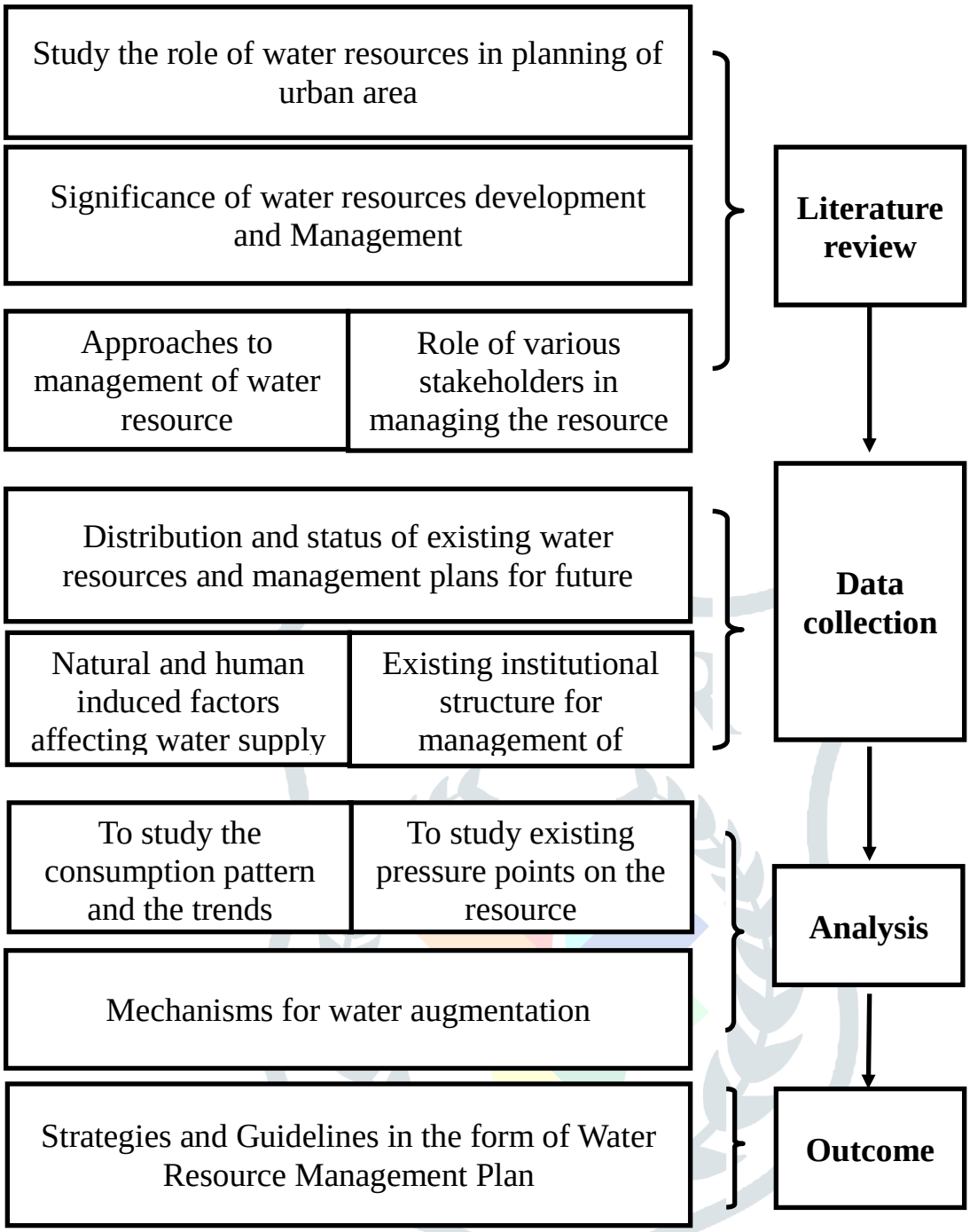
1. Study of topography of town by using GIS.
2. To identify and evaluate present water resources for Butibori town.
3. To evaluate existing water supply and issues towards distribution.
4. To evaluate and project the future population of the town using two different methods of population forecasting.

5. To estimate the town's future water demands based on projected population figures.
6. Study of remedial measures for water conservation for Butibori town.

IV. METHODOLOGY

To create a strategy for managing water resources in urban areas like Butibori city, several case studies were reviewed to understand the characteristics of water resources and the need for effective management over different time periods. These studies, drawn from various Indian cities as well as international examples, provided valuable insights for simulating the situation in Butibori and suggesting appropriate methods and techniques for managing water resources. The literature review was instrumental in outlining the steps necessary to develop a water resource management plan for a city like Butibori and in identifying potential proposals.

Fieldwork was conducted to gather secondary data from the Butibori Municipal Council, and site visits along with discussions provided a comprehensive overview of the existing conditions. Through data analysis and stakeholder engagement, key issues were identified regarding water resource availability—both surface and groundwater—and the water demands of Butibori city. This analysis identified key proposals and projects needed to improve water resources in the region, especially since new sources are crucial to meet the demands of a growing population.



V.CURRENT SCENARIO OF WATER SUPPLY IN BUTIBORI

Vena river water supply scheme is the only scheme utilized in Butibori town

For Gram Panchayat Butibori, the water supply scheme was commissioned in 2015 by the Zilha Parishad, Nagpur (ZP) by using the source Vena river which is passing through the town. The scheme was completely executed and maintained till 2018 on trial basis and handed over to Butibori Nagar Parishad in the same year.

Presently, most of the population is majorly depends on Handpumps and open wells and the remaining population is served by water supplied by MIDC.

Table 3 Details of Vena River Water Supply System

Sr. No.	Parameters	Description
1	Vena River	It is left bank tributary of river of the river Wardha.
2	RWRM	250 mm DI pipe having 3.44 Km length
3	Water Treatment Plant	Conventional WTP of capacity 3.6 MLD
4	Storage Capacity	11.50 Lakh Litres
5	Pure water	
	A) PWRM	200 mm dia DI pipe and 180 mm PVC Pipe.
6	Distribution System	HDPE and PVC pipe of about 75 mm to 160 mm

As the information available from Butobori Nagar Parishad (BNP), Vena River which is the primary source of water is polluted by the effluent from the MIDC, which has led to disturbance in the existing water supply scheme and scarcity of drinking water within town. Hence, to fulfil the demand of water in town, BNP started to purchase water from MIDC but, it is not sufficient to fulfil the current or future demand. From MIDC, purchased pure water is transmitted to the WTP sump having length of 1.26 Km.

- Pure water rising main used for transmission is 280 mm diameter HDPE Pipe.
- Pure water from WTP sump is Pumped by four centrifugal pumps of two 30HP (1W+1S) and two 15 HP (1W+1S) to two ESRs of capacity 7.50 LL and 4.00 LL respectively.
- Presently there is an uneven distribution of water supply within town and which leads to scarcity of water throughout the year.

There is separate water supply distribution through MIDC for ward no. 7 which is on daily basis. The water supply is metered and consumers are charged tariff of Rs. 11 per unit (1unit=1000 litre) which is collected by MIDC.

There is separate water supply scheme for Choti Bori i.e. Ward no. 8. This water supply scheme was developed on well in Choti Bori in year 1995. But this source is not sufficient to fulfil the demand of water for this area. Hence, presently the water is supplied for Choti Bori from Choti Bori open well and Juni Vasti open well. This water is only used for usable purpose. For drinking purpose small filter media is installed near Choti Bori ESR.

Table 4 Details of Choti Bori water Supply Scheme

Source	ESR	Transmission Line Details
Choti Bori Open Well	Near ZP School	75mm PVC
Juni vasti Open Well	Near ZP School	75mm PVC

There is no availability of water distribution system to ward no. 4. This ward totally depends on wells or bore wells available in this area for water supply. During summer, this area faces shortage of water as the wells run dry. Hence, BNP provides 2 drums (200litres/drum) of water for each house through water tanker once after 2 days for this ward.

Analysis of Existing Water Supply System

Total Water Demand

According to the guidelines in CPHEEO's handbook on water supply and treatment, paragraph 2.2.8.3, all homes with a complete flushing system for disposing of waste and an additional 15% for other demands with 15% water loss should have a minimum of 135 LPCD.It is planned to provide the floating population with 15–25 LPCD.

As per below table current Gross Demand of water (i.e. for year 2021) is 9.10 MLD and for the year 2038 & 2053, demand is 17.36 and 31.20 MLD respectively.

Table 5 Demand and Gap for Total Water Demand

Particulars	2021	2023	2028	2033	2038	2043	2048	2053
Population projection	49,500	53,281	64,278	77,814	94,393	1,14,652	1,39,398	1,69,653
Demand (MLD) = 135 LPCD + 15% other demand and 15% losses	9.04	9.73	11.74	14.21	17.24	20.94	25.46	30.99
Floating population (5% of total population)	2475	2664	3214	3891	4720	5733	6970	8483
Demand for floating at 25 LPCD	0.06	0.07	0.08	0.10	0.12	0.14	0.17	0.21
Gross Demand (MLD)	**9.10**	**9.80**	**11.82**	**14.31**	**17.36**	**21.08**	**25.63**	**31.20**

Water Reservations

As per information available from BNP, council has submitted a proposal to Government for water reservation from Wadgaon dam and this proposal is under process. But this water reservation is not sufficient and won't fulfil the demand of present population. It is observed that the water reservation for 2021 is 55 % total water requirement. Below table projects the quantity of water reservation requirement. At present, the gap in the reservations from the dam is 3.32 MM^3 and for the year 2038 & 2053, it is 6.34 and 11.39 MM^3 respectively.

Table 6 Demand and Gap for Water Reservation

Water Reservations from Dam	2021	2023	2028	2033	2038	2043	2048	2053
Required demand for reservation (MM3)	3.32	3.58	4.31	5.22	6.34	7.70	9.36	11.39
Actual Reservation (MM3)(for 5 MLD)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gap (in MM3)	**3.32**	**3.58**	**4.31**	**5.22**	**6.34**	**7.70**	**9.36**	**11.39**

Capacity of WTP

As per field survey it is noticed that, WTP in Butibori is not operated by the council as the quality of raw water is not satisfactory. Total water demand for WTP is calculated by considering Gross Demand and 20 hours of pumping. Present WTP demand i.e. 2021 is 10.92 MLD and for year 2038 & 2053 it is 20.83 & 37.44 MLD.

Table 7 Demand and Gap for WTP

Water Treatment Plant	2021	2023	2028	2033	2038	2043	2048	2053
Demand for treatment plant capacity (in MLD) considering 20 hours pumping	10.92	11.76	14.18	17.17	20.83	25.30	30.76	37.43
Available treatment plant capacity (in MLD) existing WTP	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Gap (in MLD)	**7.32**	**8.16**	**10.58**	**13.57**	**17.23**	**21.70**	**27.16**	**33.83**

Capacity of existing WTP is about 3.6 MLD which is insufficient to suffice the present demand. As it was constructed in year 2018, it's design period will be completed in the year 2033. (as per CPHHEO manual)

Water distribution network

As per information available from BNP, existing water distribution network is spread over 55.00 km of length. Demand of distribution network for leading years is calculated considering road length as per road gap assessment. 15.09 km is the current gap in the distribution system as per the CPHEEO guidelines.

Table 8 Demand and Gap for Water Distribution Network

Water Distribution Network	2021	2023	2028	2033	2038	2043	2048	2053
Road length required as per gap assessment (in km)	102.09	102.09	115.70	140.07	169.91	206.37	250.92	305.37
Existing distribution network (in km) as per NP record	55.00	55.00	55.00	55.00	55.00	55.00	55.00	0.00
Gap (km)	**47.09**	**47.09**	**60.70**	**85.07**	**114.91**	**151.37**	**195.92**	**305.37**

The existing water distribution network was laid in year 2018. Its design period is completed after 30 years of installation (as per CPHEEO manual) i.e. in year 2048. As per information available from BNP, time to time maintenance of the water distribution network is being carried out. As per above table, water distribution network required for year 2038 & 2053 is 114.91 km and 305.37 km respectively.

Water storage tank

As per CPHEEO manual, design period of Storage tank is 15 years. Hence, the calculated age of ESR is shown in following table.

Table 9 Details of Existing Water Storage Tanks (Capacities in Lakh Litre)

Location	Capacity	YOC	2021	2023	2028	2033
Choti Bori Near ZP School	0.30	1995	0.00	0.00	0.00	0.00
Near WTP ESR	7.50	2016	7.50	7.50	7.50	0.00
Near Zizamata School	4.00	2016	4.00	4.00	4.00	0.00
Near Khaparde School	1.00	1995	0.00	0.00	0.00	0.00
Navin Vasahat Near Durga temple	1.30	1983	0.00	0.00	0.00	0.00
Juni Vasahat Kumbhar Pura	1.00	1990	0.00	0.00	0.00	0.00
Total	**15.10**		**11.50**	**11.50**	**11.50**	**0.00**

Above table suggests that, the ESR near WTP and ESR near Jijamata school will be completing their design period near about the year 2028. Further, remaining 4 ESRs have already completed their design period as they were constructed during the period 1983-1995. So, for further projection their storage capacity is not considered. From this it is concluded that the Butibori town does not have sufficient water storage to fulfil the demand of water for present population of the town. APs per CPHEEO manual, Water storage demand is 50% of total water demand.

Water service connection

Below table suggests that about 33.16% of properties are served with house connection and the rest 73.47% are served with hand pumps or other sources of water. Some commercial properties do not require special water connection since their demand is less and which can be fulfilled by themselves. At present there are total 2820 water connections but demand for connections in the year 2053 is projected at 31,809, hence 28,989 is the gap projected till the year 2053.

Table 10 Demand and gap for Water Service Connections

Water Service Connections	2021	2023	2028	2033	2038	2043	2048	2053
No. of properties	10,629	11,489	13,993	17,112	21,005	25,881	32,015	39,761
80% Properties to have Water connection	8,503	9,191	11,194	13,689	16,804	20,705	25,612	31,809
Existing service connections (as per ULB record)	2,820	2,820	2,820	2,820	2,820	2,820	2,820	2,820
Total Gap	**5683**	**6371**	**8374**	**10869**	**13984**	**17885**	**22792**	**28989**

Table 11 Demand and Gap for Storage Tank

Water Storage Tank	2021	2023	2028	2033	2038	2043	2048	2053
Storage tank demand capacity (LL) 50% storage of total demand	45.20	48.65	58.70	71.05	86.20	104.70	127.30	154.95
Existing storage tank capacity (LL) (as per field survey)	11.50	11.50	11.50	0.00	0.00	0.00	0.00	0.00
Gap (LL)	**33.70**	**37.15**	**47.20**	**71.05**	**86.20**	**104.70**	**127.30**	**154.95**

As per above table demand of storage tank for year 2053 is 154.95 LL.

Table 12 SLBs for Water Supply

Sr. No.	Indicator	Benchmark	Actual
1	Coverage of Water Supply Connections	100%	33.16%
2	Per Capita Supply of Water	135 LPCD	35-45 LPCD
3	Extent of Non- revenue Water	15%	>25%
4	Extent of Metering	100%	35.46%
5	Continuity of Water supplied	24 hrs daily	Intermittent once after 2-4 days
6	Efficiency in redressal of customer complaints	80%	< 80%
7	Quality of Water Supplies	100%	50-60%
8	Cost Recovery in Water Supply Services *	100%	72.65%
9	Efficiency in Collection of Water Charges **	90%	25.92%

The table reveals significant deficiencies in water supply services, with actual performance falling well below established benchmarks. Key areas needing improvement include coverage of connections, per capita supply, metering, and customer complaint resolution. High non-revenue water levels and low-cost recovery indicate management and infrastructure challenges. Additionally, intermittent supply and poor water quality highlight urgent needs for strategic interventions. Addressing these issues is essential for ensuring sustainable water management and equitable access to clean water for all communities.

VI.PROPOSAL & STRATEGIES FOR FUTURE

Factors Influencing Water Resources Proposals & Strategies

When developing effective water resource proposals and strategies, it is essential to consider both supply-side and demand-side factors. Supply-side factors encompass the availability and management of water sources, distribution networks, and infrastructure capabilities. These elements directly influence the quantity and quality of water supplied to communities. On the other hand, demand-side factors reflect the consumption patterns, population dynamics, and economic considerations that shape how water is utilized. Understanding the interplay between these factors is critical for creating sustainable and resilient water management solutions that meet the needs of current and future populations. The following table outlines key supply and demand factors that should be taken into account in water resource planning.

Factors Influencing Water Resources Proposals And Strategies	
Supply side factors	**Demand side factors**
1. Water Sources	**1. Population**
✓ **Type**	✓ Frequency
✓ **Capacity**	✓ Per Capita Demand
✓ **Climate Change**	✓ Connection Types
	Water Pricing
2. Distribution Network Design	**2. Water Usage Issues**
✓ **Efficiency of design**	✓ NRW Losses, Illegal Connections, Unaccounted Water, Theft
3. Storage Capacity	
4. Pumping Capacity	

5. Distribution Network Capacity	
✓ **Coverage Inadequacies**	
6. System Losses	**3. Operation and Maintenance Related Issues**
✓ **NRW Losses**	Water Quality
✓ **Pipe Breakages**	✓ Maintenance Challenges

Strategies for Water Resource Management

Effective water resource management requires a multifaceted approach that addresses both supply and demand dynamics. The following table outlines a series of strategic initiatives designed to optimize water usage, enhance efficiency, and ensure sustainable practices. Each strategy targets specific areas of water management, from implementing metering systems and improving monitoring technologies to promoting rainwater harvesting and increasing public awareness. By integrating these strategies, communities can work towards reducing non-revenue water, maximizing resource utilization, and ensuring equitable access to clean water for all.

Sr. No	Strategies	Major Scope
1	Implement metering in all types of water connections to regularize the water supply process and increase revenue.	NRW Reduction
2	Use computer applications and software to monitor the water supply process.	
3	Leakage Control – Water Auditing, Fix overflow sensors.	
4	Detect and regularize illegal connections.	
5	Optimum usage of produced water.	
6	Harvesting of rainwater and other water sources.	Water Harvesting
7	Artificial recharge.	
8	Develop systems and technologies for recycling and reuse of wastewater.	Reclaimed Water
9	Restoration and rejuvenation of surface water bodies.	Alternate Resources
10	Optimum use of conserved water.	Management Approach
11	Maximum usage of storage reservoirs and tanks.	
12	Improvement of water supply in scarce locations.	
13	Integration of surface water management and groundwater management.	
14	Transfer the approach from water supply management to water demand management.	
15	Watershed-level management approach.	
16	Private sector participation in water supply projects.	PSP
17	Public awareness campaign and IEC activities for the economic use of water.	IEC

VII. CONCLUSION

After reviewing the existing water supply system of the town, it can be concluded that there is severe requirement of revision of planning and design of water storage and supply system.As the water supply depends on nearby river and rainfall hencethere is requirement of water conservation techniques like rain water harvesting, NRW reduction. It can also be concluded that Reclaimed water / Waste water reuse for industries is some of water conservation measures in water resource management and it helps to reduce fresh water demand for industrial purpose. The treated water cost (Rs. 5 to 8 per kiloliter) is always less than production cost of fresh water form sources. At present 7.80 MLD of sewage water generated in Butibori. Because of absence of Sewage network & STP, all sewage water is disposed into Vena River through gutter. From the input of 8.56 MLD, Outcome from plant is 5.77 MLD. We can use this treated water for green belt development which indirectly help in sustainable development of the town.

By implementing diverse water management practices in the city, the corporation can effectively reduce water deficiencies through a range of measures in water resource management.

Surface and groundwater are interconnected through hydrological processes. The conjunctive use of both can enhance water management effectiveness. However, excessive groundwater extraction can lead to reduced surface water availability, and vice versa. Therefore, the Butibori council should focus on maximizing rainwater storage to improve groundwater conditions, which can be crucial during drought years. Overall, managing both surface and groundwater resources increases water availability in the region, but over-reliance on groundwater can degrade water quality. It's essential to prioritize the storage and use of available surface water for future benefits.

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