Quest Journals
Journal of Architecture and Civil Engineering
Volume 8 ~ Issue 9 (2023) pp: 42-49
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Comprehensive Assessment of Water Resources and Supply in Thiruvallur District, Tamil Nadu

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ABSTRACT: *This study presents a comprehensive evaluation of water resources, utilization, and scarcity in Thiruvallur District, Tamil Nadu, with a focus on its hydrological landscape, irrigation practices, groundwater utilization, and industrial water consumption. The research investigates the Arani and Kosasthalaiyar rivers, emphasizing the role of dams in facilitating irrigation across the region. Small lakes and ponds are examined for their contributions to local water resources and agriculture. Groundwater utilization is analyzed through a comprehensive overview of wells and borewells, emphasizing the need for sustainable management. The study also discusses water consumption patterns within various industrial sectors, highlighting the importance of efficient water management for environmental sustainability. This analysis underscores the importance of adopting integrated water resource management strategies in Thiruvallur District to ensure a sustainable and equitable supply of water resources.*

KEYWORDS: *Water management, groundwater utilization, borewells, Thiruvallur district, Rivers, Irrigation*

R*eceived 04 Sep, 2023;* ***R****evised 14 Sep., 2023;* ***A****ccepted 16 Sep., 2023 © The author(s) 2023.*
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I. INTRODUCTION

Water resources and their management are of critical importance in the context of Tamil Nadu, particularly in districts like Thiruvallur. Historically, the region has relied on an intricate system of surface water bodies, including lakes, ponds, and rivers, for various purposes, including agriculture, domestic use, and livestock. Over time, the unsustainable extraction of groundwater has led to a significant decline in water tables across Tamil Nadu, including Thiruvallur District. Excessive reliance on borewells has exacerbated the problem, with a substantial number of wells running dry. The district is grappling with the consequences of this water scarcity, impacting agriculture, industry, and daily life. Water availability is the most crucial factor that governs the decisions of Tamil Nadu's farmers regarding what to plant, when to plant it, and in what quantities during a season. In this agricultural landscape, tank irrigation plays a pivotal role, sustaining the livelihoods of smallholder farmers. Therefore, the assessment of water security and the reliable measurement of the provisioning characteristics of tanks become paramount. This study examines historical reliance on surface water bodies, the challenges posed by groundwater depletion, and the critical role of sustainable water management. By exploring the state of water resources, the study aims to comprehensively assess the water resources in Thiruvallur District, encompassing surface water bodies, rivers, and groundwater sources. It seeks to meticulously calculate the water requirements for a range of purposes, including domestic use, agriculture, industrial processes. The study emphasizes the significance of adopting sustainable water management practices, underscoring the need to safeguard and restore existing water bodies, ultimately contributing to informed decision-making and sustainable water management practices in the region.

II. LITERATURE REVIEW

Tamil Nadu in southern India faces significant water challenges, it relies on monsoons and river water, using engineered systems to support agriculture and villages. The growing population in Tiruvallur District puts pressure on efficient drinking water management. Historically, the state has relied on a well-structured system of harnessing monsoon rains and utilizing river water. This sophisticated engineering, initiated by ancestors, involved diverting river water to fill lakes and ponds. This system not only provided essential resources for

agriculture and livelihoods but also helped maintain the groundwater levels, benefiting villages situated near these rivers. Ensuring a reliable and sufficient drinking water supply is vital for the well-being of Tiruvallur District.The state confronts increasing water scarcity due to excessive groundwater extraction, leading to numerous wells drying up. Borewells worsen the problem, reducing underground water storage. This threatens the crucial agricultural sector. Studies have been done, which provides diverse insights into water-related issues and irrigation practices. Ludden, [1] through his research provides a long-term perspective on the relationship between patronage and irrigation practices in Tamil Nadu, India. By analyzing historical records and narratives, the research sheds light on the evolution of irrigation practices and their socio-economic implications in Tamil Nadu. This historical perspective contributes to a deeper understanding of the region's irrigation systems and their role in agricultural development. Makarigakis and Jimenez-Cisneros, [2] provides an overview of UNESCO's contributions and initiatives aimed at tackling water-related issues on a global scale. The research underscores the importance of international organizations. Jha et al., [3] insights into how these advanced technologies can be harnessed to enhance water resource management practices, particularly in the context of groundwater. The study discusses the prospects and challenges associated with the integration of remote sensing and GIS in the field of water resources. in promoting sustainable water management and addressing pressing water challenges worldwide. Senthilkumar et al., [4] employs hydrogeological assessments and water quality analyses to assess variations in groundwater quality within the coastal aquifer. The findings provide insights into the complex interactions between land use patterns and groundwater quality, offering valuable information for sustainable groundwater management in the region. Periyasamy et al., [5] analyzes factors such as topography, rainfall patterns, and land use; the research identifies zones at risk of flooding. The findings contribute to improved flood management and disaster response strategies in the rural areas of Thiruvallur district. Palanisami et al., [6] investigates the impacts of climate change on agriculture in India, focusing on selected river basins. It delves into the challenges and opportunities presented by changing climatic conditions for agricultural practices. The research is part of a broader effort to understand and adapt to the implications of climate change on food security and rural livelihoods in India. Singh and Kumar, [7] examines the impacts of climate change on hydrology and water resources. It discusses how changing climate patterns are affecting the availability and distribution of water resources in India. The research is essential for policymakers and water resource managers seeking to address the challenges posed by climate change in the context of Indian river systems. Bhattacharya, [8] examines the socio-cultural and hydrological aspects of these traditional structures, shedding light on their role in maintaining water security and fostering community resilience. By bridging the gap between traditional wisdom and modern hydrology, this paper underscores the importance of preserving and integrating traditional water management practices into contemporary strategies for sustainable water resource management in India. Thamar et al., [9] provided a comprehensive assessment of the Thamirabarani river's hydrogeochemical properties and water quality, providing valuable information for sustainable water management and conservation efforts in the region. Renganayaki and Elango, [10] presented a review paper that addresses the critical issue of groundwater management and conservation, especially in water-scarce areas like Chennai. Managed aquifer recharge through check dams is recognized as an effective strategy for sustainably managing and enhancing groundwater resources.

III. STUDY AREA

Tiruvallur District, formed on January 1, 1997, holds a significant place in Tamil Nadu's geography. Previously known as Sengapattu and part of the combined Chengalpattu District, it earned the moniker "the lake district" due to its abundant lakes when combined with Kanchipuram. Located in close proximity to the state capital, Chennai, this district covers a sprawling 3,42,243 square kilometers and boasts a population of 3,728,104 people as per the 2011 census. Administrative divisions include 3 revenue groups, 9 revenue circles, 1 corporation, 6 municipalities, 8 town panchayats, and 14 panchayats under union, totaling 526 village panchayats.

Tiruvallur District is home to three primary rivers:

Koshasthalai River: This river, extending 136 km in length, originates from Bullur Hill in Andhra Pradesh and eventually flows into the Bay of Bengal via various routes. Notably, it plays a crucial role in irrigating 33,336 hectares of land through 336 lakes.

Koovam River: Originating from Kesavaram Dam, this river combines waters from Koovam Lake in Tiruvallur District. It travels through several barrages and finally empties into the Bay of Bengal near Anna Square in Chennai. The Koovam River stretches over 82.98 km.

Arani River: Surplus water from Bichatur Reservoir in Andhra Pradesh enters Thiruvallur District, covering a distance of 65.20 km. It passes through various areas, including Oothukottai, Periyapalayam, Arani, and Ponneri, before ultimately joining the Bay of Bengal. The Arani River features nine barrages and serves 39 lakes. Tiruvallur District experiences an average annual rainfall of 66.42 mm, primarily during the northeast

monsoon (October, November, December). While this precipitation pattern supports agriculture and other sectors, it is crucial to focus on effective rainwater harvesting and watershed management to ensure sustainable water resources.

Water usage in Tiruvallur District primarily revolves around two key sectors:
Agriculture: With 19,457 open wells and a significant portion of land under cultivation in the Kosasthalai and Arani River drainage zones, agriculture is a prominent water-consuming activity. Lakes and ponds play a pivotal role in irrigating over 73,000 hectares of agricultural land.
Industries: Notable industrial estates, including Kakkalur Industrial Estate (SIDCO) and Gummudipoondi Industrial Estate (SIPCOT), contribute to groundwater usage. Additionally, numerous modern rice mills and factories rely heavily on groundwater for their operations.

IV. RESULTS AND DISCUSSION

Data was successfully collected from various sources, including government reports, official records, census data, municipal databases, and industry-specific sources. This data encompassed crucial variables such as population figures, daily water requirements, water sources, infrastructure details (e.g., wells and borewells), groundwater irrigation data, and industrial water consumption statistics. The collected data was organized systematically into structured datasets categorized by administrative areas, including municipalities and panchayats. Data validation procedures were implemented to ensure accuracy and consistency.

4.1 Administrative Areas Analysis

The analysis of administrative areas in Thiruvallur District revealed significant variations in water sources, daily water usage, and population figures. Table 1 provides comprehensive data for various administrative organizations, including the number of wards, borewells, population figures from the 2011 Census, the latest population figures, required drinking water quantity measured in LPCD (Liters Per Capita per Day), and the actual supplied drinking water quantity in LPCD.

Tble.1: Demographics and Water Supply details of Thiruvallur district

S.No	Administrative Organization	Number of Wards	Number of Borewells	Population (2011 Census)	Latest Population Figures	Required Drinking Water Quantity (LPCD)	Supplied Drinking Water Quantity (LPCD)
1	Avadi Corporation	48	730	344,701	475,628	50	36.60
2	Thiruvallur Municipality	27	28	56,074	64,082	88	87.88
3	Thiruthani Municipality	21	73	44,781	49,259	82	54.76
4	Thiruverkadu Municipality	18	140	62,289	89,164	85	58.47
5	Poonamallee Municipality	21	135	56,685	67,756	85	74.64
6	Ponneri Municipality	18	63	22,040	24,780	80	96.91
7	Thirunindravur Municipality	18	60	37,095	43,306	73	83.68
8	Arani Town Panchayat	15	19	12,833	13,008	97	96.86
9	Gummidipoondi Town Panchayat	15	32	18,891	21,047	117	91.30
10	Minjur Town Panchayat	18	32	28,337	32,013	79	75.00
11	Naravarikuppam Town Panchayat	18	47	20,946	23,038	72	66.77
12	Pallipat Town Panchayat	15	16	8,721	8,791	73	83.03
13	Podhaturpet Town Panchayat	18	113	31,025	36,398	111	92.25

14	Thirumazhisai Town Panchayat	15	63	19,733	22,473	100	93.75
15	Uthukottai Town Panchayat	15	35	12,740	14,431	76	83.23

The key observations from this data include Avadi Corporation has a substantial population increase from 344,701 (2011) to 475,628. However, it supplies drinking water at a lower rate than the required LPCD, indicating potential challenges in meeting the water needs of its residents. Thiruvallur Municipality stands out for supplying more drinking water (87.88 LPCD) than the required quantity (88 LPCD), suggesting efficient water management practices. Several municipalities and town panchayats, such as Ponneri, Gummidipoondi, and Arani, supply drinking water well above the required LPCD, indicating a proactive approach to meet the water demands of their populations. Naravarikuppam Town Panchayat has a lower LPCD of supplied drinking water compared to the required quantity, which may indicate room for improvement in its water supply infrastructure. Overall, this data provides valuable insights into the population dynamics and water management practices of these administrative units, highlighting areas where adjustments and improvements may be necessary to ensure equitable and sustainable access to clean drinking water.

4.2 Panchayat Unions Assessment

The analysis of Panchayat Unions underscored substantial variations in population figures and water demand across different regions.

Table.2: Rural Panchayat Unions and Water Supply Statistics of Thiruvallur district

S. No.	Name of Panchayat Unions	Total Number of Panchayats	Total Number of Villages	Population Census 2011	Number of Borewells	Daily Water Supply Amount (litres)	Amount Required Daily Water Supply (liters)
1	Ellapuram	53	248	120,509	477	10,720,000	16,268,715
2	Gummidipoondi	61	410	170,877	350	18,570,000	23,068,395
3	Kadambathur	43	255	127,964	398	9,980,000	17,275,140
4	Minjur	55	517	164,718	870	8,850,000	22,236,930
5	Pallipattu	33	231	78,816	277	6,480,000	10,640,160
6	Poonamallee	28	169	141,280	501	8,290,000	19,072,800
7	Poondi	49	331	102,279	713	10,880,000	13,807,665
8	Puzhal	7	60	21,437	103	2,080,000	2,893,995
9	R. K. Pettai	38	287	104,496	789	9,070,000	14,106,960
10	Sholavaram	39	340	141,603	469	11,120,000	19,116,405
11	Thiruttani	27	224	74,230	527	7,510,000	10,021,050
12	Thiruverkadu	42	202	92,280	471	7,790,000	12,457,800
13	Thiruvallur	38	431	140,113	445	10,780,000	18,915,255
14	Villivakkam	13	157	104,678	330	8,000,000	14,131,530
	Total	526	3862	1585280	6720	120,652,000	214,012,800

Table 2 provides a comprehensive overview of various Panchayat Unions, including the total number of Panchayats, total number of villages, population figures from the 2011 Census, the number of borewells, daily water supply amounts in liters, and the required daily water supply in liters. The Panchayat Union of Ellapuram has a significant population of 120,509 (2011) and 477 borewells but supplies a substantial daily water amount of 10,720,000 liters, which exceeds the required daily water supply of 16,268,715 liters. This suggests efficient water management practices. Gummidipoondi, with a population of 170,877 (2011) and 350 borewells, supplies 18,570,000 liters of water daily, surpassing the required daily supply of 23,068,395 liters, indicating effective water management. Several other Panchayat Unions, such as Minjur, Poonamallee, and Poondi, also exceed their required daily water supply, highlighting their efforts to meet the water needs of their populations. Puzhal and Villivakkam, while having a lower population and borewell count, still aim to provide a significant daily water supply relative to their requirements. The total population across all Panchayat Unions is 1,585,280 (2011), with a total of 6,720 borewells. The total daily water supply amounts to 120,652,000 liters, which is below the required daily supply of 214,012,800 liters, indicating a potential water supply deficit that may need addressing. This data offers valuable insights into the population dynamics and water management practices of these Panchayat Unions, highlighting both efficient and potential areas for improvement in ensuring access to clean and sufficient daily water supplies.

Table.3: River and Lake Water Management Statistics of Thiruvallur district

S. No	Rivers	Length of rivers	Number of Dams	Water Received by Lakes through Dams	Lakes without River Water	Lands Irrigated by Lakes through Dams (Hectares)	Total Lands Irrigated by Lakes (Hectares)	Total Irrigated Land (Hectares)
1	Arani river	Thiruvallur district 66.40kms Andhra boundary 65.20 kms	9	39	213	7284.61	22685.86	29970.47
2	Kosasthalaiyar river	Kosasthalaiyar river - 156 kms Coovam river - 82.98kms Nagari river - 43.80kms Nandi river - 32.40 kms	19		336	-	39789.60	39789.60
Total			28	39	549	7284.61	58854.89	69760.07

Note: The Chennai district administration has now taken control of the areas drenched by 15 lakes falling under Kosasthalaiyar river.

Table 3 presents a comprehensive overview of the water resources and irrigation practices in two distinct regions, namely the Arani River area in Thiruvallur District and the Kosasthalaiyar River basin. In the case of the Arani River, it's notable that there are nine dams in place, facilitating the flow of water to 39 lakes. This arrangement has allowed for the irrigation of a significant expanse of land, totaling 7,284.61 hectares. The cumulative effect of these dams and lakes in the region results in a substantial 29,970.47 hectares of irrigated land, underlining their vital role in sustaining agriculture and livelihoods in the area. On the other hand, the Kosasthalaiyar River basin boasts an even larger network of 19 dams, although specific data regarding water inflow to lakes is not provided. Despite this, a noteworthy 336 lakes exist in the region, demonstrating the prevalence of water bodies. This extensive network contributes to the irrigation of a substantial 39,789.60

hectares of land. The cumulative figures for all the rivers and lakes in the dataset reveal the vast scale of land being irrigated, totaling 69,760.07 hectares. These statistics underscore the critical importance of dams and lakes in supporting agriculture and ensuring a stable water supply in these regions. They represent vital components of the local irrigation infrastructure, providing sustenance to a considerable expanse of agricultural land.

Table.4: Lakes and Water Resources of Thiruvallur District

S. No	Administrative system	Total No of lakes	Aggregate Water Vol. in lakes (MCM)	Total No of lake's catchment capacity (Hectares)
1	Village Panchayat	581	97.2	2042.21

Table.5: Ponds and Water Resources Thiruvallur District

S. No	Administrative system	Total No of Ponds	Aggregate Water Volume in Ponds (MCM)	Total Pond's catchment capacity (Hectares)
1	Village Panchayat	3296	65.92	3587.36

Table 4 and 5 indicate the presence of numerous small lakes and ponds in the district contributes significantly to local water resources and irrigation capabilities. The Village Panchayat oversees a remarkable water resource management system, which includes 581 lakes and 3,296 ponds. The lakes collectively hold 97.2 million cubic meters of water, while the ponds store 65.92 million cubic meters, both signifying substantial water reservoirs. Additionally, the lakes have a total catchment area of 2,042.21 hectares, and the ponds' catchment capacity spans 3,587.36 hectares. This data underscores the Village Panchayat's significant role in managing a considerable number of lakes and ponds with substantial water resources and associated catchment areas, emphasizing their critical importance in local water resource management.

Table.6: Comprehensive Groundwater Irrigation Data and Water Table Level Chart

S.No	Name of Panchayat Unions	Number of wells	Number of borewells
1	Thiruvallur	439	4211
2	Kadambathur	4017	1983
3	Poondi	1848	2798
4	Ellapuram	4679	6517
5	Poonamallee	881	1417
6	Thiruttani	3192	764
7	Thiruverkadu	4678	769
8	Pallipattu	1006	2881
9	R.K. Pettai	407	484
10	Gummidipoondi	721	7797
11	Villivakkam	542	1716
12	Puzhal	359	293
13	Minjur	348	9205
14	Solavaram	155	6286
Total		23272	47117

The comprehensive groundwater irrigation data for Thiruvallur District's various Panchayat Unions reveals a substantial infrastructure supporting agricultural activities shown in Table 6. The district boasts a total of 23,272 wells and 47,117 borewells distributed across these unions. Minjur Panchayat Union stands out with 9,205 borewells, reflecting its significant reliance on groundwater for irrigation. The extensive infrastructure of wells and borewells across Panchayat Unions indicates a heavy reliance on groundwater for irrigation shown in Table 6. shows sustainable groundwater management practices are imperative to prevent overexploitation and ensure long-term agricultural viability.

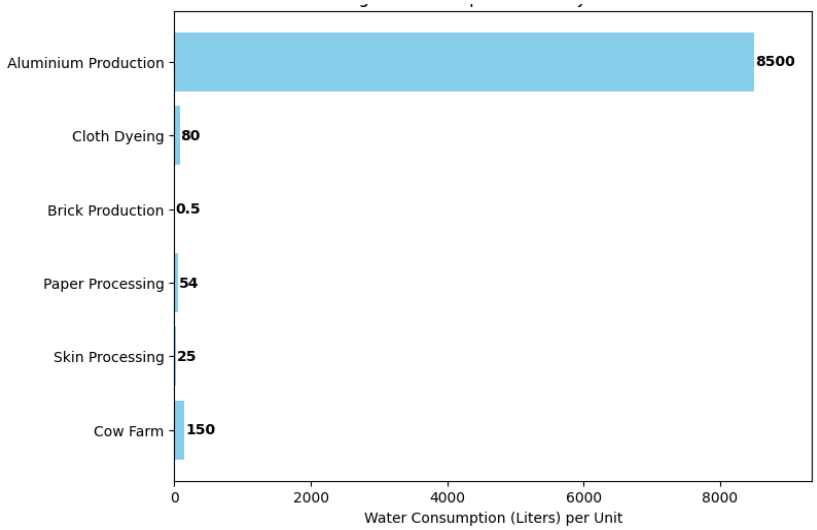

Figure.1: Average Water Requirements by Industries (Liters)

Figure 1 presents average water requirements for various industrial processes. For instance, the table indicates that a single cow on a farm requires 150 liters of water, while skin processing demands 25 liters per kilogram. Paper processing by hand consumes 54 liters per kilogram, and brick production uses 0.5 liters per brick. Cloth dyeing, a water-intensive process, consumes 80 liters per kilogram, highlighting the need for efficient water management in this sector. On the other end, aluminum production is notably water-intensive, with a staggering consumption of 8,500 liters per ton. Understanding these water consumption rates is crucial for industries to implement sustainable practices and minimize their environmental footprint while meeting their production needs. It underscores the importance of adopting efficient water management practices, especially in water-intensive sectors like aluminum production, to minimize environmental impact and promote sustainability. The data and analysis underscore the pressing need for a holistic approach to water resource management in Thiruvallur District. Addressing the water deficit, sustaining agriculture, and ensuring equitable access to clean water for all residents are key challenges that require coordinated efforts from government agencies, communities, and industries. Strategic planning, conservation measures, and infrastructure development are essential steps toward achieving a reliable and sustainable water supply in the region.

V. CONCLUSION

The Tiruvallur district faces a challenge where the increasing population and growing demands for drinking water, domestic use, agriculture, food production, industry, and animal husbandry exceed the available water resources. Rainfall patterns, primarily during the North-East Monsoon, are not sufficient to recharge aquifers and adequately store rainwater for these purposes. To address these challenges, it is imperative to plan for population growth by increasing water resources accordingly. Additionally, conducting watershed management studies is essential to harness rainwater effectively, ensuring the sustainable supply of drinking water and addressing the district's diverse water needs. Further, proactive and sustainable management of drinking water resources is crucial to meet the ever-growing demands of Thiruvallur District's residents and support its various sectors, especially in the face of changing climatic patterns. Thiruvallur District's water resources are integral to sustaining its agriculture, industries, and growing population. Managing these resources effectively, including proper rainwater harvesting and sustainable groundwater use, is imperative for the district's continued development and ecological balance. Balancing economic growth with responsible water management remains a critical challenge for the region.

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