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EXPERIMENTAL ANALYSIS OF IMPACT ON QUALITY & QUANTITY OF WATER BODIES IN CHENNAI

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ABSTRACT-- *Rapid urbanization throughout the world leads to pressure on infrastructure development for planners. The provision of clean water, treatment and disposal of wastewater has become a challenge to water resources and environmental engineers. It is perceived that new approaches will reduce the water stress and can contribute markedly to improve the availability of water. This research work relates to water management aspects of Chennai Metropolitan Area (CMA), Tamil Nadu state in its entirety to suggest effective measures for improvement. Chennai Metropolitan Area spread over 1172 sq. km. with a population of about 6.6 million consists of Chennai city, 13 municipalities, 23 town panchayats and 214 village panchayats of which 18 were classified as census towns. Chennai city's water supply is governed by the Chennai Metropolitan Water Supply and Sewarage Board and Tamil Nadu Water Supply and Drainage Board looks after the water supply aspects in Municipalities, Town Panchayats and Village Panchayats of Chennai Metropolitan Area. A detailed literature review regarding water demand and supply, wastewater management and stormwater management are carried out. Water scarcity, water quality determination, inadequate institutional capacity, lack of comprehensive regulation and financial constraints are some of the aspects that need to be looked into to develop plan for further investigation. Essentially this study indicates the opportunity for creating additional storages, making use of the available tank storages, additional water treatment plants with its location, to utilize the, Veeranam water , Poondi, chembarampakkam, cholavaram waters within Chennai Metropolitan Area suitably. Various technical investigations essential for planning water resources development activities for Chennai Metropolitan Area are indicated. This will serve as the starting point for the long term development of water management policies for this area.*

KEY WORDS-- Tamilnadu Water supply And Drainage Board (TWAD BOARD), Mean Sea Level (MSL), Capacity, Catchment area, Chennai Metropolitan Area (CMA), Hard-rock run-off percolates areas

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1.INTRODUCTION

Chennai city, the capital of Tamilnadu state, is located on the coast of the Bay of Bengal at latitude 13°4" North and Longitude 18°15" East. The terrain of the city is generally low lying and flat coastal plain known as the Eastern Coastal Plains, with an average slope of less than 1/1500. Most of the places are within 4 m to 5 metres above Mean Sea Level (MSL), its highest point being 60 m. The Chennai Corporation was expanded from 174 km2 (67 sq mi) to an area of 426 km2 (164 sq mi), dividing into three regions—North, South and Central. The Current Population of Chennai in 2016 is 8,233,084 (8.2 million).

The geology of Chennai comprises mostly clay, shale and sandstone. The city is classified into three regions based on geology, sandy areas, clayey areas and hard-rock areas. Sandy areas are found along the river banks and the coasts. Clayey regions cover most of the city. Hard rock areas are Guindy, Velachery, Adambakkam and a part of Saidapet. In sandy areas rainwater run-off percolates very quickly. In clayey and hard rock areas, rainwater percolates slowly, but it is held by the soil for a longer time.

2.QUANTITY ANALYSIS

Total Population In Chennai = 8.6 Million

Per Capita Demand= 135MLD

Average Water Required= $8.6 \times 135 \times 10^{12} = 1161 \times 10^{12}$litre

Total Quantity of Water available from Reservoir = 8367 Mcft = 236.927×10^{9}litre

THIS CONCLUDES THAT THE WATER AVAILABLE FROM THE WATER RESOURCES NEAR CHENNAI IS NOT SUFFICIENT TO MEET THE NEED OF THE PEOPLE IN CHENNAI.

3.QUALITY ANALYSIS

The WQI method adopted here is ARITHMETIC WEIGHTED METHOD.

Water Quality Index = $\frac{\sum(WnQn)}{\sum Wn}$

Where,

→Q_n - Quantity rating for the n^{th} water quality parameter

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$$Q_n = \{ \frac{(Vn - Vio)}{(Sn - Vio)} \} x100$$

Here,

V_n - observed value of n^{th} parameter
S_n - standard permissible value of n^{th} parameter
V_{io} - ideal value of n^{th} parameter in pure water
(i.e. 0 for all other parameters except the pH and dissolved oxygen whose values are 7 and
14.6 mg/l respectively)

→W_n - unit weight of n^{th} parameter

$$W_n = \frac{K}{Sn}$$

Here,

S_n - standard permissible value of n^{th} parameter
K - constant proportionality

$$K = \frac{1}{\Sigma(\frac{1}{Sn})}$$

WATER QUALITY INDEX LEVEL	WATER QUALITY STATUS
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
>100	Unsuitable

MODEL CALCULATION:

The Model Calculation is done for Chembarabakkam observed values,

The S_n of the Calcium is 75

The ($1/Sn$) is 0.0133

(similarly for various parameters the ($1/Sn$) is computed)

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The Total ($1/Sn$) value of all parameters i.e. $\sum(\frac{1}{Sn})$ = 5.5503

Now, the K value is computed,

$$K = \frac{1}{\sum(\frac{1}{Sn})} = 0.1801$$

The unit weight of calcium is given by

$$W_n = \frac{K}{Sn} = 0.0024$$

(similarly for other parameters the unit weight is computed)

The total unit weight of various parameters i.e. $\sum Wn$ = 0.8202

The quantity rating of parameter is given by

$$Q_n = \{\frac{(Vn - Vio)}{(Sn - Vio)}\}x100$$

For calcium: $Q_n = \{\frac{(21-0)}{(75-0)}\}x100 = 28.00$

(similarly the Q_n is computed for various parameters)

The total value of W_nQ_n is computed i.e. $\sum(WnQn)$ = 65.16

We know that WQI = $\frac{\sum(WnQn)}{\sum Wn} = \frac{65.16}{0.8202} =$ 79.44

Now compare the value with the water quality status table,

The Water Quality status of chembarabakkam is VERY POOR

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3.1 WQI CALCULATION FOR PUZHAL

PARAMETER	OBSERVED VALUES	STANDARDS	UNIT WEIGHT (W_n)	QUALITY RATING (Q_n)	W_nQ_n
Total dissolved solids at 105*c (mg/l)	740	500	0.00036	148.12	0.0532
Calcium (mg/l)	64	75	0.0024	85.30	0.204
Magnesium (mg/l)	27	30	0.006	90.05	0.54
Total hardness (mg/l)	270	200	0.0009	135.04	0.1215
Chlorides (mg/l)	220	250	0.00072	88.00	0.06336
Hydrogen ion concentration	7.6	6.5-8.5	0.0277	40.01	1.108
Alkalinity to methyl orange (mg/l)	168	200	0.0009	84.10	0.0756
Sulphates (mg/l)	140	200	0.0009	70.02	0.063
Iron (mg/l)	0.15	0.30	0.6003	50.22	30.015
fluorides(mg/l)	0.20	1	0.1801	20.00	3.602
			$\sum W_n$ = 0.8202		$\sum W_nQ_n$ = 35.84

WATER QUALITY INDEX = $\frac{\sum(WnQn)}{\sum Wn} = \frac{35.84}{0.8202} = 43.696$

On comparing with the table, the WQI status is **GOOD**.

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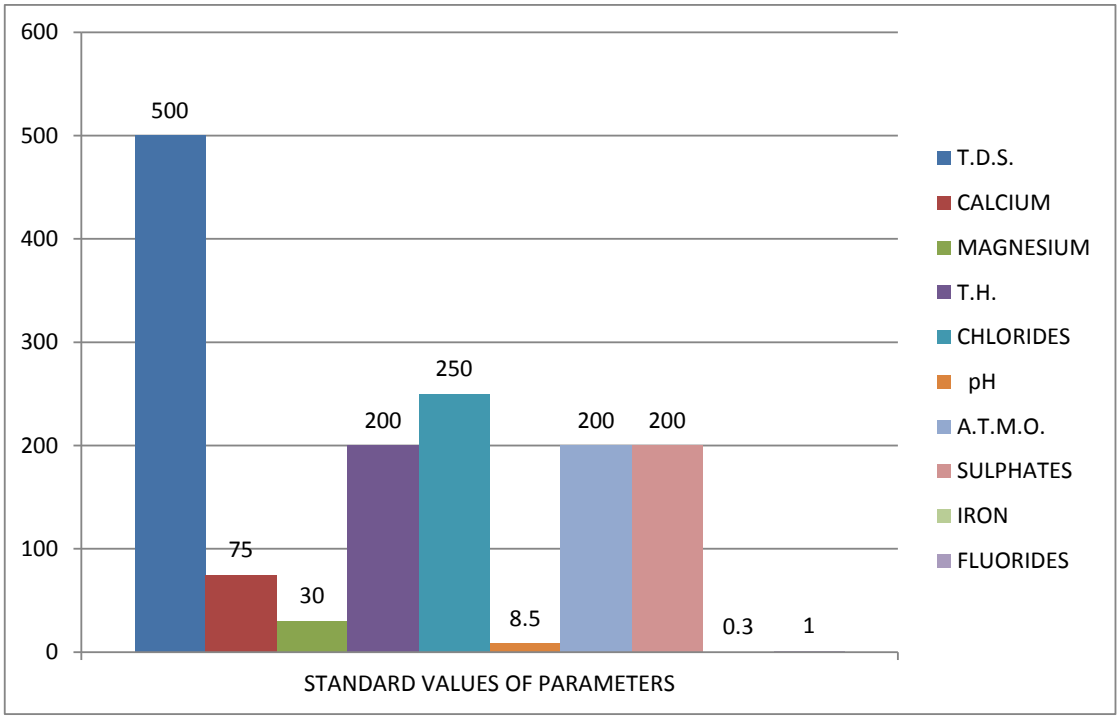
COMPARING THE STANDARD AND OSERVED VALUES IN BAR CHART



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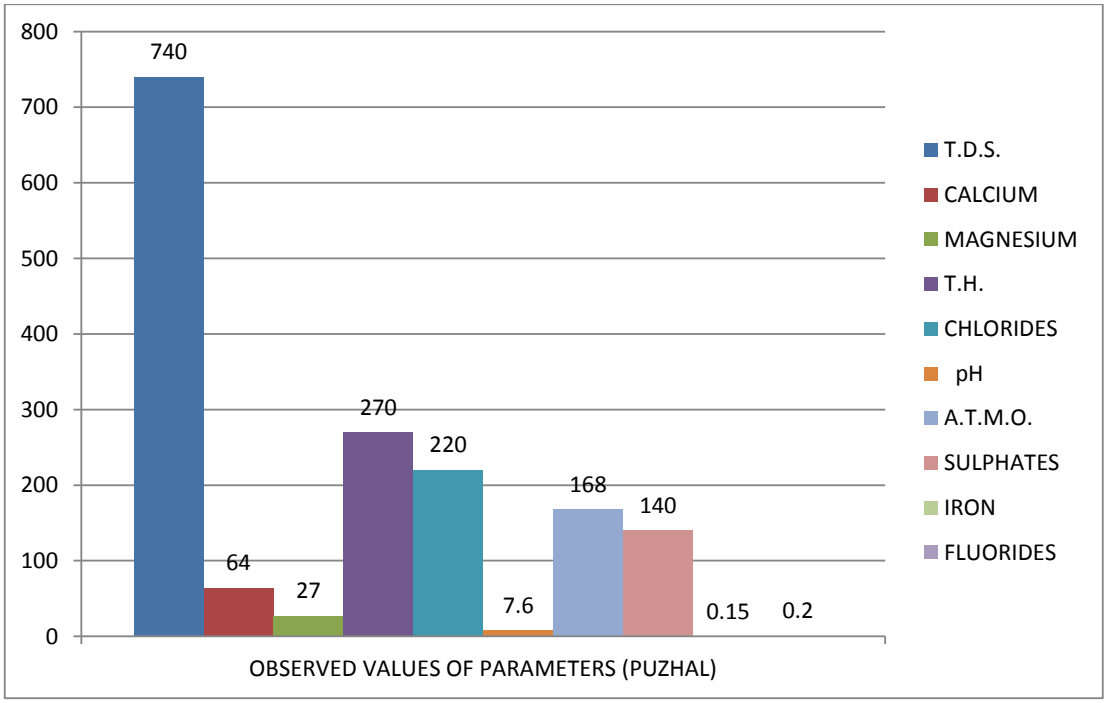

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3.2 WQI CALCULATION FOR PORUR

PARAMETER	OBSERVED VALUES	STANDARDS	UNIT WEIGHT (W_n)	QUALITY RATING (Q_n)	W_nQ_n
Total dissolved solids at 105*c (mg/l)	415	500	0.00036	83.00	0.029
Calcium (mg/l)	38	75	0.0024	50.667	0.1216
Magnesium (mg/l)	17	30	0.006	56.66	0.34
Total hardness (mg/l)	164	200	0.0009	82.01	0.0738
Chlorides (mg/l)	120	250	0.00072	48.12	0.03456
Hydrogen ion concentration	7.5	6.5-8.5	0.0277	33.33	0.9233
Alkalinity to methyl orange (mg/l)	116	200	0.0009	58.00	0.0522
Sulphates (mg/l)	100	200	0.0009	50.05	0.045
Iron (mg/l)	0.15	0.30	0.6003	50.00	30.015
fluorides(mg/l)	0.2	1	0.1801	20.11	3.602
			$\sum W_n$ = 0.8202		$\sum W_nQ_n$ = 35.24

WATER QUALITY INDEX = $\frac{\sum(WnQn)}{\sum Wn} = \frac{35.24}{0.8202} = 42.9608$

On comparing with the table, the WQI status is **GOOD**.

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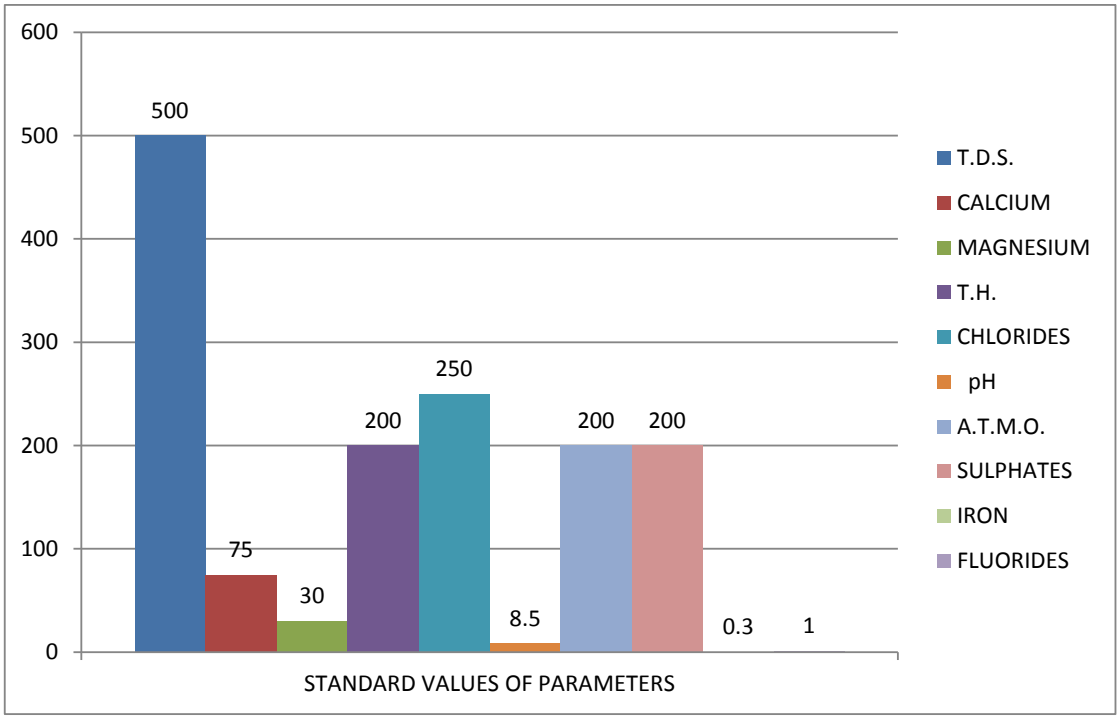
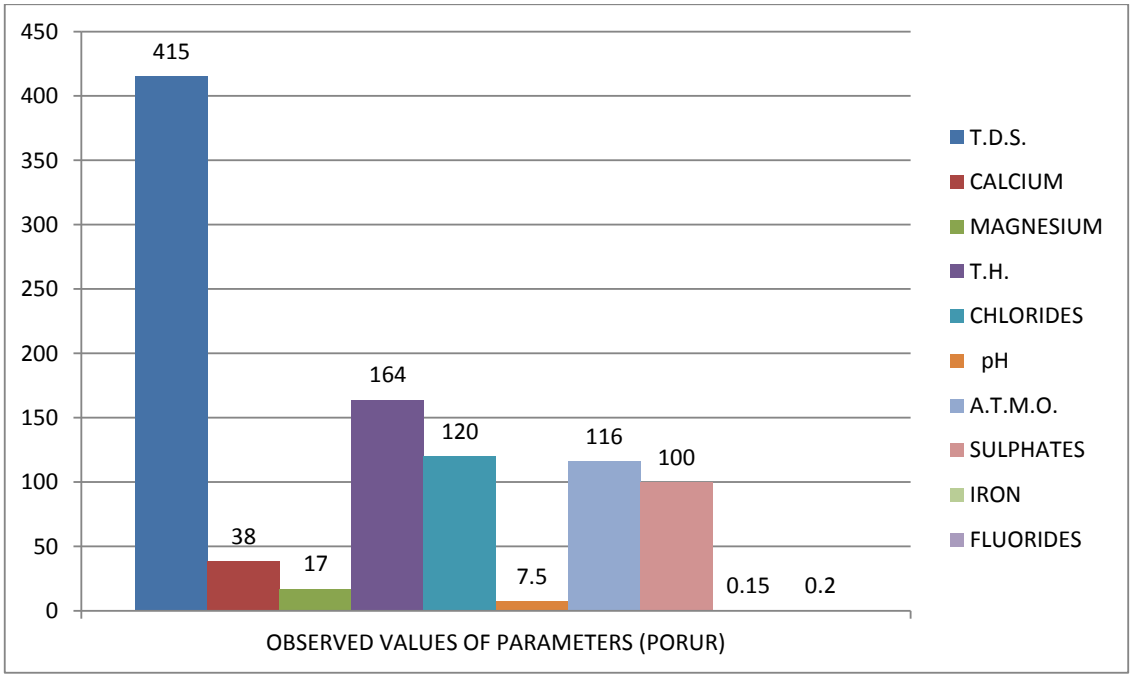
COMPARING THE STANDARD AND OSERVED VALUES IN BAR CHART



VS



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4. CONCLUSION

For Quantity:

The water level is now at an average of 4.70 metre, which is 0.5 metre lower than last year, according to a study conducted by Metrowater. The prolonged dry weather and inadequate rains have led to the drop in the water table. Residents of several years are heavily dependent on tanker lorry supply as the water level in their wells has dipped and also turned saline in some pockets such as Okkiyam Thoraippakam and Ambattur. Residents of Ambattur said borewells were being dug deeper to cope with the shortage.According to a Metrowater official, the water table in some areas such as Valrasaravakkam, Ambattur and Perungudi has seen the worst dip this May. The ground in these areas is composed of hard rock and clay that make percolation of water difficult.The water levels vary depending on the soil condition and density of population.The quality of groundwater too has deteriorated. The total dissolved solids in the water ranged between 900 and 1,900 parts per million (ppm) — 200 ppm more than last year — in various localities. The desired limit for drinking water is 500 ppm. (Metrowater collates data collected from 145 observation wells for its monthly study.)

Though there are many water resources bound with Chennai, due to various factors like Population, Pollution and Improper rainfall there is a Water Scarcity every year. As the population growth is high, the sewage is mixed with fresh water which leads to major water scarcity in Chennai.

The remedial measures may include the treatment of sewage water without getting mixed with underground water and from edible water.The cleaning of the river coovum and adyar will be effective measure to reduce the scarcity. The installation of many desalination plants also reduces the water scarcity. Treating and reusing of non-toilet waste water from the building will surely be a effective way as the water requirement for the building would to reduced.

For Quality:

As mentioned in the introduction, the WQI for the following lakes which are CHEMBARABAKKAM, PUZHAL and PUZHAL are 79.44, 43.696 & 42.96 respectively. On the WQI ratings scale, these values falls under the category of very poor for chembarabakkam and good for both puzhal and porur. This WQI values was obtained from ten previously discussed.

Despite the good overall WQI, the individual turbidity tests on the samples were not satisfactory. The low water levels at the time of testing increased the concentration of suspended solids. Also, the very fine particles that existed on the substrate of the lakes were easily kicked up or dislodged. These two factors resulted in a high turbidity of the chembarabakkam lake. The significance of a turbidity is that the temperature of the water goes up, and the water's capacity

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for dissolved oxygen goes down. But for the puzhal and porur lake the turbidity levels where within the acceptance limits.

The good water quality ratings that resulted from WQI calculations implies that the lakes are healthy. However, some of the individual tests prove that they need improvement. One way to improve the lake's health would be to increase the water level of the lakes. This could be done by efficient usage of the water which are drawn from the lakes as a result less water would be extracted from the resources. Another way to improve the lake's health would be by decreasing the amount of organic matter/waste that is introduced into the water. This could be done by making sure that no domestic animals use the lake for excretion, and by prohibiting the deposit of any animal carcasses and/or waste by humans into the lakes. To continue the existing quality, it is important to keep the watershed mostly free of human alteration.

The possible reason for discrepancy in the WQI rating is that they are more sensitive to daily weather and the influx of runoff. Many of the chemical tests are greatly affected by qualities of the lake that can change frequently, such as the lake's water level. Therefore, a study conducted on a day like ours that followed a short period of no rain can impact the results of many of the tests in a negative way.

One major limitation to our study is the fact that all tests were based on a small sample of a much bigger lakes. With a sample size this small, it is possible that the average results of the entire lakes could be significantly different. Another limitation is the fact that our tests were only taken on one day. As stated above, daily changes in weather and other factors mean that results may be quite different from one day to the next.

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