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MITIGATING DRINKING WATER CRISIS IN TAMIL NADU

K. Sivasubramaniyan [1], S. Rajendran [2]
[1] Professor, Department of Economics, Madras Institute of Development Studies, Adyar, Chennai, India
[2] Professor and Head, Department of Economics, The Gandhigram Rural Institute - Deemed to be University, Dindigul, Tamil Nadu, India

Abstract

India is the fifth largest country in terms of area in the world. It has 3.288 million sq. km. The first four largest countries are: Russia (17.075 m.sq.km); the USA (9.629 m.sq.km); China (9.597 m.sq.km); and Brazil (8.512 m.sq.km). Population wise, India ranks second in the world. As on 18.08.2019 India's population is 1365.3 million and World population is 7676.6 million (**indiastat.com**). That is, India has 17.8% of the world population. As far as Tamil Nadu is concerned, its population in 2011 was 72.14 million and it increased to 81.20 million in 2019. As far as the world water resources is concerned, the 29% of land area has one lakh KM^3 of fresh water, in which about 60% goes as evaporation annually. The remaining 40%, i.e. 40,000 KM^3 goes as run-off by rivers and percolation to groundwater in the world. India's share is 4% of world supply that is 4000 KM^3. It is estimated in India, 51% of precipitation goes as evaporation and the remaining 49% is the annual water resources that is 1953 KM^3. This is divided as 1521 KM^3 (78%) as surface water and 432 KM^3 (22%) as groundwater resource. From this quantum, the annual utilizable water is calculated as 1086 KM^3 (690 KM^3 as surface water and 396 KM^3 as groundwater). However, the present quantity of water use is only 600 KM^3 from both surface and groundwater resources. This is only 31% of annual water resources (for details see **chart 1**). If, available quantity is prudently used India can solve many water related problems.

Keywords: Mitigating; Drinking Water; Crisis.

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1. Introduction

1.1. New Research Studies on Irrigation Theories

First hypothesis on Rainfall: The total quantum of rainfall available on the earth (both land area - 29% and sea surface – 71%) is always equal to that of the total quantum of rainfall occurs every

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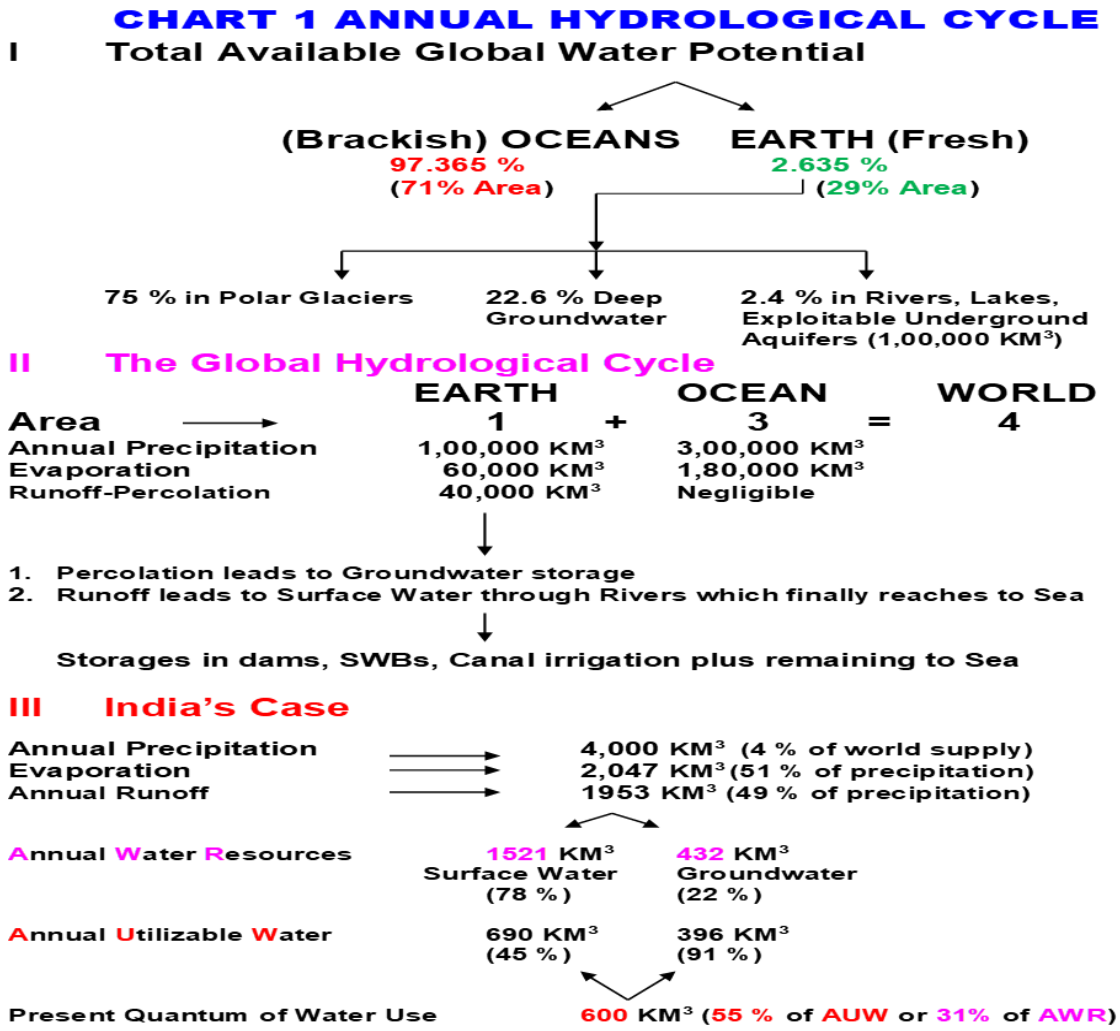
year, but it has its skewed distribution of quantum among regions (So, no dearth of rainfall – store rainwater and use it directly for all purposes).

Second hypothesis on Groundwater: The groundwater recharge is a function of the intensity of rainfall coupled with the capacity and availability of surface water systems (either canal or tank) in a region (Raise infiltration capacity everywhere at the maximum extent possible).



2. Objectives of the Paper

The paper is constructed based on twin objectives:

1) To state the glimpses of the present condition of drinking water supply in Tamil Nadu as well as in Chennai city; and
2) To provide remedial measures to avert continued drinking water problems and to ensure a sustainable supply of drinking water in Tamil Nadu and Chennai.

3. Methodology

The paper is based on the secondary sources of data published in government documents, reports and the day-to-day details available from newspapers and other related sources.

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Government Initiatives in Rural Drinking Water Supply

Ever since the planning era, Government of India (GOI) has been planning to broaden the scope of economic growth process to overcome many inequalities and ensure that more people have better jobs and better access to basic infrastructure and improved public services like health, education, water supply and sanitation. Evidently it is revealed that "Since the First Five Year Plan (1951-1956) Government of India and state governments have spent about Rs. 1,10,000 crores on rural drinking water. During the Eleventh Five Year Plan (2007-2012) the total expenditure is likely to exceed Rs. 1,00,000 crore and it is certain that investment in rural water supply will increase even more" [1]

In the process of implementation of rural water scheme, it has been identified that this sector is beset with the problems such as persistent deterioration in groundwater, affected water quality, poor operation and maintenance, weak governance, insufficient support facilities in the supply front and lack of participation and ownership of people who are benefitted in the demand side.

Drinking Water Sector Reform

Provision of rural drinking water supply is primarily the responsibility of the states, yet Government of India (GOI) has had a significant role in guiding sector reform by creating incentives and making significant financial contribution. In 1999, the GOI introduced Sector Reform Projects on a pilot basis which championed the so called 'Demand Driven Approach' as a departure from the previous top-down service delivery model. "In December 2002, these were extended to the entire country with the introduction of the Swajaldhara guidelines. These guidelines recognized the transformation from a target based "supply driven" approach to the 'demand driven' approach in which users would get the services they wanted and were willing to pay for full cost recovery of operation and maintenance (O&M) and replacement cost were expected from the users to ensure financial viability and sustainability of schemes (Swajaldhara guidelines 2002)" [2] Subsequently, GOI launched the Bharat Nirman program. As a part of drinking water agenda, it targeted a total of 6 lakh habitations.

To meet these challenges, GOI has launched National Rural Drinking Water Programme (NRDWP) in April 2009. This NRDWP provides grants for construction of rural water supply schemes with special focus on water stressed and water quality affected areas, rainwater harvesting and groundwater recharge measures and for operation and maintenance including minor repairs. Most importantly, the programme promotes conjunctive use of surface, groundwater and roof water, rainwater harvesting and the activity supports convergence with other development programmes such as Mahatma Gandhi National Rural Employment Guarantee Act and Watershed Development Programmes.

Another important reform measures, conceived in NRDWP is to mainstream the 'demand – responsive community participation' based approach.

[1] GOI Strategic Plan-2011-2022 Department of drinking Water and Sanitation –Rural Drinking Water. Ministry of Rural Development. P. 9.
[2] Swajaldhara guidelines 2002: "Sector Reform Impact on Rural Drinking Water Schemes - A Case Study from Raigad District in Maharashtra" Pooja Prasad and others, Center for Technology Alternative for rural Areas, (CTARA) Indian Institute of Technology Bombay.

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4. Current Situation

According to Ministry of Rural Development[3] "there is no question that India has been successful in providing access to basic water supply facilities for nearly everyone: the challenge now is how to provide higher level of service with sustainable sources and systems that provide good quality water to a growing population. The uncovered habitations as of 1st April 2010 were only 376 in India. However out of the total number of 16,61,058 habitations in India, the states reported that 4,94,610 habitations (30%) had slipped back to partial coverage and 1,44,064 (9%) habitations were water quality affected as 1st April 2010 due to reasons such as slippage of covered habitation, poor O&M, increase in population and growth of settlements.

Piped Water Connection in Rural Areas

As reported in the Strategic plan[4] the number of piped water supplies in rural areas is rapidly increasing, driven partly by water resources constraints, but increasingly because people want a higher level of service in 2010, about one third of rural households already use piped water, and about one third of those have a house connection.

A separate piped water supply program has been conceived for assisting the lagging states in terms of coverage under this programme. The NSSO 65th round (2008-09) survey indicates the state wise coverage of rural population with piped water supply (table 1).

Status Position in States

The state wise position of piped water connection (table 1) reveals that the percentage of population covered at national average is 31.6 and the states like Uttar Pradesh, Bihar,

Table 1: State Wise Rural Population Covered with Piped Water Supply (PWS) NSSO 65th Round (July 2008–June 2009)

Name of the state/UT	Total population	Population covered with Piped Water Supply (PWS) as per IMIS on date	Percentage of population covered with PWS
1.Andaman & Nicobar	241964	16539	6.84
2.Andra Pradesh	61357604	44768341	72.96
3, Arunachal Pradesh	975110	803540	82.41
4.Assam	26351703	5437393	20.63
5.Bihar	90415338	2368635	2.62
6.Chandigar	81397	0	0.00
7.Chattisgarh	18378854	3297274	17.93
8.Dadra &Nagar Haveli	168664	0	0.00
9.Daman & Diu	78219	0	0.00
10.Delhi	0	0	0.00

[3] Ibid 1 P. 10
[4] GOI Strategic Plan 2011-2022, Department of Drinking Water and Sanitation, Rural Drinking Water, Ministry of Rural Development, New Delhi. P. 10.

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11.Goa	754931	262360	34.75
12.Guarat	36071891	27660053	76.68
13.Haryana	17503346	13742768	78.52
14.Himachala Pradesh	6247229	4024513	64.42
15.Jammu &Kashmir	9592413	3744578	39.04
16.Jharkhand	24661289	1062439	4.31
17.Karnataka	38168224	28507562	74.69
18.Kerala	25471476	19315986	75.83
19.Lakhadweep	50947	0	0.00
20.Madhya Pradesh	52691600	3892409	7.39
21.Maharastra	64770901	32827697	50.68
22.Manipur	2478842	1736283	70.04
23.Megalaya	2318489	1543038	66.55
24.Mizoram	522543	297233	56.88
25.Nagaland	1721522	1004812	58.37
26.Orissa	34741802	8842583	25.45
27.Pudhucherry	356996	304725	85.36
28.Punjab	17670495	15651330	88.57
29.Rajesthan	51995399	12264025	23.59
30.Sikkim	540848	114553	21.18
31.Tamil Nadu	35111001	21084840	60.05
32.Tripura	2813306	1053749	37.46
33.Uttar Pradesh	157042060	4975321	3.17
34.Uttarkhand	7060130	1359224	19.25
35.West Bengal	75088208	10441568	13.91
India	863494741	272405371	31.55

Source: GOI. Strategic plan 2011-22 Ministry of Rural Development, 28.1.2011

Rajasthan, West Bengal, Odisha, Assam, Chhattisgarh and Uttarakhand reported under the group having less than national average. The gravity of the water connection problem could be perceived in the states of Bihar, Andaman Nicobar, Madhya Pradesh, Jharkhand and Uttar Pradesh having less than 10% of piped water connection with Bihar having the least of 2.62% coverage. In the case of the states having higher percentage of population covered with piped water connection include, Punjab with 88.6% followed by Puducherry (85.4%) and Haryana (78.5%). In Tamil Nadu, 60.1% of population is covered in this piped water category[5].

The strategic plan 2011-22[6] indicates that the total planned investments by the Centre and states under the Eleventh Five Year Plan is about rupees one lakh crore, including National Rural Drinking Water Programme (NRDWP) state plan funds, Finance commission grants, and External assistance.

[5] Sivasubramaniyan, K., V. Rengarajan and T. Veeraian, Impact Evaluation Study in Respect of Rural Drinking Water Supply Project Assisted under Rural Infrastructure Development Fund (RIDF) in Tamil Nadu, NABARD Project Study, MIDS, April 2019. P. 3.
[6] Swajaldhara guidelines 2002; Op cit. - P 56.

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NABARD Initiatives

Towards promotion of piped drinking water connection facility in rural households, NABARD has been extending financial support to state governments under Rural Infrastructure Development Fund (RIDF). It is succinctly emphasized by NABARD that "Continued support to build rural infrastructure through public investment is necessary not only to create basic infrastructure such as irrigation facilities, road, bridges, drinking water, rural health and education but also give push to private capital formation through commercialization of sectors such as agriculture, animal husbandry, fisheries rural non-farm sector" [7]. In this regard, it may be observed that RIDF, covering three broad categories viz., Agriculture and related sectors, rural connectivity and Social sector, has a significant share in public investment in rural infrastructure development.

The progress, made for funding projects, according to NABARD annual report[8], indicates that under social sector, RIDF assistance to the tune of Rs. 20,335 crores have been sanctioned (cumulative sanction RIDF I-XXI) for 13,271 rural drinking water projects till 31st March 2016. Likewise, Tamil Nadu Government has also emphasized in its policy document Vision 2023, the need to provide water and sanitation has been included as one among 10 identified themes for the state. The government policy clearly envisions the improvement in the quality of human life and overall economic growth. Towards this end, among the social sector schemes under Rural Infrastructure Development Fund, the provision of water supply and sanitation services, broadly conceived, is a huge societal enterprise occupying vital place in the rural infrastructure. In Tamil Nadu[9] RIDF loan has been sanctioned to the tune of Rs. 1150.53 crore (RIDF-II-XIX) accommodating for 2042 rural drinking water projects as on 31st March 2014.

5. Requirement of Water

The estimate for the requirement of water has been done by the Central Public Health and Environmental Engineering Organisation manual. As per the manual different locality requires different water needs (table 2), which is given as follows:

Table 2: Location Wise Per Capita Requirement of Water

Location	**Norm (liter per capita daily – lpcd)**
Municipalities provided with underground sewage scheme	135
Municipalities without underground sewage scheme	90
Town Panchayat with underground sewage scheme	90
Town Panchayat without underground sewage scheme	70
Rural Habitations	40

Sivasubramaniyan K., et al. April 2019. P. 23.

A point may be clear from the table that in cities like Chennai, the prescribed quantum of per capita supply is 135 liters per day. However, in times of scarcity, it may be perceived that the minimum level of supply to be maintained is 90 lpcd, since cities are covered with under underground sewage scheme. So, the government should think of the possibilities of providing the prescribed quantum

[7] Annual Report 2015-16 NABARD Page 102.
[8] Ibid. page 107, Table 5.3.
[9] State Focus Paper 2015-16. Tamil Nadu, NABARD Regional office pages 50 & 51.

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of water supply to meet both ends of maximum and minimum during normal and scarcity supply periods.

As against the norm for provision of drinking water supply in Tamil Nadu and Chennai, table 3 provides the required quantum of water, for drinking purpose @ 3 litres per capita per day.

Table 3 Drinking Water Requirements in Tamil Nadu and Chennai

Total Population of Tamil Nadu in 2019 is 81.20 million. In Chennai 9.1 million.

Annaul Per Capita Drinking Water Requirement	**Lts / Day**	Per Year	**Total Population**	Total Quantity of Water: Litres / year	Million litres per yearr	**M.lts =1Mcft**	Mcft/ year	**TMC/ year**
1	2	3	4	5=(2*3*4)	6	7	8=(6/7)	9
Tamil Nadu-Drinking Water Alone	3	365	81200000	88914000000	88914	28.32	**3140**	3.1
Tamil Nadu-For All Purpose	**90**	365	81200000	2.66742E+12	2667420	28.32	**94189**	94.2
Minimul Supply to be Given	**60**	365	81200000	1.77828E+12	1778280	28.32	**62792**	62.8
Chennai - Drinking Water Alone	3	365	9100000	9964500000	9965	28.32	**352**	0.4
Chennai - For All Purpose	**135**	365	9100000	4.48403E+11	448403	28.32	**15833**	15.8
Minimul Supply to be Given	**90**	365	9100000	2.98935E+11	298935	28.32	**10556**	10.6

Note: In March 2019 daily water supplied to people in Chennai was 10 mcft /day. The same in 2004 was 1 to 2 mcft.

1 million = 10,00,000. M.lts = Million litres. 1 Mcft = 28.32 million litres. TMC = Thousan million cubic feet.

90 litres and 135 litres per capita per day in normal period for Tamil Nadu and Chennai. Also, a scarcity period quantity of 60 litres and 90 litres per capita per day for Tamil Nadu and Chennai is also provided. It shows in Tamil Nadu for drinking water 3140 mcft (3.1 TMC) is required for one year, whereas for Chennai the same is being 352 mcft (0.352 TMC) a year. Water for all purposes, the data indicate in normal period the quantity required for Tamil Nadu and Chennai is 94.2 TMC and 15.8 TMC respectively. Whereas the minimum supply (based on scarcity period) required to be given shows 62.8 TMC and 10.6 TMC. This indicates that the government has to be prepared to supply for this much quantity without fail.

Across the states of India, the quantum of water available in Tamil Nadu is much limited, since the state does not have any perennial rivers. However, the state is blessed with 41,127 tanks to store the annual rainfall and to irrigate the registered ayacut of 10.12 lakh hectares. Some 11,000 tanks are major tanks managed by the Public Works Department and their total ayacut is about 80% of the registered ayacut. Some 20 tanks are very large in size. Among these the four tanks, viz. Chembarampakkam (3.645 TMC); Redhills (3.300 TMC); Poondi (3.231 TMC) and Cholavaram (1.081 TMC) are considered most important because these tanks supply water to Chennai population. Although Chembarampakkam tank was an irrigation tank till last decade, but it is converted into drinking water tank now. Also, this is the only large tank gets its increased storage capacity through modernisation from 3.15 TMC to 3.65 TMC now. Further this tanks whole ayacut of about 13,000 acres have been urbanised in the past 2 decades consequently the tank is now converted into a drinking water tank.

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Government Initiative to Solve Drinking Water Problem in Chennai

Mitigating the problems of drought and water scarcity is one of the Himalayan tasks of the state government that is currently witnessed in Tamil Nadu. But this problem can be solved if the government takes efforts by way of rainwater harvesting including all household level, increasing the diversion from Cauvery water through Veeranam lake and more importantly advancing the sewage treatment and recycle of water for secondary uses. Tamil Nadu is one of the well-developed states in India and its geographical area is 13.027 million hectares, which is 3.96 % of India. In 2019, the population of the state is 81.5 million, adding 1.2 million people annually. The comparable figures for Chennai metropolitan area are 11.13 million. The normal annual rainfall of Tamil Nadu is 932 mm, whereas Chennai receives 1324 mm, since it is located on the coastal zone. However, wide fluctuations in actual rainfall has been noticed in many years that lead the state and the capital facing severe drought and water scarcity at least once in a period of five years.

Dealing with drought and water scarcity has therefore become an urgent policy issue, to be guided by the principles of conservation, protection of water quality, sustainability and equitable access. Effectively combating drought and water scarcity requires that local water resources are harnessed, conserved and used in the most optimal manner. That requires, water users and communities themselves have a central role in the overall management of local and regional water resources, with government playing a suitable supportive and regulatory role in providing appropriate information, technical help and financial resources (Kathpalia and Kapoor, 2002). Taking these principles into account, if one analyses the present water scarcity in Tamil Nadu, either no effective steps to solve recurrent water scarcity or proper planning to overcome this type of situation in future is attempted so far by the government, except by doing things on a piece meal and fire-fighting manner. Consequently, water scarcity problem is enduring.

The severity of water problem in Tamil Nadu may be seen through two separate incidents: During the first week of June, a drinking water pumpset operator was attacked by a few fellow villagers leading to his death in Vilar panchayat in Thanjavur district, a week later (13th June), Tamil Nadu State Assembly Speaker's driver was stabbed by his neighbour over sharing of drinking water in Anagaputhur of Chennai. These are symptoms of growing enmity over water sharing, which has become a precious commodity. Also, the heat waves touched more than 40-degree Celsius in 20 districts for nearly two months (May-June) in Tamil Nadu that witnessed ever worst drinking water crisis. It is pity to note that a wild elephant in Valparai on the western Ghats of Tamil Nadu smashed a toilet and drank water from the commode. Wild animals[10] crisscross the roads and railways in search of water and become fatal to speeding vehicles.

In Chennai also, the 17-year data presented in table 4 and table 4a show the driest situation experienced by the Chennai Metro Water Board, due to almost drying up of all the four city drinking water reservoirs. This situation happened almost 15 years later after 2004 when the city experienced a severe drought. But so far, no good lesson has learned by the government to avert this type of severe water scarcity situations in the city.

[10] Domestic animals are not spared from water stress and as per media reports cattle flocks in Sivagangai and Ramanathapuram districts died.

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Table 4: Chennai Metro Water Lakes Storage Levels (MCFT) as on First July - since 2003

RESERVOIR	1 POONDI	2 CHOLAVARAM	3 REDHILLS	Sub Total	4 CPT	Total	% of storage to total
FTL (ft.)	**140**	**64.5**	**50.2**	**-**	**85.4**	**-**	
Capacity	**3231**	**1081**	**3300**	**7612**	**3645**	**11,257**	**100**
2003	3	0	897	**900**	**25**	**925**	**8.2**
2004	5	0	109	**114**	**0**	**114**	**1**
2005	126	0	1091	**1217**	**30**	**1247**	**11.1**
2006	793	387	1331	**2511**	**1719**	**4230**	**37.6**
2007	305	37	2254	**2596**	**1060**	**3656**	**32.5**
2008	736	514	2421	**3671**	**1971**	**5642**	**50.1**
2009	1567	83	1786	**3436**	**1478**	**4914**	**43.7**
2010	1050	100	1600	**2750**	**1881**	**4631**	**41.1**
2011	1180	90	1883	**3153**	**1983**	**5136**	**45.6**
2012	1705	85	1201	**2991**	**759**	**3750**	**33.3**
2013	219	0	476	**695**	**757**	**1452**	**12.9**
2014	105	0	1281	**1386**	**1105**	**2491**	**22.1**
2015	80	0	690	**770**	**511**	**1281**	**11.4**
2016	1018	80	1202	**2300**	**1977**	**4277**	**38**
2017	**19**	**0**	**21**	**40**	**49**	**89**	**0.8**
2018	**132**	**61**	**1120**	**1313**	**906**	**2219**	**19.7**
2019	**18**	**0**	**0**	**18**	**0**	**18**	**0.2**

Source: http://www.chennaimetrowater.tn.nic.in/public/lake.htm

Note: On 20.06.2019 the CM informed to press that the 4 lakes didn't have a drop of water. But the MWB maintained 18 mcft in Poondi tank as on 1.7.2019.

Table 4a: Chennai Metro Water Lakes Storage Levels (MCFT) as on First May - since 2003

RESERVOIR	1 POONDI	2 CHOLAVARAM	3 REDHILLS	Sub Total	4 CPT	Total	% of storage to total
FTL (ft.)	**140**	**64.5**	**50.2**	**-**	**85.4**	**-**	
Capacity	**3231**	**1081**	**3300**	**7612**	**3645**	**11,257**	**100**
2003	14	7	1447	**1468**	**56**	**1524**	**13.8**
2004	4	0	151	**155**	**0**	**155**	**1.4**
2005	235	0	1640	**1875**	**131**	**2006**	**18.1**
2006	1744	521	2141	**4406**	**2168**	**6574**	**59.5**
2007	1867	49	2156	**4072**	**1312**	**5384**	**48.7**
2008	2257	676	2489	**5422**	**2099**	**7521**	**68**
2009	2287	539	2248	**5074**	**2560**	**7634**	**69**
2010	1356	84	2344	**3784**	**2379**	**6163**	**55.7**
2011	2381	624	2263	**5268**	**1719**	**6987**	**63.2**
2012	2348	86	1820	**4254**	**1574**	**5828**	**52.7**
2013	404	41	1257	**1702**	**1422**	**3124**	**28.3**
2014	294	7	1746	**2047**	**916**	**2963**	**26.8**
2015	155	19	1359	**1533**	**799**	**2332**	**21.1**
2016	1239	120	1881	**3240**	**2307**	**5547**	**50.2**
2017	**58**	**0**	**418**	**476**	**287**	**763**	**6.9**
2018	**396**	**70**	**1779**	**2245**	**1198**	**3443**	**30.6**
2019	**192**	**11**	**125**	**328**	**3**	**331**	**2.9**

Source: http://www.chennaimetrowater.tn.nic.in/public/lake.htm

Other Sources of DW Supply: 1. Andhra-Telugu-Ganga. 2.Cauvery - Veeranam (180 mld). 3. Desalinisation plants. 4. Groundwater. 5. Quarry water. 6. Local Wells.

Demand Side MGT: 1. RWH 2. Less use of Fresh water 3. Avoid wastages 4. Awareness creation among children 5. Expand reservoirs/ augment W. 6. Institution Involve

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Several reasons including climate induced monsoon variation, increasing demand for water due to sustained growth of population, absence of short/long term planning for water scarcity management during summer, lack of rainwater harvesting, inadequate storages and dilapidated infrastructure facilities, leakages and pilferages, delayed intervention and lack of awareness among people on scarcity water management mechanism have all contributed for severe water crisis in Tamil Nadu. In the past three consecutive years, rainfall was below normal and last year it was about 25 percent deficit in many districts of Tamil Nadu. Immediately after the general elections in May 2019, realizing the gravity of the issue, the Chief Minister announced an outlay of Rs. 136 crores for taking up various drinking water projects but by the time the situation became worse.

On an average the state receives normal rainfall of 932 mm with 331 mm from south west monsoon; a maximum of 470 mm during north east monsoon and 131 mm during summer with a variation from plus or minus 15 mm, which is sufficient to take care of agriculture, industry and service sector usages. Nonetheless, the larger issue is that it is a "manmade scarcity" as neither water conservation nor scientific management is in place for judicious and sustainable use of water and the situation becomes more acute during summer, when there is growing demand.

6. Paradox of Abundant Rain and Mismanagement

Mismanagement of water was visible during north east monsoon in 2015, when Chennai received unprecedented rainfall of 1663 mm. On December 1st and November 16th of 2015, Chennai recorded 345 mm and 266 mm rainfall respectively within 24 hours and the maximum water of more than 350 TMC[11] drained into sea[12]. It also caused flooding and inundation in Chennai Corporation Zone where boats were pressed into service. Paradoxically, during summer, in 2015, 2017 and also in 2019 Chennai encountered severe water crisis. Pathetically, even in December 2015, the four city reservoirs had not filled up to their full capacity. A maximum storage of 10.17 TMC (92% of total capacity) only was stored on December 2, 2015 and the Chembarampakkam tank was filled up only 3.40 TMC against its full capacity of 3.65 TMC. Encroachment of houses in the tank foreshore area forced the Public Works Department (PWD) authorities to keep the water level below Full Tank Level.

Daily water use data available by online in the Chennai Metropolitan Water Supply and Sewerage Board since 2003 clearly indicate the mismanagement of the four city reservoirs on distribution of water. During the 17-year period the four city reservoirs supply was distributed on a monthly average of minimum 1 million cubic feet[13] (mcft) per day from May to July 2004 and also in September 2012 and a maximum distribution of 46 mcft (1.3 TMC a month) per day in July 2009 and May 2016. This huge variation in distribution of metro supply was due to lack of adequate availability of water storage. In short, the most drought affected years in Chennai since 2003 are: 2003, 2004, 2005, 2014, 2015, 2017 and 2019. The Chennai city has been witnessing drought in every alternate year. Also, exactly, more than a year from November 2016 to November 2017 all the four city drinking water reservoirs had a capacity below 15% of its total storage.

[11] One TMC of water alone is sufficient to meet one month's demand in Chennai.
[12] The storage capacity of Chennai's four drinking water reservoirs (Chembarampakkam, Poondi, Redhills and Cholavaram) is just 11.3 TMC. But it is possible to raise the storage capacity up to 16 TMC.
[13] 1 mcft is equal to 28.32 million litres.

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Same precarious situation in rural areas is noticed where there are 41,127 small and large irrigation tanks available across the state. Unfortunately, more than 95% of tanks were not deepened for longer period, resulting to hold only less storage.

To solve rural drinking water in villages, the Tamil Nadu Water Supply and Drainage Board (TWAD) has been supplying water through 556 combined water supply schemes (CWSS) for 24 districts. Each scheme supplies water for thousands of villages. For instance, the Cauvery scheme located in Metu Mahadhanapuram supplies water for 1430 villages in Madurai district and the Cauvery fed Kollidam scheme supplies for 1751 villages in Pudukkottai district. Likewise, the river Tamiraparani scheme situated near Murappanadu supplies water for 637 villages in Virudhunagar district. These CWSS ensure 40 liters of water per head and this has been ensured along with the local bore well supply available from each of these village panchayats. In Tamil Nadu, usually the 556 schemes provide 2146 mld for 42.3 million rural people and due to scarcity, now it is given only 1800 mld (in June 2019). For unforeseen situations, due to power failure, breakdown of pipes, etc., tanker lorries are pressed into service. Bigger CWSS provide 90% distribution through Cauvery supply[14].

7. Industry Hit

In Chennai the service sector establishments such as hotels (about 50,000), hospitals, educational institutions are in distress. There is no potable water in some areas and the available bore well water is unfit for use due to severe salinity. Unbearable to increase in water price, while some water starved hotels have been closed in busy areas like Nungambakkam, a few others partially cancelled their services during morning and evening. A lorry load of 12000-litre water is sold anywhere between Rs. 3500 and Rs. 5000 and the supply is highly erratic, sometimes unavailable. Of 650 Information Technology (IT) companies on the Old Mahabalipuram Road (OMR) in Chennai, 20 have asked their 20,000 workers to carry out their assignments in their homes. Some IT companies, as a short-term measure, advised their workers to migrate to other cities like Bangalore and Hyderabad to tide over the problem. It is surprising to note that water stored in the ponds and tanks for fire services is already used by the SIPCOT IT park complexes. Many residents in Chennai have been migrating to their native owing to water crisis.

The situation in other parts of the state is no way different. Not only for domestic purpose but also for cattle and wild animals the condition is pitiable. Perennially water starved southern districts like Pudukkottai, Ramanathapuram, Sivagangai, Madurai, Dindigul and Virudhunagar people spend day and night to collect water whatever sources available. Sadly, serving ladle (agappai) – are used to fetch water from the temporary dug wells. While they help to extract water in the rivers like Vaipar in Tuticorin and Gundar in Sivagangai districts at times they become death traps to children and animals. Some people moving in a hurry became victims to pits laid down for new pipelines in Kumbakonam and Pudukkottai towns.

The educational institutions are running into trouble for want of water and informally school managements ask their students to bring water even for toilet purpose. Some schools have even locked their toilets and a government primary school in Poovarattakudi in Pudukkottai district is a

[14] *Dinamani* daily, Chennai, 27.06.2019.

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testimony to it. It is disappointing to note that a few private schools in Kancheepuram district conduct classes only during the morning hours.
Highly subsidized state run Amma canteens, hospitals and construction industry are also severely affected. Workers in the Amma canteens ask the public to bring water for drinking and washing. Unable to meet the demand, many government hospitals[15] locked washrooms and stopped construction work leaving thousands of unskilled construction workers jobless.

Dwindling Water Table

Without replenishing groundwater, overexploitation continues unabatedly throughout the state. Previously water was drawn from 50 feet for agriculture operations and now it has gone to over 1000 feet in Coimbatore, Dindigul, Tiruppur and Virudhunagar districts, which are semi-arid in nature.

The Cauvery delta is also showing similar trend. Normally in the old delta region water was available within 30 feet, but now it is 300 feet and in new delta regions it has gone down from 250 feet to 900 feet. In many taluks groundwater reached dangerous level (exploitation exceeds 100%) and around 10 % of wells are dried.

On the east coasts from Chennai to Ramanathapuram shrimp farms impacting salinity and polluting the groundwater thereby unfit for consumption. Over exploitation of groundwater by deep bore wells results in sea water intrusion in Nagappattinam, Thiruvarur and Thanjavur districts.

Dilapidated Infrastructure

Most of the drinking water pipelines, pumping stations, pumpsets, storage tanks, processing centers, valves and shutters have been functioning several decades and now they are in mutilated condition causing water leakage. Also, it is a common scene that excessive vegetative growth on the reservoir bunds enables rats to furrow holes through which water seeps and further leads to crack. Similarly, on many pumping stations, storage points and even on larger pipelines, plants with strong root system grown thereby impacting damage leading to water loss. Both in towns and villages, while the affluent draw water from the supply lines, lower middle class, slum dwellers and tribal feel the pinch.

In many places. unknowing the water levels, the pumpset operators switch on the motors which are burnt. As there is no representative from PRIs[16], it takes longer time to repair and people continue to suffer. Further erratic power supply and insufficient manpower are other issues affect water supply.

More importantly, desilting of water bodies and removal of encroachments are necessary to store more rain water. It has been time and again made appeals in the court to recover the encroached[17]

[15] There are 15 major government hospitals, where more than 50000 patients are treated every day in Chennai and get only 50 percent water supply.
[16] Elections are due for more than four years in this state.
[17] Nineteen years back itself the Madras High Court observed (L. Krishnan Vs State of Tamil Nadu, 2005) that lands marked in the revenue records as ponds or lakes had been encroached and the Bench directed removal of all illegal encroachments (Katju, 2019).

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water bodies. Strangely many public sector facilities - bus stand, court complex, educational institutions, hospitals, administrative buildings - all have been constructed mostly on the irrigation tanks. The Madras High Court's Madurai Bench and new bus stand in Salem town to name a few establishments located on irrigation tanks.

8. Drinking Water Management

There are allegations that the state is attaching more importance to Chennai Metropolitan areas alone and treating with step motherly attitude with other areas of the state. Even in this case, the state government failed to provide adequate supply since March, although water has been tapped from six different sources, viz. 1. Four city reservoirs 11.3 TMC (January 2019 availability was 1.4 TMC); 2. Veeranam lake 180 mld (for 6 months – 1.1 TMC); 3. Krishna waters -12 TMC (received 2 TMC); 4. Minjur and Nemmeli desalination plants 200 mld (2.5 TMC); 5. Govt. well fields, agricultural wells and quarry supply (2 TMC); 6. Neyveli Lignite Corporation supply (2 TMC). From all these, possible supply was 30.9 TMC. But this year's availability was 11.0 TMC that made severe water scarcity. Annual requirement for all sectors (households, industries and services) is about 18 TMC with a shortfall of 7 TMC this year. This scarcity situation prevails every alternate year in Chennai. In spite, the state government has not taken adequate steps to solve this everlasting drinking water problem. Also, the same situation prevails all over Tamil Nadu.
In order to lessen the scarcity problem, drinking water is supplied each day with more than 9000 fleet services of lorries drawn from the bore wells owned by the farmers in and around districts like Tiruvallur, Kancheepuram and Chengalpattu by the Metro Water. Some farmers who sell water expressed that it is a lucrative business since agriculture will not yield this much amount. Earlier water was extracted within the 20-30 kms radius from Chennai and the water table is fast depleting, so the distance is increased to more than 50-60 kms. A lorry with 10000 liters was sold at Rs. 1700-1900 and now it increased to more than Rs. 5000 and unable to meet the demand. Bigger lorries supply water only in main residential areas and mini lorries with 2000-3000 liters are pressed into service in the interiors. Due to depletion of ground water, supply of subsidized[18] Amma bottled water across the state is reduced to 50 percent.

The Chennai Drinking Water Management: Demand and Supply Perspectives

The Metropolitan area of Chennai consists of three districts namely Chennai city and the districts of Kanchipuram and Thiruvallur. The city occupies a total area of 426 square kilometres. The latter two districts have respectively 1942 and 1895 irrigation tanks that are more useful to store abundant rainwater compared to City's household rainwater harvest. All three districts are coastal districts, so their annual normal rainfall ranges from 1140 mm in Thiruvallur to 1324 mm in Chennai, which is more than 200 mm of state average of 962 mm.

A rough calculation of the quantum of rainfall available in Chennai area when 70% probability occurrence of normal rainfall indicate the available quantity of 13.7 TMC (426*910/28.32). This shows, if proper rainwater harvesting is done almost adequate drinking water supply requirement could be solved. Apart from the rainfall source for drinking water in Chennai, it is important to analyse the possibilities of overall supply sources available and the overall demand for water to different sectors of the economy. Relevant details are given as follows:

[18] Per litre bottled water is sold at Rs 10 in all major bus stations.

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The analysis is done based on Demand and Supply Side Water Management:

Demand Side

A. Household Requirement

1)	Size of Population in Chennai in 2019	-	90 lakh
2)	Per Capita Daily Water Requirement	-	135 litres
3)	Daily water requirement	-	1215 MLD
4)	Annual water requirement for Households	-	15.66 T.M. Cft
B.	**Industrial Water Requirement** (15% of A-4) #	-	2.35 T.M. Cft
C.	**Service Sector Requirement** (20% of A-4) #	-	3.13 T.M. Cft

So, Annual Water Requirement for Three Sectors (100%) - 21.14 T.M. Cft
Note: # Any additional water requirements of B & C may be met by RWH method.

Whether the government is ready to provide or not, it has to augment 21.14 T.M. Cft of water supply annually to match the annual requirements on a sustainable basis.

Supply Side

A. Existing Supply Source Currently under Use

1)	City's 4 Reservoirs Supply (53.4% of Demand)	-	11.3 T.M. Cft
2)	New Veeranam 180 mld for 180 days (5.2%)	-	1.1 T.M. Cft
3)	Sea Water Desalination Plants (Minj+ Nem) (10%)	-	2.1 T.M. Cft
4)	Govt. well fields + Agri wells (2.4%)	-	0.5 T.M. Cft
	Gross Local Availability (71%)	-	**15.0 T.M. Cft**

B. Supply Augmentation Possibilities

1)	City's 4-reservoir modernisation additional storage	-	2.0 T.M. Cft
2)	Construction of 2 New Reservoirs* each with 1 tmc	-	2.0 T.M. Cft
3)	Veeranam Addnl. 180 mld for 180 days	-	1.1 T.M. Cft
4)	Krishna Water July to Oct: 8 tmc+Jan to Apr: 4 tmc	-	4.0 T.M. Cft
5)	Compulsory Household RWH in Chennai	-	3.0 T.M. Cft
6)	Compulsory RWH for Industries & Service Sector	-	2.0 T.M. Cft
	Gross Supply Augmentation Possibilities (66%)	-	**14.1 T.M. Cft**

(* Thervoi Kandigai and Tiruneermalai reservoirs)

C. Additional Supply Augmentation Possibility

1)	Sewer Treatment (for secondary uses for Industries and Service sectors - 0.5 tmc /month (28.4%)	-	6 T.M. Cft
Total Possible Supply A+B+C = 15.0+14.1+6.0 (166%)		-	**35.10 T.M. Cft**

D. Result: Supply – Demand Balance

1)	Total Supply: 35.10 TMC. Demand 21.14.: Balance (166%) (100%)	-	13.96 T.M. Cft (66%)

Above calculations are based on the normal period water requirement and demand.

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9. Policy Suggestions

During deficit / drought year 50% (17.5 TMC) to 75% (26.3 TMC) of the above supply / demand can be maintained. To succeed the drought year situation, the following recommendations are advocated that can be done by the people / NGO and Government on a priority basis annually.

1) The existing 4 reservoirs and all the 36 temple tanks and other water bodies in and around Chennai are to be desilted and increase their capacity from their normal level.
2) It should be made 100% rain water harvesting to cope with water requirements for drinking / industrial and service sector needs.
3) Waste water / sewage of about 50% of normal water supply provided to be treated and made it for reuse, especially for industries and service sector units.
4) Option to be found to provide treated water for agriculture around Chennai and in turn good quality well / bore well supply to be received for drinking water purpose.
5) Encouraging shallow depth (<50 feet) groundwater use for fulfilling household water requirements, wherever average to good quality groundwater potential is available. Especially during rainy season these wells may also be used of direct RWH. This local well supply will serve as a conjunctive use to augment metro water for summer needs.
6) Additional reservoirs as already planned should be created on a war footing manner.
7) During rainy periods, metro water should limit its water distribution through pipeline to avoid wastage of water either by over use of water by people or going waste when the metro supply is contaminated with leaked sewerage pipes due to flooding etc.
8) It was planned to get 12 TMC of Krishna water annually. Since its inception from 2016, not even a single year has got its full quantity. So, intensive efforts should be made to augment at least 50% of the earmarked quantity annually and more so during drought period, since a huge amount was spent for laying of canals in the past to get the supply, that cannot go waste.
9) To increase the probability of assured drinking water supply, one more Veeranam pipeline, along the same course of the present one, should be made from Veeranam to Chennai to tap an additional quantity of 180 mld during Cauvery river Supply period.
10) Chennai's storm water drains should be connected to one low level point to store and refine it for use by Metro Water Board. This should be done intensively during both the monsoons.
11) Every year, in the last week of December, "stock taking of drinking water" to be done to ensure the management of water supply for the next 10 months. This will ensure, how much supply to be distributed, based on the quantum of stock available in all supply sources.

Even after doing all these measures, it is difficult to ensure whether all citizens get the prescribed norm of (135 litres) water supply. It is pertinent to quote the following in this regard: "It is important to stop evaluating a city by the local level of water provided per capita per day according to Santha Sheela Nair[19]. Emphasizing the system of liters per capita per day only marks the average level of supply without ensuring equity she says. We have to see each family be it in slum or well-off family how much water it gets. We have to decide that there is a basic lifeline supply that is

[19] Former Chairman and MD of Chennai metro water and Secretary Municipal Administration & Water Supply department of GOTN. The Hindu dated 30th June 2018. "Need to rethink Western water supply standards."

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maintained at all time. It can be either free or at minimum cost." Let us hope to achieve this norm by taking active steps by all people concerned.

10. The Way Forward

Lack of vision for harnessing rainwater; absence of repairing and deepening of water bodies; inadequate attention to periodic maintenance of infrastructure and a host of issues led to drinking water crisis. Not only in Chennai but also all over Tamil Nadu the following five basic activities have to be done on a war footing manner in the next 3 to 5 years to solve water problem. 1. Rainwater harvesting in Chennai at all levels such as households, institutions, govt. land/ buildings etc. should be done on a compulsory basis; 2. At least 50% of daily supplied water in Chennai should be treated for reuse of secondary and tertiary requirements; 3. Already planned additional reservoirs in Tiruneermalai and Kandigai Pudur near Chennai should be completed; 4. All surface water bodies – tanks and rivers – must be kept in condition and all 41,127 tanks must be deepened to hold water to their original storage capacity or even more, that itself take care of groundwater recharge throughout the state. This will help to lessen drinking / agricultural water problems in rural areas; 5. Water literacy, on the importance of conserving and judicious utilisation of water must be compulsorily taught to all people including children and aged. Without these basic steps, mere firefighting operations like laying foundation for sea water desalination, rail water from Jolarpet, quarry water etc. may only lessen the water crisis but it will not solve the crisis in the long run.

More importantly government's initiative, on timely intervention of proper water management practices both in normal and scarcity periods would help to tide over the water crisis in future. The present water crisis will be solved gradually in the next five months based on the south west monsoon (SWM) and north east monsoon rainfall. Interestingly, the SWM started on 22nd July in Chennai after a gap of 198 days (last spell was received on 5th December 2018), the city received 2-3 good showers in June and July that resulting in considerable raise in groundwater level in Chennai city. Indeed, shallow depth well (<40 feet) have reached a water level of 30 feet out of 40 feet depth.

But the question still remains is whether the state government / NGOs and the general public learned lesson to store rainwater in all possible ways and ready to face the monsoon? Whether all 41,127 tanks are to be made pukka to hold its full tank capacity? We have to wait and see the future development! Once this is done, rural drinking water problem could adequately be solved and Chennai will always get its sustainable drinking water supply.

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*Corresponding author.
E-mail address: ksivam2010@ gmail.com