Indian Meteorological Society, Chennai Chapter Newsletter

Vol.18, Issue No.2, Dec 2018 and
Vol.19, Issue No.1, June 2019

Contents

No.	Title of the Article	Author	Page No.
1.	Community based water management for water sustainability	Prof. R.Sakthivadivel	4
2.	Sources of water front	Prof. K.Sivasubramaniyan	8
3.	Application of Behavioural Economics on Water conservation - Urban Context	Er. K.Nagarajan	13
4.	Need for interstate co-operation in solving the water crisis of Chennai city	Er. R.Subramanian	20
5.	What is scarce – Rain or Water?	Shri. S.Raghavan	25
	Photographs taken on 25.02.2019– Seminar on Monsoons - 2018		30
	Photographs taken on 25.04.2019 - Lecture on "Recent Trends in Cosmology"		31
	Photographs taken on 03.08.2019 - BSMCWM		32
	Obituary: Smt. B. Usha		40

From the Chairman's Desk……

Dear members of IMS Chennai chapter and readers of BREEZE,

The current issue of BREEZE is a combined one of December 2018 & June 2019 (Vol. 18, Issue 2 & Vol 19, Issue 1), albeit belated in view of the fact that we were all pre-occupied in conducting the Brainstorming Meet on Chennai Water Management (BSMCWM) in collaboration with Regional Meteorological Centre (RMC), Chennai on 3.8.2019. Keeping the ongoing water scarcity and precarious digging of borewells to the depth of even 400-1000Ft below the ground level at some locations in the coastal city of Chennai in mind, BSMCWM was conducted by inviting subject experts to discuss over this problem with an ultimate view to suggest ways and means to avert such a crisis in future. In all 61 persons (14 resource persons; 16 from IMS & RMC Chennai; 15 Research Scholars, Consultants & PGStudents; 12 from Print, Audio & visual media channels besides 4 volunteers) attended the Meet. After hearing and deliberating on 14 invited lectures, Recommendations were discussed in the summary and wrap-up session at the end of the day on 3.8.2019. The recommendations were submitted to the appropriate Government authorities (from the Hon'ble Chief Minister of Tamilnadu to the Hon'bleMinisters and Officials concerned) on 10.08.2019 for consideration of action as deemed fit. This issue of Breeze has a write-up of 5 out of 14 lectures delivered in the BSMCWM for the benefit of IMSCC members. We are periodically reminding other Resource persons also to send their write-up on the presentations made by them in the BSMCWM. I am optimistic that in the ensuing of Breeze, we may have a few more write-ups on the presentations made in the BSMCWM. Further details of the BSMCWM (Presentations, Recommendations etc.) can please be browsedintheIMSCC web link http://www.imdchennai.gov.in/IMSWEB/imsimd/ims.htm

The following are activities of our chapter since the release of the previous issue of BREEZE Vol.17, Issue 2 & Vol. 18, Issue 1 dated 20.10.2018.

i. 'Review of Monsoons 2018' seminar on 25.2.2019 at RMC Chennai.
ii. Lecture on "Recent Trends in Cosmology" by Dr. AzhagarRamanujam, Former Principal, NGM College, Pollachi on 25.4.2019.
iii. Annual General Body meeting was held on 16.5.2019.
iv. Three Local Council meetings were held on 12.3.2019, 3.6.2019 and 10.7.2019.
v. Brainstorming Meet on Chennai Water Management (BSMCWM) was conducted on 3.8.2019 at Conference Hall, 4th Floor, Health and Family Welfare Training Centre, 54 Pantheon Road (12 Police Commissioner Office Road), Egmore, Chennai 8.

All members are requested to send articles for the forthcoming issue at the earliest.

With best regards
R. Suresh, Chairman, IMS Chennai Chapter, Chennai
Dated: 05 Sept 2019.

Life Membership details of IMS Chennai Chapter (as on 01.07.2019): 152
The list is available in http://www.imdchennai.gov.in/IMSWEB/imsimd/ims_imd.html

INDIAN METEOROLOGICAL SOCIETY
CHENNAI CHAPTER

Email ID: ims.chennai6@gmail.com

COUNCIL MEMBERS: 2018-2020

Immediate PastChairman	:	**Shri. S.BagulayanThampi** Mobile: 97910 35198 E-mail Id: sbthampi@gmail.com
Chairman		**Dr. R. Suresh** Mobile: 98682 38212 E-mail Id: suresh.imd@gmail.com
Secretary	:	**Dr. B. Amudha** Mobile: 94980 02635 Ph.No: 044-2824 6037 E-mail Id: amudha2308@gmail.com
Joint-Secretary		**Shri. A. Roiden** Mobile: 94444 51537 Ph.No: 044-2824 6040 E-mail Id: roiden.antony@gmail.com
Treasurer		**Shri. N. Selvam** Mobile: 94442 43536 E-mail Id: nselvam_kavi@yahoo.com

Members

Dr. K.V. Balasubramanian
Mobile: 98847 15004
E-mail Id: kvbmanian@yahoo.com

Dr. B. Geetha
Mobile: 98405 31621
E-mail Id: geethab67@gmail.com

Shri. R. Nallaswamy
Mobile: 98846 56543
E-mail Id : rns115@gmail.com

Prof. Dr. P. Nammalwar
Ph.No. 98843 26610
E-mail Id: drnrajan@gmail.com

Shri. V.K. Raman
Ph.No: 94449 80541
E-mail Id : vkraman46@gmail.com

Smt. P.R. Sailaja Devi
Mobile : 89395 80740
E-mail Id : sailaja.imd@gmail.com

Dr. R. Venkatesan
Ph.No. : 95553 99829
E-mail Id : venkat@niot.res.in

Community based water management
for water sustainability

Dr. R. Sakthivadivel
Emeritus Professor
Anna University, Chennai
(Email:sakthivadivelr@yahoo.com)

Introduction

For a Country like India, where it rains roughly 100 days in a year, the management of water becomes more critical. The per capita availability of water for India in 2001 is half of its 1947 level. The issue of water is not about scarcity but about its careful use and about its equitable and distributed access. Water is the starting point for the removal of poverty in the country. It becomes the basis of food and livelihood security. Water management strategies will need to be carefully designed so that they lead to distributed wealth generation. It is clear now that local and distributed water infrastructure will require new forms of institutional management as water bureaucracies now existing find it difficult to manage such vast and disparate systems.It is here that India must learn from their traditional community-based water management systems.

Ground water

To-day in India, groundwater is the main source of irrigation even as the country had invested thousands of cores of rupees in creating surface water systems. While the surface water systems are in the public domain, much of groundwater development is in the hands of private sector. The question is how to bridge the use and management of surface and ground water. It is here we need to innovate, by borrowing from the past. The challenge is to enlist this array of informal water users in managing their resources better. It is imperative that groundwater is recharged so that the abstraction quantum is not greater than the recharged water. The traditional water systems were designed to ensure that rain water was stored in millions of disaggregated and diverse structures, which would in turn lead to local recharge of water in to the ground.

Water development in India

Water problems become more intractable as the country progresses: moves from using water in traditional sectors like agriculture to industries and urban areas. India has to make a transition from traditional water economy to a modern water economy. In other words, the water sector has become part of the formalized economy with formal institutions and mechanisms for its management and pricing. In industrialized world, industry and urban households use over 70 percent of the country’s water resources, while agriculture gets the remaining 30 percent. In traditional water economies like India, the reverse is true: Agriculture consumes over 70 percent, and industry and urban areas the rest. The point is: where are we heading?

The problem is that the "informal" water economy of rural India, its agriculture dependent population still exists. The economy has not transformed from being agriculture dependent to a manufacture- service sector driven one. The water crisis is about the management of these competing needs-the vast rural economies, which need water for their food and livelihood scarcity and the newer growth economies of modern and industrial India. This water competition is leading to conflicts between different users.

Modern water policy will have to be built on the premise that scarcity is not about the lack of resource but about being wise about the use of resources.

Learning the traditional use of water

The current water crisis in India is not about scarcity per se. It is about the management of water resources that is capable of reaching out to poor people living in poor region of the country.It is here that the country needs to learn the technologically diverse systems of rain water harvesting that were practiced across the ecologically diverse country by our fore fathers. In these systems, it is not the technology per se but we need to learn, about the manner of control and governance of the resource. These are community- based systems and not the state or private systems.

Rain water harvesting not only provides a source of water to increase water supplies but also involves people in water management, making water everybody's business. Water harvesting and integrated land-water management is not new to India. The art and science of collecting water where it falls is ancient but this dying wisdom needs to be revived to meet modern fresh water needs and modernized with inputs from science and technology.

Decline of the water harvesting systems

- Early Indian period.
- Colonial period.
- Post-Independent period:

1. India invested almost exclusively in mega irrigation projects and depended on the same bureaucracy to manage its water systems.
2. Overall there has been downfall in community self-management as bureaucratic intervention in village affairs has been steadily encouraged by India's political leaders.
3. Technological changes like introduction of tube wells exacerbated the non-cooperation of the decentralized water harvesting systems.
4. In urban areas, these structures have disappeared.

5. Traditional water harvesting systems continue to play an important role largely in remote areas.
6. It is variously estimated that as much as three-fourth of the irrigated area in the country now is under groundwater irrigation.
7. Ground water structures have increased from 4 million in 1951 to 19 million in 2008.
8.The water history documents that people across India had found diverse solutions in diverse ecological regions to manage their water needs.

- People have learnt to live with excess water and with its scarcity.
- They all practiced and worked on the principle of rain water harvesting.
- As and when it comes, they captured the rain and use it to recharge ground water reserves for the remaining year.
- This can be done only through local community involvement. Therefore, the water agenda needed building local interests and institutions, so that its governance is put in to the hands of people.
- Overdraft has occurred in many pockets of India. Recently, water harvesting and recharging the aquifer is being taken up at a large scale under watershed development programme.
- The key to this ecological restoration lies in good management and effectively using the local rain water endowment. The entire exercise must be underpinned by community-baseddecision-making systems and institutions and enabling legal and financial measures which promote community action
- They must work on the concept of participatory democracy and not representative democracy.

Case studies

1.Sukhomajri in Punjab.
2. ReleganSiddi in Maharashtra.
3. Jhabua in Madhya Pradesh.
4. Arvari river in Rajasthan.
5. Ennai watershed in Pudukkottai, Tamilnadu.

- The experience of villagers shows that community based rain water harvesting can in fact become the starting point to eradicate rural poverty. Increased and assured water availability means increased and stable agricultural production and improved animal care.
- It is important to note that ecological restoration is not primarily about planting trees or rehabilitating landscapes. It is about deepening democracy
- Communities were mobilized and won greater power to manage their environment.
- Water harvesting is more about water rights than about building infrastructure.

- Country's legal frame work denies villager's property rights over common land and water.
- Open participatory institutions with clearly defined property rights are in the best position to balance competing interests in the community.

Principles of upscaling

Successful examples of resource management and poverty eradication remain scattered because the governance system needed to foster people's control over natural resources does not exist. Therefore, the institutional framework for governance will have to be restructured keeping in mind the following principles:

- Planning for village resources must be done at the settlement level.
- Community participation in the programme must be secured.
- Village institutions must be strengthened.
- The legal frame work must enable people to manage their localresources.
- Funds for water management must be directed to the village institution

*****

Sources of water front

Dr K.Sivasubramaniyan
Professor of Economics, Madras Institute of Development Studies
(Email:ksivam2010@gmail.com)

Introduction:

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 (9.629m. 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 31.07.2019 India's population is 1364.6 million and World population is 7674.2 million. 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^3goes 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. If, available quantity is prudently used we can solve many water related problems.

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 PWD 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.

Piped Water Supply in India

As reported in the Strategic plan[1] the number of piped water supplies in rural area is rapidly increasing, driven partly by constraints in water resources, but increasingly because people want a higher level of service, in 2010, a third of rural households already use piped water.

The state wise position of population covered with piped water connection reveals that the percentage of population covered at national average is 31.6 and the states like UP, Bihar, Rajasthan, WB, Odisha, Assam, Chhattisgarh and Uttarakhand reported under the group having less than the national average. The gravity of water connection problem could be perceived in another group of states, viz., Bihar, Andaman Nicobar, MP, Jharkhand and UP 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 include Punjab (88.6%); Puducherry (85.4%) and Haryana (78.5%). In Tamil Nadu, 60.1% of population is covered in this piped water category[2].

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, which is given as follows:

Location	**Norm (litre 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 litres per day. However, in times of scarcity,

---

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

[2] 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.

it may be perceived that the minimum level of supply to be maintained is 90 lpcd, since Chennai is covered under underground sewage scheme. So, the government should think of the possibilities of providing the prescribed quantum of water supply to meet both ends of maximum and minimum during normal and scarcity supply periods.

The Chennai Drinking Water Management

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:
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) #- 2.35T.M. Cft

C. Service Sector Requirement (20% of A-4) # - 3.13T.M. Cft

So, Annual Water Requirement for Three Sectors (**100%**)- **21.14T.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

(* ThervoiKandigai 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%**) - **6T.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 TMC = Balance:**13.96T.M. Cft**
   (166%) **(100%)** **(66%)**

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

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 plannedshould 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 SanthaSheela Nair[3]. 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 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.

*****

[3]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."

Application of Behavioural Economics on Water conservation - Urban Context

Er. K. Nagarajan
Former Special Chief Engineer, Public Works Department
President, Centre of Excellence for Change, Chennai
(Email: nagarajgeeth@yahoo.com)

1. Introduction

The Urban Water Crisis persists despite multipronged efforts aimed at 'conservation, augmentation and infrastructure development'. The reduced spatial and temporal availability of fresh water is further worsened by increased urbanizatio, rapid climate change, and competitive sectoral demands and reduced public financial outlays. This exacerbating the issue of the competing demand for water from other sectors is substantially growing with the nine billion populations (World Bank 2015). In an urban context, augmenting the increase of water resources to meet out the growing demand is very limited and the only alternative is **'Demand Side Management'** with some innovative management techniques.

2. Drinking water status

2.1. Global level

Drinking Water supply is not well distributed in the world. Only 0.007% of worlds freshwater are available for human consumption. As the human population increases the demand of freshwater resources is also increases. Globally, more people live in urban areas than in rural areas, with 54 per cent of the world's population residing in urban areas in 2014. In 1950, 30 per cent of the world's population was urban, and by 2050, 66 per cent of the world's population is projected to be urban (United Nations, 2014)

2.2. National level

In India, the water supply in most of the cities is available for a few hours per day (4 to 5 hours) with an irregular pressure and with questionable quality. Piped water is never distributed for more than a few hours per day irrespective to quantum of water available. Less than 50% of urban population has access to piped water. Average use of the Urban Water is 126 litres per person per day. In India few urban residents are depending exclusively on water vendors and they are the only way-out for the poor during the periods of scarcity (and in some case the rich aswell).

2.3. The macro context of drinking water status in Tamil Nadu

As per 2011 Census of India, Tamil Nadu urban population is 34.95 million (Total Population is 72.138 millions), constituting 48 % of the total population. The operational area of the Chennai Metro Water Supply and Sewerage Board (CMWSSB) is 426 sq.km and providing safe drinking water in adequate quantity to people of the Chennai city is the most important function of the Board. Water supply and demand in Chennai Metropolitan Area is estimated at 1750 MLD (22.56 TMC) and 2248 MLD (28.98TMC) in the Chennai Second Master Plan and Chennai revised City Development Plan respectively. The existing storage capacity of all water reservoirs is estimated at 11.057 TMC. This gap between supply and demand requires a combination of conservative resource utilization with sustainable supply augmentation.

In Chennai metro, the residents who are not in the reach of the water utilities meet their water requirements through the following means viz., shared standpipes operated by the local bodies, individual house-hold tube wells and through water vendors. The constraints in meeting out the demand are mainly due to bottlenecks in managing the available water resources as detailed below.

2.4. The micro context

Hidden underneath the generic tragedy of the commons is inherent resistance to change that manifests as inertia, political distaste for pecuniary disincentives, absence or disregard of both contextual knowledge and feedback, cognitive discounting of future gains and Mindless rather than deliberateaction.

The solution lay in addressing the status quo bias and unmindful waste of water by leveraging loss aversion, redesigning the choice architecture, generating feedback for mindful decisions and referencing social norms.

Behavioural Economics suggests that "human decisions are less cold calculated outcomes and more an amalgamation of cognitive biases, emotions and social influences which are strongly persuaded by context and choice architecture". (Amishi, 2017) *

3. Applying behavioural economics for water conservation

Water Conservation by way of reduction in water use in urban areas can be done by adopting "Pecuniary or Non-Pecuniary Approaches". The Pecuniary approaches involve certain financial or tariff related measures to motivate residents in reducing their water usage and thereby conserve water. In the absence of assured and regular water supply to households, any increases of tariffs are socially and politically unacceptable. In the absence of meters for volumetric tariff, despite its shortcomings, any incentive to save water is not feasible. Similarly, despite the "economic benefits associated with efficient water management", consumers have not invested or shown interest in water efficient products and practices. On the other end of the spectrum regulatory efforts focused on "Rationing of water supply" try to reduce the demand supply gap, though it is critiqued for being contrary to freedom of choice. This requires policy level decisions on fixing prices for the supply ofwater.

Similarly, this approach includes providing information on water scarcity and to foster water conservation. However, studies indicate that "providing consumers with information can

Increase their awareness of a topic, but infrequently provides actionable knowledge and more rarely produces significant changes in behaviour". (Ashby, et.al 2010).To quote an example, in one of the studies the individuals who participated in a workshop on residential energy conservation showed changes in attitudes and knowledge but did not produce changes in behaviour. (Geller, 1981). Similarly, in another study, the "individuals who had undergone a two and half month's course on water conservation showed change in knowledge of the need to conserve water but did not display any subsequent change in water consumption patterns" (Geller, et.al 1983).

Tamil Nadu and especially Chennai have witnessed number of governments supported awareness campaigns to save water and the media has also reported on such programs However, these have mostly not made any visible impact on consumption patterns. This dichotomy was also reflected in the focus group discussions conducted as prelude to this study.

Considering the above facts, Non-Pecuniary Approaches based on simple and inexpensive behavioural interventions are chosen for this study to test their efficacy in reducing water consumption. "Non-pecuniary interventions (i.e. psychological interventions) do influence the behavior which is water conservation, with a higher effectiveness of social comparison in the group of high-use households, and a larger effect in the short-term rather than in longer periods". (Ferrara and Miranda, et.al 2013).Also, the behaviour is influenced by considerations beyond information and financialfactors.

4. Nudges

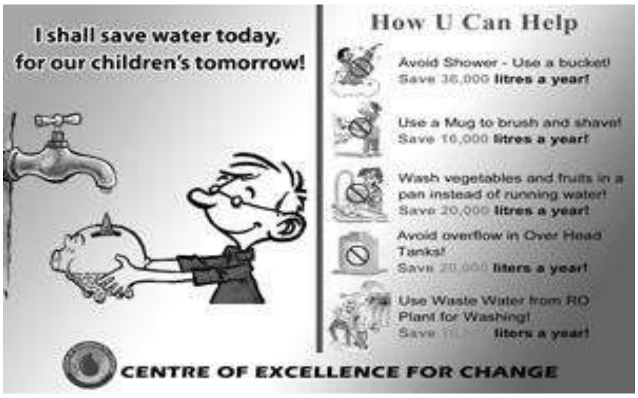
Nudges are simple low-cost behavioural interventions within the choice architecture to steer individuals by addressing specific psychological effects to make use of or overcome them. They do not specify any restrictions on behaviour but influence by giving many opt-out options and centres on social interaction, social influence and related 'Social Norms'

Social and Psychological factors play a significant role in shaping consumers' decisions and behaviours in resource use. Therefore, Behavioural economics when used strategically has the potential to assist in achieving organization objectives, in this case drive down water usage and to achieve a measurable gain in water conservation andefficiency.

The above nudges "Activation of a Desired Behaviour- (Child-Parent-Household), Self- imposed, Mindful and Encouragement" are chosen due to the fact that the emotional bond between the child and the parent is the key factor for exercising nudges, with children playing a role of change champions, who carry and enable the implementation of nudges.

5. Implementation of the nudges in Chennai Metropolitan

Inspired by Behavioural Economics and Theory of Decision points, focused on influencing the behaviour of city families through their children in conserving water and reducing its wastage, Nudges were designed. The Nudge practices based on the principles' viz., Social Norms, Social Comparison, Encourage and Changing the Choice Architecture with Mindful and Default, were adopted in this study, through the following Nudge tools 1) Personal Appeal to Households, 2) Information Card (highlighting the plight of have notes, Positive acts of Peer Group & Action points on how to save water with quantification) and 3) Reminder stickers (at decision checkpoints).



In order to carry out the study based on the above approach; the following methodology is adopted. The Youth volunteers named as change champions from Interact / Environmental Club of Senior School were selected and they were given awareness about water scarcity andWater wastage in Chennai and also the struggle in rural Tamil Nadu for water. Also, they were appraised about the nudges to be used and about the messages they have to share with the students of middle school. Trained change champions were given the Nudge intervention materials i.e. Appeal Letter, Information cards and Reminder stickers along with user survey forms. The students were motivated to fix the stickers in their house in selected three places i.e., wash basins, bath room and kitchensinks.

In the study area, treatment households were administered the nudge (n=615) whereas the control group (n=150) which has similar characteristics received only a generic conservation message. The survey forms to collect data during the study period was given through trained change champions to student volunteers to record the energy meter readings in which the pump lifting water for their use is attached.

The electricity billing system in Chennai is bimonthly which varies by time and place. We refer in this paper; energy consumption pertaining to the pre study period (baseline data) is converted to monthly consumption (30 days) from the bimonthly bill of Month X. For the study period, the energy meter reading recorded for 15 days, is extrapolated for 30 days.

Table 1: Reduction in Average Monthly Electricity and Water Consumption

Treatment / Control	Average Monthly Consumption of Electricity in wk.		Difference in Average Monthly Electricity Consumption in kWh	Change in Monthly Water Consumption in Litres	Percentage of Change
	Pre-Study Period	Study Period			
Treatment (N=615)	227.57	203.98	23.61	9688.68	10.30
Control (N= 150)	223.24	219.01	4.23	1734.75	1.89

The impact of the nudge (designed tapping the power of the behavioural economics and theory of decision points) rolled out in five large school reaching about 615 households was studied through regression analysis of the data obtained through the survey. From the Table 2 differences in difference between the average monthly water consumption by the treatment group and control group during the pre-study period and study period. In our study, the estimated regression coefficient of the treatment group is 9688.68 and 1734.75 for the control group. This clearly shows the differences in difference between the average monthly water consumption is 7953.93 litres when the group followed a nudge practice.

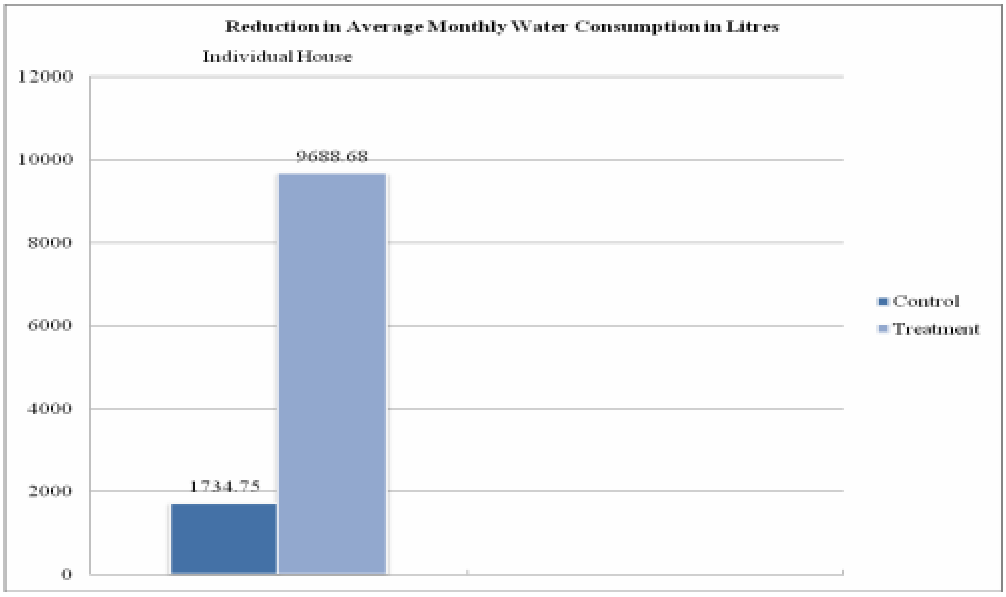


Figure – 1 Reduction in Average Monthly Water Consumption

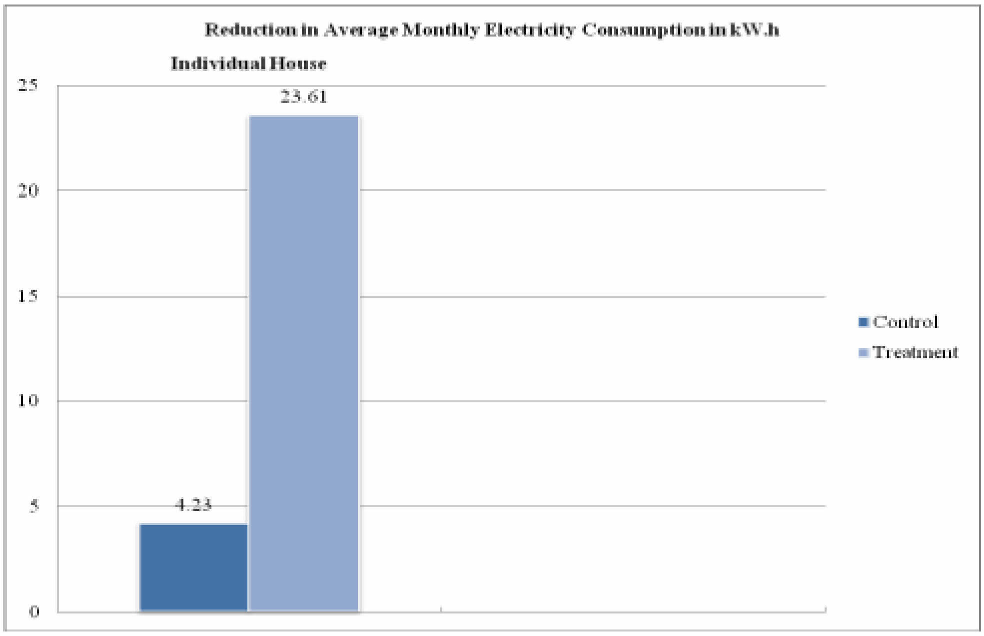


Figure – 2 Reduction in Average Monthly Electricity Consumption

6. Policy implications

This study encourages practitioners and policymakers to consider the impact of nudges and the potential opportunities created by these persistent cognitive biases and 'irrationalities' when determining how best to shift consumer behaviour in the desired direction i.e. water wastage reduction. "Notably, Nudges have exciting potential for conservation because they do not require changes in awareness or attitudes or potentially costly incentives. (Shiela.m.w.Reddy2016)". All the above said nudge treatments from behavioural economics can guide the effective design and delivery of consumer-focused strategies and public policy interventions to improve residential water conservation, particularly solutions that capitalize on message framing, choice architecture and incentivization to shift human behaviour.

The findings of this study are heartening in so far as they suggest that behavioural economics interventions can usefully supplement the persuasion-based tools currently in use to undertake this issue at the neighbourhood level.Secondly and more importantly, the study shows that behavioural nudges provide a potent alternative to policy makers to address the urban water conservation challenge, and are effective in resource and technology-constrained settings, such as in Chennai city.

Third the study also provides policy makers a hint of addressing "future discounting tendency". Educating school students to influence the family can address the behaviour to discount future gains. Future gains when equated with the needs off-springs get valued at a much higher level and are not discounted. Therefore, education department can explore adding this to the syllabi with more emphasis on resource conservation especially water besides environmental concerns like pollution. These are fertile areas for more detailed study in thefuture.

7. Acknowledgement

This Study was conceptualised and guided by our Founder-Mentor,Mr.Vibhu Nayar, I.A.S., Principal Secretary to Govt., of Tamilnadu

I gratefully acknowledge the impetus given in taking up the study including guiding the entire team with the concept,modalities to be adopted and but for our Founder-Mentor this study would not have been possible.

8. References

1) Nudging urban water conservation: evidence from India on the effect of behavior economics on water consumption
   i. Ms. Amishi Nayar, Centre for Excellence of Change Chennai
   ii. Dr. S. Kanaka, Senior Resource Economist Centre for Excellence of Change Chennai, India
   iii. *Ms. Amishi Nayar unpublished project report presented to CEC, Chennai-2017.

*****

Need for interstate co-operation in solving the water crisis of Chennai city

Er. R. Subramanian
Chairman,Cauvery Technical Cell cum Inter-State Water Wing
WRD, Govt. of Tamil Nadu
(Email: subrathi14@gmail.com)

The population of Chennai City, which was only 7000 in 1639, has gone up to 4 lakhs in 1691, and the growth of the city was moderate since then. There was a quantum jump in the extent of Chennai Metropolitan area and in the population of the city, especially after the commencement of the establishment of I.T. parks from late 1990s. As on 2010, the Chennai Metropolitan area has spread over 1189 sq.km. covering the Chennai city and part of Thiruvallur and Kanchipuram districts and as per the 2011 census, the population of Chennai Metropolitan area is 89.31 lakhs and the projected population by 2020 is 110.73 lakhs. In 2050 it is expected to reach 203.18 lakhs, and the domestic water supply demand would be 3750 MLD.

Historical development of water supply to Chennai city

The first water supply scheme was executed in 1772, which is called 7 Wells government works. Actually 10 Wells of diameter 7 to 9 meters were sunk for supplying water to the city. Then, in 1866, Public Works Department prepared a scheme for drawing water from the Kosasthalayar river, 40 km north of Chennai (Madras) through an open channel to reach Kilpauk for treatment and supply. For this purpose, Thamaraipakkam Anicut was constructed across Kosasthalayar. Under the scheme, a channel was excavated to carry the flows to Redhills tank, where the Jones tower was constructed to draw water from the tank. Then, Sathyamurthy reservoir across Kosasthalayar referred as Poondi reservoir, was constructed in 1944 with a capacity of 78 MCM (2.75 TMC) exclusively for supply of water to Chennai city. Subsequent to that in 1962, the water supply to city was further improved by acquiring the irrigation rights of the command areas of Cholavaram, and Redhills tanks, and by this arrangement about
3 TMC was augmented for city water supply. Having found these sources are not adequate, in 1960-65 UNDP team was invited to assess the groundwater potential in the Kosasthalayar and Araniyar river basins. Well fields near Minjur, Punjetti and Thamaraipakkam were identified. Water supply from these aquifers commenced in 1969. Though it was estimated that 125 MLD could be extracted, in practice only about 65 MLD could be supplied. During the years in which North East Monsoon rainfall was poor these well fields were helpful. At present Thamaraipakkam, Poondi and Neyveli aquifers supply about 35 to 65 MLD. But, over extraction of groundwater, especially during drought years, 1983, 1987 to

1990, and 1993, resulted in salt water intrusion to a distance more than 10 kms from the coast.

The above scenario made the Government to look for supply from neighbouring States. River Krishna was considered as the best surface water source for supply of water to Chennai city. In 1976, the basin States of Krishna river, namely, Maharashtra, Karnataka and composite Andhra Pradesh agreed to spare 5 TMC each to Chennai city. Followed by it an Inter State Agreement between Andhra Pradesh(Composite) and Tamil Nadu was entered into in 1983 covering all aspects of the scheme, namely, components of the Scheme, monthly quantum of supply, en-route losses, cost sharing, etc. The scheme came into operation in 1996. Thus, for the first time with the co-operation of the three States Krishna water supply project to meet the drinking water supply of the Chennai city came into existence. The Krishna Water Disputes Tribunal – II, while deciding the share of water over and above 75% dependable yield of the basin to the basin States, has considered the need of the drinking water supply to the Chennai city and it has incorporated in its Order, the quantity to be shared by the States. The relevant para reads as under:-

That all the three States are hereby directed that for the purposes of drinking water supply for Chennai city, each State shall contribute 3.30 TMC in equal quantity distributed in the months of July, August, September and October and 1.70 TMC distributed similarly in four equal installments in the months of January, February, March and April.

However, in practice the quantum of water diverted to Chennai city by the scheme is far less than the stipulated quantity of the water in a year.

The Government of Tamil Nadu, to tide over the crisis, in 2004 executed the Veeranam water supply project to supply water to Chennai city, 180 MLD capacity, by diverting Cauvery water to Veeranam tank and then to Chennai city through pipelines. The infrastructure of the scheme is utilised to convey the groundwater enroute whenever there is inadequate supply at Veeranam tank.

In the years of deficit North East Monsoon rainfall in the catchment areas of the tanks supplying water to Chennai city, during summer months and subsequent months up to North east Monsoon sets in, i.e., up to middle of October, water supply could not be met and the citizens of the Chennai city is put hardship. In some years inter basin transfer also fails. This prompted the Government to go in for desalinization plants. Two plants, one at Minjur at 25 Km from Chennai, in 2010, and second at Nemmeli at about 45 Km from Chennai, in 2013, were commissioned with a capacity of 100 MLD each. In 2017-18 the capacity of Nemmeli plant was increased to 110 MLD. These desal plants meet the water supply needs of North Chennai and South Chennai population, respectively. In this deficit year 2019 these plants are of great help.

Ongoing Schemes

- Construction has commenced in June 2019 for one more desal plant of 150MLD capacity at Nemmeli. There is a proposal to have a desal plant of

400MLD capacity at Perur, 31Km from Chennai, to meet the growing needs of Chennai Metro.

- ❖ In order to increase the storage capacity of water supply reservoirs of Chennai Metro the capacity of Poondi reservoir, Redhills and Cholavaram lakes were marginally increased (about 1.70 TMC), as component of Krishna water supply scheme in 1990s. Desilting of these reservoirs is progressing to restore the original capacity.
- ❖ To further increase the storage capacity, the water bodies Thervoy-Kandigai and Kannankottai are linked to store about 1 TMC in a year and this project is nearing completion.
- ❖ Rain water harvesting is being implemented by the citizens and Government and its instrumentalities.

Proposal for augmenting water to meet the growing need

The existing and ongoing arrangements will not be adequate even after considering the quantum that could be obtained by recycling and reuse of treated sewage and industrial effluent generated from the Metro to meet the growing need by 2050. Chennai Metro needs about 48 TMC or 3750 MLD. This needs further inter basin transfer of water. The options available are :-

- Transfer of water from Mettur reservoir about 9 TMC.
- Transfer of water from surplus basins, lying North of Tamil Nadu, i.e., Mahanadi and or Godavari.

Transferring about 9 TMC from Mettur reservoir was considered by CMWSSB in 2015-16. Since the Hon'ble Supreme Court in its Judgment dated 16-2-2018, on the Civil Appeals filed by the Party States against the Final Order of the Cauvery Water Disputes Tribunal dated 5-2-2017, has reduced the quantity to be ensured to Tamil Nadu by Karnataka at Billingundulu, where the CWC gauging site lies in the common border, from 192 TMC to 177.25 TMC, the proposal of diverting water to Chennai Metro from Mettur reservoir is deferred.

Diverting water from Godavari river

Government of India through its agency, viz., NWDA has prepared a Feasibility Report in 2002-03 for inter linking of peninsular rivers, viz., Mahanadi-Godavari-Krishna-Pennar-Palar-Cauvery link and thereafter uptoVaigai and Gundar. However, NWDA is yet to finalize the surplus quantity of Mahanadi basin, and there are objections to construct reservoirs across Mahanadi to store surplus waters, since a large extent of land is to be acquired for water spread area etc. Therefore, instead of waiting for the issues to be settled or resolved, the Government of India has proposed to take up the Godavari-Krishna-Pennar-Palar-Cauvery link as a first phase. Once this materializes, Tamil Nadu could expect about 125 TMC for its use. By Godavari-Cauvery link diversion of water could be expected during South West Monsoon, when the reservoirs in Chennai City would be having poor storage.

Inter-state cooperation

- **ParambikulamAliyar Project**

The Inter State ParambikulamAliyar Project links three west flowing rivers, viz., Bharathapuzha, Chalakudy and Periyar. It is one of the unique project executed under the second five year plan in pursuance of the Inter State Agreement entered in 1970 with retrospective effect from 1958 between Government of Tamil Nadu and Kerala, on sharing the waters of the three river basins for drinking water supply, irrigation, generation of Hydro electric power, and industrial use in both the states. As per the Agreement, a Joint Water Regulation Board is functioning and it is meeting periodically to sort out day-to-day regulation issues and over all sharing of the waters of the above referred rivers at the designated locations. Thus with the co-operation of the State of Kerala, Tamil Nadu is able to operate the project and regulate the flows and both the States could utilize the waters for the past 4 decades. There may be few issues in meeting the day-to-day problems, which are sorted out by the Joint Water Regulation Board and if the Board could not solve, such issues are discussed by the representatives of both the Governments and resolved.

- **Siruvani water supply scheme**

Another example for Inter State co-operation is supplying drinking water to Coimbatore city from Siruvani river. In the year 1965, an understanding was reached to share 1.3 TMC of water to meet the Coimbatore city water supply from the flows of Siruvani river, which is a tributary of Bhavani river, between the Government of Tamil Nadu and Kerala. It was followed by a working agreement in 1973, and a reservoir across Siruvani river was constructed exclusively for supplying water to Coimbatore city by Government of Kerala and it is operated and maintained by it, for which the capital cost was paid by Tamil Nadu and the Operation and maintenance cost is being paid periodically by Government of Tamil Nadu. Water is supplied to Coimbatore since the completion of the project in 1983. A Joint Control Board constituted under the Agreement, is meeting periodically to sort out the problems, if any, in supplying the Siruvani water to Coimbatore city.

- **Krishna water supply**

Krishna water supplyto Tamil Nadu is regulated by the Government of Andhra Pradesh. There is a liaison Committee, which meets to sort out the issues, if any. There is another inter State Committee under the Chairmanship of the Chairman Krishna Water Management Board with Members drawn from the State of Maharashtra, Karnataka, Telangana, Andhra Pradesh, and Tamil Nadu, which has been constituted recently, to sort out the issues and supply water to Chennai city without shortfall.

- ✓ **Godavari water to Chennai**

Similar co-operation is required from the basin States for diverting water from Godavari river to Chennai city for meeting the drinking water supply. Co-operation of Telangana, Andhra Pradesh and the other basin states of Godavari river, viz., Maharashtra, Chattishgarh and Odisha are required.

Participation of GoI

The national Water policy of Government of India, 1987, 2002, and 2012, gives first priority for drinking water, and to transfer surplus water of a river basin to the deficit river basin for beneficial uses. At the same time for inter linking of rivers (ILR), the policy adopted by Government of India is that the consent of the river basin States is necessary. Government of India, therefore, has to take special measures for implementing ILR scheme. It has to be taken up as a national scheme and if required, it may have to enact a law for linking the rivers for drinking water supply and for optimal utilization of available waters of the nation for the benefit of its citizen.

Conclusion

With the co-operation of the States and participation of Government of India Godavari-Krishna-Pennar-Araniyar-Palar-Cauvery link could be executed in a fast track mode and Godavari water could be diverted to Poondi reservoir to quench the thirst of the citizens of the Chennai city.

References

1.History of Krishna water supply project for Chennai city by Prof. A.Mohanakrishnan, August 2011.

2. Kerala – Tamil Nadu Agreement on PAP – 1970.
3. Inter State Agreement on Siruvani water supply to Coimbatore town, 1973
4. FR of NWDA on Godavari- Cauvery link, Dec, 2017
5. National Water Policy of India.

*****

What is scarce – Rain or Water?

Shri.S. Raghavan
Former Deputy Director-General of Meteorology
India Meteorological Department
Fellow, Indian Meteorological Society
(Email: raglaksh@gmail.com)

It is considered important that Meteorologists and indeed all Scientists and Technologists should concern themselves not only with their Science but reach out to various interests in Society and various disciplines: Sociology, Economics, Politics Psychology and even Law. (Amer.Meteor.Soc. 2014).Water is a subject which is of interest to everyone and cuts across all disciplines. Everyone has been talking about it in the recent past.Water is a subject which is of interest to everyone. So it is good that the Indian Meteorological Society has sought the views of experts by arranging this brainstorming session.

I was brought up on a farm where we had no electricity, no telephone, no radio, no water taps but *plenty of water*. Now the same place has all these technologies but NO water. I have been dabbling in Meteorology for the past 66 years.When I got into tropical cyclone observation and warning I realised that I was serving Society by way of saving lives and property in the context of cyclones. I interacted with Disaster Managers and others and studied the reasons for the enormous increase in **impact** of cyclones over the years by way of damage. I found that the impact increased **not** because cyclones were increasing in frequency or intensity **but** due almost entirely to socio-economic reasons (Raghavan and Rajesh, 2003 and references cited therein). Similar results have been obtained by other scientists in other countries. I also find that FLOODS are increasing over the years **not** because rainfall is increasing *but because of human-made causes*

Water scarcity is increasing. Why? Chennai's normal annual rainfall is 138 cm, Chennai gets water from the rest of Tamil Nadu too.So, let us consider the whole of Tamil Nadu.The State's annual rainfall in the period 1901-2000 is as below.

	Mean mm	SD mm	CV %
January-February	46.8	46.4	99.3
March to May	135.1	45.1	33.4
June to September	337.1	71.3	21.2
October to December	488.3	132.3	27.1
Annual	1005.6	145.2	14.4

[CV is the ratio of SD to Mean expressed as a percentage]

So the year to year variation is large. Considering the extreme values in the northeast monsoon season when we get the major part of our rain, years 2016 and 1876 had the maximum deficiency.

Year	OND Rain mm	Normal mm	Departure%
2016	168.4	442.0	-62
1876	163.5	457.0	-64.5
The data of 1876 are said to be based on 20 rain gauge stations in the Tamil Nadu part of the Madras Presidency			

Tamil Nadu received about a third of the normal. The deficit in the year 1876 led to famine in much of India said to be compounded by certain actions of the British government. The year is known in Tamil as "*DhaatuKaruppu*" as that was the Tamil year Dhaaatu. Note that the deficit of 2016 is **not** unprecedented

Is Rainfall decreasing?

Some say that rainfall is decreasing over the years. Is this true? An India Meteorological Department (IMD)study (Rathore et al (2013) of trends mm/year in Tamil Naduin the period1951 to 2010 are as below.

Trends in annual and seasonal rainfall mm/year

State	**Number of stations**	**Annual**	**Winter**	**summer**	**Monsoon**	**Post-monsoon**	**annual rainfall change in 60 years mm**
TN and Puducherry (22 gauges)	207	+0.80	-0.16	-0.47	-1.35	+1.49	+48

Annual rainfall is **increasingnot**decreasing! But Climate experts say that there will be fewer spells of rain in future but these will be heavier. This has implications for Agriculture, flood management and water conservation.

What is drought?

Our demands for water have increased enormously. We cannot expect rainfall to increase correspondingly!Chennai city water demand 1200 million litres per day (MLD) expected to increase to 2100 MLD by 2031. Shortage of water is described as "DROUGHT" and attributedto deficit of rain. This nomenclature is unfortunate. Various meteorological Services around the world define drought differently.The UK Meteorological Office says:

"there is ***no*** *generally accepted definition of exactly what a* **drought** *is". "A drought's slippery definition means it is sometimes easier to refer to them by their causes or impacts:*
hydrological drought- refers to a lack of water in all parts of the water cycle
meteorological drought- determined by the number of days without rain
agricultural drought-focuses on the amount of water in the soil
socioeconomic drought- a lack of water means that demand for an economic good exceeds the supply".
Impact on citizens is in the form of scarcity of water due to *various reasons* not just below-normal rainfall.The National Oceanic and Atmospheric Administration (NOAA) of the USA defines drought as *"Drought is a* ***deficiency of moisture*** *that results in adverse impacts on people, animals, or vegetation over a sizeable area".*So drought is "*deficiency of moisture*" not of rain. if a problem is not accurately specified, then solutions may not fully address the issue*". (*Bertrand and Shafer, 2017)
If drought is seen only as a deficit of rainfall, it is taken as an *act of God* and desperate crisis control measures are taken *after* the event such as drilling wells, transporting water over long distances or even *cloud seeding.*Our neighbouring States have been conducting **"***operational***"** cloud-seeding programmes without a proper scientific basis. It is to the credit of the TN government that advice to do cloud seeding in the 1990s and early 2000s was rejected.
Other proposals e.g. Evaporation Control, Desalination of sea water: an expensive process with adverse environmental effects and even Geo-engineering solutions such as building a wall to intercept moist winds have been suggested. Benefit-cost ratios and socio-political fallouts of such actions need to be considered.
Costly palliative measures taken *after* the event such as monetary relief to affected people of areas *declared as drought-affected*. *Only*on the basis of rainfall of the area *without* considering other factors do not take account of the *temporal* distribution of rain during the farming season. If the rain comes in fewer but heavier spells it will affect water management and farming operations. The **impact** of the percentage deficit of rainfall may differ from one area to another depending on type of crops raised, alternative sources of water available. The rainfall figures are used for claiming or allotting funds and here socio-political considerationsenter.

What have we done?

1. Water bodies including rivers, and irrigation tanks (41000 in Tamil Nadu) built in earlier centuries have been encroached, or destroyed or polluted with effluents in the name of development.Our ancestors realised the importance of conservation measures as "*Pittukku Mann Sumantha*" story (பிட்டுக்கு மண் சுமந்த கதை) illustrates. There are (numerous inscriptions about endowments made for

the upkeep of waterbodies and assignment of responsibilities (Nagaswami 2019). But we have not only not maintained them but destroyed them

2. Wetlands which absorb water and mitigate floods have been destroyed. It is worth noting that tsunami damage of 2004 was least where mangroves had not been disturbed (Swaminathan 2005)

3. Natural drainage of water has been interfered with resulting in floods even with relatively less rain intensity.

4. Ground recharge of rain water has been prevented in many areas even while large scale over-exploitation of ground water is taking place, aided by free power

5. Allowing rain water to runoff without storage or recharge of ground water, results in scarcity of water in the non-rainy seasons and cries of "Drought"So there is the strange spectacle of floods followed soon by water scarcity!

6. Unwise land use such as constructions over waterbodies or in other vulnerable terrain lead to landslides and floods.

7 Deforestation in hilly areas lead to flash floods and landslides followed by water shortage.

Action Needed

Reversal of the above activities and rain water harvestingon a large scale, recycling of used water, changes in irrigation techniques and cropping patterns are some of the actions which can be taken. Rain water harvesting (which was encouraged in the 1990s and 2000s) has gone into the background in recent years. Wastage of water on non-essential activities need to be curbed. The IMD has recently brought out studies of the rain water harvesting potential in two States, Madhya Pradesh and Maharashtra (IMD, 2016a,b) which show the enormous scope for systematic storage of water by this means.

Water scarcity is **not** something which occurs at short notice like floods or cyclones.

Normalized Difference Vegetation Index (NDVI), a satellite product is available for monitoring vegetation. *Hence proactive and long-term action before the problem arises is necessary*rather than post-disaster actions*. Varumun Kaappom(வருமுன் காப்போம்)* instead of *Varungaar Kaappom* or *Vandapin Kappom*

Legal, administrative and engineering measures

What does not seem to be adequately appreciated is that human actions relating to the Environment (whether or not they are related to Climate Change), are the causes of most of our problems and need urgent action). Let it be noted that the Inter-Governmental Panel on Climate Change (IPCC) (IPCC, 2012) has only recently redefined climate change to include the land use factor. All the above consequences have been pointed out by various experts and Committees.

Ignoring these and labelling the disasters as "*Acts of God*" shifts blame and *misdirects resources.*

It is necessary to impress on governments, administrators, the media and the public that the real causes of these Impacts must be tackled by **legal, administrative and engineering measures, strict enforcement and creation of awareness.**

GAIA

James Lovelock of England formulated what he calls the GAIA hypothesis. (Lovelock 1988). GAIA was the Greek goddess of the Earth. Lovelock postulates that the Earth as a planet with all its living organisms is a living entity which adapts the climate to the maximum good of all its components, _ not necessarily forthe good of humans. This is a beautiful concept, although more poetic than scientific, which will encourage adaptation rather than a business-as-usual approach.

References

American Meteorological Society, 2014, Strengthening Social Sciences in the Weather–Climate Enterprise, AMS Statement https://www2.ametsoc.org/ams/index.cfm/about-ams/ams-statements/statements-of-the-ams-in-force/strengthening-social-sciences-in-the-weather-climate-enterprise/

Bertrand D. and M. Shafer, 2017, Defining Hazards, Bull. Amer. Meteor.Soc. 98, 4, pp 659-663

IMD, 2016a: Rainwater Harvesting Potential for different locations in the state of Madhya Pradesh, Met Monograph No.ESSO/IMD/Hydrology/02(20

IMD 2016b, Rain water harvesting potential for different locations in the state of Maharashtra, Met Monograph No.: ESSO/IMD/Hydrology/03(2016)/21

IPCC, 2012: Summary for Policymakers. In: "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19. (available on IPCC website).

Lovelock James. 1988, The Ages of GAIA. Oxford Univ. Press

Nagaswamy R 2019, Lecture at Tamil Heritage Society 6 July 2019 http://www.tamilheritage.in

Raghavan S. and S. Rajesh, 2003, "Trends in tropical cyclone impact: A study in Andhra Pradesh, India", Bull. Amer. Meteor. Soc., 84, 635-644.

Rathore et al 2013, STATE LEVEL CLIMATE CHANGE TRENDS IN INDIA Meteorological Monograph No. ESSO/IMD/EMRC/02/2013.

Swaminathan M.S., 2005, Report of the Committee to review the Coastal Regulation Zone Notification, 1991, February2005, 122 pages pdf file

*****

Photos taken on 25.2.2019 – Seminar on Monsoons - 2018 held under the auspices of IMSCC

Lecture on 25 April 2019 at 1030 hours IST

A lectureon "Recent Trends in Cosmology" was delivered on 25 April 2019, by Dr.AlagarRamanujam, Former Principal, NGM College, Pollachi. The lecture focused upon his published paper dealing with Cosmology in the context of Indian philosophical systems, in the Indian Journal of Physics. IMS members and newly posted Scientific Assistants in RMC Chennai eagerly participated.






Photos of Brainstorming on Chennai Water Management – 3.8.2019


Chennai Water


Management
Dr. B. Amudha


Indian Meteorological Society, Chennai
and
Dr. S. Balachandran


Brainstorming Meet on


Shri S. Raghavan


Shri S. Raghavan


Indian Meteorological Society, Chennai
and


Society, Chennai Chapter

Obituary

Smt. Usha B

Life Member No.744, IMS Chennai Chapter
RMC Chennai

Smt. Usha B, Scientific Assistant was born on 01.01.1970. She joined Regional Meteorological Centre, Chennai on 6.4.1998. She worked in RMC Chennai and also at AMS and MO Puducherry. She was working at AMS Puducherry from 23.9.2017. Smt. Usha with her iron will, battled with cancer and breathed her last on 30.3.2019. She is survived by her husband and two daughters.

Smt. Usha rendered a commendable service to IMD for 20 years, 11 months and 25 days. Smt. Usha was a sincere, dedicated, hardworking officer with a determination worthy of emulation. She became a member of IMS Chennai Chapter as soon as she had joined IMD, Chennai and was an avid participant in the activities of the Chapter.

****