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Review Article

Urban Water Management for Sustainable Development: The Role of "Climate Change and Human Interference"

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Abstract

Water and oxygen are the two nature's gifts to human survival on the Earth. With the non-linear growth in human population and thus creation of infrastructure for such population under the changing lifestyles has resulted imbalance on these two nature's gifts. This led to bulging of urban areas with population and slum dwellers with disastrous consequences on the nature and human health.

Urban water involves *in-situ* and *ex-situ* water resources, which are affected by climate change and human interference on nature. Climate change plays important role in year to year variations in primary water resources availability, which is beyond human control and thus needs to be adapted to it. Unfortunately, this is rarely accounted in the management and sustainable development issues. Human interference on nature relates to several factors. Pollution is the main component. This affects both quality and quantity.

Poor governance and poor civic sense among elite to poor with the slum culture affected the sustainable water development processes in urban areas. The gravity of this is in proportion to percentage slum population in any given urban area. Under these scenarios, fresh water availability in urban areas is drastically reduced. Around 75% of the water used in urban areas turns in to wastewater and this in turn pollutes the more water by joining water bodies, rivers and on its way groundwater. This makes water management unsustainable and thus this leads *in-situ* water share reaching to practically zero level and thereby increases the dependence on *ex-situ* water sources that primarily depends up on the variability in precipitation. Same is the case with oxygen availability in the urban environment but in terms of air pollution.

Some of these are discussed with reference to Hyderabad as an example. In this context in brief discussed the usefulness and limitations of NITI AAYOG's Composite Water Management Index [CWMI] and Chinese Sponge City [SPC] concepts.

Keywords: Urban Water; Water Management; Sustainable Development; Climate Change; Human Interference; NITI AAYOG; Composite Water Management Index; Chinese Sponge City

Introduction

Population Scenario

Water and oxygen are the two nature's gifts to human survival on the Earth. With the non-linear growth in human population (Figure 1) and associated infrastructure built to meet their needs under changing lifestyles lead imbalance on these two nature's gifts. At the same time the process of globalization culture created steep economic gradient among urban and rural population and thus led bulging of urban areas. This impacted the quality and quantity of the two natural resources in urban areas severely with the progression of time.

Figure 1: World population Growth.

China and India cover major share of the world population. Let us see some features:

1. The geographical area of China and India respectively are 9,596, 960 km^2 and 3,287, 263 km^2.
2. Area under agriculture of China and India respectively are 54.7% and 60.5%.
3. Area under irrigation in 2012 of China and India respectively are 690,070 km^2 and 667,000 km^2.
4. The population changed from 1950 to 2014 of China and India respectively are 543 million to 1.39 billion and 376 million to 1.27 billion.
5. Urban population in 2017 of China and India respectively are 57.9% and 33.5%.

Though in terms of geographical area China is around "three times" to India but population and area under irrigation are more or less the same. This resulted meeting the food requirement of the growing population. At global level, Indian population constituted 16% of global population occupying 2.7% of the land area and uses only 4% of world's fresh water but uses 25% of global groundwater.

India's population in 2001 was estimated at 1029 million, in 2011 it was estimated at 1210 million and now it is estimated as 1337 million. Urban population in India has grown from 78.9 million in 1961 to 286 million in 2001 and by 2011 to 380 million. That is, the urban population in India went up from 27.81% in 2001 to 31.16% in 2011. A total of 42.6 million people were living in 8.3 million households of 640 slums in cities/towns across 26 state and Union Territories according to 2001 census. By 2011 it has reached around 95 million. However, at state-wise these are quite different. For example, in Andhra Pradesh in 2011 the urban population was 33.5% in which slum population is 32.69%. The same for Tamil Nadu were 48.45% and 17.85%; and Karnataka 38.57% and 11.51%.

The growth being urban-centric is giving rise to rapid urbanization leading to slums. The population growth and density figures are misguiding as the cities grow outwardly; and we count population inwardly. For example Hyderabad MCH has grown outwardly from about 179 to 836 under HUDA and to 7257 sq. km. under HMDA. As a result the slums extended outwardly and so also population. The slums define the destruction of natural resources in any given Urban Centre. The other important issue is the destruction of natural resources under the disguise of development. Real estate is not truly speaking the development.

Water Availability

Two-thirds of the Earth is covered by water, of which 97% of it is saline and fresh water constitutes 3%, which is in icecaps and glaciers - 68.7%, as groundwater - 30.1%, rest 0.9%. Small part of groundwater and ice melt is available as fresh water and surface water constitutes 0.3% of which 87% in Lakes, 11% in Swamps, 2% in Rivers but only small part is available. Table 1 presents sector-wise global current water usage and future water use projections.

In USA water use in agriculture showed a decrease from 2000 to 2050 (Table 1). US Geological Survey [USGS] study published on June 19, 2018 states that "Water use across US has been decreasing since 2005, has now reached pre-1970 levels [511 BCM]". The water use in BCM in 1950 was 248.7, peak in 1980 with 594, 1985 with 548.5 and 2005 with 548.5 (Figure 2).

Sector	Current water Usage in %			
	World	Europe	Africa	India
Agriculture	69	33	88	83
Industry	23	54	05	12
Domestic	08	13	07	05

Year	Future water usage [BCM*]				Per capita [liters/ day]
	Agriculture	Industry	Domestic	Total	
India /2000	1658	115	93	1866	89
2050	1745	441	227	2413	167
China /2000	1024	392	105	1521	83
2050	1151	822	219	2192	155
USA /2000	542	605	166	1313	583
2050	315	665	187	1167	485

Table 1: Sector-wise global current water usage and future water use projections.

* billion = 10 crores; million = 10 lakhs; crore = 100 lakhs.

Figure 2: US Water Use Trend over the years [Source-USGS].

According to this report 445 BCM of water were withdrawn for use in the US during 2015 and about 489 BCM during 2010. The two main water consumer sectors, namely the thermometric power and irrigation use gradually increased from 1950 and reached a plateau around 1975 to 2005 and there onwards showed a decreasing trend. However, in urban areas it is rarely possible to achieve such results as the governments, with their pro-active tendencies fond of implementing 24-hour water and 24-hour power supply, resulting in huge wastage. Also, show high variations in water use in different states for the same crop and for different crops in the same state (Figure 3). Kilogram of rice produced per lakh liters of irrigation showed the highest in Bihar and the lowest in Punjab wherein paddy farmers in Punjab need three times the amount of irrigation water used by farmers in Bihar to produce one kilogram of rice. In Maharashtra sugarcane consumes two-thirds of the state's irrigation water.

Figure 3: State-wise water use in paddy and crop-wise water use in Maharashtra.

Table 2 presents per capita water availability in India during 1951 to 2050 along with the population. Table 3 presents sector-wise water consumption and projections in India for 1990-2050. 80% of total water resources goes to agriculture in which Paddy and Sugarcane are India's most water guzzling crops using up over around 60% of the country's total irrigation water resources. With 5000 large dams, India ranks third globally in numbers of large dams completed. Though crop rotation brings down the water consumption levels neither governments nor the farmers rarely like this approach. However, this must be implemented in India.

Year	Population (lakhs)	Per capita (cubic meter/year)
1951	3610	5177
1955	3950	4732
1991	8460	2209
2001	10270	1820
2025	13940	1341
2050	16400	1140

Table 2: Population and per capita water availability in India [1951-2050].

Source: Government of India, 2009.

Source	Consumption in bcm/(%)			
	1990	2010	2025	2050
Irrigation	460	536	688	1008
	88.60%	77.30%	73.00%	70.90%
Industry + Energy	34	41.6	80	143
	6.60%	6.00%	8.50%	10.10%
Total [includes others]	519	693	942	1422

Table 3: Sector-wise water consumption and projections in India [1990-2050].

Note1: Different agencies have presented different percentages and bcm figures [very difficult to figure out which is correct].

Note 2: Each liter of wastewater discharged further pollutes about 5-8 liters of water, which raises the share of industrial water use to some-where between 35 to 50% of the total water used in the country and not 7 - 8% Industry very rarely use the wastewater in place of fresh water.

Water Management

Water management is the activity of planning, developing, distributing and managing the optimum use of water resources. We find reports after reports on water issues such as "Almost no place on the Earth gets more rain than Chirrapunji with nearly 40 feet rainfalls, storms often drop more than a foot a day. But during the dry season many struggle to find water. Some fetch water from long distances. According UNICEF every year about 600,000 Indian children die because of diarrhea or pneumonia, often caused by toxic water and poor hygiene. Half of the water supply in rural areas, wherein around 70% of India's population lives, is routinely contaminated with toxic bacteria.

In India's great cities, water problems are endemic, in part because system maintenance is nearly nonexistent. Water plants in New Delhi, for instance, generate far more water per customer than many cities in Europe, but 30% to 70% of the water is lost to leaky pipes and theft. This is not different in other cities. For example, it is around 55% in Hyderabad, of which 40% through leakages and 60% unaccounted. India is lagging far behind the rest of the world in providing water and sanitation both to its rural and urban population. Here the main weakness is governments have been more interested in getting water from faraway places at huge cost that includes power supply rather attending in the reduction of losses as the former fetches huge sum of money through percentages.

Natural variability

Precipitation and snow forms the basics of water through hydrological cycle. This presents a natural variability [climate change]. The average all-India Southwest Monsoon rainfall constitutes 78.2% of average annual rainfall. This presents a 60-year cycle similar to Indian Astrological cycle [this is lagging by three years to Chinese 60-year Astrological cycle] - (Figure 4). The current cycle started in 1987 [starting with Prabhava]. The first 30 year period constitutes above the average and subsequent 30-years below the average part. The frequency of occurrence of floods in the northwest Indian rivers is also follows this pattern (Table 4).

Figure 4: Annual March of All-India Southwest Monsoon Rainfall and 60-year cycle.

	Frequency of high magnitude floods*		
River	Period	Frequency	Climate cycle
Chenab	1962 - 1990	1 in 9 years	Below the average cycle
	1990 - 1998	1 in 3 years	Above the average cycle
Ravi	1963 - 1990	1 in 14 years	Below the average cycle
	1990 - 1998	1 in 3 years	Above the average cycle
Beas	1941 - 1990	1 in 8 years	Below the average cycle
	1998 - 1995	1 in 2 years	Above the average cycle

Table 4: Frequency of occurrence of floods in few selected northwest Indian Rivers

***State of Environment Report, India - 2009, MoEF/GoI:** The frequency of floods in India is largely due to deforestation in the catchment area, destruction of surface vegetation, changes in land use, increased urbanization and other developmental activities – this is the false statement but it is more in association of cyclic variation in rainfall.

However, at regional level the cyclic nature is different from the all-India. For example undivided Andhra Pradesh annual rainfall presents 132 year cycle. The first 66 years form the below the average wherein 24 years are drought years with < 90% of the annual average and 12 years are flood years with > 110% of the annual rainfall. Next 66 years form the above the average wherein 24 years with > 110% and 12 years with < 90%. This started in 1935 and ended by 2000. The current below the average 66 year period started in 2001. Annual water availability in Krishna River followed this pattern (See Figure 5). However, in this part of the country receives rainfall in southwest and northeast monsoon seasons. They follow a 56-year cycle but in opposite direction. The cyclonic activity in Bay of Bengal follows the northeast monsoon 56 year cycle patterns. Annual rainfall accounts the rainfall in the two monsoons as well as summer rainfall from cyclones and thunderstorms activity [2,3]. Figure 6 presents Famine stricken people during the famine of 1876-78 in Bangalore, Karnataka state in India.

Figure 5: Annual march of Andhra Pradesh [undivided] Annual Precipitation and (b) Annual Water Availability in Krishna River.

Figure 6: Famine stricken people during the famine of 1876-78 in Bangalore.

My studies relating African and South American rainfall showed the current drought condition [1]. Thus, the knowledge of systematic variations in precipitation plays vital role in short, medium and long term planning of water resources management as well agricultural planning. Without such actions both people and government have to face severe problems and thus cause huge sums of wasteful expenditure. We have seen this scenario in Cape Town in South Africa in 2017 and now in 2018 the reservoirs are full with good rains. Therefore both state and central governments must give top priority to studies in this direction.

MGNREGA

It is paramount important to assess the water availability in rivers, ponds/tanks and groundwater under the systematic variations existing in those belts. This facilitates building dams, water bodies or linking of rivers and in an efficient way use of groundwater.

Close to 65 per cent farms in India are rain-fed and one-third of the country faces drought every year, the government of India initiated extensive water conservation works under the Mahatma Gandhi National Rural Employment Guarantee Act, 2005 (MGNREGA), with an objective to protect farmers against deficit rainfall!!! These structures meant for soil and water conservation, groundwater-recharge, irrigation and drought-proofing. Since April 2014, the completion rate has been declining at rapid pace. In 2014-15, the work completion rate (defined as works started and finished) was 97 per cent. It came down to 71.24 per cent in 2015-16. In 2016-17, it further declined to 41 per cent. This financial year, till October 12, the completion rate is an alarming 8 per cent. We must not forget the fact that these are primarily depends upon the rainfall.

Majority of the incomplete works are in the states that have witnessed drought in the last three years or are currently reporting drought-like situation in many districts. Since 2005, it has created 45 such structures for every village in the country. Despite this, even a slightly deficit monsoon leads to widespread drought, having a manifold effect on agriculture. Now Telangana Government is contemplating linking 44, 928 tanks with the water channels of the projects under construction or constructed. Here the main weakness in all such programmes including watershed-check-dams-water recharging pits is that the success or failures of all such works depend upon the seasonal rainfall in the given year.

CWMI - A Tool for Water Management???

The National Institute for Transforming India [NITI] Aayog brought out a report titled "Composite Water Management Index [CWMI]: A tool for water management" dated 12th June 2018 to unable effective water management in Indian states in the face of growing crisis. The indicators in the Water Index have been grouped into nine broad themes, namely:

1. Source augmentation and restoration of water bodies
2. Source augmentation (Groundwater)
3. Major and medium irrigation-Supply side management
4. Watershed development-Supply side management,
5. Participatory irrigation practices-Demand side management
6. Sustainable on-farm water use practices-Demand side management
7. Rural drinking water
8. Urban water supply and sanitation, and
9. Policy and governance

Based on the index states were ranked for 2016-17. Water Index scores vary widely across states. The Water Index scores vary from 76 (Gujarat) to 26 (Meghalaya). Unfortunately, these indices appear to be based on qualitative information and not quantitative true information.

Telangana State index score for the year 2015-16 was 45.2 and for 2016-17 it is 49.6. It states that Telangana showed "significant improvement in irrigation potential by raising its ratio from 4% to 53%. However, it scored very low on watershed development-supply side management, demand side management participatory irrigation practices, demand-side management of sustainable on-farm water use practices, etc. But "it scored high on augmentation at source and restoration of water bodies and groundwater source augmentation". However, 1st and the last of nine themes are highly depends upon natural variability in precipitation. This is clearly evident from the area under tank and well/bore-well irrigation statistics. Irrigation potential raising 4% to 53% is false statement as this should have been 50% to 53% as most of the irrigation potential was created earlier.

Sustainable Development

Even though the concept of sustainable development was there even before 1970, the first Prime Minister of India, late Pundit Jawaharlal Nehru used this with respect to agriculture. It's importance with the focused emphasis entered into political arena after 1992 environmental summit conference in Rio de Janeiro, Brazil wherein emphasized the threat continued economic growth poses to life support environmental systems and natural resources bases. However, off late this word is used casually like the word global warming [in the last one decade most of the time the word climate change is used as de-facto global warming].

In simple terms sustainable development is nothing but a balancing act between "present needs" and "future needs" that provide economic growth under environmental protection scenario. At present what is happening is economic growth for few at the cost of environmental degradation. Here it is profit driven.

During the 20th Century both the producers and consumers depleted natural resources with little thought for the environmental damage they were causing. This is part of the game by the so-called global warming groups. We continued to overlook environmental damages until polluted land, water, food and air, began threatening human health and until native species and ecosystem began disappear. Resulting groundwater contamination, rivers become efficient channel to carry pollution, reservoirs became cesspools of poison.

India is among the 10 most industrialized countries in the world with 6th largest economy. However, rapid economic and industrial growth is causing severe agriculture, urban and industrial pollution. India, thus, has been ranked as 7th most hazardous country in the world.

Let us look at on whether we can achieve sustainable development in urban water resources with reference to Hyderabad under this scenario?

Urban Water Management for a Sustainable Development Hyderabad Drinking Water: An example

Needs protection of Himayatsagar and Osmansagar Lakes: In urban areas water is used primarily for drinking purposes; and then, comes construction activity, transport and industrial activities. They get water from two resources, namely *in-situ* and *ex-situ. In-situ* refers to water available locally from rivers, water bodies, and groundwater; and *ex-situ* refers to water brought from faraway places at huge costs by displacing poor people and grabbing their lands for laying pipelines. They mainly come with pumping, recurring electricity bills. Here is an example how the government is mismanaging valuable *in-situ* drinking water resources in Hyderabad in the state of Telangana.

Himayatsagar and Osmansagar lakes were built on the river Musi and its tributary Esi. They were ready by 1930. They provide 45 MGD of water along with around the same amount from groundwater. Since then this water was supplied for drinking; and in 1960 these lakes provided drinking water to the entire Hyderabad city of around 12 lakh populations. As the city grew government brought water through pipelines to meet the growing population water needs and as well the industrial water needs around the city from *ex-situ* sources such as Manjira (Phase-I and II) and Singuru (Manjira Phase-III and IV) during 1965 to 1994 of 120 MGD; from Krishna River - Nagarjunasagar Reservoir in three phases during 2004 - 2016 of 270 MGD. Now, water is available-planned from Godavari River by around 172 MGD - water from Krishna and Godavari covers around 400 million gallons per day (MGD) or 146000 = 400 x 365 million gallons per year (MGY); one gallon (G) means 4.54609 x 10^{-3} m^3; billion cubic meter [BCM] = 35.31 tmcft]. In addition to these, huge quantity of groundwater has been in use - nobody has quantitative figures on this and as well bottled water coming from outside.

Metro Water Board instead of protecting the two lakes that provide drinking water through gravity argues that they are unreliable. A "foolish argument", the water level depends on the rainfall. The fact is these reservoirs were built by taking in to account the rainfall data for 100 years in the catchment area so that excess water cleans up the river Musi. Later JNTU study showed rainfall is steady except year to year variations in line with all other river basins; but they found in water flows there is a continuous decrease due to illegal constructions and extraction of water. Instead of controlling illegal activities in the catchment area that affect the quantity and quality of inflows in to the two reservoirs they say they are redundant to help real estate business at the cost of the two lakes. Here hundreds and thousands of crores of black money is changing hands for protecting the interests of violators of laws.

Needs controlling of water losses: The water brought to Hyderabad for drinking purpose at huge cost running in to thousands of crores along with recurring expenses for pumping using electricity. However around 55% is going as waste through losses from pilferage (60%) and leakages (40%). The Telangana State Government instead of minimizing these losses is giving top priority in bringing water from faraway places by depriving the other people's need and as well taking away the lands and displacing the poor people for this purpose. One report observed that the water from the two lakes constitutes 10% of the water brought from outside. To bring water from outside costs Rs. 780 crores per annum and thus Rs. 72 - 84 crores per annum could be saved from the two lakes.

Use treated wastewater: Around 75% of water used in urban areas turns in to wastewater. This includes not only industrial effluents [treated, partially treated and untreated] and domestic sewage [both metro supplies and used from groundwater] that includes biomedical wastewater from hospitals and slaughter houses wastewater. 75-80% of wastewater generated enters rivers, lakes, ponds and on its' way contaminates the groundwater. Rivers become efficient channels to carry pollution. Reservoirs became cesspools of poison. Hyderabad generates around 2000 MLD of wastewater; and STPs/CETPs have capacity to treat 800 MLD with 50% effectiveness as this uses power. The treated and untreated wastewater joins water bodies and Musi River and again turns in to wastewater. No exception to the two drinking water lakes, namely Himayatsagar and Osmansagar, which are protected by GO111 plus Supreme Court order of 2000 and my 2007 PIL. Properly treated wastewater can reduce bring the water from outside. This water can be used for greenbelts development, construction purposes, recharging groundwater by putting the treated water in the existing lakes - by protecting them.

Pollution changes sector-wise water use: According to Environment Impact Assessment (EIA), in addition to primary factors, we use secondary factors in terms of additive and multiplicative factors. While accounting sector-wise water use, we rarely take into account secondary factors, primarily wastage created by pollution. According to Centre for Science and Environment in its 2004 report, on an average, each liter of wastewater discharged further pollutes about 5 - 8 liters of water which raises the share of industrial water use from 7-8% to somewhere between 35 - 50% of the total water used in the country. Polluted water is very rarely used by industries. The future demand will inevitably put pressure on the available freshwater resources, both due to water consumption and water pollution. Industry coined a new word "zero discharge". The fact is there is no such thing in reality. This is used to produce more illegally and mint thousands of crores.

'Civic Sense' Takes a Knock in Hyderabad

The large-scale shift of population rural to Hyderabad from 12 lakhs in 1960 to 130 lakhs in 2018 has resulted in congestion and unplanned growth of human settlements forcing major changes in land use. Further, it has also resulted in enormous pressure for shelter and services infrastructure. The prevailing infrastructure is insufficient to cope with increasing demands on water, roads and sanitary facilities. This in turn has resulted in unhygienic conditions in many areas and the trend continues to date. This resulted 90% of the age-old greenery has been butchered with the passing of time. Now the government is barking on greening at huge cost - pocketing the large part of it.

The haphazard growth of Hyderabad has degraded natural resources like water, air, and soil. Environmental pollution has reached alarming levels, chiefly due to growing congregation of industries and increase in number of automobiles [around 1, 09, 19, 995 vehicles]. Several bulk drug industries on the outskirts feed their effluents into open pits, leading to extensive ground water pollution affecting the sources of agricultural and drinking water needs of the surrounding colonies. Several lakes have been inundated with effluents from industries, including Hussainsagar Lake in the heart of the city. Figure 7 presents an example how the industries dump untreated effluents in to nalas/drains. Pro-Telangana Government appreciated pollution control board and the industry for creating pollution free environment and thus government allowing new industries. Next day another media showed the new trend in dumping industrial wastes along the outer ring road. They even dumped around Wattinagulapalle within the Osmansagar Lake catchment area. The industries have been dumping effluents in to Nalas through underground pipelines also. On one side the government unable to control this menace but on the other side wanted establish pharma city that pollute new areas/water sources.

Figure 7: The flow of untreated industrial wastewater from industry to public nala.

Vehicular pollution is responsible for more than 80% of the air pollution and domestic sewage for more than 80% of water pollution - ground and surface water. Industrial growth in and around twin cities is also responsible for increasing air and water pollution. Corporate Hospitals are multiplying and piling up biomedical wastes. Domestic garbage and industrial hazardous wastes are dumped everywhere, more particularly along the roads, low lying areas, water bodies and Musi River.

Hyderabad generates around six thousand tons per day of garbage but not even 50% goes to dump sites. The rest goes in to nalas, tanks, and open places. Figure 8 presents one such an example of spread of garbage. We can see such scenarios all over Hyderabad. This is one another source of groundwater contamination and as well creation of hazardous air pollution by burning them. Also, this effect the water flows during rainy season and help flooding.

Figure 8: On land spread of garbage.

According to one estimate, Mumbai City's Mithi River, blocked debris and garbage, has lost about 60% of its catchment to development. In 2015 study, the World Bank found that half of the poor did not consider moving out of flood-prone areas, because of the uncertainty of living in a new place with several social disruptions and reduced access to education and health facilities.

According to a report in HMDA zone district-wise tanks/kuntas are 28 in Hyderabad, 913 in Ranga Reddy, 531 in Medchal, 576 in Medak, 538 in Sanga Reddy, 277 in Sidhipet and 269 in Yadadri districts. Even though Mission Kakatiya was in force with Rs. 25,000 crores to protect and restore the state lakes, the fate of these lakes unknown. In HUDA area, covers Hyderabad and Ranga Reddy districts -- Survey of India identified 932 lakes covering 22,600 ha. Around 500 lakes have been already converted in to concrete jungle. The rest and Musi River are partially encroached and turned in to cesspool of poison.

Destruction of water bodies-nalas has been causing severe floods even with little rain as the sewage joins the rain amount. This is aggravated with dumping of garbage in to nalas and water bodies. Also, this reduced the groundwater recharging capacity. In Hyderabad groundwater level dropped from 20-30 feet to around 1000 feet in the last 50 years. Also, ground water is contaminated through seepage of industrial effluents and domestic sewage. In many cases sewage is contaminated with hazardous hospital waste water and animal slaughter houses wastewater. This reduces the groundwater available for use. Thus, in-situ fresh water availability is gradually reducing and may become zero in coming one decade.

Chinese Model "Sponge City"

After 2012 Beijing floods China initiated an urban water management programme called Sponge City [SPC] in 2014. The SPC concept is represented by six words - infiltrate, detention, store, clean, utilize, and discharge. Thus, the optimal goals of the SPC is that the storm water generated from rainfall events could be absorbed, stored, infiltrated and cleaned with the natural and/ or manmade facilities and the rainfall and storm water could be transformed into water resource that could be utilized during the drought. The construction of SPC typically includes three parts: urban natural ecological protection, ecological restoration, and LID system construction.

1. Urban natural ecological protection means to preserve the natural forests, green spaces or lands, rivers, lakes, wetlands, ponds, trenches and so on in the largest extent as undeveloped as possible, and this is considered as the basic requirement of SPC construction;
2. Ecological restoration means to repair the destroyed and impaired ecological systems during the urbanization process with ecological techniques to rouse the ecological function of these destroyed systems;
3. LID system construction means to minimize the destruction to environment due to urbanization based on the LID concept by limiting the impervious areas in the city, preserving adequate areas as ecological land use, and increasing storm water storage, infiltration, and cleaning.

Urban drainage system is to take the responsibility of storm water runoff gathering, transport and discharge. Emergency discharge system is used to deal with the extra runoff that could not be discharged by urban drainage system under the extreme storm events. The emergency discharge system may include the natural water bodies (lakes or reservoirs), multiple function detention ponds, spillways, storm water tunnels, etc. These three systems are not independent of each other but they can be integrated to work together for comprehensive urban storm water management. Therefore, these three systems are supplement to each other and important components of the SPC construction and development. Figure 9 presents an aerial scenario of flooding disaster in Mumbai during July 2018 rains. Mithi River is the main river system that used to carry rainwater in to the Sea has been filled with rubbles and waste around 62% and converted in to concrete jungle. The protective Mangroves were destroyed and thus water that enters the river moves in to urban sprawl in Mumbai. Also several lakes were converted in to real estate ventures.

Figure 9: Aerial scenario of flood devastation in Mumbai during July 2018.

Rapid concrete development in China has often blocked the natural flow of water with hard, impervious surfaces; to reverse this, the sponge city concept focuses on green infrastructure, such as wetland areas, rooftop plants and rain gardens. In the natural environment, most precipitation infiltrates the ground or is received by surface water, but this is disrupted when there are large-scale hard pavements. Now, only about 20-30% of rainwater infiltrates the ground in urban areas, so it breaks the natural water circulation and causes waterlogging and surface water pollution.

Sponge city concept is nothing but traditional *in-situ* water conservation followed by farming community by building bunds around the farm land. The water collected recharges the soil and excess will go as runoff. However, the success and failure depends upon the rainfall amount and distribution in the season. In Indian urban areas this makes a futile exercise due to mixing of the wastewater with rain/flood water. Lakes/tanks, rivers, drains are being converted in to concrete jungle in violation of existing laws/acts of both state and central governments and some are converted into cesspools of poison.

In 2001, Hyderabad District Collectorate established a water conservation mission. I was one of them. I was tasked to present a report on roof-top water infiltration pits and water bodies. In my report I suggested to restore the water bodies and drains and as well Musi River instead of wasting cores of rupees on roof-top water infiltration pits. But unfortunately media and government agencies are putting more emphasis on infiltration fits whose life is very short and active only when there is rain unlike water bodies with continuous infiltration.

However, government is not interested in restoring water bodies and every year city is flooded during rains causing several problems to residents and as well vehicle movements and causes crores of rupees of losses.

For the last 20 years I am using a watershed concept of infiltration in my plot with house and greenery similar to SPC. The roof top water enters the watershed area. The excess goes out and again joins a small watershed. Net result is maximum rain water infiltrates in the soil. This system is the best in areas with no pollution over the infiltration pits [fixed area].

Oxygen Scenario

Without Oxygen, there is no life, more particularly humans, on the Earth. Same is the case with life in water. Figure 10 presents the variation of carbon dioxide in the atmosphere with growth of population. Civic sense in fact follow the reverse pattern - as population grows civic sense among people goes down.

Figure 10: Variation of carbon dioxide with growth of population.

In urban areas air pollution plays the major role in reducing oxygen in the atmosphere. Urban air pollution includes: vehicular pollution (directly and indirectly), industrial pollution, domestic pollution by burning garbage and wood, agriculture pollution by burning crop stubbles, etc. Vehicular pollution has been brought down drastically through fuel and vehicular technologies [Bharat stage-I, II --- VI] and thus raising the cost of fuel and vehicles. However this has been counteracted by adulteration of fuel with kerosene (major contributor), unplanned urban growth and associated urban-heat-island effect - formation of temperature inversions cause low dispersion of pollution and thus development of pollution clouds --, dust from construction activity, destruction of greenery, destruction of water bodies, etc. All these factors are associated with the population growth combined with poor civic sense among elite to poor and poor governance. All these cause reduction in oxygen and thus cause several types of health hazards.

Conclusions

As long as concentrated developments are confined to urban areas there is no way to make India slum free even in the next 1000 years and thus clean and green cities a mirage and thus clean air and water!!! The generalized water quantities with reference to sector-wise water use, region-wise crop water use, crop-wise water use, etc. are too general and qualitative in nature. Under the present urbanization scenarios, it is rarely possible to achieve sustainable water management and development. This is basically because of poor governance and poor civic sense among people both urban and rural; and as well elite to poor. Thus, in urban areas *in-situ* fresh water availability is gradually diminishing to nearly zero point. Urbanites have to live on off-situ water brought at huge cost at the expense of rural population. Niti Aayog's CWMI is not a realistic index for interstate comparison. Even in SPC they accepted this fact. In the context of Hyderabad, Chinese SPC Concept is not realistically applicable at city level but can be implemented at individual household and zone levels where wastewater does not mix with rainwater flows. Increased levels of air pollution is causing the reduction in oxygen levels in the atmosphere and thus creating health hazards.

Bibliography

1. Reddy SJ. "Agroclimatic/Agrometeorological Techniques: As applicable to dry-land agriculture in developing countries". (1993): 205. [Book review: Agricultural and Forest Meteorology 67 (1994): 325-327.
2. Reddy SJ. "Irrigation and Irrigation Projects in India: Tribunals, Disputes and Water Wars Perspective", BS Publications, Hyderabad (2016a): 132.
3. Reddy SJ. "Climate Change and its Impacts: Ground Realities", BS Publications, Hyderabad (2016b): 276.

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