Achieving Water Resiliency from Sewerage Treatment plant Effluent for Kalyan Dombivli City within MMR Area

S. C. Kulkarni[1], Vikas Varekar[2]
[1,2]*Veermata Jijabai Technological Institute Mumbai*

***Abstract* - A water crisis is one of the major issues prevailing in various regions of the world. Fulfilling the growing demand with available limited freshwater resource is significantly faced by urban water supply authority. Hence urban areas felt a great need to explore alternative measures for satisfying the growing demand of water. Application of resiliency for urban water management can be act as an effective tool. Resilience means "The ability to survive a crisis and thrive in a world of uncertainty" Resilience points towards the capacity of a social–ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime. Urban water resiliency could be achieved by using the treated wastewater to meet gap between water demand and supply. Kalyan Dombivli is the fastest growing urban hub in the vicinity of Mumbai. Kalyan Dombivli Municipal Corporation (KDMC) is having acute water shortage during dry seasons. Also ground water table in the city is depleting fastly. Therefore, sustainable water demand management (SWDM) is essential in this city. The Municipal Corporation has an area of 67.65 sq. km. The present piped water supply of the city from Ulhas River is 320 million Litres per Day (MLD) against demand of 370 MLD including water for gardening and flushing. Therefore, in present study an attempt is made to explore the possible application of recycled water for building water resilience of Kalyan Dombivli City. Sewerage system of KDMC has been divided into 7 zones. The total Sewerage Network is 300 Km in length. KDMC has total 08 sewage Treatment Plants (STP's) with treatment capacity of 210 MLD. The sewage is mainly treated for organic and inorganic constituents. Presently KDMC generates 66 MLD recycled water. The treatment achieves reduction of BOD & suspended solids from 200 mg/litre and 350 mg/litre to less than 10 mg/litre and 100 mg/litre respectively. The pH of treated water is achieved in the range of 7.0 to 7.3. This recycled water is satisfying the standards prescribed by Maharashtra Pollution Control Board for reuse and which could be effectively used to satisfy the water demand for gardening (15MLD) and flushing (35MLD) purpose of residential and commercial units.**

***Index Terms* - Kalyan Dombivli City; Sewerage Treatment plant; Resilience; Recycled Water; Ulhas River ; MMR region.**

I.INTRODUCTION

Potable Water which is gradually exhausting from the earth is becoming a scarce day by day. Water availability will be the most important word in near future and will get equal importance as today fresh air has. Presently every water supply authority is facing acute problem of potable water shortage. In 2014, closely 3.9 billion people i.e. 54% of the glob's population was residing in cities, and it is projected that by 2050, two-thirds of the global population will be living in cities, which will generate 55% additional water demand in the world as per United Nations Department of Economic and Social Affairs (UNDESA, 2012). Most of the developing countries in the world are having problems like unplanned urbanization, rapid industrialization and immense migration inflows, which are putting tremendous pressure on existing piped water distribution systems. Though, tropical developing countries receiving a sufficient rainfall, the existing sources of fresh water and distribution network are not capable to cater the growing water demand. Being a tropical developing country and having rapidly growing mega cities, India is attributing to manage with limited water resources for fulfilling the growing potable water demand. Therefore, there is a great need of Sustainable water demand management (SWDM). Rapidly growing cities are facing problems of; water demand management, ensuring minimum water supply for daily consumption, and efficient water resource planning. Hence, in dry season water supply authorities are facing acute water shortages. Water resilience is an emerging and efficient solution to meet the shortfall of water demand. The term resilience can be defined as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the efforts of a hazard in a timely and efficient manner” (UNISDR, 2009). Resilience can be referred as the capacity of a social–ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions. To date various approaches have been proposed for urban water resilience. Reuse and recycle of wastewater were used to build the water resilience (Jonathan Wilcox 2016, Nikolaos Voulvoul 2018). Also, many of the researchers tried to build the urban water resilience by accounting the various configurations for water distribution network and water supply systems (Zhang et al., 2019; Porag, 2016; Li and yang, 2011; Soildi et al., 2015; Herrera et al., 2015; Diao et al., 2016; Noiva et al., 2016; Klise et al., 2017); Ali et al., 2017; Zhao et al., 2018; Verdaguer et al., 2018). Further researchers attempted to achieve sustainable water resilience by defining the indicators of resilience (Jensen, 2018), Urban water management (Arto, 2016) and quantifying the impacts of ground water resources on water resilience (Arfanuzzaman et al., 2017). The social scientists have also proposed various socio-economical accepts of resilience (Balaei et al., 2018; Brodnik et al., 2018). The proposed techniques for building the water resilience are mathematically rigorous and difficult to implement on the field. Storm water/rainwater harvesting is one of the viable alternatives to fill up the gap of supply and demand. Amarasinghe et al., (2016) performed a quantitative assessment of resilience of a water supply system under rainfall reduction due to climate change. The resilience indicators were developed which could be used for the sustainable supply of water distribution system without its failure. Rodriguez-Sinobas et al. (2017) proposed a concept of storm water management by enhancing the infiltration of storm water in a engineered soil which ultimately recharges the ground water resources and the off-site treatment reduces load on sewage treatment plant which reduces greenhouse gas emissions and prove to be sustainable. Building of water resilience by recycle and reuse of wastewater may find to be effective under Indian scenario as it can widely accepted as cost of operation and maintenance can be significantly reduced by using existing networks in the buildings. Therefore, the treated wastewater from sewerage treatment plants can be used to meet gap between water demand and supply in urban areas in tropical countries like India and may find to be very effective. Territory of Kalyan Dombivli Municipal Corporation is selected as a study area for demonstration of proposed methodology.

II. MATERIAL AND METHODS

A Proposed Framework

The proposed framework for building of urban water resilience is as shown in Figure 1, which is mainly consisting of following steps:

B Assessment of existing water resources

The existing water resources are having defined storage capacities, whereas gradually growing potable water demand exerts a consistent pressure on present reservoirs. In most of the developing countries present water infrastructure facilities are not designed for catering the rapidly growing demand of population, urbanization and industrialization. Therefore, there is a strong need to build water resilience for satisfying the water demand with rationalized utilization available water resources.

C Estimation of quantity of treated water

In tropical countries now a day’s sewage treatment plants are constructed at all municipal limits with variable treatment technologies. The water is treated to achieve the limits laid down by pollution control boards. In India about 80% of potable water supplied is contributed to municipal wastewater in cities. Central Pollution Control Board (CPCB), Government of India had laid down limits of various parameters required for safe reuse of treated wastewater from sewage treatment plants. Sewage treatment plants can be designed to produce effluent of required standard for reuse. There is readily available source of reusable water which can be used for fulfilling the growing water demand.

D Building of water resilience

Urban water resilience can be achieved by bridging the gap between supply and demand. For present study area water resilience can be built up by compensating the gardening and flushing demand and overcome the water deficit with reuse of recycled water.

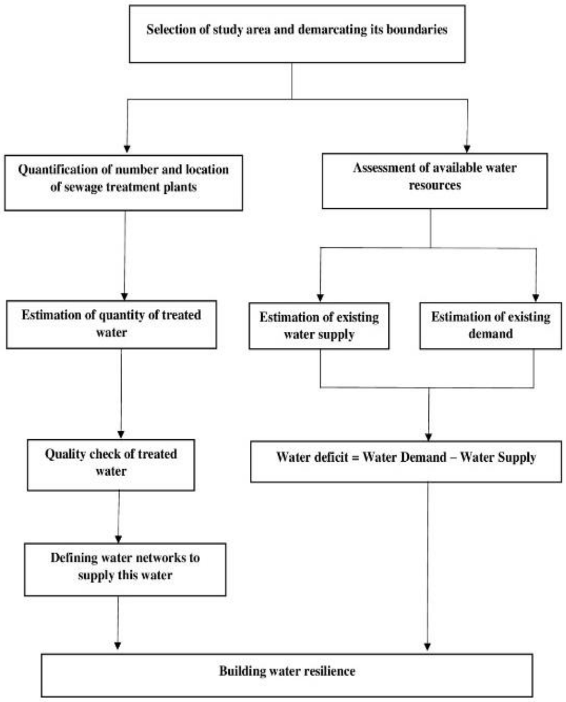

Figure 1: Proposed framework for building urban water resilience

E Study area

The Kalyan Dombivli Municipal area is selected as a study area. KDMC is situated in Latitude 19°4’ - 19°14’ North and Longitude 72°9’ - 73°17’South. Kalyan and Dombivli are known as twin cities located in the vicinity of capital of Maharashtra i.e. Mumbai. The Kalyan Dombivli Municipal Corporation (KDMC) is water supplying authority. KDMC came in existance in the year 1983 by adding areas of Municipal Councils of Kalyan, Dombivli, Ambarnath, Badlapur and surrounding 27 urbanisable villages. This is one of a fast-growing major corporation area in Mumbai Metropolitan Region (MMR). Due to close proximity to Mumbai Metropolitan City, low living cost and well connected by rail and road facilities, Kalyan & Dombivli are attracting great influx of human population. Unplanned urbanization, rapid industrialization and immense migration inflows are putting tremendous pressure for water demand. The Corporation is experiencing rapid urban, industrial and commercial growth causing great stress on civic amenities like water supply, drainage, sanitation facilities etc. There is uplift of the population from 442242 in1981 to 1247324 in 2011 and projections show that in 2019 it will reach to1902525. Presently, 90% of the supplied water comes from the Barave dam and only 10% water comes from the sub-surface water (SW) in the form of ground water source like bore well and open wells. Kalyan Dombivli area is bordered by Ulhas creek which is highly polluted due to disposal of; municipal and commercial waste, industrial effluent, and other anthropogenic activities and it can’t be accounted for water supply. Presently KDMC has area of Kalyan, Dombivli and 27 villages admeasuring 67.65 Sq. Km, out of which 12.99 Km^2 is roof top area with population of 1.9 million. The present water demand is 370 Million Liters per Day (MLD).

Rapidly increasing issues for fulfilling water demand of Kalyan Dombivli area are Water demand management; ensuring minimum water for daily consumption, and water resource planning. Approximately, 30 hours per week of water cut-off is employed by KDMC in the months of December to June. The residents of the city are facing acute water shortage during this period. In this paper we present study it is investigated that, how the resilience concept can be systematized, operationalized, and applied to sustainable urban water management in Kalyan Dombivli area. KDMC is not getting sufficient source of fresh surface water, also capacity of Barave dam will not be sufficient to supply water to all dependents. Hence in present analysis an attempt has been made to propose a water resilience plan for Klayan Dombivli city by accounting treated water from sewerage treatment plants water in the city area. The future water condition will be difficult to manage unless KDMC is able to address reuse of treated water in its area.

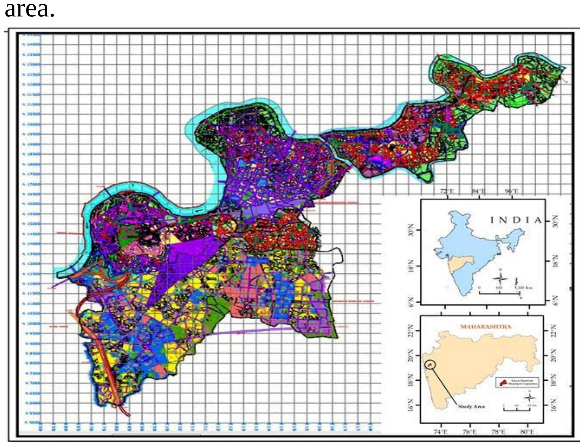

Figure 2: Study area of Kalyan Dombivli Municipal Corporation

III APPLICATION OF PROPOSED FRAMEWORK

A Assessment of existing water resources for KDMC area:

The present source of raw water for KDMC is Barave dam which caters the potable water demand. KDMC is lifting total 320 MLD water from Ulhas River and Kalu River as summarized in Table 1.

Table 1: Sources of water for KDMC area

Sr. No	Lifting Station	Quantity of raw water lifted (MLD)
1	Barave	135
2	Netivili	115
3	Mohali	65
4	Titwala	05
Total		320

B Estimation of existing water supply for KDMC area:

Total existing water demand of KDMC area is 370 MLD against which corporation is permitted to lift 320 MLD from various resources. Presently 50 MLD water is purchased from MIDC daily which is causing financial burden on Municipal Corporation.

Table 2: Daily Water supply in various wards of KDMC area

Sr. no	Water treatment plant	Total water treated (MLD)	Ward name	Quantity of water supplied (MLD)
1	Netivali	115	F ward	35
			G ward	30
			H ward	50
2	Barave	135	D ward	40
			J ward	30
			b ward	35
			C ward	30
3	Mohili	65	A ward	35
			B ward	30
4	Titwala	5	A ward	5
5	MIDC supply	50	E ward	25
			I ward	25

C Assessment of existing water demand for KDMC area:

This water demand consists of water utilised for various applications viz. drinking, flushing, gardening. The assessment of water demand was done and summarized in Table 3.

Table 3: Bifurcation of water demand for KDMC area

Sr.No	Purpose water demand	Daily requirement
1	Water for flushing	35MLD
2	Water for gardening	15 MLD
3	Water for Drinking and Others	320 MLD
Total		370 MLD

D Estimation of treated water produced from sewage treatment plants in KDMC area:

The capacity of sewage treatments plants in KDMC area which are producing treated effluent is estimated. The sewerage system of KDMC has been divided into 7 zones. The total Sewerage Network is 300 Km in length. KDMC has total 08 sewage Treatment Plants (STP's) and 11 sewage pumping station (SPS) as located in figure 3 with treatment capacity of 210 MLD. Presently treated water produced from all STP's is 66 MLD (Table 4).

Table 4: Details of STP's for KDMC area

Sr. No	STP Location	Treatment capacity (MLD)	Treated effluent (MLD)
1	Adharwadi	25	21
2	Barave	15	11
3	Titwala (east)	2	1
4	Titwala (west)	1	0.5
5	Chinchpada	40	15
6	Motha gaon	40	0
7	Dombivali (east)	66	17.5
8	Wadavli	21	0
	Total	210	66

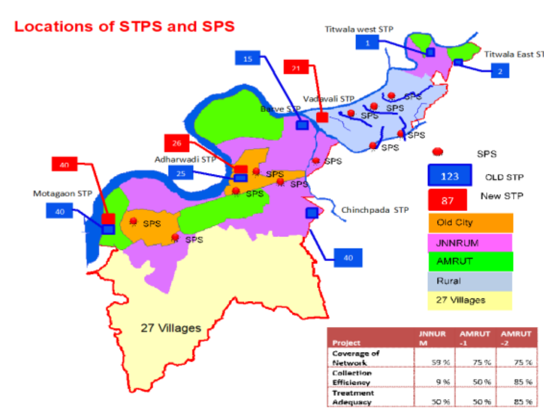

Figure 3: Location of STP's of Kalyan Dombivli Municipal Corporation

E Building of water resilience for KDMC area:

Presently wastewater from the sewer line networks is collected at STP's and treated using Sequencing batch reactor (SBR) technology, parameters of treated water are checked at laboratories established in the premises. The sewage is mainly treated for organic and inorganic constituents. The treatment achieves reduction of BOD & suspended solids from 200 mg/litre and 350 mg/litre to less than 10 mg/litre and 100 mg/litre respectively. The pH of treated water is achieved in the range of 7.0 to 7.3 There is shortfall of 50 MLD of water for daily supply. The effluent from STP's can be used to fulfil this gap.

IV. RESULTS AND DISCUSSIONS

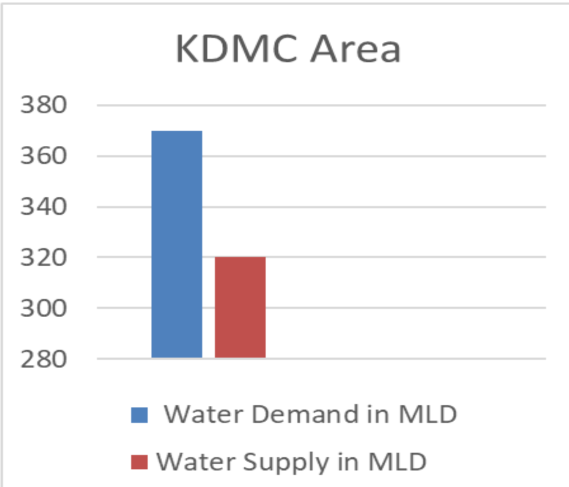

Figure 4 Building of water resilience

The relative comparison of water deficit for KDMC area is as shown in Figure 3. The total water deficit is of 50 million litters per day whereas, available treated water fulfilling CPCB guideline is 56 million litters per day. (by deducting 15 % losses). This recycled water is satisfying the standards prescribed by Central Pollution Control Board (CPCB) for reuse and which could be effectively used to satisfy the water demand for gardening i.e. 15MLD and flushing purpose of residential and commercial units i.e. 35MLD.

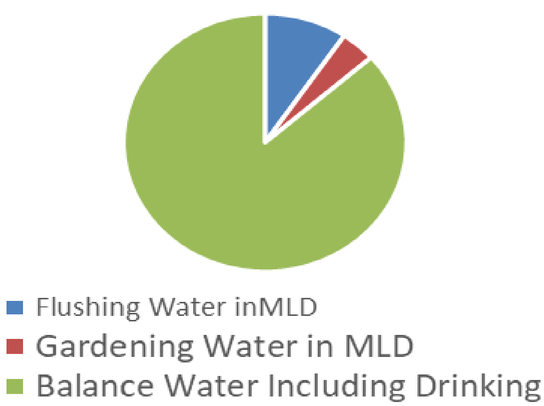

Figure 5 Water Demand Components

This treated water from STP's can be supplied for gardening and flushing use through separately developed network. Users can store this water in separate overhead water tanks (presently all ldgs.. Have separate borewell tanks with pipeline in KDMC area). The Down take pipe network presently used for Bore water can be used for this reused water without any cost addition resulting in increase of ground water level. It is one of the sustainable water management tools, as with the growing population the infrastructural development is accelerating and the available treated water will also be increasing.

V. CONCLUSION

Fulfilling daily water demand throughout the year is one of the major issues prevailing in every part of the world. Presently, climate change has increased the complexity of global water system. Also, the anthropogenic threats to the availability of freshwater resources are; rapid infrastructure development, inefficient water use and increasing pollution. This analysis aimed to achieve water resilience by various alternative resources which may imparts much more effective and efficient operations in fulfilling water demand of an urban area. The present study shows that due to close proximity to Mumbai and less land cost (as compared to Mumbai) Kalyan Dombivli area is facing rapid and uncontrolled population growth along with industrialization which causes increase in water demand and available water source are falling short. To meet growing water demand, available effluent of STP's should be planned for use by local bodies. Available water from Barave dam and STP's effluents together will help in achieving water resilience for Kalyan Dombivli area. The study recommends that, mandatory reuse of recycled water can achieve water resilience. Reuse of recycled water is one of the effective solutions for the acute water crisis in near future.

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