Hybridization of Exisiting Water Supply System

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Abstract- *The steady increase of urban population and the possible effects of climate change may adversely affect the amount of water available & existing water supply systems. As a result, a high priority is given to the study of alternative water service options such as storm water, rainwater harvesting and wastewater recycling along with centralised systems. In this type of systems, water is supplied via a centralised water supply system in combination with decentralised water supply options such as rainwater-storm water harvesting wastewater reuse. This combination of centralised-decentralised water supply systems is termed as Hybrid water supply system (WSS). Such hybrid WSS can offer the potential for increased urban water system security and sustainability by reducing net urban water use, freeing up water supplies for other uses and reducing resource consumption because of reduced conveyance requirements and absence of the need to treat all water to the same high standards. This paper demonstrates about the water harvesting through surface water bodies and treatment and reuse of the sewage. The paper gives an ideology to adopt decentralised WSS options in combination with centralised system to aid with meeting the water demand as well as flood mitigation and stream health restoration. This paper also provides a framework to understand the interaction between the components (centralised and decentralised system) of hybrid system. The framework depends on understanding the existing local conditions and developing a solution.*

I. INTRODUCTION

Water, food and energy securities are emerging as increasingly important and vital issues for India and the world. Most of the river and lake basins in India and elsewhere are closing and experiencing moderate to severe shortages, brought on by the societal exploitation, agricultural growth, industrialization and urbanization. Current and future fresh water demand could be met by enhancing water use efficiency and demand management.

Waste water along with rain and storm water is emerging as a potential source for demand management after essential treatment. An estimated 38354 million litres per day (MLD) sewage is generated in major cities of India, but the sewage treatment capacity is only of 11786 MLD. Similarly, only 60% of industrial waste water is treated.

Centralised water systems have been common in every part of the world since over 100years. This is due to the historical reasons, life span of the system and partly due to the maturity of technology. In some cities there are concerns about over-reliance on centralised systems in terms of their future sustainability for meeting a range of social, economic and environmental goals as well as for meeting the water demand because of the increasing growth and concentration of population in urban areas. Centralised system can also be vulnerable to occurrences of periodic drought and climate change. Therefore, the centralised system is not alone sufficient to meet the demands and hence alternate sources, technologies have to be used. The non-traditional supply sources called as decentralised water supply system such as rainwater, storm water, treated sewage water or recycled water have emerged to meet the demands. This type of centralised-decentralised integrated system helps both in cases of increasing and decreasing population by making centralised water supply system more flexible and adaptable. The combination of centralised WSS with decentralised WSS is termed as Hybrid water supply system. In the recent years, hybrid system has displayed potential to meet the increasing water demand.

Bangalore being the dynamic and rapid growing city has been ranked 2nd across the globe likely to run out of drinking water, in a report published by BBC. Bangalore has a myriad number of lakes, although many have been encroached or vanished due to urbanisation, the current lakes are sufficient to meet the water demands of the city. Unfortunately, none of the lake water is fit for drinking purpose. Currently Bangalore is solely depended on Cauvery water which is being pumped to the city from Cauvery River, over 100kms south of the city, has been a challenge to meet the water demand. However, according to a recent survey conducted by a Environment Info System, CES, IISc, shows that Bangalore is a water surplus city, if the available water is managed properly. The report highlights that the city requires 20.05TMC of water per year, which would increase to 24.47TMC by 2021. The city receives annual average rainfall of 770mm, harvesting this water over 741sq.km will yield 14.80TMC per year. Also the sewage generated is about 1259MLD, recycling of this will provide an additional 16.04TMC of water per year, the amount of water by rainwater harvesting and sewage recycling will sum up to 30.85TMC/year. Hence, the amount of water obtained is more than the future demand. These approaches

help reduce the volume of water imported to cities and can also reduce the volumes of waste water and storm water discharged into the environment.

Jakkur, Sampigehalli lake in Hebbal valley situated in north Bangalore can be chose as an alternative source for Cauvery water as it poses the required criteria. Jakkur lake is a rain fed lake which receives an average annual rainfall of 807mm with a minimum runoff (during drought) of 60mm. The statistics shows that there is sufficient water available in the region, but however it fails to understand the inability to sustainably manage the water resources. The water can be managed efficiently provided rainwater and storm water harvesting is adopted, also treatment and reuse of sewage is followed. The water balance can be obtained by adopting hybrid supply system and managing the water resources.

II. DE-CENTRALISED WATER SUPPLY SYSTEM

Centralised water supply system serves millions of households. However, these systems are not enough to meet the requirements of humans due to myriad reasons such as urbanization, population growth, industrialisation, depletion of ground water etc. Hence, there is a necessity to access water from other sources. In the face of future threats, there is a need for water systems to provide ecological sustainable services. Decentralised WSS offer the possibility to provide safe water for drinking as well as other purposes. This system involves locally available sources to supplement the centralised systems. These systems operate as standalone or as distributed system along with centralised system.

The benefits of decentralised system can be summarised as follows:

- Viable alternative where centralised systems are not feasible
- Efficient use of resources
- Reducing pressure on centralised systems
- Simple and cost-effective
- High self compatibility
- Since waste water is treated for reuse, it prevents entry of sewage into lakes. Thus, preventing contamination of lakes
- Reduces the need of water pumping over long distances
- Provides ecological sustainability.

Urban Water cycle

The figure (1) below shows the urban cycle's main components, pathways and alternative supply options in the urban water system. It consists of two main subsystems; the waste water system and the rainwater system. There is a possibility to develop an interconnection between these two systems and in-turn use it as a water source depending on location, season and source. Change in one component of the water cycle can have impacts on other systems. Hence, alteration of one water source component can bring change in the overall Urban water system.

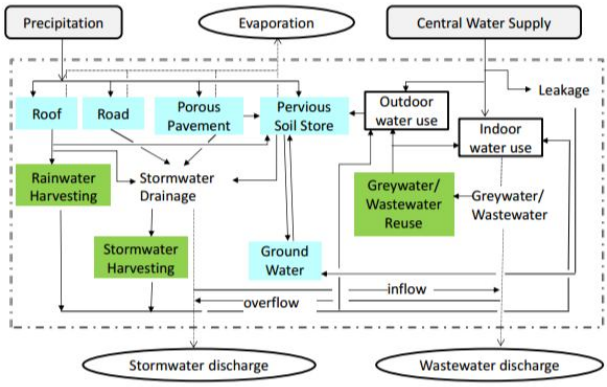

Fig 1. Urban water cycle (Source- Internet)

III. RAINWATER-STORMWATER HARVESTING

Rainwater harvesting is he collection of rainwater from the rooftops and further utilising it for domestic purposes. This supplements the municipal supply system and reduces the stress on centralised system. Bangalore has an average rainfall of 1000mm annually and it has been estimated that about 2 lakh litres of water can be collected annually from the rooftop of 40'x60' house. The collected rain water can be directly used for secondary purposes such as gardening, washing etc.

Storm water is the runoff from pervious and impervious areas collected via the drainage system. Strom water is capable of catering non-potable water requirements.

The merits of water harvesting are:

- Easy and reliable alternative source of water
- Reduces the volume of water pumped to cities
- Reduces the stress on sewage networks and storm water drains
- Recharge of ground water
- Prevents urban flooding
- Prevents soil erosion
- Eco-friendly

With all these possible outcomes, it can be inferred that combination of such systems with centralised systems help in resolving existing challenges in the urban water system.

IV. TREATMENT OF WASTE WATER FOR REUSE

Treated waste water can be used for both domestic as well as irrigation purpose. It also reduces the peak demand of water supply. Hence treatment of waste water is very essential and benifitial as it is an eco friendly process.

The following figures (3) shows the components of treatment units

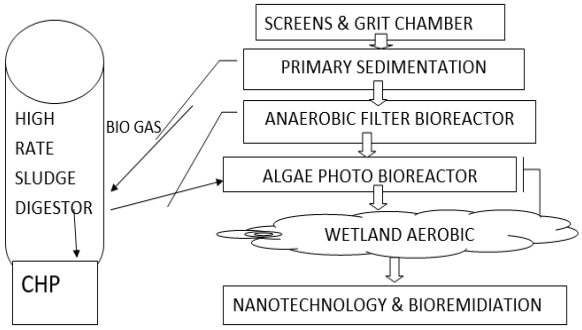

Fig 3. Secondary treatment

Tertiary treatment of water

Secondary treatment removes 85 to 95 percent of BOD and TSS and minor portions of nitrogen, phosphorus, and heavy metals. Tertiary treatment is the next wastewater treatment process after secondary treatment. This treatment is sometimes called as the final or advanced treatment and consists of removing the organic load left after secondary treatment for removal of nutrients from sewage and particularly to kill the pathogenic bacteria

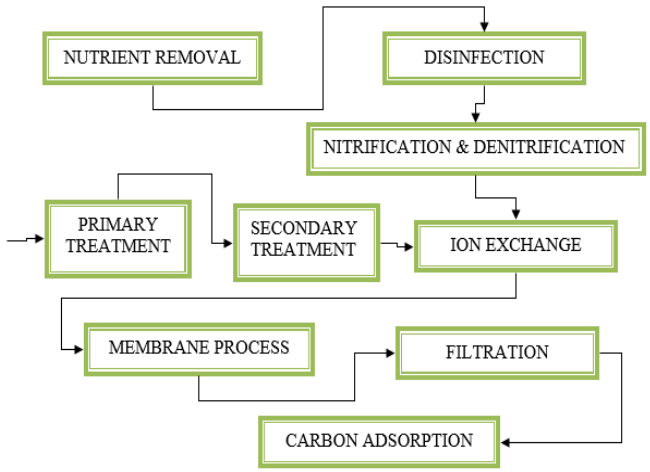

Fig 4. Flow diagram of tertiary treatment plant

V. HYBRID WATER SUPPLY SYSTEM

Hybrid water supply system can be defined as systems provided for water services through a centralised water supply system along with decentralised water supply options such as rainwater tanks, storm water harvesting and water-wastewater reuse.

This system can be considered as a part of sustainable urban water management by adopting alternative water supply and waste water treatment, while the predominant service remaining the centralised WSS. This phenomenon uses centralised system with added potentials of decentralised system to meet the water demand. These innovations help in reducing the amount of water imported to cities and reduce the amount of storm and waste water discharged into environment. However , there are certain issues related to adoption of decentralised system such as the impact of it on centralised system, change of water characteristics, public acceptance. It is important to understand the interaction between the centralised and decentralised systems.

The advantages of hybrid systems can be summarised as follows:

- Reduction in volume of water extracted from lakes, rivers, groundwater, dams
- Provides a flexible water supply system
- Reduces the pollution of water bodies
- Sludge from sewage treatment can be used for energy production
- A major alternative source of water for all purposes
- The capacity is flexible depending on the requirements

VI. CHALLENGES ASSOCIATED WITH HYBRID WATER SUPPLY SYSTEM

Despite all the promising benefits of the systems, there are certain issues related to hybrid system that needs to be considered. Primarily, collection and storing is a major aspect. Also, a question arises that, if the water harvested and treated is fit for drinking. Public health must be taken into consideration. There is a possibility that two separate distribution networks are required for centralised and decentralised systems. The challenges are also associated with setting up of plants and available land. The design period or life span of the system must be known. There is a necessity of setting up a new management to control and manage the hybrid system. Excessive collection of storm water might prevent the runoff flowing into the lakes and thus it might pose a danger to lake life. Management of hybrid system is

more complex compared to centralised systems. Challenges pertaining to public health, environmental protection, responsibilities at household and government levels remain unpredictable.

VII. FRAMEWORK TO EVALUATE HYBRID WATER SUPPLY SYSTEM

Discussing the advantages and disadvantages of hybrid water system, it can be inferred that the potential of centralised and decentralised system together can be synergetic. It is essential to design a framework to evaluate this system. The following figure (2) shows that framework for evaluation of hybrid supply system

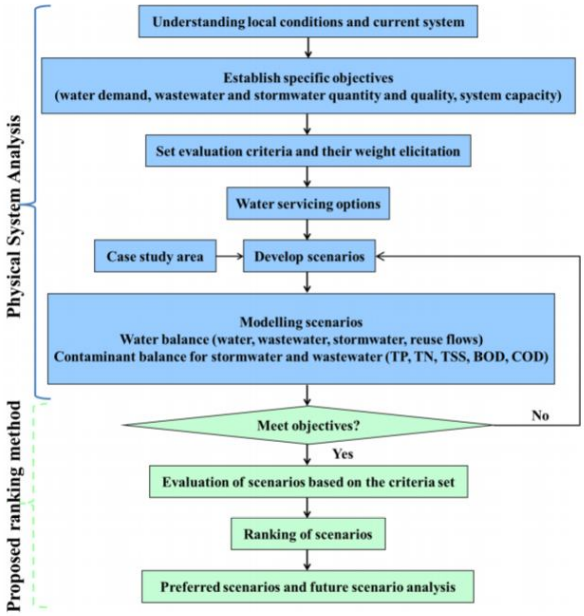

Fig 4. Framework to evaluate hybrid system

VIII. CONCLUSIONS

This paper reviews an overview of exiting challenges of Bangalore city to meet the water demand. This paper explores the impact of centralised and decentralised urban water supply systems which are considered to provide a way out to meet the increasing water demand. It reviews an overview of hybrid water supply system and its benefits. The paper gives a brief description of decentralised system and its components. Also, it provides a methodology of wastewater treatment and tertiary treatment of water for domestic purpose. The challenges associated with hybrid systems are also discussed. Finally, a framework for evaluation of hybrid water system is developed. This framework contributes in understanding and implementing the hybrid system. The framework can be used to identify the impacts of hybrid systems arising from changes in quantity and quality of storm water and waste water while meeting the water demand. This framework will support further research to assess the impacts of various combinations of hybrid systems in various study locations. The study provides a solution to water industry which is in need of a resilient and reliable methodology to meet the water demand.