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Sustainable Urban Water Management Systems: A Review of Status with focus on Surat city of Gujarat state in India

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Abstract

Research efforts in recent years have been made on water and waste water technologies and management. However, there is need to clarify and define urban water management systems and how to manage it for achieving sustainability. Sustainable development in social and economic prosperity while protecting natural systems. Many recent efforts have been undertaken to transfer knowledge from the developed to the developing nations to achieve more sustainable future. This paper aims to present the concept and approach of sustainable development for urban water management with recommendations for future efforts. It includes literature review of sustainable urban water management system, gaps of urban water management and identifies potential approach for sustainable urban water management focusing on Surat city of Gujarat state in India. The collected data and analysis represents that urban water management is not only concerned with functional aspect but environmental, economic, engineering and social aspects are equally important. The management of the system should transform from a reactive approach to proactive approach and from end of pipe solution to close loop system.

1. INTRODUCTION:

'Water is the key to socio-economic development and quality of life" is the statement from Stockholm symposium. The water resources are under tremendous pressure and there is widespread scarcity of fresh water resources. It is estimated that by 2015, nearly 3 billion inhabitants, mainly from developing countries, are expected to face water stress[1]. By 2030, population in developing countries would be 84.7% of total world's population. In Asian region more than half the population is living in urban areas[2]. As a result, the increase in demand from population and economic growth has put tremendous pressure on water supply especially in urban areas. More water consumption implies more waste water generation and pollutants may transfer from untreated waste water to environment and affects human health and contaminate other water source.

According to Millennium Development Goals's (MDG's) report in 2004, access to improved drinking water source and sanitation has been completed in the developed countries while in the developing countries it is only 80% and 50% respectively. Currently, the world spends around US30 billion $ / year on water and sanitation in developing countries. They attempt to fulfill demand but still face the challenge of securing access to safe water, of cutting down on wasteful and illegal uses, and also sustainability of services. The question of water system and their management especially in urban areas are becoming very important and needs more research to get a better knowledge and understanding from sustainability point of view[3].

This paper reviews the sustainability of urban water system and status of existing system for Surat city in state of Gujarat by aiming at contribution to future actions including research towards sustainable urban water management. The specific objectives are (1) to define urban water management system (2) to present the concept of sustainable development to urban water management (3) to review the performance of the system in order to determine the gaps of urban water management.

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BACKGROUND :

The principle of sustainable development is embedded first time in the 1972 Stockholm conference which was introduced by the International Union for the Conservation of the Nature (IUCN). The IUCN is the first who has layed down the concrete base for economic, social and environmental sustainability (Adams 2001).

The year 1981 was launched as first decade of action, focusing on safe water and sanitation for everyone.

In 1987, Brundtland Commission report stated the definition for sustainable development[4].

In 1992, UN Conference on Environment and Development, Rio de Janerio: established the Agenda 21, a guide for sustainable development into the 21st century. This Agenda mentions the importance of an integrated water management approach[5].

In 1992, International conference on water and environment was held at Dublin. They issued four guiding principles regarding water, (1) its importance as a finite and vulnerable resource, essential to sustain life, development and the environment, (2) the management should be based on participatory approach, (3) the importance of woman's role, (4) water is an economic good, in all its competing uses[6].

In 2000, Millennium Development Goals stated eight major goals for the year 2015 horizon, including poverty reduction, health improvements and sustainable development targets.

In the year 2002, World summit on sustainable development, Johannesburg, added a target to the MDG for halving the number of people without safe access to drinking water and included a commitment for the development of integrated water management[7].

The year 2005 was launched as "Water for Life" decade to promote the efforts in the field of water targeting the horizon 2015.

The year 2006, fourth world water forum, Mexico published a guideline regarding water issue and target is to achieve environmental sustainability and protection[8].

As a result at the beginning of year 2007, many water related success and failure stories are available.

2. STUDY AREA:

The data were collected from the Surat Municipal Corporation. The city of Surat is situated at latitude 21°12'N and longitude 72°52'E on the bank of river Tapi having coastline of Arabian Sea on its West. It is 13 m above the mean sea level. The topography is controlled by the river and is flat in general and the gentle slope is from north-east to south-west. The summers are quite hot with temperatures ranging from 37° C to 44° C. The climate is pleasant during the monsoon while retreating monsoon is temperate. The winters are not very cold but the temperatures in January range from 10° C to 25° C. The maximum humidity is 80%. The south west monsoon is usually four months with an average rainfall of 1200 mm.

3. PROBLEM ASSOCIATED WITH STUDY AREA:

Some issues related to Surat city are narrated which need immediate attention for sustainable urban water management.

- Surat city has perennial river Tapi, but local government can extract only 700 MLD (Million liters per day) of water daily from river Tapi according to riparian right, which is not sufficient to fulfill the demand of citizen and high growth rate of population.
- Due to construction of Weir cum cause way on river Tapi, a reservoir is formed on upstream side of river, which led to stagnation of flowing river water. Stagnation of water gives rise to growth of algae and weed, hence raw water quality gets degraded.
- Moreover, a sewage discharge from Chaprabhatha, Kosad, Amreli, Motta Varraccha, and Kathor has created terrible impact on river water quality on upstream of river
- Recently, it was decided to lay down pipelines from Ukai to Surat (100 km) to resolve the issues regarding quality and quantity of water supply demand as a suggestion in revised city development plan. The question is, will this decision economically viable or sustainable?
- In the downstream of weir in river Tapi, due to tidal influences river water becomes brackish.

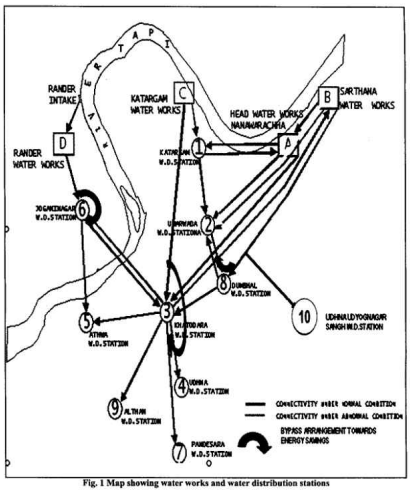

Fig. 1 Map showing water works and water distribution stations

Owing to these problems the bore water of adjacent area like Rander, Athwa, and Old walled city area becomes salty and not fit for drinking.

- Over withdrawal of ground water for industrial and irrigation purpose has depleted the ground water table and degraded the quality of ground water also.
- Total population of city is not covered by easy access to water supply and sanitation system. Whole city area is also not covered with storm water drainage system. Rainwater recharging/ harvesting systems are not implemented on large scale. Most of the water connections are without meter.

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4. METHODOLOGY:

The study involves compilation, review and comparison of information with threshold value on urban water management and recommending potential approaches to achieve sustainability. It consists of following steps.

1) First step involves review of the fundamental concept focusing on sustainable urban water management as background study.
2) An approach of sustainable development in urban water management system is proposed by aiming to answer the following questions: What are the requirements of sustainable urban water management? Which parameters should be considered as measure of sustainability? And what are the approaches used in past experiences.
3) Third step focuses on review of indicator for assessing urban water management systems and selected indicator for identifying the status of urban water management system.
4) Fourth step involves review and compilation of data regarding the urban water management to assess sustainability performance.
5) Fifth step involves assessment of existing situation by comparing with threshold value. The results obtained from this step are the identification of gap in urban water management towards sustainability.
6) The recommendations on possible approaches for sustainable urban water management in the city are based on the gaps and selected approaches that are expected to suit the overall condition of the region.

SYSTEM BOUNDARY FOR URBAN WATER MANAGEMENT SYSTEM:

System boundary is decided based on systematic consideration of the various dimensions of water.

Domain of system boundary consists of water supply system, waste water, storm water, rain water recharging/harvesting & its sub criteria. Sustainability is related to prolonged time perspectives hence it should be selected accordingly.

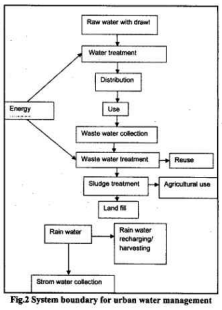

Fig.2 System boundary for urban water management

SELECTION OF INDICATOR AND CRITERIA:

Criteria selection involved the selection of appropriate criteria for the field of research given their relevance to current issues, their appropriateness to the area in question, their scientific and analytical basis plus their ability to effectively represent the issues they are designed for. Theoretical framework building provides the underlying basis for criteria selection and supported the overall structure of urban water management. The four dimensional view on sustainability was employed, and these four dimensions constituted the basic components for measure of sustainability of system.

DATA COLLECTION:

The data were collected related to the criteria and indicators which were selected for the study. This includes data related to social, economic, environmental and engineering factors and its sub factor like population served by water supply and waste water system, storm water, capital investment, economic expenditure and maintenance, water supply per capita per day, waste water generation per capita

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per day, area covered under pipe network, energy consumption, cost recovery, revenue collection from water supply, sewerage system, flood prone area etc. from Surat Municipal Corporation (SMC).

All data related to studies are collected from hydraulic and drainage department of Surat Municipal Corporation. The data collection was very difficult task. The ground water monitoring wells are available in the out skirts of the city (only 3-4 wells) but within the city limit no wells are available hence, the data related to decrease in ground water table were skipped, though it was very important parameter.

Table 1. Comparison of different indicator with threshold value

Sr. No	Criteria	Sub criteria	Threshold Value	Existing Status
1	Social	Access to water supply	100% population should catered	56%
		Access to sanitation	100% population should catered	30%
		Water availability/capita/day	According to WHO for domestic supply 135 lpcd	195 LPCD
		Supply hours	24 x 7 hours	3 hrs
		Service complaints	As low as possible	350 complaints/ year
		Flood prone area	Minimum	250
2.	Economic	Capital investment	Payback period Should be minimum	Payback period is minimum
		Cost recovery and maintenance	100% Cost should be recovered	99%
		Research and development fund	At least 10-15% fund should available	No fund for R & D
3.	Environmental	Water withdrawal	Less than 100% of available quantity	100% water withdrawal from surface water source
		Energy consumption	Maximum renewable energy source should be utilized	Energy used is generated from fossil fuel
		Pollution load on environment	Minimum load	
		Wastewater treatment performance	Within the standards laid by WHO	Within the standards laid by WHO
		Water reuse	100% should be reused	Not reused
		Recycling of nutrient and sludge	100% should be utilized	Not utilised
		Strom water area covered under piped network	100% area should be covered	45%
		Rain water recharging/ harvesting	100% area should be covered	0.05 %
		Salinity ingress	As low as possible	
4.	Engineering	Metered connection	100% area should be covered	0.41%
		Service interruption and water losses	As low as possible	Approximately 30%

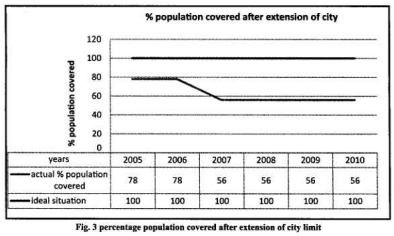

Fig. 3 percentage population covered after extension of city limit

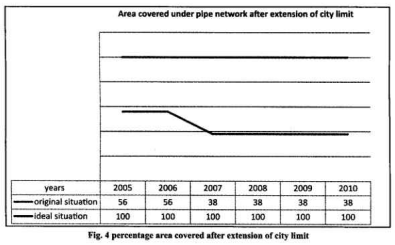

Fig. 4 percentage area covered after extension of city limit

5. CONCLUSION:

The study reveals that, there is large gap between threshold value and existing situation in engineering criteria. For improvement in the UWM system it is essential requirement to install metered connection in whole city area. Unaccounted for water results both from leakages and illegal connections. Along with that SMC has to think in the direction of asset management and for modeling of pipe failure or leakage prediction. This will minimize the water losses and that available water can be utilized to serve more people.

Environmental criteria shows that system can be improved by reusing water, recycling of nutrients, recharging and harvesting of rain water, installing storm water line in whole city area. The energy consumption

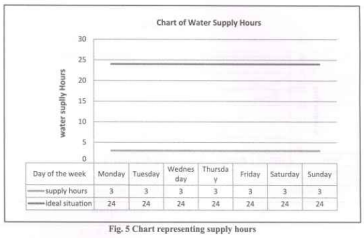

Fig. 5 Chart representing supply hours

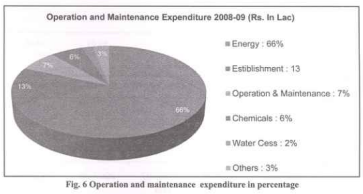

Fig. 6 Operation and maintenance expenditure in percentage

contributes 66% of total water management cost so, it can be reduced to some extent by implementing energy efficient technique or renewable energy sources should be used.

The study of social criteria reveals that whole area of city is not covered with water supply and drainage network so it is essential to complete the network. At the same time per capita water consumption is higher than the basic need which represents that due to lack of infrastructure facility people are not getting water supply in some of the area. Majorly this happen due to extension of city limit in year 2003. There is huge variation between area covered under pipe network & percentage population covered before & after extension of city limit. This is because of transition stage of extension of city limit. It takes time for establishing infrastructure facilities which represents a drop in population & area coverage. The consumer with intermittent water supply tend to use more water than those with continuous supply because consumers store water, which they then throw away to replace with fresh supply each day.

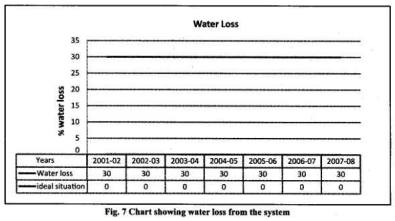

Fig. 7 Chart showing water loss from the system

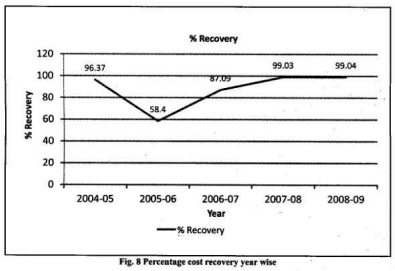

Fig. 8 Percentage cost recovery year wise

ACKNOWLEDGEMENT:

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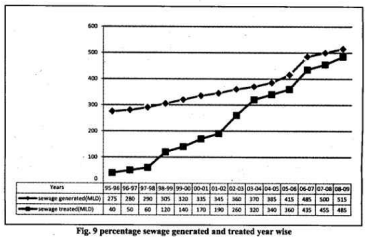
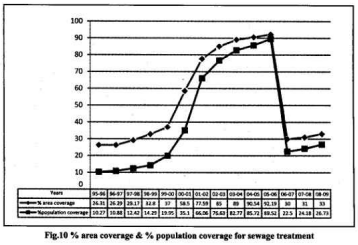


Years	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09
sewage generated(MLD)	275	280	290	305	320	335	345	360	370	385	415	485	500	515
sewage treated(MLD)	40	50	60	120	140	170	190	260	320	340	360	435	455	485

Fig. 9 percentage sewage generated and treated year wise



Years	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09
% area coverage	26.31	26.29	25.17	32.8	37	58.5	77.59	85	89	90.54	92.19	30	31	33
%population coverage	39.27	33.88	12.42	14.29	19.95	35.1	66.56	76.63	82.72	85.72	89.52	22.5	24.18	26.72

Fig.10 % area coverage & % population coverage for sewage treatment

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