Potential Measures for Tackling Water Crisis in Cities

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With the climatic changes happening all over the globe and resultant drastic changes in weather patterns, many countries are facing related issues. Inadequate rain causing severe droughts is one of these critical issues. While the droughts affect the entire population as well as the means of living (agriculture, industry etc), the immediate impact is seen on the urban population as the water availability for them falls rapidly.

India, a country itself dependent on seasonal rains (monsoon), frequently undergoes water-deficiency situations for their large cities. In addition, Indian urban population is growing explosively which puts additional pressure on the utility supplies. The "smart city" initiative by Indian government is aiming at structured upgrade of city infrastructure towards 'smart' as well as sustainable cities. India does have expertise to design & build water / waste water systems; and also to sustain these systems through the explosive population growth of Indian cities.

The current paper draws from substantial Indian experience in tacking water shortage issue and provides a broad overview of the possible steps that could be taken by the city administrative authorities to tackle the same. This paper assumes a large city with proximity to sea, as an example. While it considers Indian scenario, it could well be applicable for similar situations elsewhere in the world e.g. current significant water crisis at Cape Town, South Africa. It is quite likely that some of these steps could be in place, but the paper attempts to list all the measures together that could be handy in such situations.

Based on the situation, the measures to be taken, could be classified under 3 timelines –

1. Short term – This period will normally correspond to the time between completion of a deficient rainy season and the time for the next rainy season. Thus, it represents a period of about 8-10 months in Indian context. It considers that the next year rains could provide breather to the augmentation measures in medium and long term.

2. Medium term – This refers to about 1-2 years after the short term period. It is expected to provide sufficient time to complete the mitigation measures that would make the city sustainable for 3-4 years and provide adequate time for long term measures to get implemented.

3. Long term – This would refer to the period of 3-5 years after the short term period. This would target measures that would address the water crisis in comprehensive and sustainable way.

It is quite possible that implementation of some measures would continue across the time periods. The purpose for these timelines is to focus on specific objectives for that period.

1. **Short term measures**

The water supply issue could be tackled by –

a) **Reducing or restricting the supply**

The easiest and quickest way of matching supply-demand is to reduce supply. In the example of Cape Town, it was restricted to as low as 50 lit / person / day.

Depending on the situation, it is expected that the fresh water supply to commercial/industrial or even agricultural use is curtailed or stopped.

b) **Reducing waste**

Avoid waste (leaks) – High leaks and Non-Revenue Water (NRW) % is a chronic problem for many Indian cities. While significant reduction of such waste may be time consuming, the attention may be provided to all major leaks as well as leaks within individual homes / properties i.e. after the metering.

For minimizing the leaking water losses, it is important to switch from 24 X 7 supply to intermittent supply in an efficient manner. Normally, for the same water supply rate, the intermittent supply requires bigger diameter piping network as compared to 24 X 7 water supply. However, under restricted water supply (i.e. when the water flows are low), existing network may potentially suffice for intermittent supply. The conversion (from 24 X 7 supply to intermittent supply) calls for operational changes in the system. The operational changes also need to consider possibility of contamination in distribution systems in case the header pressures go very low. This practice of intermittent water supply is followed widely in India and it could be handy for the cities / part of cities where 24 x 7 water supply is to be converted to intermittent water supply.

Also, there is another possible source for water wastage - generally up to 5% of water produced in Water Treatment Plants (WTPs) is used for filter bed backwash. While most of the modern plants recycle this water, the older designs route this water to the waste water system. If latter is the case, this water can be recycled after preliminary treatment. It can be implemented very quickly.

c) **Reducing requirement at user end**

Reducing the requirement at user end – could be done by recycling the waste water after tertiary treatment, using sea water for flushing toilets and also be recycling water internal to the household (using water in cascaded fashion for different usages). It involves capital investments & larger project life cycles (especially for the first two measures) and citizen acceptance / behavior change.

d) **Augmenting the supply from other sources –**

For the short term crisis, the availability & hygiene is expected to take precedence over the cost. Accordingly, some of the potential alternatives are –

i. Fresh water supply from other nearby basins – if there is adequate water availability in nearby areas, such fresh water could be brought in drought hit city water systems – either by inter-basin transfers or through other routes like ships, temporary pipelines or even by railways (water wagons). In India, the potable water has been transported using railway (water wagons) to the areas where drought conditions prevailed. Transportation of water to Chennai in Tamilnadu and Latur region in Maharashtra in the recent decade is a typical example of resolving water crisis by this way as a short term measure.

ii. Fresh water from distant geographies through fresh water carrying ships – to our understanding; ship capacities of 6000 m3 are available. It may require hiring of multiple ships / logistics & water transfer arrangements. This method has been practiced at global levels.

iii. Recovering dead-storage water from existing reservoirs – In extreme drought case, the water in reservoirs may reach below pumping levels. In such cases, arrangements may be made to withdraw water from below pumping levels. There can be floating pumps taking out the water or auxiliary sets of pumps. As the water at low levels could be muddy, the water treatment needs to be geared up to handle such supply. The dam / reservoir safety considerations are also to be taken into account while deciding ultimate dead storage.

   In the states of Andhra Pradesh and Karnataka of India, during recent water crisis, pumps were installed within reservoirs and they helped lifting water from below minimum draw down levels.

iv. Tapping the ground water / aquifers – drilling maximum tube wells and tapping available other natural sources / ground aquifers is another alternative.

   With the support of hydro geologist analysis on ground water potential and its quality, ground water may be blended with fresh water if required, to meet drinking water standards. Ground water may also be utilized after providing preliminary treatment. Number of tube wells may be sunk in different parts of city and ground water from these tube wells may be collected and supplied to community.

v. Infiltration galleries/wells in river beds and reservoir catchments may give higher yields than tube wells. India has experience of giving services related to hydro-geology surveys, providing infiltration galleries and tube wells for water supply schemes.

vi. Floating desalination plants – Possibility of renting such units for short term, if available, may be explored. The navies may have such ships.

vii. Packaged desalination units – to our understanding. 10 m3/hr capacity units are available. Multiple such units may be hired and deployed. It may require electric power.

viii. Cloud seeding – India has experimented with cloud seeding to induce rains.

ix. Pursuing new technologies – e.g. 5 m3/day units are available for 'air to water' technology that uses electric power to recover water vapor from the air. As an extension of the same concept, water condensed in the HVAC systems (especially in larger systems like offices, big buildings, malls etc) may possibly be harvested. However, owing to small size and high costs, it may not be able to provide significant relief. Also, the water availability through such methods depends on moisture carrying capacity of air - it is high at higher ambient temperature and high humidity. In the past, there have also been discussions to transport icebergs from Antarctica to get fresh water to middle-east Asian countries. However, making such option work in the short span seems unlikely.

2. Medium term measures

This corresponds to about 1-2 years after the short term period. It is expected that the rains expected at the end of the short period would provide some breather to take further actions.

a) This would be the time to ensure that all the projects that have been undertaken to augment water availability, are executed and products are available on demand. It could correspond the execution of desalination units, recycle water treatment or any other project undertaken for enhancing water availability.

b) Lowering of Non Revenue Water (NRW) % – All efforts should be made to avoid water waste through leakages. There is significant expertise available in detection / plugging of NRW, smart water grids and smart metering as well as implementation of such measures in congested and highly populated Indian cities on ‘brownfield’ basis, This experience should be leveraged to minimize water loss through leaks.

c) Containerized desalination units - In case, the water augmentation projects under implementation are seen to be inadequate, containerized desalination units can be considered. They come in capacity of about 2.5 MLD per unit and multiple such units can help meeting the capacity required. It is a well proven option. While the delivery of the containerized part of the plant is relatively quick, it also requires building of external facilities like intake, outfall, clarifiers, electrical systems etc. If planned well, such options could deliver product within 1-2 years.

d) This time period may also be utilized for drawing a long term, holistic roadmap for sustainable and resilient water management for the city under consideration. It needs to be an all-encompassing roadmap - considering the future population and business growth, agriculture and industry needs, as well as environmental and sustainability needs.

3. Long term measures

It would be the time for executing the detailed roadmap, as discussed above. Some of the key measures in this stage could be –

a) Rain water harvesting – All efforts need to be made to capture and retain the rain waters. If a reasonable success is achieved, water crisis can be addressed in effective way. In India, there have been some great examples, where relatively low-rain areas have overcome the water shortage by ensuring good rain water harvesting systems coupled with proper detention or retention systems and this experience can be handy for others.

b) Use of sea water – For a city in proximity of sea, the sea water could be used for all flushing requirements. However, it requires development of the entire piping network system. It can bring down the fresh water requirement considerably. This option may need to be weighed against a similar system using recycled treated water.

c) Water saving measures – The city may promote use of ultra-low-flush toilets, change the shower and sprinkler heads to high efficiency, low water usage types, and many other ways of using water responsibly. If the residents can hold per capita water consumption at low levels by their own sensitivity towards water usage, it could be a significant milestone in the journey of water management for the city.

d) Waste water treatment and reuse – All efforts may be made to collect, treat and re-utilize waste water to maximum extent. In rain-water deficient regions, it may work out to be a (relatively) cheaper and yet major source for water supply.

   All major waste water treatment plants may be upgraded to tertiary treatment level by adding necessary facilities. This treated water may be utilized for industrial, agricultural, commercial and even residential purpose.

   Many developed and developing countries are practicing this approach. In Bangalore and other places in India, tertiary treated water is supplied for irrigation, power plants, HVAC and other non-potable use including flushing.

   Further as a strategic policy, all the future commercial establishments, housing colonies and big apartment complex may be asked to install recycle plants and use tertiary treated water for non potable purpose. Many of the cities/metros in India are opting for the concept of Zero Liquid Discharge (ZLD). In Bangalore city all apartments having more than 50 flats are required to implement this and also for IT parks and big commercial complexes, it is mandatory.

To conclude, India, with its dependence of seasonal rains, variation in rainfalls due to climatic conditions and ever increasing urban growth is expected to face drought conditions or water availability crisis more frequently. This paper attempts to list various alternatives available to tackle water availability issue in a drought-hit city. The possible measures have been divided in the various time frames i.e. short, medium and long term. The paper has highlighted many examples from Indian context that may be useful for handling water crisis. Successful, resilient and sustainable water management at major cities can act as a showcase for the entire global community and may usher the path forward to overcome climatic changes triggered by industrialization.

Tata Consulting Engineers Limited (TCE), with its very significant experience in water and waste water systems for major Indian cities and states over last 50+ years, could provide consultancy and project management expertise in these areas; and help building resilient and sustainable water systems.