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Premature saturation of water demand due to rapid urbanization

S.A. Ubaiddha and M. Manoharan, Sri Lanka

Some water supply schemes in Sri Lanka very rapidly become unable to meet the demand imposed on them. This premature 'saturation' of the components of the water supply facilities such as intake, transmission main, treatment unit, storage reservoirs and distribution system are discussed in this paper. The reasons for it are that urbanization and industrial development are taking place at a higher rate than anticipated. As a general practice water supply schemes in Sri Lanka are designed for a 20-year life span. However most of the water schemes are saturated within a short duration. That is the 20-year design demand is reached within 4 to 5 years and the water supply infrastructure is unable to cope with the demand. This paper describes the background of these water supply schemes and causes for premature saturation. It also suggests concepts and preventive measures that can be used to overcome this problem, when designing water supply schemes in the future. The high growth in demand is a critical issue in most of the water supply schemes in Sri Lanka. Though the growth rate, migration, urbanization and industrial growth were considered, when designing the water supply schemes, the actual rate of increase in migration, urbanization and industrial growth are usually very much higher than the predicted levels. This results in them very quickly reaching their design capacity. A detail analysis was carried out of two of these schemes, to find the reasons for the problem and to propose suitable solutions. It is desirable to design a water supply scheme to cover all areas not yet likely to be developed but which are fed by the existing schemes. This is not practiced since the funds available are limited. Hence there is a tendency to limit the distribution area in order to make a scheme affordable. In the years following completion of the scheme the distribution system is often extended in all directions due to the pressure exerted on the water supply organization by the local political authority. This, coupled with the usual migration of people towards the water-served areas, leads to the premature saturation of the water supply facilities. The following optimal solution is suggested, considering all factors related to this issue. It is proposed that at the design stage all major demands are considered in consultation with all relevant institutions. The investment on the scheme can then be phased and the commissioning of the distribution areas staggered accordingly. Although it will take more time to complete the scheme in full, this will prevent the premature saturation of water schemes.

Introduction

There are a number of water supply schemes in Sri Lanka, which reach the design capacity within a very short duration. The institutions that maintain these schemes find it very difficult to provide the actual water demand, which leads to the suspension of giving new service connections. The population growth rates used in the initial demand calculations are based on the population census carried out by the census department. An allowance for the migrant population is added to this figure in order to arrive at the rate used for design purposes. These values are used by the local design engineers as well as by the foreign consultants to determine the water demand 20 years into the future. The present industrial and commercial water demands are calculated and the same growth factor is used to determine the future demand. Although the anticipated industrial water demand is generally reliable, the predicted demands exceed the design values in some cases due to unplanned industrial development. The premature saturation in most of the cases is caused by the high domestic demand especially in areas outside the initial distribution system. The assumed growth rate in water demand can be increased to overcome most of the problems. However due to severe fund shortages, low growth rates are often used in designing water supply schemes.

The per capita domestic water demand normally used is 140 litres/person/day. The number of occupants per household is assumed to be 5, which amounts to a predicted domestic household demand of 0.7 m3/day. The actual average value of the household demand is about 0.72 m3/day for scheme I and 0.66 m3/day for scheme II.

Data collected from two water supply schemes facing premature saturation are considered in this analysis. These two schemes are located in the Central Province of Sri Lanka. The analysis reveals that, the scheme Udu -Yatinuwara reached the saturation within 6 years and the scheme Kundasale reached it within 3 years of completion of additions to their respective water supply schemes. These augmented schemes should have enabled them to cater for the demand

Table 1. Data from Kundasale

Year	Number of connections				Average daily consumption in m^3				
	New Domestic	New Non Domestic	Total of New	Cumulative Total	Domestic	Non Domestic	Total	Growth in Demand	Domestic / Non Domestic
2001	5474	306	5780	5780	4198	909	5107	-----	82 : 18
2002	1733	144	1877	7657	5486	1126	6612	1505	83 : 17
2003	3696	47	3743	11400	8219	1148	9367	2755	88 : 12
2004	576	18	594	11994	8248	1164	9412	45	88 : 12

Table 2. Data from Udu – Yatinuwara

Year	Number of connections				Average daily consumption in m^3				
	New Domestic	New Non Domestic	Total of New	Cumulative Total	Domestic	Non Domestic	Total	Growth in Demand	Domestic / Non Domestic
upto1997	5441	597	6038	6038	3597	792	4389	-----	82 : 18
1998	2417	136	2553	8591	5199	1002	6201	1812	84 : 16
1999	2604	172	2776	11367	6857	1356	8213	2012	83 : 17
2000	2600	09	2609	13976	8886	1371	10257	2044	87 : 13
2001	1984	21	2005	15981	10238	1390	11628	1371	88 : 12
2002	463	13	476	16457	10448	1389	11837	209	88 : 12
2003	143	06	149	16606	10481	1399	11880	43	88 : 12

20 years after completion of each scheme. Feasibility studies have recently been carried out to further augment the supply in the near future with donor assistance. The data given below were obtained from the Operation and Maintenance Division of the National Water Supply and Drainage Board, Central Province.

Scheme I - Kundasale
Design capacity: 13,250 m3/day
Design population growth rate plus migration: 3 %
Unaccounted for Water (UFW): 25%
Anticipated number of connections: 12,000
Year of implementation: March 2001
Designed length of distribution system: 206 Km
Length of the extension within design zone: 77 Km
Length of the extension out side the design zone: 12 Km

The new service connections provided in Kundasale and the consumptions in domestic and non-domestic sectors are shown below. All service connections are metered and charged monthly.

Kundasale water supply scheme was constructed in 1990 and the Local Authority owned the major part of the distribution system. The augmentation of this scheme was completed in 2001. The National Water Supply and Drainage Board maintains the new distribution system and the distribution areas maintained by the local authority were also taken over by the National Water Supply and Drainage Board in January 2003. At that time about 6300 service connections were taken over from the Local Authority.

Scheme II – Udu - Yatinuwara
Design capacity: 16,500 m3/day
Design population growth rate plus migration %: 3%
Unaccounted for Water (UFW): 25%
Anticipated number of connections: 16,500
Year of implementation: 1997
Designed length of distribution system: 198 Km
Length of the extension within design zone: 106 Km
Length of the extension out side the design zone: 27 Km

The new service connections provided in Udu – Yatinuwara and the consumptions in domestic and non-domestic sectors are shown below. All service connections are metered and charged monthly.

Udu – Yatinuwara scheme was commissioned in 1997 after augmentation. The design demand was achieved within 6-year duration.

Problems identified

The water supply level in these two schemes is not satisfactory and some consumers complain of inadequate supply. At present no new service connections are given in these schemes because of the saturation of the water supply facilities. There are about 5000 applicants in the waiting list for new service connections in both these schemes. The following facts have been identified during the study.

- There was no proper town development plan or land use policy in either town and there were no specific areas identified for the residential, industrial, recreational and commercial zones. Due to this, people are migrating towards the areas where better basic facilities are available.

- Rapid growth in industrial development has taken place within the water-served areas.
- Extensions to the distribution system have taken place beyond the planned areas.
- The extent of the distribution system was limited during the planning stage because of insufficient funds.
- Agencies who are responsible for infrastructure development are not properly interchanging details about their future plans. Due to this, future demand cannot be forecast accurately.

The actual water demand growth rate is very high in both the cases (30% and 15% for Kundasale and Udu - Yatinuwara respectively). When people migrate towards water-served areas there is a high rise in the demand for drinking water. This results in the extension of the distribution lines beyond the originally designed areas. This leads to a situation where water supply facilities need augmentation earlier than anticipated.

Probable solutions

In the following sections the solutions to the problems in the existing schemes are first considered and then the precautionary steps to prevent under-design of new schemes are suggested.

Solutions to existing schemes

The following data should be collected in schemes facing premature saturation in order to arrive at appropriate solutions:

- Identifying the existing demand, population growth rate and migration percentage from the records.
- Identifying the areas where future growth such as residential, industrial and other infrastructure developments etc is possible.
- Maximum possible water extraction from the source and the maximum production capacity of the treatment plant.
- Maximum quantity of water that can be transmitted.
- Record of the existing distribution network, including nodal elevation, nodal demand, diameter and length of each branch etc.

After analysing the entire data described above, intake, treatment plant, transmission main and the distribution networks are likely to need augmentation to cater for the existing demand plus probable extensions and future demand. If the existing water source does not have the capacity to meet the new demand, then alternative new sources will have to be explored.

Solutions to new schemes

The problems encountered in the existing schemes should be taken into account while designing any new water supply scheme. The following precautions shall be taken while designing such schemes.

- Identifying all possible future developments within the selected area, by having discussions with agencies, which are responsible for housing, industrial and other infrastructure developments.

- The future water demand due to the development of empty plot of lands for housing and industrial purposes should be assessed accurately.
- When the designs of water supply schemes are carried out, the designer must ensure that there is provision for future expansions. When the land is acquired for the treatment facilities and storage reservoirs, additional space should be included for future developments. Future augmentation should be considered when designing the trunk mains.

If the future developments take place as planned and the migrating population is within the assumed limits, the water demand should remain within the design capacity. However, predictions can be accurate only if a planned land use policy is practiced by the relevant authorities. The area-wise demand taken into consideration will depend on the development potential. If this is correctly judged when choosing the design demand there should not be any further increase, as the maximum water demand is already considered. Then the intake, treatment unit and water conveyance systems should be designed to cater for the future demand.

Up to this point, this paper has dealt mainly with technical problems. In addition water supply organizations also face funding difficulties. Most are depending on the donor assistance for the development activities and the available funds are limited. Further, the funds are being granted to various infrastructure development works in an area but at different times. So the proposed solutions may become meaningless if the development activities are implemented individually. So a corporate plan must be prepared with the participation of all the institutions, which are responsible for the infrastructure development works, and the implementation should go ahead accordingly.

Conclusion

Two water supply schemes have been examined in this paper but there are so many other schemes in Sri Lanka facing similar problems. All these problems are due to poor planning, lack of co-ordination between relevant agencies, and absence of a land use policy and integrated development plan. Social and political pressure to extend the distribution system coupled with the lack of funds to improve the water supply schemes often causes the premature saturation of the water supply facilities.

The integrated approach previously described should be adopted to prevent the new schemes rapidly failing to meet the demand. The bitter experiences identified in the cases studied will have to be borne in mind. The recommended data should be collected and used wisely to design new water supply schemes. It is advisable to consider all future demands and have in mind the necessity for future improvements when designing such water supply facilities.

The recommended town development plan should include the residential, commercial and industrial zones. The minimum land area for residential plots needs to be determined. The construction of multi story apartments to overcome the land scarcity will have to be taken into account. The land extent for commercial and industrial purposes shall also be determined. The local authority shall ensure that the development plan drawn up and the land use policy defined are adhered to by all citizens. The future water demand can be calculated accurately by this method and the water facilities sized accordingly. If this is carried out then extensions within the zone can be done at any time because the main line has been designed for the total carrying capacity. However, while planning the development of the whole area, all the existing residential, industrial and commercial areas need to be taken into consideration and careful attention should be given to choosing appropriate new development areas for each category. Social and environmental impacts and the existing life styles of the residents around the developing area also need to be taken into consideration.

The above process is suitable for the newly implemented schemes only. The schemes, which are facing the premature saturation will have to be handled separately. Their problems have to be analysed independently so suitable solutions can be found. Though the basic problems in these schemes are same there will be unique problems, which need to be independently analysed.

References

Records from Operation & Maintenance Division, National Water Supply and Drainage Board, Regional Support Centre, Central Province, Sri Lanka.

Feasibility Study Report, Kundasale and Udu -Yatinuwara Water Supply Schemes, by National Water Supply and Drainage Board, Regional Support Centre, Central Province, Sri Lanka.

Contact address

S. Abu Ubaiddha,
Senior Engineer,
COWI Consulting Engineers & Planners As,
ADB assisted Third Water Supply & Sanitation Sector Project,
Sri Lanka.

M. Manoharan,
Regional Manager (Operation & Maintenance),
National Water Supply & Drainage Board,
Sri Lanka.