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**FINANCING URBAN SERVICES THROUGH COST
RECOVERIES FROM SEMI-PUBLIC GOODS – THE
CASE OF DRINKING WATER SUPPLY**

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Financing Urban Services Through Cost Recoveries from Semi-Public goods – The Case of Drinking Water Supply

J V M Sarma

Abstract

Non-tax revenues in the form of cost recoveries of public services provided by governments are the most important source of revenue for urban local governments in India. However, most governments lack rational pricing policy for these services and generally charge token prices, which may hardly relate to their supply and distribution costs. The financial sustainability of the drinking water supply system involves 'cost recovery' principle, and the tariff rate structures should be designed in such a way that revenue yield should compensate the operation and maintenance cost. However, the current water pricing practices are deficient in the sense that often the price of urban water supply is lower than the costs incurred for its provision. In this paper it is attempted to design an objective tariff system that is efficient, adequate, equitable and is suitable for recovery of the costs involved in the drinking water sector. The model basically aims at linking the water tariff rates to the volumetric consumption of water, with adequate progressivity.

Preface

Madras School of Economics (MSE) established the Centre for Public Finance (CPF), which started functioning from April 1, 2021. This Centre is financed by the Government of Tamil Nadu. Its activities are guided by an Advisory Council (headed by me). The Centre focuses on both theoretical and empirical issues of public finance covering the following areas: deficit financing and public debt, monetary and fiscal interactions, tax policy and reforms, public expenditure management, public investment appraisal and cost benefit analysis, public enterprises reform, intergovernmental transfers, local finances and environmental issues.

Apart from general research activities, the Centre is committed (i) to review the Tamil Nadu Economy and State Finances every year, (ii) to conduct an Annual Conference on topics related to public finance and policy and (iii) to conduct Training Programs on public finance. It will also undertake specific studies on public finance funded by Government of Tamil Nadu and other National and International agencies.

During the academic year 2021-22, the Centre organized —Virtual Meeting on Improving the Presentation of Tamil Nadu Budget Document// on April 29, 2021 and conducted 5-day Training Programs on Public Finance for 15 batches covering a total of 270 Group A and Group B officials of Government of Tamil Nadu through online mode (from August 31, 2021 to December 31, 2021). It organized a two-day national Conference on - Issues of Public Finance// during January 20-21, 2023 and also summer training program for college teachers and Ph.D. scholars from July 3-15, 2023. It has also initiated several research studies.

The study "Financing Urban Services Through Cost Recoveries from Semi-Public goods – The Case of Drinking Water Supply", by JVM Sarma is the thirteenth working paper of the CPF. This study has attempted to design an objective tariff system for urban drinking water system in Tamil Nadu that is efficient, adequate, equitable and is suitable for recovery of the operation and maintenance costs involved in providing drinking water supply.

**C.Rangarajan
Chairman**

INTRODUCTION

Non-tax revenues form a significant component of the urban local government revenues. Generally, the commodities and services that are marketable are priced based on demand and supply. The equality of the marginal cost of producing a commodity and the marginal revenue generated out of it determines the equilibrium price. Such a clear-cut pricing mechanism cannot be adopted for 'pure' and 'semi'-public goods and services because of their features of non-excludability and externality. This raises the question of how to price and finance their provision. While 'pure' public goods provided by the government are fully financed by tax revenues, provision of the 'semi' public goods such as electricity, water supply, education, health, and other social services are supposed to be partly financed by the taxes and partly by levying charges such as fees, tariffs, and cesses. These non-tax revenues derived are mostly supposed to partially offset the costs of these semi-public goods, that is at least their operation and maintenance (OandM) expenditures.

A substantial part of the non-tax revenues is generated at the local government level and in fact, they are the major own sources of revenue for the local governments. A major challenge for the urban local bodies, therefore, has been to meet the present as well as rapidly increasing future demand for urban services including water supply, sewerage, solid waste disposal, storm water drainage, roads, and street lighting. Thus, it is imperative that they need improved pricing methods. However, most governments lack any rational pricing policy for these services and generally charge a token price, which may hardly relate to their cost of supply and distribution. Moreover, some of these services are the minimum basic subsistence goods and services required for survival and are to be provided irrespective of any payments being made against them.

In this context, it is useful to understand the generally suggested drinking water pricing policies by the ADB (Asian Development Bank,

2006). ADB insists that “conservation of water and its sustainable use are increasingly critical factors in managing the scarce resource. Governments need to see water as an economic good. Financial incentives for optimizing water use will be strengthened through a mix of water charges, market-based instruments, and penalties. Public awareness programs will reinforce the incentives which include water use rights, licenses and charges, tradeable permits, effluent charges, water treatment fees, access fees, environmental liabilities, and tax incentives. Managing water demand depends on efficient pricing, effective regulation, and appropriate reduction and awareness” (Asian Development Bank, 2006). ADB thus promotes tariff reforms through its water-related projects and programs to modify structures and rates so that they reward conservation and penalize waste. ADB consistently advises governments of the need to adopt cost recovery principles in their water policies and strategies.

As regards water subsidies, ADB supports subsidies for water services in the following circumstances:

- (i) where treated water uses have beneficial external effects in preventing health problems,
- (ii) where the transaction costs of measuring usage are very high, and
- (iii) where a limited quantity of treated water for the poor is regarded as a basic human need.

(Asian Development Bank, 2006).

Thus, it has become imperative to look for a proper pricing mechanism, especially for urban services, to make them self-sustainable. The expansion of access to water and the improved provision of water services requires that capital costs be funded mainly from within the sector by accessing the debt market and developing appropriate tariff structures to repay the debts. Consumers are expected to meet the operation and maintenance costs of water facilities and service provision

in urban and rural water supply and sanitation schemes subject to subsidy considerations.

In this study, the next section discusses the concept of cost recovery, especially as applied to the drinking water sector; the subsequent sections review the broad principles involved in the determination of the drinking water tariff; explain a model of objective tariff determination for urban drinking water based on these principles; illustrates the model applicability urban sector taking Coimbatore Tamil Nadu as an example; and finally examines the impact of inefficiencies on the tariff rate determination in the same order of sequence.

COST RECOVERY IN THE DRINKING WATER SECTOR

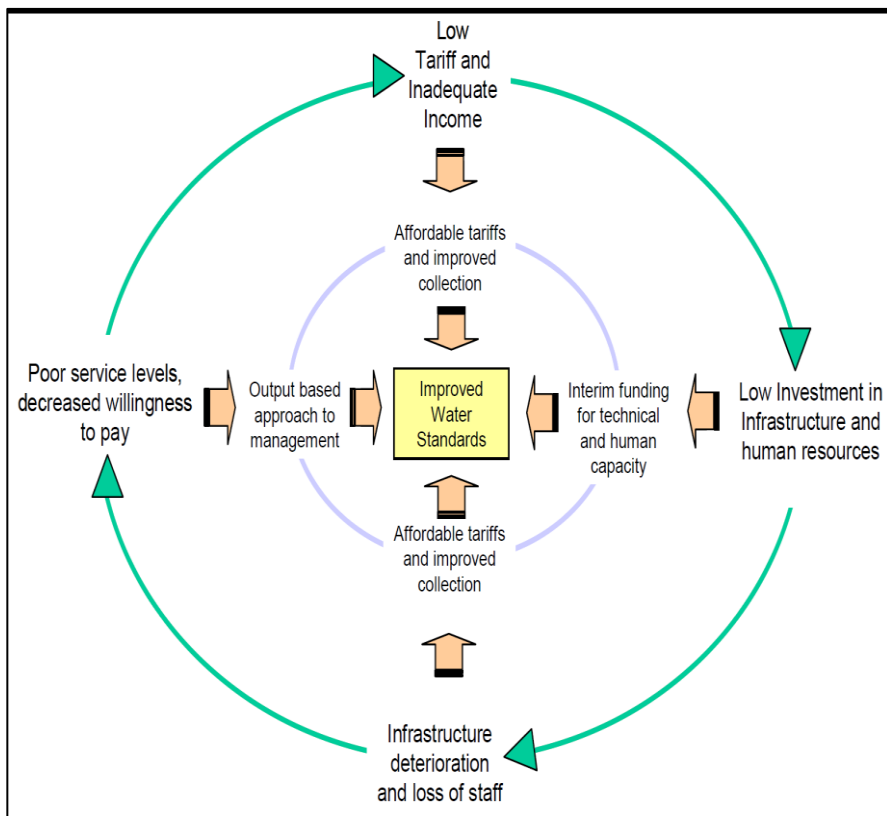
Cost recovery of the water supply sector, in simplest terms, could be - 'to recover all costs associated with a water supply service to ensure long-term sustainability'. However, it is debatable which costs to be recovered, and in what way they are to be recovered.

The drinking water system involves many activities - right from policy making, macro-level planning, developing, and maintaining institutional arrangements, capacity building and maintenance of support organizations, and so on. The costs involved in all the activities are rarely recovered. Generally, only the costs of system operation and maintenance, development of community institutions are considered for recovery. The government policy dictates which part of these costs should be recovered from consumers and makes tariff design and billing accordingly.

The growing urbanization and the aging infrastructure, would mean that sustaining the existing water supply and wastewater services poses a difficult financial task, let alone expanding access to new households and new areas. Low service levels and poor water quality dampen the willingness of water users to pay, which in turn lowers the

service level. Inadequate cost recovery can lead to the waste of this resource, inability to maintain machinery (such as pumps), and possible health risks if people are compelled to use alternative, and often unsafe, sources of water.

Figure 1: Cycle of Water Poverty and Pathways to Change



Source: DFID (2001:19)

The Figure 1 shows a vicious circle arising from poor cost recovery of drinking water supply. In essence, low levels of cost recovery leads to insufficient income for the effective and efficient operation and management of the service. Poor management of water supply leads to further dissatisfaction of users, thus decreasing willingness to pay, which, on top of already poor cost recovery levels, further exacerbates the system.

While the need for appropriate pricing of urban water has been long stressed and is widely recognized, the goals and objectives of water pricing are often conflicting (Cardone & Fonseca, 2003) Urban Local Bodies (ULBs) incur significant costs in supplying the drinking water supply. While the state government gives some grants, it is desirable to recover at least the operation and maintenance (OandM) costs of supply, if not the capital costs. Most often the water tariff rates are set well below the cost of the service, justifying this in terms of the importance of water services for the health status of the poor. However, results have often been unsatisfactory. Service quality and coverage remain inadequate in many countries, and subsidies directed at public water companies have often benefited the middle classes rather than the poor, who remain unconnected to the public network (TERI, 2010).

Underpricing has affected the finances of state governments who have either absorbed the losses of urban water utilities or adjusted the losses by reducing the capital account support to them for capacity expansion. Although the macroeconomic consequences of low water prices are difficult to assess, urban water services could cost the state governments the equivalent of 0.3 to 0.4 per cent of their gross domestic product. (Singh, Upadhyaya, & K, 2005).

Types of Drinking Water Tariffs in Practice

Three types of instruments are generally used for charging drinking water supply. In many states, a connection fee or a fixed access charge. Such a fee is levied to provide the user with a connection to a municipal (public) water supply system. A connection fee or charge is based on the size of the plot or holding or the size of connection and ferrule or a combination of plot size and the size of the ferrule. It is unclear if the connection fee is designed to contain an element of capital cost that is involved in laying out the distribution network. The second type of charge prevalent is a water tax for which provision exists in most municipal legislation. It is a tax which is unrelated to water use or consumption. It

forms a part of property taxation and is leviable on the annual ratable value of land and property and is meant to essentially serve as a general tax. Conditions under which a water tax may include certain categories of water users who may be exempted from payment of water taxes, ceiling on the rate at which water tax may be levied, and the use to which receipts from such a levy may be applied. For example, the Uttar Pradesh Municipalities Act lays down that a water tax may not be levied on properties which have an annual value of less than ₹300; the Uttar Pradesh Municipal Corporation Act, 1959 lays down that the proceeds of water tax (and drainage and conservancy taxes) may be pooled and used for purposes connected with the construction, maintenance, extension, and improvement of the service.

The Maharashtra Municipal Act 1965 provides for a general water tax as a part of the consolidated tax on property and a special water tax for water supplied by the municipal council. It further lays down that a municipal council, instead of imposing a special water tax may fix rates for supply of water by measurement. The Bombay Municipal Corporation Act provides for a water tax if the premises are not charged for water by measurement, and a water benefit tax, which is in addition to water tax or water charges on all residential properties in Greater Bombay. Water tax and water benefit tax are applied to the annual rate able value of premises, with the tax rate discriminating between residential and non-residential properties.

A third method of charging is water charge designed as a charge on consumption (also known as 'volumetric' charge). Volumetric structures are used only under conditions of metered supplies of water. Non-volumetric structures are applied to other measures that are proxies to water consumption.

Besides a connection fee, a water tax, and a water charge, there are minor instruments such a meter rent, a license fee, a water cess, a meter maintenance charge where meters are provided by the water

supplying agency, development charges, and fixed charges for capital renovation of the water system which are used for operating water supply systems. Many of the instruments yield little revenue, raising questions about the purpose for which they are being kept on statutes or rules.

As regards the volumetric charge, marginal cost pricing is an indispensable aspect of the water pricing rule. A basic premise for the creation of autonomous water boards, for instance, was that they would be able to set a tariff equal to the marginal cost of providing services to each category of consumers. However, few water supplying entities have control over price fixation. Further, implementing the principle of marginal cost pricing for water has proved to be difficult.

Thus, water pricing structures in India are complex and often even clumsy. At one level, price structures distinguish between metered connections and unmetered connections as also bulk provision from non-bulk, discrete provision. At another level, price discrimination is common with (i) categories of water users which comprise not only the principal categories of domestic users and non-domestic users but also the assorted categories consisting of water used for washing motor vehicles, cattle sheds, stables, and the like, and (ii) income groups of households, assumption being that low-income households use less quantities of water and high-income households have higher consumption levels.

Water pricing may differ with the quality of water supplies, for example, filtered, unfiltered, tube-well supplies, and the like. Cross-subsidy is central to the principle of price discrimination. Non-domestic users subsidize the domestic sector. High income households using larger quantities of water subsidize low-income households, raising questions about the desirability of overloading certain categories of water users. (Birkenholtz, 2010)

Water Tariff Structure: Increasing Block Tariff (IBT)

One of the most popular methods of levying water tax is the 'increasing block tariff (IBT) method. An increasing block tariff is a series of prices that increase in steps as consumption rises, akin to progressive taxation. The key feature of IBT is that it contributes to equity by allowing low-income households to pay lower rates for water than other households. An IBT structure is based on the volumetric component. A water user in a particular category, such as residential, is charged a relatively low price per unit for consumption up to a specific amount. This amount defines the size of the initial block. A user whose consumption exceeds the size of the initial block faces a higher price per unit for the additional consumption until he exhausts the second block, and then a still higher price until reaching the top block in the increasing block structure. To construct an increasing block tariff, three parameters are needed: (i) the number of blocks, (ii) size of the block in terms of water, and (iii) price per unit in each block. The case for IBT is argued on several grounds. First: IBT provides equity as high-income households tend to subsidize the water usage of low-income households. It is based on the argument that the consumption levels of water among high income households is greater, and because a greater percentage of their water use occurs in the higher blocks, they pay a higher average price for water. Second, IBT can promote water conservation and sustainable water use. This is because the price in the higher blocks carry high rates, and they discourage wasteful water use. Third: an IBT is needed to implement marginal cost principles. It is argued in this regard that because marginal costs are expected to rise with total water use, prices should rise accordingly with individual household use. This has been the main justification.

Deficiencies in the Current Practices of Pricing of Drinking Water

The setting of water pricing in most Indian cities and towns calls for fundamental reforms. The current water pricing practices are deficient in the sense that often the price of urban water is low in relation to the cost incurred for its provision. Although firm estimates are not available,

recoveries from the sale of water and other charges relating to water provision are approximately 22-25 per cent lower than the O and M costs, raising serious concerns about the financial viability and sustainability of urban water utilities. The under pricing has resulted in poor spatial and temporal coverage of services. Most households face limited hours of service, and water services are uniformly sub-standard.

Besides, the poor and inefficient management of water supply is leading to waste with the resultant large claim on resources. The shortfall between tariff revenue and costs is met through subsidies – operating and capital – from the government. The result is a low-level equilibrium characterized by low tariffs, poor service, and limits on access, especially of poor households. The objective of large-scale subsidization of water to the poor has not been achieved either. Evidence points out that the poor pay more and share the costs more, and the price subsidy meant for them and built into tariff structures, is often appropriated by the non-poor households. Further, subsidies on private taps are poorly targeted, reaching only no more than 30 per cent of the poor. Such regressivity in the distribution of subsidies when poor do not have access to subsidized piped water service is a common phenomenon in Indian cities and towns (Mukherjee, Namrata, & Gronwall, 2015).

The underpricing of water supply has affected the finances of state governments who have either absorbed the losses of urban water utilities or adjusted the losses by reducing the capital account support to them for capacity expansion. Although the macroeconomic consequences of low water prices are difficult to assess, urban water services could cost state governments significantly. Therefore, water tariff rationalization is an essential pre-requisite to the financial viability of agencies responsible for water supply and for increasing the financial flows into the sector.

A Framework for Water Tariff Reforms

Water reforms are constrained by the lack of rational tariff structures which match the costs and charges in relation to the incidence of benefits

(World Bank, WSP, 2011). Customer consultation in service planning is needed to link investment decisions to effective demand. (Mathur & Thakur, 2003).

The Principles of Tariff Designing in India

Setting water tariffs requires striking a balance between four main objectives

The Cost Recovery principle

The financial sustainability of the water supply system involves 'cost recovery' principle, that is, the expenditure of water supply is to be met from the tariff revenue collected. However, the consensus is that it is sufficient to recover only the operation and maintenance component of the expenditure (OandM) and not necessary to aim at recovering the capital component of the expenditure.

Further, the energy expenditure component of the OandM expenditure is also excluded from the costs to be recovered. This is because, payment of the energy expenditure accrues to the State Government, and therefore, in effect, is a mere book transfer in India. As a result, there is a case for excluding the energy component from the OandM cost to be recovered.

Thus, the tariff revenue should compensate the O and M costs only and that too, excluding the energy cost.

1. Volumetric Principle

The tariff rates should be volumetric and related to the water consumption by the individual users or groups of users.

2. Equity and Affordability Principle

The tariff structure should adhere to the 'equity' as also the 'affordability' principles. Thus, it should provide for collecting higher revenue from the rich as compared to the poor. It can also provide

for collecting a higher share of revenue from certain consumer categories such as commercial, industrial and non-domestic categories of consumers compared to domestic category consumers.

3. Efficiency principle.

The tariff design also considers the level of efficiency. If the water supply and revenue collection efficiency is 100 percent, with low non-revenue water (NRW) then the revenue targeted could be exactly to be equal to the OandM expenditure considered. If the efficiency is lower than full, then there is a need to aim at higher than required revenue collections by prescribing higher tariff rates.

A MODEL OF TARIFF DETERMINATION OF DRINKING WATER SUPPLY

The tariff design model should have the following characteristics.

The model basically should aim

1. To resolve what expenditure to be recovered – capital expenditure incurred to install the water network system, current expenditure due to operation and maintenance of the system
2. To link the water tariff rates to water consumption of the users, that is, based on volumetric consumption of water, and not a flat rate.
3. To prescribe a progressive tariff rate structure, for example, by the Increasing Block Tariff (IBT) method, that is the tariff liability progressively goes up with the volume blocks of water consumption. The tariff rate is progressive just as in the case of income tax.

The design allows the tax authorities a certain amount of freedom to alter certain parameters.

1. To categorize the consumers according to their use of water, for example, differentiate between household consumers, non-domestic consumers, commercial and industrial consumers.

2. To divide the tariff to be collected among different categories and how much should be the portion to be raised in each category.
3. To fix the number of consumption brackets, the bracket limits, and
4. To some extent, the basic tariff rate in each category.

Once these parameters are set, then the rates to be charged to the consumers of each bracket of each category will be determined by the model.

Let the water consumers are categorized into three groups: Domestic, Nondomestic, Commercial and Industrial. Later, the method can be extended to other categories.

Let the number of tariff slabs = 4, with the upper limits of i^{th} slab being B_i . The slab-wise number of consumers for i^{th} slab = N_i . The slab-wise water consumption C_i and per connection monthly consumptions for i^{th} slab = c_i , so that $C_i = N_i \cdot c_i$. The slab-wise marginal tariff rates are τ_i where $i = 1$ to 4.

The monthly tariff liability of an average household depends upon the tax brackets, the consumption, and the marginal tariff rates. If the monthly consumption of the average household is c_1 , then the tariff liability is = $c_1 \tau_1$.

Depending upon the size of consumption, different households falling into different slabs have different liabilities as shown in the following table.

Table 1: Typical revenue computations for each tariff brackets

| Tariff bracket | | Marginal tariff rate | Number of consumers | Total consumption | Percapita consumption | Percapita Tariff revenue |
|----------------|----------------|----------------------|---------------------|-------------------|-----------------------|---|
| lower | upper | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 = 5/4 | 7 |
| 0 | B ₁ | τ_1 | N ₁ | C ₁ | c ₁ | $T_1 = c_1 \tau_1$ |
| B ₁ | B ₂ | τ_2 | N ₂ | C ₂ | c ₂ | $T_2 = B_1 \tau_1 + (C_2 - B_1) \cdot \tau_2$ |
| B ₂ | B ₃ | τ_3 | N ₃ | C ₃ | c ₃ | $T_3 = B_1 \tau_1 + (B_2 - B_1) \cdot \tau_2 + (C_3 - B_3) \cdot \tau_3$ |
| B ₃ | B ₄ | τ_4 | N ₄ | C ₄ | c ₄ | $T_4 = B_1 \tau_1 + (B_2 - B_1) \cdot \tau_2 + (B_3 - B_2) \cdot \tau_3 + (C_4 - B_3) \cdot \tau_4$ |

The total tariff revenue obtainable from a category in a month R_m which is a function of the tax bracket limits, the number of households in different slabs, their monthly consumption levels, and the marginal tax rates.

$$R_m = f(B_1, B_2, B_3, B_4; N_1C_1, N_2C_2, N_3C_3, N_4C_4; \tau_1, \tau_2, \tau_3, \tau_4) \quad (1)$$

Let us assume that the tax bracket limits, the households falling in different slabs and their consumption levels are known. Only the marginal tariff rates are not known.

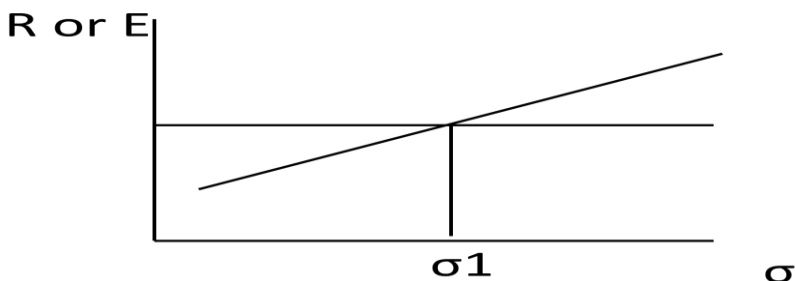
Let us assume that the marginal tariff rate for the first slab τ_1 and the other marginal rates are related to it through a common parameter σ , such that

$$\tau_2 = \tau_1 + \sigma; \tau_3 = \tau_1 + 2\sigma; \tau_4 = \tau_1 + 3\sigma. \quad (2)$$

Then the revenue function would be

$$R_m = f(B_1, B_2, B_3, B_4; N_1C_1, N_2C_2, N_3C_3, N_4C_4; \tau_1 : \sigma) \quad (3)$$

It is obvious that given the other parameters, the higher the value of σ , higher would be the gap between the marginal rates and the total revenue. We identify the unique value of σ where the monthly revenue line meets the monthly expenditure line. Once the σ is identified, the marginal tariff rates can be computed and the optimal revenue equivalent to the expenditure can be computed.



The detailed derivations and calculations are as follows.

$$R_m = \sum N_i T_i = X_m \quad (4)$$

$$= N_1 c_1 \tau_1 + N_2 [B_1 \tau_1 + (c_2 - B_1) \tau_2] + N_3 [B_1 \tau_1 + (B_2 - B_1) \tau_2 + (c_3 - B_2) \tau_3] + N_4 [B_1 \tau_1 + (B_2 - B_1) \tau_2 + (B_3 - B_2) \tau_3 + (c_4 - B_3) \tau_4]$$

(5)

Re-arranging the terms and substituting for σ

$$\sigma = \frac{[X_m - (\tau_1 N_1 B_1 + C_2 + C_3 + C_4)]}{[(C_2 + 2C_3 + 3C_4) - N_2 B_1 - N_3 (B_1 + B_2) - N_4 (B_1 + B_2 + B_3)]} \quad (6).$$

By a policy decision, it is imposed that households in the first slab will consume the maximum water of the slab, and therefore, the consumption of the first slab would be $N_1 B_1$ instead of $N_1 c_1$. Thus

Let

$$C = (N_1 B_1 + C_2 + C_3 + C_4) \quad (7)$$

And

$$C' = (C_2 + 2C_3 + 3C_4) \quad (8)$$

$$N' = N_2 B_1 + N_3 (B_1 + B_2) + N_4 (B_1 + B_2 + B_3) \quad (9)$$

$$\sigma = \frac{(X_m - \tau_1 C)}{(C' - N')} \quad (10)$$

$$\sigma = [X_m - \tau_1 C] / (C' - N').$$

Once the σ is known, the marginal tariff rates can be obtained as

$$T_2 = T_1 + \sigma; T_3 = T_1 + 2\sigma; T_4 = T_1 + 3\sigma \quad (11)$$

The model has the following advantages.

1. The model is simple and handy for computing the tariff rates.
2. The main advantage is it helps in reducing the arbitrary fixation of tariff rates.
3. The model allows policy calibration to the extent the marginal tax rates are inter-related. To facilitate solving for a unique value of σ we specify a linear inter-relation only. Any non-linear relation can result in several cross products and there may not be any unique solution.
4. It is quite useful to check and verify to what extent the existing tariff structure enables cost recovery.

However, there are some difficulties in applying the model.

1. The model is highly sensitive to any alteration in the tariff bracket limits, as also the tariff rate fixed for the lowest category.

2. The most important thing is that prior fixation of the tariff rates is not possible as they cannot be derived without knowing the consumption in each category and in each slab.
3. And the tariff rate structure will change every year as the cost to be recovered cannot be known till the end of the year as also water consumption.
4. Since the water consumption figures should be known prior to tariff rate fixation, they cannot accurately respond to the rate structure.

The Step-by-Step Process of periodic Tariff Determination

An illustrative blank Excel document is attached herewith to readily yield the required tariff rates. Assuming the brackets remain the same, the excel form is to be filled up step-by-step as follows.

1. The item-wise monthly expenditure is to be given.
2. The slab-wise number of households is to be given.
3. Their corresponding monthly consumption in kilo litres is to be given.
4. The tariff rate for the initial slab is to be prescribed.

Once the initial tariff rate for the lowest slab is given, the tariff rates for other slabs are estimated automatically.

However, caution needs to be exercised while prescribing the initial tariff rate. If the initial tariff rate is too low, the estimates of other tariff rates will be very high. On the other hand, if the initial tariff rate prescribed is too high, then the other tariff rates will be in descending order and the tariff structure will be regressive.

5. It is also desirable to prescribe the revenue shares expected from each of the categories: Domestic, Non-domestic, and Commercial/Industrial.

For example, even if the consumption share of the domestic category households is at about 90 per cent, and if the policy makers wish to reduce the tariff burden to about 70 per cent,

say, on the domestic category households under a revised tariff structure, this share is to be prescribed for domestic category and higher shares for other categories.

6. It is desirable to prescribe the efficiency parameter, so that the determination of the new tariff rates takes the level of efficiency into account.

If the efficiency is expected to be less than optimal (100 percent), the tariff rates required would be higher than optimal, and vice versa.

A CASE STUDY OF COIMBATORE IN TAMIL NADU

In this section, the model is illustrated by taking Coimbatore, which is a major metropolitan city in the Indian state of Tamil Nadu. It is located on the banks of the Noyyal river and surrounded by the Western Ghats. It is administered by the Coimbatore Municipal Corporation and is responsible for determining the water tariff rates.

The primary sources of water for Coimbatore city are mainly from reservoirs in the Western Ghats - Siruvani dam and Pillur reservoir. The 3rd source is Aliyar reservoir, in the south of Coimbatore, from the Bhavani River. The 4th source is the Kavundampalayam-Vadavalli scheme which also draws from the Bhavani River. The Tamil Nadu Water Supply and Drainage (TWAD) is responsible for water supply and sewage. Nearly 104 MLD water is drawn from the Siruvani dam located in Palakkad, Kerala, around 36 km upstream from the city. This water provides for around 36 wards in the city and several villages outside Coimbatore. However, with the recent decision of Kerala Government to lower the Siruvani dam, the water supply is reduced to 90 MLD, of which about 83 MLD is supplied to the corporation limit and the rest is being supplied to the villages in the outskirts of the city. With a population of 1.6 million,

the water supply demand would be about 216 mld. But the supply at present is only 116 mld.¹

Table 2: Drinking Water Tariff Rates of Coimbatore Town in Tamil Nadu

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable Rs. | Frequency of billing |
|--|--------------|----------------|-------------------------------------|----------------------|
| Domestic Residential premises, other than flats or block of houses | Upto 10 KL | 4 | Rs.80/- per month per dwelling unit | Monthly |
| | 11 to 15KL | 16 | | |
| | 16 to 25 KL | 24 | | |
| | Above 25 KL | 40 | | |

However, since the geographical structure and water availability, as also the consumption pattern among the water users, differ among the selected towns, the ULBs are free to modify the tariff structure to be adopted.

ESTIMATION OF MODIFIED TARIFF STRUCTURE FOR COIMBATORE

The total expenditure involved in drinking water supply for Coimbatore city in 2019-20 is about ₹64.5 million. The items of expenditure are

¹ Coimbatore City Municipal Corporation has chosen SUEZ to manage and operate the water distribution system within the entire city (60 wards) to ensure continuous drinking water access to its 1.6 million inhabitants. The 26-year project (1 study period, 4 years of implementation period and 21 years of maintenance), worth near €400 million (₹ 34.6 billion or nearly 1.64 billion a year over 21 years of capital and maintenance cost that includes the optimisation, rehabilitation and operation of the entire water distribution system (reservoirs, water network, house connections, water meters, valves, etc.) which will cover an area of over 100 sqkm with 150,000 connections and a distribution network of 1,200 km. The contract also aims to improve customer services with a state-of-the-art customer call centre and customer agencies to ensure a personalized service and faster complaints resolution.

culled out from different available sources and reports. The pattern of expenditure is as in **Error! Reference source not found..**

Table 3: Item-wise Average Monthly Expenditure of Water-Supply, Coimbatore, 2021.

| O&M Expenditure | Amount (₹) |
|----------------------------|--------------------|
| Operator's Fee | 2,41,70,570 |
| Chemicals | 19,19,143 |
| Energy | 3,21,75,863 |
| Technical Auditor | 8,70,141 |
| Repair Cost | 28,58,895 |
| Administrative | 19,23,977 |
| Others | 5,80,094 |
| Total | 6,44,98,684 |
| Excluding energy | 3,23,22,820 |

Source: MC of Coimbatore supplemented by other sources and discussions.

The operator's fee is the main item accounting, for over half of the total expenditure. The next big item is energy. The cost of repairs accounts for about 10 percent. Accordingly, the operation and maintenance cost to be recovered is ₹32 million.

Water Consumption

The total number of domestic connections is 1,17,673. The monthly consumption is about 17,75,293 KL per month.

Existing Tariff structure

Table 4 shows that the existing water tariff rates can yield a revenue of about ₹29.3 million which is about 45 percent of the total cost of water provision. If energy costs are excluded, then the coverage is over 91 percent.

Table 4: Coimbatore Tariff Revenue with GO Specified Tariff Rates

| Users | Volumetric Slabs monthly (KL) | | No of Connections | Monthly consumption (KL) | Average monthly consumption per connection (KL) | Present ULB Tariff rates (%) | Monthly revenue per connection with minimum liability (₹) | Total Monthly revenue (₹) |
|----------|-------------------------------|----|-------------------|--------------------------|---|------------------------------|---|---------------------------|
| | 0 | 10 | | | | | | |
| Domestic | 0 | 10 | 44,105 | 1,59,655 | 4 | 4.00 | 40 | 17,64,213 |
| | 10.01 | 15 | 30,620 | 3,39,448 | 11 | 16.00 | 57 | 17,56,750 |
| | 15.01 | 25 | 22,714 | 4,28,141 | 19 | 24.00 | 212 | 48,23,973 |
| | 25 | 50 | 20,233 | 8,48,049 | 42 | 40.00 | 1,037 | 2,09,72,648 |
| | Total | | 1,17,673 | 17,75,293 | 78 | | 1,346 | 2,93,17,583 |

The Tariff Model Scenarios

There are two alternative views as to what extent the tariff revenues should cover the costs. The first view is that the tariff revenues should cover the entire capital costs and current O and M costs; and the second, and the most widely agreed upon view is that the water tariff revenues should at least cover the O and M costs and not necessary to cover the capital costs. Following the consensus view, we considered tariff revenues covering the O and M, that too, excluding energy costs. The energy cost incurred ultimately is understood to be borne by the government and is a mere book transfer. The optimal tariff rates are derived such that the tariff revenue collected compensates the defined OandM expenditure excluding energy costs.

For the purpose of the model and its simulations, the minimum rate for the domestic category is pegged at 4 percent as specified in the government order. The intermediary parameter is estimated and used to derive the tariff rate structures.

It should be noted that although the model requires specification of the tariff rate for the initial bracket, if the initial rate is too low, the derived tariff rates for other brackets would be very high. On the other hand, if the initial rate is too high, those for the other brackets can be regressive. Therefore, discretion is needed to specify the initial tariff rate

such that the progressivity is safeguarded. Also, in case a uniform rate is required, the model allows to calibrate the initial tariff rate such that the tariff rates of other brackets to be the same, indicating a flat uniform rate.

Excluding the cost of electricity, the tariff rates are derived to cover the costs. The optimal tariff rates derived from the model shows that the revenue collected will equal the OandM costs as defined. The initial tariff rate for the initial brackets is specified as 4 and the model derives the optimal tariff rates for the other brackets for each category.

Table 5: Estimated Tariff Rate structure and Revenue to cover the OandM other than electricity cost with 100% efficiency

| Users | Volumetric Slabs monthly (KL) | | No of Connections | Monthly consumption (KL) | Average monthly consumption per connection (KL) | Tariff rate | Monthly revenue per connection with minimum liability (₹) | Total Monthly revenue (₹) | Estimated monthly cost (₹) | Intermediate parameters | |
|----------|-------------------------------|----|-------------------|--------------------------|---|-------------|---|---------------------------|----------------------------|-------------------------|-------------|
| | | | | | | | | | | | |
| Domestic | 0 | 10 | 44,105 | 1,59,655 | 4 | 4.00 | 40 | 17,64,213 | 3,23,22,820 | C | 20,56,692 |
| | 10.01 | 15 | 30,620 | 3,39,448 | 11 | 17.00 | 58 | 17,89,854 | 100% | C-N | 18,54,155 |
| | 15.01 | 25 | 22,714 | 4,28,141 | 19 | 29.99 | 240 | 54,60,871 | | s | 13.00 |
| | 25 | 50 | 20,233 | 8,48,049 | 42 | 42.99 | 1,152 | 2,33,07,882 | | R | 3,23,22,820 |
| | Total | | 1,17,673 | 17,75,293 | 78 | | 1,491 | 3,23,22,820 | | - | |

IMPACT OF EFFICIENCY ON TARIFF COLLECTION

The model also has room for considering collection efficiency. The above table, for example, assumes that the revenue is collected with 100% efficiency. As a result, the revenue requirement exactly equals the O and M expenditure.

In case, if the collection efficiency is less than optimal, then the target revenue collection should be greater than the OandM expenditure. There are two types of inefficiencies – the production inefficiency, and the distribution inefficiency. The production inefficiency arises either as leakages in the water supply equipment (Jackwell, Water treatment plant, storage tanks, supply pipes and other equipment). The production inefficiencies are well reflected in the amounts of unaccounted for water

(UFW). Collection inefficiencies basically arise from wrong meter readings, non-availability of payers, inaccuracies in meter readings, damaged reading equipment and so on. The production and collection inefficiencies will show up as non-revenue water (NRW). In India, in most urban areas, the NRW ranges from 45% to 85%.

In case the efficiency is suspected to be short of full efficiency, then the revenue required to be collected is to be more than the actual O and M expenditure, and the derivation of the optimal tariff rate structure will be higher than optimal to that extent. Such a system in place will help enable us to monitor the financial balance of the water utility and help revise tariffs proportionate to the expenses.

For example, if the efficiency is only 65% then the revenue target to be aimed at should be ₹ 4,97,27,416, that is, greater than the OandM expenditure of ₹ 3,23,22,820. The summary of the derived tariff rates is as in

Table 7 and graphically depicted below.

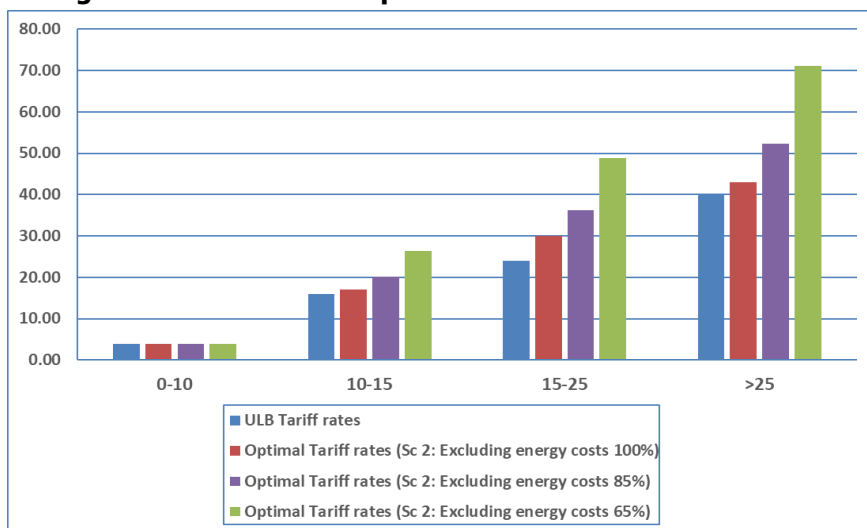
Table 6: Estimated Tariff Rate structure and Revenue to cover the OandM other than electricity cost with 65% efficiency

| Users | Volumetric Slabs monthly (KL) | | No of Connections | Monthly consumption (KL) | Average monthly consumption per connection (KL) | Tariff rate | Monthly revenue per connection with minimum liability (₹) | Total Monthly revenue (₹) | Estimated monthly cost (₹) | Intermediate parameters | |
|----------|-------------------------------|----|-------------------|--------------------------|---|-------------|---|---------------------------|----------------------------|-------------------------|-------------|
| | | | | | | | | | | | |
| Domestic | 0 | 10 | 44,105 | 1,59,655 | 4 | 4.00 | 40 | 17,64,213 | 4,97,27,416 | C | 20,56,692 |
| | 10.01 | 15 | 30,620 | 3,39,448 | 11 | 26.38 | 69 | 21,01,933 | | C-N | 18,54,155 |
| | 15.01 | 25 | 22,714 | 4,28,141 | 19 | 48.77 | 360 | 81,68,276 | | s | 22.38 |
| | 25 | 50 | 20,233 | 8,48,049 | 42 | 71.15 | 1,863 | 3,76,92,995 | | R | 4,97,27,416 |
| | Total | | 1,17,673 | 17,75,293 | 78 | | | 2,331 | 4,97,27,416 | | - |

Table 7: Summary of the Estimated Tariff Rates from the Model as Compared to the Present Rates

| Volumetric Slabs (KL) | ULB Tariff rates | Optimal Tariff rates (Sc 2: Excluding energy costs 100%) | Optimal Tariff rates (Sc 2: Excluding energy costs 85%) | Optimal Tariff rates (Sc 2: Excluding energy costs 65%) |
|--------------------------------|--------------------|--|---|---|
| Domestic | | | | |
| 0-10 | 4.00 | 4.00 | 4.00 | 4.00 |
| 10-15 | 16.00 | 17.00 | 20.07 | 26.38 |
| 15-25 | 24.00 | 30.00 | 36.14 | 48.77 |
| >25 | 40.00 | 43.00 | 52.22 | 71.15 |
| Revenue Expected (₹) | 2,93,17,583 | 3,23,22,820 | 3,80,26,847 | 4,97,27,416 |
| O&M considered | 3,23,22,820 | 3,23,22,820 | 3,23,22,820 | 3,23,22,820 |
| Coverage of O&M (%) | 90.7% | 100.0% | 117.6% | 153.8% |

Figure 2: Present vs Proposed Water Tax Rate Structures.



SUMMING UP

A model for designing the optimal tariff rate structure is explained with its application to Coimbatore. The model helps in removing the

arbitrariness in prescribing the water tariff rate structure. At the same time, it also allows sharing of the tariff burden between different categories of water consumers.

Energy efficiency may be achieved by improving the pump station design, system design, installation of Variable Speed Drives to pumps, and operating pumps efficiently. Leakage reduction would bring significant savings in power consumption.

Production side (technical and engineering design and management of water pumping and treatment, OHT and consumer networks); consumer meter connections, consumer meter readings, tariff collection, consumer complaint management; water accounting and measures of reducing NRW, and water safety measures; other organizational and institutional factors drinking water suppliers need to adopt best industry practices for water efficiency, and new strategies that adjust for changes in water quantity and quality.

From source to tap to the quantity of wastewater we must treat, it is important that we reduce the amount of water we use and manage our use of water more effectively. Drinking water suppliers and operators can pursue best industry practices for water efficiency, such as: System-wide water loss accounting, Leak detection and repair, and pricing that encourages consumer water conservation. Water suppliers can also take steps to ensure adequate source capacity and system readiness for variable water quality.

Water Loss Control: National studies indicate that, on average, 14 percent of the water treated by water systems is lost to leaks. Some water systems have reported water losses exceeding 60 percent. Accounting for water and minimizing water loss are critical functions for any water utility that wants to be sustainable.

APPENDIX

Detailed water tariff rates of Coimbatore

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable (including sew charges)in Rs. | Frequency of billing |
|---|--------------|----------------|---|----------------------|
| Domestic | | | | |
| Residential (i) Domestic Residential premises (Other than Flats or Block or line of Houses) | Upto 10 KL | 4.00 | Rs.80/- per month per dwelling unit | Monthly |
| | 11 to 15KL | 16.00 | | |
| | 16 to 25 KL | 24.00 | | |
| | Above 25 KL | 40.00 | | |
| (ii) Flats or houses in a Block of flats or line of houses respectively used wholly for residential purposes. Total consumption divided by no. of flats.(Not applicable to Dedicated mains) | Upto 10 KL | 4.00 | Rs.80/- per month per flat | Monthly |
| | 11 to 15KL | 16.00 | | |
| | 16 to 25 KL | 24.00 | | |
| | Above 25 KL | 40.00 | | |

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable (including sew charges)in Rs. | Frequenc y of billing |
|----------------------|---|----------------------------|--|------------------------------|
| | | | | |
| B. Commercial | Private Hospital - upto 500 KL Rs.103/KL. | | Rs.1694/- * (Water Intensive) | Monthly |
| | All others upto - 500 KL Rs.73/KL. | | Rs.787/- (Non Water Intensive) | |
| | Private Hospitals - above 500 KL Rs.169/KL. for entire quantity. | | Rs.1694/- * (Water Intensive) | Monthly |
| | All others - above 500 KL Rs.132/KL. for entire quantity | | Rs.1452/- * (Water intensive) | Monthly |
| | Industry Upto – 500 KL Rs.73/KL | | Rs.787 /- (Water intensive) | Monthly |
| | Industry – above 500 KL Rs.145/KL for entire quantity | | | |
| C. Partly commercial | Upto 10 KL | 8.00 | | |
| | 11 to 15 KL | 25.00 | Rs.250.00 | Monthly |
| | above 15 KL | 40.00 | | |
| D. Institutional | i) Pvt. Edn. Institution. | 85.00/K.L. entire quantity | Rs.787.00 | Monthly |

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable (including sew charges)in Rs. | Frequenc y of billing |
|--|---------------------|--|--|------------------------------|
| | ii) Govt. Hospital | 43/K.L. entire quantity | Rs.424.00 | Monthly |
| | iii) All others | 61.00/K.L. entire quantity | Rs.605.00 | Monthly |
| E. Municipal Bulk supply | Entire consumption | 32.66/KL | - | Monthly |
| E. (i) Municipal Bulk supply | Entire consumption | 7.00 /KL (wherever Local bodies met the cost of infrastructure) | - | Monthly |
| * Sewerage charges at 25% on water supply charges wherever sewer connections are provided | | | | |
| * Water intensive means premises used fully or partly as Theatres, Hotels, BoardingHouses, Lodges, Clubs, Private Hospitals, Private Hostels, Kalyanamandapam s, Clinic with inpatient facility, Swimming baths Places for keeping | | | | |

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable (including sew charges)in Rs. | Frequenc y of billing |
|---|---|-----------------------|---|------------------------------|
| animals, Vehicle Service Stations, Nurseries. | | | | |
| F. | i. Hydrant and Public Supply per fountain per month including maintenance charges | | Rs.1200/- | Monthly |
| | ii. Maintenance charges | | | |
| G. | i. Mobile Water Supply to Slums | | Rs.39/- per 1000 litres for entire quantity supplied. + Hire charges | Monthly |
| | ii. Maintenance charges for steel tanks | | Rs.600/- per month per tank | |
| H. | CASUAL WATER SUPPLY | | | |
| | Mobile Water supply to customers | | | |
| | i. Domestic including Hostels of Colleges and Schools Recognised by State/Central Govt./Govt.Qtrs. etc. | | Rs.475/- per load of 6000 litres Rs.700/- per load of 9000 litres Rs.1200/- per load of | |

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable (including sew charges)in Rs. | Frequenc y of billing |
|-----------------|---|-----------------------|---|------------------------------|
| | | | 16000 litres | |
| | ii. Partly Commercial a) Domestic purpose | | Rs.475/- per load of 6000 litres Rs.700/- per load of 9000 litres Rs.1200/- per load of 16000 litres | |
| | b) Other than Domestic purpose | | Rs.770/- per load of 6000 litres Rs.1100/- per load of 9000 litres Rs.1870/- per load of 16000 litres | |
| | iii. Commercial (Including Private Hospital) | | Rs.770/- per load of 6000 litres Rs.1100/- per load of 9000 litres Rs.1870/- per load of 16000 litres | |
| | iv. Institutional a) Private Educational Institution including Hostels | | Rs.770/- per load of 6000 litres Rs.1100/- per load of 9000 litres Rs.1870/- per load of | |

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable (including sew charges)in Rs. | Frequenc y of billing |
|-----------------|---|-----------------------|--|------------------------------|
| | | | 16000 litres | |
| | b) Govt. Offices/Schools/ Colleges/ Hospitals etc. | | Rs.499/-per load of 6000 litres Rs.735/- per load of 9000 litres Rs.1260/- per load of 16000 litres | |
| | iv. Institutional a) Private Educational Institution including Hostels | | Rs.770/- per load of 6000 litres Rs.1100/- per load of 9000 litres Rs.1871700/- per load of 16000 litres | |
| | v. Water supply at the Metro water filling points a) Domestic: Including Govt. Schools/ Colleges/Offices/ Institutions/Hospitals | | Rs.40/- per 1000 litres | |
| | b) Commercial: Including Private Hospitals/ Private Educational Instutions. | | Rs.60/- per 1000 litres | |
| | vi. For the | | Rs.200/- per | |

| Category | Qty of water | Rate/KL in Rs. | Minimum Rate Chargeable (including sew charges)in Rs. | Frequenc y of billing |
|----------|--|----------------|---|-----------------------|
| | employees of the Chennai Metropolitan Water Supply and Sewerage Board whodesires to avail the lorry water supply for their own household requirements, the cost will be calculated at actual cost price. | | load of 6,000 litres Rs.300/- per load of 9,000 litres | |
| I. | Hire charges for tanks hired out | | Rs.250/- for two days and Rs.50/- for every additional day. | |

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