

Chapter 2

Theoretical Background of Water Sector

This chapter introduces the economics of the water sector including water pricing, objectives of water tariffs and possible subsidy programs. Furthermore, the institutional framework of water suppliers with different Private–Public Partnership (PPP) options is explained and the value chain of services of a water utility with sanitation service is briefly described. The chapter ends with a presentation of general facts on water supply and sanitation in India.

2.1 Water Pricing

Even though water is essential for living, it was not explicitly manifested as a human right in the “Universal Declaration of Human Rights” of the UN in 1948. The simple reason might be, that it is as fundamental as the air to breathe, which is not included in the human rights declaration either. Furthermore, one can argue that it is implicitly included in many international agreements and conventions in which the right to food, human health and development are guaranteed. Those objectives can only be achieved by having access to clean water (Gleick 1998).

In the last decades, organisations felt the need to support access to clean water as a human right and put it explicitly into their declarations. In the UN “Declaration on the Right to Development” of 1995 denying access to water is seen as a “mass violation of human rights” (Gleick 1998, p. 494).

According to the World Health Organisation (WHO), a minimum of 50 litres per capita and day (LPCD) is required to fulfil the needs for consumption and assure hygiene (Howard and Bartram 2003). Gleick (1998) states that on average 5 L per day are needed for drinking water, 10 L for food preparation and 35 L for bathing and sanitation services.

The water supply in those parts of the world without water shortages should orientate toward the optimal access of 100 LPCD and more that allow all the needs of an individual to be met (Howard and Bartram 2003). In arid or semiarid parts of the world, the human right to water has to be limited to the minimum requirement

and the water supply should also orientate toward that quantity to make sure that everybody can be supplied. The development of the water supply in all parts of the world has to guarantee a “sustainable access to safe drinking water” which is one of the millennium goals set by the UN (2010).

The fact that the access to water has the status of being a human right nowadays, creates an on-going discussion about whether water should be priced or not, and if yes, what an appropriate price would be.

In the following sections the different aspects of pricing, several arguments for and against water pricing, the objectives of water tariffs, as well as the different existing tariff systems are presented. Last but not least, possible subsidies are pointed out, that can help to diminish the disparities in the access to a piped water supply between wealthy and poor households.

2.1.1 Economical Theory of Water Pricing

Before discussing the reasons for water prices and what different tariff systems can be applied, it is important to explain the economic concept of water and what interdependencies exist when determining water prices.

The real value of an item to somebody is the “measure of what the item is worth to the individual, not what it cost” (Hanemann 2006, p. 64). This implies, that the value is a subjective preference. It is important to note that the demand and the supply of a product are independent of one another. The demand shows how much the product is worth to people, the supply how much the product itself costs. The market price can be seen as the result of the interaction between supply and demand as the point where the supply and demand curve intersect (Hanemann 2006).

The demand curve is a plot of all possible purchased quantities of one product against the related prices per unit. The shape of this curve is determined by the availability of the product, the costs for a substitution and the taste, preference and income of the purchaser. If the total demand changes, the curve will be shifted upwards or downwards depending on whether more or less is purchased for the same price (Agthe and Billings 2003b).

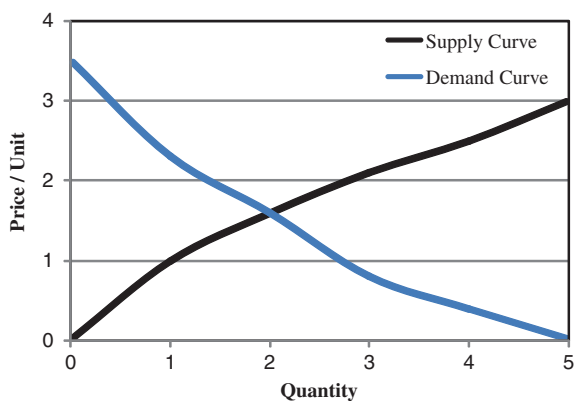
By increasing the purchased quantity, the subjective value of the item decreases (e.g. the first bottle of water brings the most benefit) so that the demand curve generally declines. As a consequence, the market price would have to decrease as well if the supplier is to maximise the consumed quantity. This phenomenon is called “declining marginal value” and was first introduced by Dupuit in the 1800 (Hanemann 2006, p. 64).

The supply curve indicates for which price the producer can sell the product. The slope with which the price per unit rises also depends on the availability of the goods. In the case of the water sector, it depends on the availability of water sources and is characteristic of the condition of the water utilities (Agthe and Billings 2003b).

Figure 2.1 depicts an exemplary demand and supply curve to illustrate the theory.

In general, the supplier can apply two different pricing strategies. He can price according to the marginal costs, which is the price for the last unit of sold water, or the average costs that are calculated by dividing the production costs by

Fig. 2.1 Exemplary demand and supply curve



the number of sold units. If the supplier levies one of those prices, he is able to recover his costs (Agthe and Billings 2003a).

In the water sector, the marginal price often rises with increased water consumption instead of declining (in contrast to companies that can profit from economies of scale), as the development of new sources costs a lot of money especially when no groundwater can be drawn and surface water bodies need to be commissioned. Furthermore, the water price seldom declines, because the objective of the water sector is not the maximization of the demanded water quantity as this would lead to an unsustainable use of water. The “law of demand” says that with an increased price the demand will decrease, ensures the realisation of the intended effect, which is to reduce the amount of water used (Agthe and Billings 2003b).

In a competitive market, the market price, as the intersection point of the supply and demand curve, represents the point where the marginal value of satisfaction equals the marginal production costs. As this model ignores external factors that have to be taken into account on real water markets it cannot be applied without alterations that have already been implicitly mentioned above. Positive externalities that cause a decrease in the market price are, for example, considerations of public health and of equity in water distribution to all income groups. Negative externalities like overexploitation of water sources or environmental pollution through insufficient treatment of waste water result in the augmentation of the water price. If water is sold at a higher price than the marginal costs, the price is called conservation price (Agthe and Billings 2003b).

Rogers et al. (1998) define three different levels of cost for water that can be taken into account when discussing the basis for water prices: Full supply costs, full economic costs and full costs.

Full supply costs only include operation and maintenance (O and M) costs and capital charges for the development of the supply system. Full economic costs additionally take opportunity costs and economic externalities into account and full costs furthermore add environmental externalities. Opportunity costs arise in cases of conflicts in water allocation. A water price that recovers the full costs, charges the “sustainable value [of water] in use” (p. 7).

After presenting the costs of water and what costs a sustainable price should cover in detail, it is important to look at how consumers adapt to changes in water prices more closely.

The economic mechanism that is intrinsic to the phenomenon is called price elasticity of demand. Elasticity in general describes the percentage change of a variable in response to a change of another variable. Price elasticity of demand is the change in purchased quantity caused by a 1 % change in water price.

$$\text{Price elasticity of demand} = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}}$$

It would be wrong to say that the price elasticity measures a change in the demand, but in the quantity demanded due to the change of price. A change in the demand can only be achieved by varying the demand curve through a change in non-water price influence (Agthe and Billings 2003a).

Price elasticities of demand are generally negative numbers due to the negative slope of demand curves. If the price elasticity of demand is smaller than -1 the price is elastic, if greater than -1 inelastic. Goods that can easily be replaced by substitutes close in price and goods with a large number of uses tend to be price elastic. Goods with opposite characteristics are more likely to be price inelastic. Following this theory, municipal water is often price inelastic due to low prices and few or no substitutes. Water in the form of bottled water and water used for luxurious purposes such as swimming pools or gardening might be price elastic (Agthe and Billings 2003a).

Price elasticity of demand can be seen in relation to the price elasticity of revenue:

$$\text{Price elasticity of revenue} = \text{Price elasticity of demand} + 1$$

If one raises the price around 15 % and the price elasticity of demand is -0.3 , the resulting price elasticity of revenue would be 0.7. Due to the quantity effect fewer units are sold, which leads to 4.5 % quantity drop ($-0.3 * 0.15 = -0.045$). The price effect brings a revenue increase of 10.5 % ($0.15 - 0.045 = 0.105$).

If the price elasticity of demand is one, both effects offset each other and the revenue stays the same. But because the production costs might decrease due to fewer produced unites, the price augmentation might still help the producer to reduce deficits (Agthe and Billings 2003a).

The elasticity of demand can also change due to differences in household incomes, which is called income elasticity of demand and generally lies between 0.2 and 0.4:

$$\text{Income elasticity of demand} = \frac{\text{Percent change in quantity of water}}{\text{Percent change in income}}$$

Watering lawns, laundering clothes more often or additional bathrooms might be some reasons for an increased water consumption with rising income. The knowledge of income elasticity of demand can help urban water suppliers to predict changes in water demand due to higher incomes resulting from big newly established industrial or governmental employers in an area (Agthe and Billings 2003a).

Another important aspect in water pricing is the willingness-to-pay (WTP) for an improved water supply. There are two different approaches to analysing this WTP. The indirect method observes consumer behaviour and estimates the costs

through the means of time and money that they have to invest to get a sufficient supply. Those costs are called coping costs and can be considerable for customers with an intermittent water supply. The direct approach applies surveys with questionnaires including “specific prices for hypothetical services” and is often called the “contingent valuation method” (Raje et al. 2002, p. 392).

Even in service areas where such WTP studies were carried out and the results clearly indicated that consumers are willing to pay more for an improved water supply, policy makers do not believe in it. They still argue “the people” would not be willing to pay and leave the tariff and the resulting insufficient funding of the service as it is (World Bank 1999).

2.1.2 Objectives of Water Tariffs

Now that the general concept of pricing has been explained, the basic arguments for and against water prices will be presented and the objectives of water tariffs will be discussed.

Opponents of water pricing argue the state should supply water at no charge, as it is a public good provided by the earth to all species. The more it becomes a profitable commodity the more it will be privatized and become a target for investors. The decisions will then be based more and more on augmentation of profits and focus on the highest bidder instead of on the poor (Barlow and Clarke 2002). From their point of view water should not be seen as a commodity to make sure that everybody can afford this vital resource.

Supporters of water prices put forward the argument that other vital goods such as food or medicine are traded as economic goods as well without anybody complaining (Hanemann 2006).

Furthermore, they have got the economic system on their side. Even if the water utility does not charge anything for the water itself, it has to charge something to finance the supply system, the service it offers and so forth. This is especially true for utilities in large cities with a continuous need for supply network development. In many cities in developing countries the rapid population growth and the dilapidated supply network, make a lot of high value investments necessary. To accomplish that, the water suppliers need to create sufficient revenues to be able to invest.

Another point is that in those huge communities the water consumption is enormous. In cities with comparatively limited water sources, the water consumption needs to be regulated to ensure that everybody has access to water. This regulation can be achieved by pricing water (Rogers et al. 2002).

This last argument leads to water tariffs being efficient management tools if they are applied properly. Therefore, several objectives of a tariff system need to be balanced to guarantee a functioning and effective system. In the following section those targets are presented.

The most important objective from the supplier’s point of view is cost recovery and revenue sufficiency. Before one can design a tariff, it must be evaluated how much revenue the supplier aims for to set the price at a sufficiently high level (Boland and Whittington 2000).

Economic efficiency is another target that should be achieved with the tariff system. It means that for fixed costs for water supply the aggregated benefit to the customers has to be maximized. Economists postulate that this is true when all prices equal their marginal costs. This means too, that the development of a new source to increase the production capacity can only be realized, if the consumer shows the excess of the benefits over higher cost by their willingness to pay higher prices for water out of this new source (Boland 1993).

Equity and fairness are the third objective of water tariff design. While equity induces that “equals be treated equally and unequals be treated unequally” (Boland and Whittington 2000, p. 8), fairness is subjective, so that some might think charging more for water used in industry is fair, some don’t.

The objective “income redistribution” is connected to fairness. In some countries tariff systems are designed in a way that some consumer groups pay more for water and subsidise other consumer groups with this extra charge. This concept will be further explained in Sect. 2.1.4.

With the help of tariff systems resource conservation can be achieved. The tariff can provide incentives to save water by increasing the price for an increased water use. This instrument implies that only customers using large quantities waste water (Boland and Whittington 2000).

An objective introduced by Whittington et al. (2002) is affordability. As water is crucial for well being it needs to be taken into account that everybody has to be able to purchase at least a basic quantity.

Boland and Whittington (2000, p. 9) present some considerations that are “less fundamental and long-lasting than objectives” but nevertheless need to be taken into account. They list things like public acceptability, political acceptability, simplicity and transparency. Another important factor is that the tariff system needs to be reasonably easy to implement and to administrate.

2.1.3 Introduction of Different Tariff Systems

Over the years different tariff systems have been developed. The main classification is the division into single part tariffs and two part tariffs.

As the name implies, single part tariffs only consist of one part, which can either be independent or dependent on the quantity of used water (Whittington et al. 2002).

If the charge is independent of the water consumption, it is called “Fixed charge” and is the only possible way to charge for water without installing a water meter. Still, there are different ways to determine charges adjusted to the customers. They can vary depending on residential properties, numbers of people using the connection or technical parameters like the diameter of the pipe (Whittington et al. 2002).

Advantages of the fixed charge are that meters can be omitted and the administration is simple. If the supplier is a public operator, the charge can even be collected as a tax (The Energy and Resources Institute 2010).

Unfortunately, fixed prices do not conform to the objective of equity, as the income and the ability to pay the price are not sufficiently considered. Another big disadvantage is that customers have no incentive to save water as their bill stays the same. On the contrary, people who use a lot of water are being subsidized because they do not have to pay more for the larger quantity than people who use less (Tsagarakis 2005).

Tariffs dependent on the water consumption and therefore on the existence of a water meter can be construed as uniform or non-uniform volumetric tariffs. While the charge of a uniform volumetric tariff is calculated by multiplying the consumed quantity of water with a fixed price per volume, non-uniform tariffs apply different prices per water unit. If the tariff is a block tariff, all water units within certain bounds, are priced with the same price that can either increase or decrease with each successive block (Le Blanc 2008). Blocks are synonymously called slabs.

To design a block tariff the number of blocks and the volume of water in each block has to be determined. Thereafter, the prices related to the blocks need to be identified (Boland and Whittington 2000). While the increasing block tariff (IBT) promotes the conservation of water, the decreasing does not, as was already discussed in the context of declining marginal prices in the water sector in Sect. 2.1.1.

The decreasing block tariff should therefore only be employed in countries without water scarcity. It prevents consumers of large quantities of water (e.g. industry) from implementing their own supply system and protects the infrastructure of the supplier to become obsolete. The low prices can be granted due to economies of scale (Agthe and Billings 2003b).

The increasing block tariff (IBT) is often applied in developing countries, as the prices for the first slab can be set very low, so that everybody can afford the basic water quantity. The higher prices in other blocks are ideally designed in a way to cross-subsidise the lowest price, which is often set below marginal costs. The tariff is generally applied to help poor households, but it disregards the fact that many of them do not have metered water connections and therefore cannot be charged according to the IBT. Another problem is that people with low incomes often share one connection to save connection charges. This results in a high total water consumption per connection, so that they are charged with the higher unit prices and cannot purely profit from the subsidized first block. Furthermore, poor households are more likely not to be connected to the supply systems than households with a higher income, so that in total more people not included in the target group are subsidized than the actual people in need. It can be concluded that wealthier households consume more frequently and altogether more water than poor ones so that they receive more of the subsidies (Boland and Whittington 2000).

Many IBTs are designed in a way that the first block is too big and most consumers only have to pay these subsidized prices, which leads to the fact that the cross-subsidisation does not work out and the water supplier cannot raise sufficient revenues. A point that increases this problem is, that the price levels of the upper consumption blocks are often not high enough (Whittington et al. 2002).

The volume-differentiated tariff prices all units the same according to the total quantity of water consumed (Le Blanc 2008). This tariff is a huge incentive to water conservation.

Two part tariff systems contain a fixed part and a volumetric part. The former is to cover all fixed costs the water supplier has got like maintenance cost, administration and so forth. The volumetric part is related to the water consumption in the billing period as in the volumetric tariffs described above (Whittington et al. 2002).

In addition to the presented tariffs, a special seasonal pricing or peak load pricing can be applied (Tsagarakis 2005). The seasonal pricing would result in a higher price during the summer season, when there is water scarcity and the consumers have to be more motivated to save water. If wasteful consumption directly leads to a considerably higher water bill, this would be the case.

Peak load pricing could for example raise the price at peak times when the supply capacities are not great enough to meet the total demand. This form of pricing is an incentive to use water at another time e.g. wash clothes in the evening instead of at lunchtime.

2.1.4 Subsidies in Water Supply

Even though the creation of subsidies conflicts with the objective of economic efficiency and equity, they are employed in most water supply systems in developing countries, to decrease the disparities in access to water supply between income groups.

The decreased economic efficiency can create problems. Because of the insufficient revenues, utilities are often financially weak and even the governmental funds cannot always cover all the subsidies they give to their customers. The resulting lack of money slows down the development of the supply network especially in the areas not yet serviced. A common consequence is that the unconnected households have to get their water from different sometimes more expensive sources (Komives et al. 2005).

Whittington et al. (2002) present four criteria that are important for well-designed subsidies to avoid the mismanagement described above.

First of all it has to be evaluated who actually needs subsidies to prevent a needless loss of revenue. Indicators for the need of subsidies can be the percentage of income spent on water supply or results of willingness-to-pay studies.

If genuine groups are detected, the tariff has to be altered in a way, that those groups are targeted by the subsidies. Komives et al. (2005) define targeting more precisely by dividing it into implicit and explicit targeting.

Implicit targeting does not implement specific measures to subsidise a genuine group. The utility simply tolerates low collection rates without disconnecting the household that did not pay from the supply system or accept illegal connections to the supply network, which generally occur more often at informal settlements. This way of targeting obviously does not support equity nor fairness, as everybody who is paying for the water subsidizes the ones who are not paying, whether they can afford it or not.

Explicit targeting addresses specific groups. This can be done through self-selection and administrative selection. Self-selection embraces two methods. The quantity targeting with IBTs and volume differentiated tariffs, in which the consumer can choose the price by varying the water consumption. The other method

is service level targeting, where households can choose the level of service according to the price they are willing to pay, e.g. a public tap instead of a private connection (Komives et al. 2005; Le Blanc 2008).

For administrative targeting methods like categorical targeting (e.g. pensioners, families), geographic targeting or targeting through means testing or proxy means testing can be applied. The latter measure the welfare of a household. The level of detail of the information is important for the efficiency of administrative targeting (Le Blanc 2008). It is especially difficult to carry out geographical targeting efficiently, as many of the poor do not live in slums but are scattered throughout the cities (Whittington et al. 2002).

The third criterion for a good subsidy program Whittington et al. (2002) present is low administrative costs. Even though the targeting should be done accurately, it is important, that the cost generated stays reasonably low. In general limiting the number of people who get subsidies is administratively more difficult than giving them to everybody (Komives et al. 2005).

Last but not least, it is important to prevent “perverse incentives” that can emerge due to subsidies. If the income redistribution that is carried out through the subsidies is immoderately done, industrial users who face exaggerated high volumetric prices might disconnect from the supply system and implement their own water supply. This would lead to great economic losses for the utility as cross-subsidization cannot work out properly anymore. On the other hand, the subsidized households that pay nothing or just a little bit for the water are more likely to waste it (Whittington et al. 2002).

An important question in the design of a subsidy program is how the subsidies are funded. They can either be funded by the government, by other customers or not be funded at all (Komives et al. 2005).

When the government funds the subsidies it has to be financed through for example taxes that can not be used for other projects anymore, which leads to a certain loss in economic wealth elsewhere (Komives et al. 2005).

Governmentally funded subsidies can be paid in two different ways. The government can make a payment directly to the targeted group (demand-side subsidy) or to the water supplier (supply-side subsidy) (Whittington et al. 2002).

The supply-side subsidy can take several forms. The first is that the government makes a payment to the utility if it proves, that a subsidy was provided to a specific user group. By this method, the money from the government directly finances the subsidies and cannot be spent on something else. The other two alternatives are less reliable. The government either grants general financial support, which it expects the supplier to forward to the customers, or the government reimburses losses of utilities if they provide subsidies. In both cases the consumer faces the risk that the transferred money is not used to actually finance subsidies but is “absorbed in a form of inefficiency” (Komives et al. 2005, p. 14).

Supply-side subsidies always have to cope with the risk that the government might not be able to pay the necessary amount to finance the subsidies. This risk and the fact that cost recovery can be achieved are the reasons why subsidies funded by other customers, the so-called cross-subsidies, are very attractive for the water supplier (Komives et al. 2005).

Cross-subsidies are generally designed in a way that industrial customers pay a surcharge on the actual costs to subsidise residential customers. Within the residential customer class the high-volume customers subsidise the low-volume customers (Le Blanc 2007).

The subsidies can be directed to two different costs. They can result in a decreased consumption cost or connection charge. One main objection to consumption subsidies is that only households connected to the supply system are able to profit from it. Moreover, water expenditure is generally only a small proportion of the household's budget so that those subsidies only have little impact on the budget of poor families. Moreover poor households are difficult to identify and therefore difficult to target (Le Blanc 2007).

The role of the extension of the water supply network to unconnected households is an important step in social development. Therefore, it is peculiar that connection subsidies are not increasingly used (Le Blanc 2007). Connection subsidies reduce or eliminate the charge that households have to pay for being connected to the supply system.

A different approach is presented by Whittington et al. (2002) who demand an improvement in the development of subsidies in the sanitation sector. Poor households see the necessity for a water supply but they do not always understand why they should spend money on waste water disposal. This development is essential for the health and hygiene of people living in fast urbanising cities and megacities. As this field is most often integrated in the responsibilities of the water supplier, this suggestion should be given a thought by the responsible authorities.

2.2 Water Supply and Sanitation Service

2.2.1 *Institutional Frame*

A particular characteristic of the water supply as well as the sanitation service is that the sector often evolved as a natural monopoly. Costs of services of natural monopolies are subadditive, which means that a single supplier can provide the service cheaper than two different providers could. Furthermore, investments that are carried out by a natural monopolist are irreversible and therefore generate high sunk costs, which can be seen as exit barriers on the one hand, and barriers to enter the market for competitors on the other hand (Spelthahn 1994).

Examples for such natural monopolies are besides the water supply, electric power, telecommunication or natural gas distribution. If the monopolist does not have to fear the entrance of competing companies into the market, the market is not able to regulate it. In that case governmental institutions often introduce exogenous regulation mechanisms (Joskow 2005). Those mechanisms regulate pricing strategies and present incentives to expand the supply network into areas where the profitability for the supplier is not guaranteed. In many countries natural monopolies were formerly publicly owned.

The low profit interest of public companies and the fact that the possibility of bankruptcy is often eliminated from the beginning by permitting the possibility of injecting money out of governmental funds tends to lead to low operating and production efficiency. The lack of competition on the monopolized market reinforces this phenomenon. The generation of incentives within the company or privatisation can improve the efficiency (Spelthahn 1994).

Nowadays, the monopolized industries listed above have become more and more opened to privatisation in many countries. An example of the water sector: in Germany, Australia or Hungary 30–50 % of the population is supplied by private water utilities. In England and France it is even over 70 % (Perard 2009).

The Indian Government supports the privatisation of the water supply and sanitation service as well but makes clear that the resource itself is not privatised, but only the supply. The first PPP projects were taken up in the 1990s but failed, which led to decreased efforts to promote further projects. Since 2005 some successes with new projects have been achieved. Especially segments like bulk water generation, treatment of (waste) water, the distribution and network rehabilitations are phases of the value chain in which PPP projects are preferentially established (Department of Economic Affairs 2009).

The general elements of the value chain of a water supplier will be explained in the Sect. 2.2.2.

Kumar and Prasad (2004) present several options of PPP. The level of investment can reach from almost completely public to private. Depending on the financing, the government can play a big role and act as the service provider or it can play a minor role. In this case, it enables the private investor to operate and only sets regulations. Further differences in PPP exist with regard to their duration. While management and service contracts usually run for 3–5 years, lease contracts run for 8–15 years. Concessions, build-operate-transfer (BOT) and build-own-operate(-transfer) (BOO(T)) projects even have durations of 20–30 years.

If PPP projects worked without any problems and risks there would probably be more of them. But political risks like internal resistance, labour resistance, instability of governments or simply uncertainty of government policies might lead to problems and even failure. Further risks come from the economic side (e.g. foreign exchange risk, inflation), legal environment (changes in law and regulation, legal barriers) and from transactions risks that include problems in the privatisation program due to improper project design, incapable administrative bodies or reluctance to proceed (Nallathiga 2007).

2.2.2 Value Chain of Water Supplier

As many water suppliers are not only responsible for the supply but also for the sanitation sector of the service area the value chain presented in this section includes these functions as well. Figure 2.2 shows the whole supply chain from the water source to the sewage treatment and disposal.



Fig. 2.2 Value chain of water supply and sanitation sector

The water source always depends on the geographical and geological environment of the service area of the water utility and therefore is a partly exogenous component. If several sources are available, it is most likely that those sources with the lowest total cost for water withdrawal, transmission, treatment and distribution are developed and commissioned.

There are three different types of water sources used for water supply. Surface water sources include lakes, ponds, artificial reservoirs, rivers and seawater dams. Groundwater can be drawn up from aquifers or taken from springs (CPHEEO 1999). While the commissioning of groundwater and spring water is relatively easy and low priced, the construction of artificial reservoirs by constructing dams is more expensive. The costs are always dependent on actual conditions. Desalination of seawater is another possible but very costly solution.

For all sources a good watershed management is a crucial point. It guarantees the possibility for the source to recharge and prevents its pollution by employing restrictions in land usage.

The water taken out of the source needs to be transmitted to the treatment plant and the service area of the water utility. Important for the water production costs is in this respect whether the water can be transported through the pipes by gravity or whether it needs to be pumped. The latter results in considerable energy costs especially over long distances. The distance between the supply area and the source also influences the cost for the construction of the transmission lines.

The next step in the value chain is the treatment of the water. There are several techniques that can be applied and need to be adjusted according to the chemical and biochemical quality of the raw water.

Treatment costs for groundwater and spring water are often cheaper than for surface water because those sources are generally less polluted. By adding certain chemicals like chlorine the water can be partly protected from contamination during the distribution (Oelmann 2005).

After treatment the water is stored in subsurface reservoirs or overhead tankers to enable the supplier to respond to fluctuations in water demand and to keep up the water pressure in the pipe system (CPHEEO 1999). Those reservoirs need to be maintained and cleaned regularly to prevent a contamination of the water.

According to the “Manual on water supply and treatment” (CPHEEO 1999) the water distribution accounts for 40–70 % of the capital costs of a water supply project. There are different kinds of pipeline sections: Trunk mains that distribute the water to different locations and service connections that connect the household to the supply network. It is common, that customers have to pay for the connection to the system.

The distribution system can either be used for an intermittent or continuous water supply. Systems intermittently supplying water have the disadvantage that contaminants can enter the pipes while they are not filled and there is no pressure in the system. This leads to pollution of the water when the supply sets in and water re-enters the system (CPHEEO 1999).

Apart from the costs for the construction of the distribution system, its O and M is another matter of expense for the water utility. But as this is the only possibility to prevent water pollution during the supply it is of prime importance.

After the customers have used the water, it is recollected and transmitted to sewage treatment plants (STP). In a well functioning supply and sanitation system the water connection and sewage connection of a household are laid simultaneously to prevent the discharge of waste water into storm water drainages, trenches or rives in the cities. The sewerage system can only protect the environment and lead to hygienic living conditions if enough waste water treatment plants with sufficient capacities are available in the service area and the resulting waste material is disposed of appropriately.

All costs arising for the water and sanitation provider are recorded in the expense and income statement that is used for preparing the balance sheet at the end of each financial year. Some general information on this financial accounting is presented in the next section.

2.2.3 Financial Accounting

Financial accounting has got several functions in a company. It records every financial consequence of business operations and compresses it into a balance sheet, which informs decision makers about the financial situation of the firm. From this information, plans for the future are made and objectives are set. Whether those objectives are met, can be controlled with the help of balances of future periods (Coenenberg et al. 2009).

The balance sheet is prepared at the end of each financial year and has got two columns that show the assets on one side and the equity and liabilities of the company on the other. Assets are the economic resources of the company and can be classified into fixed (long-term) assets (real estate, machines, financial assets,...) and current assets (inventory, securities, receivables, cash...). The other side shows the source of money and therefor the ownership of the assets of the company. The balance states how much equity the company has got in the form of capital funds and what part is financed by debts (liabilities, loans). The sums on both sides are equal.

Preliminary to the final balance sheet, the "Equity transfer account" that reveals equity changes and the "Income and expenditure account" that states all the revenues and expenses of the company are prepared. The latter is used to calculate the income or loss of the period.

Apart from the balance sheet and the income and expenditure account, the financial account of a year often includes an appendix where different positions of the statement are broken down into several points.

For example “operating expenses” can be broken down into costs for power, chemicals, other operating expenses and repairs and maintenance of water supply and sewerage systems (HMWSSB 2002–2011). With the help of those figures the cost structure of a company can be evaluated.

A problem frequently seen in balances of operators in the water sector in developing countries is a low cost recovery. This means that because of high costs due to over staffing, poor governance and in some cases high water production costs and an insufficient generation of revenue due to a low price level and too many subsidies, the costs cannot be recovered and no capital funds can be established (Liang and van Dijk 2006). This leads to the vicious circle in which the revenue level will not improve without exogenous monetary help, as the service level and therefore the use of service and resulting willingness to pay will not increase.

To break out of this circle it is necessary to revise water tariffs to achieve cost recovery and to reform the company in order to become more efficient and to improve the public image so that the customers trust in the service provider and pay the augmented prices.

2.3 Examples of Implemented Water Tariffs in Different Countries

This chapter gives an impression of the application of water tariffs in some countries and what the overall development of different tariff systems is like.

OECD (2009) presents findings from a survey conducted in 2007/08 that was designed to find out changes in water pricing compared to 1999. In OECD and some non-OECD countries, the real water prices increased, which is taken as a signal for a higher contribution of the charges toward cost recovery.

Furthermore, the application of fixed tariffs and decreasing block tariffs in domestic categories as well as in the industrial ones is declining. Two part tariffs with uniform or IBTs is seen more often. Waste water charges are increasingly separated from drinking water charges, which leads to substantial price increases in the waste water management services.

The last two findings of the OECD study (2009) are that domestic customers barely react to small price changes by reducing their demand but more significantly to changes in tariff structures (e.g. from flat to volumetric rates). Social concerns in water pricing are still an important issue and are taken into consideration through innovative tariff structures and subsidy programmes.

Olivier (2006) presents some examples of what tariff systems are applied in which country. Fixed charges are for example used in countries without water allocation conflicts like Canada, Norway and the United Kingdom. On the other hand, this tariff is also applied in developing countries without a metered water supply irrespective of the water availability. Price changes in this system do not provide possibilities for poor households to diminish the augmentation by reducing their demand, but the total price hike is directly reflected in their water bills.

Volumetric charges are used, amongst other countries, in Australia, the United States, Japan and in most European countries. Japan and Spain, for example apply IBTs (Olivier 2006).

The tariff structures in Mexico are set according to the specific laws in the states but mainly represent IBT that include charges for a minimum consumption level. The number of slabs is most often greater than five and leads to opaque-ness. In Mexico City there are 14 blocks and Monterrey published its tariff for each cubic meter OECD (2009).

A problem that arises with minimum consumption levels is that they have got the same effect on low quantity consumers as fixed prices. A price rise in Manaus for example had the consequence that the total increase of 31.5 % was only this high for people below the billing threshold. People that got bills with metered quantities were able to reduce their demand and therewith their bill (Olivier 2006).

2.4 General Information on Water Supply and Sanitation in India

While in developed countries the total water supply is managed by utilities with piped water, in developing countries there are some additional forms of access, including direct access to groundwater via tubewells or boreholes or to surface water and the supply by water tankers, water carts, kiosks and bottled water (Le Blanc 2007).

While piped water, public taps/standpipes, protected access to groundwater, rainwater and bottled water are improved sources of drinking water, unprotected access to groundwater, surface water and tanker tracks are non-improved sources (International Institute for Population Science 2007).

For the urban population the coverage of drinking water supply from an improved source in India is 95 % according to the “National Family Health Survey 2005–2006” (International Institute for Population Science 2007). For rural areas the coverage is only 85 %. The average shares of the different sources in urban and rural areas are displayed in Fig. 2.3.

The comparison shows that the supply through pipelines is more common in urban areas, but still only represents 50 % of the total supply. Zéhra (2006) points out that limited hours of supply and alternate day supply are common in many cities and the low water pressure makes the supply even more unreliable.

Other main sources of the urban water supply are public taps (20.3 %) and tubewells or boreholes (21.3 %). The latter represent the main sources for the rural water supply with 53.2 %.

It should be underlined that the figures on access to improved water sources do not indicate whether the source is reliable and provides the required water quantity in time, nor does it exclude the possibility of the supplied water being of minor quality or even bacteriologically polluted sometimes.

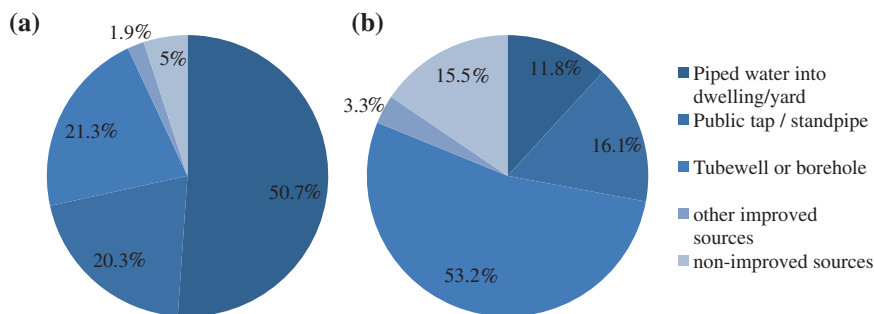


Fig. 2.3 Drinking water sources in **a** urban and **b** rural areas

Subramanian (2002) states that the per capita supply in India can vary from 9–584 LPCD, depending on the analysed towns and cities.

In the “9th Five Year Plan” presented by Raghupathi et al. (2005) and the “Norm for water supply suggested by the Central Public Health and Environmental Engineering Organisation” (CPHEEO 1999) recommend different quantities of water supply depending on the classification of a town or city. Both norms are shown in Tables 2.1 and 2.2 respectively. The lowest supply recommendation of the “9th Five Year Plan” of $40 < 50$ LPCS that were claimed to be a necessity by the WHO (cf. 2.1).

Just like the water supply, the coverage of sanitation in India displays differences between rural and urban areas. Depending on the source only 18–19 % of the households in rural areas have got a toilet, while in urban areas the coverage is 75–81 %. These differences exist due to a lower awareness of potential health benefits of a better hygiene practise in rural areas and because of the costs that might not be affordable (Subramanian 2002). Another point that needs to be examined is the coverage of organised sewerage systems. Toilets do not necessarily have to be connected to a system but can be connected to septic tanks instead or simply be pit latrines. The coverage of sewerage systems ranges from 35 % in class IV cities with fewer than 5,000 people to 75 % in so called class I cities with over 100,000 inhabitants. Even if there might be good sanitation coverage, it does not imply that there is enough capacity for the treatment of the collected waste water. On average only around 30 % of the sewage are treated before being disposed into rivers, lakes or the sea (Subramanian 2002).

Under the Constitution of India the responsibility for water supply and sanitation lies with the states. As they can delegate this responsibility to urban local bodies following the 74th Constitutional Amendment, the institutional arrangements vary between the states (Subramanian 2002).

Agencies like municipal corporations, public health departments or independent water boards are in charge of supplying water to the end users on city-level (The Energy and Resources Institute 2010), which explains different service standards throughout the country.

Table 2.1 Water supply levels of CPHEEO (1999)

Classification of towns/cities	Recommended maximum water supply level (LPCD)
Town provided with piped water supply but without sewerage system	70
Cities provided with piped water supply where sewerage system exists/is contemplated	135
Metropolitan and mega cities provided with piped water supply where sewerage system exists/is contemplated	150
<i>In urban areas, where water is provided through public stand posts 40 LPCD should be considered</i>	

Table 2.2 Water supply level of the “9th Five Year Plan” (Raghupathi et al. 2005)

Classification of towns/cities	Recommended maximum water supply level
Towns with spot sources/standposts. One source for 20 families within a walking distance of 100 m	40
Urban areas with piped water supply but without underground sewerage system	70
Urban areas with piped water and underground sewerage system	125

The “10th Five Year Plan” (Planning Commission—Government of India (GoI) 2008) sets the target to achieve 100 % coverage for the drinking water supply and 75 % for the sewerage system until 2012. Therefore, a lot of money is given to the local bodies by the Indian government.

To support the development of infrastructure and public services in urban areas and the accessibility of those services to the poor, the Indian government introduced Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for cities with more than 1 million inhabitants. Important parts of the infrastructural improvement are improvements in the water supply and sanitation sector. The renewal mission was launched for 80 cities, including the two research areas Hyderabad and Varanasi. The government provides Rs. 500 billion in the form of grants-in-aid. JNNURM funds can be accessed after an application of the responsible authority that include city development reports, detailed project reports and timelines (Min. of Urban Employment and Poverty Alleviation and Min. of Urban Development 2010)

A similar project for cities and towns with fewer than one million inhabitants exists under the title Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) (Planning Commission—GoI 2008).

Until the development schemes succeed in decreasing the disparities between poor and wealthy people the institutions responsible for the sanitation and water supply in fast growing cities have to cope with the difficult situation. On one hand, the suppliers have to create a network that everybody can financially afford and on the other hand it has to fulfil the needs of all customer groups. This problem does not only exist in India but in many developing and newly industrialized countries.

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