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Services Provided by Operators of Public Water Supply and Sewerage Systems and their Sustainability

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Abstract: Services provided by operators of public water supply and sewerage systems are a specific segment of Services of general economic interest. Their sustainability is controlled on the one hand by public regulation and, on the other hand, by a combination of economic, social and environmental objectives and the means of their achieving. Privatization of resources and the entry of private operators into this segment led to the emergence of markets and quasi-markets of these services and their components, and resulted in emphasis on balancing their economic and financial parameters. It reduced the internal control of the system sustainability to cost return or even only profitability. Restoring the emphasis on sustainability and availability of water services increases, both for the regulator and operators, the demand for balancing financial costs as well as other costs and effects of service.

The comparison of household expenditures on water services in the Czech Republic shows that some are already approaching and even exceeding the limit of considered social acceptability. There is also a stratification of households by physical consumption of these services (volumetric measurement), interpreted as an indicator of social effect. The results are discussed within the concept of „price drought“ used by authors for the role of price barrier to access to public water services and also qualitatively different response on the demand side in relation to sustainability.

I. INTRODUCTION

Water services play a key role in ensuring sustainable development of society. In recent decades, effects which increase the uncertainty of the sustainability of these services have been strengthening. Primarily, these are the impacts of climate change on the variability of the hydrological cycle, which emphasizes the importance of accumulation, energy use of water, water quality, flood and drought prevention and sustaining ecosystem services. This is reflected in the growth of demandingness in ensuring drinking water supply for the population, wastewater sewerage and treatment at a reasonable (affordable) price. These services are provided by the branch of public water supply and sanitation. In the Czech Republic, this system comprises owners of technical infrastructure (municipalities) and operators – public interest enterprises (often private owned) and is aimed at environmental, economic and social objectives [1]. Sustainable management of these enterprises is related to a complex of specific economic (natural, technical monopoly), social (necessary for health and safety) and environmental (pollution prevention and internalization) of costs and revenues, which influence each other. The scope of sustainable development aspects in this area is evident, inter alia, from the Global Reporting Initiative [2] methodology indicators.

Of major influence on the sustainable management of water supply and sanitation enterprises is – under European rules – the regulation of economic activity and entrepreneurship in the field of public services (in the EU - services in general interest). Public water supply and sanitation services are characterized by economic specificities such as: local monopoly (natural monopoly based on source of water, technical monopoly based on the use of unique infrastructure), public subsidies/grants (with a link to the public nature of services) and strong links in the social, environmental and safety areas. There collide two principles: functioning of water supply and sanitation system in real market environment (resources

purchased on labour, material, energy and investment markets) and regulation of economic and ecological behaviour and distribution of social and other public effects. The regulation affects all areas. Public services are largely operated by private companies with exclusive rights for a limited time period and a well-defined geographical space. It is the result of the process of partial privatization of the water management sector in the Czech Republic in the 1990s. The analyses can therefore, on the one hand, be based on data, procedures and methods common for enterprises, on the other hand, economic regulation, ecological and social functions directly enforce its extension to a sustainable development framework.

The aim of this paper is, based on the parameters of supply (quantity, price) and demand (consumption, acceptability) to quantify the most important aspects of sustainable management of water supply and sanitation enterprises in connection with the current way of the state regulation. The paper describes the trend of prices of water (followed by sewage) tariffs, the impact on drinking water consumption and the impact on different population groups. Also a possibility of changing regulation in the conditions of the Czech Republic is outlined.

II. MATERIAL AND METHODS

The steady decrease in the consumption of drinking water draws attention of enterprises to the economy of operation, costs and price, innovation activities, including elements of infrastructure, new technologies and financing the facilities. There appear difficulties in cost recovery and profitability. Raising prices is becoming a major and effective tool to face these problems. Other options (loss reduction, cost management) are already partially depleted (residual loss reduction measures are more costly) and other are not helped by the set conditions (the method of cost-based pricing [3], tenders,

grants/subsidies). Urgency of addressing this issue in economic terms can be indicated by examination of the relation between price and income of consumers (demand) and their sensitivity to price. The first relation is sometimes referred to as „social acceptability“ of water price (and is indicated by the proportion of expenditure for water services more than 2-3% of net household income). The latter – income elasticity of demand – characterizes active consumer behaviour and in a specific case it can be interpreted in the context of the theory of demand. Assuming that the quality of supplied drinking water is a general standard in the Czech Republic, then the main factor of the level of social and other effects is its quantity. Another prerequisite is transparency of payments (billing according to actual consumption), which is not always a matter of course [4]. The relation between the amount of water consumed and the social effect is not simple. From a certain level, however, it may pose a more serious problem than „cost management“ and with further decrease in consumption it may escalate [5].

Regarding the environmental area, enterprises are governed by the laws regulating water abstraction and quality and wastewater discharges in terms of quantity and quality. It can only be stated that the trend of water and sewage tariffs has a positive effect on the abstraction of water as a natural resource, i.e. that the amount of water consumed shows a long-term decrease. This fact, however, has great implications in the above-mentioned social area, and these are dealt with in this paper [6].

The general method is based on indicators of consumer behaviour (households) as reflected in the „water bills“. Payments for „water“ (including sanitation) are one of the items studied by social statistics in a sample set of respondents. These indicators are compared with the average values of the total amount of billed drinking water and payments for water and sewage tariffs in the Czech Republic as a whole.

The paper builds on an analysis based on CZSO (Czech Statistical Office) [7] data sets: Water Supply and Sewerage Systems, in a time series 2005-2012, Household Budget Survey and Household Income and Living Conditions, time series 2005-2012 (data broken down by CZSO household definition and the EU or OECD standard). Basic statistical data and their economic interpretation allow to specify the problem of social stratification of consumption of drinking water, which has a technical dimension (effect of demographic development on technical capacity and operation), economic dimension (impact on cost recovery and economic stability of both owners - municipalities and operators), social dimension (direct effect of the water services on the quality of life) and political dimension housing. The costs of water and sewage tariffs are therefore strongly linked with housing costs. Drinking water supply in place of a local operator – where there is natural and technical monopoly – has no substitution. Due to the strict water quality standards the quality standard is practically the same for all suppliers. Supply cannot significantly increase or decrease the level of

(the equal access to water services is limited by price). This is not a transient detail, but an essential characteristics of a broader meaning.

Similarly to the previous, such a situation can be indicated by several ways. The basic include the identification of the specific consumption of drinking water (per person per day). Using the economic analytical apparatus it is possible to determine the response of consumption to price and its sensitivity (price elasticity of demand). If we intend to use the „price“ as a tool of „demand management“, it is necessary to identify as best as possible where the relations between consumption and benefit of drinking water are set acceptably and their development does not show a tendency to a problem, and where it is vice versa.

III. THEORY

From the 1990s, water and sewage tariffs in the Czech Republic have been steadily rising and are accompanied by a declining per capita volume of public water supply and sanitation services. This is not an exception. In developed countries with more than 100-year tradition of public water supply systems, this trend has been evident for decades. In comparison with other European countries and the OECD average, however, water consumption per household member in the Czech Republic is lower [5]. The main driving forces of the rising prices of water and sewage tariffs are generational replacements of technologies [8] and the basic infrastructure and technical standards in extensive development of networks. Another effect are new generations of technologies and materials used to reduce losses and waste. Of influence are also attempts to liberalize and privatize the sector [9], whose accompanying negatives have so far been only partially remedied by regulation and re-communalization. Specifically, in the post-communist countries, this price signal is of a significant influence on consumers [10].

The theory of demand derives a change (decrease) of quantity in dependence on the growth of price from marginal utility. Thus, with the growth of prices (due to „setting“ prices to the level of „full costs“ and due to the growth of input prices) consumption decreases. Water is given as an example of the necessity, the demand for which little depends on the price (inelastic demand). In applying these principles to the case of drinking water we encounter several problems. It is a service which is strongly linked to the subsequent disposal of wastewater, within which the consumer pays for the pollution. Supply of drinking water and sanitation is associated with

technical equipment, offer assortment or lower quality for a lower price and vice versa. Finally, drinking water is a necessity, but qualitatively seemingly homogeneous supply comprises entirely essential parts (drinking consumption, basic hygiene) and parts related to household equipment (dishwasher, swimming pool etc.). The essential part is seemingly very little elastic

(consumers decide „about the life and health“). However, the increase in costs and prices of water resources, technologies and wastewater treatment raised the price of drinking water so that it paid households to invest in saving equipment [11] (not only for environmental or moral reasons, but purely for economic reasons – for example, price for dual-flush toilets will return in a few years). The problem is that consumption reduced in this way means also reduced sales for water treatment companies. Savings in operating costs by reduced consumption will not result in savings of fix costs, linked to long-term costly investments in infrastructure and networks. Efforts to cover costs at reduced consumption will result in a repeated growth of offer price. The response of consumers is becoming increasingly smaller. Price elasticity decreases. If the price of drinking water – for some consumer groups – affects their ability to get enough water for direct consumption and sanitation (after the introduction of saving techniques in the household), the item of water and sewage tariff on household bills „becomes independent“ and acts competitively on other necessities of life. These processes can be described by the relation between demand and household incomes (income elasticity of demand) and/or examination of the cross effects of necessities. The issue of cost recovery (profitability) gets associated with the problem of price „affordability“ and its acting as a barrier to achieving social and safety effects of drinking water supply. Paradoxically, the problem in question is not primarily a lack of water or neglected infrastructure, but the problem to manage the economic management of supply and demand, i.e. problem, which cannot be avoided even by developed countries in the field of water management. The ecological effects are impacted by this situation through the costs of wastewater sewerage and treatment. For the operator of new publicly funded investment this represents a substantial increase in operating costs, therefore, a necessary increase in sewage tariff.

The points of demand dependence are derived from the equilibrium situation in each year, which is corresponded to by the price and the identified quantity of drinking

water consumed.

Income elasticity (as well as price elasticity in another part of the research) is determined as the proportion of annual increases in quantity and price, i.e.:

$$E_{DP} = ABS \left[\frac{Q_2 - Q_1}{(Q_1 + Q_2):2} ; \frac{P_2 - P_1}{(P_1 + P_2):2} \right] \quad (1)$$

where Q1, Q2 are Quantity and P1, P2 are Prices in previous (1) and current (2) period; ABS is an operator for absolute value (elasticity expresses a change and is always positive).

Price elasticity estimates are generally found in the range of 0 to 0.5 in the short run and 0.5 to 1 in the long run: income elasticity estimates are of a much smaller magnitude (usually) and positive. Further, price elasticities are found to be higher in summer than winter and price elasticities are generally the highest where outside (read discretionary) water usage is the highest (including lawn and garden watering, car washing and swimming pools) [6].

IV. RESULTS AND DISCUSSION

Three areas are worth discussing at this stage:

- a) Expected results corresponding to the theory of consumer behaviour (with increasing prices and/or with lower income effective consumer demand decreases).
- b) Parameters of income elasticity of demand for drinking water in different household groups (income deciles) to be expressed as short-term (average annual), medium-term (blocks of 4 years) and long-term (entire period, i.e. 8 years) response of demand with changing income.
- c) Affordability of water and sewage tariff prices. Czech Republic is included in OECD countries, where expenditures for water (incl. sanitation service) [12] exceed the level of affordability and meet the conditions for „water poverty“, technically defined as equal to or more than 2- 3% of net household income.

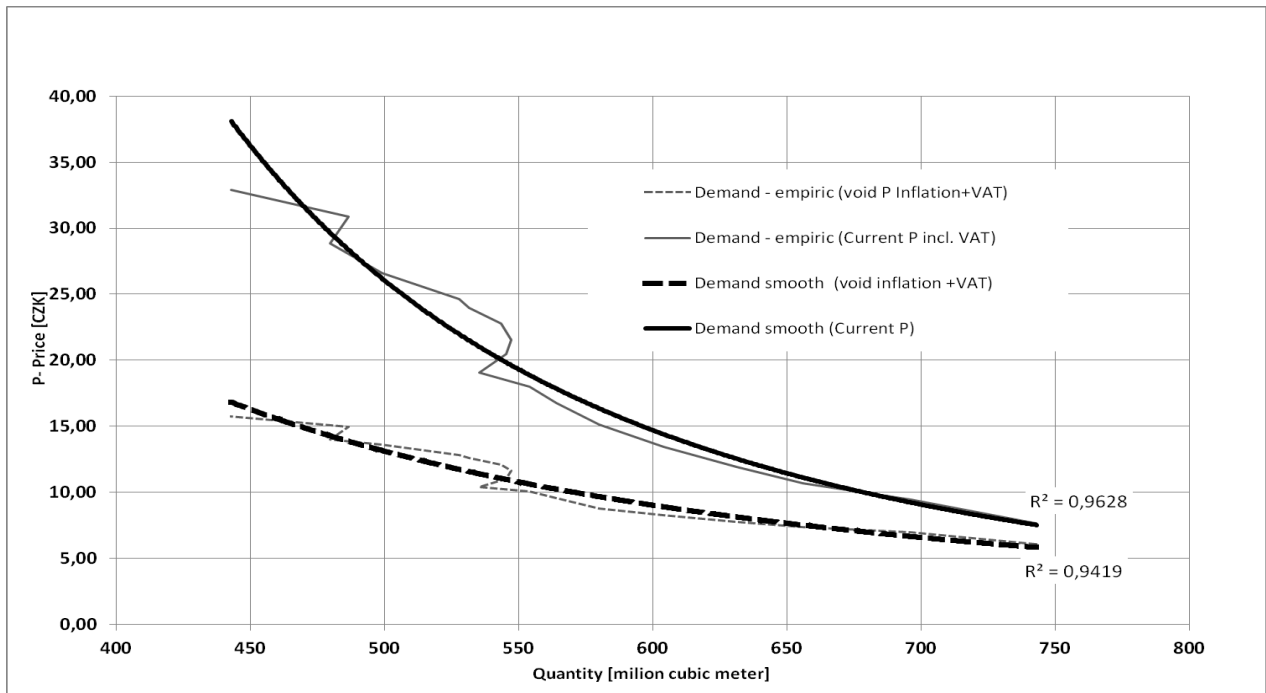


FIGURE 1: DRINKING WATER DEMAND IN THE CZECH REPUBLIC.

The presented results are based on the use of „family bills“. Calculations made concurrently with the statistics of the „living conditions“ show somewhat different results. The differences between the calculations of weighted average prices of water and sewage tariffs according to CZSO [7] and MoA [13] data are small, and do not affect the overall picture of the results. The tested effect of changes in the VAT rate (which in the mind of consumers is unaffordable part of the monthly water

„bill“) also did not show up markedly. A significant discrepancy can be considered the comparison of recalculated specific consumptions of drinking water per person with the average statistically recorded and reported volume of billed water per supplied (connected) consumer. It requires additional comparison, however, the overall picture and the tendency of social stratification of drinking water consumption in the Czech Republic remains virtually unchanged.

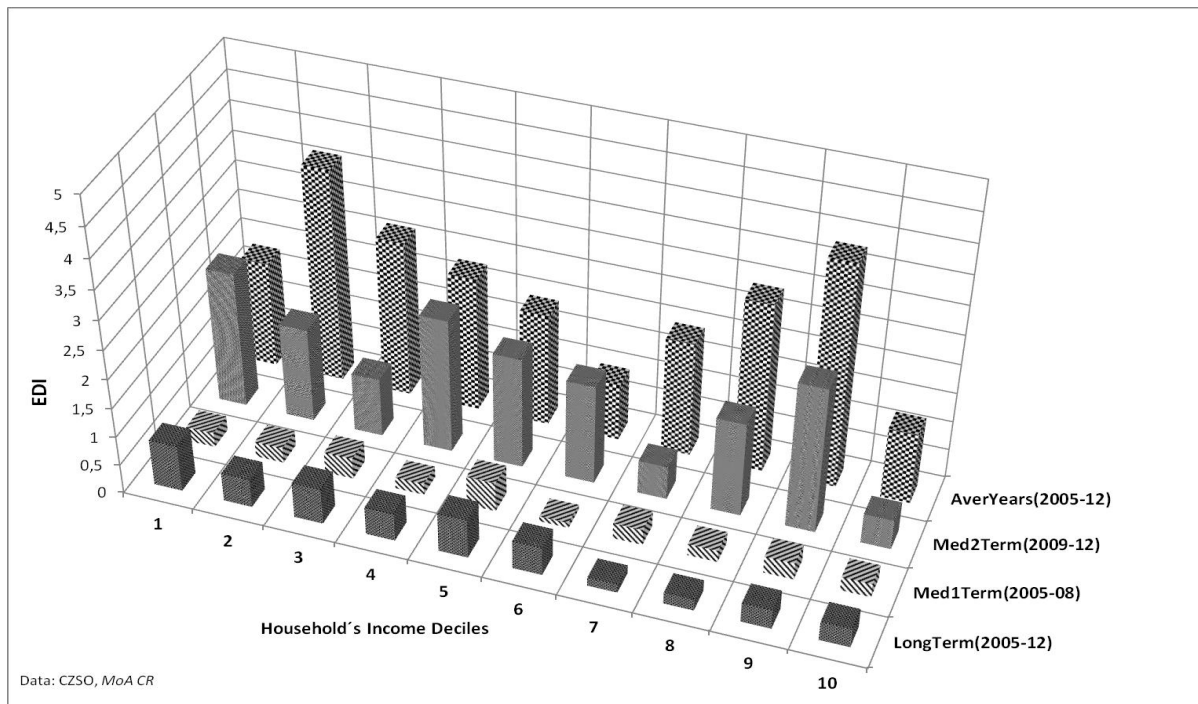


FIGURE 2: AGGREGATE DEMAND INCOME ELASTICITY IN THE CZECH REPUBLIC.

Ad a) The behaviour of consumer of drinking water in the Czech Republic corresponds to theoretical

assumptions. It confirms the so far prevailing influence of economic behaviour, prices and financial parameters of

households on this situation (compared to social, health, etc.). The results will not suffice as evidence for the (theoretical) economic methods to identify the characteristics of demand. The demand curve can be constructed using empirical data of price development, using current prices, or using prices net of inflation and value added tax. Connection by the best correlation (in relation to reliability) gives smooth curves corresponding to the theoretical course of demand.

Ad b) The demand for drinking water in most of the monitored situations in „households“ (70 points, characterized by the parameter of income elasticity) shows two different types of behaviour depending on the period: rather inelastic demand (< 1) and rather elastic demand (> 1) (Fig. 1). Short-term (annual) elasticity („AverYears“) is on average higher than medium-term („Med, 2 Term“) and long-term elasticity („LongTerm“). Medium-term elasticity in the second 4-year period is higher (see Fig. 2). While the long-term elasticity confirms the character of drinking water as the necessity (less dependent on conditions), the evident difference in income deciles can be interpreted with caution as a more significant link between demand and income in lower income groups. The increasing sensitivity of consumption

definition of demand as part of the „water market“, but confirm the effectiveness of the application of general to income in the second (later) 4-years period can be considered as an indicator of the growing importance of water services within the framework of housing. It is also interesting to compare two medium-term periods, of which the later falls in conditions of economic crisis.

Ad c) The determination of „affordability“ of water bills in the Czech Republic [14] shows the stratification by income as well as a certain time development. (Tab. 1) The results derived from „water“ bills suggest that the problem of „water poverty“, – in the definition mentioned above [15], [16] covertly occurs in about a third of households throughout the monitored period. Evident is the increase of the problematic group to reach as much as 25% in the years affected by the decline of economic growth. Should we choose the „transient“ critical range of between 2.5 and 3% of water expenditure of net household income, then there appears the trend of distancing the two halves of the population from each other, of which the first shows the increasing problem of price affordability, while in the latter this problem is moving away.

TABLE 1: DRINKING WATER AND SEWAGE BILLS IN NET HOUSEHOLD'S BUDGET

Income deciles	Water poverty									CZ
	1	2	3	4	5	6	7	8	9	
2005	3,19%	5,07%	3,46%	2,93%	2,75%	2,55%	2,17%	2,15%	1,94%	1,33%
2006	3,40%	4,51%	3,31%	2,98%	2,54%	2,30%	2,17%	2,13%	1,80%	1,24%
2007	3,33%	3,78%	3,44%	2,81%	2,63%	2,23%	2,20%	2,02%	1,67%	1,35%
2008	3,10%	3,75%	3,18%	2,66%	2,61%	2,18%	2,18%	1,91%	1,67%	1,03%
2009	3,48%	3,64%	3,00%	2,63%	2,55%	2,12%	2,16%	1,91%	1,67%	1,14%
2010	3,54%	4,14%	3,26%	3,02%	2,28%	2,22%	2,30%	1,83%	1,77%	1,28%
2011	4,18%	4,01%	3,45%	3,26%	2,45%	2,11%	2,10%	2,01%	1,83%	1,30%
2012	3,69%	3,80%	4,03%	3,06%	2,74%	2,40%	2,18%	2,28%	1,73%	1,23%

V. CONCLUSION

Based on the results of the investigation it is clear that the current and the most important aspect of sustainable management of water supply and sanitation enterprises is decreasing consumption, which has a negative impact on economic and social areas. This is also associated with the method of price regulation by the government, since it supports these negative tendencies.

The investigation was based on structured statistical series of Household Budget Survey (incl. water services payments) and parallel statistics on household consumption of drinking water, water and sewage tariffs in the Czech Republic in 2005-2012 and confirmed the possibility and effectiveness of economic methods, derived from the theory of consumer behaviour by investigating the behaviour of drinking water demand. It allowed to identify a social relief of drinking water consumption, which indicates, as expected, a negative correlation between price and volume of consumption (with growth decreases) and a positive correlation between consumption and household income (increases with increasing income). The long-time income elasticity ranges mainly in the zone of inelastic demand (less than 1 - consumption responds to changes in income reluctantly). The response is higher in the first, compared to the

second monitored 4-years period. Further research may confirm, inter alia, the effectiveness of social modification of the price tool – water tariff in the form of block rates [5] or warn against optimism in „recovery“ of drinking water demand by pricing manipulations.

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