

A model to assess water tariffs as part of water demand management

JJ Hoffman* and JA du Plessis

Stellenbosch University, Department of Civil Engineering, P/Bag X1, MATIELAND, 7602, South Africa

Abstract

Water Conservation and Water Demand Management (WC/WDM) forms part of integrated water resource management and can be used as an economically viable alternative to the upgrade of infrastructure to balance supply and demand. In order to enable effective decision-making, a model was developed in this study to estimate expected water savings and the financial impact of a change in water tariff as a WC/WDM measure. This paper describes a model that was developed for municipalities to calculate the predicted change in water use and the associated income. The model takes into account variation in price elasticity per tariff block. The effectiveness of the model as a planning tool is illustrated through an appropriate example.

Keywords: water demand management, price elasticity, change in water tariff, block tariff, WC/WDM model

INTRODUCTION

Limited water supplies and increasing water demands mean that the effective management of water resources has become much more important now than in the past. The implementation of WC/WDM projects is usually used as a crisis management tool to reduce immediate water shortage and to allow time for the planning and construction of infrastructure to increase water supply. In the current economic climate, it is however important to incorporate WC/WDM into integrated water resource management and to evaluate WC/WDM as an economically viable option.

Different models (e.g. as presented by Hoffman, 2011) are available to evaluate WC/WDM options. Some of these models focus on the economic evaluation of WC/WDM options while others estimate the impact that the implementation of different WC/WDM options have had or will have on water consumption. Economic evaluation models include aspects such as the deferral of capital, economic sustainability and calculation of unit reference values (URV), while the implementation models have focused on the impact WC/WDM projects such as meter replacement (Noss et al., 1987), pressure management and leak detection have had or will have on water consumption and income.

Jansen and Schulz (2006) focused on the evaluation of the factors influencing WC/WDM, i.e., climate, revenue and pricing. Regression analysis was done on the impacts thereof and price elasticity was calculated based on these values. No attempt was however made to quantify the economic impact a change in a block water tariff has on price elasticity. Nataraj and Hanemann (2011) analysed the impact of the introduction of a third price block on residential water consumption in Santa Cruz, and concluded that consumers who expected to face

the higher marginal price in the 3rd block would reduce their consumption.

This paper presents a novel, robust WC/WDM model that was developed to estimate the change in consumption as well as the expected revenue due to a change in water tariff. The model takes into account a block tariff structure and incorporates the possibility that consumers will react differently to tariff increases depending on their current consumption patterns. In their study, Klaiber et al. (2013) presented a similar estimation of water consumption with a 2-block pricing structure incorporating monthly and seasonal variations. Data related to all of the variations in their model are not necessarily available from relatively small South African municipalities. The model presented in this paper was however developed for a 6-block pricing structure and allows for limited available input data from municipalities. An example was used to illustrate the impact of a change of water tariff on consumption as well as the associated revenue for municipalities.

Changing the water tariff

The relationship between the cost of water and consumption is described as price elasticity. Price elasticity can be illustrated with the use of a combination of different graphs, presented in Figs. 1 to 3. The relationship in its simplest form can be presented as a linear relationship – consumption (Q) linearly decreases as the price of water (P) increases. The relationship may also be represented by an arc illustrated in Fig. 2 (Veck and Bill, 2000). In this representation, the consumption gradually decreases as the price increases.

Stephenson (1999) suggested that the best way to represent the relationship is by 3 well-defined regions, presented in Fig. 3. This graph consists of an elastic zone and 2 inelastic zones. In the elastic zone, it is very easy for the consumer to adjust their consumption. As the cost decreases, the consumption increases. Subsequently, as the cost increases, it becomes harder to reduce consumption at the same rate as before and, thus, the inelastic zone results. There is however a minimum required consumption for each consumer. The relationship thus

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* To whom all correspondence should be addressed.

☎ +27 21 808-4358; e-mail: hoffmann@sun.ac.za