# A COMPARATIVE STUDY FOR THE VARIABLES AFFECTING MUNICIPAL WATER DEMAND

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## ABSTRACT

In this study a real case is used in order to evaluate the effect of the factors controlling the residential water demand in one of the suburb of the state of Kuwait. The important of this study comes from the fact that our case study has at the same time two kinds of residential areas in which one of them contains complete and modern water and sewage networks, while the other is lacking this surface.

Therefore an evaluation of the effect of the availability of water and sewage networks on residential water demand is made by making a comparison studies between two different residential areas. These two residential areas have the same controlling factors for water demands, such as economical conditions, climatical conditions, standard of living, and social life.

The method presented is based on a sensitivity analysis of the effect of the availability of water and sewage networks on the per capita daily water demand compared to water demand at the other part of our residential area with no water and sewage networks. The analysis of data from both residential areas showed a greater water demands for all houses that located at the part of no availability of water and sewage networks which is in contrast with assumption that the demand for water will increase with water and sewage networks.

**Keywords:** water demand, residential water, factors affecting water demands

## INTRODUCTION

The efficient performance of water resources projects depends largely on the accuracy of future water demands, which in turns depends on the evaluation of the factors affecting water consumption rates in the city. There are many important factors playing an important role in the in the estimation of the per capita water consumption rates in the city. These include climatic conditions, economical conditions geographical locations, composition of the community and the existence of water and wastewater pipe networks system with installed water meters.

Empirical studies of the response of the residential water demand to some important controlling factors have frequently faced some problems of finding the real effect of these factors on water demands. These problems usually are presented due to the dependency of these studies on simplified assumptions that might be far from the real case.

However most cited studies dealing with residential water demand focused on the water price and the income of the area residents as the main factors affecting water demand. Whitford (1970) has developed a forecasting model based on the use of a formal decision tree to include some of the important controlling factors. Saunders and Warford's study (1976) determined the most important variables affecting municipal water demand in some metropolitan areas. Narayanan, *et al.,* (1987) examined the feasibility of seasonal water pricing considering metering costs.

## RESEARCH OBJECTIVE

In this study an evaluation of the effect of the availability of water supply networks with installed meters and sewers is conducted by making a comparison study between two existing residential areas in one of Kuwait suburb called Sabah AL-Naser located about 25 Km from Kuwait city . This modern residential area is an excellent typical type for applying this study, since it gives the opportunity to evaluate the effect of water and sewage networks system on the municipal water consumption rates, particularly the household water consumption rates.

The other important controlling factors affecting residential water consumption rates are considered to have the same effect on both residential areas. We considered these factors such as climatic conditions, economical conditions, standard of living, habits and traditions, to have the same effect on both residential areas.

This study benefit from the real case available from these residential areas, since one part of this residential area ( part A) covered with a complete modern water and sewage networks, while the other part ( part B) lack this surface for the time being.

## RESEARCH HYPOTHESES

It was hypothesized that the availability of water and sewage networks in the city will increase the daily per capita consumption rate.

The only important factor that will have an essential effect on this study is the factor of water and sewage networks system, since in this study one part of our suburb residential area (Part A) has complete ideal water and sewage network system, while in the other part this network is not available.

## METHODOLOGY AND DATA COLLECTION

In this study an evaluation of the relationship between household consumption rates and the effect of water and sewage networks is examined. This examination is made by comparing two sets of data collected from two different residential areas.

However data collected from residential area with water and sewage networks (Part A) are made by day to day direct water meter reading for about one hundred twenty individual house.

The other part of this residential area with no water and sewage networks (Part B) is getting its water by tankers from water filling stations, and also transporting its wastewater by tankers as needed.

In addition a sample of about one hundred twenty houses is taken, and each house daily water consumption rates are estimated depending on the size of tankers, the frequent of water supply to these houses, and the volume of tanks placed over each house.

## COMPARISONS

The comparisons are made as follows:

- A comparison between houses in both residential areas which have same area.
- A comparison between houses in both residential areas that have same number of people living in.
- A comparison of the daily per capita consumption rates.

A time series data for average water consumption daily rates are recorded based on total monthly records taken from house water meters as shown in Table 1.

In the other hand a monthly bills of water supply by water tankers in houses in part B of the residential area are taken to estimate average water daily consumption rates in Table 1.
In part A of our study area we grouped the houses into three groups depending on the area of the house hold, and the number of people living in as follows.

1. 40 houses with a 750 squared meters area with an average of 12 habitants.
2. 40 houses with a 600 squared meters area with an average of 10 habitants.
3. 40 houses with a 500 squared meters area with an average of 8 habitants.

The houses in this part of our study area are two levels with basement type. The numbers of persons living in these houses are varied; there are small variations of number of people living in these houses with an average of 10 persons in the house.

In the other hand we have selected a one hundred twenty family houses located in part B of our case study area. These houses are selected to have the same number, the same

area, and the same number of people living in compared with part A of our case study. A time period of one year has been selected to follow up each consumption rate on monthly basis, started on June 1st 2003 to 31st of May 2004, a full record of water meters reading has been recorded and evaluated for each month in order to estimate the daily per capita consumption rates.

For part B of our case study area in which there are no availability of water and wastewater networks, an estimation of water consumption for each house has been conducted based on size of filling tankers, amount of water these tankers supply each day to these houses, and the volume of tanks located on the top of each house, then estimating the per capita consumption rate by dividing the amount of water by the number of people living in each house.

All the houses selected for our study in part B of our case study are getting water from tankers according to contracts that guarantee steady water supply for each house every day on a monthly payments.

It is worth able to mention that all the residents of selected houses are Kuwait national families, and the houses are owned not rented.

**Table 1. Water demand in each area of our study (gallons per capita per day)**

| Area of house ($m^2$) | Residential area (Part A) Gallons per capita per day | Residential Area (Part B) Gallons per capita per day |
|---|---|---|
| 500.00 | 108 | 133 |
| 600.00 | 92 | 115 |
| 750.00 | 104 | 125 |

## RESULTS AND DISCUSSION

By comparing the results found for similar houses in both of our study areas (A&B), we found that the average per capita consumption rate for all the daily average per capita water demand in area A is less than those of area B , for all these groups of houses we have selected for the study.

We have found that the average capita water demand for the houses of 500 squared metered is 108 gallons per capita per day (gpcd) for area A, while the daily average per capita consumption rate in houses of the similar area and number of habitants is about 133 gallons per capita per day (gpcd) in part B of our study area.

Also we have found a lower water demand for houses of 600 squared meters area in part A of our study area than those in part B of the same area and number of habitants. These are found to be 92 gallons per capita per day (gpcd) for part A houses and 115 (gpcd) for part B houses.

In addition we have found a greater water demand in houses of 750 squared meters in part B of our case study compared to the houses of the same area and number of people in part A of our case study. There are 125 (gpcd) for houses in part B and 104 (gpcd) for houses in part A of our study.

In general we have found a greater water demand for all houses in part B of our study area, in which there is no available water and waste water networks for all the area compared with part A of our case study.

## CONCLUSIONS

The conclusion of this study is in a contrast with the hypothesis, that an increase of water demand with the existing of water and waste water networks is a must. In other word it is always assumed that the existing of water and waste water networks for a city will result in an increase of water demand and consumption rates.

We are expecting our result will support this hypothesis of the relation between water demand and the availability of water and waste water networks, which is happened not to be the case. Since our findings do not support this hypothesis we must discuss these results in more details to focus on the reasons of these differences.

**1-** Although both our case studies A and B have similar conditions of the most affecting factors that control water demand, such as weather, standard of living, and water pricing, there are some differences that may affect the results, other than the existence and non existence of water and wastewater networks.

**2-** The water pricing is very low which will have no effect in this study for both areas, since the people in these areas with high income rates will not care about this water low pricing.

**3-** The houses in part B of our case study are new and more modernized compared with houses in part A of our case study , which may result in an increase in water for houses in this part of area.
This increase may come from new water consuming devices in these houses, and the more in-suit bedrooms which are preferred in these days.

**4-** It is found that most of the people living in the new area part B of our case study are young couples families compared with the families living in part A of our case study.

**5-** It is found from this study that the daily per capita water consumption rates in this suburban residential area are very close to the national per capita daily consumption rates (Ministry of Water and Electricity Statistical Annual Year Book, 2004).

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