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# An Analysis of Residential Demand for Water: A Case Study of the City of Basrah

**Adnan A. Al-Samawi and Jawad S. Hassan**

*Civil Engineering Department, University of Basrah, Basrah, Iraq*

ABSTRACT. Stepwise regression procedure is used to estimate residential water demand in each house as a function of number of fitments, number of occupants, area lot price, and tap water pressure using cross-sectionally metered readings from 50 households in Basrah, Iraq, between January, 1977 and February, 1978. A methodological approach is used that provides unbiased estimate of parameters and standard errors. Demand relations are estimated for total residential, summer, winter, and sprinkling demands. Sprinkling use per day per customer for a year is estimated by subtracting winter consumption from summer consumption.

The number of fitments per dwelling variable explained the largest proportion of the variation in the data in all demand models. Results are reported herein.

The variations in water consumption depend upon a number of important factors. Knowledge of the impact of such factors on water consumption is vital for proper management and design of waterworks.

Several investigators have examined some factors thought to affect residential water demand over time (*e.g.* water price, family income, climate, ...). Most have relied upon multiple regression analysis on data sampled cross-sectionally (Howe and Linaweaver 1967, Morgan 1973, Morgan and Smolen 1976, Boland *et al.* 1980, and Young *et al.* 1983) or data sampled as a time series (Wong 1972, Danielson 1979, Hansen and Narayanan 1981, Maidment and Parzen 1984, and Abdul-Majeed 1985).

The purpose of this study was to identify and quantify the factors affecting water consumption at house level in the city of Basrah.

## The Study Area

The data for this analysis were collected by the British consultants Humphries and Brown, H&B (1979) from a household survey of 200 dwellings chosen randomly from throughout the city of Basrah in southern Iraq. The survey was conducted between Jan. 1977 and Feb. 1978. However, their statistical analysis, which utilized all the data, were confined mainly to simple statistics (descriptive statistics and simple measures of location and variations) to study the inadequate state of water supplies in Basrah.

Basrah, which is the second largest city in Iraq, is located on the southern bank of the Shatt Al-Arab approximately 90 km from the Arabian Gulf and 550 km south east of Baghdad. Its climatic conditions are as follows:

| | |
|---|---|
| Minimum winter climatic conditions | 0°C |
| Maximum summer climatic conditions | 57°C dry bulb |
| | 24°C wet bulb |
| Average range for outdoor summer daily temperature | 19°C dry bulb |

The data were collected cross-sectionally over six-time periods of approximately two months each. The data consist of metered water consumption recorded together with information on the number of fitments in each house, number of persons per house (household size), area of each house, and tap water pressure inside the house.

Upon inspecting the H&B survey sheets, some irregularities were observed, such as the tap water pressure of some of the houses were zero, the number of fitments and the metered water consumption for some of the houses were missing during some periods, and the winter water consumption of 75 households were found to be higher than their summer consumption.

To make these data reflect the response of residential water consumption to some influencing factors, when the water supply system is considered to operate under adequate conditions of supplies and pressure, the following restrictions were applied in the selection procedure:

(a) All data from houses with tap water pressure less than 4.2 m were deleted. For the single-story houses which predominate in Basrah, 4.2 m may be considered adequate mains pressure. The reason for rejecting such data is because conclusions drawn from these data do not reflect the true behaviour of the customers in Basrah. This is based on the work of Twort *et al.* (1974) who stated that "where existing supplies are inadequate, then some consumers will be starved of water by inadequate pressure in the mains; hence their peak recorded consumption (by meter) may be no indication of what they would take if the pressure were adequate".

(b) All houses with the irregularities mentioned above were not included in the sample to be analyzed in this study. As a result of applying those sampling restrictions, the records of only 50 houses were available for our analysis. Since the original H&B data were chosen randomly and since our sampling restrictions were applied to all H&B data, therefore the filtered data were also considered to be random.

## Empirical Results

Demand for water was hypothesized to vary by season. Four different residential water demand models were constructed for total residential, summer, winter, and sprinkling. Ordinary least squares regression method was used to estimate empirically a residential water demand equation for each model as well as to ascertain the separate contribution of each independent variable introduced in the models to each of the water demands mentioned above.

Generally, in our analysis demand for water is hypothesized to be a function of the number of fitments per dwelling unit, the number of occupants actually living in each house, the area of the house, the lot price of each house, and the tap water pressure in the house variables.

The number of fitments which are introduced in total residential demand and summer demand models include the number of toilets, washbasins, showers, aircoolers, and washing machines; while the fitments, which are used in winter demand model, consist of all these fitments excluding the number of aircoolers. These fitments are denoted as winter fitments. On the other hand sprinkling fitments, which are introduced in the model of sprinkling demand, include aircoolers only.

Table 1 shows the areas of the different house categories as classified by H&B (1979).

**Table 1.** House categories area

| Category of housing | Area ($m^2$) |
|---|---|
| 1 | less than 100 |
| 2 | 100 – 200 |
| 3 | 200 – 300 |
| 4 | 300 and over |

House category number 1 was excluded from our analysis because of the irregularities in water consumption which were mentioned earlier. Consequently, only three house categories were left for this study. Two area dummy variables (or binary variables) which take values of 0 or 1, were needed in our analysis because the actual areas per dwellings were not available.

Lot price was calculated in Iraqi Dinar (ID) per $m^2$ of dwelling unit as obtained from Basrah Land Office by the authors. Lot price is used as a proxy for household income in this study. Other investigators used appraised house and lot value of the residential customer as a proxy for income (Howe and Linaweaver 1967, Wong 1972, Danielson 1979, and Young *et al.* 1983).

Tap water pressure, which is used in our analysis, ranged from 4.2 to 17.6 m. These pressures may be considered adequate or quasi-adequate and may reflect the true habits of consumers in the Basrah region.

The water price was not introduced in our analysis because it did not change during the period of the survey. In Basrah, water costs are charged directly to consumers.

Theoretically, two problems may exist in the estimated model of each demand. First is the existance of heteroscedasticity in the error terms, and the second is multicollinearity. Al-Ani (1977) used the double log transformation of data to remove heteroscedasticity. One test for multicollinearity is the Klein test (1962) which is used for this study because this test is sufficient to detect any serious multicollinearity that might exist between the explanatory variables involved in the model. The test simply states that if R (the square root of the coefficient of multiple determination) is greater than or equal to $r_{ij}$ (the simple correlation coefficient between any two independent variables (i and j) multicollinearity is not harmful.

*Total Residential Demand*

Total residential demand for water is defined as the total quantity of water consumed daily for all residential purposes taken over one year. It includes water used for in-house purposes and for outside purposes (Danielson 1979).

Total residential demand of Basrah during the surveyed period (Jan. 1977 to Feb. 1978) ranged from 349 to 3121 liter/household/day (1hd) with a mean of $\overline{Y}_T =$ 906 1hd and a standard deviation of $\sigma_{Y_T} = 555$ 1hd. Figure 1 shows the distribution of the per household total residential demand. From this figure, it is seen that 90% of the households consumed water less than 1460 1hd, or water consumption of 98% of the households was less than 2570 1hd and so on.

The model for total residential demand is written as a function of those variables affecting both in-house and sprinkling demands. In notational form the model is summarized as,

$$Y_T = f_T, (X_1, X_4, D_1, D_2, X_5, X_6) \quad \ldots. \quad (1)$$

where:

$Y_T$ = the average daily water consumption per household (1hd),
$X_1$ = the number of total fitments per dwelling unit,
$X_4$ = the number of occupants per house,
$D_1$ = 1 for area of the house category 3, and
0 for area of the house categories 2 and 4;
$D_2$ = 1 for area of the house category 4, and
0 for area of the house categories 2 and 3;
$X_5$ = the lot price of each dwelling unit,
$X_6$ = the tap water pressure in each house.

The means and the standard deviations of the explanatory variables which were defined earlier are shown in Table 2.

**Table 2.** Means and standard deviations of the explanatory variables (in linear form)

| Variable | Mean | Standard deviation |
|---|---|---|
| Total fitments | 9.70 | 2.11 |
| Winter fitments | 8.28 | 1.79 |
| Sprinkling fitments | 1.42 | 0.50 |
| No. of occupants | 6.60 | 1.51 |
| Lot price ($ID/m^2$) | 55.30 | 18.19 |
| Tap water pressure (m) | 9.01 | 4.92 |

From this Table it is found that the average household size is 6.6 persons. This is almost similar to the figure reported for the city of Riyadh in neighbouring Saudi Arabia (Shammas 1984), but higher than that reported for north American cities (Danielson 1979). The average daily water consumption in Basrah is estimated at 137 liter/capita/day (lcd). This is rather low when compared with cities in neighbouring countries. For example, average daily water consumption for the city of Riyadh (in 1978) was put at 200 lcd, while that for the city of Kuwait (in 1978) was reported to be 265.5 lcd (Shammas 1984 and Ministry of Electricity and Water, Kuwait 1983).

In the United States, Danielson (1979) reported an average daily water consumption of about 245 lcd for the city of Raleigh, North Carolina.

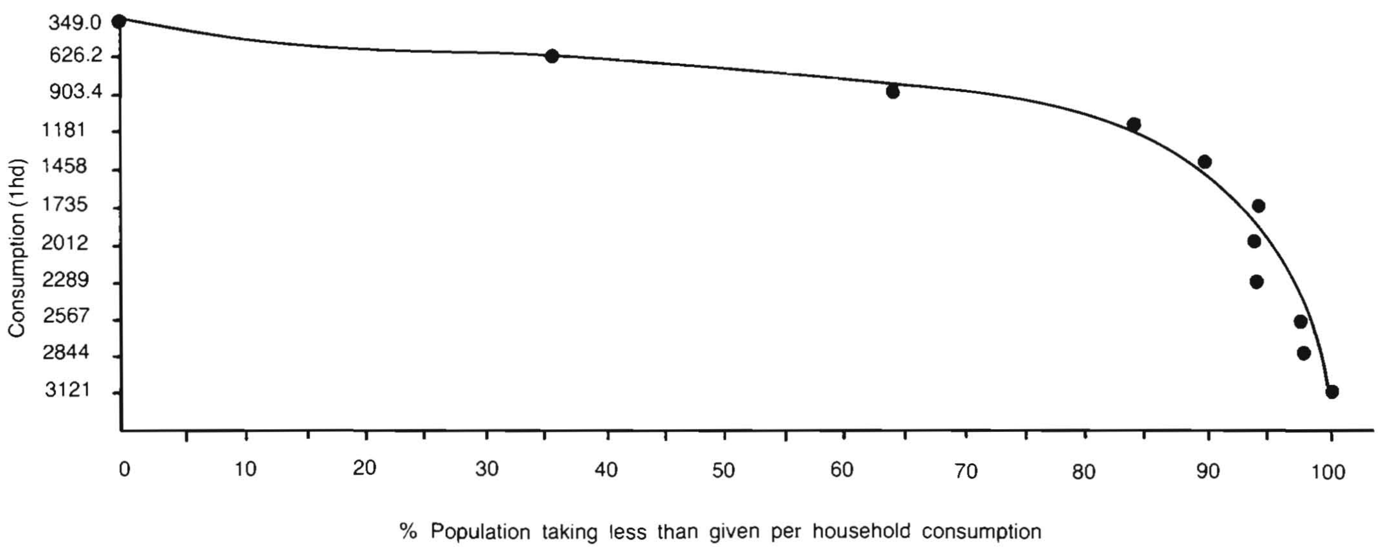


**Fig. 1.** Distribution of the per household total residential demand.

To estimate the coefficients of (1), the cross-sectional data of the study were fitted to,

$$Y_i = \alpha_o + \sum_{k=1}^{6} \alpha_k X_{i,k} + \sum_{j=1}^{2} \beta_j D_{i,j} + \varepsilon_i \qquad \ldots (2)$$

where:

i = 1, 2, ..., 50 denotes households; $\varepsilon_i$ refer to the observed error term for customer i; $\alpha_o$ = intercept; $\alpha_k$ and $\beta_j$ = regression coefficients.

Since there was no a priori basis for selecting the functional form for the analysis, linear, semilog, and double log forms were included. The double log form has been chosen because it reduces heteroscedasticity, it fits the data well (it has the highest $R^2$), and it is not difficult to interpret the coefficients as constant elasticities. The serial correlation was checked on the basis of evidence provided by the Durbin-Watson ratio test (test statistics were calculated separately for each demand model). This ratio was improved in the double log form and it fluctuated around 2 which is a proof of the randomness of the residuals.

Results of stepwise regression analysis are shown in Table 3 for total residential demand.

The number of fitments consistently explained more variation in household demand than did any other variable. Only the fitments variable was found to be highly significant for this demand model, while the remaining variables did not seem to have any significant impact on total residential demand. The coefficient of the number of fitments was estimated to be 1.375 which means that on the average a unit increase in the number of fitments per dwelling (10%) is associated with an increase in total water consumption of 14% which is equivalent to 127 lhd based on the data of 1977.

*Summer Demand*

Summer demand for water is defined here as the demand for the period roughly from the middle of March to the middle of October. Summer demand is hypothesized to be equal to the in-house demand plus outside (sprinkling) demand through the given period. For the city of Basrah, summer demand ranged from 414 to 4919 lhd during the surveyed period with a mean of $\overline{Y}_{SM}$ = 1186 lhd and a standard deviation of $\sigma_{Y_{SM}}$ = 851 lhd. The average per capita summer consumption was approximately 180 lcd.

In the United States, average summer consumption was reported to be 640 lcd (Hammer 1977), which is more than 3 times the average summer consumption of Basrah.

The average daily use in the summer is 31% higher than the annual daily average which is similar to that reported for the United States by Linsley and Franzini (1979) and Hammer (1977).

The variables hypothesized to influence summer demand were the same variables affecting total residential demand. In symbolic notation, the postulated domestic summer water consumption function is of the form:

$$Y_{SM} = f_{SM}(X_1, X_4, D_1, D_2, X_5, X_6) \quad \ldots\ldots \quad (3)$$

where:

$Y_{SM}$ denotes the average daily summer water consumption per household (lhd), and the explanatory variables are as defined in (1).

Using stepwise regression procedure, the estimated parameters of the summer demand model are shown in Table 3. Again only the fitments variable was found to be highly significant. Number of fitments elasticity was 1.412 which is nearly identical to the coefficient estimated for total residential demand.

*Winter Demand*

Winter demand is defined here as the demand for water roughly from the middle of October to the middle of March when outside use of water is expected to be almost zero. Spring and autumn seasons are very short (about two to three weeks each) in Basrah, consequently they are not considered as independent seasons. Winter demand is assumed to be identical to in-house demand and is used interchangeably (Danielson 1979).

Winter demand for water in the city of Basrah during the surveyed period ranged from 233 to 1433 lhd with a mean of $\bar{Y}_W = 580$ lhd and a standard deviation of $\sigma_{Y_W} = 291$ lhd. The per capita average daily winter consumption was about 88 lcd.

In the United States, average daily winter consumption of water was reported to be 380 lcd (Hammer 1977) which is 4 times more than the average winter consumption of Basrah.

The average daily winter consumption was found to be 36% lower than the annual daily average which is lower than that reported for United States by Linsley and Franzini (1979), and Hammer (1977).

Variables, hypothesized to influence winter demand, are the number of winter fitments, the number of occupants, the area dummies, the lot price, and the tap water pressure for each dwelling unit. The model of winter demand for water is written as,

**Table 3.** Residential demand parameters of regression analysis, double - log form

| Parameters | Intercept | Number of fitments | Lot price | Tap water pressure | Multiple R | SE | Durbin - watson ratio | F - value |
|---|---|---|---|---|---|---|---|---|
| Total residential demand | 3.590 | 1.375** (0.253) | | | 0.617 | 0.383 | 1.624 | 29.570** |
| Summer demand | 3.744 | 1.412** (0.282) | | | 0.585 | 0.427 | 1.741 | 25.005** |
| Winter demand | 5.352 | 1.237** (0.257) | −0.426** (0.167) | | 0.602 | 0.387 | 1.828 | 13.384** |
| Sprinkling demand | 4.969 | 0.666* (0.328) | | 0.415* (0.219) | 0.392 | 0.786 | 2.201 | 4.272* |

* Significant at 0.05 significance level;
** Highly significant at 0.01 significance level;
The numbers in parantheses are the standard errors of estimate of the regression coefficients;
SE refers to the standard error of estimate of the multiple regression equation; F-valuc is the variance - ratio.

$$Y_W = f_W (X_2, X_4, D_1, D_2, X_5, X_6) \quad ..... \quad (4)$$

where:

$Y_W$ = the average daily winter water consumption per household (lhd),
$X_2$ = the number of winter fitments per house, and the remaining variables are as defined in (1).

Results of stepwise regression analysis are shown in Table 3 for winter demand. Only the number of fitments and the lot price variables were found to be highly significant. Using the Klein test, multicollinearity was found to be not harmful. Number of fitments elasticity was estimated to be 1.237. Therefore, on the average a unit increase in the number of winter fitments per house (12%) is associated with an increase in winter consumption of nearly 15% which is equivalent to 87 lhd based on the data of 1977.

The lot price variable was found to be negatively correlated with the winter demand. This may be interpreted as follows: The negative correlation between number of occupants per dwelling and lot price (surragate for income) variables (see Table 4) on one hand and the positive correlation between number of occupants per house and winter consumption variables on the other meant that houses with high income have fewer number of people and *vice versa*. Assuming that water consumption per capita in the study area remained fairly uniform during the survey period, then it is expected that houses with high lot prices (fewer people) consume less water than houses with low lot prices and *vice versa*. Similar results were reported by Morgan (1973).

The lot price elasticity was equal to −0.426. A 10% decrease in the lot price per house (5.530 ID/$m^2$) is associated with an increase in winter consumption of 4.3% or nearly 25 lhd based on the data of 1977.

*Sprinkling Demand*

The difference between the summer and the winter demands is termed as sprinkling or seasonal demand in our analysis. Thus, the sprinkling demand represents the outdoor water use, since the summer demand represents the total residential water consumption while the winter consumption is hypothesized to be identical to the summer in-door use (Morgan and Smolen 1976, Danielson 1979, and Boland *et al.* 1980). The term sprinkling should not be interpreted literally as the water used for lawn irrigation but as defined above.

Sprinkling use of water in Basrah during the surveyed period ranged from 52 to 3897 lhd with a mean of $\overline{Y}_S = 606$ lhd and a standard deviation of $\sigma_{Y_S} = 699$ lhd. The per capita average daily sprinkling use was found to be 92 lcd.

**Table 4.** Simple correlation coefficient matrix for the variables (in natural logs)

| | Total fitments | Winter fitments | Sprinkling fitments | Number of occupants | $D_1$ (Area Dummies) | $D_2$ (Area Dummies) | Lot price | Tap water pressure | Total residential demand | Summer demand | Winter demand | Sprinkling demand |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total fitments | 1.000 | | | | | | | | | | | |
| Winter fitments | | 1.000 | | | | | | | | | | |
| Sprinkling fitments | | | 1.000 | | | | | | | | | |
| Number of occupants | 0.390 | 0.377 | 0.292 | 1.000 | | | | | | | | |
| $D_1$ Area dummies | −0.072 | −0.101 | 0.033 | −0.088 | 1.000 | | | | | | | |
| $D_2$ Area dummies | 0.176 | 0.202 | 0.037 | −0.168 | −0.650 | 1.000 | | | | | | |
| Lot price | 0.113 | 0.135 | 0.004 | −0.377 | −0.003 | 0.468 | 1.000 | | | | | |
| Tap water pressure | 0.239 | 0.261 | 0.097 | −0.326 | −0.345 | 0.835 | 0.622 | 1.000 | | | | |
| Total residential demand | 0.617 | | | 0.282 | 0.020 | 0.014 | −0.077 | 0.042 | 1.000 | | | |
| Summer demand | 0.585 | | | 0.210 | 0.025 | 0.060 | −0.012 | 0.109 | | 1.000 | | |
| Winter demand | | 0.524 | | 0.398 | 0.005 | −0.105 | −0.223 | −0.143 | | | 1.000 | |
| Sprinkling demand | | | 0.298 | −0.095 | 0.052 | 0.194 | 0.189 | 0.282 | | | | 1.000 |

In the United States, average daily sprinkling use was reported to be 260 lcd (Hammer 1977) which is 2.5 times more than the average daily sprinkling demand of Basrah. The average daily sprinkling use was found to be 51% of the summer daily average.

Sprinkling demand was hypothesized to be a function of number of sprinkling fitments, number of occupants, area dummies, lot price, and tap water pressure. The model for sprinkling demand took the following form:

$$Y_S = f_S\,(X_3, X_4, D_1, D_2, X_5, X_6) \qquad \ldots\ldots \quad (5)$$

where:

$Y_S$ = the average daily sprinkling water use per household (lhd),

$X_3$ = the number of sprinkling fitments, and the rest of the variables are as defined in (1).

Results of stepwise regression analysis are shown in Table 3 for sprinkling demand. Only the number of fitments and tap water pressure variables were found to be significant, while the remaining variables did not seem to have any significant impact on sprinkling water use. Using the Klein test, multicollinearity was found to be not harmful.

Number of fitments elasticity was estimated to be 0.666. On the average, a unit increase in the number of sprinkling fitments (70.4%) is associated with a 47% increase in sprinkling demand which is equivalent to 285 lhd based on the data of 1977.

The coefficient of tap water pressure was positive as hypothesized and was equal to 0.415. Average tap water pressure in each house was 9.01 m (Table 2). Therefore, an increase in the tap water pressure from nine to ten meter (11%) is associated with an increase in sprinkling use of 4.6% and is equivalent to 28 lhd based on the data of 1977.

## Conclusions

The results of the analysis indicate the following conclusions when the water supply pipe network is considered to operate under good pressures using the 1977 data:

*Total Residential Demand*

1. The annual daily average consumption of water in the city of Basrah was found to be 906 ± (555) lhd. The per capita annual daily average consumption was

137 ± (84) lcd which is found to be lower than that for the cities in the neighbouring countries (Kuwait, and Riyadh-Saudi Arabia) as well as for the United States.

2. The water consumption of 90% of the households was found to be less than 1460 lhd, or 98% of the households consumed water less than 2570 lhd.

3. On the average, in each house the total fitments were found to be 9.7 ± (2.11), the number of occupants were 6.6 ± (1.51) persons (which is found to be similar to the figure reported for the city of Riyadh in neighbouring Saudi Arabia, but higher than that reported for north American cities), the lot price was 55.3 ± (18.19) ID/$m^2$, and the tap water pressure was 9.01 ± (4.92) m.

4. The number of fitments explained the largest proportion of the variation in the data. The estimated coefficient of the number of fitments variable which is found to be the only significant variable, indicates that on the average a one-unit increase in the number of fitments (any fitments) per dwelling (10%) is associated with an increase in total water consumption of 14% which is equivalent to 127 lhd based on the data of 1977.

*Summer Demand*

1. The summer daily average consumption of water in Basrah was found to be 1186 ± (851) lhd. The per capita summer daily average consumption was 180 ± (129) lcd which is lower than that for cities in the United States. The average daily consumption of water in the summer for Basrah is 31% higher than the annual daily average consumption. This is similar to that reported for the United States.

2. The estimated coefficient of the number of fitments which is found to be the only significant variable, indicates that the quantitative effect of a unit increase in the number of fitments per dwelling on the summer demand is identical to its effect upon total residential demand.

*Winter Demand*

1. The winter daily average consumption of water in Basrah was found to be 580 ± (291) lhd. The per capita winter daily average consumption was 88 ± (44) lcd which is lower than that reported for cities in the United States. The average daily water consumption of Basrah in winter is 36% lower than the annual daily average which is lower than that for the United States.

2. The average winter fitments were 8.28 ± (1.79). Both number of fitments and lot price variables were found to be significant. On the average, a one-unit increase in the number of fitments per house (12%) is associated with an increase in winter water consumption of nearly 15% which is equivalent to 87 lhd based on

the data of 1977. A 10% decrease in the lot price per house (5.530 ID/$m^2$) is associated with an increase in winter consumption of 4.3% and is equivalent to 25 lhd based on the data of 1977.

*Sprinkling Demand*

1. The average daily sprinkling demand in Basrah was found to be 606 ± (699) lhd. The per capita average daily sprinkling demand was 92 ± (106) lcd which is lower than that for the United States. The average daily sprinkling water use of Basrah is 33% lower than the annual daily average which is nearly similar to that for the United States.

2. The average sprinkling fitments were 1.42 ± (0.50). Both number of fitments and tap water pressure variables were found to be significant. On the average, a one-unit increase in the number of fitments per house (70.4%) is associated with a 47% increase in sprinkling demand and is equivalent to 285 lhd based on the data of 1977. An increase in the tap water pressure from nine to ten meters (11%) is associated with an increase in the sprinkling use of 4.6% and is equivalent to 28 lhd based on the data of 1977.

*Insignificant Independent Variables*

Both number of occupants per dwelling and area of the house variables were found to be statistically insignificant in all water demand models.

The results of this study indicate that the unrestricted (adequate mains pressure) demand for water in Basrah is highly responsive to the number and type of fitments (fixtures). The results suggest that (1) projections of future residential water demand should not be based solely upon historical per dwelling (or per capita) use but should incorporate the number of fitments including any new additions of water-consuming devices (such as dish-washing machines, garbage grinders, etc.), and (2) the number of fitments is an important variable which can be used in any future water saving schemes which could be built on changing the design of water consuming devices (such as changing the design of the conventional evaporative type aircooler which is known to be a high water consuming device to a low water consuming device).

Furthermore, the results of this study can be put into use in the planned construction of new satellite towns around Basrah. Their average daily unrestricted demand for water can be used as a basis for calculating revenues; whereas seasonal and summer demands can be used in the design of the water supply system components (source, pipelines from source, impoundment reservoirs, water treatment plant, and pumping stations).

Conclusions of this study should be interpreted with due consideration given to the potential limitations of the data among which are: (1) the procedure for estimating quantities of water used for seasonal (sprinkling) purposes is an approximation based upon available data, and (2) the data date back few years, however, this data may be viewed as the most recent "peace time" data.

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# تحليل استهلاك الماء المنزلي : دراسة خاصة لمدينة البصرة

عدنان عباس السماوي و جواد سوادى حسن

قسم الهندسة المدنية ـ جامعة البصرة ـ البصرة ـ الجمهورية العراقية

يشتمل البحث على دراسة حقلية للعوامل المؤثرة في الاستهلاك اليومي للماء في مدينة البصرة، وذلك باستعمال معلومات قراءة العداد (metered water reading data) الخاصة باستهلاك الماء المنزلي لمقطع (a cross-section) مكون من (٥٠) عائلة والمختارة من المسح المعد من قبل همفريز وبراون (Humphries and Brown 1979) على (٢٠٠) عائلة في مدينة البصرة خلال كانون الثاني ١٩٧٧ ولغاية شباط ١٩٧٨ .

يقدم البحث نموذجاً إحصائياً متعدد الانحدار (multiple regression-analysis) اعتمد عليه في التنبؤ باستهلاك الماء المنزلي لمدينة البصرة. تم تقسيم الطلب السكني للماء إلى أربعة نماذج مختلفة هي :
نموذج الطلب السكني الكلي، نموذج الطلب الصيفي، نموذج الطلب الشتائي ونموذج طلب الرش (sprinkling demand) . يشمل الطلب الصيفي استهلاك الماء داخل وخارج المنزل للفترة من منتصف آذار ولغاية منتصف تشرين الأول في حين يشمل الطلب الشتائي استهلاك الماء داخل المنزل فقط وذلك للفترة من منتصف تشرين الأول ولغاية منتصف آذار تقريباً على اعتبار أن استهلاك الرش خلال فصل الشتاء مقارب إلى الصفر. وعليه فإن طلب الرش للماء يساوي الطلب الصيفي مطروحاً منه الطلب الشتائي، أي أن طلب الرش يمثل استعمال الماء خارج المنزل فقط.

وبشكل عام تم دراسة كل نموذج من نماذج طلب الماء المذكورة أعلاه كدالة لعدد التوصيلات الصحية (number of fitments) في كل بيت، عدد أفراد الأسرة (household size) ، مساحة البيت (باستخدام متغيرين مبهمين two dummy variables هما $D_1$ و $D_2$ وذلك لعدم توفر المساحة الحقيقية لكل بيت)، وضغط ماء الحنفية (tap water pressure) داخل كل منزل.

أظهرت الدراسة ان عدد التوصيلات الصحية في كل بيت لها تأثير كبير على استهلاك الماء المنزلي أكثر من بقية المتغيرات المذكورة أعلاه. أما عدد أفراد الأسرة ومساحة البيت فلم يظهرا أي تأثير معنوي على استهلاك الماء المنزلي. كما ظهر ان قيمة الأرض لها تأثير على الطلب السكني للماء في نموذج الطلب الشتائي فقط، أما ضغط ماء الحنفية فله تأثير على استهلاك الماء في نموذج طلب الرش فقط، علما أن قيم هذه التأثيرات لكل متغير مدونة في هذا البحث وبشكل مفصل.