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Research Article

Evaluating the Parameters Affecting Rationalization of Water Consumption in Ablution

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Abstract: Muslims do ablution several times daily and a considerable amount of water is consumed in this process. Rationalization of water consumption is a critical issue because of limited water resources in many countries and high cost of water purification or desalination. Various parameters affect the quantity of water consumed in ablution. Awareness about the importance of rationalization is needed as it is a key parameter in practice. Therefore, it can be claimed that the first step in modeling of water consumption rationalization in ablution is the identification of the most important of these parameters. In this research, the indicators of awareness level about effective rationalization of water consumption in ablution are determined and evaluated using the rough-set approach as a modern mathematical method. A 17-items closed questionnaire was designed and filled by different individual Muslims. This questionnaire addresses the awareness and actual behavior of these individuals regarding their practice in consumption of water. The primary purpose of this paper is to find the smallest sets of attributes having quality equal to the general quality of the defined characteristics in the information system. So, the number of parameters used in the modeling is reduced. To evaluate the results, the best algorithm of the defined attributes in the information system is identified by making use of the stepwise (stepwise linear regression) method and then, compare the results with each other. The results of the research indicate that the rough-set theory has a better and stronger operational capability in identifying the effective modeling indicators in measuring the awareness level about rationalization of water consumption in ablution. By taking advantage of these results, the amount of necessary data for measuring the awareness level about the rationalization of water consumption in ablution modeling is decreased and the speed and effectiveness of information processing are increased considerably.
Keywords: rough-set theory, decision-making algorithms, awareness of water consumption rationalization

INTRODUCTION

The water is the most important natural resource; it is the lifeblood of the most important elements. In spite of that water covers 70% of the globe but quantity of water is limited. The water that everyone can take advantage of them do not exceed 0.01% of the total available water. The amount of water in the hemisphere reaches to 1360 million km3 in the oceans and seas, and 37 million km3 water frozen at the poles, 8 million km3 of underground water in places inaccessible 0.0126 km^3 lakes, rivers and other images that can be for a person to benefit from it [1].

Rationalization is to optimize the use of water so that it leads to benefit from the least amount of the cheapest financial costs possible in all areas. When we talk about guide consumption, we aim to consumer awareness of the importance of water as the basis of life. The development of water resources has become a vital requirement to ensure sustainable development in all fields. It includes domestic use, industry, tourism and agriculture. By working to change the patterns and habits, consumer behavior of the individual or the family to rationalize consumption is not intended deprivation of the use of water as much as intended to work on raising self-mediate and not wasteful to take advantage of the grace of Allah.

A study published in ARABIA NET, Friday, 21 Muharram 1433 (H) - 16 December 2011 states that Saudi Arabia, Kuwait, the world's most wasteful water - Individual consumes more than 500 liters per day [2].

According to the report published by the Ministry of Water and Electricity in the Kingdom Saudi Arabia [3], the rate of water consumption in the Kingdom Saudi Arabia of the highest rates in the world despite the fact that the Kingdom is one of the poorest areas in water resource. This has led to more interest in research on water consumption, which is the demand of national and religious on every resident on its territory. The Ministry of Water and Electricity in the Kingdom provide free means to rationalize the consumption of tap water which are parts installed at the tip of taps or faucets. The method of these means depends on introducing of air into the water from the tap flow to form a mixture. The amount of air is in the mixture increases the flow rate by 3,785 or 7.57 l / min to reach an end savings to 12 liters/ day.

One of the important problems regarding the construction of Awareness models is the identification of effective parameters on the number of Awareness produced by a household. Accordingly, the experts and researchers have always tried to use the parameters indicating the number of Awareness by a household in the best way. Therefore, to gain this goal, they have relied on their knowledge and experience.

Gradually, by developing methods like artificial neural network, the way was paved for the selection of the parameters for experts. Nevertheless, the aforementioned methods did not enjoy enough efficiency and accuracy to cross out the surplus parameters and determine the shortest decision-making algorithms. In this regard, the rough-set theory can be considered as an efficient method to analyze the data and information and delete the extra factors and attributes existing in the information system. One of the paramount advantages of using this method is the recognition of the shortest decision-making algorithms with very high precision. In this research, the rough-set theory has been used to determine the most important parameters affecting the number of household Awareness.

ROUGH-SET THEORY

The Rough-set theory was proposed by Pawlak as a new mathematical tool for analyzing vague, uncertain, and imprecise information [14]. The Rough-set theory has been very effective in extracting laws from decision tables, automated extraction of rules from clinical databases, learning conceptual relations, extracting rules of water demand prediction, and data mining and knowledge discovery [4-7]. Recently Kryszkiewicz presented a general rough-set framework for dealing with incomplete information systems [8, 9].

Rough-set analysis is essentially a nonparametric statistical method that is able to handle a diverse and less immediate tangible set of factors. It provides a formal tool for transforming a data set, such as a collection of past observations or a record of experiences, into structured information in a way that it can classify objects having distinctive patterns of attributes. It is not always possible to distinguish objects on the basis of available information (descriptors). The imperfect information causes the indiscernibility of objects through the values of the attributes describing them and prevents them from being unambiguously assigned to a given single set. In this case, the only sets that can be precisely characterized with regard to the values of ranges of such attributes are lower and upper approximations of the set of objects [10-14]. Human knowledge based on experiences (e.g. concerning decision making in a specific field) is often recorded in a structure called the information system. This information system contains information about particular cases (objects, states, observations, events, etc.) and factors and attributes effective on them (features, variables, characteristics, symptoms, etc.). The set of attributes consists of two types. The first type (called condition attributes) is concerned with the results of some tests or measurements, data from observation, anamnesis, symptoms of cases, states etc. The other (called decision attributes) is concerned with some expert's decisions, diagnoses, classification and evaluation of the results considering the object attributes [15].

With reference to a certain finite set of objects U, it is assumed possible to perceive the differences existing between them by observing some information associated with each of them. A finite set Q of attributes is identified, which serves to identify and characterize these objects. Since the rough-set theory aims to classify and distinguish data on the basis of different values their attributes assume with reference to each object, each attribute $q \in Q$ must be able to assume different values in its domain U_q.

There must be, therefore, at least two of these values for the attribute to be a significant basis for the required characterization. If an attribute is quantitative, its domain is, in practice, partitioned into a suitable number of sub-intervals, which give a good description of the phenomenon studied, so as to avoid ending up with a distribution of values with a high number of modalities, which would not be useful for the analysis intended. The difficult choice of the bounds (called norms) used to define these sub-intervals is the importance of ensuring a correct application of this approach so that too much information is not lost in the translation of the original quantitative attribute-values into qualitative coded values.

At this point, every $x \in U$ may be introduced to a vector whose components are the distinct evaluations of x with respect to every attribute of Q and called the description of x in terms of attribute values from set Q. The table, containing the descriptions of every $x \in U$ by means of the attributes of the set Q, is known as the information table. It is also possible to obtain a description of $x \in U$ in terms of any one subset of attributes $P \subseteq Q$.

A fundamental concept of the rough-set theory is that of the binary relation of indiscernibility, denoted by I_P. Two objects $x, y \in U$ are said to be P-indiscernible by means of the set of attributes $P \subseteq Q$ if they have the same description. Thus the binary relation I_P is reflexive, symmetric, and transitive (equivalence relation); its classes, that is, the subsets of U containing all the objects with the same description in terms of the attributes from subset P, and only these, are called P-elementary sets. If all the attributes of Q are considered, the Q-elementary sets are called atoms. The P-elementary sets, $P \subseteq Q$, generate a partition of U, in which every object $x \in U$ belongs to one and only one P-elementary set.

To explain the rough-set theory, it is necessary to introduce two other key concepts. Let $P \subseteq Q$ be a subset of attributes and $X \subseteq U$ a subset of objects of U. P-lower approximation of X, denoted by $P_L X$ is a subset of U with the elements as the objects belonging to the P-elementary sets contained in the set X, and only these. In other words, the elements of $P_L X$ are all the elements of U belonging to all the classes generated by the indiscernibility relation I_P and contained in X.

We define the P-upper approximation of X, denoted by $P_U X$ as the subset of U with the elements all being the objects belonging to the P-elementary sets having at least one element in common with the set X, and only these. In other words, the elements of $P_U X$ are all the elements of U belonging to all the classes generated by the indiscernibility relation I_P that have at least one representative belonging to X, and only these.

The difference between these sets is known as the P-boundary of X, denoted by $Bn_P(X) = P_U X - P_L X$. Therefore, $P_L X \subseteq X \subseteq P_U X$ results and, consequently, if an object x belongs to $P_L X$, it is also an element of X; if x belongs to $P_U X$, it may belong to the set X; therefore $Bn_P(X)$, constitutes the "doubtful region" (with reference to its elements, nothing can be said with certainty about its belonging to the set X). The indiscernible classes generated by I_P, therefore, constitute the basic instrument of the rough-set theory for better recognition and evaluation of data. This knowledge is intended as a family of partitions of U, generated by the indiscernibility relation I_P on U, $P \subseteq Q$.

A P-rough-set is the family of all subsets of U which includes the same lower and upper P- approximations. The intention is thus to approximate a set X, $X \subseteq U$, by means of a pair of sets associated with it, called lower approximation, $P_L X$, and upper approximation, $P_U X$, of X, which can then be considered as a particular case of the interval set. Only if $P_U X = P_L X$ does X prove to be equal to the union of a certain number of P-elementary sets and is called P-definable. Clearly, in this case (and only in this case), it is possible to affirm with certainty whether x, $x \in U$, belongs to X, $X \subseteq U$, using the set of attributes P. Moreover the accuracy of the approximation of X, equal to:

$$\frac{\text{card}\,(P_L X)}{\text{card}\,(P_U X)} \qquad (1)$$

It will be at the maximum value (i.e., equal to 1). In general, therefore, the aim of the rough-set analysis is to establish whether x is an element of X based on the lower and upper approximations of X, rather than directly by means of a specific characteristic function.

Let $Y = (Y_1, Y_2, ..., Y_n)$ be a certain classification of U. Regarding the classification of Y, P-lower approximation and P-upper approximation respectively, are the sets in Y that have as their elements the P- lower and P-upper approximations, that is $P_L Y = (P_L Y_1, P_L Y_2, ..., P_L Y_n)$ and $P_U Y = (P_U Y_1, P_U Y_2, ..., P_U Y_n)$. The quality of the approximation of the partition Y considering the set of attributes P, denoted by $\gamma_P(Y)$, can be gained by the ratio of the total number of P-correctly classified objects (i.e., belonging to the P- lower approximations of Y_i, i = 1, 2,..., n), to the total number of objects considered. This ratio is called the quality of the classification and will have its maximum value (equal to one) if, and only if, each class Y_i of Y proves P-definable.

Another fundamental concept in this theory is that of attribute reduction (i.e., given a classification Y of the objects of U, the goal is searching for a minimal possible set of independent attributes (R) that has the same quality of classification as the original set of attributes P). The minimal subset $R \subseteq P \subseteq Q$ that $\gamma_R(Y) = \gamma_P(Y)$ is called Y-reduct of P and denoted by $RED_Y(P)$. (Note that a single table of information may have more than one reduct). The intersection of all the Y-reducts is known as Y-core of P, that is, $CORE_Y(P) = \bigcap RED_Y(P)$. Naturally the core contains all the attributes of P, which are the most important attributes in the information table (i.e., the most relevant for a correct classification of the objects of U).

In other words, in order to analyze the information table, it is sufficient to use any one of the reduced attributes $R \subseteq Q$. So, the classification Y of the objects of U may be characterized only without eliminating any information and there is no need for any other defined attributes of Q-R. On the other hand, each of the attributes not belonging to the core may be neglected without deteriorating the quality of the classification considered, but if any one attribute belonging to the core were eliminated from the information table, it will not be possible to obtain the highest quality of approximation with the remaining attributes.

Consequently, as mentioned above, the rough-set theory is essentially a classification method devised for non-stochastic information and by making use of it, the following results are obtainable:

Evaluation of the relevance of particular condition attributes; Construction of a minimal subset of variables ensuring the same quality of description as the whole set (i.e., reducts of the set of attributes); Intersection of those reducts giving a core of attributes that cannot be eliminated without disturbing the quality of the description of the set of attributes; and identification and elimination of irrelevant attributes [10].

APPLICATION OF THE ROUGH-SET THEORY IN THE ANALYSIS OF INFORMATION AND RECOGNITION OF RATIONALIZATION OF WATER CONSUMPTION ALGORTHIM

Firstly, to be able to make use of the rough-set theory to detect the effective parameters on rationalization of water consumption in ablution, the KSA data and information have to be gathered and provided.

In this research, in order to provide the data, six hundred questionnaires containing impressive specifications and characteristics on household of water consumption in ablution were distributed in the city of Arar. Therefore, in the first step, most of the questionnaires were distributed among teachers, students, instructors, managers, experts and employees in the universities and schools. In the second step, in order to complete the obtained statistics and cover the other social categories, the rest of the questionnaires were distributed among physicians, engineers, businessmen and etc. Finally 321 questionnaires have been used in the analysis from the total 600.

The information was then categorized in a table, the row of which reflects the specifications of a household. Each column of the table indicates one of the characteristics considered for households and the last column shows the awareness level produced by those households.

Secondly, in order to utilize the rough-set theory to analyze the information table provided in the previous step, the information should be classified. To this end, each of the impressive attitudes and characteristics on the household awareness level has been classified. The results of this classification have been shown in Tables 1 and 2. Thus, if we substitute the associated code for each investigated characteristic of households, the informational table can be provided.

Table 1: Categorization of investigated dependent variable

Decision attribute
Awareness Level 1- Low 2- Medium 3- High

Table 2: Categorization of investigated independent variables

Explanatory variables (Condition attributes)	
1- Educational Level 1-Secondary 3- Graduate 2- University 4- post graduate 5- Other	10- Do you close the water faucet while washing your face or teeth Always 3- Rarely 2- Sometimes 4- Never
2- what is the Islamic ruling in the economy in the use of water? Obligatory 3- permissible Religiously desirable 4- don't know	11- Do you try the rationalization of water in the kitchen Always 3- Rarely 2- Sometimes 4- Never
3- Do you know the amount of water used by the Prophet in ablution? Less than 0.5 liter 3- 1 to 2 liters 0.5 to 1.0 liter 4- don't know	12- Do you fix water faucets immediately after malfunction Always 3- Rarely 2- Sometimes 4- Never
4- Do you know the amount of water used by the Prophet in Washing? 1 to 2 liters 3- 4 to 5 liters 2- 2 to 3 liters 4- don't know	13- Do you educate your family members the importance of water rationalizing Always 3- Rarely 2- Sometimes 4- Never
5 - Do you know the average amount of water used by a Muslim once in ablution from the tap in current time? Less than 1 liter 3- 2 to 3 liters 2- 1 to 2 liters 4-more than 3 liters 5- don't know	14- Do you ignore the leakage of water from the Siphon Always 3- Rarely 2- Sometimes 4- Never
6- Is the amount of water pumped by the metropolis to your house sufficient quantity? Always 3- Rarely 2- Sometimes 4- Never	15- How satisfied are you in raising awareness of ways to rationalize the use of water in Saudi Arabia Very satisfied 3- Not satisfied Satisfied 4- Not interested
7- Do you fix buoys, tanks and upper floor immediately after malfunction Always 3- Rarely 2- Sometimes 4- Never	16- Do you use water to clean the floors instead of brooms Always 3- Rarely 2- Sometimes 4- Never

8- Is there a water leak from the roof or ground reservoirs due to malfunction of buoys or pumps? Yes 3- Partially 2- No	17- What do you think the best ways that can be followed in raising awareness to rationalize the use of water in Saudi Arabia Friday sermon 3- SMS 2- TV 4-Seminars
9- Do you use means of water rationalizing that is provided free by the Ministry of Water Yes 3- Partially 2- No	

In this table all the samples in the form of distinct categories have been set forth, concerning the dependent attribute. In other words, the information system is an information table in which each row indicates one of the samples (a household), that has been studied, and each column shows one of the evaluated attributes of that household in a categorized form. The last column implies the decision parameter. A portion of the input information system has been given in Table 3.

Table 3: Part of coded table for rough-set analysis

Objects	Condition attributes																	Decision attrib.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1.	1	1	4	4	5	2	1	2	2	1	1	1	1	4	1	1	3	H
2.	5	2	1	2	1	1	2	3	2	3	2	2	3	2	2	2	4	M
3.	1	2	2	2	4	2	2	2	1	1	2	2	1	2	1	1	2	M
4.	2	1	2	2	4	1	3	1	2	4	2	1	2	2	2	3	3	M
5.	5	4	4	3	3	2	3	3	3	3	2	2	2	3	1	2	3	M
6.	2	2	2	2	4	2	1	1	2	1	2	1	1	4	2	2	2	M
7.	1	3	1	1	5	4	3	2	2	2	4	1	1	3	3	4	3	M
8.	5	1	1	1	5	1	1	2	2	1	1	1	1	4	1	4	2	H
9.	2	3	1	2	4	1	3	1	1	3	3	1	2	1	1	3	2	M
10.	4	2	4	4	2	1	1	1	2	4	1	1	3	4	2	1	2	M
11.	5	4	4	1	4	1	4	1	2	2	3	4	4	1	2	3	3	L
12.	5	4	1	2	2	2	4	1	2	3	2	4	1	1	2	2	1	L
13.	5	4	1	4	5	2	4	1	2	1	1	4	1	1	1	4	2	L
14.	2	1	1	3	4	4	1	2	2	4	3	1	4	1	3	1	1	M
15.	5	1	1	1	4	2	1	2	1	2	2	1	2	4	1	3	2	H
16.	4	1	1	1	3	2	1	2	1	1	1	1	1	3	2	2	1	M
17.	4	1	4	4	3	2	1	2	2	4	2	1	1	4	2	1	1	H
18.	2	1	1	4	3	2	4	2	2	2	2	1	2	2	3	3	1	M
19.	4	1	1	4	3	2	1	2	3	1	1	1	1	2	3	3	4	M
20.	4	1	1	4	4	2	3	3	2	2	2	2	1	2	2	2	4	M

Rough-set out-put

In order to analyze the information and apply the rough-set theory, Rose2-Lite software has been used and its input data is the above information system.

The results obtained from the application of the rough-set theory in the analysis of the information system produced by the of household Knowledge and their characteristics can be divided into two major parts as follows:

Decision-making algorithms (Reducts)

The attained decision-making algorithms are composed of defined independent parameters, existing in the system, by means of which the of household knowledge can be estimated and evaluated regardless of the other parameters. In other words, these algorithms enjoy the quality equal to the total defined attributes in the information system in question. The algorithms resulted from the rough-set analysis are set forth in Table 4. With respect to the results of the rough-set theory, there are twelve different reducts which evaluate the degree of knowledge produced by each household. The shortest algorithm obtained in this study comprises six attributes and predicts the awareness level of each household by the combination of {X2, X7, X8, X9, X12, X14}. On the whole, each of the twelve decision-making algorithms can be utilized for estimating the awareness level and these algorithms are not, from the viewpoint of quality and accuracy of approximation, different from each other. However, it is noteworthy that the shortest algorithm is always superior to the others.

Another noticeable point in rough-set analysis is that there are sometimes attributes in the information systems that are present and common among all the reducts. In this study, as Table 4 indicates, these attributes {X2, X7, X8, X14}, which are called Core because without them, a more exact evaluation of the dependent parameter is not conceivable. These parameters are paramount regarding the analysis of household characteristics and strongly affect the awareness level by each household.

Table 4: Reducts and core

Algorthim no.	Reduct
Algorthim no. 1	{X2, X7, X8, X9, X12, X14}
Algorthim no. 2	{X2, X5, X7, X8, X11, X12, X14}
Algorthim no. 3	{X2, X6, X7, X8, X11, X12, X14}
Algorthim no. 4	{X1, X2, X3, X7, X8, X12, X14}
Algorthim no. 5	{X1, X2, X6, X7, X8, X12, X14}
Algorthim no. 6	{X1, X2, X4, X7, X8, X12, X14, X17}
Algorthim no. 7	{X1, X2, X7, X8, X14, X15, X16, X17}
Algorthim no. 8	{X1, X2, X4, X7, X8, X10, X12, X14}
Algorthim no. 9	{X2, X3, X7, X8, X10, X11, X12, X14}
Algorthim no. 10	{X1, X2, X5, X7, X8, X9, X11, X14}
Algorthim no. 11	{X2, X5, X7, X8, X9, X11, X14, X17}
Algorthim no. 12	{X1, X2, X4, X7, X8, X11, X14, X15}
Core	{X2, X7, X8, X14}

Accuracy and quality of classification

We can evaluate the accuracy of independent parameters in predicting the awareness level separately. In addition, the accuracy and quality of the classification of categories and parameters defined in the information system can be appraised. The results concerning the accuracy of different levels (or thresholds) of the decision attribute have been given in Table 5. As it can be seen in the table, the accuracy and quality of the classification are equal to 1. This means that based on the attributes defined in the information system, the awareness level produced by each household can be strongly estimated.

Table 5:Accuracy and quality of the classification regarding the number of household Awareness level

Level of awareness	Quality of Approx.	Quality of Approx.
1	1	1
2	1	1
3	1	1

APPLICATION OF LINEAR REGRESSION METHOD IN THE ANALYSIS OF INFORMATION AND RECOGNITION OF AWARENESS LEVEL ALGORITHM

One of the most regular methods in making awareness level models is the linear regression method. In this case, an attempt is made to find a linear relationship between the awareness level produced or attracted by the zone, and the average characteristics of the households of that zone. Selecting the best form of the linear regression equation and determining its parameters require experience and abundant study about the subject in question. Applying the linear regression model is a common form of using a correlation model as follows:

$$Y=a_0+a_1X_1+a_2X_2+...a_nX_n \qquad (2)$$

In which Y, X_i and a_i stand for dependent variable, independent variables and model parameters respectively, and are determined before anything else in the procedure.

The dependent variable in a household-based rationalization of water consumption in ablution model is the awareness level. Each independent parameter in the models is an indication of a particular specification and characteristic of household consumption-behavior. Therefore providing a household-based linear regression model needs full studies about the characteristics of household consumption-behavior. Making use of the parameters, which can define the number of awareness level in their best form, is a key problem because applying all the parameters in a model is a difficult and impractical task. Accordingly, in the modeling and forming regression equations, the stepwise method is used to build the shortest and the most appropriate linear regression equations. In this case, different parameters are tested to achieve the best linear combination in providing the model with the minimum number of independent parameters in it. So the data collected in the research was analyzed and it was found that the {X14} parameter is the first and the most important parameter of household specifications having the highest amount of correlation with the dependent parameter, then {X2, X7}, are respectively the second and the third ones in the information system. Obtained linear regression equations are shown in Table 6. It is observed that by adding and replacing other additional parameters in the outcome structure of the equation of these three independent parameters, slight changes happen in the rate of R^2 which can be accepted. This means by applying these three independent parameters with high value of correlation, one can predict the awareness level produced by household members.

Table 6: Stepwise linear regression equations

Step	Equations	R^2	Parameters
1	$Y=1.286+0.289X_{14}$	55.5%	X_{14}
2	$Y=1.824+0.217X_{14}-0.818X_7$	67.9%	X_7
3	$Y=2.006+0.86X_{14}-1.523X_7-0.897X_2$	79.2%	X_2

THE COMPARISON BETWEEN ROUGH-SET AND LINEAR REGRESSION METHODS

In this research, the decision-making algorithms obtained from the rough-set analysis and the algorithm resulted from the stepwise linear regression analysis are studied. The results of these investigations, accomplished by statistical software through the regression method, are listed in Table 7. In this table the shortest and the most important algorithms obtained from the rough-set analysis are recorded. In addition, the rate of the correlation coefficient of some linear equations resulting from different algorithms used in the various and common rationalization of water consumption in ablution models are evaluated in this research. So, we can point out the algorithm that contains the parameters {X2, X7, X12, X14}, which are key parameters in different rationalization of water consumption in ablution models (such as cross-classification method).

Table 7: Comparison of correlation coefficient, quality and accuracy of approximation of different algorithms

Algorthim	R^2	Quality of Approx.	Quality of Approx.
{X2, X7, X8, X9, X12, X14}*	77.6%	1	1
{X2, X5, X7, X8, X11, X12, X14}	77%	0.86	0.96
{X2, X6, X7, X8, X11, X12, X14}	74.6%	0.65	0.71
{X1, X2, X3, X7, X8, X12, X14}	72.4%	0.42	0.63
{X1, X2, X6, X7, X8, X12, X14}	71.8%	0.80	0.87
{X1, X2, X4, X7, X8, X12, X14, X17}	68.6%	0.77	0.82
{X1, X2, X7, X8, X14, X15, X16, X17}	68.3%	0.74	0.80
{X1, X2, X4, X7, X8, X10, X12, X14}	66.2%	0.70	0.78
{X2, X3, X7, X8, X10, X11, X12, X14}	66%	0.64	0.70

As shown in Table 7, the difference between the values of R^2 resulting from the decision-making algorithm of the rough-set analysis to estimate the number of awareness level and that of the stepwise linear regression algorithm is 1.6%, which is inconsiderable and can be neglected. In addition, the R^2 value obtained from the rough-set algorithm is slightly different from the value of R^2observed for different evaluated algorithms of attributes. For example, we can mention {X2, X7, X12, X14}, which are the basic parameters defined in different rationalization of water consumption models. Therefore, it can be concluded that the algorithm resulting from rough-set analysis enjoys a suitable correlation coefficient to estimate the number of household water consumption, in comparison with the other evaluated algorithms.

The amounts of accuracy and quality of approximation have been used as a criterion in the current research. These values represent how carefully the defined independent parameters can predict the dependent parameter in the algorithm. In other words, the accuracy and quality of the evaluated algorithm in analyzing characteristics and parameters of household ablution behavior are estimated by the aforementioned criteria. Therefore, the value of accuracy and the quality of approximation were studied for different decision-making algorithms and consequently it was observed that other algorithms of attributes have less values of accuracy and quality of approximation in comparison to reducts resulting from rough-set analysis. For example, it was observed that the algorithm resulting from stepwise analysis and the algorithm obtained from the most important attributes defined in different rationalization of water consumption models, have lesser values of accuracy and quality of approximation.

Based on the above studies, it can be concluded that the multivariable linear regression equation obtained from the rough-set algorithm has a desirable correlation coefficient in estimating the number of household water consumption and enjoys the highest values of accuracy and quality of approximation (in comparison with other algorithms) in the analysis of the information and predicting the number of Awarnesss. Therefore, the decision-making algorithms resulting from rough-set analysis are the most assured algorithms in the information processing and rationalization of water consumption modeling and can work better than the other algorithms in analyzing the reasons of differences among the number of water consumption produced by different households.

CONCLUSION

In this research, the rough-set theory and stepwise linear regression method have been used to determine the shortest decision-making algorithms in providing and analyzing Awareness models. To this end, seventeen important characteristics of household ablution-behavior specifications have been evaluated. The most important results are as follows:

1. The main impressive characteristics on water consumption of a household are {X2, X7, X12, X14}, (these characteristics have been obtained through Rough-set theory analysis).

2. The shortest decision-making algorithm resulting from rough-set analysis suggests the combination of {X2, X7, X8, X9, X12, X14} to estimate awareness level of a household. This algorithm can be used instead of all the other parameters, to evaluate the awareness level of a household.

3. The results obtained from the stepwise linear regression method suggest the use of a decision making algorithm consisting of a set of {X2, X7, X14} to estimate the number of awareness level of a household.

4. In this research, the correlation coefficients of the algorithms, which result from the rough-set analysis and the stepwise linear regression method to estimate the number of household consumption, have been compared with each other. It was observed that the difference between the values of R^2 in algorithms concerning rough-set analysis and the stepwise linear regression method is negligible. It was also observed that the value of R^2 resulting from the algorithm of rough-set analysis is slightly different from the value of R^2 obtained from the other evaluated algorithms of attributes. For instance, we can mention the algorithm of {X2, X7, X14}, which contains the most important parameters defined in different rationalization of water consumption in ablution models.

5. The Rough-set theory makes use of the quality of approximation value as a criterion to determine the best decision-making algorithms. This value represents how carefully the independent parameters, defined in the algorithms, can predict the dependent parameter. Therefore, in order to evaluate the results obtained from the rough-set analysis, the quality of approximation values are investigated for the algorithms concerning stepwise linear regression analysis and the ones resulting from the important parameters applied in rationalization of water consumption in ablution models (for instance, we can enumerate the set of {X2, X7, X12, X14}, which are mostly the main parameters defined in rationalization of water consumption in ablution models). In this research, it was observed that other evaluated algorithms of attributes enjoy fewer values of accuracy and quality of approximation, in comparison with algorithms resulting from the rough-set analysis. So, the rough-set output reducts enjoy the highest values of accuracy and quality of approximation in analyzing households' ablution-behavior specifications and estimating the level of their awareness.

According to the studies accomplished in this research, it can be claimed that the reduced algorithms resulting from rough-set analysis are the most reliable algorithms to analyze and explain the information about the household produced awareness level. Thus, using the rough-set output reducts in rationalization of water consumption in ablution modeling, a significant amount of information necessary for the modeling can be reduced and the speed and effectiveness of information processing are increased considerably.

REFERENCES

1. Movik S; Return of the Leviathan? 'Hydropolitics in the developing world' revisited. Water Policy, 2010; 12:1–13.
2. Available online at http://tarsheed.mowe.gov.sa
3. Wolf A; Shared waters: conflict and cooperation. Annu Rev Environ Resour , 2007; 32:241–269.
4. Skowron A; Extracting laws from decision tables. Compute. Intelligence, 1995; 11(2):371-388.
5. Geng Z, Zhu Q; Rough set-based heuristic hybrid recognizer and its application in fault diagnosis, Expert Systems with Applications: An International Journal, Expert Systems Applications, 2009;36(2):2711-2718.
6. An AJ; Discovering rules for water demand prediction: an enhanced rough-set approach. Eng. Applic. Artif Intell., 1996; 9(6):645-653.
7. Kudo Y, Murai T; Heuristic Algorithm for Attribute Reduction Based on Classification Ability by Condition Attributes. Journal of Advanced Computational Intelligence and Intelligent Informatics, 2010;15(1):102-109.
8. Kryszkiewicz M; Chapter 21: Properties of incomplete information systems in the framework of rough- sets, rough-set and knowledge discovery. L. Polliowski and A. Skowron, eds., 1998; 422-450.
9. Kryszkiewicz M; Rules in incomplete information systems. Information Science, 1999; 113:271-292.
10. Nijkamp P, Pepping G; Meta-analysis for explaining the variance in public transport demand

elasticities in Europe. Journal of Transportation and Statistics, 1998; 1(1):1-14.

11. Deng D; Parallel Reduct and its Properties", Granular Computing , 2009; 121-125.
12. Slowinski R, Stefanowski J; Handing various types of uncertainty in the rough-set approach, rough-sets, fuzzy sets and knowledge discovery. Edited by Ziarko, W. P. Berlin, Germany: Springer. 1994.
13. Qinghu Hu, Xiaoodong Li, Daren Yu; Analysis on classification performance of Rough set Based Reducts. LNAI, 2006; 4019:423-433.
14. Pawlak Z; Rough-sets: Theoretical aspects of reasoning about data. Kluwer Academic, Boston. 1991.
15. Predki B, Wilk Sz; Rough-set based data exploration using rose system. In: Z.W.Ras, A.Skowron, eds, Foundations of intelligent systems, Lecture Notes in Artificial Intelligence, Springer-Verlag, Berlin, 1999; 1609:172-180.