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Model of Climatic Elements Affecting water Production by Air Conditioner (Case Study of Rasht)

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Abstract

Three percent out of seventy percent of earth planet water is freshwater that one percent of that is accessible. Pollution is added to the water shortage crisis, so humans are thinking about new water resources and trying to obtain them. Rainfall in Gilan province is abundant but irregular, especially in Rasht city. Temperature and evaporation increase in the late spring and summer, also, rainfall decrease in that time. Meanwhile, all cities and villages of Gilan, especially Rasht and its suburbs, use the gas air conditioner, and using this cooling system in buildings is developing day by day. The research was carried out in a room with a square of 33 m^2 at the temperature of comfort range of 20 °C using an air conditioner of the 28000 type. The water flow, temperature, and humidity were recorded hourly during the day and night, and statistical analysis (descriptive-analytical) was performed. Finally, a simple model was obtained from the existing relationship between climatic elements (temperature and humidity) with water flow. Temperature and water flow have a first-degree relationship and humidity and water flow have a second-degree relationship. The first-degree relationship showed that when the temperature decreases, the water flow increases so that a negative or inverse relationship is created. But in the second relation, with increasing humidity, Water flow increases, and with decreasing humidity, the flow decreases. Temperature as an independent and main factor has an inverse effect on water flow and humidity. Finally, the data (temperature, humidity, and water flow) were classified in SPSS software. By setting the temperature and humidity data in one of the groups, the amount of water obtained from the air conditioner (flow) is well predicted, and it can be generalized. The average amount of water obtained from the air conditioner is about 30 Lit/hr for an area of 33 m^2. Using more air conditioners in more areas will obtain more water flow which will meet a big part of the needs of families.

Keywords: Temperature, Air conditioner Water, Rasht, humidity, water shortage.

1- Introduction

The total volume of water on the Earth is relatively large, but more than 97% of this water is concentrated in the seas and oceans, and about 2% is accumulated in the form of ice and glaciers in the Polar Regions. Of the remaining one percent of water, a large part is in the depths of the earth, which is difficult to extract and out of reach of humans. Access to adequate and convenient water has become a serious crisis in some countries due to increasing population, industrial development, and increased pollution of freshwater sources. That's why individuals and researchers are struggling to eliminate constraints and solve the problems about water deficiencies. This research pursues two main goals. The first is that the factors producing artificial rainfall (cooler) and the second is that the relationship between water flow and elements is examined.

Saleh Nia et al., (2014) compared the two models LARS-WG and ASD to predict the effect of precipitation and temperature on the climate change process in different climatic conditions and showed that LARS-WG is more accurate. Dehghan et al., (2015) determined that the Gen-Clim statistical model could estimate rainfall, temperature, solar radiation, dew point, and relative humidity. Razzaghian et al., (2017) evaluated the climate change of the Babolrood watershed using HadCM3 and ECHO-G simulators and determined that the changes will be associated with increased rainfall in high rainfall months and a sharp decrease in rainfall in low rainfall months of summer. Haghtalab et al., (2013) used to form the LARS-WG climate model and compared the rainfall changes on the northern and southern fronts of Central Alborz and showed that the increase in temperature and decrease in rainfall will accelerate in the future, which is much more significant in the southern slope of central Alborz in compare to the northern slope. Tambo et al., (2016) found that the predicted elements in the Lars model have a high correlation. Rainfall increase at high latitudes, rainfall decreases at low latitudes and precipitation changes all over the world are increasing. Bigiarini et al., (2017) used the SDSM and LARS-WG methods and predicted the precipitation and temperature in the Tana Basin, Ethiopia, and showed that the temperature has a favorable performance in comparison to the amount of rainfall and climate change is becoming a major threat to the hydrological cycle that is influential on social and economic issues.

Meng et al., (2018) tested artificial rainfall in the river basin and showed that drives due to rainfall lead to a serious threat in northwest China. Also, most of the rainfall penetrates in seismic areas.

Sun et al., (2018) found that the amount of runoff and sediment will decrease significantly with increasing sand cover and have a negative relationship with rainfall intensity.

Akbarpour et al., (2015) by determining suitable places for collecting rainwater for use in agriculture using the AHP model in Birjand watershed and grouping watershed in four classes of the weak, medium, good, and very good, resulted that potential for rainwater collection will increase from the west to the east of the watershed. Chaman Pira and Hassani Moghadam (2015) by inventing and studying a new method in the obtaining and collection of rainwater, found that this device has enough efficiency to collect and maintain rainwater until the use and the total water waste during the rainfall collecting and storage process until the use is less than 5%. Soltani et al., (2016) made a comparative location of rainwater harvesting and the results showed that rainfall, slope and, soil hydrological groups as the main factors are more effective than other factors. Heshmati et al. (2021) studied the rainwater harvesting approach to deal with the drought phenomenon of Zagros forests. Construction of banquets along with enclosure was proposed as a suitable, short-term, and compatible option with Zagros forests to increase humidity to reduce the drought phenomenon. Rashidimehrabadi (2011), suggested collecting the rainwater from the roof of buildings in cities and villages for drinking and non-drinking purposes is a practical solution to reduce the growing water supply crisis for citizens. Since the vast surface of the impenetrable areas of the city forms on the roof of residential buildings, the volume of rainwater extracted from the roof is significant and can be a valuable alternative or a support water source. Kahinda (2007) using rainwater as drinking water, depending on the climatic conditions in the area, could account for up to 20% water savings in Brazil. Mohammadpour (2012) examines ways of coping with water shortage and also the major strategy for preventing damage due to water shortage, including new methods and green space systems. Heidari et al (2014) suggested that rainwater as the main source of all water resources is one of the best, cheapest, cleanest, and most suitable water sources. Because rainwater not only can provide all non-drinking needs in low water seasons but also can reduce pressure on urban water supply networks during water shortage time. Yoshioka et al (2015), investigated changes in the temperature of soil and water under the control of artificial rain. The results showed that the soil and water in the soil temperature are dependent on the penetration of rainwater. Ma et al (2012), presented a model for building cooling systems. This methodology is a prediction based on the MPC model for the construction of cooling systems to store thermal energy, which was approved at the University of California. Their results indicated a reduction in central power costs and improved performance. This research aims to create a simple model that first determines the temperature-humidity relationships of air conditioner water. It then categorizes the numbers related to the extracted water elements. And the amount of water flow Lit/hr is obtained based on the elements of temperature and humidity.

2- Materials & Methods

Geographical location

Guilan province in the north of Iran with longitude and latitude 50.35 to 48.32 and 38.27 to 36.33 respectively is located at the north of the Caspian Sea, east of Mazandaran province, south of Qazvin province, and west of Azarbaijan and Ardebil provinces. Its area is 13790.5 m^2. Geographical location is shown in Table (1) and Figure (1).

Table 1- The geographic position of Rasht station

Station name	longitude	latitude	height	Average precipitation
Rasht	49.36	37.19	- 8.6	1369.45

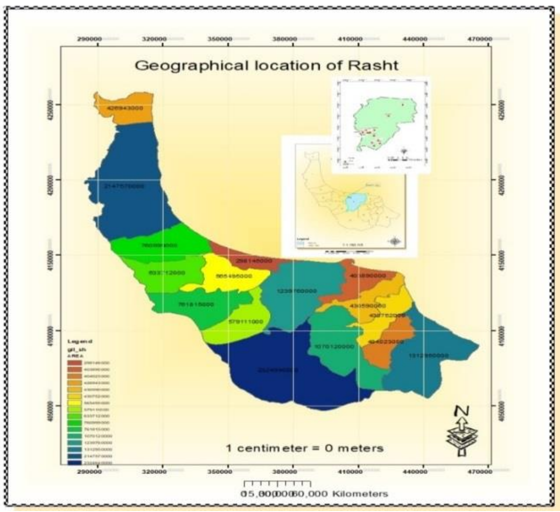

Fig. 1- Location of Rasht city in Gilan province

Statistical analysis of atmospheric elements affecting the amount of water flow (water produced by air conditioner)

In the statistical study of this research, descriptive and analytical methods were used by SPSS software. Recorded data is from 6/7/2017 to 18/9/2017. In the descriptive part of this study, central indicators and dispersion of variables X_1, X_2, and Y were presented. Also, measurements were made in a room with an area of 33 m^2, approximately 100 m^3, by adjusting the temperature to a comfort level of 20 degrees with a split of 28,000.

X_1, X_2, and Y represent temperature, humidity, and water flow produced by the air conditioner, respectively. In the descriptive-analytical study of the elements affecting the water flow of the air conditioner, the amount of water produced by the air conditioner, temperature, and humidity are recorded at different times of the day to obtain the relationships and determine the amount of produced water.

3- Results and discussion

Descriptive

Since all variables (temperature, humidity, and water) are continuous, central indexes including average and mode and dispersion Indexes including variance, standard deviation, and maximum, minimum, and variation range are used in the descriptive section.

Based on table (2), the average, maximum, and minimum temperatures were 29.68, 38, and 20 ^oC respectively. In addition, the average, maximum, and minimum humidity was 63.5, 100, and 29 respectively. Also, the average, maximum, and minimum of water produced by the air conditioner (water flow) were 0.967, 2, and 0.5 Lit/hr respectively.

Table 2- Descriptive indices

indicator		temperature (^{C})	relative humidity	Air conditioner's water (Lit/hr)
Central	Average	29.68	63.52	0.967

	Mode	31	73	1
Dispersion	Variance	14.171	302.298	0.095
	Standard deviation	3.764	17.387	0.03
	maximum	38	100	2
	minimum	20	29	0.5
	variation range	18	71	1.5

Correlation (Pearson)

Pearson correlation test – assumption of the linear relationship between variables.

There is significant relationship (P = 0.011) between water flow (Y) and temperature (X_1) ($P<0.05$). Correlation coefficient is - 0.375. There is an inverse relationship between temperature and water flow, in other words, with increasing temperature, the amount of water flow decreases, and with decreasing temperature, the amount of the water flow increases.

No significant relationship (P = 0.0296) is between water flow (Y) and humidity (X_2) ($P>0.05$). According to the correlation coefficient that is 0.072. There is a direct relationship between humidity and water flow but it is not significant.

There is significant relationship (P = 0.001) between humidity (X_2) and temperature (X_1) ($P<0.05$). The relationship between temperature and humidity is inverse and negative according to the correlation coefficient that is - 0.687. In other words, with increasing temperature, humidity decreases, and with decreasing temperature, humidity increases. The relationship between temperature and humidity and water flow is inverse and the temperature factor is decisive and causes changes in humidity and water flow during the day and night. Relationship between water produced by the air conditioner and air temperature using a simple linear regression model.

Considering to relationship between water flow and temperature, the appropriate regression line between variables y (dependent) and X_1 (independent) was examined. For regression, the normal distribution of the dependent variable (y, water flow) was measured using the Kolmogorov-Smirnov test and normalized.

The results of fitting the regression model between water flow and temperature variables are presented in table (3).

The significance level of the regression model based on the F statistic of variance analysis showed that the fitted model was suitable at the level of 0.05. There is a significant relationship between the amount of water produced from the air conditioner and temperature. Also, the above model, based on Watson Camera statistic, which is 1.68, could significantly justify the changes in the water variable. Acceptance of the independence of regression error, which are the presuppositions of the model's fit is possible, thus claiming that the results obtained from this model can be applied because of its fitting goodness. (Figure 2)

Table 3- Estimation of regression coefficients of water produced by the air conditioner and air temperature

significance level	t	standardized coefficients	Not standardized coefficients		Model
		Beta	estimation error	B	
P < 0.001	14.143		0.086	1.216	Fixed parameter
P = 1.004	- 2.677	- 0.194	0.003	-0.008	temperature

Significance level of the model= P-value = 0.004
Statistics= 0.275
Watson Camera Statistics = 1.68
Correlation coefficient = 0.194

A: Regression model

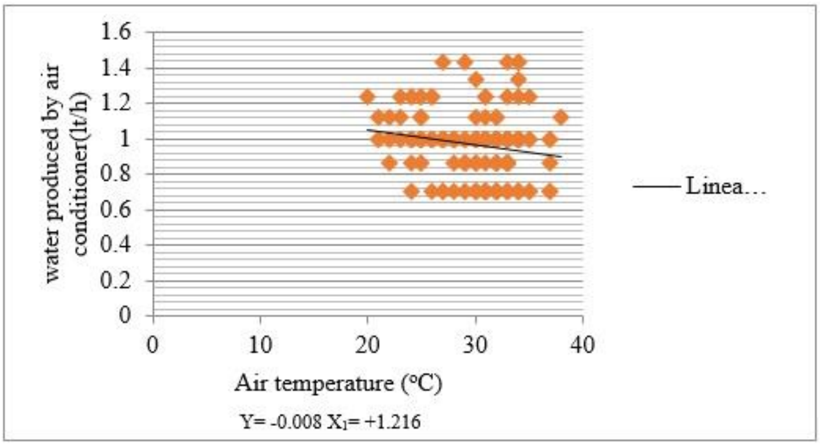

Fig. 2- Regression line receiving water from the cooler in terms of temperature

B: Regression line

Using the above function (regression line), we now examine the accuracy of the inverse relationship between temperature and water produced by air conditioner for arbitrary observations. Suppose we want to estimate the water produced by the air conditioner at 20, 23, 26, 29, 32, 35, and 38 degrees, and show the relationship between water flow with temperature in a graph. According to Figure (3), water flow is reduced by increasing the temperature.

Based on the significant reverse relationship between water produced by the air conditioner and temperature, we categorize existing data in terms of temperature into three categories including 20 to 26, 26 to 32, and 32 to 38 as first, second and third category respectively. The frequency percentage of each category was determined circle graph. (Figure 4)

As you can see in the graph above, the temperature was between 20 to 26 ^{o}C on 24% of the research days, and it was between 26 to 32 ^{o}C on 51% of the research days.

Now, we measure humidity and water content in table (4) categories.

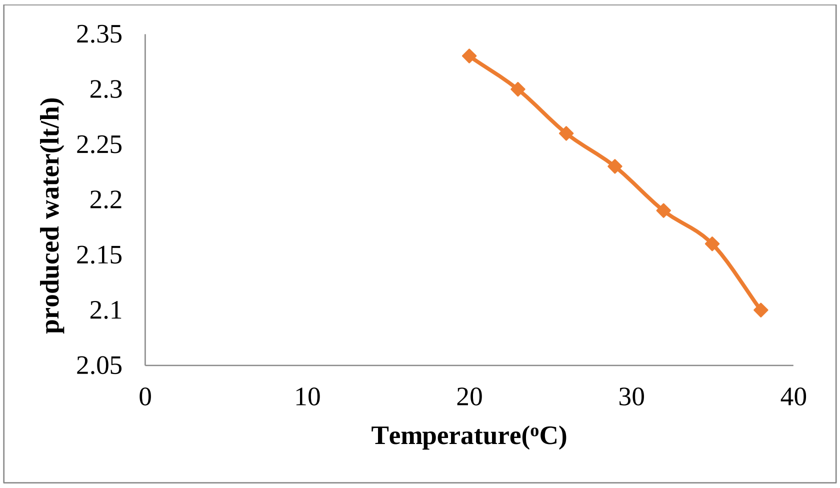

Fig. 3- Reverse relationship between water flow and temperature

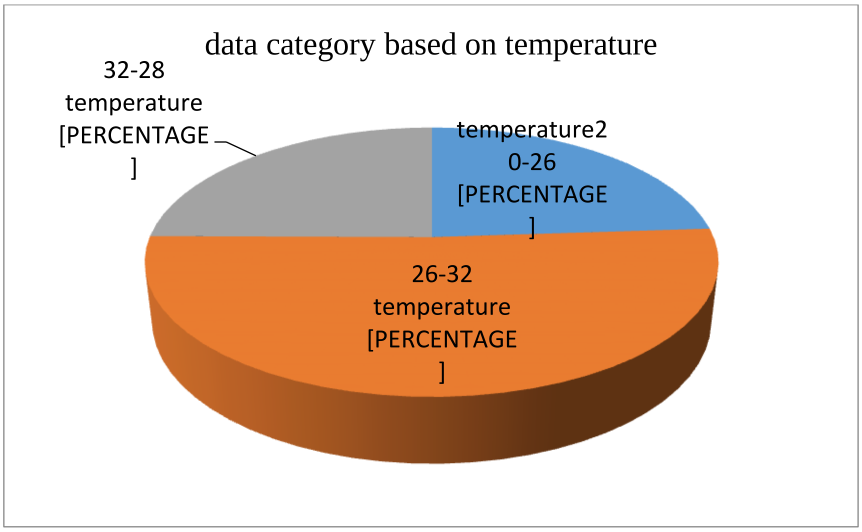

Fig. 4- Classification of receiving water from the cooler according to temperature

Table 4- Classification of the relationship between temperature, humidity, and water flow

Water flow average per hour	Humidity average	Temperature category
1.7	57.82	20-26
0.95	4.61	26-32
0.92	49.49	32-38

Based on the prepared table, the relationship between temperature, humidity, and water flow of the cooler was determined and the average water flow is one Lit/hr and is approximately 30 Lit/day. The relationship between climatic elements and air conditioner flow was shown in Figure (5).

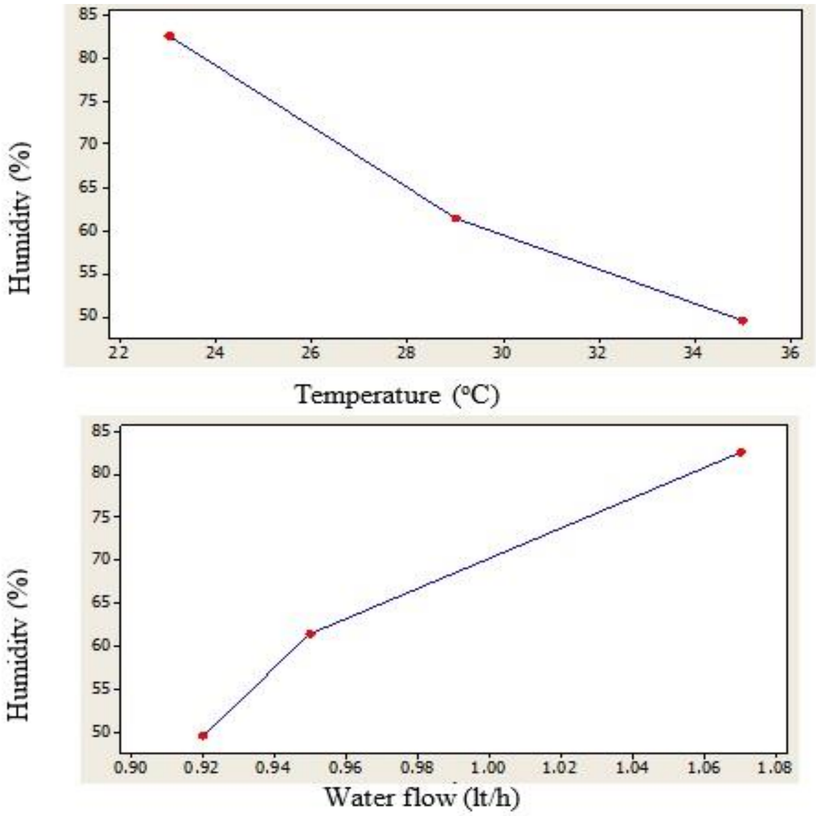

Fig. 5- Regression diagram of temperature with humidity and water flow

What is obtained from the examination of the temperature and humidity to the water flow is that the independent factor is temperature, which in the first stage has an inverse relationship with water flow so that water flow increase with decreases in temperature and Vis versa. This reverse relationship is also established with humidity. But the water flow-humidity ratio is direct so that with increasing humidity, water flow increases and decreases with decreasing humidity content. Based on grouping between elements (temperature, humidity, and water flow) water flow will obtain using temperature and humidity. According to the classification, the most water extracted from the cooler is at a temperature between 26 and 32 degrees, approximately one Lit/hr and 30 Lit/day.

4- Conclusion

The rainiest province of Iran will suffer from drought even after a month without rain, especially in the warm season. This crisis is exacerbated by declining rainfall, excessive freshwater consumption, traditional agriculture, and a variety of pollutants. This challenge is very serious in the hot months and the need for water is felt more and more. To solve this problem and provide safe water, it is necessary to use all available facilities and technologies. The use of gas air conditioners has been greatly expanded in the province during the last two decades, even it was seen in villages with enjoyable weather. Therefore, the production of water by the air conditioner in the warm season is increasing day by day and artificial rainfall is rising, and produced water is left unused. For this purpose, in the first stage, the relationship between temperature and humidity with water flow was analyzed descriptively and analytically in SPSS software, and in the second stage, it was determined by grouping that how water flow changes with the fluctuations of climate elements. Temperature and water flow are of the first-degree type but they have an indirect relationship. Temperature as an independent element has an inverse relationship with water flow and humidity. Humidity has a direct relationship with water flow and it is a second-degree relationship; however, water flow and humidity are indirectly controlled by temperature and create an inverse relationship. Three groups were created based on the regression model and the relationships between temperature, humidity, and water flow that in each group, a certain amount of temperature corresponds to a certain range of humidity and flow. In fact, by creating a model, it was found that the climate elements (atmosphere) along with the air conditioner as a new source, can solve the crisis when there is a need for water and it can be generalized to other similar climates. The water flow is 20-40 Lit/day. Because the average water flow of extracted water from the cooler is 30 Lit/day, it can easily compensate for the lack of water in the city's buildings and is even a good alternative to the city's water.

5- Acknowledgments

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6- Conflicts of Interest

No potential conflict of interest was reported by the authors.

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