

Selection of parameters to predict dew point temperature in arid lands using Grey Theory: a case study of Iran

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Abstract Dew point is the temperature at which water vapor in the air condenses into liquid with the same rate it evaporates. Dew point study is important in arid lands with low rainfall, also in other regions with various hydrological and climatological conditions. In this study, the Grey theory is applied for the first time to propose a framework approach to identify the important parameters affecting the prediction of dew point temperature. The ability of Grey theory to estimate and rank the parameters of a problem with missing data and uncertain conditions means that it has a good potential for mentioned application. For this research, 8 parameters are selected using literature review including: global solar radiation on a horizontal surface (H), water vapor pressure (VP), atmospheric pressure (P), sunshine duration (n), minimum air temperature (T_{min}), maximum air temperature (T_{max}), average air temperature (T_{avg}), and Relative Humidity (RH). The study is conducted for the city of Abadeh in Iran by using the data pertaining to a 10 year period between 2005 and 2015. The findings show that RH , T_{avg} , P , T_{max} , T_{min} , H , n and V_p with the grey possibility degrees of, respectively, 0.534, 0.551, 0.608, 0.622, 0.635, 0.695, 0.697 and 0.712, are the most important and effective parameters in prediction of dew point temperature. The proposed method also prioritizes the studied parameters in the order of their effectiveness on predicted dew point temperature.

Keywords: Dew Point Temperature; Grey Theory; Daily Dew Point Temperature; Fuzzy; Abadeh city.

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Nomenclature			
DPT	Dew Point Temperature	$\otimes G$	Fuzzy Number
ANN	Artificial Neural Network	$\underline{\mu}_G(X)$	Fuzzy Membership Function
ANFIS	Adaptive Neuro Fuzzy Inference System	$L(\otimes G)$	Length of grey number $[G, \bar{G}]$
SVR	Support Vector Regression	D_i	i-th Grey's dimension
SVM	Support Vector Machine	Parameters	
ELM	Extreme Learning Machine	H	Horizontal global solar radiation
MLP	Multi-Layer Perceptron	n	Sunshine Hour
RBNN	Radial Basis Neural Networks	V_p	Water Vapor Pressure
GRNN	Generalized Regression Neural Networks	P	Atmospheric Pressure
CANFIS	Coactive Neuro Fuzzy Inference system	T_{min}	Minimum Air Temperatures

MLR	Multiple Linear Regression	T_{max}	Maximum Air Temperatures
GEP	Gene Expression Programming	T_{avg}	Average Air Temperatures
Greece Letters		RH	Relative Humidity
$\otimes w$	Grey's Attribute weight	T_d	Daily Dew Point Temperature
$\otimes r$	Grey's Attribute range	T	Temperature
x_i	The i-th value of variable "x"	x_{min}	The minimum value of variable "x"
X_o	Normalized value of variable "x"	x_{max}	The maximum value of variable "x"

I. Introduction

Dew point is the temperature at which water vapor in the air (at constant barometric pressure) condenses into liquid with the same rate it evaporates. When air temperature goes below the dew point temperature, some portion of the water vapor in the air condenses until reaching a new equilibrium. The water vapor condenses on a solid surface is called dew [1, 2]. In fact, dew point temperature (T_d) is the temperature below which the air can no longer hold its water vapor. In this process, pressure (P) and mixing ratio (r) of moist air remain constant [3, 4]. When air pressure is constant and no water vapor gets added or removed from the air, the mixing ratio of air remains constant. At the dew point temperature, water content of the air is at saturation point; therefore throughout the process the mixing ratio remains equal to its value at the point of saturation (at dew point temperature). In other words, at this temperature, the relative humidity is always 100% [5]. The presence of a relatively cool layer of air near the ground at night can push the temperature down to dew point. A basic method of measuring dew point is to acquire a container with a fully smooth outer wall, fill it with a mixture of water and ice, and then measure the temperature of water at the moment when water droplets (dews) gradually appear on the outer wall [6].

As regards the high importance of dew, many researches have been done into it. Several are summarized in the following. Meng and Wen [7] investigated the amount, frequency, and also duration of dew events in two croplands, arid and sub-humid, in order to quantify the characteristics of dew events and analyze the underlying mechanism of dew formation in different ecosystems. Their finding show that dew events play a more important role in crop growth in arid areas in comparison to sub-humid areas considering the dew occurrence frequency and the amount per night. In another research, Zhuang and Zhao [8] scrutinized the effects of dew events on non-mucilaginous seed germination of annual desert plant species during dry seasons. Finally the results showed that the presence of

dew significantly increased seed germination percentages and decreased the nonviable seed percentages. Wang et al. [9] studied dew formation, amount, and duration of rain-fed jujube trees in a semi-arid loess hilly region of China. In this regard they used dew intensity and duration, relative humidity, temperature, and wind speed. The results indicated that atmospheric conditions of relative humidity of $>78\%$ and dew point temperature of 1°C – 3°C are significantly favorable to dew formation. Pan and Wang [10] performed measurement of accumulated dew formation amount and duration in order to determine the dew formation on different kinds of soils associated with various shrub species and microhabitats. The results showed that the accumulated dew formation amount was four times larger at open spaces as compared to under the canopy, and it was nearly twice as much under living *Artemisia ordosica* plants as compared to under living *Caragana korshinskii* plants. These mentioned studies show that dew is of significant importance and needs more investigation into its different aspects, as a result, it is attempted to predict dew point temperature in this study.

The accurate and reliable data for dew point is very important in agronomical and climatological related research works. Usually, dew point is used with relative humidity for identifying of the moisture level in the air. Dew point can also be used for providing the estimation of the humidity for near-surface of plants that influences the stomatal closure. Dew point study is important in arid lands with low rainfall, also in other regions with various hydrological and climatological conditions [11].

The majority of studies on dew point temperature prediction and evaluating the factors affecting this process have used a variety of artificial neural networks or in other words the soft computing methods. Some researchers have employed the soft computing techniques to evaluate and determine the most important parameters affecting the dew point prediction for a variety of case studies. The following researches were also found in the literature.

Amirmojahedi et al. [11] utilized a hybrid computational intelligence method for predicting dew.

They used a hybrid approach including the extreme learning machine (ELM) with wavelet transform (WT) algorithm for prediction of daily dew point temperature for city of Bandar Abbas in Iran.

In a study by Baghban et al. [2], the dew point of atmospheric moist air was estimated by LSSVM and ANFIS methods. The model developed in this study was tested with 100 data instances, and the MSE and R-Square (R^2) of results were found to be 0.000016, 1.0000 for LSSVM model and 0.382402, 0.9987 for ANFIS model respectively.

In a study by Sarkar [12], a new theoretical formulation for dew point temperatures was developed with the use of modified Clausius–Clapeyron equation. The developed formulation was aimed for comfort air-cooling systems. This study reported that the error of proposed method is far less than that of standard psychrometric measures. These authors also used the DPT equation to plot the wet sensible and latent loads of a cooling dehumidifying coil based on discretized temperature and humidity.

Evaluation and determination of the most important and most effective parameter in prediction of dew point temperature with due consideration given to availability and reliability of data is of utmost importance. The majority of research conducted to determine the most effective parameter in dew point temperature prediction has neglected an issue, and that is the uncertainty in the accuracy of data pertaining to parameters and the number of samples available for each parameter. Although most studies have used an acceptable number of samples, the accuracy of the data used in earlier researches and the effect of human and instrument error in data recorded and collected by meteorological offices have been overlooked. Therefore, when evaluating and determining the most effective parameter in dew point temperature prediction, it is crucial to use a method that can deal with inaccuracy and the possibility of errors in data and provide a satisfactory output with the lowest possible error. In this regard, Grey theory, which can use consecutive formulation, standardize the data, and take the environmental uncertainty for each parameter into account (through fuzzy calculation), can be employed to prioritize the parameters and determine the most important and effective ones.

This paper seeks to use the Grey theory to cover the mentioned gap in the research on this subject and provide a decision making framework for ranking and determination of the most important parameters in dew point temperature prediction.

The rest of paper is structured as follows: In section 2, Geographic characteristics are presented. The

methodology is brought in Section 3. In Section 4, analysis of the research is done. Finally, conclusion remarks are drawn in Section 5.

II. Area of study

Iran as a developing country is located in Western Asia with a population of about 81 million people and an area of approximately 1,648,195 km² [13-15]. The country has different types of climates including mild and wet, Mediterranean, cold, cold semi-desert, dry and hot dry [16,17], which Fars province lays in areas with semi-arid, cold and Mediterranean climates [18].

Abadeh is capital of Abadeh County in Fars Province of Iran that is located in 31°09'39"N52°39'02"E [18]. As of 2014, the population was estimated to be 94042 [19]. It features a continental semi-arid climate with extreme heat and dryness over summer, and cold (extreme at times) and wet winter, with huge variations between daytime and nighttime throughout the year [20]. Figure 1 illustrates map of Iran including location of Abadeh.

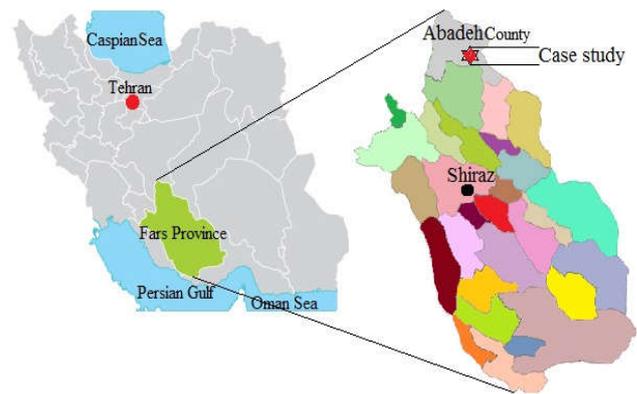


Figure 1. Map of Iran including Abadeh area.

III. Methodology

In this research, a new methodology by using Grey Theory for selection of parameters to predict dew point temperature is proposed. In this section, the description of the proposed theorem is presented.

Grey theory was introduced in 1982 by Deng. This theory is a modern mathematical theory developed from the concept of Grey set [21]. Its general procedure includes obtaining a set of initial data and repetitively processing them to weaken the effect of random information on these data with the intention of establishing a robust order (rule) in the data arrangement. The theory consists of five main parts: grey prediction, grey relational analysis, grey decision, grey programming and grey control [22, 23]. Based on the degree of

information, the grey theory calls the system “white” when its information is fully known, calls it “black” when its information is fully unknown, and calls it “Grey” when its information is partly known. This fuzzy approach is a very effective method for solving problems involved with uncertainty, discrete data and incomplete information [24]. Other reasons behind the widespread use of this method include its simple calculations, the small size of its required sample, lack of need for distribution of the initial sample, its ability to deal with discrete data, and the fact that qualitative output obtained from Grey relational grade cannot be seen in the results of quantitative analyses [25]. Application of Grey theory is classified into 5 categories of evaluation, modeling, predicting, decision-making and control [26].

In an empirical formula provided by the researchers, dew point is a function of temperature and relative humidity [27]:

$$T_d = (112 + 0.9T)RH^{0.125} + (0.1T - 112) \quad (1)$$

Researchers have introduced the following eight parameters for predicting the dew point temperature and evaluating the factors affecting the prediction of dew point:

global solar radiation on a horizontal surface (H), water vapor pressure (VP), atmospheric pressure (P), sunshine duration (n), minimum air temperature (T_{min}), maximum air temperature (T_{max}), average air temperature (T_{avg}), relative humidity (RH) [12, 28]. In this study, these eight parameters are used to achieve the research objective.

Grey set is defined as a set of uncertain data that can be described by a series of Grey numbers, Grey equations, Grey matrices, etc. the Grey set G is defined by reference set X with $\bar{\mu}_G(X)$ and $\underline{\mu}_G(X)$ as upper and lower bounds of the membership function [29]:

$$\bar{\mu}_G(X) : x \rightarrow [0,1] \quad (2)$$

$$\underline{\mu}_G(X) : x \rightarrow [0,1]$$

$$\text{Where } \underline{\mu}_G(X) \leq \bar{\mu}_G(X)$$

, and when these two variables are equal Grey set turns into a fuzzy set. This means that Grey set is a fuzzy set that is flexible in dealing with different problems. Figure 2 shows a representation of Grey system procedures.

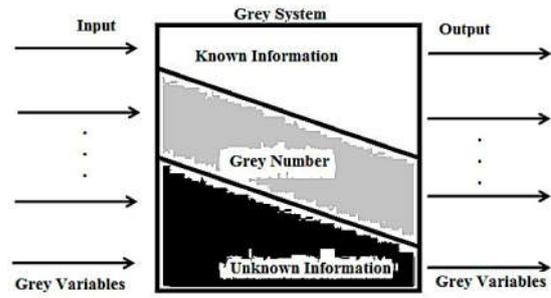


Figure 2. Grey system [30]

Assuming each fuzzy number as $\otimes G = [\underline{\alpha}, \bar{\alpha}]$, the fuzzy relationships between two Grey numbers $\otimes G_1 = [\underline{\alpha}_1, \bar{\alpha}_1]$ and $\otimes G_2 = [\underline{\alpha}_2, \bar{\alpha}_2]$ can be defined as follows [31]:

$$\otimes G_1 + \otimes G_2 = [\underline{\alpha}_1 + \underline{\alpha}_2, \bar{\alpha}_1 + \bar{\alpha}_2] \quad (3)$$

$$\otimes G_1 - \otimes G_2 = [\underline{\alpha}_1 - \bar{\alpha}_2, \bar{\alpha}_1 - \underline{\alpha}_2] \quad (4)$$

$$\otimes G_1 * \otimes G_2 = [\min(\underline{\alpha}_1, \underline{\alpha}_2, \underline{\alpha}_1, \bar{\alpha}_2, \bar{\alpha}_1, \underline{\alpha}_2, \bar{\alpha}_1, \bar{\alpha}_2), \max(\underline{\alpha}_1, \underline{\alpha}_2, \underline{\alpha}_1, \bar{\alpha}_2, \bar{\alpha}_1, \underline{\alpha}_2, \bar{\alpha}_1, \bar{\alpha}_2)] \quad (5)$$

$$\otimes G_1 \div \otimes G_2 = [\underline{\alpha}_1, \bar{\alpha}_1] * [\frac{1}{\underline{\alpha}_2}, \frac{1}{\bar{\alpha}_2}] \quad (6)$$

$$k \cdot \otimes G_1 = k * [\underline{\alpha}_1, \bar{\alpha}_1] = [k\underline{\alpha}_1, k\bar{\alpha}_1] \quad (7)$$

Length of grey number $[G, \bar{G}]$ is defined as:

$$L(\otimes G) = \bar{G} - G \quad (8)$$

In a Grey set, an option can be chosen over another only when we can establish that those two options are actually comparable and one can be considered more preferable. In deterministic sets, this fact can be established one through simple judgment, but in fuzzy sets this can be done via multi-parameters or multi-objective decision making techniques [32].

In the following, the instruments of Grey evaluation of dew point temperature parameters are described. Here, 5 evaluated dimensions are represented by $D_i = \{D_1, D_2, \dots, D_5\}$. The scale of Attribute ratings (shown in table 1) are used to assess the qualitative judgments of respondents for each criterion and, the scale of Attribute weights (shown in Table 2) are used to evaluate the weight of parameters [31]. For calculate the amounts of table 1, we first normalized Abadeh's meteorology data (including the parameters) using following formula and then multiply them in 10 to changed Abadeh's meteorology data in Grey data. So we have:

$$x_0 = \frac{x_i - x_{min}}{x_{max} - x_{min}} \Rightarrow x_i = x_0 \times 10 \quad (9)$$

Table 1 illustrates the scale of attribute ratings, and Table 2 shows the scale of attribute weights.

Table 1. The scale of Attribute ratings

Scale	Attribute ratings ($\otimes r$)
Very poor(VP)	[0, 1]
Poor(P)	[1, 4]
Moderate(M)	[4, 6]
Good(H)	[6, 9]
Very good (VG)	[9, 10]

Table 2. The scale of Attribute weights

Scale	Attribute weights ($\otimes w$)
Very Low(VL)	[0.0, 0.1]
Low(L)	[0.1, 0.4]
Medium(M)	[0.4, 0.6]
High(H)	[0.6, 0.9]
Very high(VH)	[0.9, 1.0]

Equation 10 is used to assess the opinions of received data [29]:

$$\otimes G_{ij}^t = [\underline{G}_{ij}^t, \overline{G}_{ij}^t] = \frac{1}{t} [\otimes G_{ij}^1 + \otimes G_{ij}^2 + \dots + \otimes G_{ij}^t] \quad (10)$$

In the above equation, $\otimes G_{ij}^t$ is value for the t-th data for i-th observation with respect to j-th parameter, and can be represented by the Grey number $\otimes G_{ij}^t = [\underline{G}_{ij}^t, \overline{G}_{ij}^t]$. The value of j-th parameter can be calculated via equation 11 [33]:

$$\otimes G_j = \frac{\sum_{i=1}^7 G_{ij}}{7}, j=1,2,3 \quad (11)$$

After calculating the weights of parameters, options need to be evaluated. This evaluation is conducted via equation 12. The obtained Grey values $\otimes G_{ij}^t$ is then used to form Grey decision matrix D:

$$D = \begin{bmatrix} \otimes G_{11} & \dots & \otimes G_{1n} \\ \vdots & \ddots & \vdots \\ \otimes G_{m1} & \dots & \otimes G_{mn} \end{bmatrix} \quad (12)$$

The evaluation numbers are all positive, so the decision matrix can be normalized. Equation 13 shown below is used to obtain normalized matrix D^* [31].

$$\otimes G_{ij}^* = \left(\frac{\alpha_{ij}}{G_j^{\max}}, \frac{\beta_{ij}}{G_j^{\max}} \right) \quad (14)$$

$$s.t \quad G_j^{\max} = \{\max \beta_{ij}; 1 \leq i \leq m\} \quad (13)$$

$$D^* = \begin{bmatrix} \otimes G_{11}^* & \dots & \otimes G_{1n}^* \\ \vdots & \ddots & \vdots \\ \otimes G_{m1}^* & \dots & \otimes G_{mn}^* \end{bmatrix}$$

Multiplying the normalized decision matrix by the obtained weight matrix gives the normalized weighted decision matrix:

$$\otimes N_{ij} = \otimes G_{ij}^* \times \otimes W_{ij} \Rightarrow D^* = \begin{bmatrix} \otimes N_{11} & \dots & \otimes N_{1n} \\ \vdots & \ddots & \vdots \\ \otimes N_{m1} & \dots & \otimes N_{mn} \end{bmatrix} \quad (15)$$

Hypothetical and important parameter of dew point temperature in case study, which is denoted by B^{\max} , is calculated via the following equation [32]:

$$B^{\max} = \{\otimes G_1^{\max}, \otimes G_2^{\max}, \dots, \otimes G_n^{\max}\} = \{\max_{1 \leq i \leq m} \alpha_{i1}, \max_{1 \leq i \leq m} \beta_{i1}, \dots, [\max_{1 \leq i \leq m} \alpha_{in}, \max_{1 \leq i \leq m} \beta_{in}]\} \quad (16)$$

The concept of preference degree is used to compare two Grey numbers with each other. Preference degree of Grey number $\otimes G_1$ with respect to Grey number $\otimes G_2$ is calculated via equation 17 [34]:

$$p(\otimes G_1 > \otimes G_2) = \frac{\max(0, \overline{G}_1 - \underline{G}_2) - \max(0, \underline{G}_1 - \overline{G}_2)}{(\overline{G}_1 - \underline{G}_2) + (\underline{G}_1 - \overline{G}_2)} \quad (17)$$

And when $\otimes G_1$ equals $\otimes G_2$, equation 18 holds true:

$$p(\otimes G_1 > \otimes G_2) = p(\otimes G_2 > \otimes G_1) = 0.5 \Rightarrow p(\otimes G_1 > \otimes G_2) + p(\otimes G_2 > \otimes G_1) = 1 \quad (18)$$

This means that sum of the preference degrees of two Grey numbers always equal with 1. The Grey possibility degree between each decision parameter (dew point temperature) and the important parameter is then calculated via equation 19. Parameters with a lower Grey possibility are more suitable [29]:

$$p(B_i \leq B^{\max}) = \frac{1}{n} \sum_{j=1}^n P\{\otimes N_{ij} \leq G_j^{\max}\} \quad (19)$$

Next section will describe the research findings.

IV. Case study and data collection

First, the data concerning the eight study parameter was collected from the meteorology office of Abadeh. This data pertained to a 10-year period from 2005 to 2015. Figure 3 shows the average monthly minimum temperature, maximum temperature and mean temperature of the study area during the period of 2005 to 2015. According to Figure 3, during this period, the maximum temperature of Abadeh has been 35°C s and its minimum temperature has been -5°C.

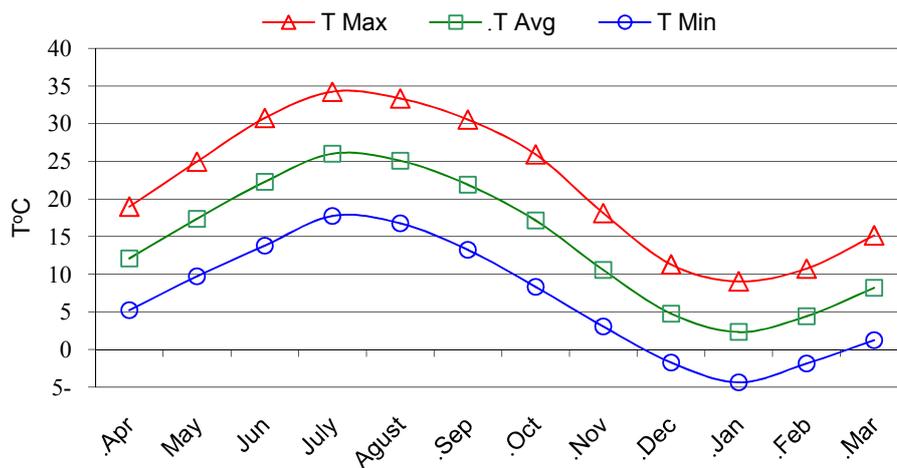


Figure 3. Monthly average of T_{max}, T_{min} and T_{avg} for case study over a period of 10 years from 2005 to 2015

Figure 4 illustrates the graph of average monthly precipitation and monthly mean temperature of Abadeh during the period of 2005 to 2015. According to Figure

4, during this period, the minimum precipitation has been zero and maximum precipitation has been 16 mm.

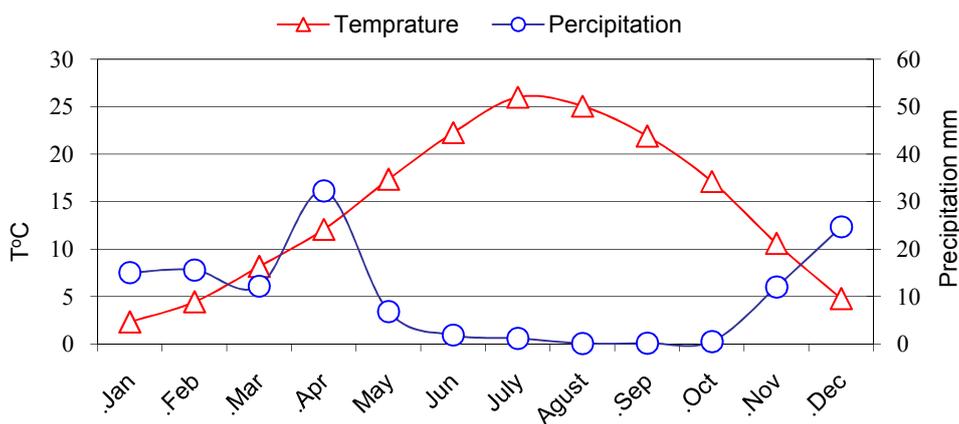


Figure 4. Monthly average of Temperature and Precipitation for case study over a period of 10 years from 2005 to 2015

Figure 5 displays the graph of minimum humidity, maximum humidity, and monthly mean humidity of Abadeh during the period of 2005 to 2015.

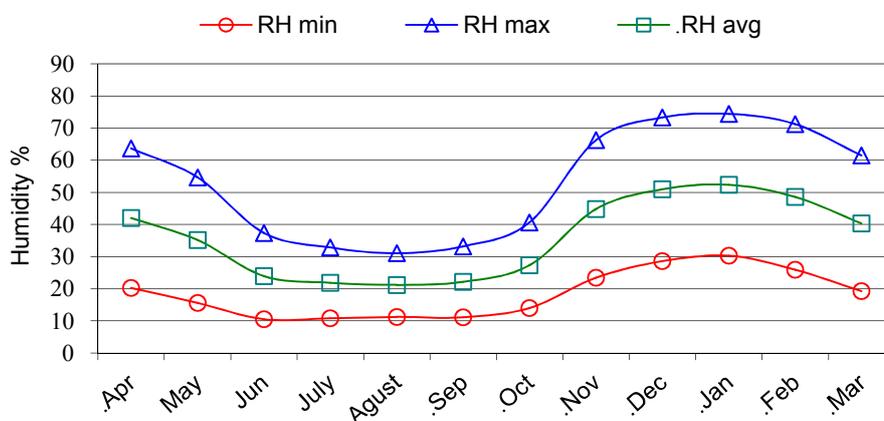


Figure 5. Monthly average of RH_{max}, RH_{min} and RH_{avg} for case study over a period of 10 years from 2005 to 2015

Figure 6 presents the graph of monthly mean hours of sunshine and monthly means water vapor in study area (in millimeter). According to Figure 6, in the period between 2005 and 2015, the maximum monthly mean water vapor has been 390 mm in July, and the minimum

monthly mean water vapor has been 5 mm in January and February. Meanwhile, the maximum monthly mean hours of sunshine has been 340 hours in June, and the minimum monthly mean hours of sunshine has been 200 hours in December

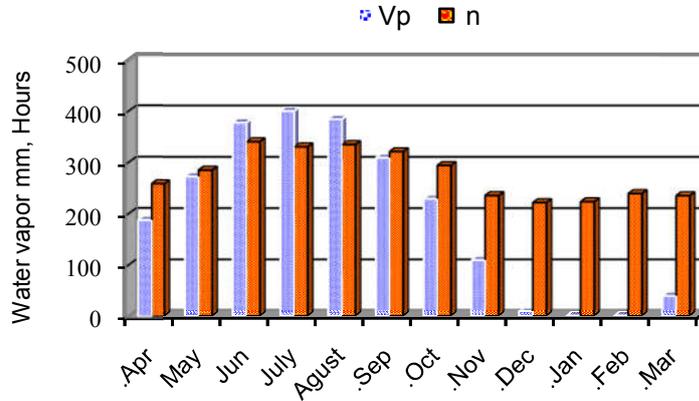


Figure 6. Monthly average of n and V_p for case study over a period of 10 years from 2005 to 2015

V. Analysis

Equations 10 and 11 were used to calculate the attribute weight of each parameter for the given data. Table 3 illustrates attribute weights of dew point's parameters as follows:

Table 3. Attribute weights of dew point's parameters

Parameters	Attribute weights
H	[0.00,0.08]
n	[0.08,0.14]
V _p	[0.14,0.18]
P	[0.18,0.24]
T _{min}	[0.24,0.30]
T _{max}	[0.30,0.32]
T _{avg}	[0.32,0.36]
RH	[0.36,0.40]

Attribute weights of each parameter were evaluated via equation 12 to assess the priority and selection dew point temperature's parameters. Grey decision table of the obtained data is illustrated in table 4:

Table 4. Grey decision table

	D ₁	D ₂	D ₃	D ₄	D ₅
H	[0.5, 1.5]	[2.4, 5.0]	[3.4, 6.6]	[7.5, 8.5]	[6.5, 9.0]
N	[0.4, 2.5]	[2.3, 4.0]	[4.0, 7.8]	[3.0, 6.2]	[7.5, 9.8]
V _p	[0.5, 1.9]	[2.5, 3.6]	[4.2, 5.7]	[5.5, 8.0]	[8.5, 9.5]

P	[0.8, 2.7]	[2.0, 3.2]	[3.3, 5.1]	[5.9, 7.2]	[7.7, 9.0]
T _{min}	[0.1, 3.5]	[0.9, 2.7]	[3.0, 4.4]	[5.3, 8.2]	[7.0, 9.4]
T _{max}	[0.6, 2.3]	[1.8, 2.5]	[3.7, 6.3]	[6.2, 7.4]	[8.5, 10.0]
T _{avg}	[0.2, 2.8]	[1.5, 4.4]	[2.9, 6.1]	[5.4, 8.0]	[8.2, 9.9]
R _h	[0.3, 3.1]	[0.6, 2.3]	[3.5, 5.6]	[4.5, 7.0]	[7.3, 9.7]

Using equation 13, the matrix of Table 4 is normalized which is shown in Table 5:

Table 5. Normalized Grey decision table

	D ₁	D ₂	D ₃	D ₄	D ₅
H	[0.2238, 0.8339]	[0.1386, 0.7694]	[0.3501, 0.4879]	[0.0347, 0.5497]	[0.0540, 0.8095]
n	[0.2588, 0.7513]	[0.1493, 0.3499]	[0.1966, 0.4090]	[0.3034, 0.9172]	[0.5308, 0.9443]
V _p	[0.2551, 0.8622]	[0.0349, 0.2577]	[0.2511, 0.4172]	[0.2858, 0.7269]	[0.4384, 0.7792]
P	[0.3188, 0.5060]	[0.1407, 0.7254]	[0.3160, 0.6715]	[0.2934, 0.7528]	[0.3256, 0.9340]
T _{min}	[0.3077, 0.6991]	[0.0631, 0.2543]	[0.2075, 0.4733]	[0.2174, 0.6832]	[0.1299, 0.7549]
T _{max}	[0.4336, 0.8909]	[0.2050, 0.7147]	[0.3517, 0.7172]	[0.3804, 0.8884]	[0.3705, 0.5688]
T _{avg}	[0.3426, 0.5993]	[0.2435, 0.8143]	[0.6302, 0.8308]	[0.1471, 0.5678]	[0.4694, 0.7115]
R _h	[0.1093, 0.6591]	[0.1241, 0.9293]	[0.4889, 0.5853]	[0.0689, 0.7590]	[0.0119, 0.8637]

Finally, the normalized decision weighted matrix of Table 6 was obtained by multiplying the normalized matrix by the weight matrix.

Table 6. Standard Grey weighted decision matrix

	D ₁	D ₂	D ₃	D ₄	D ₅
H	[0.0000, 0.1649]	[0.0532, 0.1558]	[0.1209, 0.1749]	[0.1256, 0.2106]	[0.1063, 0.2328]
n	[0.0192, 0.1277]	[0.1381, 0.1812]	[0.1470, 0.2173]	[0.1818, 0.2802]	[0.2012, 0.3509]
V _p	[0.0301, 0.1326]	[0.0154, 0.1961]	[0.1963, 0.2687]	[0.1811, 0.2638]	[0.1111, 0.2085]
P	[0.0135, 0.1742]	[0.0872, 0.1427]	[0.1844, 0.2414]	[0.1455, 0.2294]	[0.1259, 0.2502]
T _{min}	[0.0112, 0.1655]	[0.0430, 0.1491]	[0.1890, 0.2868]	[0.1316, 0.2707]	[0.1948, 0.2759]
T _{max}	[0.0632, 0.1943]	[0.1067, 0.1535]	[0.2835, 0.3685]	[0.1693, 0.2620]	[0.2305, 0.3176]
T _{avg}	[0.0630, 0.1133]	[0.1690, 0.2614]	[0.2998, 0.3001]	[0.2350, 0.2893]	[0.1832, 0.3234]
R _h	[0.0524, 0.1022]	[0.0046, 0.1477]	[0.2599, 0.3314]	[0.2468, 0.3797]	[0.1707, 0.3722]

Equation 16 was then used to calculate the value of important parameter:

$$B^{\max} = ([0.00, 0.1934], [0.0046, 0.2614], [0.1209, 0.3685], [0.1256, 0.3797], [0.1111, 0.3722])$$

Equation 19 was then used to compare the values of weighted decision matrix with the ideal values. Table 7 shows the Grey possibility degrees of parameters of dew point temperature in Abadeh with respect to important parameters.

Table 7. Grey possibility degree

Possibility	Degree
$P\{H \leq B^{\max}\}$	0.695
$P\{V_p \leq B^{\max}\}$	0.712
$P\{P \leq B^{\max}\}$	0.608
$P\{n \leq B^{\max}\}$	0.697
$P\{T_{\min} \leq B^{\max}\}$	0.635
$P\{T_{\max} \leq B^{\max}\}$	0.622
$P\{T_{\text{avg}} \leq B^{\max}\}$	0.551
$P\{R_h \leq B^{\max}\}$	0.534

Options with lower Grey possibility degrees with respect to ideal option are more suitable [27]. According to the results of Table 7, among the assessed parameter's Grey possible, parameters including: RH, T_{avg}, P, T_{max}, T_{min}, H, n and V_p

These parameters were determined –in that order- as the most effective parameters in dew point temperature prediction. RH and T_{avg} were determined as the most important parameters in dew point temperature prediction, and P was obtained as the third most important factor in this process. Given that at a fixed P, formula (1) holds true, these findings seem reasonable and acceptable. Therefore, the proposed method can properly evaluate the importance of parameters in dew

point temperature prediction and prioritization of the parameters in the order of their effective and general importance. The findings of this study were found to be consistent comparing with previous studies.

Options with lower Grey possibility degrees with respect to ideal option are more suitable [27]. According to the results of Table 7, among the assessed parameter's Grey possible, parameters including: RH, T_{avg}, P, T_{max}, T_{min}, H, n and V_p are important and effective respectively. Then, in spite of RH and T_{avg}, it received that P (air pressure) has noticeable effect on dew point temperature. To sum up, the Grey approach would be efficient for precise predictions of daily dew point temperature and also higher accuracy. Also, the findings are compatible to pervious research.

VI. Conclusions

The aim of this paper was to use Grey theory to evaluate and determine the most important parameters in prediction of dew point temperature for the city of Abadeh located in southern Iran. The used method is able to properly assess the problem and its dimensions in presence of any number of data, and has been used extensively by many researchers for different applications. In this study, 8 parameters affecting the dew point temperature including V_p, n, H, P, T_{min}, T_{max}, T_{avg} and RH were obtained from literature and then the data pertaining to these parameters was gathered from meteorological organization of the study area. Then, the proposed method was used to devise the table of parameter weights, Grey decision table, normalized Grey decision table, standardized weighted decision matrix and the grey possibility degree of each parameter. The results showed that RH, T_{avg}, P, T_{max}, T_{min}, H, n and V_p with the Grey possibility degrees of, respectively, 0.534, 0.551, 0.608, 0.622, 0.635, 0.695, 0.697 and 0.712, were the most important and effective parameters in predicting the dew point temperature. The results obtained through the use of proposed method were also found to be consistent with the results of previous works, except that parameter P was found to be the third most important parameter, after RH and T_{avg}, in the prediction of dew point temperature.

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