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Environmental impact evaluation and forecast of dust in the cities of Khuzestan province using time series models (during the statistical period of 1990-2010)

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Abstract

Dust is an atmospheric phenomenon that causes the adverse environmental effects. Problems associated with dust phenomenon more striking are that the frequency of occurrence of this phenomenon in our country has been an upward trend. The aim of this study is to predict and identify the best models for time series in the province during the years 2016-2020. In order to identify and predict the best time-series models over the years 2016-2020, eight selected cities of the province including Masjed Soleiman, Ahvaz, Rāmhormoz, PA, Dezful, Aghajari, Abadan and Omidiyeh are selected. Statistical methods and annual data are performed by using the software 17 Minitab, spss19 and Excel 2013. For this purpose the annual dust data from eight meteorological stations in Khuzestan province during the period 1990-2010 are obtained, and homogeneity test data on dust, are analyzed. Using time-series models dusts are analyzed and then the best model is proposed for prediction. In addition, the accuracy of the model are verified based on statistics, the average absolute error (MAE), mean absolute percentage error (MAPE), root mean square error (RMSE) and Standard (BIAS) approaches. Results indicates that the most appropriate model for the city of Masjed Soleiman and Behban is Holt Winters model, and for the cities of Ahwaz, Rāmhormoz, Aghajari, Abadan and Omidiyeh is a model simple flat development are selected. Furthermore ARIMA model (0,0,0) is proper only for the Dezful city.

Keywords: dust, time series, Holt Winters, Arima, Anderson-Darling, Khuzestan.

Introduction

In Iran there are a few years that the phenomenon of dust in the vast regions, especially regions in the South West has been caused some concerns. Khuzestan province due to certain circumstances of geomorphology and climate as well as its proximity to Iraq is one of the main centers of dust creation in the Iran. It is at greatest amount of dust, so that this province experienced 26 days of intense dust in July 2008 and the amount of dust has been also reached to 36 times of the standard level in a few days. Dust storm intensity is determined by the rate of absorption, locative dispersion, and the rate of reduced visibility. Based on the duration of the occurrence of dust storm, it is divided into short-term (half an hour) and long -term (sometimes a few hours to a day) (laskariand Keikhosravi, 2008: 18). Dust phenomenon is one of the atmospheric - climatic disasters that its occurrence causes damages in biological - environmental fields and causes exacerbation of respiratory and cardiac diseases, ground and air traffic, and tourism and agricultural threat and so on.

Iran due to locating in arid and semi-arid belt of world is frequently exposed to numerous local dust and synoptic systems (Rasoliet al., 2010: 89). Numerous studies have been conducted in the world on the status of dust, for example Gady and Midelton (2006). In providing a global lighting from regions with dust storms has considered the occurrence of summer dust storm in the Middle East due to the establishment of a low pressure center in the south of Iran and a high pressure center in the northern half of the Arabian Peninsula following the emergence of a strong and persistent winds called north wind on the region.
EnglandDollar (2008) in relation to the zoning frequency of the dust occurrence of the world considers the more important role for the lakes' bed and Sahara as the original dust producer. He believes that Sahara generates dust more than any other desert in the world.

Els (2010) in investigation of the origin of China's dust storms found that these storms are formed in the northern cold regions, and crossing the Gobi plate (Gobi desert) and picks up particles, and creates excessive dust which causes excessive problems for these regions. Researches of Li et al. (2010) showed that the number of days with dust storms is less than the number of windy days in Mongolia in China. this shows that the appearance and severity of these storms also affected by climatic conditions such as wind speed is affected by the ground-level features such as vegetation cover, soil moisture level and so on (10).

Several studies have also examined the situation of dust in the country. For example, "Raeis Pour" (2007) has conducted a statistical synoptic analysis on phenomenon of dust in Khuzestan province. "Heidari "(2007) after a case study of a sample of dust-generating system in Kermanshah province concluded that the cyclone closed on Iraq and Arabia causes dust in Kermanshah province. This is the only source in the country that has examined the phenomenon of dust using nonparametric methods.
Miri et al (2009) on dust storms in Sistan noted that after occurrence of a drought in the late 70's storm frequency has been significantly increased (up to 5) times.
Ansari (2011) examined the correlation of parameters such as relative humidity, temperature, wind speed and precipitation with the occurrence of dust storms in Zahedan province. Among

these studied parameters, wind speed allocated the highest significant correlation to itself, and relative humidity allocated the lowest inverse correlation to itself.

The importance of the present study is in terms that the cities selected in Khuzestan province (Masjed Soleiman, Ahvaz, Rāmhormoz, Behbahan, Dezful, Aghajari, Abadan and Omidiyeh) are as cities have been located in the Southwest and West of the country on the path of migratory dust entry that flows from dry neighboring countries, including Iraq, Saudi Arabia, Kuwait, Turkey, Sudan, and even North Africa to Iran. Study on the phenomenon and its dust conditions can be considered as the vanguard dust entering the country.

The aim is to investigate the environmental impacts and to forecast the status of dust phenomena in selected cities in Khuzestan province (Masjed Soleiman, Ahvaz, Rāmhormoz, Behbahan, Dezful, Aghajari, Abadan and Omidiyeh). So that through this environmental impacts of dust and the best time-series models for the coming years (2016-2020) can be identified, and the level of entry of dust phenomenon to be specified for each of these cities. Finally, the strategies are expressed for controlling and reducing and preventing this problem.

Data and Methods

The geographical location of the study area Khuzestan province with an area of 64 234 square kilometers is located between 47 ° 41 'to 50 degrees 31 minutes east longitude and 29 degrees 58 minutes north latitude to 33 degrees 4 minutes in south west of Iran (Figure 1). (www.amar.org.ir2014.6.4).

In this research, Khuzestan dust numbers data has been obtained from Meteorological Organization annually for the eight cities including: Masjed Soleyman, Ahvaz, Rāmhormoz, Dezful, Behbahan, Aghajari, and Badano Omidiyeh. Due to enough duration of statistical periods which is at least 21 years and proper distribution of its location, these stations (table 1) are selected. Studied time period in this research, is a 21-year which is ranged from 1990 to 2010.

Statistical characteristics of time series of studied stations rainfall are presented in Table 2:

Table 1: Details of the regions studied in Khuzestan province

Station name	**Longitude**	**latitude**	**Height from sea level**	**Station Code**	**Statistical period**
Masjed Soleyman	49.28	31.93	320	40812	21
Ahvaz	48.67	31.33	22.5	40811	21
Rāmhormoz	49.6	31.26	150	40813	21
Dezful	40.38	32.4	143	40795	21
Behbehan	50.23	30.6	313	40834	21
Aghajari	49.67	30.64	27	40833	21
Abadan	48.25	30.36	6.5	40831	21
Omidiyeh	49.65	30.76	35	40830	21

Table 2: Time series data details of dust of studied stations

stations								
details	**Masjed Soleyman**	**Ahvaz**	**Rāmhormoz**	**Dezful**	**Behbehan**	**Aghajari**	**Abadan**	**Omidiyeh**
Average	66.6190	83.9048	38.4762	89.3810	30.7619	51.5714	73.2853	128.9048
Standard deviation	34.44195	44.52292	29.31488	43.46548	34.32206	37.71150	37.64723	67.49586
Chulky factor	380.	329.	874.	365-.	1.236	374.	1.169	182-.

The forecasts steps in time series

Forecasting has various steps in time series which important cases of them are classified as below.

Time series Characterization and component determination: the research carried out by process changes methods, using Minitab software 17. In the step first requires observing process existence or non-existence has entered to annul dust numbers reach to primary knowledge with chosen cities of Khuzestan and each of cities through charting.

Selection of forecast potential methods

In order to determine forecast potential methods after that process and non-process of season and non-season changes of dust phenomenon has been determined in the application Minitab software 17, then spss19 software is used to choose the best method for appropriate forecast (figure 2)

In order to accuracy measurement data related to time series, four common methods has been used which is available in time series. We use the following four relationships.

The mean absolute error (MAE)

MAE or Bias $= \sum_{i=1}^{n} \frac{(Y_i - Y_i)}{n}$ (1)

The mean absolute percentage error (MAE)

MAPE $= 100 \sum_{i=1}^{n} \frac{(Y_i - Y_i)}{Y_i}$(2)

The square root of the mean square error (RMSE)

RMSE $= \sqrt{MSE}$ (3)

Square mean error (MAE)

MAE or Bias $= \sum_{i=1}^{n} \frac{(Y_i - Y_i)2}{n}$(4)

For the normal distribution of and the accuracy of the data normality Anderson-Darling test, and Kolmogorov - Smirnov is done by using Minitab 17 software. Also, for homogeneous data Ron test will be conducted by using the SPSS19 software.

Forecast

In this research, expert structural model automatically by spss 19 software to identify and predict the best model for statistical years (2016-2020). In addition for charting Minitab 17 software and to sort predictions is used of Excel 2013 software.

ARIMA model

The most widely used statistical models, is Arima family patterns. In this approach, statistical pattern of values Based on their past behavior are modeled and predicted (Asakereh, 2011: 2).

Certain types of seasonal models show good results in practice and on the overall structure of the Arima models matches, from the Box Jenkins called multiplicative seasonal models are read and summarized as ARIMA (p, d, q) (P, D, Q) has been shown.

In this structure (p, d, q) non-seasonal component model (P, D, Q) is seasonal component model. By using backward shift operator B the general form of the model is shown below :(about 5).

$$\varphi_p(B)\Phi_P(B^s)\nabla^d\nabla_s^d z_t = \theta_q(B)\Theta_Q(B^s)a_t$$

$$\phi(B), \Phi(B), \theta(B), \Theta(B) \quad (5)$$

In this model, polynomial is with the confidents of P, D. q, Q and coefficients of p, q are non-seasonal order and P, Q are seasonally order of autoregressive processes and moving averages show. In order to equation in this equation d, D, respectively, the degree of simple and seasonal differencing shows that most of these factors does not exceed of one factor. In this model ∇_s^d is seasonal operator and∇^d is non-seasonal operator.

Prediction model of Holt-Winters smooth development

The observed value of the time series shows at time t with x_t. It can be said that tẍ will be represented the predicted value. So we introduce the process met with tT in this model, two estimating equation are (Eq. 5 and 6)

$(0< A < 1)$
$t\ddot{x} = A(\ddot{x}t_{-1} + Tt_{-1}) + (1 - A)\ x_t$(5)
$(0< B < 1)$
$tT=B\ t_{-1} + (1 - B)(t\ddot{x} - \ddot{x}\ t_{-1})$ (6)
Process use of Holt-Winters models is summarized as follows:

Estimates of tẍ and tT are obtained as follows :(Eq. 7 and 8)

(0<A< 1 ؛t=4،3،....،n) (7)
$t\ddot{x}= A(\ddot{x}t_{-1} + Tt_{-1}) + (1 - A)\ x_t$
(0<B< 1 ؛t=4،3،....،n) (8)
$tT=B\ t_{-1} + (1 - B)(t\ddot{x} - \ddot{x}\ t_{-1})$

2. With reaching time of n future required quantities x_{n+h} is expected as follows: (about 9).

$\dot{x}_{n+h}=\ddot{x}_n+ht_n$ ، (h= 1 ، 2 ، 3) (9)

Ever simple development model

In many cases of ever simple development models time series are used to forecast future values. This method is one of the best ones and yet simple forecast that is considered basis for the other forecast methods. Simple development method is useful for time series which are not considered periodical changes. The method of forecasting next period data consists: ever simple development formula (Equation 10).

$$F_{t+1} = F_t + a(A_t - F_t) \qquad (10)$$

Ft + 1 calculates to forecast next periods, Ft to forecast pre-periods and, the actual amount for the pre-periods. Whatever alpha with ever development nears coefficient to zero, reflecting recent data is worthless and whatever with ever development nears to one, shows that recent data e more valuable.

Results and discussion

In The time-series related data to the number of dust during the statistical period (2010-1990) has shown annually. (Table 3)

First in order to determine seasonal process and changes should be selected time series diagram to each of the cities that in this research we have done this work by using Minitab software 17.

Table 3: Distribution of dust phenomenon in Khuzestan province during 1990-2010

YEAR	MASJED SOLEYMAN	AHVAZ	RĀMHORMOZ	DEZFUL	BEHBEHAN	AGHAJARI	ABADAN	OMIDIYEH
1990	9	93	42	148	*	35	81	79
1991	48	159	22	179	*	84	65	123
1992	84	146	55	*	*	88	86	*
1993	58	56	20	*	***	43	60	78
1994	66	82	49	102	48	72	83	107
1995	48	33	9	78	2	13	35	37
1996	57	26	16	73	9	6	31	39
1997	70	38	18	150	12	12	46	88
1998	8	12	0	50	8	4	26	58
1999	50	54	27	76	13	9	54	75
2000	116	97	72	112	62	60	84	174
2001	40	47	9	46	6	7	40	161
2002	45	53	9	58	3	17	39	152
2003	129	108	70	124	49	70	84	235
2004	65	64	22	94	31	47	49	166
2005	79	102	30	117	44	77	79	189
2006	41	72	29	121	28	39	74	190
2007	49	104	40	80	45	71	75	202
2008	110	152	92	118	118	127	144	231
2009	131	160	106	112	102	120	170	187
2010	96	104	71	84	66	82	134	136

As shown in Figure 1, the existed time series has uneven and the most changes surface in which time series for to be taken dust samples for each of the cities. Observing the changes which in general can study status of each city individually in terms of dust phenomenon

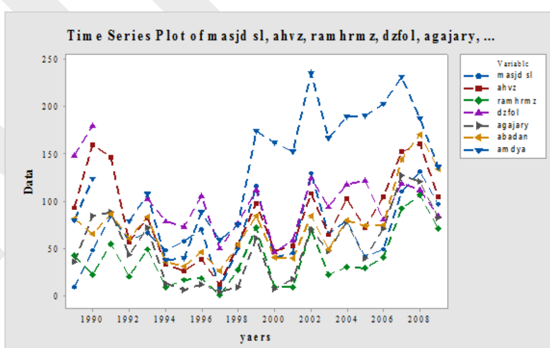

Figure 1: Time series diagram of dust phenomenon in cities of province Khuzestan during 1990-2010

Table 4: explain the model to predict the number of dust Selected cities of Khuzestan province for years (2016-2020)

	Cities	Model. No	Model type
Best models	Masjed Soleyman	1	Holt Winters
	Ahvaz	2	Growth smooth
	Rāmhormoz	3	Growth smooth
	Dezful	4	ARIMA (0,0,0)
	Behbehan	5	Holt Winters
	Aghajari	6	Growth smooth
	Abadan	7	Growth smooth
	Omidiyeh	8	Growth smooth

Output of Table (4) is model explanatory. According to the professional modeler it is possible to the software automatically choose the best model for dust forecasting annually basis on each of the cities. In fact, the findings show that the for city of Masjed Soleiman and Behbahan the Holt winters model is proper, for cities Ahvaz, Rāmhormoz, Aghajari, Abadan and Omidiyeh from ever simple development model provide accurate results, and finally for the Dezful ARIMA model (0, 0, 0) have been recognized as the most appropriate model for the dust phenomenon in years (2016-2020)

Outputs in the table (5) show the adaptation rate of forecast model with actual values at the level of all the models. For each statistic of the current table shows mean, standard deviation, maximum and minimum number value among all the models. It can also see the percentage of the numerical value of the statistical distribution. To percentiles also stated the percentage of models, numerical values for statistical adaptation with smaller amounts certainty level. In fact percentile of the model shows that they have had several percentages of numerical value compatibility tests.

Table 5: amount of adaptation model of predictions with actual values in all models for selected cities in Khuzestan province during the statistical period of (1990-2010)

Compatibility test	Mean	SE	Minimum	Maximum	Percentiles						
					5	10	25	50	75	90	95
Static coefficient of determination	.318	.306	-110.2	.820	-210.2	-210.2	.123	.200	.649	.820	.820
The coefficient of determination	.266	.183	-110.2	.495	-210.2	-210.2	.104	.236	.465	.495	.495
Mean Square Error	739.34	208.8	040.25	360.48	040.25	040.25	483.29	919.31	545.425	360.48	360.48
Mean Absolute Error	292.77	648.54	688.29	927.190	688.29	688.29	218.32	980.66	680.106	927.190	927.190

Absolute maximum relative error	15.409	35.369	306.94	03.1162	306.94	306.94	107.123	722.274	980.638	037.1162	037.1162
Mean Absolute Error	077.27	597.6	108.18	826.36	108.18	108.18	924.21	410.25	161.33	826.36	826.36
The absolute maximum error	739.73	503.17	232.54	806.104	323.54	323.54	296.59	012.68	328.88	806.104	806.104

Table (6) output proceeded to specify forecast model compatibility of annual dust number accuracy to chosen cities of the province which can specify compatibility ability and measurement accuracy through comparison of existing differences in all of the cities from high significant coefficient by use of appropriate models to forecast.

The City Rāmhormoz with highest significant coefficient 0.910, and Ahvaz with 0.153 have allocated the least significant coefficient in the province annual number of dust.

Table6: amount of consistency and accuracy of prediction models in the series when the dust in the cities of Khuzestan province during the statistical period of (1990-2010)

Model	Statistic fitting of model							Ljang factor Box		
	Static coefficient of determination	Coefficient of determination	Mean Square Error	Mean Absolute Error	Mean Absolute Error	Absolute maximum relative error	Absolute maximum error	Statistics	Degrees of freedom	Significantly
Masjed Soleyman	820.	227.	31.068	78.095	23.808	669.954	54.223	20.208	16	211.
Ahvaz	144.	202.	39.784	55.866	32.985	223.021	84.453	22.884	17	153.
Rāmhormoz	294.	071.	28.254	81.103	21.556	326.522	58.203	9.850	17	910.
Dezful	2.11-	2.11-	43.465	29.688	33.220	94.306	89.619	17.699	18	473.
Behbehan	767.	495.	25.040	190.927	18.108	1162.037	62.577	13.978	16	600.
Aghajari	178.	245.	32.769	115.206	26.940	546.057	66.150	18.975	17	330.
Abadan	116.	400.	29.169	36.743	23.099	120.544	69.874	16.606	17	481.
Omidiyeh	221.	478.	48.360	30.709	36.826	130.795	104.806	21.114	17	221.

Study of data Normal distribution:

For this purpose have been used two test of Anderson-Darling in (Minitab17) software, and Kolmogorov - Smirnov in (spss19) Software

Anderson-Darling test

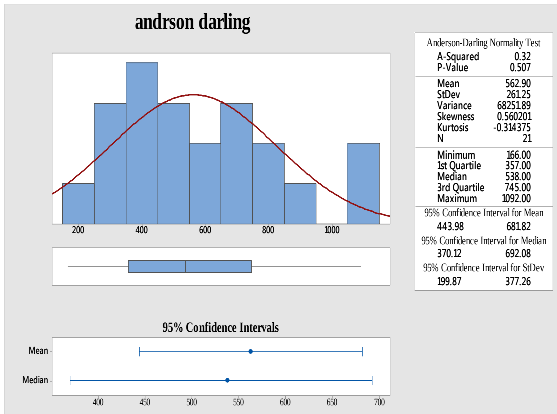

Figure 2: Data normalization study of dust phenomenon of province Khuzestan chosen cities during 1990-2010

According to (Fig. 2) Anderson-Darling diagram can be seen as obtained (P-Value) from the test equals 507/0 and the value is much larger than the test significance level, so dust phenomenon data in province Khuzestan cities during 1990 to 2010 is normal.

Kolmogorov-Smirnov (K-S)

As shown in Table (7) the calculation of amount of dust phenomenon normalization in province Khuzestan cities with differences maximum has been specified in three absolute, positive and negative levels. In this regard, the absolute difference and positive are equal, while there is a difference with negative level which indicates that the absolute level, while positive are larger than the negative surface. Accordingly, with respect to the calculated significance which is larger than level of alpha 0.5, can be accepted that the phenomenon dust data of the province Khuzestan cities are normal.

Table 7: review on data normalization of dust phenomenon of selected cities of Khuzestan province during 1990-2010

dust phenomenon		Value
Number		21
Normal	Mean	562.9048
	SD	261.25063
Maximum difference	Absolute	128.
	Positive	128.
	Negative	073-.
Kolmogrov - Smirnov		587.
Criteria of Decision Making		881.

Homogeneity test of data

There are methods to test the homogeneity of climate data that we go on in the following through test-run test by using 19spss software.

Table (8) findings show the descriptive statistics of Province Khuzestan cities dust phenomenon during the statistical period 1990-2010 which has studied the mean, standard deviation, minimum, maximum, and percentiles of dust phenomenon over the expressed years. Since we choose the Average Test Value and its value is obtained 561.9048. The number of samples lower or higher than or equal to the average has been come in the Test Value table. The number of turnover period (Number of Case 10) has been achieved which regarding to significant level Asymp.sig. (2-tailed), the homogeneity of the data will be accepted. (Table 9).

Table 8: Descriptive statistics dust phenomenon of cities in Khuzestan Province during the statistical period

Descriptive statistics								
	Number	**Mean**	**SD**	**Minimum**	**Maximum**	**Percentage**		
						25	**50**	**75**
Duct	21	9048.562	26351.251	00.166	00.1092	0000.357	0000.538	0000.745

of 1990-2010

Table9: Test of Run of dust test data in city of Khuzestan Province during the statistical period of 1990-2010

Runs Test	**DUST**
Test Value	562.9048
Cases < Test Value	11
Cases >= Test Value	10
Total Cases	21
Number of Runs	10
Z	-.438
Asymp. Sig. (2-tailed)	.661

With respect to the forecast issue of entered dust quantities into the province Khuzestan chosen cities during the 5-year period (2016-2020) has studied with high and low confidence in 95% confidence level. Table (10) results and shape (3) show that best model to forecast Holt winter has been identified for the city of Masjed Soleiman. In addition the forecast value has done for the years (2016-2020).

It shows the amount of dust reach to 109.24 days annually in 2016 and to 119.83 days in 2020 per year that reflects dust increasing process in future year.

Table 10: Forecast model for the phenomenon of dust entered into during the years 2016 to 2020

Forecast		Years					
Model City		2016	2017	2018	2019	2020	Mean
Holt Winters Masjed Soleyman	Forecast	109.24	111.89	114.56	117.19	119.83	114.542
	up	174.26	176.91	179.56	182.21	184.86	179.56
	Low	21.44	86.46	51.49	16.52	81.54	51.59

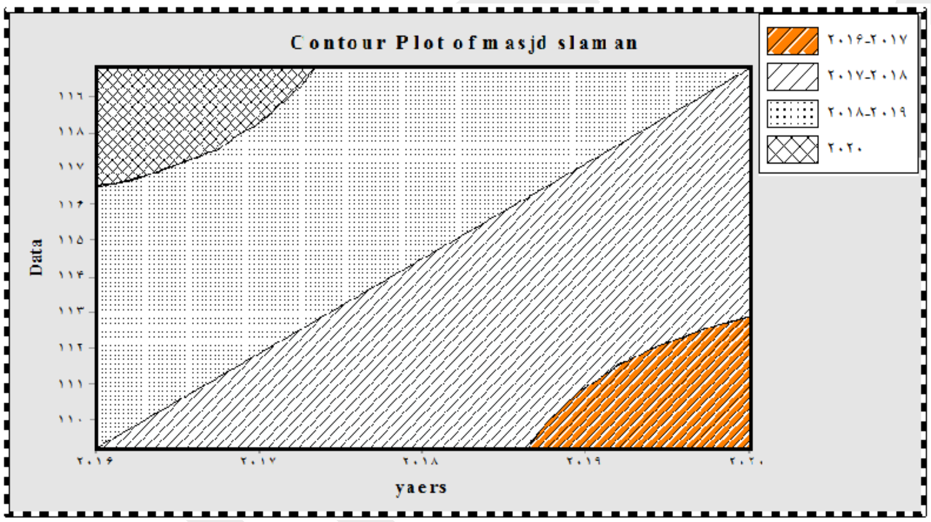

Figure 3: Forecast model for dust phenomenon imported during the years 2016-2020

The results of Table (11) and Figure (4) show that the best model identified for Ahvaz is ever simple development model. The specified values show that the amount of dust in Ahwaz from 2016 to 2020 is 122.13 days per year. Of course the upper limit of this table shows an increasing process since (2016-2020).

Table 11: Forecast model for dust phenomenon imported during the years 2016-2020

	Years					**Forecast**	
Mean	**2020**	**2019**	**2018**	**2017**	**2016**	**City Model**	
13.122	13.122	13.122	13.122	13.122	122.13	**Forecast**	**smooth Growth**
53.269	283.70	276.95	269.89	262.48	254.64	**Up**	

							of
28.25-	-44.39	-69.32	-63.25	-22.18	-40.10	**Low**	**Ahvaz**

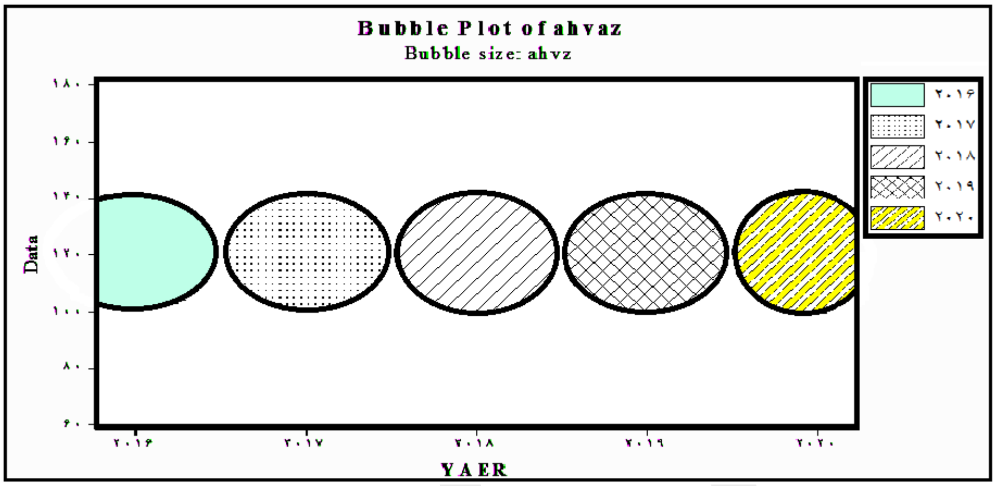

Figure 4: Forecast a model for entering phenomenon of dust during the years of 2016 to 2020

Output of Table (12) and Figure (5) show that the best model identified for Rāmhormoz city. Ahvaz city is ever simple development model. The specified values of forecast for the years of (2016-2020) are fixed and reached to 70.82 days. In fact the upper limit of confidence indicates an increasing process for the forecasted years. According to these findings, Rāmhormoz city has the least forecasted value of dust for the coming years among the selected cities of Khuzestan province.

Table 12: Forecast model for the phenomenon of dust entered into during the period 2016-2020

	Years					**Forecast**	
Mean	**2020**	**2019**	**2018**	**2017**	**2016**	**City Model**	
70.82	82.70	82.70	82.70	82.70	70.82	**Forecast**	Growth smooth
149.25-	07.154	73.151	149.32	146.84	144.27	**up**	
-61.7	-44.12	-10.10	-69.7	-20.5	-63.2	**low**	

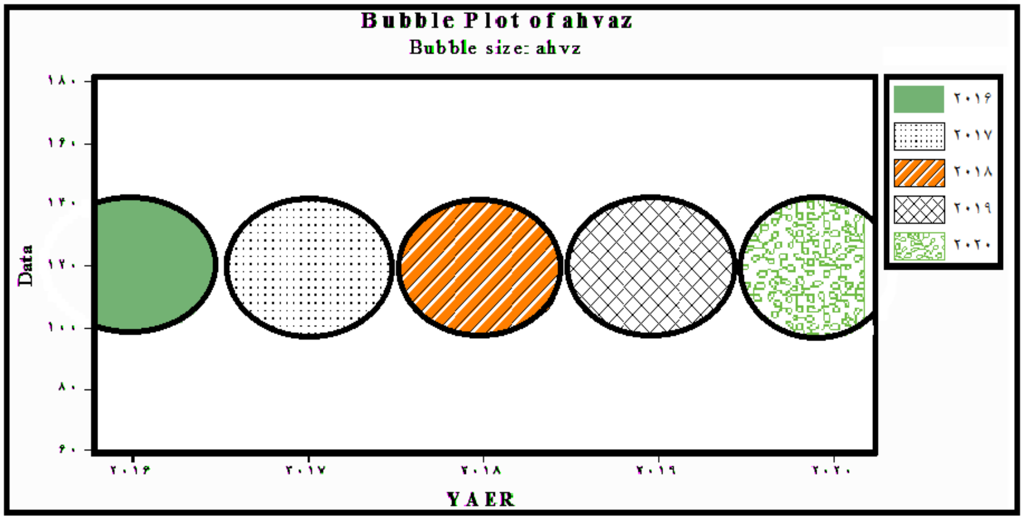

Figure 5: Forecast a model for entering phenomenon of dust during the years of 2016 to 2020

Results of Table (13) indicate that the best model identified for Dezful city in years of (2016-2020) is ARIMA model (0, 0, and 0) (the only identification model for this city). Dezful city after Rāmhormoz city has the least forecasted value of dust between these forecasted years. The number of dust days for the city of Dezful is reached to the average of 89.38 for the forecasted period.

Table 13: Forecast model for the phenomenon of dust entered into during the period 2016-2020

	Years					**Forecast**	
Mean	**2020**	**2019**	**2018**	**2017**	**2016**	**City Model**	
38.89	38.89	38.89	38.89	38.89	89.38	**Forecast**	**Arima Dezful**
05.180	05.180	05.180	05.180	05.180	05.180	**Up**	
-29.1	-29.1	-29.1	-29.1	-29.1	-29.1	**Low**	

The table (14) and Figure (6) indicate that the best identification model for the phenomenon of dust for Behbahan city like as Masjed Soleiman city in the years (2016-2020) is Holt Winters model.

Behbahan city has an increasing process for the years of forecasted period. This city is actually the fifth city in terms of the number of days of dust annually in selected cities of Khuzestan province. Its value is reached to 96.65 days in a year in 2016, and is reached to 112.76 days in a year in 2020.

Table 14: Forecast model for the phenomenon of dust entered into during the years 2016 to 2020

	Years					**Forecast**	
Mean	**2020**	**2019**	**2018**	**2017**	**2016**	**City Model**	
104.73	112.80	.10876	104.73	100.69	65.96	**Forecast**	**Holt-Winters Behbehan**
158.84	167.39	.16312	158.84	154.56	28.150	**Up**	
62.50	21.58	41.54	61.50	82.46	02.43	**Low**	

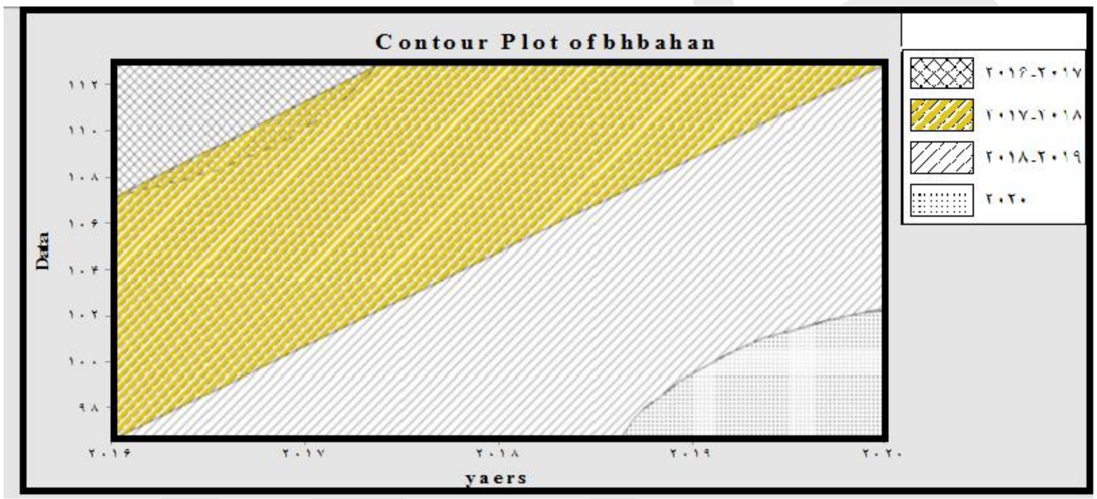

Figure 6: Forecast a model for entering phenomenon of dust during the years of 2016 to 2020

The findings listed in Table (15) indicate that the best model identified for Aghajari city is ever simple development model like as cities of Ahvaz, Rāmhormoz, Abadan, and Omidiyeh. High confidence limit of forecast in Aghajari in 2016 is reached to the value of 198.51 days per year in 2016, and is reached to 219.92 in 2020. In this means the forecast in Aghajari has an increasing process in the forecasted years.

Table 15: Forecast model for dust phenomenon entered into during the years 2016-2020

	Years					**Forecast**	
Mean	**2020**	**2019**	**2018**	**2017**	**2016**	**City Model**	
53.94	53.94	53.94	53.94	53.94	94.53	**Forecast**	**Growth**

20.46	92.219	93.214	209.71	204.25	198.51	**Up**	**smooth Aghajari**
-41.20	87.30-	88.25-	-66.20	-20.15	-46.9	**Low**	

Results of Table (16) indicate that the forecasted value of median of lower and upper limits for Abadan city is fixed in 2016-2020, and is reached to 140.1 per year. In fact Abadan city after Omidiyeh city has the greatest number of dust for forecasted years in the selected cities of the province. The best dust identification model for this city is ever simple development model.

Table 16: Forecast model for dust phenomenon imported during the years 2016-2020

	Years					**Forecast**	
Mean	**2020**	**2019**	**2018**	**2017**	**2016**	**City Model**	
13.140	13.140	13.140	13.140	13.140	140.13	**Forecast**	Growth smooth Abadan
257.14	26913	263.43	257.46	16.251	244.49	**Up**	
13.23	14.11	84.16	81.22	11.29	78.35	**Low**	

The findings listed in the Table (17) indicate that the best dust identification model for the intended year in Omidiyeh city is ever simple development model. The forecasted value for Omidiyeh city is an average of 168.39 days per year with the highest number of dust days compared to the selected cities of the province. The high limit of number of dust days in Aghajari is reached to 318.50 in 2016 and is reached to 348.45 in 2020.

Table 17: Forecast model for dust phenomenon imported during the years 2016-2020

	Years					**Forecast**	
Mean	**2020**	**2019**	**2018**	**2017**	**2016**	**City Model**	
39.168	39.168	39.168	39.168	39.168	39.168	**Forecast**	**Simple weight Omidiyeh**
333.81	45.348	341.45	334.15	326.52	318.50	**Up**	
96.2	67.11-	-67.4	62.2	25.10	27.18	**Low**	

Figure 7 shows dust forecasted values for each of the cities of Khuzestan province along with the decreasing and increasing process during the years of 2016 to 2020. These findings indicate that the amount of dust forecasted for the cities of Masjed Soleiman and Behbahan using the Holt Winters model has increasing process. The cities of Ahvaz, Rāmhormoz, Aghajari, Abadan, Omidiyeh use ever simple development model, and Dezful city using ARIMA model (0, 0, and

0) show a fixed and unchanged process in the next years (2016-2020). Status of dust phenomenon for Omidiyeh city compared to other cities of the province shows different process during the years of 1990 to 2010, so that since 2000 the increasing and growing process of the number of dust days has continued until 2009. But in other cities of the province similar process can be seen.

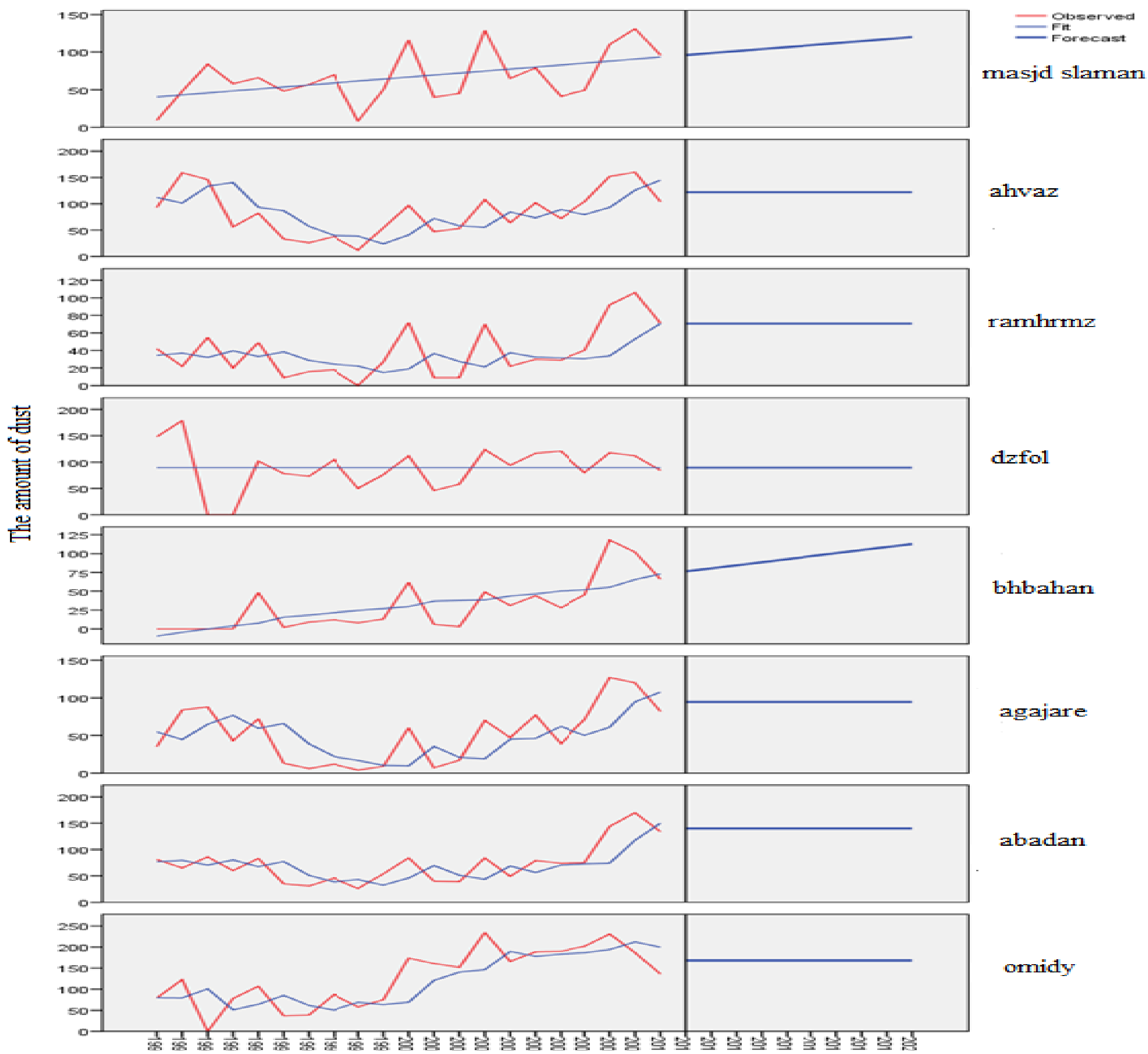

Figure 7: Forecast the number of dust entering the selected cities in Khuzestan province during the years (2016-2020).

Conclusion

Statistical methods are considered efficient and useful tools to understand and evaluate climate behavior. One of the usages of statistics in climatology is climatic elements behavior modeling. Arima group patterns are widely used statistical patterns that climatologists have paid high attention to it. Time series models have rich level of various and different structures in dust forecast modeling. Usually these models require large amounts of data to make a successful prediction model.

Personal judgment and experience in selecting the parameters and optimal model is important in these models. In fact, choosing the best model has no specific form, and is done by trial and error. Time series model was used in this research to identify and predict the amount of dust entering the selected cities of Khuzestan province during the statistical period of 1990-2010. The results show that the best time series models of dust for the cities of Masjed Soleiman and Behbahan has been achieved by Holt Winters Forecasting model, for Dezful city has been achieved only by ARIMA model (0,0,0) and for the cities of Ahwaz, Rāmhormoz, Aghajari, Abadan and Omidiyeh the proper model is ever simple development model. The results of forecasting dust for the years of (2016-2020) show that the cities of Masjed Soleiman and Behbahan using Holt Winters model have increasing process, and for the cities of Ahvaz, Dezful, Rāmhormoz, Aghajari, Abadan and Omidiyeh have fixed and unchanged process during the specified years. The amount of forecasted dust for years of 2016-2020 for the selected cities in Khuzestan Province shows that Omidiyeh city with the highest amount of dust (is reached to average of 168.39 days per year) and Rāmhormoz city with the least amount of dust (is reached to average 70.82 days per year).

Dust storms prevention and control strategies

Biological actions are key strategies to overcome dust storms. An example of such actions include the creation of vegetation cover in desert areas, other actions include the development of ecological barriers like a forest belts that impede the progress of desert.

Mechanical strategies

Mechanical actions include the use of cover is to stabilize sand dunes. These coatings are grains of wheat straw, rice, sand, gravel, sawdust, Montmorillonite, plants leaf, lignin, plants and animals fertilizers, which are widely used in China. Also the synthetic materials such as polymer (acrylic polymer emulsion and poly-acrylic acid) and polyethylene coatings are used in some areas of the United States.

Engineering strategies

China's arid provinces use wire fences in high population areas in order to protect rangelands and lands from overgrazing to prevent further development of the desert.

Chemical strategies

In Iran, waste oil (petroleum mulch) can be used to stop the movement of sand dunes. In China, the chemical materials and plastic mulch is also used in dry areas. Chemical methods are harmful for environment, soil and underground water. Petroleum mulch causes land degradation, which is used. However this method is effective in controlling sands.

Social and economic strategies

The focus of these actions is on land management that includes land reclamation policies, poverty reduction strategies, and greater efficiency in water use (Naddafiet al., 2010: 53)

Miscellaneous strategies to reduce release of dust

To prevent the release of short-term dust, various methods including spraying water Batank method must be used before undertaking any actions that impair the Earth's surface. These short-term methods can be completed by stopping activities in high high-speed winds conditions. Dust creator surfaces can be fixed for a more long time by paving a dirt paths or using chemical dust stoppers. Other methods such as sand fences to catch coarse particles, chemical surfactants (surface active substances), mechanical compression, irrigation with sprinkler, and creation of vegetation cover should be used again (Yarahmadi2011: 253,263)

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