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Short Comminucation

Variability and trends of sultry in Hormozgan province in Iran

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Sultry weather is always a problem in tropical and sub tropical counties that adversely affect the human efficiency and its health (Blazejczyk and Matzarakis 2007; Hass 2016) particularly during summer months. Sultriness happens due to warm and humid climatic conditions under which human body cannot lose heat easily by sweating. Various workers have given the threshold values for sultriness based on different weather parameters viz. vapor pressure, temperature and humidity, dew point temperature, wind speed either individually or in combinations (Steadman,1979; Lancaster, 1898; Dieterichs, 1980). Due to increase in temperature, and change in rainfall pattern as a result of climate change, the variability in sultriness has increased (Ghaedi and Masoudian, 2007; Chattopadhyay and Edwards, 2016; Shi *et al,* 2011). Tabatabaei *et al.* (2014) has prepared the maps of southern province of Iran showing various zones based on intensity of sultriness. Borna and Shaeri Karimi (2016) reported a positive trend in the south of Khuzestan province. The non-parametric Mann-Kendall test is commonly employed to detect monotonic trends in series of climate data (Lunagaria *et al*. 2012; Kumar and Sidana, 2017) and the Sen slope estimator is used to calculate the line slope.

Hormozgan province in southern Iran was selected for this study. The long-term (1985 to 2013) data on temperature, relative humidity and vapor pressure of six stations (Table 1) of Hormozgan province were collected from the Meteorology Organization.

The index of sultriness was calculated for each day by the following equation Tabatabaei *et al*. (2014);

$$D = \frac{RH}{21.55} - \frac{100}{T} + 1.3$$

Where, D is the index of sultriness intesity, RH is the relative humidity (per cent) and T is the average temperature (^{0}C). Table 2 shows the classification of sultriness intensity index. When D is equal to or greater than 0.1, the sultry occurs. The index was calculated on daily basis and summed up monthly and annual basis. Mann-Kendall test was applied to test significance in trends of sultriness at different stations.

The mean monthly frequency of sultry days (Fig.1) shows that during cold months (December to February) the sultry weather condition is not felt at any of the stations. The

Table 1: Stations in Hormozgan province of fran

Station	Latitude		Longitude		Height(m)
Abu Musa	25°	52'	55°	1'	110
Bandar Abbas	27°	11'	56°	17'	10
Bandar Lengeh	26°	33'	54°	53'	14
Jask	25°	38'	57°	46'	8
Kish	26°	33'	54°	01'	32
Minab	27°	09'	57°	04'	27

Table 2: Classification of sultriness intensity index (D)

Class	Index (D)
Poor sultry	0.1- 0.49
Middle sultry	0.5- 0.99
Sever sultry	1- 01.49
Very sever sultry	< 1.5

sultry phenomenon appears in April months and be seen until September in most parts of the province. Minab experienced the fewest days with very severe and total sultriness whereas the highest number of these days were observed in Jask. The number of annual occurrence of total sultry days is between 100 to 200 days. The highest (170 days) being at Jask followed by 161 days at Abu Musa, 152 days at Kish, 135-136 days at Bandar Abbas and Bandar Lengeh and the lowest (67 days) at Minab. Minab station is located far from sea and has low degree of sultriness. With the exclusion of Minab because of its distance from the sea, the lowest sultriness was observed in Bandar Lengeh (west of the province) while the highest was related to Jask (east of the province), Therefore, Oman Sea has a greater effect on sultriness compared with the Persian Gulf.

Trend analysis suggests that there was a significant (P=0.05) positive trend of very severe sultry days at Abu Musa, Jask, and also of mean sultry over all stations (Table 3). The sum of all type of sultry days was highly significant (P=0.01) at Abu Musa and Jask. The severe sultry days at Jask and sum of all type of sultry days at Kish were significant at 90 per cent confidence intervals. The trends at other locations were found to be non-significant. Q is the slope and B is a constant of Sen's slope estimator that

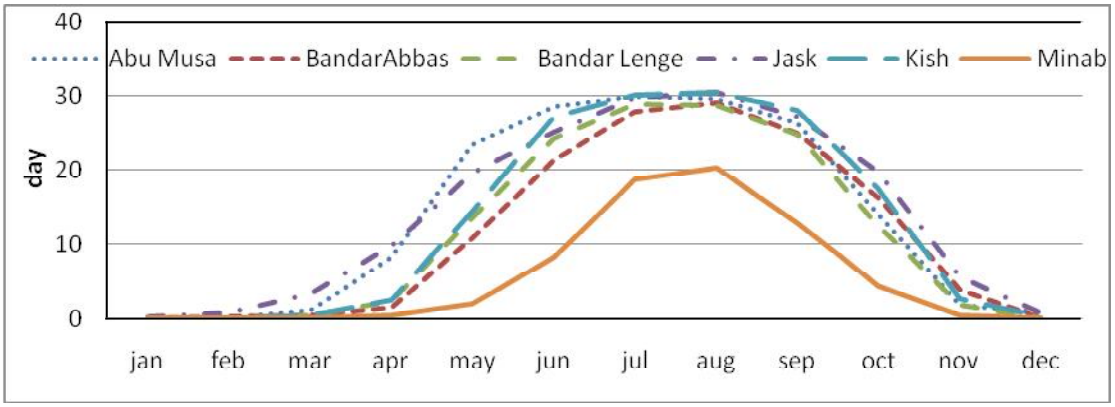

Fig.1: Mean monthly frequency of sultry days

Table 3: Mann- Kendall test and Sen.'s slope estimator

Stations	Intensity of sultry	Test Z	Q	B
Abu Musa	Severe	-0.62	-0.19	88
	Very severe	2.40*	1.72	60
	Sum	2.80**	1.42	146
Bandar Abbas	Severe	0.34	0.09	62.6
	Very severe	-0.11	-0.04	70
	Sum	0.15	0.074	134
Bandar Lengeh	Severe	-0.53	-0.14	78.7
	Very severe	1.45	0.62	54.7
	Sum	1.39	0.43	130
Jask	Severe	1.65+	0.41	42.5
	Very severe	2.31*	0.81	111
	Sum	3.14**	1.17	157
Kish	Severe	0.6	0.15	57.5
	Very severe	0.19	0.0	91
	Sum	1.66+	0.5	145
Minab	Severe	1.18	0.36	53.7
	Very severe	0.4	0.0	3
	Sum	1.61	0.92	51
Mean of all stations		2.57*	0.67	129

+Significant at P=0.1, *P=0.05, **P=0.01, Q = slope, B = constant of Sen's slope estimator

includes positive and negative values. The significant values were all positive indicating increasing trend in sultry days as different locations.

The regression analysis carried for the annual sultry for Abu Musa, Jask and Kish is shown in the Fig.2. The developed functional relationships for the variables are also shown in the charts. The value of slope of Abu Musa is +0.934, Jask +1.183, +0.347 and of the mean of total is + 0.607, which also indicates an upward trend of sultry days.

Thus it can be concluded from this study that the annual frequency of occurrence of sultry days in Hormozgan province fluctuated from 100 to 200. Oman Sea has a greater effect on sultriness compared with the Persian Gulf. The overall mean of sultry days in the province has significant increasing trend. However among the different locations, Jask and Abu Musa has highly significant (P=0.01) positive trend in sum of all type of sultry severity. Other stations had non-significant trends. Regression analysis confirms the result of Mann-Kendall and Sen's slope estimator.

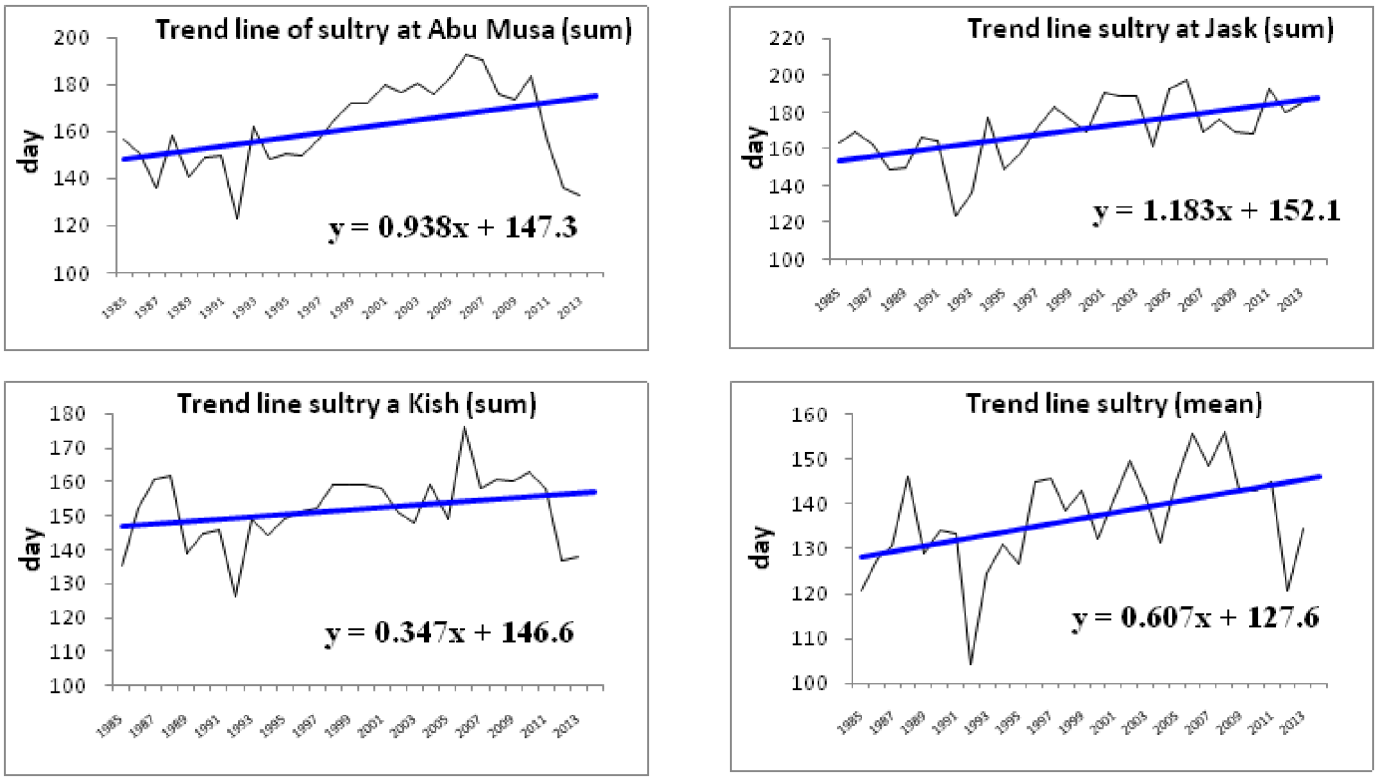

Fig. 2: Regression analysis for stations with significant trend at 95% and 99% confidence level

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