Natural Resoures

Climate Change in Moghan Plain

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Climate change is one of the main challenges in agro-meteorological researches. In recent years, high temperature and moisture stresses caused a reduction in crop yield at some regions of Iran. In present study the climate change of Moghan plain located at the north-west of Iran was investigated using the meteorological data from 1986 to 2000. Results showed that annual total precipitation and average temperature were as 258.9 mm and 14.99 °C, respectively. The minimum and maximum temperatures were occurred in January and July and high variation was for February. From a year to year, the minimum, mean and maximum temperature varied slightly. Total precipitation was increasing in months of a year. The high variation belonged to October with trend slope of 2.95 and indicating an increasing about 3 mm to the annually total precipitation. The maximum and minimum of precipitation occurred for autumn and spring seasons and were as 81.83 and 40.59 mm, respectively.

Introduction

Climate change and global warming is one of the basic challenges of agro-meteorological research. Climate has always changed during the history. But its changes were completely perceived after industrial revolution in the latter half of the 1700s and fossil fuel use, consequently, increasing concentration of CO_2 in the atmosphere. Concentrating greenhouse gases is the main reason of increasing air temperature. Approximately, the air temperature will increased 3°C ,if the concentration of greenhouse gases raise up to two times of pre-industrialization ones. Increasing AT up to 1 to 2°C with 10% reduces in precipitation can be decrease 40 to 70% in runoff quantities. Consequently, decrease in rainfall causes confrontation of wide area of agricultural lands with water deficit, overthrow of many plants species, limitation of extension and quality in civil living, confrontation of environment with serious damages. Due to rising AT the crop evapotranspiration, water requirements for irrigated crops will accordingly increase. Then, it is necessary irrigation practices should be extended over agricultural lands, for compensating augmentation in evaporation results from warmer air. Therefore, a great expenses about 250 milliard $ is essential for using 5% of rainfall water for irrigation over the world. The following cases originated from increase in AT: (a) The precipitation is often as rainfall in the winter, (b) the rivers flows decrease in the summer, with snow-melting at the beginning of the year, (c) the seasonal precipitation and marine storms increasingly occur, and (d) the marines water levels will rise due to oceans warming and polar ice-melting. Climate changes affect agriculture and irrigation. The estimating water requirements of crops, designing canals capacities; irrigation systems; and hydraulic structures are based on meteorological data analysis. Evidently, changes in climate factors can be affect efficiencies of designed and constructed systems. A sample of weather incidents in the last decades are presented as follow: The years 1995 and 1997 were already very warm years on the meteorological record. On 15 Dec. 1986 and 10 Jan. 1993 all time pressure lows on the North Atlantic of 916 mbar were recorded in the surrounding area of Iceland. On Dec. 27th 2001 a typhoon crossed slightly North of Singapore that trees were leveled. Samples of climate events in Iran's agriculture in the recent years are as; Because of rain falling, sugar-beet planting was delayed till the end of June 1991 in Khorasan. Also, cutting rainfall at the end of Mar. 1994 Caused a considerable deficit in irrigation water as well air warming in the spring caused a decrease in pollination and yield of wheat. The moisture and thermal stresses caused reduce in crop yield in Gorgan.

Sevikumar (1992) reported that average precipitation considerably changed since 1960 in Niger, and were often blow normal quantities. Cutforth et la. (1999) showed that since 1950 the max. and min. temperature increased at the end of the winter and beginning of the spring in the Saskatchewan. Gorbani and Soltani (2002) showed that precipitation annually reduced as 4.3 mm but the max and min temperature were without variation during a 40 years period. The Moghan plain which located in the north-west of Iran is one of the important regions for agriculture. Changes in climate factors such as AT and precipitation can affect irrigated and rain-fed lands production in this plain. The rainfall regime in Moghan plain is Mediterranean. Average precipitation and relative humidity are as 260mm and 71.8 %, respectively. Therefore, the present study was made with aim of investigation of climate changes in Moghan plain for identifying and analyzing changes directions.

Materials and Methods

The air temperature and precipitation data analyzed for meteorological station of Parsabad-e-Moghan located at the north-west of Iran (latitude 39º 39´ N, longitude 47° 55´ E, and 31.9 m above mean sea level) in this study. Analyze and compare periods were 1984-2000 and 1961-1981, respectively. Because of effectiveness of AT and precipitation on climate changes, the following factors selected for study; (a) daily mean AT (°C) ,(b) daily max AT (°C), (c) daily min. AT (°C), (d) days sum having temperature more than 35°C (DT>35), (e) annual precipitation (mm), (f) days sum having precipitation more than 1mm (P>1), (g) days sum having precipitation more than 5mm

(P>5) and (h) days sum having precipitation more than 10mm (P>10). The variations of above factors during months and years using linear regression were investigated.

Results and Discussion

Air Temperature Data Analysis

Annual AT during 1984-2000 period averaged as 14.99°C and varied as coefficient of 6.25%. The min. and max. AT belonged to Jan. and July and were as 3.37 and 27.52°C, respectively. The highest variations of AT was for Feb. (Table 1).

Table1: Mean air temperature and its coefficients of variations for months of year.

Months	*Mean AT (°C)*	*Coefficient of Variations (%)*
Jan.	3.37	29.48
Feb.	4.09	40.89
Mar.	7.57	22.43
Apr.	14.30	11.27
May	19.38	7.23
Jun.	24.81	7.58
July	27.52	5.12
Aug	26.88	4.79
Sep.	22.09	6.45
Oct.	15.45	8.37
Nov.	9.19	18.07
Dec.	4.76	33.36
Annual	14.99	6.25

Table 2 shows slope and correlation coefficient of variations trends for mean, min. max AT and DT>30. Results present that mean AT slightly changed (slope= -0.024 and r =0.124) year by year (from 1984 to 2000). There was found no changes in slope of trends for months of years excluding Sep. (slope= -0.129 and r =0.458*). Also, min. AT somewhat changed (slope= 0.0048 and r =0.058) year by year. The highest and least changes were for Mar. (slope=0.248) and Sep. (slope=0.006). Annually, max. AT slightly changed (slope= 0.090 and r =0.505).The highest and least increasingly changes were for Feb. (slope=0.231) and Jan. (slope=0.003). About 2.3, 2.0 and 1.4°C are augmented to max. AT of Feb., Dec. and Aug. every ten years. There wasn't statistically found changes between months or years for DT>35. The mean AT from the 1984-2000 were compared with 1961-1981 periods by paired t-statistics. There was statistically found no difference between mean AT form two periods. Mean temperature for months during two periods was presented in Figure 1. The mean AT for 1961-1981 and 1984-2000 periods obtained as 14.71 and 14.95°C, respectively.

Precipitation Data Analysis

There is annual precipitation was obtained as 258.9 mm with coefficient of variation of 19.22%. Its min. and max. respectively were as 319.7 and 153 mm and for 1996 and 1991. The max. and min. precipitation respectively were obtained for the fall (81.835 mm) and summer (40.594 mm). Also, the spring and winter precipitations were as 77.721 and 63.956 mm. Table 3 shows that the max. and min. precipitation were for months of Oct. and July with 36.259 (as 14% annual precipitation with CV=88.2%) and 7.264 mm (as 2.8% annual precipitation with CV=143.97%) that present a major changes of precipitations in two months. Table 4 presents that annual precipitation had a slight changes year by year but increasingly changes for months. The highest variation was for Oct. (slope=2.949*) that annually adds 3 mm to the precipitation.

Annually increasing for Mar. May and Nov. were as 2.7(r=0.56), 2.4(r=0.94) and 2 mm(r=0.73), respectively. The lowest escalating belonged to July with annual increment of 0.55 mm (r=0.44). Consequently, it seems an increasingly changes in precipitation during crop growing season, caused an escalating in crop yield. Therefore, it is recommended that planting date in rain-fed lands should be determined considering of precipitation changes trends.

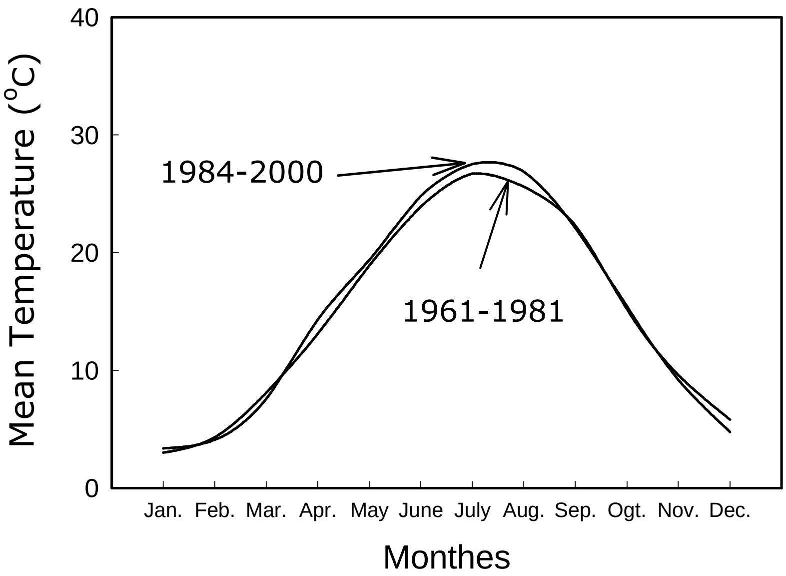

Figure1. Mean temperature for months during 1961-1981 and 1984-2000.

Table3: Mean precipitation and its coefficients of variations for months of year.

Months	*Mean Precipitation (mm)*	*Coefficient of Variations (%)*	*% relative to annual*
Jan.	15.912	83.013	6.15
Feb.	19.344	56.058	7.47
Mar.	28.700	69.249	11.08
Apr.	24.562	96.719	9.48
May	34.576	76.747	13.35
Jun.	18.582	83.858	7.18
July	7.264	143.970	2.80
Aug	8.541	128.379	3.30
Sep.	24.788	166.667	9.58
Oct.	36.259	88.176	14.00
Nov.	25.629	84.315	8.98
Dec.	19.947	92.598	7.70
Annual	258.9	19.224	1.00

Table 2. Monthly variation of air temperature for Moghan climate condition.

Months	Min AT		Mean AT		Max. AT		DT>35	
	Slope	r	Slope	r	Slope	r	Slope	r
Jan.	-0.038	0.515*	0.0025	0.01ns	0.003	0.011ns	0.00	-
Feb.	-0.041	0.205ns	0.027	0.078ns	0.231	0.517*	0.00	-
Mar.	0.248	0.775**	0.045	0.126ns	0.161	0.381ns	0.00	-
Apr.	0.092	0.379**	0.021	0.061ns	0.169	0.364 ns	0.055	0.231ns
May	0.109	0.577*	-0.045	0.162ns	0.056	0.170ns	0.296	0.410ns
Jun.	0.004	0.021ns	-0.084	0.226ns	0.012	0.038ns	-0.051	0.043ns
July	0.026	0.188ns	-0.036	0.129ns	0.065	0.242ns	0.110	0.22ns
Aug.	0.155	0.694**	0.047	0.185ns	0.140	0.529*	0.188	0.288ns
Sep.	0.006	0.037ns	-0.129	0.458*	-0.099	0.310ns	-0.247	0.276ns
Oct.	0.045	0.192ns	0.019	0.076ns	0.119	0.306ns	0.039	0.288ns
Nov.	-0.050	0.199ns	-0.059	0.181ns	0.065	0.144ns	0.00	-
Dec.	0.149	0.510*	0.099	0.317ns	0.207	0.563*	0.00	-
Annual	0.0048	0.058ns	-0.024	0.124ns	0.090	0.505*	0.141	0.055ns

Results revealed that days sum having precipitation more than 1mm (DP>1) didn't change year by year. The DP>1 increasingly changed for months. The highest changes were for May (slope=0.46**) that about one day is increased to mentioned days sum during two years (Table 4). Annually increasing for Mar., Oct. and Feb. were nearly identical. There are about two days were increased to DP>1 in mentioned months during five years as well as during two years only one days were increased to DP>1 in Jan. There are found no changes in Apr. June and Dec. (Table 4). Results showed that days sum having precipitation more than 5mm (DP>5) didn't change year by year. The DP>5 increasingly changed for months. The highest changes were for Oct.

Table 4. Monthly variation of precipitation for Moghan climate condition.

Months	Annual precipitation		DP>1		DP>5		DP>10	
	Slope	r	Slope	r	Slope	r	Slope	r
Jan.	1.556	0.404^{*}	0.348	0.62^{*}	0.061	0.196^{ns}	0.000	0.000^{ns}
Feb.	1.717	0.945^{**}	0.406	0.91^{**}	0.107	0.498^{*}	0.027	0.378^{ns}
Mar.	2.749	0.563^{*}	0.418	0.93^{**}	0.189	0.389^{ns}	0.045	0.027^{ns}
Apr.	1.887	0.715^{**}	-0.139	0.33^{ns}	0.115	0.858^{**}	0.050	0.549^{*}
May	2.417	0.937^{**}	0.463	0.93^{**}	0.177	0.999^{**}	0.047	0.763^{**}
Jun.	1.584	0.597^{*}	0.179	0.29^{ns}	0.121	0.490^{*}	0.037	0.460^{ns}
July	0.556	0.444^{ns}	0.076	0.68^{*}	0.029	0.400^{ns}	0.022	0.334^{ns}
Aug.	0.706	0.426^{ns}	0.102	0.56^{*}	0.037	0.400^{ns}	0.015	0.417^{ns}
Sep.	2.316	0.283^{ns}	0.188	0.41^{ns}	0.128	0.338^{ns}	0.079	0.320^{ns}
Oct.	2.949	0.646^{*}	0.412	0.89^{**}	0.212	0.541^{*}	0.082	0.420^{ns}
Nov.	2.003	0.730^{**}	0.353	0.95^{**}	0.135	0.616^{*}	0.046	0.408^{ns}
Dec.	1.477	0.725^{**}	-0.132	0.26^{ns}	0.081	0.83^{**}	0.027	0.389^{ns}
Annual	0.506	0.023^{ns}	-0.051	0.032^{ns}	-0.142	0.145^{ns}	-0.011	0.333^{ns}

(slope=0.212*) that about one day is increased to days sum during five years (Table 4). The DP>5 changed annually having slope of 0.177 for May. There are no changes in DP>5 for Jan., Mar., Jul., Aug. and Dec. months. The days sum having precipitation more than 10mm (DP>10) didn't change for months and years (Table 4).

The return periods for precipitation occurrence were estimated based on 1984-2000 data. It is expected a precipitation will occur as 267,293,303 and 319 mm or more than for 1,2,3 and 12 years, respectively (Figure 2).

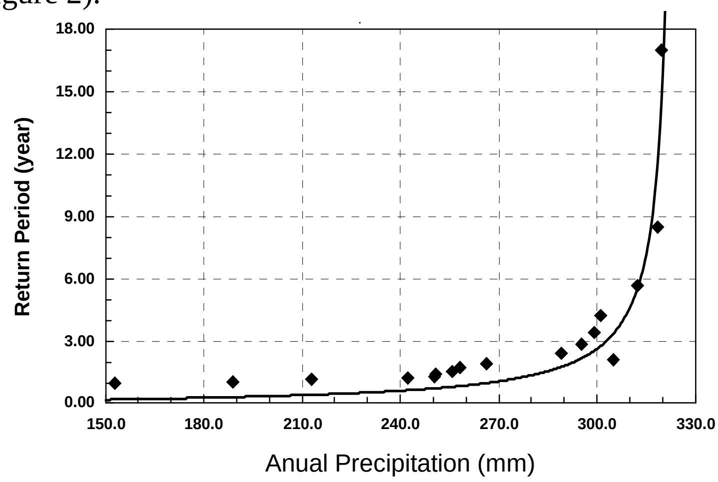

Figure 2. Annual precipitations versus return periods estimated based on 1984-2000 data.

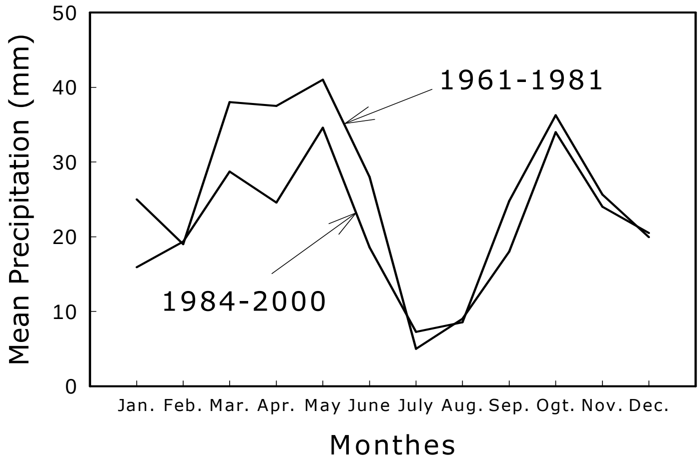

Figure 3. Mean precipitation versus months for 1961-1981 and 1984-2000 periods.

The mean precipitation from 1961-1981 compared with ones of 1984-2000 periods by using paired t-statistics that obtained as -1.62. There are found no difference between mean precipitations acquired from above-cited two periods (Figure 3). Annual precipitation for 1961-1981 and 1984-2000 periods obtained as 299 and 264.1 mm, respectively.

Conclusion

Air temperature and precipitation data during 1984 - 2000 period from meteorological station of Parsabad were analyzed and compared with data during 1961-1981 period. There was found no changes in minimum, mean and maximum temperature as well as DT>35, annual precipitation, DP>1, DP>5 and DP>10, year by year. The min., mean and max. temperatures were as 3.37, 14.99 and 27.52°C, respectively. The mean temperature changed in Dec. and Sep. About 2.3, 2.0 and 1.4°C are increased in max. temperature of Feb., Dec. and Aug. every ten years. There was found no statistically difference between mean AT form two periods of 1984 - 2000 and 1961-1981. Annual precipitations for the first and second periods were 299 and 258.9 mm, respectively. The max. and min. precipitation belonged to Oct. and July which were as 36.259 and 7.264 mm. The max. and min. precipitations were occurred in the fall and summer that were 81.835 and 40.594mm, respectively. In general, precipitation changed as increase in months year by year. The max. change was for Oct. which about 3 mm is increased to precipitation during one year. The min. change was for July. Consequently, it seems the increasingly changes in precipitation during crop growing season, caused an increasing in crop yield. Therefore, it is recommended that planting date in rain-fed lands should be determined with considering of changes trends of precipitation occurrence. The DP>1 increasingly changed for months. The highly changes was for May that about one day is increased during two years to mentioned days sum. During five years about two days were increased to DP>1 in March (Mar.), Oct. and Feb. as well as during ten years abut five days were increased to DP>1 in Jan. There are found no changes in foregoing days sum in Apr. June and Dec. An increasingly changes were found in days sum having precipitation more than 5 mm in months year by year. The highly changes were for Oct. that for every five years, one day was increased to mentioned days sum. The return period for precipitation occurrence was estimated. It is expected a precipitation will occur as 267 and 319 mm or more than for 1 and 12 years, respectively. There are found no difference between mean precipitations acquired from two periods of 1961-1981and 1984-2000.

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