Journal of Agrometeorology 17 (2) : 271-272 (December 2015)

Short Comminucation

Trends and variability in pan evaporation at Ludhiana

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Evaporation is one of the most important components of hydrological cycle having a significant impact on crop water requirements. It has a great significance in the application of need based irrigation to the crops. Under present scenarios of changing climatic conditions and depleting water resources, its importance increase manifolds. Because of the dependence of pan evaporation on climatic conditions, any changes in the meteorological parameters i.e. temperature, relative humidity, rainfall, wind speed etc. lead to changes in rate of evaporation and finally affect the crop water requirements.

Increased concentration of green house gases increases temperature across the globe (IPCC, 2007). In future, evapotranspiration and crop water productivity will be altered due to climate change (Thomas, 2008; Mo *et al*, 2007). Thus, the impacts of climate change on agriculture and water resources has emerged as important issue for scientists as well as policy makers (Gregory and Ingram, 2000; Sanchez, 2000; Furher, 2003). To adapt crop systems to changing climate, it is important to know how climate change affects water resources, crop and water productivity (Guo *et al*, 2010), but before conducting such studies long-term analysis of trends and variability in pan evaporation is indispensable.

The state of Punjab is already suffering from depleting water resources, climatic variability impacts and increased occurrence of extreme weather events. Under such conditions, it becomes inevitable to analyse the long-term variability in the rate of pan evaporation, so that management techniques for efficient and sustainable utilization of water resources can be explored in view of the changing climatic conditions. Keeping this in mind, the present investigation was carried out to analyse the long-term variability and trends of open pan evaporation in central Punjab.

Data on open pan evaporation and other meteorological parameters was collected for a period of 44 years (1970 – 2013) from the Agrometeorological Observatory, School of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana situated at 30° 54' N latitude, 75° 48' E longitude and at an elevation of 247m above mean sea level. Ludhiana has semi-arid climate with hot summer and mild winter seasons. In order to analyse the long-term variability in open pan evaporation, trend analysis of open pan evaporation was conducted on monthly, seasonal and annual basis.

Monthly variability in open pan evaporation

Significant variation has been observed in monthly open pan evaporation at Ludhiana. Summer months experience highest rate of evaporation which is 307.1±52.2, 265.2±44.3 and 213.2±32.4 mm during May, June and April, respectively (Table 1). Increase in atmospheric humidity during monsoon period decrease rate of evaporation which is 161.2±37.7, 128.4±22.0 and 127.6±18.5mm during July, August and September, respectively. Under moderate weather conditions during the months of March and October, pan evaporation is 117.0±18.4 and 115.2±19.4 mm, respectively. Whereas during the winter months, rate of pan evaporation decreases, which is lowest during the coldest months i.e. 46.9±9.3 mm during January and 50.8±15.8 mm during December. Whereas somewhat increase evaporation is observed during November and February, when it is 74.7±14.0 and 65.3±11.4 mm, respectively.

Trend analysis of monthly pan evaporation over a period of 44 years indicates a decrease during most of the months except March and April, during which no significant change has been observed in the rate of open pan evaporation. Analysis indicates that pan evaporation is decreasing by 0.4, 0.3, 1.2 and 1.0 mm per year, respectively during the months of January, February, May and June. Similarly during the months of July, August, September, October, November and December pan evaporation is decreasing by 0.6, 0.2, 0.6, 1.0, 0.7 and 0.3 mm per year, respectively (Table 1).

Seasonal and annual variability in open pan evaporation

Ludhiana experiences mean annual evaporation of

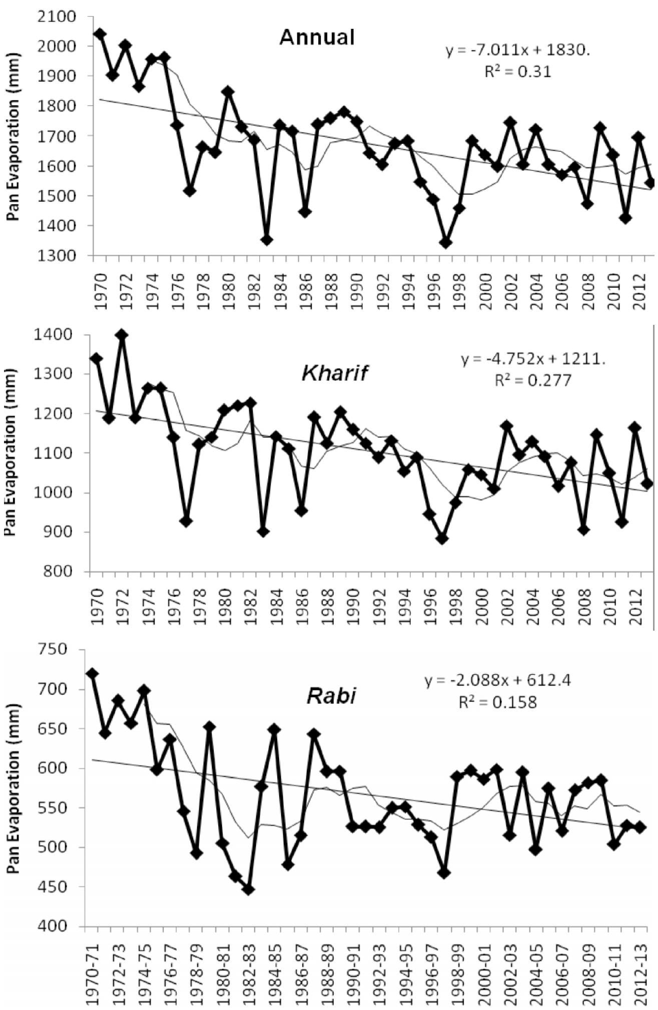

Fig. 1 : Variability in annual, *kharif* and *rabi* season open pan evaporation at Ludhiana

1672.7+295.3 mm. During the past 44 years, maximum annual pan evaporation of 2043.6 mm was observed in 1970 and minimum of 1343.9 mm was observed in 1997. Average *kharif* season pan evaporation during the same period is 1106.7±116.6 mm with a maximum of 1399.1 mm during 1972 and minimum of 883.0 mm during 1997. Similarly, *rabi* season average pan evaporation is 566.5±65.9 mm with a maximum of 720.0 mm during 1970-71 and a minimum of 447.3 mm during 1982-83. Trend analysis of annual, *kharif* and *rabi* season pan evaporation during the period under study indicates a decreasing trend with time (Fig. 1). Analysis depicts annual decrease of 7 mm in pan evaporation which is about 5 mm during *kharif* season and 2 mm during *rabi* season.

Such studies are of great significance for studying the impact of climate change on rate of evaporation and crop water requirements, which can help in the management of limiting water resources and sustainability of crop production under changing climatic conditions.

Table 1: Variability in monthly, seasonal and annual open pan evaporation (1970-2013) at Ludhiana

Month	Mean (mm)	Trend	R^2
January	46.9	y=-0.355x+54.91	0.239
February	65.3	y=-0.289x+71.80	0.106
March	117.0	y=-0.035x+117.8	0.000
April	213.2	y=-0.390x+221.9	0.024
May	307.1	y=-1.202x+334.1	0.087
June	265.2	y=-1.046x+288.7	0.092
July	161.2	y=-0.607x+174.9	0.042
August	128.4	y=-0.235x+133.6	0.018
September	127.6	y=-0.626x+141.6	0.188
October	115.2	y=-1.035x+138.5	0.470
November	74.7	y=-0.734x+91.25	0.452
December	50.8	y=-0.478x+59.93	0.262

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Received : July, 2014; Accepted: June, 2015