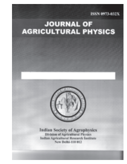
Vol. 10, pp. 44-49 (2010)
Journal of Agricultural Physics
ISSN 0973-032X
http://www.agrophysics.in



Length of Rainy Season and Climatic Water Balance as Influenced by Climate Change in the Sub Temperate and Sub Tropical Mid Hills of Himachal Pradesh

RAJENDRA PRASAD* AND R.S. RANA

Department of Agronomy, CSK Himachal Pradesh Agricultural University Palampur - 176 062

ABSTRACT

Information on climate and its application can make valuable contribution in arriving at the decisions in agricultural practices and management. The agroclimatic region is invariably confronted with dry conditions during the pre sowing periods causing poor establishment of crop stand. The rainfall data for the past 30 (1974-2004) years for Palampur (lat. 32^{o} 6' N and long. 76^{o} 3' E and elevation 1290.8 m) has been analyzed to assess the decadal variations in the onset and withdrawal dates of southwest monsoon and winter rainfall. The seasonal and annual water deficiency/surplus was also evaluated on decadal basis in order to evaluate the possible effects of climate change. The results showed that the length of rainy days during monsoon has been reduced by 5 days and water surplus by 764 mm. The rainy season during winter has also been reduced by 24 days and water deficit has increased by about 41mm (68.3 percent) during past three decades.

Key words: Climate change, Rainfall, Water balance, Monsoon, Himachal Pradesh

Introduction

Water is a highly precious resource. Reports by the Intergovernmental Panel on Climate Change (IPCC) experts have revealed that scarcity of water, droughts and floods would increase due to changing global climate. Mountain ecosystem provide invaluable water resources, forest products, refuge for threatened species, and untouched recreation areas for a rapidly growing and urbanized population. These hills and mountains can be appropriately described as sloping marginal lands where in climatic, hydrological, and ecological conditions change strongly over short distances. Agriculture, horticulture and animal husbandry are the mainstay of 60-70% of the population in the hills despite very small irrigated area.

*Corresponding author,
Email: plm.aicrpam@gmail.com

In Himachal Pradesh, evidence of global warming could be clearly deciphered by changes like receding snowfall in the Himalayas, retreating glaciers (Bhagat, *et al.,* 2004) and drying up of perennial hill springs, shifting of temperate fruit belt upward, adversely affected productivity of apples, shifting and shortening of *rabi* season forward, disrupted rainfall pattern and more severe incidences of diseases and pests over crops and forest trees. The impact of climate change in the context of the mountain regions has already started surfacing. (Partap and Partap, 2002), however, mitigating efforts are still nowhere visible. A mean annual rainfall of 2300 mm is received in the region out of which 77 percent is received during southwest monsoon season, 5 percent in post monsoon season, 8 percent in winter season and 10 percent during summer season (Rana *et al.*, 2005). The mean onset of monsoon occurs on June 21 ±10 days and withdrawal on September 21±9 days. The onset of winter rains is December 16± 29 days and withdrawal on May 27± 4 days (Annon, 2003-04). Water affects the performance of crops not only directly but also indirectly by influencing the availability of other nutrients, the timing of sowing and cultural operations, etc. With water and other production inputs interacting with one another and in proper combinations, crop yields can be boosted manifold under irrigated agriculture. Total annual and seasonal rainfall in Himachal Pradesh is showing a decreasing trend and warming is also being experienced particularly during the months of March, April, May and June (Prasad and Rana, 2005; Annon, 2002-03 and Annon, 2003-04). The variation could possibly influence the length of rainy season and climatic water balance of the region. The present paper attempts to investigate both of these aspects which may have bearing on future water availability and regional water use.

Materials and Methods

The onset and withdrawal of rains during summer and winter rains for Palampur (lat 32° 6′, long 76° 32′ and altitude 1290.8 m) station were worked out following Mooley (1995) procedure and climatic water balance by Thornthwaite and Mather (1955) for three decades viz., decade I (1974-83), decade II (1984-94) and decade III (1995-2004). The weather data of only one India Meteorological Department (IMD) monitored station was considered for this analysis in order to ascertain the quality and consistency in the data base.

Results and Discussion

Onset and Withdrawal of Monsoon

During past three decades, onset of monsoon took place by June 13 in 10 percent of years, June 15 in 30 percent years of, June 17 in 50% years, June 26 in 70 percent years and July 4 in 90 percent of years with mean date on June 21 (Table 1; Annon , 2003-04).

The withdrawal of monsoon during past three decades took place by September 9 in 10 percent of years, September 15 in 30 percent years, September 19 in 50% years, September 24 in 70 percent years and September 30 in 90 percent of years with mean date on September 21 (Table 1).

Table 1. 10, 30, 50, 70 and 90 percentile of onset and withdrawal of monsoon

Percentiles	Onset	Withdrawal
P_{10}	June 13	September 9
P_{30}	June 15	September 15
P_{50}	June 17	September 19
P_{70}	June 26	September 24
P_{90}	July 4	September 30
Mean	June 21	September 21

Normal (±1SD) Between June 11 - July 1 Between September 12 – September 30

Table 2. 10, 30, 50, 70 and 90 percentile of onset and withdrawal of winter rains

	Onset	Withdrawal
P_{10}	November 6	May 22
P_{30}	December 4	May 25
P_{50}	December 19	May 28
P_{70}	January 11	May 30
P_{90}	January 16	May 31
Mean	December 16	May 27

Normal (±1SD) Between November 13 - January 14 Between May 23 – May 31

The onset and withdrawal of monsoon for individual years is presented in Fig 1. The onset of monsoon during decade I took place on June 28± 8days. The onset dates for second and third decades were June 23±14 days and June 15±5 days, respectively. This indicates that the onset of monsoon has shifted back by 13 days from June 28 to June 15 and the variability has also reduced by 5 days from 14 days during second decade. Thundershower activities have also increased during June. There is a sort of overlap of thundershowers with actual onset of monsoon which uses to be a well marked feature of the region.

The withdrawal of monsoon during decade I occurred on September 12±9 days. The dates for decades II and III were found to be September 25±8days and September 21±5days (Fig 1). The variability during withdrawal has been decreased. However, 1979 and 1982 were two years when

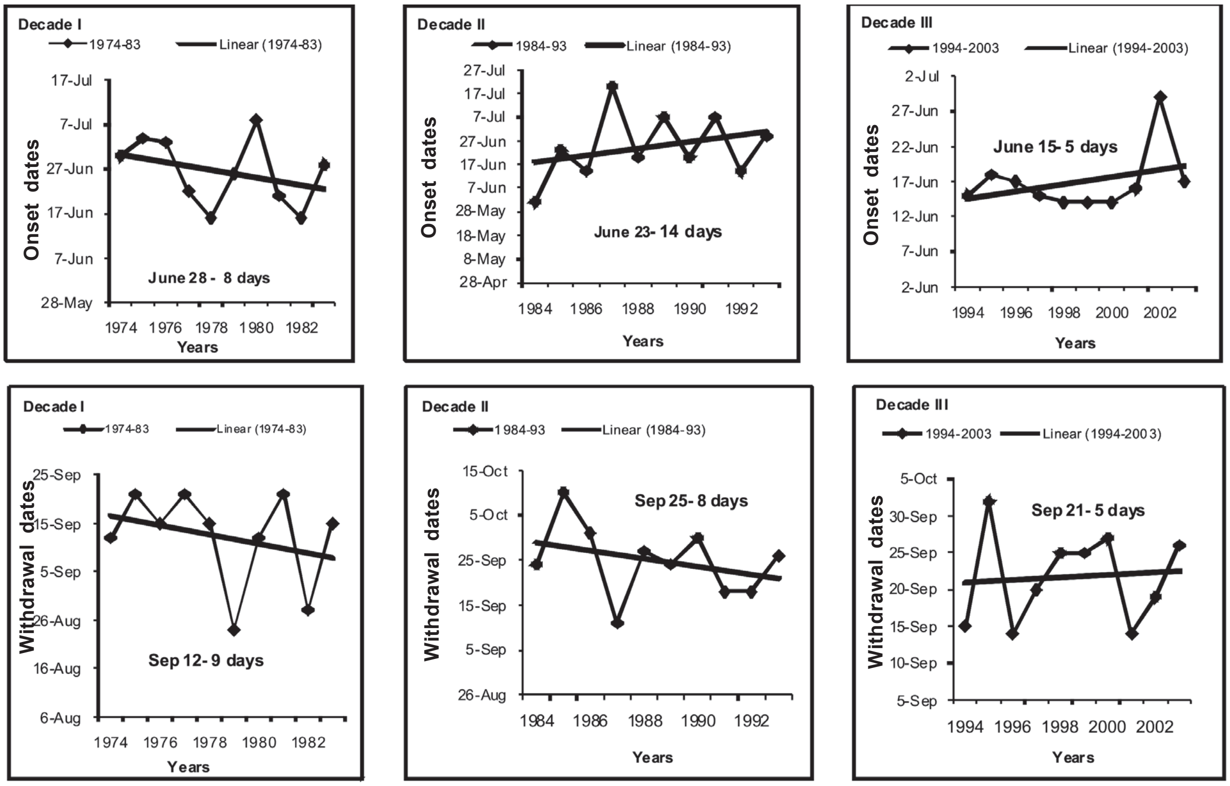


Fig.1. Onset and withdrawal of monsoon rains during three decades

monsoons withdrew as early as by August 24 and 28, respectively.

Onset and Withdrawal of Winter Rains

During past three decades, onset of winter rains took place on November 6 in 10 percent of years, December 4 in 30 percent years, December 19 in 50% years, January 11 in 70 percent years and January 16 in 90 percent of years with mean date on December 16 (Table 3; Annon , 2003-04). The onset and withdrawal of winter rains for individual years is presented in Table 2 and Fig 2. The onset of winter rains during decade I took place on December 6± 21days. The onset dates for second and third decades were December 20±18 days and December 28±36 days, respectively. This indicates that the onset of winter rains has shifted ahead by 22 days from December 6 to December 28. It is pertinent to note that the onset during 1979-80 and 1997-98 was as early as October 11 October 1. Such individual seasons provided better opportunities for higher agricultural production.

The withdrawal during past three decades took place by May 22 in 10 percent of years, May 25 in 30 percent years, May 28 in 50% years, May 30 in 70 percent years and May 31 in 90 percent of years with mean date on May 27 (Table 3 ; Annon , 2003-04). The withdrawal of winter rains during decade I occurred on May 27±3 days. The dates for decades II and III were found to be May 28±3days and May 25±5days, respectively indicating early receding of winter rains by 3 days and variability increased by 2 days (Fig 2).

Duration of Monsoons Rains

The duration of the rainy season during monsoon in decade I was 97 days, it increased to 121 days during decade II and then came down to 116 days during the decade III (Table 4).

Duration of Winter Rains

The duration of the winter rains during decade I was 172 days, it decreased to 159 days during decade II and then came down to 148 days. This

Table 3. Onset and withdrawal dates of monsoon and winter rains during three decades

Years	Monsoon		Years	Winter	
1974	30-Jun	12-Sep	1973-74	17-Dec	27-May
1975	4-Jul	21-Sep	1974-75	24-Nov	21-May
1976	3-Jul	15-Sep	1975-76	12-Jan	25-May
1977	22-Jun	21-Sep	1976-77	10-Jan	29-May
1978	16-Jun	15-Sep	1977-78	29-Nov	27-May
1979	26-Jun	24-Aug	1978-79	21-Nov	25-May
1980	8-Jul	12-Sep	1979-80	11-Oct	31-May
1981	21-Jun	21-Sep	1980-81	26-Oct	31-May
1982	16-Jun	28-Aug	1981-82	2-Nov	27-May
1983	28-Jun	15-Sep	1982-83	23-Nov	29-May
1984	1-Jun	24-Sep	1983-84	10-Jan	30-May
1985	23-Jun	10-Oct	1984-85	11-Dec	25-May
1986	14-Jun	1-Oct	1985-86	25-Dec	31-May
1987	20-Jul	11-Sep	1986-87	16-Dec	23-May
1988	20-Jun	27-Sep	1987-88	24-Dec	28-May
1989	7-Jul	24-Sep	1988-89	19-Dec	25-May
1990	20-Jun	30-Sep	1989-90	6-Nov	30-May
1991	7-Jul	18-Sep	1990-91	14-Dec	26-May
1992	14-Jun	18-Sep	1991-92	21-Dec	30-May
1993	29-Jun	26-Sep	1992-93	31-Dec	31-May
1994	15-Jun	15-Sep	1993-94	10-Jan	24-May
1995	18-Jun	2-Oct	1994-95	7-Dec	22-May
1996	17-Jun	14-Sep	1995-96	14-Jan	28-May
1997	15-Jun	20-Sep	1996-97	21-Jan	31-May
1998	14-Jun	25-Sep	1997-98	1-Oct	18-May
1999	14-Jun	25-Sep	1998-99	8-Jan	24-May
2000	14-Jun	27-Sep	1999-2000	10-Jan	30-May
2001	16-Jun	14-Sep	2000-01	23-Jan	31-May
2002	29-Jun	19-Sep	2001-02	14-Jan	31-May
2003	17-Jun	26-Sep	2002-03	28-Jan	22-May
2004	8-Jun	19-Sep	2003-04	17-Nov	26-May

Table 4. Length of rainy season, water surplus and water deficit during three decades

Period	Length of rainy season (days)		
	Annual	Monsoon rains	Winter rains
Decade I (1974-83)	269	97	172
Decade II (1984-93)	280	121	159
Decade III (1994-04)	264	116	148
	Moisture surplus (mm)		
Decade I (1974-83)	1598	1483	115
Decade II (1984-93)	1323	1285	37
Decade III (1994-04)	834	977	-144
	Moisture deficit (mm)		
Decade I (1974-83)	105	45	60
Decade II (1984-93)	148	44	104
Decade III (1994-04)	145	43	101

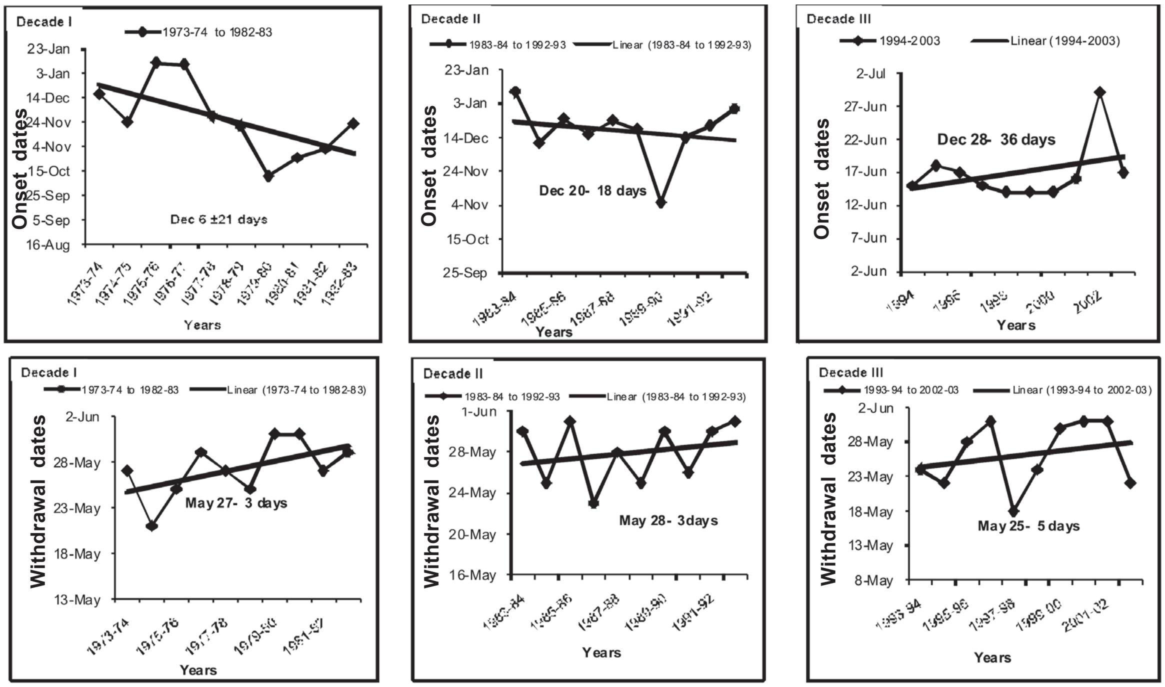


Fig. 2. Onset and withdrawal of winter rains during three decades

indicates that the length of winter rains have decreased by as many as 24 days (Table 4). This reduction in winter rains along with warming during March, April and May could have serious bearing on the selection of wheat varieties.

Annual Moisture Surplus and Deficit

The mean annual moisture surplus in the region is 1259 mm and deficiency is 119 mm (Rana *et al.*, 2005). The value during decade I was 1598mm which decreased to 1323 mm during decade II with reduction by 275 mm. During decade III the values further decreased to 834 mm (Table 4). The overall surplus decreased by as much as 764 mm during the past 30 years which makes about 47.8 percent of total water surplus. The annual moisture deficit was only 105 mm during decade I, which increased to 148 mm during decade II and then stabilized at 145 mm during decade III (Fig. 3).

Seasonal Moisture Surplus and Deficit

The mean seasonal moisture surplus during *kharif* season is 1259 mm which could be harvested and stored for subsequent irrigation of *rabi* crops (Rana, *et al.,* 2005). The surplus during *kharif* was 1483 mm during first decade which decreased by 201 mm (1282mm) during second and by 506 mm (977mm) during the third decade. This reduction is as much as 34.1 percent in past two decades (Table 4).This might have reduced the ground water recharge considerably. It is noteworthy to mention here that the water discharged from the perennial water springs is also decreasing (personal communication). Moisture surplus during winter season */rabi* season was 115 mm during first decade which reduced to 37 mm during second decade and then to -144 mm during third decade. The cumulative deficit increased to 259 mm which is 225.2% of water deficit value of the first decade. Though there is not much decrease in monsoon moisture deficit, the annual moisture deficit increased by 38.1 % (from 105 mm to 145 mm) and winter from 60 to 101 mm, an increase of the order of 68.3 percent.

Conclusions

Not only has the shape of the rainfall curve, indicating the rainfall distribution, has been modified but also moisture surplus and deficit. This investigation clearly brings out that the

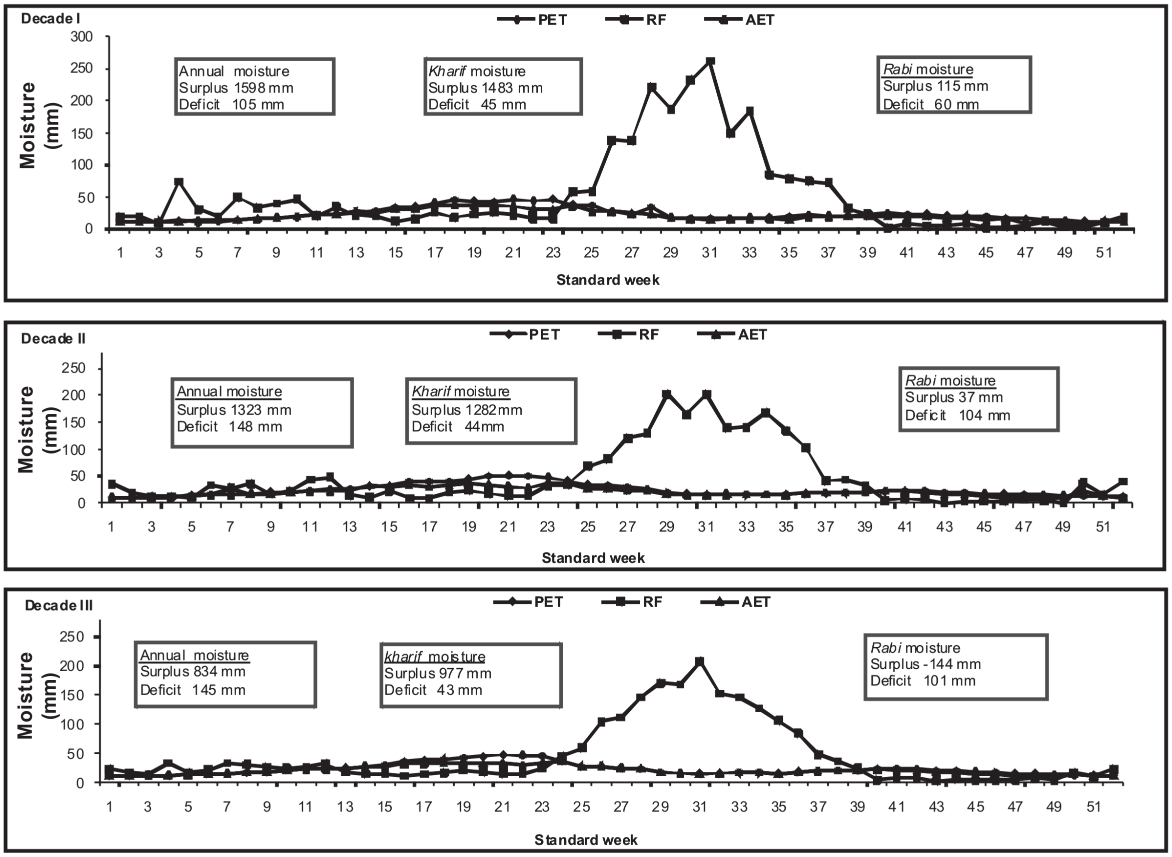


Fig. 3. Climatic water balance during three decades

duration of monsoons rains at the end of third decade is 116 days whereas the duration of winter rains has been reduced by as many as 24 days. The duration of the annual, monsoonal and winter rains surplus have been reduced by 47.8, 34.1 and 179.9 per cent. The moisture deficit during annual and winter rains has increased by 39.0 and 68.3 percent.

References

Annon, 2002-03, All India Co-ordinated Research Project on Agrometeorology, Annual Progress Report, Palampur Centre, Himachal Pradesh.

Annon, 2003-04, All India Co-ordinated Research Project on Agrometeorology, Annual Progress Report, Palampur Centre, Himachal Pradesh.

Bhagat, R.M., Varinder Kumar, Sharda Singh, Vaibhav Kalia, Chitra Sood, Anil Rathore, Basantha Shrestha and Sushil Pradhan. 2004. Mapping Census Indicators and Trends- Himachal Pradesh, India. Final technical report submitted to ICIMOD-Kathmandu Nepal.

Rana R.S., Prasad Rajendra and Kumar, S. 2005. Reliability of medium range weather forecast in the mid hill region of Himachal Pradesh. *Journal of Agrometeorology,* **7**(2).

Mooley, D.A. 1995. Indian Climatology. Pub. In Agrometeorological Data Monitoring and Management. Lecture notes of DST- Sponsored Tarining Course for NCMEWF Agromet Field Units Scientists. Edited by G.B. Pant and K.Rupa Kumar, Indian Institute of Tropical Meteorology 2-23.

Partap, Uma and Tej Partap 2002. Warning *Signals from Hindu Kush Himalayas, Productivity Concerns and Pollination Problems,* International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Prasad, Rajendra and Rana, R.S. 2005. A study of maximum temperature during March 2004 and its impact on *rabi* crops in Himachal Pradesh. *Journal of Agrometeorology,* **7**(2).

Thronthwaite C.W. and Mather, J.R. 1955. *The Water Balance.* Publ. In Climatology. Drexel Inst. Tech. N. J. 8: 1-104.