The Journal of Animal & Plant Sciences, 21(1): 2011, Page: 107-110
ISSN: 1018-7081

IMPACT OF GLOBAL WARMING ON MONSOON VARIABILITY IN PAKISTAN

A. Ghaffar and M. Javid

Department of Meteorology
COMSATS Institute of Information Technology (CIIT), Islamabad
Communicating author; e-mail: aghaffar@comsats.edu.pk

ABSTRACT

This study is based on fifty years (1951-2000) data of temperature and rainfall from six different stations of Pakistan. The selection of the stations is based on hilly areas that are totally dependant on rains. This study is divided into three parts Pre-Monsoon (April- May), Summer Monsoon (June- August) and Post Monsoon (September- October). Variation trends are analyzed based on the processed data that temperature is increasing during Pre and Post Monsoon while rainfall has over all decreasing trend during the study period. Pakistan needs better prediction of Monsoon, accurate calculation of water storage and losses, particularly for the agriculture use.

Key words: Temperature, rainfall, Monsoon variability, prediction, Pakistan

INTRODUCTION

Pakistan is basically a developing country of high variability and deficient rainfall, lying at extreme north-west corner of the Indo-Pak subcontinent. At this time developing countries are facing lack of food and water. For this purpose, accurate prediction of Monsoon will help to understand problems of agriculture, irrigation, flooding, and water reserves. (Chaudhry, 1992; Fowler and Hennessy, 1995; Shen and Lau, 1995; Rasul, *et al.,* 2004); Hatwar, *et al*., 2005; Sika, 2005, Dimri, 2006; 2007). This region, as compared to others, experiences four distinct seasons, winter (December–February), Pre-Monsoon (March–May), Monsoon (June–September) and Post Monsoon (October–November). (Wu and Zhang, 1998, Latha and Badarinath, 2004; Ding, 2007). Summer Monsoon in Subcontinent India is going to be extreme. Temperature, CO_2 and CH_4 records of past decades represent this change (Joseph and Raman, 1966; Pant, 1982; Joseph 1990; Siegenthaler, *et al.*, 2005). One of the key controls of the seasonal-to-inter annual variability of the Asian summer Monsoon is associated with the reversal of meridian temperature gradient in the upper troposphere over the Tibetan Plateau and regions to the south in May and early June, (Tu and Hauang, 1944; Geol and Srivastava 1990; Wu and Zhang 1998).

In this study all stations are selected from totally rain dependant mountaineous region
(i) Gilgit (ii) Muzaffarabad (iii) Kakul (iv) Murree (v) Peshawar (vi) Islamabad. All these areas are from active Monsoon region,

Data of monthly rain fall and monthly mean temperature of 50 years (1951 -2000) is considered for this study. Temperature trend of Monsoon region is checked by mean monthly temperature and through monthly rainfall precipitation and then Monsoon behavior based on these factors is analyzed. (Anonymous, 1995, 2005; Ding, 2007).

For this purpose Monsoon is divided into three parts and after the data processing the following finding are made (Tables 1-4)

(i) Pre-Monsoon Period (April & May)
(ii) Summer Monsoon Period (June, July & August)
(iii) Post Monsoon Period (September & October)

Gilgit; In Pre-Monsoon, both temperature and rainfall are decreasing in April and May.

In Summer Monsoon, temperature of June, July and August is decreasing while rainfall has increasing trend in all these three months. In Post Monsoon, temperature in September and October is decreasing while rainfall is same.

Muzaffarabad; In Pre-Monsoon, Temperature of April and May has increasing trend. Rainfall in April is also increasing while in May it has no change. In Summer Monsoon, temperature of June, July and August is decreasing while rainfall in June and July is increasing. But rainfall in August has rapid decrease. In Post Monsoon, temperature in September and October is again decreasing but rainfall in October has only decreasing trend.

Kakul; In Pre-Monsoon, temperature of April and May is decreasing but rainfall in April is increasing. In Summer Monsoon, temperature in June, July and August is decreasing while rainfall in June is only increasing but in July and August rainfall is decreasing. In Post Monsoon, temperature has again decreasing trend while rainfall has slight increasing trend.

Murree; In Pre-Monsoon, the temperature of April is decreasing and in May is increasing. Rainfall in April has increasing and in May has decreasing trend. In Summer Monsoon, the temperature of June is decreasing while in July and August, it remains same. Rainfall in all three

months is decreasing. In Post Monsoon, temperature and rainfall has increasing trend in both September and October.

Peshawar; In Pre-Monsoon, temperature in April and May has increasing trend, rainfall in April is increasing while in May it is decreasing. In Summer Monsoon, temperature has no change, while rainfall has small increasing trend. In Post Monsoon, both temperature and rainfall are increasing in September and October.

Islamabad; In Pre-Monsoon, the temperature of April and May is nearly same; rainfall in April has decreasing trend while in May has increasing trend. In Summer Monsoon, the temperature of June, July and August, has decreasing trend, rainfall in June is nearly same but in July, it has increasing trend while in August it has no such increasing trend, as observed in July. In Post Monsoon, temperature is nearly same but rainfall in September is increasing trend while in October, it is nearly same.

Table 1.Annual Mean Temperature variability (1951-2000)

Stations	AMTV			MMTV			WMTV			PMMTV			PoMMTV		
	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av
Gilgit	15.8			25.2			6.5			18.4			12.8		
Muzaffarabad	20.5			28.3			12			23.3			18.9		
Kakul	17.1	15.8-22.7	18.3	24.3	19-31.2	26.2	9.3	5.5-13.5	9.9	19.7	15.2-15.9	21.3	16	12.8-20.6	16.7
Murree	12.8			19			5.5			15.2			12.5		
Peshawar	22.7			31.2			13.5			25.9			20.6		
Islamabad	21.4			29.1			12.7			25.1			19.5		

Table 2. Mean Minimum Temperature variability (1951-2000)

Stations	AMTV			MMTV			WMTV			PMMTV			PoMMTV		
	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av
Gilgit	8.1			16.2			0.5			10.8			4		
Muzaffarabad	13.6			21.8			5.5			16.2			10.7		
Kakul	11.4	8.1-15.9	12	19	16.2-25.2	20.1	3.8	0.5-6.7	3.9	13.4	10.8-17.5	14.6	9.5	4-12.9	9.3
Murree	8.7			15.2			1.4			10.8			8.1		
Peshawar	15.9			25.2			6.7			18.7			12.9		
Islamabad	14.3			23.2			5.4			17.5			10.9		

Table 3. Mean Maximum Temperature variability (1951-2000)

Stations	AMTV			MMTV			WMTV			PMMTV			PoMMTV		
	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av	MT	T. Range	Av
Gilgit	23.7			34.4			12.7			26			19.9		
Muzaffarabad	27.3			34.8			18.4			30.5			24.6		
Kakul	22.9	16.9-29.5	24.8	29.6	22.8-37.3	32.3	14.8	9.5-20.5	16	29.9	19.9-33	28.7	20	14.5-28.6	22.4
Murree	16.9			22.8			9.5			19.9			14.5		
Peshawar	29.5			37.3			20.5			33			28.6		
Islamabad	28.5			35.1			20.1			32.6			26.9		

Table 4. Monsoon Rainfall (mm) variability (1951-2000)

Stations	MRV			WRV			PMRV			PoMRV		
	TSR	R. Range	Av	TSR	R. Range	Av	TSR	R. Range	Av	TSR	R. Range	Av
Gilgit	45.7			30.4			47.3			9.7		
Muzaffarabad	808.4			474.8			188			88.1		
Kakul	695.2	45.7-962.3	566	371	30.4-550.8	308.4	186.3	47.3-234	137.6	85.9	9.7-99.7	60.3
Murree	962.3			550.8			234			99.7		
Peshawar	132.4			171.2			76			30.4		
Islamabad	752.1			252.2			94			48.3		

Abbreviations: ATM; Annual mean temperature variability, MMTV; Monsoon mean temperature variability, WMTV; winter mean temperature variability, PMMTV; Pre-monsoon mean temperature variability, PoMMTV; Post monsoon mean temperature variability, MT; mean temperature, T; temperature, Av; Average, MRV; Monsoon rainfall variability, WRV; winter rainfall variability, PMRV; pre- monsoon rainfall variability, PoMRV; post monsoon rainfall variability, TSR; total seasonal rainfall, R; rainfall

DISCUSSION

For comparative analysis we selected the data of two decades i-e 1951-1960 and 1981-1990. The annual mean temperature increased for Gilgit, decreased for Islamabad, Murree, Kakul during second decade (1981-1990) and remained same for Peshawar and Muzaffarabad. The mean minimum and maximum temperature increased for Gilgit, Kakkul and Murree during the second decade indicating more severe conditions in winter and summer but the duration of cold winter days decreased and the hot summer days increased indicating the adverse effects. The mean maximum temperature for Islamabad and Muzaffarabad increased and mean minimum temperature decreased during second decade. The mean maximum and minimum temperature for Peshawar remained same during the both decades. Number of rainy days for Kakul, Murree Peshawar and Islamabad increased and for Gilgit and Muzaffarabad decreased during the second decade. It is also clear from the mean precipitation that the no. of rainy days increased for different cities but the average rainfall (mm) decreased during 1981-1990 as compare to 1951-1960.

The prediction of Monsoon onset and change in rainfall behavior is definitely remains a challenge for the meteorologists. (Chung and Nigam, 1999); Lau and Yang, 1996); Pant, 1982). Monsoon has direct influence on the vegetation and agriculture of an area. Pakistan is basically an area of high variability and deficient rainfall, lying to extreme north-west corner of the Indo-Pak Subcontinent. Agricultural is predominant in the south-east Monsoon region of south-Asia and Pakistan being part of this important climatic region is basically agricultural. (Barros and Lung, 2003; Lighthill and Pearce, 1981)

Pakistan has one of the world's best and largest irrigation infrastructures, which mainly rely on its rivers. Water flow in rivers is highly dependent on Monsoon and snow melt. The objective of this study is to monitor the impact of global warming on Monsoon and the use of water reserves for agriculture sector in Pakistan. Monsoon not only fulfills the water requirements but also a major cause of flooding especially in lower parts of country. Pakistan needs better prediction of Monsoon, accurate calculation of water storage and losses for the above-mentioned relation. Rainfall is, of course, the critical factor for crop production; there is substantial year-to-year variation in rainfall. The variability in rainfall needs advance prediction for better crop yields and crop production. (Afzaal and Hussain, 2006; Pal, *et al.*, 2000; Sun and Hansen, 2003)

At this time under developed countries are facing lack of food and water. So accurate prediction of monsoon will help to understand problems of agriculture, irrigation, flooding, and water reserves. This study will help not only day to day work of agriculture but also the future planning and better future of Pakistan especially in agriculture sector.

In study area the wheat crop is most important and this study shows that mean maximum temperature should be higher in the 2nd decade of November and lower in the 2nd decade of December similarly mean minimum temperature should be higher during two first decades of January and lower in the 2nd decade of February, for a better yield.

Similarly in the study area where the temperature remains below zero during December-January, the dormancy period prolongs and because of the shortage of rainfall in April – May crops take more time to ripen, water demand increases and ultimately the crop yield suffer.

Recommendations

Improved prediction skills about rainfall and environmental data are important for

1: Better water resource management, these rains are only the source to provide water for agriculture in the study area.
2: Economy of Pakistan is agro-based and needs better hydrological resources.
3: With increased temperature during winter, rainfall will be more than snow subsequently less water will be stored and not available during water-deficient times later in the year.
4: Better investigation of the seasonal and intra-seasonal variability of temperature and rain.
5: Better identification of the most suitable sowing time of wheat.
6: Better analysis regarding the impact of climatic variability for yield of wheat.

REFERENCES

Afzaal, M. and A. Hussain (2006). Numerical Simulation of Summer Monsoon Precipitation of 1992 over Pakistan. *Pakistan Journal Meteorology*, 3: 57-67.

Anonymous (2005). Climatic Normal (1971-2000) of Pakistan. Pakistan Meteorological Department (PMD), Karachi.

Anonymous, (1995) Climatic Normal (1961-90) of Pakistan. Pakistan Meteorological Department (PMD), Karachi.

Barros, A. P. and T. J. Lang (2003). Monitoring the monsoon in the Himalayas:observations in central Nepal, June 2001, 1999 and 2000 monsoons in Central Nepal, *Monthly Weather Review*, 131: 1408p.

Chaudhry, Q. Z. (1992). Analysis and Seasonal prediction of Pakistan Summer Monsoon Rainfall, Ph.D. Thesis, Univ. of Philippines, Quezon City, Philippines.

Chung, C. and S. Nigam (1999). Asian summer monsoon-ENSO feedback on the Cane-Zebiak model ENSO. *J. of Climate*, 12: 2787-2807.

Dimri, A. P. (2006). Surface and Upper air fields during extreme winter precipitation over the western Himalayas, *Pure and Applied Geophysics*, 163: 1679-1698.

Dimri, A. P. (2007). A study of mean winter circulation characteristics and energetic over Southeastern Asia, *Pure and Applied Geophysics,* 164:1081-1106.

Ding, Y. (2007). The Variability of Asian Summer Monsoon, *J. Meteoro. Soc. Japan*, 85B: 21-54.

Fowler, A. M. and K. J. Hennessy (1995). Potential impacts of global warming on the frequency and magnitude of heavy precipitation. *Natural Hazards,* 11: 283-303.

Goel, M. and H. N. Srivastava (1990). Monsoon Trough Boundary Layer Experiment (MONTBLEX), *Bulletin of AMS*, 71:1596-1600.

Joseph, P. V. (1990). Warm pool over the Indian Ocean and monsoon onset, *Trop. Ocean–Atmos. Newslett., Winter*, 1–5

Joseph, P. V. and P. L. Raman (1966). Existence of low-level westerly jetstream over Peninsular India during July, *Indian J. Meteorol*., 407–410.

Latha, K. M. and K. V. S. Badarinath (2004). Direct radiative forcing from black carbon aerosols over urban environment, *National Remote Sensing agency*, pp 244

Lau K. M. and S. Yang (1996). The Asian monsoon and predictability of the tropical ocean-atmosphere system. *Q. J. Roy. Meteor. Soc*., 122: 945-957.

Lighthill, J. and R. P. Pearce (1981). Monsoon Dynamics, Cambridge University Press, 989pp

Pal, J. S., E. E. Small, and E. A. B. Eltahir (2000). Simulation of Regional-Scale Water and Energy Budgets: Representation of Subgrid Cloud and Precipitation Processes within RegCM, *J. Geophysical Res.*, 105: 29579-29594.

Pant, M. C. (1982). Some characteristic features of the low-level jet field over the Arabian Sea during the Indian summer monsoon. *Mausam*, 33: 85–90.

Rasul, G., Q. Z. Chaudhary, S. X. Zhao and Q. C. Zeng (2004). A diagnostic study of record heavy rain in twin cities Islamabad-Rawalpindi, *Advances in Atmospheric Sci.,* 21: 976-988.

Shen, S. and K. M. Lau (1995). Biennial oscillation associated with the East Asian summer monsoon and tropical sea surface temperature. *J. Meteor. Soc*. Japan, 73:105-124.

Siegenthaler, U., T. F. Stocker, E. Monnin, D. Lüthi, J. Schwander, B. Stauffer, D. Raynaud, J-M. Barnola, H. Fischer, V. M-Delmotte and J. Jouzel (2005). Stable Carbon Cycle–Climate Relationship during the Late Pleistocene *Science,* 310: 1313 – 1317.

Sun, S. and J. E. Hansen (2003). Climate simulations for 1951-2050 with a coupled atmosphere-ocean model. *Journal of Climate*, 16:2807-2826

Tu, Z. and S. S. Hauang (1944). The Advance and Retreat of Summer Monsoon, *Meteor. Magazine*, 18: 1-20

Wu, G. and Y. Zhang (1998). Tibetan Plateau forcing and the timing of the monsoon onset over South Asia and the South China Sea, *Monthly Weather Review*; 126: 913- 927