IMPACT OF GLOBAL WARMING ON MONSOON VARIABILITY IN PAKISTAN

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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 dependent 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, CO₂ and CH₄ 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 dependent mountainous 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)

<table>
<thead>
<tr>
<th>Stations</th>
<th>AMTV</th>
<th>MMTV</th>
<th>WMTV</th>
<th>PMMTV</th>
<th>PoMMTV</th>
</tr>
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<tbody>
<tr>
<td>Gilgit</td>
<td>MT</td>
<td>T. Range</td>
<td>Av</td>
<td>MT</td>
<td>T. Range</td>
</tr>
<tr>
<td>Muzaffarabad</td>
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<td>25.2</td>
<td>6.5</td>
<td>6.5</td>
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<td>Av</td>
<td>MT</td>
<td>T. Range</td>
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### Table 2. Mean Minimum Temperature variability (1951-2000)

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<td>Av</td>
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<td>T. Range</td>
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### Table 3. Mean Maximum Temperature variability (1951-2000)

<table>
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<tbody>
<tr>
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<td>T. Range</td>
<td>Av</td>
<td>MT</td>
<td>T. Range</td>
</tr>
<tr>
<td>Muzaffarabad</td>
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</tr>
<tr>
<td>Kakul</td>
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<tr>
<td>Muzaffarabad</td>
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<td>22.8-37.3</td>
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<td>Peshawar</td>
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</tr>
<tr>
<td>Islamabad</td>
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<td>35.1</td>
<td>20.1</td>
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### Table 4. Monsoon Rainfall (mm) variability (1951-2000)

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<th>Stations</th>
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<th>WMTV</th>
<th>PMMTV</th>
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<tbody>
<tr>
<td>Gilgit</td>
<td>MT</td>
<td>T. Range</td>
<td>Av</td>
<td>MT</td>
<td>T. Range</td>
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<td>30.4-550.8</td>
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<td>550.8</td>
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<tr>
<td>Islamabad</td>
<td>732.1</td>
<td>252.2</td>
<td>94</td>
<td>48.3</td>
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</tbody>
</table>

**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


