LONG RANGE REGIONAL CLIMATE FLUCTUATIONS/CHANGES AND THEIR IMPACT ON AGRICULTURE—A CASE STUDY FOR CHHATTISGARH STATE IN CENTRAL INDIA

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ABSTRACT:

Climate change is now felt as a reality world wide and intensive research work is being carried out on the scale of the change and its impact on different sectors. However, the global changes are the totality of the regional scale changes which integrate to form a global scenario. More over, the regional scale changes are much more than the global changes in either positive or negative intensities. So also their impact at regional scale varies depending upon several factors including socio-economic conditions. In view of the above, studies were carried out to assess the regional climate changes in Chhattisgarh state in Central India and their impacts on agriculture have been assessed. It was found that the scale of variability is not the same in the entire state. In pockets, the rainfall decreased by 30-35 per cent while in some other pockets, the rainfall decreased from 0-5 per cent only. With the changes in rainfall the general climate of the region has also changed. In some pockets, the climate changed from 'moist sub-humid' type to 'semi-arid' and in other pockets it changed from ' moist sub-humid' to dry-sub-humid'. Such changes in the rainfall and there by the climate change have influenced the agriculture in the state. Studies revealed that the farmers are adopting the climate change by shifting from long duration local rice varieties to short duration high yielding varieties (HVY) of rice. It was also observed that during last 3 decades the wheat-growing zone has moved northwards.

1. INTRODUCTION

Climate change has now become a reality and several researchers are working on this burning issue by working out the future projections as well as assessing the impact in several sectors including agriculture. While some researchers especially IPCC are working on global climate change and its implications, researchers in different countries are working on the regional scale climate changes. (Rao et al 2008) and the impact on agriculture is very location specific which includes soil type, crop, and even the socio-economic conditions of the farmers. In view of this it is important to assess the impact of regional climate changes on agriculture. An analysis of the regional climate changes in Chhattisgarh state in central India. Fig 1 shows the Chhattisgarh state.

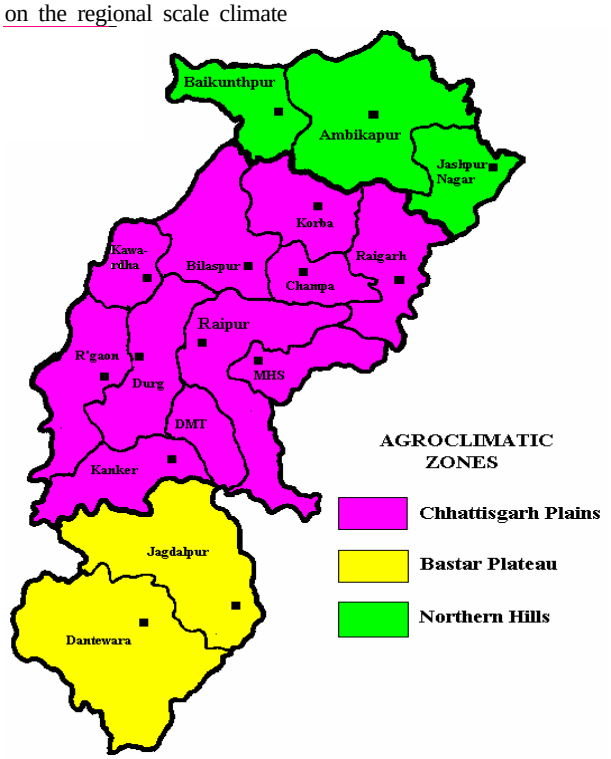

Figure 1. Agroclimatic Zones of Chhattisgarh State in India

Chhattisgarh state is primarily an agrarian state with rice as a main crop cultivated in about 3.6 million hectares during wet season. Only about 20-22 per cent area is under irrigation and the rest of the area is under rainfed conditions. As such any decline in rainfall adversely affects the rice productivity and thereby the state's economy. Thus assessment of the regional climate changes at micro-regional level and their impact on agriculture is necessary for developing strategies for its mitigation. In view this, an analysis has been made to find out the changes, if any, in the rainfall pattern of the state in order to assess the impact and work out mitigation techniques for the same. For this purpose about 58 stations in the state with availability of historical rainfall data in different districts of the state have been considered. The rainfall has been analysed month-wise as well as annual basis too. The rice is cultivated in the state under a typical system of cultivation locally known as ' direct seeded *biasi*'(Fig 2). Under this system the rice seeds are broadcast in a pre-ploughed rice fields after the arrival of monsoon rains. After 30-35 days after sowing and when sufficient water is impounded in those bunded rice fields, the fields are ploughed in the standing rice crop. This operation is called '*biasi*'. This *biasi* operation is performed for two main reasons. The number one is for weed control and secondly for creating semi-puddled condition for minimizing the percolation losses.

Figure 2. Biasi Type of rice Cultivation Prevalent in Chhattisgarh

Any delay in rainfall during the period of *biasi* (usually 20 July to 5 August), the *biasi* operation is delayed and hence the productivity declines due to heavy weed-rice competition.

2. RAINFALL CHANGES

When the national scenario of rainfall changes in India were analysed by Rupa Kumar et al (2002), it was found that the rainfall in Central India is in decreasing trend while the same is in increasing trend in Western and South-west India (Fig 3). As per this macro-regional (national) analysis, attempts were made to analyse the rainfall trend in Chhattisgarh region of Central India.

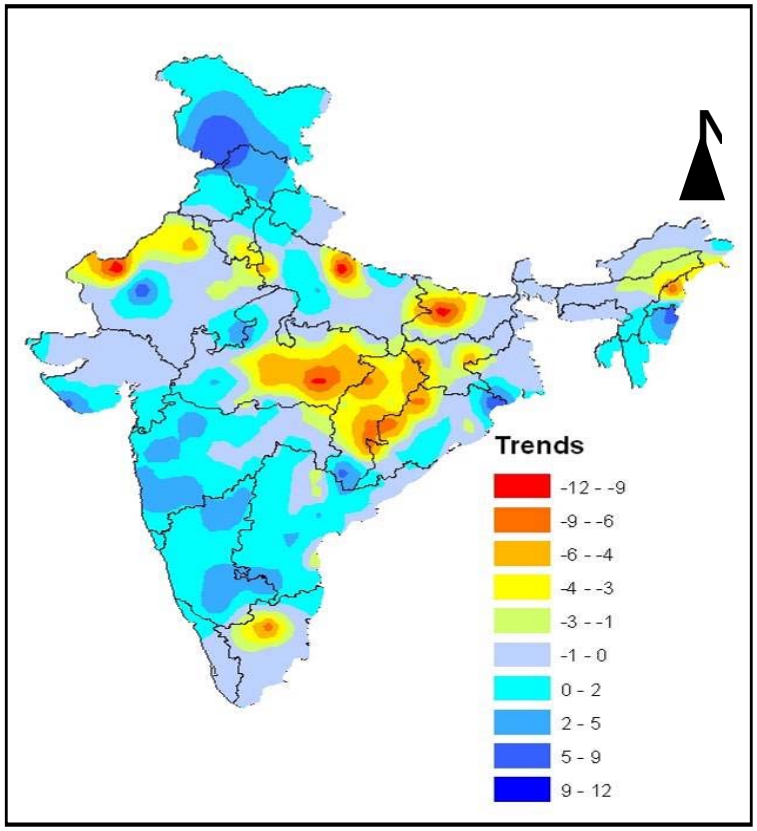

Figure 3. Annual Rainfall Trends Over India (Rupa Kumar 2002)

It was observed that in some stations the rainfall is decreasing in a very alarming way and thus, the rice crop is often failing in those areas. For example the annual rainfall of Mahasamund had decreased from 1800 mm in the beginning of the century to about 800-900 by the end of 20th century. (Also at Kanker the annual rainfall decreased from 1600 mm to about 900 mm during the last century (Fig 3a and 3b)

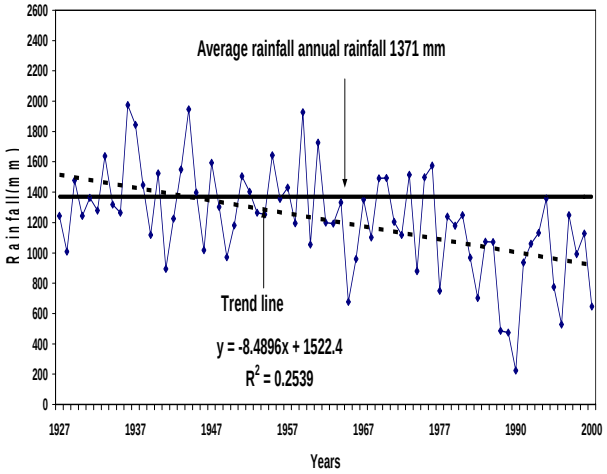

Figure 3a. Rainfall Pattern During Last Century at Mahasamund

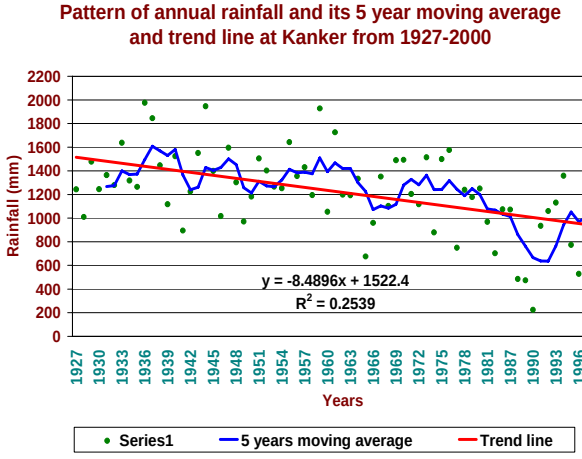

Figure 3b. Rainfall Pattern During Last Century at Kanker

3. CLIMATE CHANGES

As a result of the decreasing rainfall the climate of Mahasamund had changed from moist sub-humid type to semi-arid type and if the same trend continues the climate of Mahasamund may change even to arid type of climate (Figure 4a). In the other words the desertification process has just started in Mahasamund district of Chhattisgarh state. Also, the soils of this district are sandy and sandy loam as it is called the Trans-Mahanadi area and Mahanadi the biggest river of Central India. The other characteristics of deserts are raising dust, rainfall concentrated in a couple of months and rest of the year, it is dry. All these characters of desert confirm the desertification process in the district (Sastri and Urkurkar 1996).

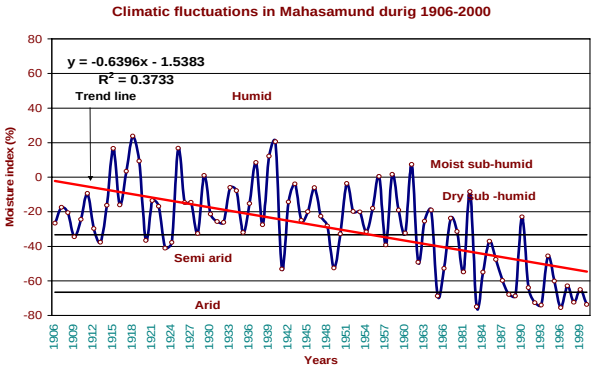

Figure 4a. Climate Change Scenario at Mahasamund

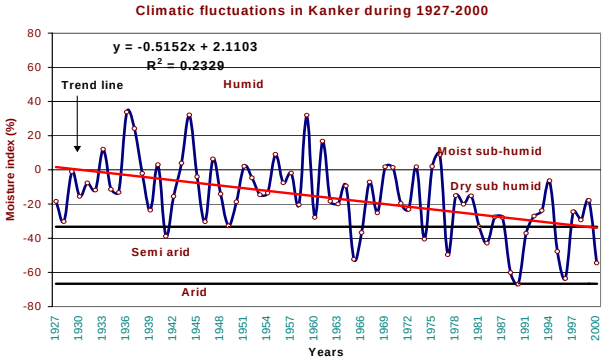

Figure 4b. Climate Change Scenario During Last Century at Kanker

When the long term rainfall records of about 58 stations of Chhattisgarh state were analysed it was found that the rainfall is changing in the state from 35 per cent in some localities to as low as 5 per cent in some other localities (Fig 5).

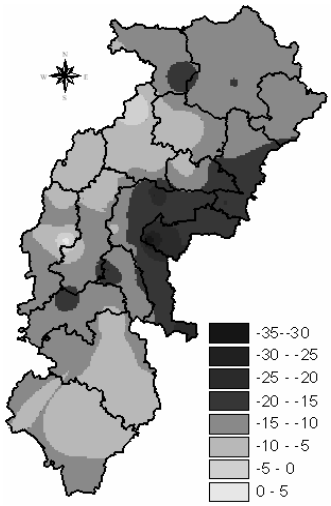

Figure 5. Spatial Variation of Rainfall Pattern in Chhattisgarh

4. FARMERS' ADAPTATION

The farmers earlier used to grow long duration tall varieties of rice, which flower in mid-October and mature by mid November. As a consequence of decreasing rainfall trends, especially in the month of October (Fig 6), the long duration varieties started failing and farmers started taking early or medium duration rice varieties since last few years (Table 1)

Year	Local Varieties (Area: '000 ha)		Improved Varieties (Area: '000 ha)	
	Transplanted	Direct Seeded	Transpla -nted	Direct Seeded
2008	166.8	1422.7	1361.9	1672.8
2002	176.2	1779.4	584.2	1356.7

Table 1. Changes of Local Varieties to Improved Varieties in Chhattisgarh During Last 6 Years.

Thus the area under local varieties started decreasing since last few years.

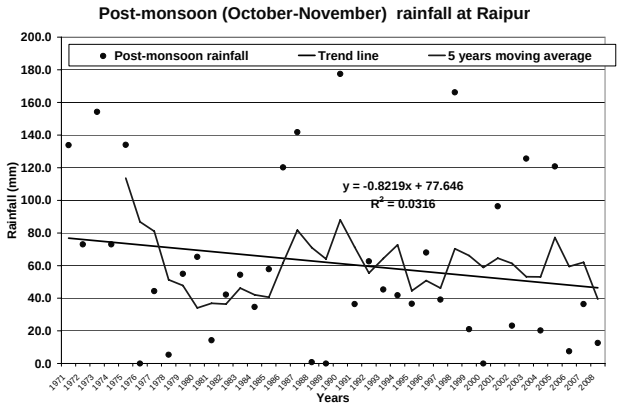

Figure 6. Pattern of October Rainfall at Raipur

5. TEMPERATURE CHANGES

During winter months the temperatures started slightly increasing in the state during last 2-3 decades(Fig 7a & 7b)

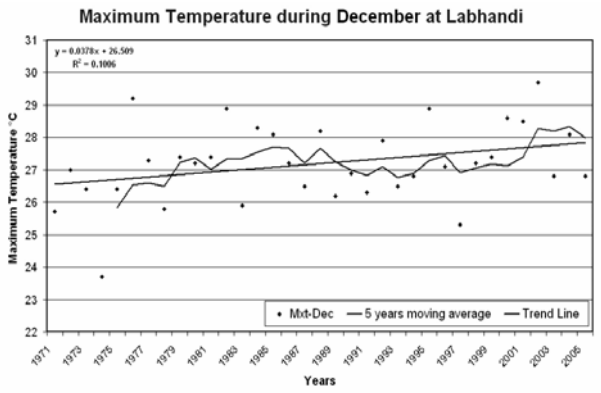

Figure 7a. Decreasing Pattern of December Temperature at Raipur

Even in November month the maximum temperature started increasing and hence, the wheat sowings in November is affected even though the farmers take early duration rice varieties

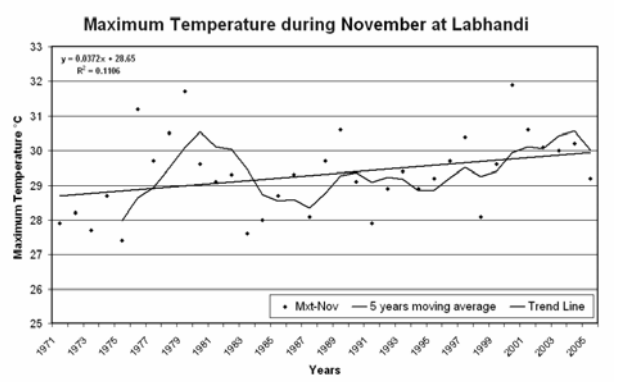

Figure 7b. The Temperature Pattern in November at Raipur

6. CHANGES IN CROPPING PATTERN

Due to changes in rainfall during kharif season and temperature in *rabi* (winter) season, there are changes in the crops and crop rotations in the state For example, the rice area in the state in continuously decreasing. Because of decreasing rainfall pattern , rice is failing in fragile ecosystems like upland areas and as a result the rice area is decreasing as shown in figure 8.

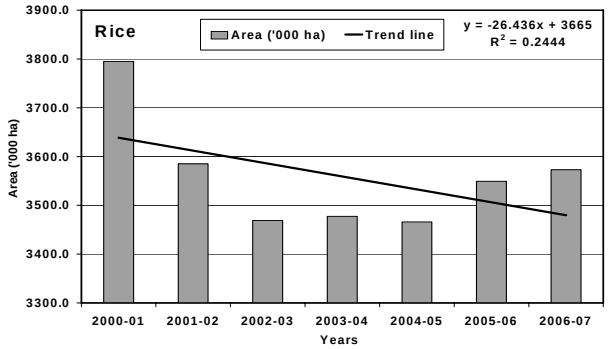

Figure 8. Decreasing Trend of Area of rice Crop During Last Few Years

The decreased area of rice is being replaced with other pulses and oilseed crops like soybean (Fig 9)

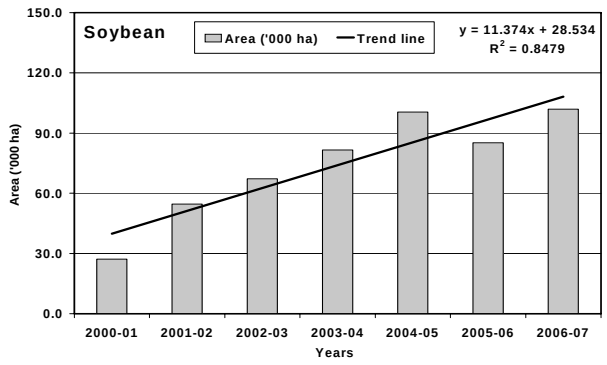

Figure 9. Increasing Trend of Soybean Crop in Chhattisgarh

Similarly during winter (rabi) season, the area of wheat is in decreasing trend as evidenced by the decreasing growth rates of wheat during 90s decade as compared earlier decades as shown in figure 10

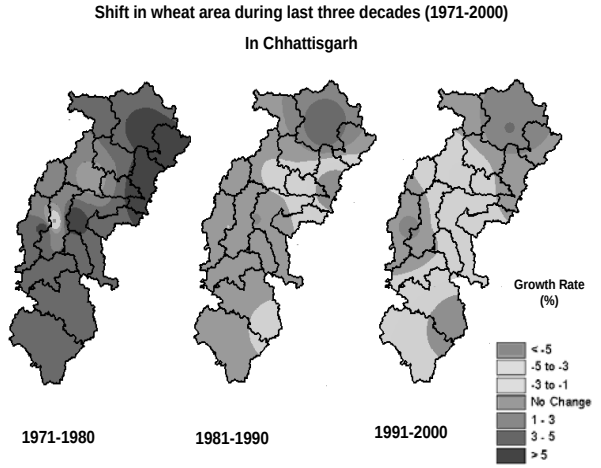

Figure 10. Decreasing Growth Rates of Wheat in 90s Decade as Compared to 70s and 80s Decade

The decreased area under wheat is mainly being replaced with chickpea crop (Fig 11) which requires less water as well as short and mild winters as compared to wheat

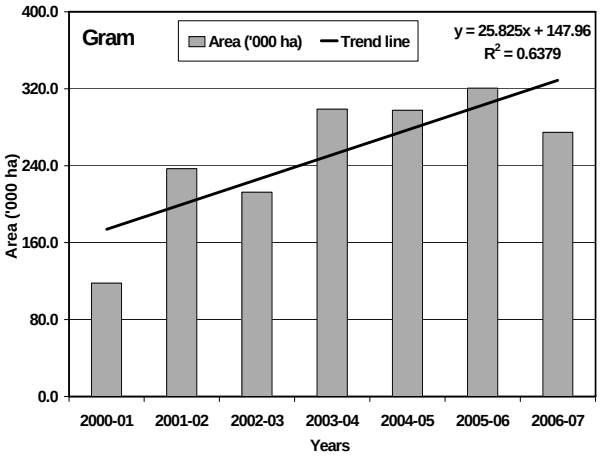

Figure 11. Increasing Area Under Chickpea During Last Decade in Chhattisgarh State

7. FUTURE STRATEGIES

In view of t6he changing climate scenario both from decreasing rainfall in wet season and increasing temperatures during winter season, there is a need to review the existing cropping pattern at micro-regional level and work out strategies for improvement in the agricultural economy of the state. Some of the strategies to be considered are

- Change in cropping pattern
- Changes in crop rotation
- Water conservation through rainwater harvesting and recycling
- Breeding drought resistant varieties suitable to a given location
- Managing the village tanks with proper maintenance of catchment area as well the de-siltation of the tanks.

Thus, the regional climate changes are detrimental for crops and crop production and necessary location-specific technologies need to be developed.

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