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Effect of climate change on rainfall variability of Katihar district: Bihar

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Abstract
This study examines effect of climate change on rainfall variability for the periods of 2014 to 2020 in Katihar district, Bihar. It indicates that for the past Seven years the effect of climatic variability on the annual rainfall distribution upto 2019 is not obvious because of little gap in the mean values but there is positive deviation in annual rainfall within the interval of seven years. Climate change is change in weather pattern for a significantly long period. One of the major impacts of climate change is variation in rainfall pattern which directly or indirectly affects the regional water resources. This study examines effect of climate change on rainfall variability, total annual rainfall for the periods under consideration were collected by observing the last seven years rainfall data we found that the annual avg. rainfall of the district was 1089.2 mm, 1099.7 mm, 1025.2mm, 1026.9 mm, 732.9 mm,1218.7 mm and 1631.92mm against the avg. normal rainfall *i. e* 1281 mm in the year 2014, 2015, 2016, 2017,2018,2019 and 2020 respectively -14.79%, -14.15%, -19.96%, -19.90%, 42.78,-4.91 and +27.39% deviation observed in previous seven year *i.e* 2014, 2015, 2016, 2017,2018,2019 and 2020.

Keywords: rainfall variability, avg. annual rainfall, deviation from annual rainfall, climate change

Introduction

Agriculture, particularly the crop sub-sector has ever since the beginning of life served as Agriculture, particularly the crop sub-sector has ever since the beginning of life served as man's supplier of foods. Agricultural practices exist in the rural economy which is characterized by low income, poor infrastructural facilities and low level of education in terms of adequate record keeping and measurement of the farm produce. Agriculture remains the mainstay of Indian economy, it provide about 17.32% of Indian gross domestic product (GDP). The effect of climate change on agricultural system can be seen in the interaction between changes in climate variables and the stresses that result from actions taken to increase agricultural production. The local farmers are experiencing climate change even though they have not considered it's deeper implications. The arable crops sub-sector is particularly important not only because of the size and employment generation potential, but also because it supplies food and therefore has the potential for dampening the rate of inflation. Arable crops are important food items to the livelihood of millions of people providing nourishment and generating income. However, Katihar district of Bihar state produces a wide variety of arable crops most of the which are consumed as food, the major food crops includes- Rice, Wheat, Maize, Mustard, Green gram, Lentil, Linseed, Pigeon pea, Chick pea etc. other arable crops which double as industrial and food crops to some extent also include Makhana, Jute, Banana, Vegetables. With climate change, food and water supplies will become unreliable and insecure, available arable land reduced causing population movements by making certain parts of the world much less viable place to live (Brown, 2008) [2]. Agriculture is the most significant user of water resource (UN Research, 2009). Agriculture has faced obvious challenges and the foremost problem of the sector in Bihar is that, it is still largely informal, subsistent, rain-fed and lacking mechanization. The agricultural practices depends on natural weather patterns, so also variations in rainfall level result in large variations in total output and farm income and again changes in rainfall will also increase variability in ground water recharge and rivers flow, hence affecting all water resources. Agriculture is an important sector of the Indian economy and climate change leads to projected increases in temperatures, changes in precipitation patterns and climate extremes (e.g., heat waves, cold wave); pests and diseases; atmospheric carbon dioxide and ground-level ozone concentrations; the nutritional quality of some foods and changes in sea level and reductions in water availability may all

result in reduced agricultural productivity. Increases in the frequency and severity extreme weather events can also interrupt food delivery, and resulting spikes in food prices after extreme events are expected to be more frequent in the future. Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on the Earth.

Objectives of the study

The general objective of this study is to determine the effect of climate change on the rainfall variability over the years in Katihar district of Bihar state.

Climatic profile of Katihar, Bihar

This study was conducted in Katihar, district of Bihar (India). The district is situated in eastern part of Bihar state. The district is situated between latitude 25^0 42' - 26^0 22' north and longitude 87^0 10' - 88^0 05' east. The total geographical area of the district 3057 sq. km. It has 16 community development blocks and 1514 villages. The topography of the Katihar district has been very much affected by the floods of river Ganges, Maha-nanda and Kosi. The district has alluvial soil and due to deposit of sand-silt by rivers, soil in southern and western part has become sandy. The Climate of this district is characterized by a hot summer and a pleasant Winter Season. March to June comprises the summer months while the cold season lasts from November to February. Monsoon sets sometimes in the part of June and the rains continue till September, October being a transitional month. The district also received some winter rains. The South- west monsoon generally breaks in during the second half of June. The bulk of the rainfall occurs in July and August. The average normal rainfall is 1281 mm almost uniformly throughout the district.

Constraint in agricultural production due to climate change

Water and food security are the key challenges under climate change as both are highly vulnerable to continuously changing climatic patterns. Unusual rainfall patterns observed in recent year due to climate changes as a result of which the district is frequently suffering from flood situation. There are several key challenges related with policy and strategy making that have to be confronted. Some of the important challenges are as follows:

- Collection of information and data and their sharing among people related with climate change and its impact on water resources. It is necessary because water resource management requires, systematic and well planned actions based on accurate scientific data.
- Majority of the block have varying hydrological conditions, therefore adaptation of the same policies and strategies by each block is not possible. The policies and the action plan will be different for each location based on its hydrological conditions.
- Climate change has increased the frequency and intensity of the natural calamities and now it has become necessary to invest in the study of these natural calamities and their future impacts and prepare a comprehensive plan to minimize their impact on countries.
- Among all the challenges the biggest challenge is the financing of the climate change study related projects and the adaptation of their recommendation because these investments are not profitable.
- Many poor and developing countries are unable/hesitant to construct expensive infrastructure required to meet climate change related challenges because of imperfect information and data about intensity of climate change impact on their country.

  To minimize the impact of climate change on water resources it is necessary to understand and evaluate the vulnerability of water resources to global warming impacts. After understanding these impacts only policies and strategies should be formed and implemented.

Materials and Methods

The effect of climate change on agricultural system can be seen in the interaction between changes in climate variables and the stresses that result from actions taken to increase agricultural production. Rainfall data was analysed from the year 2014 to 2020 and deviation from normal were analysed by using linear regression equation.

$$\text{Deviation (\%)} = \frac{(\text{Actual rainfall} - \text{Normal Annual rainfall})}{\text{Normal annual rainfall}} \times 100$$

Rainfall pattern of Katihar district in past five year

This study examines effect of climate change on rainfall variability, total annual rainfall for the periods under consideration were collected by observing the last seven years rainfall data we found that the annual avg. rainfall of the district was 1089.2 mm, 1099.7 mm, 1025.2 mm, 1026.9 mm,732.9 mm,1218.7mm and 1631.9mm against the avg. normal rainfall *i. e* 1281 mm in the year 2014, 2015, 2016, 2017, 2018, 2019 and 2020 respectively -14.79%, 14.15%, -19.96%, -19.90%, -42.78, -4.91 and +27.39% deviation observed in previous five year *i.e* 2014, 2015, 2016, 2017,2018, 2019 and 2020.

Result and Discussion

The result of the graphical method (table-1) shows that annual rainfall for the periods of 2014 and 2020 vary minimally, there is no obvious pattern in the distribution as shown in the figure-1. This implies that there is little disparity in the amount of rainfall in the past seven years within the district. For example, in 2014 the amount of rainfall was 1089.2 mm and it increased in 2015 to 1099.7 mm and dropped again in 2016 to 1025.2mm, the distribution of rainfall varied in this pattern until 2018 but in 2020 there is positive deviation. Later Sastri (2010) [3] observed that the rainfall had decreased from 35 to 0 percent in different parts of the state during the period 1951- 2000 as compared to the normal values of the period 1901-1950.Behgal and Shastri (1992) [1] reported the decreasing trend of rainfall in Raipur, Durg, Bilaspur, Rajnandgaon and Raigarh district and not only the quantum of rainfall but also the number of rainy days was decreasing trend during cropping session.

Table 1: Mean annual rainfall and it's deviation from normal rainfall for Katihar district

Year	Normal rainfall (mm)	Mean annual rainfall (mm)	Deviation from normal (%)
2014	1281	1089.2	-14.97
2015	1281	1099.7	-14.15
2016	1281	1025.2	-19.96
2017	1281	1026.9	-19.83
2018	1281	732.9	-42.78
2019	1281	1218.7	-4.86
2020	1281	1631.9	+27.39

Source: www.imd.gov.in

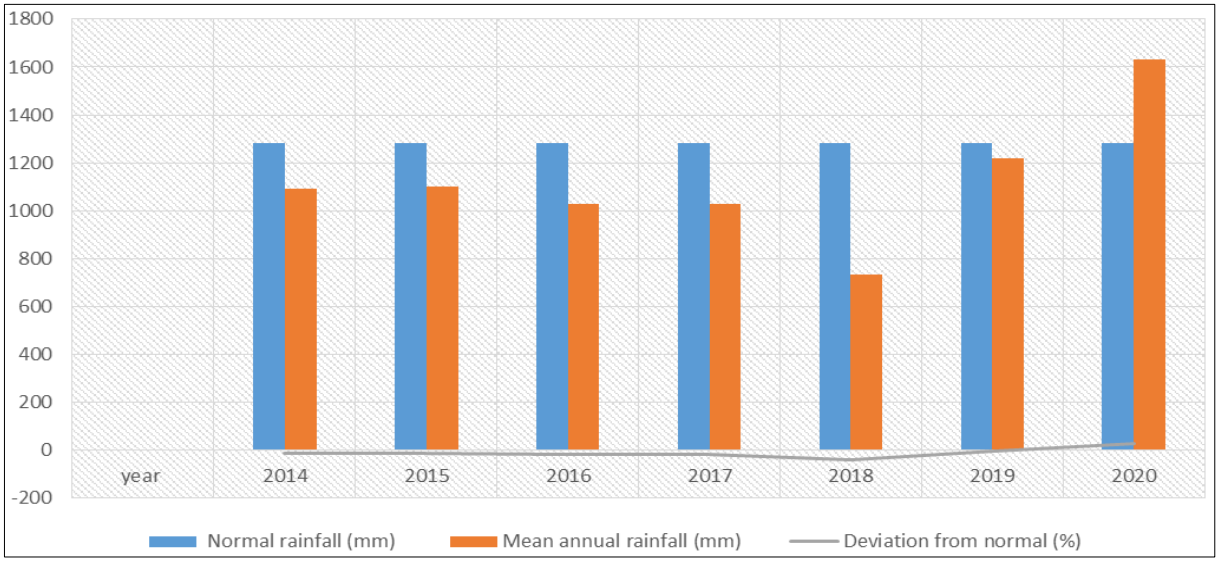

Fig 1: Mean annual rainfall and it's deviation from normal rainfall for Katihar district

Crop planning under changing climate scenario

In agriculture, management practices are usually formulated for individual crops. However, farmers are cultivating different crops in different seasons based on their adoptability to a particular season, domestic needs and profitability. Recasting the crop production recommendations, keeping in view, all the crops grown in a year or in a sequence or rotation beyond one year appear to be more appropriate for efficient use of costly inputs. Hence, cropping system approach is gaining importance. The yearly sequence and spatial arrangements of crops and fallow on a given area is known as cropping pattern. The cropping pattern used on a farm and their interaction with farm resources, other farm enterprises and available technology which determines their make- up is called cropping system. The cropping patterns differ from region to region. It depends on the land, topography, slope, temperature, amount and reliability of rainfall, soils and availability of water for irrigation.

Conclusion

Looking into the challenges in rainfed crop cultivation in Katihar district of Bihar that our future agricultural planning must be taken into account of this rainfall. Short duration but high yielding varieties need to be developed in this region because as district is suffering from flood situation every year due to unusual monsoon behaviour and uneven distribution of rainfall. To cope with this climatic condition, we need to adjust our cropping pattern and cropping system accordingly. Erratic climatic conditions and their variability with time play an important role in the crop production and overall yield. Most of the crop failures worldwide are associated with either a lack or excess of rainfall. Precise climate forecasting can reduce the risks of crop failure and also help in the pre and post decision making processes for better agricultural yield. Further the nature of the forecasting also influences the ability of farmers to respond like farmers are more concerned about within- season characteristics of rainfall rather than the amount of total seasonal rainfall. The value of forecasts diminishes if information is received after the number of pre-planting decisions are made, therefore the forecasting should be in time and specific.

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