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IMPACT OF AGROMETEOROLOGICAL PARAMETERS OVER BIHAR AND JHARKHAND REGIONS FOR THE YEAR 2018

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Abstract
Agrometeorological parameters are very useful in climate and irrigation based studies. The NASA's Global Land Data Assimilati on System (GLDAS-2.1) dataset was utilized in this study during the year 2018. The parameters which we have monitored in this study are wind speed, soil moisture, specific humidity, rainfall, latent heat flux, sensible heat flux, temperature, evapotranspira tion (evapo) and ground heat flux parameters. The GLDAS dataset has been playing vital in hydrological studies. All the parameters were analyzed over Bihar and Jharkhand regions. The Bihar region has high wind speed, latent heat flux, temperature, evapotranspir ation and ground heat flux than Jharkhand. Rainfall, specific humidity and soil moisture parameters have shown higher values in Jharkhand when compared to Bihar. Jharkhand has shown 0.80 correlations between rainfall and soil moisture. Specific humidity has shown 0.83 high correlations between rainfall and specific humidity parameter. Soil moisture and specific humidity have shown strong correlation with evaporation over both the regions.

Keywords: Wind speed, Soil moisture, Specific humidity, Ground heat flux and Temperature.

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INTRODUCTION

The agricultural and industrial sectors are facing a lot of water scarcity problem in recent years. The water crisis has been increasing due to the increasing global population on daily basis. The water resources are over exploited by the huge human population. As we know food is another basic requirement for humans. In order to meet the food requirements, more irrigation has to be done. Almost 70% of drinking water resources from glaciers are being utilized for irrigation sector [1]. Proper management of water resources can reduce the over usage of water for different crops [2]. Water is an essential component for all the natural processes that takes place on the earth. The problem of water scarcity increases with hydrological imbalance. According to a recent report, nearly 40 million people are affected due to water scarcity problem [3]. Due to the recent climate changes, agricultural sector has been facing adverse effects with the shortage of water resources. The rainfall distribution is affected mainly due to the increased extreme events across the world. Sudden floods, high speed winds, continuous precipitation are some of the extreme events which have created havoc on crop fields. As per recent World Meteorology Organization (WMO), report nearly 50% of high populated cities are going to face water scarcity problem by 2050. Nowadays, proper management of water resources is essential for next generations [4]. Many parameters influence the agriculture sector. (a) Rainfall is most important parameter that influences global weather. It is an essential source for fresh water lakes, rivers and ground water. As the rainfall occur, then they runoff from earth's surface to water bodies. (b) This fresh water changes its state to gaseous state due to high sun temperatures. This is called as evaporation. (c) The exhalation of excess leaf water into the atmosphere is called as transpiration. (d) The sum of evaporation and transpiration is called as evapotranspiration (evapo). This evapo is classified into two categories. In first category, the water gets evaporated from crop leaves and earth's surface. In second category, the loss of water vapor from crop fields. This is called as Potential evapotranspiration (PEVA) [5]. (e) Winds impact the crop production globally. When crops are exposed to high speed winds, they cause structural changes. During summer, the hot winds impact the plant's growth. During thunderstorms or cyclones, the high speed winds uproot crops causing heavy damages [6]. (f) Latent heat flux is the flow which extends from earth surface to atmosphere. It has an interconnection with evapo. It plays a huge role in global energy budget [7]. (g) Sensible heat flux is the flux experienced between earth surface and air above it [8]. (h) The ground heat flux is generally experienced between earth surface and it's subsurface. These fluxes play crucial role in convective systems [9]. (i) The soil moisture content affects the water table. The drought is heavily linked with soil moisture parameter. It is an important precursor for extreme events [10]. The soil moisture and evapo parameters influence the rise and fall of water tables in the ground water [11]. (j). Specific humidity is an important parameter in assessing many weather events. The evaporation rate of earth surface varies directly with the specific humidity parameter. The specific humidity is the subtraction done between earth surface and interconnecting air [12].

All these parameters influence agricultural sector and also water cycle. The evapo parameter and fluxes play an important part in maintaining water resources across the globe [13]. Proper supervision of all these parameters can help to produce better yield for the crops in India [14]. Thermopile sensors, scintillometers, lysimeters are some of the useful instruments which help to measure the above fluxes [15]. Rao et al. have presented the results in their earlier studies [16-27].

The chief purpose behind this study is to explore the NASA's GLDAS 2.1 products in analyzing the agrometeorological parameters. These parameters consist of wind speed, soil moisture, specific humidity, rainfall, latent heat flux, sensible heat flux, temperature, evapotranspiration and ground heat flux parameters. In this attempt, the monthly variations of agrometeorological parameters were studied over Bihar and Jharkhand.

DATA

NASA's Global Land Data Assimilation System Version 2 (GLDAS-2) products have three components namely GLDAS-2.0, GLDAS-2.1 and GLDAS-2.2. The GLDAS-2.0

product includes Princeton meteorological forcing input data which is available from 1948 to 2014. The GLDAS-2.1 product is a combined version of model and observation data which is available from 2000 to present. The GLDAS-2.2 product uses data assimilation (DA) techniques for giving data for different variables. The GLDAS products produce data for many variables such as precipitation, near surface air temperature, downward short wave and long wave radiation, specific humidity, wind speed, and surface pressure. In this study, the complete analysis was done on the Bihar and Jharkhand regions. Bihar region extends from 24.2 to 27.2° N latitudes and 82 to 89° E longitudes whereas Jharkhand region lies between 22 and 25° N latitudes and 83 and 89° E. The monthly GLDAS-2.1 data was collected at 1.0° by 1.0° resolution for the year, 2018 [28].

METHODOLOGY

We have used water balance method for estimating evapo [29, 30] as shown in (1).

ET (w) = P – R – ΔS -------- (1)

Where ET (w) is the estimated value of ET by using the water balance method, P is the total precipitation (mm), R is the total stream flow and ΔS is the change in terrestrial water storage (TWSC).

RESULTS AND DISCUSSION

The monthly variations of agrometeorological parameters were presented below. We have utilized GLDAS-2.1 data which was collected and monitored for the Bihar and Jharkhand regions. This entire work is done for the year 2018.

We have averaged all the grid points present in the two regions. During January and February months, the wind speeds are less than 2.5 m/s. In March, April and May months, the wind speeds have increased up to 3.6 m/s. In June, there is slight drop in wind speed and high wind speeds are seen in July month. The winds speeds started decreasing in August and September. In October, November and December there was a drastically decrease in wind speed values (Fig.1).

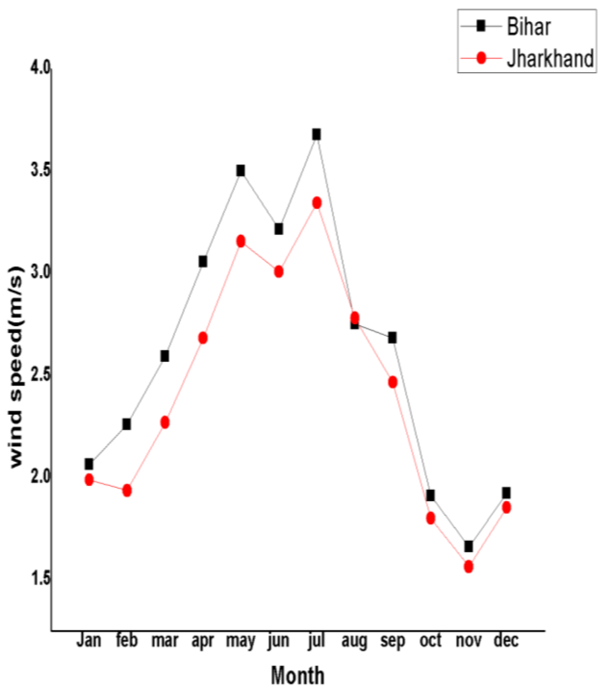

Fig.1 Monthly variations of wind speed over Bihar and Jharkhand regions for the time period 2018.

In Fig. 2 we have plotted monthly variations of soil moisture. During January and February months, the soil moisture values are decreasing from 15 to 10. The lowest soil moisture values were seen in March month. The soil moisture values increased from April to August which range between 15 and 35 kg m^{-2}. The highest soil moisture values were seen in August month. These values reduced in October, November and December months.

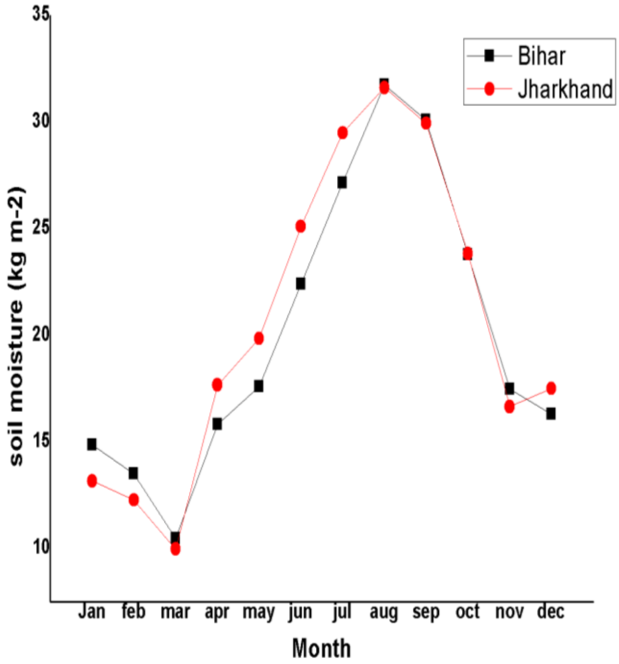

Fig. 2 Monthly variations of soil moisture over Bihar and Jharkhand regions for the time period 2018.

As soil moisture is high in August month, monsoon activity is also high in that month on these two regions which help to improve water resources. This helps irrigation. An attempt was made to analyze the specific humidity parameter as shown in Fig. 3.

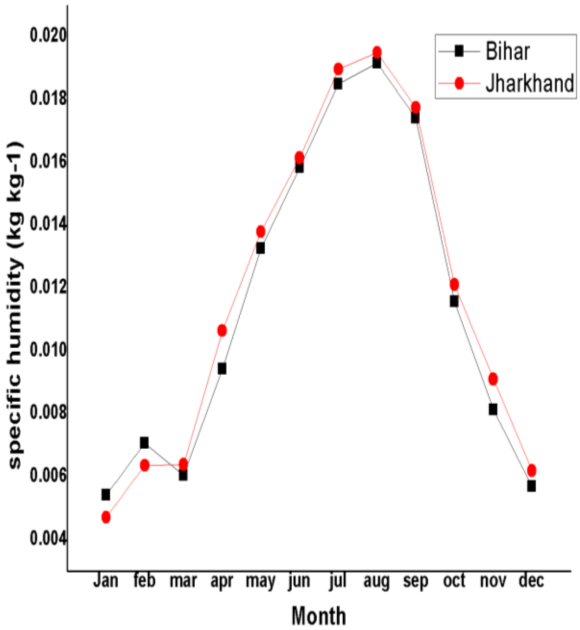

Fig. 3 Monthly variations of specific humidity over Bihar and Jharkhand regions for the time period 2018.

During January and February months, the specific humidity values are increasing from 0.004 to 0.008 kg kg^{-1}. The lowest specific humidity values were seen in March and December months. The specific humidity values increased from April to August which range between 0.010 to 0.020 kg kg^{-1}. The highest specific humidity values were seen in August month. These values reduced in October, November and December months.

In Fig. 4, we have plotted monthly variations of rainfall parameter. During January, February and March months, the rainfall values are below 25 mm. The rainfall values increased from April. Highest rainfall activity was seen in July month over both the regions. These values reduced in October, November and December months. During monsoon months, the average monthly rainfall was 150 mm.

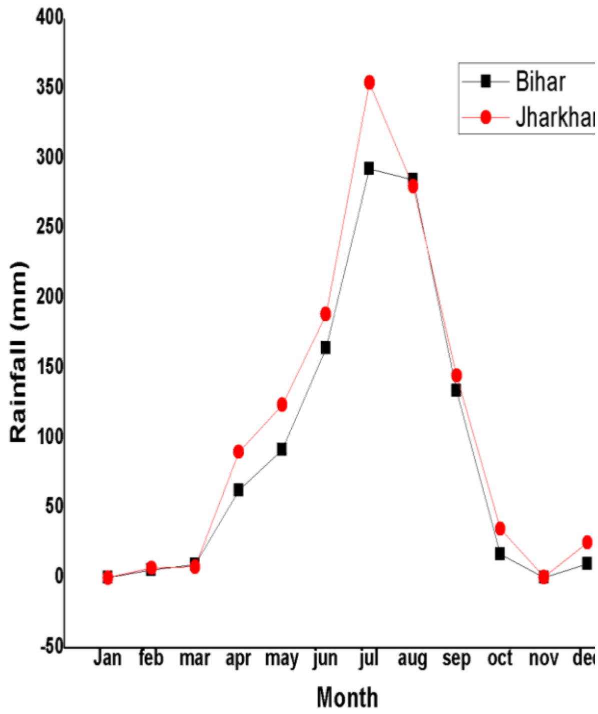

Fig. 4 Monthly variations of rainfall over Bihar and Jharkhand regions for the time period 2018.

In Fig. 5, we have plotted monthly variations of latent heat flux parameter. During January, February and March months, the latent heat flux values are below 40 wm^{-2}. The latent heat flux values increased from April. Highest latent heat flux activity was seen in August month over both the regions. These latent heat flux values reduced in October, November and December months. During monsoon months, the mean latent heat flux values were ranging between 80 and 130 wm^{-2}.

In Fig. 6, we have plotted monthly variations of sensible heat flux parameter. During January, February and March months, the sensible heat flux values are increasing from 20 to 80 wm^{-2}. The sensible heat flux values started decreasing from April. Lowest sensible heat flux was seen in September month over both the regions. These values increased in October, November and December months. During monsoon months, the monthly sensible heat flux was below 20 wm^{-2}.

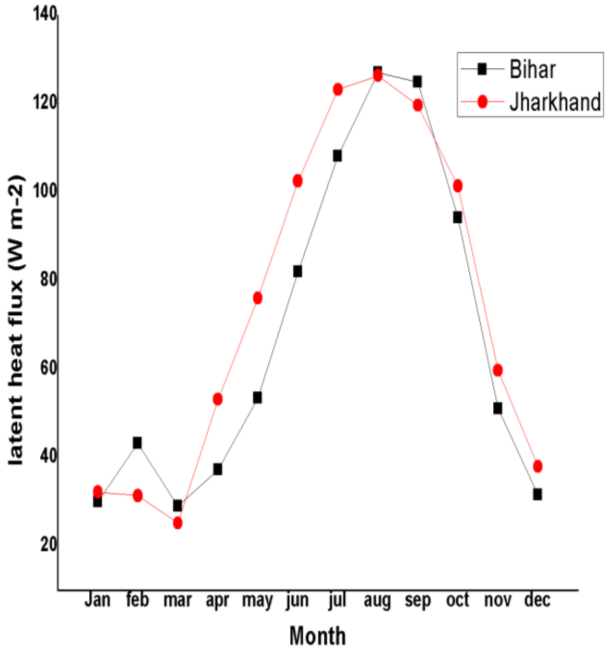

Fig. 5 Monthly variations of latent heat flux over Bihar and Jharkhand regions for the time period 2018.

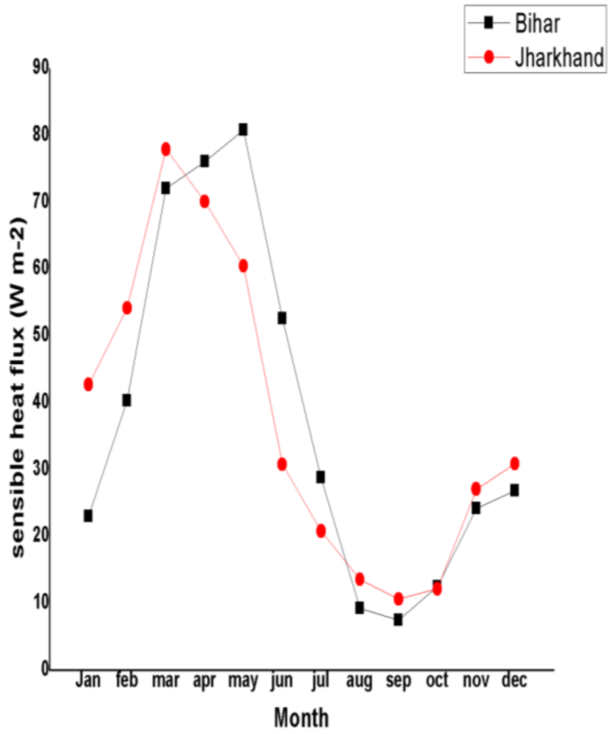

Fig. 6 Monthly variations of sensible heat flux over Bihar and Jharkhand regions for the time period 2018.

In Fig. 7, we have plotted monthly variations of temperature parameter. During January, February and March months, the temperaturevalues are increasing from 287 to 300 K. The temperature values started decreasing from June. Lowest temperature value was seen in January and December months over both the regions. The highest temperature values were seen in April and May months where values were ranging between 300 and 310 K.

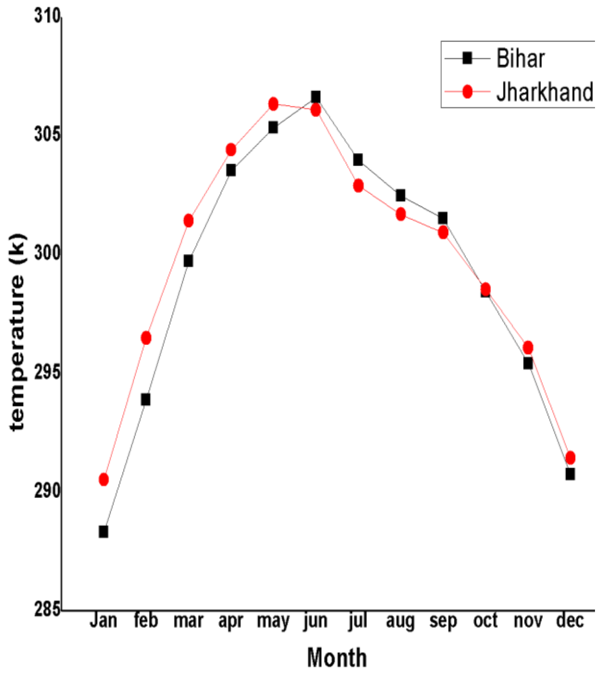

Fig. 7 Monthly variations of temperature over Bihar and Jharkhand regions for the time period 2018.

In Fig. 8, we have plotted monthly variations of evapo parameter. During January, February and March months, the evapovalues are decreasing from 40 to 20 mm. The evapo values started increasing from April. Highest evapo value was seen in August month over both the regions. The evapo values again reduced in October and November months. Highest evapovalues which were seen in July, August and September were ranging between 120 and 140 mm.

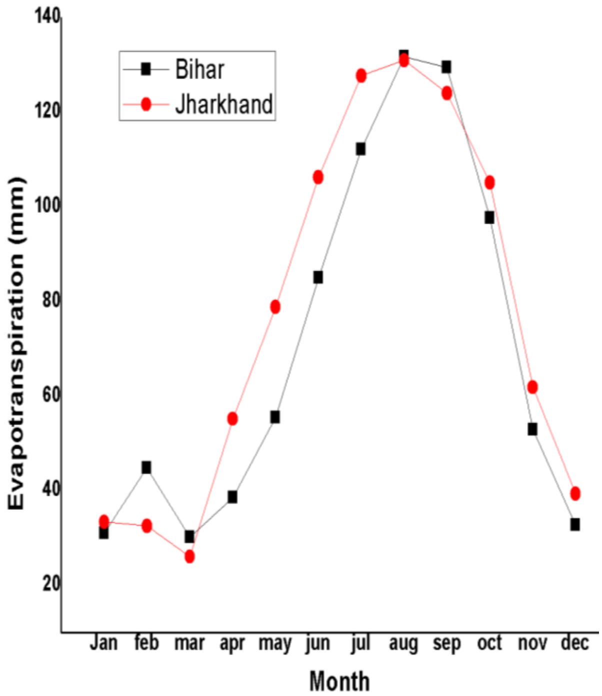

Fig.8 Monthly variations of evapo- transpiration over Bihar and Jharkhand regions for the time period 2018.

In Fig. 9, we have plotted monthly variations of ground heat flux parameter. During January, February the ground heat flux values suddenly increased from negative to positive values. The values increased to 6 wm^{-2} in May month. Later, they started decreasing. The lowest ground heat flux values were seen in December month. The values were below - 4 wm^{-2} in December month. During monsoon months, the ground heat flux values were ranging between 0 and -2 wm^{-2}.

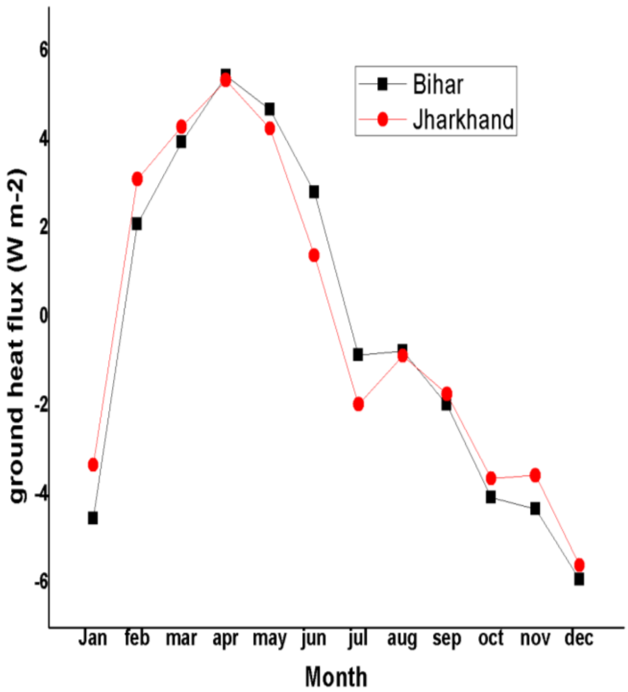

Fig. 9 Monthly variations of ground heat flux over Bihar and Jharkhand regions for the time period 2018.

CONCLUSION

An attempt was made to analyze the agrometeorological parametersfor the time period, 2018. We have studied about wind speed, soil moisture, specific humidity, rainfall, latent heat flux, sensible heat flux, temperature, evapotranspiration and ground heat flux parameters. We have utilized NASA's GLDAS 2.1 data products for this study. This work carried on two regions, Bihar and Jharkhand.

During December, January and February months, all parameters are showing very less values when compared to other months. In June, July, August and September months, the heat fluxes are high over Bihar and Jharkhand. In July, 4 m/s wind speeds were observed over Bihar whereas, 3.5 m/s wind speed was seen over Jharkhand. High soil moisture values were seen in August month which ranges between 30 and 35 kgm^{-2}.

High specific humidity was seen over both the regions which are favouring monsoon rainfall. Jharkhand received more rainfall than Bihar in 2018. High latent heat flux values were recorded on both the regions in August month (120–140 wm^{-2}). The evapo parameter indicated high values in August month (120–140 mm). The sensible heat flux parameter has shown very low values in September month. Both regions record high temperatures in June month. The Ground heat flux parameter is very high in May and June month correlating with temperature.

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