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# Climate Water Balances in Chhattisgarh

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**ABSTRACT**

*The PET values computed by different methods are not matching with each other in all the 12 months. At Raipur and Ambikapur, the PET values matched with each other during winter and monsoon months. At Jagdalpur, Hargreaves methods of PET values are always higher than any of the other methods followed by Branley-Criddle and Thornthwait methods. During summer months, interestingly the Modified Penman method calculated higher PET values than the Open pan values in all the months except Thornthwaite method in December and January. Thus, the evapotranspiration pattern at Jagdalpur was found to be different because of its thickly forested area. The actual evapotranspiration shows variability in different districts. Most of the districts showed highest AET value in June month except Ambikapur which shows highest value in July month and Raipur observed lowest AET values in April (9.6 mm and 24.1 mm, respectively) month while Bilaspur observed lowered AET in May (23.9 mm) and Jagdalpur observed in January (60.0 mm). Ambikapur districts highest surplus occurred in July month (378.6 mm) and lowest value in December (8.8 mm). Bilaspur district shows highest value in August (187.5mm), Raipur observed highest value in July (171.4 mm) and Jagdalpur shows highest value in August (121.0 mm) and lowest values observed during March (0.0 mm). Highest deficit value was observed in May month (247 mm) and lowest values observed in August (0.0 mm) at Ambikapur. Bilaspur district shows highest value in May (183.7 mm) and lowest value in August month. Raipur observed highest value in May (247.6 mm) and at Jagdalpur, highest value was observed in April month (101.4 mm).*
*Key words PET, AET, Climatic Water Balance*

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## INTRODUCTION

Drought indices evaluate the departure of climate variables in a given time interval (month, season or year) from the "normal" conditions and are used as monitoring tools and operational indicators for water managers. In other words Drought indices are quantitative measures that characterize drought levels by assimilating data from one or several variables (indicators) such as precipitation and evapotranspiration into a single numerical value. Such an index is more readily usable than raw indicator data. The nature of drought indices reflects different events and conditions; they can reflect the climate dryness anomalies (mainly based on precipitation) or correspond to delayed agricultural and hydrological impacts such as soil moisture loss or lowered reservoir levels. Different indices have been developed through the years to quantify drought intensity. Such indices are usually based on the precipitation deviation from the mean for a given period. The most commonly used indices are: Percent of Normal, Deciles, Standardized Precipitation Index (SPI), Palmer Drought Severity Index (PDSI), Crop Moisture Index (CMI) and Surface Water Supply Index (SWSI). Drought indices can be useful tools for providing information for decision-makers in business, government and to the public stakeholders. These tools can be used to provide an early drought warning system [3], to calculate the probability of drought termination Kumar and Panu, [2] to examine the spatial and temporal characteristics of drought, the severity of drought, and to make comparisons between different regions Kumar and Panu, [2]; A large number of drought indices exist, each having a variety of data input requirements and each providing a somewhat different measure of drought.

In Chhattisgarh state crops grown under rainfed conditions. In Chhattisgarh state late onset of monsoon at the initial stage, break monsoon conditions during the crop growth stages and cessation of rainfall at the terminal stage determine the productivity of rice and other *Kharif* crops. First crop failure during

1828-29 and a greater disaster due to low rainfall during 1832-33 and 1834-35 and 1945 are some of drought episodes in the state. In next 40 years, the state faced deficient rainfall in 14 years causing crop failure.

## MATERIAL AND METHODS

### Climatic water balance:

The climatic water balance for different stations and for different years was computed using the book-keeping procedure . In the water balance computations, the inputs are rainfall and potential evapotranspiration (PET) and the outputs are soil moisture storage, actual evapotranspiration, water surplus water deficit. The potential evapotranspiration values required for the water balance computations were estimated using modified Thornthwaite equation.

## RESULT AND DISCUSSION

Averages of rainfall and potential evapotranspiration was computed for 4 districts of Chhattisgarh state with the help of Modified Penman method. The graphical depiction of water balances of 4 districts were shown in Table 1 to4. In general, it was observed that the rainfall exceeds the potential evapotranspiration value in all the districts from June onward when the monsoon sets in the state. But the rainfall in June to mid-July is sufficient only to recharge the soil. After recharging the soil up to field capacity, the excess rainfall over the potential evapotranspiration values goes as surplus water.

This surplus water goes out of the root zone either as run-off or as deep percolation depending upon the topography, slope, crop, vegetation etc. The surplus water is responsible for either ground water recharge or rainwater harvesting to alleviate drought conditions by providing supplemental irrigation.

After withdrawal of monsoon the soil moisture is utilized to meet the evapotranspiration demand partially and water deficit condition start developing in field. During the monsoon season, on an average conditions the potential evapotranspirational demands are met by rainfall and hence the actual evapotranspiration losses are equal to potential evapotranspiration during the monsoon months. Thus, in Chhattisgarh state for better water management of Kharif crops and for alleviating the drought conditions in the state information on the water surplus and water deficit, and their quantum and period are important. In view of this, the amounts of water surplus and water deficit in each district have been worked out by water balance. The results of the same for 4 districts of Chhattisgarh state were shown in Table 1 to 4.The details are as follows.

### Actual evapotranspiration (AET)

The actual evapotranspiration shows variability in different districts. Most of the districts show highest AET value in June month except Ambikapur which shows highest value in July month and Raipur experienced lowest AET values were April (9.6 mm and 24.1 mm, respectively) month while at Bilaspur observed lowest values were in May (23.9 mm) and January (60.0 mm) and Jagdalpur respectively.

### Water surplus

The water surplus as mentioned earlier goes either as deep percolation or as run-off depending upon the local hydrological conditions.

Ambikapur district's highest surplus occurred in July month (378.6 mm) followed by August (343.9 mm), and September (247.2 mm). Lowest values were observed at Ambikapur in December (8.8 mm) followed by April (8.9 mm) respectively. Bilaspur district show highest value of surplus 187.5mm (August) followed by 107.2 mm (July), and 84.0 mm (September). Raipur experiences highest value in July (171.4 mm) followed by June (115.7 mm) and September (71.9 mm). Continuously five to six months observed nil or zero value or dried condition at Bilaspur and Raipur. At Jagdalpur, highest value was observed in August (121.0 mm) followed by July (92.4 mm) and September (43.9 mm). Lowest values was observed during March (0.0 mm) followed by May (0.1 mm) and January (0.2 mm). Surplus condition occurred at Ambikapur throughout the year compared to other districts.

### Water deficit

At Ambikapur, highest deficit value was observed in May month (247 mm) followed by April (200 mm) and March (151.1 mm) and Lowest values was observed in August (0.0 mm) followed by September (1.3 mm) and July (5.3 mm). Bilaspur district shows highest value in May (183.7 mm) followed by April (159.4 mm) and March (122.2 mm) and lowest value occurred in August month. Raipur observed highest value was in May (247.6 mm) followed by April (200 mm) and at Jagdalpur, highest value were observed in April (101.4 mm) followed by May (100 mm) and March (86.1 mm).

Gautam *et al.*, [1] reported dry conditions in the months of January to June, while water surplus was recorded from mid July to early October. Annual water deficiency was of the order 343.3 mm whereas annual water surplus was 613.9 mm. The Moisture adequacy index was 100% during July, August and

 

September. Therefore, during these months, there was enough moisture to support crops like maize, rice, sugarcane etc.

**Table 1: Normal monthly water balance Computation for Raipur district from 1991-2014.**

| Month | PPT | PET | AET | SUR | DEF |
|---|---|---|---|---|---|
| Jan | 14.6 | 95.8 | 31.1 | 0.0 | 64.7 |
| Feb | 15.0 | 116.5 | 28.5 | 0.0 | 88.0 |
| Mar | 12.2 | 175.3 | 24.2 | 0.0 | 151.1 |
| Apr | 18.0 | 224.1 | 24.1 | 0.0 | 200.0 |
| May | 22.0 | 271.7 | 24.2 | 0.0 | 247.6 |
| Jun | 184.3 | 208.2 | 138.4 | 16.1 | 69.7 |
| Jul | 370.9 | 133.3 | 128.1 | 115.7 | 5.3 |
| Aug | 327.5 | 117.8 | 117.8 | 171.4 | 0.0 |
| Sep | 189.1 | 125.0 | 123.7 | 71.9 | 1.3 |
| Oct | 45.9 | 128.9 | 108.0 | 0.1 | 20.9 |
| Nov | 10.2 | 104.1 | 57.7 | 0.0 | 46.4 |
| Dec | 7.1 | 90.2 | 33.7 | 0.0 | 56.6 |

**Table 2: Normal monthly water balance Computation for Bilaspur district from 1991-2014.**

| Month | PPT | PET | AET | SUR | DEF |
|---|---|---|---|---|---|
| Jan | 20.9 | 91.3 | 34.7 | 0.0 | 56.6 |
| Feb | 13.2 | 107.3 | 30.0 | 0.0 | 77.3 |
| Mar | 18.8 | 154.8 | 32.6 | 0.0 | 122.2 |
| Apr | 16.4 | 184.3 | 24.9 | 0.0 | 159.4 |
| May | 20.2 | 207.6 | 23.9 | 0.0 | 183.7 |
| Jun | 169.3 | 154.2 | 119.9 | 5.8 | 34.3 |
| Jul | 343.5 | 114.8 | 111.4 | 107.2 | 3.4 |
| Aug | 323.8 | 110.8 | 110.8 | 187.5 | 0.0 |
| Sep | 193.7 | 120.9 | 118.6 | 84.0 | 2.3 |
| Oct | 48.8 | 122.2 | 102.6 | 2.1 | 19.6 |
| Nov | 15.3 | 96.6 | 58.2 | 0.0 | 38.4 |
| Dec | 8.6 | 84.8 | 35.7 | 0.0 | 49.0 |

**Table 3: Normal monthly water balance Computation for Jagdalpur district from 1991-2014.**

| Month | PPT | PET | AET | SUR | DEF |
|---|---|---|---|---|---|
| Jan | 39.1 | 97.9 | 60.7 | 0.2 | 37.3 |
| Feb | 48.8 | 118.6 | 67.4 | 0.6 | 51.2 |
| Mar | 56.7 | 165.7 | 79.6 | 0.0 | 86.1 |
| Apr | 81.7 | 190.7 | 89.3 | 1.7 | 101.4 |
| May | 110.6 | 208.3 | 108.3 | 0.1 | 100.0 |
| Jun | 216.8 | 145.0 | 131.8 | 21.6 | 13.2 |
| Jul | 286.6 | 109.2 | 109.2 | 92.4 | 0.0 |
| Aug | 244.1 | 107.6 | 107.6 | 121.0 | 0.0 |
| Sep | 136.3 | 114.5 | 108.4 | 43.9 | 6.1 |
| Oct | 79.3 | 114.7 | 99.9 | 9.9 | 14.8 |
| Nov | 55.5 | 97.2 | 79.5 | 0.1 | 17.7 |
| Dec | 52.1 | 88.5 | 66.5 | 3.4 | 22.0 |

**Table 4: Normal monthly water balance Computation for Ambikapur district from 1991-2014.**

| Month | PPT | PET | AET | SUR P | DEF |
|---|---|---|---|---|---|
| Jan | 14.6 | 95.8 | 31.1 | 0.0 | 64.7 |
| Feb | 15.0 | 116.5 | 28.5 | 0.0 | 88.0 |
| Mar | 12.2 | 175.3 | 24.2 | 0.0 | 151.1 |
| Apr | 18.0 | 224.1 | 24.1 | 0.0 | 200.0 |
| May | 22.0 | 271.7 | 24.2 | 0.0 | 247.6 |
| Jun | 184.3 | 208.2 | 138.4 | 16.1 | 69.7 |
| Jul | 370.9 | 133.3 | 128.1 | 115.7 | 5.3 |
| Aug | 327.5 | 117.8 | 117.8 | 171.4 | 0.0 |
| Sep | 189.1 | 125.0 | 123.7 | 71.9 | 1.3 |
| Oct | 45.9 | 128.9 | 108.0 | 0.1 | 20.9 |
| Nov | 10.2 | 104.1 | 57.7 | 0.0 | 46.4 |
| Dec | 7.1 | 90.2 | 33.7 | 0.0 | 56.6 |

## REFERENCES

1. Gautam,S., Roy,S., Murty, N. S. and Nain, A. S.(2013). Climatic water balance and Moisture Adequacy Index in Tarai region of Uttarakhand. Pantnagar Journal of Research 2013 11(3): 317-321.
2. Kumar, V. and Panu, U. (1997). Predictive assessment of severity of agricultural droughts based on agro-climatic factors. Journal of the American Water Resources Association, 33(6): 1255-1264.
3. Lohani, V.K., Loganathan, G.V., Mostaghimi, S. (1998). Long-term analysis and short- term forecasting of dry spells by the Palmer drought severity index. Nord Hydrol. 29(1):21–40.

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