Original Research Paper

Statistics

COMPUTATION OF NON-CENTRAL AND CENTRAL MOMENTS WITH SHEPPARD'S CORRECTIONS BETWEEN RAINFALL AND GROUND WATER LEVELS – A CASE STUDY

Raju Sake — Academic Consultant, Department of Statistics, Sri Krishnadevaraya University, Anantapuramu, (A.P), India.

ABSTRACT Present paper deals with the Computation of Non-Central (Raw-Moments) and Central Moments with Sheppard's Corrections to analyze Rainfall (RF) and Ground Water Levels (GWLs) in Anantapuramu district based on the data collected from January 2007 to December 2016. For the purpose of analysis the district is divided into five Zones or Revenue Divisions (RD) namely, 1. Anantapuramu RD 2. Penukonda RD 3. Kadiri RD 4. Kalyandurg RD 5. Dharmavaram RD. I have calculated for the Non-Central (Raw-Moments) and Central Moments with Sheppard's Corrections between Rainfall and Ground Water Levels and compared among them by using the data.

KEYWORDS : Rainfall, Ground Water Level, Non-Central and Central Moments, Sheppard's Corrections.

1. INTRODUCTION
In this paper, I will main focus on Non-Central (Raw-Moments) and Central Moments with Sheppard's Corrections to analyze Rainfall (RF) and Ground Water Levels (GWLs) in Anantapuramu district based on the data collected from January 2007 to December 2016. For the purpose of analysis the district is divided into five Zones or Revenue Divisions (RD).

The data is collected on Average Rainfall and Average Ground Water Levels are given in the following Table-1.1 for a ready reference [1, 2, 3, 4, 5, 6, 7, 8 and 9].

Table-1.1 Average Rainfall and Average Ground Water Levels data from 2007 to 2016

Year	Zone-I RF (in mm)	Zone-I GWL	Zone-II RF (in mm)	Zone-II GWL	Zone-III RF (in mm)	Zone-III GWL	Zone-IV RF (in mm)	Zone-IV GWL	Zone-V RF (in mm)	Zone-V GWL
2007	65.60	10.57	58.20	22.58	67.20	14.23	52.00	14.97	60.50	17.03
2008	53.90	9.96	77.90	20.73	65.20	9.27	61.30	10.88	62.70	9.09
2009	45.40	12.17	50.60	17.53	46.30	11.08	57.10	9.58	38.70	10.24
2010	53.90	12.74	71.50	15.02	70.80	12.03	64.60	8.58	56.30	11.79
2011	39.50	12.69	42.30	15.20	48.90	11.48	31.80	8.93	36.60	12.84
2012	43.20	14.98	43.40	20.49	45.30	16.08	40.50	13.76	41.90	13.22
2013	35.00	15.94	52.30	23.03	47.10	18.69	34.80	16.98	38.10	14.30
2014	31.10	15.87	30.30	23.40	27.10	21.16	37.10	18.92	22.80	16.30
2015	44.10	14.90	62.60	26.88	66.30	25.80	46.00	19.26	54.30	17.66
2016	33.50	15.57	33.40	27.27	32.30	15.35	25.70	19.51	30.10	16.15

2. STATISTICAL ANALYSIS
To analyze **Rainfall and Ground Water Levels** through Non-Central (Raw-Moments) and Central Moments with Sheppard's Corrections for different zones we can consider given as follows:

The first four Non-central moments (Raw-Moments) are;

$$\mu_1' = \left[\frac{1}{N}\sum_{i=1}^{n} f_i x_i\right] \times c \quad \dots (2.1)$$

$$\mu_2' = \left[\frac{1}{N}\sum_{i=1}^{n} f_i x_i^2\right] \times c^2 \quad \dots (2.2)$$

$$\mu_3' = \left[\frac{1}{N}\sum_{i=1}^{n} f_i x_i^3\right] \times c^3 \quad \dots (2.3)$$

$$\mu_4' = \left[\frac{1}{N}\sum_{i=1}^{n} f_i x_i^4\right] \times c^4 \quad \dots (2.4)$$

$$\text{where } c = 1$$

The first four Central-Moments are;

$$\mu_1 = 0 \quad \dots (2.5)$$

$$\mu_2 = \mu_2' - (\mu_1')^2 \quad \dots (2.6)$$

$$\mu_3 = \mu_3' - 3\mu_2'\mu_1' + 2(\mu_1')^3 \quad \dots (2.7)$$

$$\mu_4 = \mu_4' - 4\mu_3'\mu_1' + 6\mu_2'(\mu_1')^2 - 3(\mu_1')^4 \quad \dots (2.8)$$

The Sheppard's Corrections are;

$$\mu_2^* = \mu_2 - \frac{c^2}{12} \quad \dots (2.9)$$

$$\mu_3^* = \mu_3 \quad \dots (2.10)$$

$$\mu_4^* = \mu_4 - \frac{c^2}{2}\mu_2 + \frac{7}{240}c^4 \quad \dots (2.11)$$

β Coefficients are;

$$\beta_1 = \frac{\mu_3^{*2}}{\mu_2^{*3}} \quad \dots (2.12)$$

$$\beta_2 = \frac{\mu_4^*}{\mu_2^{*2}} \quad \dots (2.13)$$

A: For Average Rainfall
Zone-I, II, III, IV and V

Zones	Zone-I	Zone-II	Zone-III	Zone-IV	Zone-V
Raw-Moments	$\mu_1' = 4.96$ $\mu_2' = 33.07$ $\mu_3' = 253.86$ $\mu_4' = 2099.82$	$\mu_1' = 5.03$ $\mu_2' = 33.50$ $\mu_3' = 256.03$ $\mu_4' = 2106.78$	$\mu_1' = 5.04$ $\mu_2' = 33.64$ $\mu_3' = 257.37$ $\mu_4' = 2118.76$	$\mu_1' = 4.92$ $\mu_2' = 32.10$ $\mu_3' = 241.98$ $\mu_4' = 1971.35$	$\mu_1' = 4.98$ $\mu_2' = 33.30$ $\mu_3' = 256.25$ $\mu_4' = 2121.99$
Central-Moments	$\mu_1 = 0$ $\mu_2 = 8.47$ $\mu_3 = 5.83$ $\mu_4 = 128.97$	$\mu_1 = 0$ $\mu_2 = 8.20$ $\mu_3 = 5.04$ $\mu_4 = 120.53$	$\mu_1 = 0$ $\mu_2 = 8.24$ $\mu_3 = 4.78$ $\mu_4 = 121.52$	$\mu_1 = 0$ $\mu_2 = 7.89$ $\mu_3 = 6.37$ $\mu_4 = 113.49$	$\mu_1 = 0$ $\mu_2 = 8.50$ $\mu_3 = 5.76$ $\mu_4 = 127.43$
Sheppard's Corrections	$\mu_2^* = 8.39$ $\mu_3^* = 5.83$ $\mu_4^* = 124.76$ $\beta_1 = 0.06$ $\beta_2 = 1.77$	$\mu_2^* = 8.12$ $\mu_3^* = 5.04$ $\mu_4^* = 116.46$ $\beta_1 = 0.05$ $\beta_2 = 1.79$	$\mu_2^* = 8.16$ $\mu_3^* = 4.78$ $\mu_4^* = 117.43$ $\beta_1 = 0.04$ $\beta_2 = 1.76$	$\mu_2^* = 7.81$ $\mu_3^* = 6.37$ $\mu_4^* = 109.57$ $\beta_1 = 0.09$ $\beta_2 = 1.80$	$\mu_2^* = 8.42$ $\mu_3^* = 5.76$ $\mu_4^* = 123.21$ $\beta_1 = 0.06$ $\beta_2 = 1.74$

B: For Average Ground Water Levels
Zone-I, II, III, IV and V

Zones	Zone-I	Zone-II	Zone-III	Zone-IV	Zone-V
Raw-Moments	$\mu_1' = 5.91$ $\mu_2' = 42.70$ $\mu_3' = 340.36$ $\mu_4' = 2869.46$	$\mu_1' = 5.84$ $\mu_2' = 43.14$ $\mu_3' = 352.12$ $\mu_4' = 3025.86$	$\mu_1' = 6.15$ $\mu_2' = 45.78$ $\mu_3' = 370.36$ $\mu_4' = 3135.10$	$\mu_1' = 6.12$ $\mu_2' = 46.36$ $\mu_3' = 382.40$ $\mu_4' = 3298.48$	$\mu_1' = 5.83$ $\mu_2' = 42.71$ $\mu_3' = 345.23$ $\mu_4' = 2940.66$
Central-Moments	$\mu_1 = 0$ $\mu_2 = 7.77$ $\mu_3 = -3.86$ $\mu_4 = 112.01$	$\mu_1 = 0$ $\mu_2 = 9.03$ $\mu_3 = -5.34$ $\mu_4 = 138.65$	$\mu_1 = 0$ $\mu_2 = 7.96$ $\mu_3 = -9.06$ $\mu_4 = 121.70$	$\mu_1 = 0$ $\mu_2 = 8.91$ $\mu_3 = -10.33$ $\mu_4 = 147.15$	$\mu_1 = 0$ $\mu_2 = 8.72$ $\mu_3 = -5.46$ $\mu_4 = 134.16$
Sheppard's Corrections	$\mu_2^* = 7.69$ $\mu_3^* = -3.86$	$\mu_2^* = 8.95$ $\mu_3^* = -5.34$	$\mu_2^* = 7.88$ $\mu_3^* = -9.06$	$\mu_2^* = 8.83$ $\mu_3^* = -10.33$	$\mu_2^* = 8.64$ $\mu_3^* = -5.46$

AUTHOR PROFILE

Raju Sake is awarded PhD degree in Statistics under the Supervision of Retd. Prof. P. Mohammed Akhtar in the Department of Statistics, S.K. University, Anantapuramu and working as an Academic Consultant in the Department of Statistics, S.K. University, Anantapuramu.

REFERENCES

1. S. Raju, P. Mohammed Akhtar, *"Time Series Analysis on Rainfall and Ground Water Levels Data – A Case Study"*, International Journal of Scientific Research in Mathematical and Statistical Sciences (IJSRMSS) Vol.6, Issue.1, pp.76-85, February(2019).
2. S. Raju, P. Mohammed Akhtar, *"Fitting of modified exponential model between rainfall and ground water levels: A case study"*, International Journal of Statistics and Applied Mathematics 2019; 4(4), pp. 01-06.
3. S. Raju, P. Mohammed Akhtar, *"Fitting Of Gompertz Model Between Rainfall And Ground Water Levels – A Case Study"*, International Journal of Mathematics Trends and Technology (IJMTT) – Volume 65, Issue 7 – July (2019), pp. 85-93.
4. S. Raju, P. Mohammed Akhtar, *"Fitting of Logistic Model between Rainfall and Ground Water Levels – A Case Study"*, Compliance Engineering Journal, Volume 10, Issue 9, pp. 114-122, September-2019.
5. S. Raju, *"Fitting of Poisson distribution by using recurrence relation method between Rainfall and Ground water levels - A Case Study"*, International Journal in Physical and Applied Sciences (IJPAS), Volume 7, Issue 1, January, 2020. pp. 76-87. (ISSN: 2394-5710).
6. S. Raju, *"Fitting of binomial distribution by using recurrence relation method between rainfall and ground water levels: A case study"*, Journal of Mathematical Problems, Equations and Statistics (JMPES), Volume 1, Issue 02, pp. 03-08, DOI: https://doi.org/10.22271/math.2020.v1.i2a.10, 01-07-2020.
7. S. Raju, P. Mohammed Akhtar, *"Determination of Steady State Solutions of Ground Water Levels in Anantapuramu District Through Markov Chain Model"*, publication in the conference proceeding "International Conference on Recent Trends in Theoretical and Applied Statistics (RTTAS) held during 18-20 September, 2020 on online mode, Organized by: Department of Statistics, Dibrugarh University, Dibrugarh-786004, Assam (India). Sponsored by: University Grants Commission (Under SAP DRS-II) Govt. of India.
8. S. Raju, *"Fitting of Modified Exponential Model between Rainfall and Ground Water Levels by Using Partial Sums Method – A Case Study"*, Pensee Journal, Volume 51, Issue 03, pp. 647-655, March-2021.
9. S. Raju, P. Mohammed Akhtar, *"Fitting of Gompertz model between Rainfall and Ground water levels by using Partial sums method – A case study"*, Stochastic Modeling and Applications, Vol. 25 No.1 (January-June, 2021), pp. 167-177. MuK Publications and Distributions (INDIA). ISSN: 0972-3641.
10. S. Raju, *"Fitting of Binomial Distribution between Rainfall and Ground Water Levels - A Case Study"*, International Journal of Engineering, Science and Mathematics (IJESM), Vol. 10, Issue 06, June 2021, pp. 9-18 (ISSN: 2320-0294).
11. S. Raju, *"Fitting of Poisson distribution between Rainfall and Ground water levels - A Case Study"*, International Journal of Engineering & Scientific Research (IJESR), Vol. 9, Issue 6, June 2021, pp. 6-16 (ISSN: 2347-6532).
12. S. Raju, *"Fitting of Negative Binomial Distribution by using Recurrence Relation Method between Rainfall and Ground Water Levels - A Case Study"*, PARIPEX – Indian Journal of Research (PIJR), Vol. 10, Issue 06, June-2021, pp. 1-3. DOI: 10.36106/paripex (ISSN: 2250-1991).