MERIT RESEARCH JOURNALS
www.meritresearchjournals.org

Merit Research Journal of Environmental Science and Toxicology (ISSN: 2350-2266) Vol. 3(7) pp. 079-082, September, 2015
Available online http://www.meritresearchjournals.org/est/index.htm

Original Research Article

Determination of areal rainfall using estimation methods in a tropical wet and dry climate

Eruola, A. O[1*]., Ufoegbune, G. C.[1], Eruola, A. O.[2], Awomeso, J. A.[1] and Abhulimen, S. A.[1]

[1]University of Agriculture, Abeokuta, Nigeria

[2]Yaba College of Technology, Yaba, Lagos, Nigeria

***Corresponding Author's E-mail: layosky@yahoo.com**

Abstract

A comparison of three empirical methods of calculating Areal rainfall was carried out using 10 years of rainfall data in Ogun river basin, Southwestern Nigeria. The optimum network density for estimating areal rainfall and its reliability for water resources purpose was also evaluated. Data were analyzed by one – way ANOVA using the Genstat statistical package (Release 4.24 Discovery Edition) taking each yearly mean as the average of the 10 years (2001-2010) for the basin. Results show the least deviation in areal rainfall between Thiessen polygon and Isohyetal methods but the deviation was higher between Arithmetic mean and Thiessen polygon /Isohyetal methods. Hence, under topographical condition of the Ogun river basin, either the method of Thiessen polygon or Isohyetal methods can be used for computation of areal rainfall. The relative reliability of each method in terms of accuracy of both measured and extrapolated rainfall data utilized was also discussed.

Keywords: Areal rainfall, Arithmetic mean, Catchment, Isohyetal, Thiessen polygon

INTRODUCTION

The wet and dry climates is characterized by unpredictable distribution and variability of seasonal rainfall (Bello, 1997), hence, precise quantification of rainfall for water supply remains the most critical factor for water resources planning in the region. However, the accurate measurement of average rainfall over a catchment is difficult. This is more so that rainfall measurement is essentially a point sampling procedure. Hence average rainfall over an area has to be estimated from these point measurements. In view of the difficulties of accurately measuring areal rainfall, estimation methods have been widely adopted to predict rainfall over a catchment. The reliability of method have been reported to range in complexity depending on the rainfall variability and number and spacing of rainfall gauges network involved in the computation (Warnaka et al. 1988). One major problem of the various empirical methods of estimate of areal rainfall is that they all have limitation that may be due to the use of questionable assumptions (Jackson 1991). Unfortunately, for a specific situation, no guideline can be given for selecting the methods to be used for estimating areal rainfall for a particular purpose; therefore it is desirable to develop an understanding of more accurate method. The uncertainties related to estimate methods for any practical application can best be evaluated by comparison of methods (Warnaka et al., 1988). Hence, attempt has been made in this study to evaluate some of the empirical methods of estimating areal rainfall in Ogun River Bain. The reliability of methods was also tested by comparing estimates and also effectiveness of optimum density in relation to WMO recommendation.

MATERIALS AND METHODS

Monthly rainfall data covering a period of 10 years (2001-2010) were collected from 7 rainguage stations within the

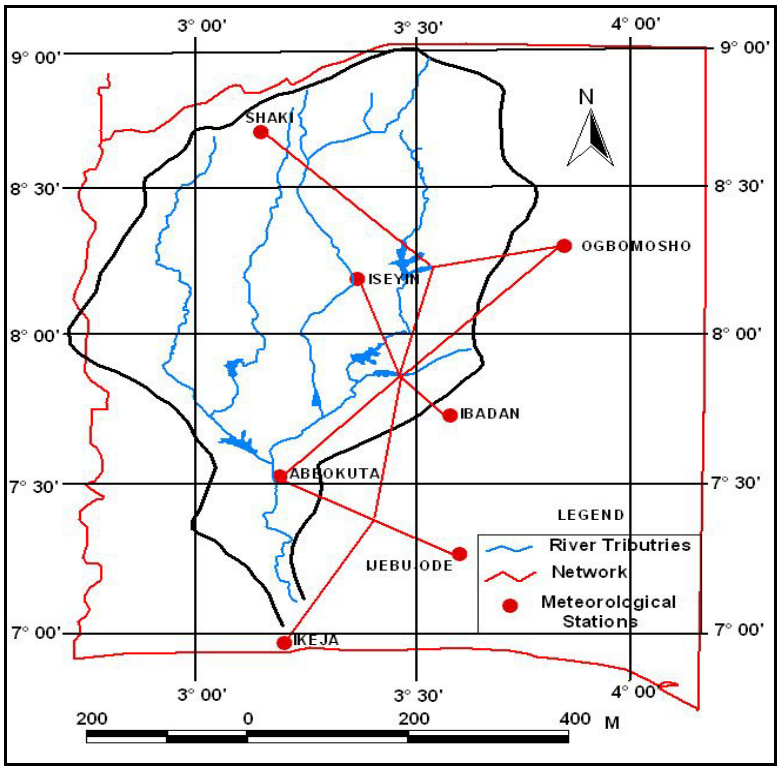

Figure 1. Selected weather stations within and in the vicinity of the Ogun River Basin Area in Nigeria

basin area (Figure 1). The estimates of areal rainfall over the basin were derived from 3 estimation methods, viz Arithmetic mean, Thiessen polygon and Isohyetal methods. The reliability of the methods considered in this study was assessed by comparing the pattern of areal rainfall estimates derived by each method. The optimum network density of the basin was evaluated to determine its reliability for water resources purpose by relating the existing raingauge station to the WMO recommended standard of 600-900km^2 per rainguage for flat area in the tropical region.

Data were also subjected to one – way ANOVA using the Genstat statistical package (Release 4.24 Discovery Edition) to determine the yearly mean and standard deviation of estimated areal rainfall computed from the selected estimates for the 10 years records for the basin.

Study Area

Ogun River Basin lies within latitude 6^{O}33'-9^O'N and longitudes 2^{O}40'-3^{O}45' E in the rain forest zone of Nigeria covering a total area of 23,700km^2. The climate is influenced by cooling, rainfall- bearing southwest monsoon blowing from the hot Atlantic Ocean and dry season by the continental North Easterly harmattan winds from the Sahara desert. The area is located within a region characterized by bimodal rainfall pattern (commences in March and is plentiful in July and September, with a short dry spell in August). The long dry period extends from November to March. The annual rainfall ranges between 1250 and 1400mm in the basin area and environs. The topography of the basin reflects the contrast between the hummocky terrain underlain by the crystalline rocks north of Abeokuta, with its compact drainage pattern, and thickly forested undulating hills and swampy lowlands of the sediments to the south (Martins, 1987).

RESULT AND DISCUSSION

A comparison of 3 estimation methods for the estimation of areal rainfall showed that the equation vary greatly in their ability to define the average rainfall over a basin (Table 1). The areal rainfall varies with the method of estimation for Ogun river basin. The least deviation in areal rainfall between Thiessen polygon (1043.14mm) and Isohyetal methods (1002.54mm) was observed. However, the deviation was higher between Arithmetic mean (1153.07mm) and Thiessen polygon /Isohyetal methods. The close agreement in the estimate of areal rainfall over the basin may be due to the fact that they are both weighted average methods.

The Arithmetic mean gave the highest estimate of areal rainfall as compared to the other two methods and

Table 1. Areal rainfall determined with different Estimates methods

Year	Areal rainfall Arithmetic (mm)	Areal rainfall Thiessen (mm)	Areal rainfall Isohyetal (mm)
2001	1494.36	1394.00	1362.60
2002	1202.61	1100.92	1075.50
2003	1316.60	1191.70	1163.70
2004	1193.23	1052.50	1031.80
2005	1294.50	1163.90	1147.50
2006	1136.80	1032.30	1022.48
2007	1085.60	945.90	927.82
2008	1006.80	971.50	956.32
2009	1534.80	1418.00	1195.08
2010	1043.50	930.20	921.61
Mean	1230.95	1121.02	1080.42
SD	1153.07	1043.14	1002.54

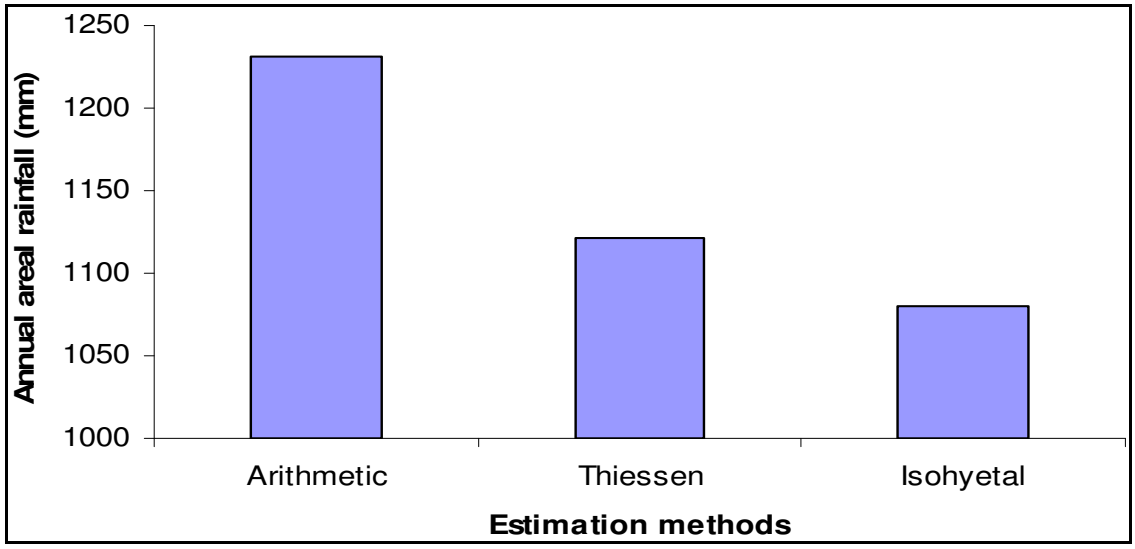

Figure 2. Areal rainfall determined with different Estimates methods

consequently deviated greatly from the mean, thereby over estimating the average rainfall over the basin. Figure 2 clearly shows this variation in estimation methods at the location as discussed earlier.

The evaluation of the optimum density network showed that the study area is characterized by irregular distribution of rainfall gauging station with about 25% efficiency. This is as a result of 7 raingauge stations covering the area of 23,700km^2 of basin as against the one raingauge for 600-900 km^2 of WMO recommended standard.

CONCLUSION

The availability of accurately measured rainfall data and number of existing station within the basin is a major consideration in selecting a method for calculating reliable result for areal rainfall. Where the bulk of data are obtained by extrapolation from nearby station and general description of rainfall trend, a less reliable result can be expected. Hence, as a first step to derive accurate rainfall data required for the estimation of areal rainfall in the Ogun river basin, there is need for additional 25 rainguages in the basin.

REFERENCES

Ayoade JO (1976). On climatic water budgeting procedures. Nigerian Geographical Journal Vol. 19(2): 157-177.

Bello NJ (1997). Evaluation of reference –crop evapotranspiration by empirical method for predicting consumptive water use of a crop in a tropical wet-dry climate. Indian Journal of Agricultural Science 67 (6): 269-270.

Blackie JR (1965). Comparison of some empirical methods of evapotranspiration estimate. Proc. OF the third specialist meeting

on applied meteorology in West Africa, EAAFRO. Mugaga, Kenya.
Cocheme J, Franquin P (1967). An agroclimatology survey of semi-arid area in Africa south of the sahara. World Meteorological Organization, 86 (210), TP 110, 136.
Duru L (1984). Comparison of some empirical method of evapotranspiration estimate. Published in climate, water and agriculture in the tropics. Longman, London. Pp169
Hounman CE (1973). Comparison between pan and lake evaporation. W.M.O. Tech. note. No. 126.
Jackson IJ (1991). Climate, water and agriculture in the tropics. Longman, London. Pp88-138.
McCulloch JSG (1965). Hydrologic net-work for measurement of evapotranspriration and soil moisture. I.A.H.S. publication (68): 579-584.
Olaniran OJ (1981). empirical methods of \computing potential maximum evapotranspiration. Arch. Met. Geog. Bioki., Serv A., 30 (4): 369-381.
Olaniran OJ (1981). Problems in the measurement of pan evaporation in Nigeria. Nigeria Met. Journal. 1: 7-12.
Warnaka K, Pochop L (1988). Analysis of the equation for free water evapotranspiration estimates, water resources research. 24(7): 979-984.