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PUBLISHED BY: Publications International Lahore, Pakistan

SCIENCE INTERNATIONAL
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ISI INDEXED
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International Scientific Indexing
Impact Factor = 1.365 (2016)
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E-ISSN	1013-5316
P-ISSN	1013-5316
Publisher Name	Publications International
Email	sciint.soc@gmail.com
Language	English
Starting Year	1988
Discipline	Multisisciplinary
Frequency	Quaterly
Website	www.sci-int.com
Country	Pakistan
Accessing Method	sciint@gmail.com/00924235865863/00923464784550
Articles Format	PDF
License Type	Normal
Impact Factor	**1.365** (2016)
Description	A multidisciplinary, online open access journal, operating independently since July 1988, generating its own sources.Devoted to all basic, applied and social sciences.

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Quarterly ISSN: 1013-5316
PUBLICATIONS INT, 11-D SABZAZAR, WAHDAT RD, LAHORE, PAKISTAN, 00000

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EDITORIAL NOTE.

Research Terminates at Infinity.

Knowledge has no limits:

Though, research at higher level has assumed immeasurable dimensions with its classification into different fields of study, yet , there are matters of mutual interest to give a comprehensive treatment to the subject under investigation. In surmounting the problems in respective areas of research, one is invariably forced to encroach other disciplines. There are a number of instances of joint ventures, involving scientists from divergent fields of study, to develop consensus to conclude. In the strict sense, Research at the top level has resisted to have been colonized or survive in isolation. The alliance of natural, life and social sciences has provided new dimensions leading to a new era of interactions between man and nature. Nature has always been compromising whenever man intellectually approached to share its secrets.

For example,

Study in genetics, has impact on a number of physical and biological sciences.

Research in crystallography is extensively applied by physicists, chemists and chemical engineers etc. alike.
Computer simulation is matter of universal interest. Environmental studies has motivated almost all the sectors of science to share responsibilities in the wake of growing pollution.
The kind of forum, thus, contemplated by the science international is aimed at providing common room, from various fields of pure and applied scientists, for direct communication. The cross breeding of ideas certainly helps in the exploration of new avenues in the world of science..

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Reprogramming adult cells into induced pluripotency with unprecedented efficiency
A team of scientists has reported a more efficient approach to reprogramming a patient's diseased skin cells into stem cells, raising hopes for future clinical trials and potential cures for critical illnesses. Find source

Shapeshifting tissue folds into coils & ripples
Tissues harnessed with programming to create shapes out of living tissues by folding up into variety of programmed tissues. Find source

Energy conversion of fats by microneedle patch
New approach to reduce bulging tummy fats via a micro-needle patch,with drugs that turn energy-storing white fat into energy-burning brown fat. Find source

Top ten people who mattered this year
From a gene corrector to an error detector, Nature profiles people who had an impact in science in 2017. Find source

Description: Research

Genes in Space-3 identifies unknown microbes
First-ever sample-to-sequence process entirely aboard the space station.NASA astronaut performed Genes in Space-3 using the miniPCR & MinION. Find source

Solution to Type 2 diabetes- Pain free skin patch
Biochemically formulated patch of dissolvable microneedles devised that interacts in bloodstream to regulate blood sugar. Find source

HEC Chairman Should Immediately Resign Over Poor Performance: Federal Academic Staff Association

By Contributors -

Islamabad: Newly elected cabinet of Federation of All Pakistan Universities Academic Staff Association (FAPUASA) has demanded from HEC Chairman Dr. Mukhtar Ahmad to tender resignation immediately over poor performance.

Elections of FAPUASA concluded on Sunday where Dr. Kaleemullah Barech from University of Balochistan was elected President, Dr. Muhammad Shoaib from UET Lahore was elected Vice president, Dr. Shakeel Farooqi from Karachi University was elected General Secretary, Dr. Rana Ali Khan was elected as Executive Member Engineering and Dr. Humayon Khan was elected as Ex-Officio member.

Read Also: Going Nowhere: HEC Scholarships for Balochistan

In a joint press statement after election, cabinet of FAPUASA vowed to protect the autonomy of universities in Pakistan. "We demand devolution of Higher Education Commission as per 18th Constitutional Amendment and establishment of provincial HECs for implementation of recent judgment of Lahore High Court.

We demand devolution of Higher Education Commission as per 18th Constitutional Amendment and establishment of provincial HECs for implementation of recent judgment of Lahore High Court - FAPUASA

FAPUASA also demanded to end interference in internal affairs of universities and urged respect for statutory bodies of universities. The press statement also asked the Law Enforcement Agencies to vacate the premises of University of Balochistan.

Earlier, Dr. Fareed Khan was elected as President of Balochistan Chapter. Dr. Shehzad Ashraf (IIUI) President of Islamabad Chapter, Dr. Humayon as President of KPK Chapter. Dr. Javed Ahmad (BZU) as President of Punjab Chapter and Dr. Naimat Ullah Laghari as President of Sindh Chapter.

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4051	Rafida Kh. Ahmed	TOTAL FLAVONOID, PHENOLIC CONTENT AND CYTOTOXIC ACTIVITIES TO STUDY THE COMBINATION EFFECT OF TWO MALAYSIAN MEDICINAL PLANTS	(1).97-101	2018	
4050	Rafida Kh. Ahmed	TOTAL FLAVONOID, PHENOLIC CONTENT AND CYTOTOXIC ACTIVITIES TO STUDY THE COMBINATION EFFECT OF TWO MALAYSIAN MEDICINAL PLANTS	(1).97-101	2018	
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26-5- Nov.-Dec.-2014
ISoRIS, 15-16 October 2014, Malacca, Malaysia, Special Issue, 26(4),Sept-Oct, 2014
(ICAPPH-2014)
26-4-2014(Sept-Oct.)
26(3), July-August,2014
26-2-2014
26-1-2014
Special Issue Agile Symposium Malaysia
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generating our own resources we remain committed to serve the world of science in general to the best of our capacity and dedication.

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SCIENCE CONFERENCE SERIES

IN COLLABOATION WITH UNIVERSITIES AND RESEARCH ORGANISATIONS

1- All Pakistan Science Conference, 16-21 May, 1992, Khanspur.
Opening Dr. I. H. Qureshi, Member Tech., Pakistan Atomic Energy Commission (on behalf of the Chairman, (PAEC).
Closing: Syed Fakhar Imam, Minister of Education, Government of Pakistan.
115 papers presented; proceedings published.

2. 2nd All Pakistan Science Conference, 26 - 30 December, 1993, Aitchison College, Lahore.
, Pakistan
Closing: Syed Babar Ali, Minister of Finance (former), Government of Pakistan.
110 papers presented; proceedings published.

3. 3rd All Pakistan Science Conference, 11-15 September, 199 4, Bara Gali.
Closing: Dr. Khalid Farooq (Chief Sceintific Officer), PCSIR, Lahore.
Chief Guest: Mudassar Tabassum, Italy.

4. 4th All Pakistan Science Conference, 26 - 30 December, 1995, University of Agriculture, Faisalabad.
Opening: Dr. Anwarul Haq, Vice Chancellor, University of Agriculture, Faisalabad.
Closing: Dr. Anwarul Haq, Vice Chancellor, University of Agriculture, Faisalabad.
105 papers presented; published.

5. 5th All Pakistan Science Conference, 15 -19 Sept., 1996 at University College of Agriculture, Rawalakot (AJ&K).
Opening: Sardar Muhammad Ibrahim, President, Azad Kashmir.
Closing: Dr. Khalid Mahmood Khan, Chairman, Pakistan Science Foundation.
130 papers presented.

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6. 6th All Pakistan Science Conference, 3- 6 November, 1997 at NWFP Agriculture University, Peshawar.
Opening: Minister of Education, NWFP.
120 papers presented.
Closing: Vice Chancellor, NWFP, University of Agriculture,

1 . Ist "International Science Conference", in collaboration with the Faculty of Science and Environmental studies, University Putra Malaysia,(UPM), Malaysia, 7 - 9 May, 1998.
Opening: The Deputy Minister, Datu Abubkar Bin Daud, Science and Technology, Malaysia.
Co-Chair: Dr. Syed Jalaludin bin Syed Salim, Vice-Chancellor, UPM, Malaysia.
150 papaers presented.

2 . 2nd International Science Conference, 26-28 October, 2000 in collaboration with Institute of Chemical Engineering and Technology, University of the Punjab,Lahore.
Opening: Lt. General(R) Arshad Mahmood, Vice Chancellor, P. U. Lahore.
Closing: Dr. Zafar Iqbal, Director, Institute of Chemistry, University of the Punjab, Lahore.
120 papers presented.

3 . 3rd International Science Conference, 26-28 September, 2002, University, of Arid Agriculture, Rawalpindi.
Opening: Khurshid-u-Zaman Qureshi, Minister of Agriculture, Government of the Punjab.
135 Papers Presented.
Closing: Dr. K. A. Malik, Member, Pakistan Atomic Energy Commission, Islamabad

4 . 4th International Science Conference due by the end of 6-8 October 2004. University of Azad Kashmir , Muzaffarabad)
150 papers presented.

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a) A series entitled "SCIENCE TASK FORCE" in collaboration with Pakistan Broadcasting Corporation (Radio Pakistan, Lahore).
i. 28 February, 1991, Alhamra Hall, Lahore.
Chief Guest: Mian Mohammad Azhar, Governor of the Punjab.
Speaker: Dr. S. H. Iqbal, Chairman, Department of Botany, Pujab University, Lahore.
Topic: Fungus - What Good Is It?
ii. 25 April 1991, at Alhamra Hall, Lahore.
Speaker: Dr. N.M. Butt, Director General, PINSTECH, Islamabad.
Topic: New Materials and Super Conductors.
iii. 30 July 1991, at Alhamra Hall, Lahore.
Chief Guest: Ghulam Haider Wayen; Chief Minister, Punjab.
, Pakistan
Speaker: Dr. Shamim Ahmad Chaudhry, CSO, PINSTECH, Islamabad.
Topic: Production of Radio Isotopes.
iv. 8 December, 1991, at Alhamra Hall, Lahore.
Chief Guest: Qazi Alun ud Din, Chairman, Pakistan Engineering Counsel.
Guest of Honour: Dr. N. M. Butt, Director, PINSTECH, Islamabad.
Speaker: Dr. Syed Mohammad Qasim (Germany).
Topic: Radio Isotopes for Emission Tomography.
b) IN P.C.S.I.R. COMPLEX, LAHORE.
i. 14 Febrary 1993.
Chief guest: Dr. M. A. Saeed, Director General, PCSIR, Laboratories, Lahore.
Dr. Khalida Usmani, Executive Director, C.R.F.P. & W.I.E.C., Asian Chapter.
Speaker: Dr. Syed Sajjad Hussain, Cancer Institute, Buffalo, U.S.A.
Topic: Cancer Diagnosis, Role of a Chemist.
ii. 3 April 1993.
Chief Guest: Mian Mohammad Azhar, Governor of the Punjab.
Guest Speaker: Dr. A. Q. Ansari, Chairman, PCSIR. Laboratories.
Speaker: Dr. Hamid Ahmad Khan, Director General, PINSTECH, Islamabad.
Topic: Radiation Hazards.

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Dr. Khalida Usmani, Executive Director, C.R.F.P. & W.I.E.C. Asian Chapter.
A talk - Preventions Against Cancer.
c) DURING CONFERENCE
i. 18 May, 1992, Khanspur, Pakistan.
Chair: : M. A. Saeed, Head, Applied Div., PCSIR, Laboratories, Lahore.
Speaker: Dr. M. A. Khan, Institute of Chemistry, Punjab University, Lahore.
Topic: News Aspects of Environmental Pollution.
Speaker: Dr. Khawaja Yaldrem, Pakistan Atomic Energy Commission, Islamabad.
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Chair: **Dr. S. A. Khan**, Chairman, PCST, Islamabad.
Speaker: Dr. N. M. Butt, Director, PINSTECH, Islamabad.
Topic: Role of New Materials and Super Conductors in Industry.
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Chair: **Dr. S. A Khan**, Chairman, PCST, Islamabad.
Speaker: Dr. M. Ashraf Tahir, Chief, DNA and Sereology, Indianapolis, Indiana, U.S.A.
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Chair: : **Dr. Khalid Farooq**
Speaker: Dr. Naeem ul Hassan Janjua, A. Q. Khan Res. Labs; on deputation NED University, Karachi.
Topic: Life Engineering.
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Chair: : **Dr. Khalid Farooq**, C. S. O., PCSIR, Lahore.
Speaker: Dr Khalid Janjua: PCSIR Laboratories, Lahore.
Topic: Elementology.
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Presided: **Dr. Khalid Farooq**, CSO., PCSIR, Lahore.
Speaker: Dr. Mudassar Tabassum; Guest from, Italy.
Topic: Laser Technology and Medical Science.
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7.5.1998- Universiti Putra Malaysia, Malaysia.
Speaker: Prof. Hjg. Rosnani Binti Ibrahim
Topic: Environmental Management in Malaysia.
Speaker: Dr. M. Anwar Chaudhry, University of Melbourne, Australia.
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Chair: Dr. Ashraf Atta.(SI, HI), Dr. A. Q. Khan Res. Labs., Rawalpindi.
Speaker: Romana Aziz, Head Computor Department, UAAR.
Topic: E-mail Packages

Speaker: Prof. Dr. M. Akhtar, FRS, University of Southampton, U.K.
Topic: On the Frontiers of Biological Sciences.

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Speakers:
i. Dr. M. N. Khan, Rector, GIK Institute of Engineering and Technology.
Fabrication of High-Tc Supper Conductors for Energy Technology and its Environmental Impact.
ii. Dr. Muhammad A. Tahir. Sereology, Indianapolis, Indiana, U.S.A.
Forensic Science; A Modern Tool for the Detection of crime.
iii. Dr. Gulam Sarwar, Head(Rtd), Dept. of Oncology, King Edward Medical College, Lahore.
Prevention & Cure of Cancer.
iv Dr. Sadaqat Mehdi, Registrar, Virtual University, Lahore.
Distant Learning

9.12.1995, University of Agriculture, Faislabad.

Chair: **Dr. Kausar Abdullah Malik**, Director, NIBGE, Fiasalabad.
Topics: (Morning Session)Higher Education & Research; Current Issues.
(Evening Session)Research & Industry; Interactions.
Speakers:
Dr. Mujtaba Naqvi, Dir. Gen., NIAB,, Faisalabad.
Dr. Tausif Rashid Butt, Universty of Philadalphia, U. S. A.
Also addressed by:
Dr. Bohari. M. Yamin, Deputy Dean, U. K. M., Malysia
Dr. Anwar Nasim, Pakistan Academy of Sciences, Islamabad.
Dr. Khalid Farooq, CSO, PCSIR, Lahore.
Dr Khurshid Alam, Dean(Agriculture), University of Agriculture, Faisalabad.
Dr. Matiullah, CNS, Islamabad.
Dr. Abrar Hussain Gilani, Dean, University of Agriculture,Faisalabad.
Dr. Altaf-ur-Rehman Rao, Dean(Physical Sciences), University of Agriculture, Faisalabad.

27.9.2002: WORK SHOP:
University of Arid Agiculture, Rawalpindi
Chair: **Dr. M. Afzal**, Director General, PASTIC, Islamabad.
Topic: Evaluation of Research Papers
Views of the participants followed by general discussion
Recommendations consolidated by the Head of the Committee,
Dr. M. Younas,
Chairman, Live Stock Management, University of Agriculture, Faisalabad.

Publication:

WATER CRISES AND CROP PRODUCTION GAPS IN PUNJAB
Identification, Risk Analysis and Mitigation Measures
Authors: M Azhar Javed and M. Tariq Yamin

ESTIMATION OF GENERALIZED GAMMA DISTRIBUTION PARAMETER WITH PROBABILITY WEIGHTED MOMENT METHOD

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ABSTRACT: *The classical Gamma distribution with two parameters is the distribution most commonly used in modeling the distribution of environmental quality data. However, this distribution is less precise for environmental quality data fittings. One way to overcome this is by making generalization of Gamma distribution. In this study Generalized Gamma distribution with parameters* ***b****,* ***d****, and* ***k*** *will be used as a model of water quality data. The parameters of the Generalized Gamma distribution probability model are to be estimated with the Probability Weighted Moment Method. To see the accuracy of estimations in various sample sizes, the Monte Carlo simulation or experiment is used to generate data. Using the data, the result indicates initial guess value b = 0.14, d = 3.28 and k = 0.001.Simulation with Monte Carlo experiments for parameter estimation with Probability Weighted Moment Method on parameters* ***b****,* ***d*** *and* ***k*** *shows better results if the sample sizes used are larger. For modeling environment quality data that has Generalized Gamma distribution, regular (routine) sampling is necessary. The Probability Weighted Moment method can be an alternative method of estimation used in Generalized Gamma distribution.*

Keywords:Generalized Gamma distribution, Probability Weighted Moment, Monte Carlo Simulation, Water Quality.

1. INTRODUCTION

Gamma distribution is one of the most commonly used distributions in environmental quality data modeling. The gamma distribution is one of a continuous probability distribution family with two parameters. However, this distribution does not necessarily fit the data well for all types of environmental quality data. Berger, et al.,[1] noted, for the sulphur dioxide data in the Gent region of Belgium, the gamma distribution gives a more precise picture. One way to overcome this is to develop the distribution of gamma into a more generalized distribution. In this case, the generalized model must contain a model commonly used in environmental pollution data modeling. For modeling to be generally applicable to each state of data, the gamma distribution is generalized by three parameters also called as Generalized Gamma (GG) distribution

Gamma distribution is very useful in modeling data distribution, among others: survival. Because of its importance, the parameter estimation for the distribution of data that has Gamma probability model should be done precisely, accurately, and efficiently. One of the most popular methods of estimating the parameters of a distribution is the maximum likelihood method.

Unfortunately, the maximum likelihood method is based on large sample theory, so this method often works poorly for data with "small" sample sizes or even for data with "medium" sample sizes. It is therefore very interesting to look for alternative methods to estimate the parameters of a distribution, and in this case it is proposed to use the probability-weighted moment method.

Marani, et al.,[2] used a Generalized Gamma model for modeling air quality data distribution with satisfactory results. Thus, it is very interesting to apply the same model to other environmental pollution data, such as water quality data.To find out if a distribution model works well in modeling a data set, the parameters of the model should be estimated first. One of the most well known methods of estimation is the maximum likelihood method. Greenwood et al. [3] and Holland and Fitz-Simons [4] stated, since the maximum likelihood method is based on large sample theory, this method often works less satisfactorily for "small" sample sizes data or even for "medium" sample sizes. To address this problem, [3] proposed the use of the Probability Weighted Moment method, as an alternative to the maximum likelihood method, to estimate the parameters of some distributions, such as the Gumbel distribution and the generalized lambda. Meanwhile, Shoukri, et al.,[5] applied the alternative method to log-logistics distribution. Therefore, to estimate the parameters of the Generalized Gamma distribution, this study uses Probability Weighted Moment method as an alternative to the maximum likelihood method. This study also examines the effect of sample size by Monte Carlo simulation or experiment on the appearance of Probability Weighted Moment method in estimating the parameters of environmental quality data distribution following the *Generalized Gamma* distribution.

2. LITERATURE REVIEW

2.1Generalized Gamma Distribution

According to Diciccio [6], a random variable X is said to have a generalized distribution of gamma probabilities with parameters α, β and θ if and only if the probability function of X is:

$$f(x) = \frac{\beta}{\Gamma(\alpha)} \frac{x^{\beta\alpha-1}}{\theta^{\beta\alpha}} e^{-\left(\frac{x}{\theta}\right)^{\beta}}; x > 0; \alpha, \beta, \theta > 0$$

Parameters α and β are known as shape parameters and θ parameter is known as scale parameter.

2.2The Probability Weighted Moment Method

In relation to the weakness of the maximum likelihood method described earlier for a "small" sample,[3] introduce the use of the Probability Weighted Moment method as an alternative to the maximum likelihood method. The Probability Weighted Moment method of the random variable X with the function of the cumulative distribution is defined as follows:

$$M_{r,s,t} = E[X^r(F(X)^s)\ (1-F(X)^t)]$$

In this case r, s, and t are the real numbers. If $s = t = 0$ and r is a non-negative integer, then $M_{r,0,0}$ is a conventionally known moment of probability. Let $X(F)$ be the inverse of cumulative distribution, then the Probability Weighted Moment can be written in the form:

$$M_{r,s,t} = \int_0^1 (X(F)^r)F^s\big(1-F(X)\big)^t dF$$

Methods of Probability Weighted Moment was introduced by Landwehr, et al.,[7] in Gumbel distribution. More specifically Hosking, et al.,[8] discussed the characteristics of probability distribution parameters of generalized extreme-value distribution generated by the Probability Weighted Moment method. Shoukri, et al.,[5] concluded that based on the simulation results the instant-Probability Weighted Moment method can be calculated, without having to go through the iteration process and always produce a visible value, and the bias and variance are smaller on the "small" sample size, equal to 15 and 25.

3. RESEARCH METHOD

3.1 Method of Estimating Parameters

To compare the appearance of the Probability Weighted Moment method in estimating the Generalized Gamma distribution parameters, the estimation of the environmental data distribution parameters model is performed by this method. Before the method is applied, it is necessary to derive and develop the predictions procedure for the Generalized Gamma distribution.

In Probability Weighted Moment method, the procedure of estimation begins with finding the inverse function of the cumulative distribution of the Generalized Gamma distribution, i.e. $X(F)$. Then the estimation parameter is calculated by solving the following equation:

$$M_{r,s,t} = \int_0^1 (X(F)^r)F^s\big(1-F(X)\big)^t dF$$

in this case $r = 1$, $s = s$, and $t = 0$. Having obtained the parameter estimation, which is still expressed in the form M_r, The unbiased estimators for M_r are obtained based on the samples of $X_{(1)} < X_{(2)} < \ldots < X_{(n)}$ from the random sample of size n and by solving the equation:

$$\widehat{M}_r = \frac{1}{n}\sum_{j=1}^{n} \frac{(j-1)(j-2)\ldots(j-r)}{(n-1)(n-2)\ldots(n-r)} X_{(j)}$$

A review of the performance of the Probability Weighted Moment method in estimating the Generalized Gamma distribution parameters for the various sample sizes is done by Monte Carlo simulation or experiment. The assessment of the two methods performance is based on the features of unbiasedness and variances, i.e. by looking at the biased values and variances of the probability parameters produced for different sample sizes.

3.2 Data Usage

The purpose of this study is to obtain the results from the Probability Weighted Moment method on Generalized Gamma Distribution on seawater quality data. To illustrate the estimation results, the data will be used as the basis for determining the parameters. This research uses sea water quality data obtained from University of Lampung. The location of data collection is on several rivers in the Coastal Area of Bandar Lampung City (Lampung Bay) which include Way Sukamaju, Way Keteguhan, Way Kuripan, Way Kunyit, Way Kuala, Way Lunik, and Way Galih. The seawater quality are assessed in through physical parameter including TDS and TSS as well as chemical parameters including DO, COD, BOD, Hardness, Alkalinity, PO4, SO4, Nitrite, Nitrate, Iron (Fe), Sulfide, Pb, Hg, Cu, and Cd with the same unit in mg/l.

3.3 Monte Carlo Simulation Scenario

Monte Carlo simulation scenarios to be conducted in this study are as follows:

a. Generating a random sample of size n = 5.
b. Generating a random sample of size n = 10
c. Generating a random sample of size n = 25.
d. Generating a random sample of size n = 50
e. Generating a random sample of size n = 100.
f. Generating a random sample of size n = 500.
g. Generating a random sample of size n = 1000.

for parameter estimation and simulation used in this research is program facilities provided in program R version 3.Generation of samples for all sample sizes above is conducted by simulation each of N = 500 times.

The sample sizes n = 5, n = 10 and n = 25 are considered to represent "small" samples, n = 50 is considered to represent a "medium" sample, and the sample sizes n = 100, n = 500, and n = 1000 are considered to represent“ large”samples. The simulated data of Generalized Gamma distribution with predetermined parameters is done by utilizing uniform distribution.

4. RESULTS AND DISCUSSION

4.1 Estimation of Generalized Gamma Distribution Parameters Using Probability Weighted Moment Method (PWM)

To estimate the parameters of the Generalized Gamma distribution using the Probability Weighted Moment method, the first step is to determine the cumulative distribution function (CDF) of the Generalized Gamma distribution for subsequent use in searching M_(r,s,t) as the basis for applying Probability Weighted Moment method and then determines the parameter estimator.

4.2 Cumulative Distribution Function of Generalized Gamma Distribution

The cumulative function of Generalized Gamma distribution can be obtained by the following steps:

$$F(x) = \int_{-\infty}^{x} f(t)dt$$

$$F(x) = \int_{0}^{x} f(t)dt$$

$$= \int_0^x \frac{\beta}{\Gamma(\alpha)} \frac{t^{\beta\alpha-1}}{\theta^{\beta\alpha}} e^{-\left(\frac{t}{\theta}\right)^{\beta}} dt = \frac{\beta}{\Gamma(\alpha)\theta^{\beta\alpha}} \int_0^x t^{\beta\alpha-1} e^{-\left(\frac{t}{\theta}\right)^{\beta}} dt$$

Due to the many parameters in the integral function, it is necessary to simplify as follows:

$$u = \left(\frac{t}{\theta}\right)^{\beta}$$
$$t = u^{\frac{1}{\beta}}\theta$$
$$dt = \frac{1}{\beta} u^{\frac{1}{\beta}-1}\theta du$$

Limit:

$$t = 0 \rightarrow u = 0$$
$$t = x \rightarrow u = \left(\frac{x}{\theta}\right)^{\beta}$$

So the above equation can be written as:

$$F(x) = \frac{\beta}{\Gamma(\alpha)\theta^{\beta\alpha}} \int_0^{\left(\frac{x}{\theta}\right)^{\beta}} \left(u^{\frac{1}{\beta}}\theta\right)^{\beta\alpha-1} e^{-u} \frac{1}{\beta} u^{\frac{1}{\beta}-1}\theta du$$

$$= \frac{\beta}{\Gamma(\alpha)\theta^{\beta\alpha}} \frac{\theta^{\beta\alpha}}{\beta} \int_0^{\left(\frac{x}{\theta}\right)^{\beta}} u^{\alpha-\frac{1}{\beta}} e^{-u} u^{\frac{1}{\beta}-1} du$$

$$= \frac{1}{\Gamma(\alpha)} \int_0^{\left(\frac{x}{\theta}\right)^{\beta}} u^{\alpha-1} e^{-u} du$$

$$= \frac{1}{\Gamma(\alpha)} \int_0^{z} u^{\alpha-1} e^{-u} du \; ; \; z > 0$$

Thus, the cumulative function (CDF) obtained from the Generalized Gamma distribution is:

$$F(x) = \frac{1}{\Gamma(\alpha)} \int_0^{z} u^{\alpha-1} e^{-u} du \; ; \; z > 0 \quad and \; z = \left(\frac{x}{\theta}\right)^{\beta}$$

The cumulative function of the GB2 distribution is an incomplete gamma function, so the inverse of the cumulative function cannot be resolved analytically but numerically. Therefore, to find the probability weighted form of the GB2 distribution used to estimate the parameter values should also be resolved numerically.

4.3 Numerical Richardson Integral Method

Richardson extrapolation is a method that uses two estimations of an integral to compute a more accurate third estimator. The estimations and errors associated with the multi-application trapezoidal rule can be described in general as

$$I = I(h) + E(h) \quad (1)$$

where I is the true value of the integral, $I(h)$ is an estimation of a trapezoidal rule with a segmented application n with the width of the step $h = \frac{b-a}{n}$and $E(h)$ is the truncation error. If we make two different estimations using step width h_1 and h_2 then we get the following equation:

$$I(h_1) + E(h_1) = I(h_2) + E(h_2) \quad (2)$$

errors from multi-application trapezoidal rules can be estimated as:

$$E \cong -\frac{(b-a)^3}{12\,n^2} f''$$

Since the value $n = \frac{b-a}{h}$ so the above equation can be changed into

$$E \cong -\frac{(b-a)}{12} h^2 f'' \quad (3)$$

If it is assumed thatf'' is a constant which means it is not affected by step width then the value of E can be used to determine the ratio of both errors:

$$\frac{E(h_1)}{E(h_2)} \cong \frac{{h_1}^2}{{h_2}^2}$$

This calculation has an important effect on removing f'' from the calculation. Furthermore, the above ratio equation can be changed to:

$$E(h_1) \cong E(h_2)\left(\frac{h_1}{h_2}\right)^2 \quad (4)$$

Then substitute equation (4) into equation (2), and the following results are obtained:

$$I(h_1) + E(h_2)\left(\frac{h_1}{h_2}\right)^2 = I(h_2) + E(h_2)$$

$$E(h_2) \cong \frac{I(h_1)-I(h_2)}{1-\left(\frac{h_1}{h_2}\right)^2} \quad (5)$$

As a result we have developed an estimation of the deduction error in terms of the integral estimation and the width of the step. This estimation can be substituted into:
$I = I(h_2) + E(h_2)$.
To produce an improved integral estimation:

$$I \cong I(h_2) + \frac{I(h_2) - I(h_1)}{\left(\frac{h_1}{h_2}\right)^2 - 1}$$

This shows that the error of this estimation is h^4. For a special case where the interval is divided into two $\frac{h_2-h_1}{2}$, the equation will be:

$$I \cong I(h_2) + \frac{I(h_2) - I(h_1)}{2^2 - 1}$$

or formed into:

$$I \cong \frac{4}{3} I(h_2) - \frac{1}{3} I(h_1)$$

This approach is a subset of a more general method for combining integral to produce an error that is O(h^4) which can then be used to look for smaller errors i.e. O (h^6), O(h^8), and so on.

4.4 Determination of Water Quality Data Parameters

The parameter values to be estimated are obtained from the water quality parameter in some rivers in coastal area of

Bandar Lampung city (Source: University of Lampung). Using the data, the parameter values are obtained b = 0.14, d = 3.28 and k= 0.001. Data on water quality parameters in some rivers in the coastal area of Bandar Lampung city are believed to have distributed Generalized Gamma from Kolmogov Smirnov test. In Kolmogorov Smirnov rank test of Generalized Gamma distribution is rank 2 with p-value= 0.07232.

4.5 Simulation and Evaluation of Generalized Gamma Distribution Parameter Estimation

The Generalized Gamma distribution has three parameters where d and k are the shape parameters, and b is the scale parameter. The parameter estimation is performed by using software R. The parameter values to be estimated are parameters of seawater quality data obtained before, they are b = 0.14, d = 3.28 and k= 0.001.

After obtaining the parameter values to be estimated, then simulation is performed to evaluate the characteristics of each estimator. A good estimator is an unbiased, efficient, and consistent predictor. In this simulation the bias value, variance, and mean square error (MSE) of the estimations obtained by using sample sizes 5, 10, 25, 50, 100, 500, and 1000 are compared. Next, we will discuss the results of the estimation evaluation on parameter b on the Generalized Gamma distribution with the Probability Weighted Method in Table 1. From the results of parameter estimation b in Table 1, it shows that the larger the samples used, the closer the estimator value of the actual parameter. This result can be supported with an increasingly small bias value as the sample size increases. The larger the sample size used, the closer to zero the bias value. Variance of estimator for parameter b shows that if the size of the sample used is larger then the value of the variance is also getting closer to zero. Likewise for the MSE value estimator for b, the larger the sample used, the smaller the error value. Based on the results of the estimator evaluation shown in Table 1, the estimator for b with the Probability Weighted Moment Method on the Generalized Gamma distribution, the larger the sample size used in the estimation by the Probability Weighted Moment Method, the better the estimation will be with the bias, variance, and MSE approaching zero.

Table 1: The predicted, biased, variance, and MSE values for parameter b with initial value b = 0.14 from Generalized Gamma distribution

Sample Size	$\hat{b}$	Bias $\hat{b}$	Variance $\hat{b}$	MSE $\hat{b}$
5	11.4004	11.2604	10.79596	137.5926
10	10.83954	10.69954	10.35214	124.7433
25	10.15808	10.01808	9.98652	110.3484
50	9.15263	9.01263	8.61373	89.84123
100	7.889112	7.749112	7.02612	67.07486
500	5.31125	5.17125	4.98748	31.72931
1000	3.14271	3.00271	2.87251	11.88878

Table 2: The predicted, biased, variance, and MSE, values for parameter d with initial value d =3.28 of the Generalized Gamma distribution

Sample Size	$\hat{d}$	Bias $\hat{d}$	Variance $\hat{d}$	MSE $\hat{d}$
5	21.79714	18.51714	11.0779	353.9624
10	21.52569	18.24569	10.90974	343.8148
25	20.5857	17.3057	10.17834	309.6656
50	19.2222	15.9422	9.03112	263.1849
100	17.56315	14.28315	7.96581	211.9742
500	15.25442	11.97442	6.01637	149.4031
1000	12.42064	9.14064	3.25024	86.80154

The estimation value of parameter $\boldsymbol{d}$ gets closer to the actual parameter as the number of samples increases. Table 2 summarizes estimator evaluation by bias, variance, and MSE. For the bias of estimated parameter $\boldsymbol{d}$ in the Generalized Gamma distribution, bias will be smaller or closer to zero as the number of samples gets larger. Likewise on the variance and the MSE, the value of the variance and the MSE is getting closer to zero when the sample size used is larger.

Thus, for estimating the parameter $\boldsymbol{d}$ by the Least Square Method indicates better estimation results when the sample size used is larger indicated by the bias, the variance, and the MSE approaching zero.

Table 3 presents the estimator evaluation results with the bias, variances, and MSEs by the estimation parameter k with the Probability Weighted Moment method on Generalized Gamma distribution. Based on the results in Table 3, the estimation of parameter k with the Probability Weighted Moment Method produces bias, variance, and MSE approaching zero as the sample size increases. The estimated value of the parameter k is also closer to the actual value for the larger sample size. As for estimation parameters b and d, estimation parameter k gets better as the sample size gets larger based on the evaluation of estimation bias, variance, and MSE parameters. This suggests that the Probability Weighted Moment Method will be more accurate to estimate the parameters of water quality data in Generalized Gamma distribution when the sample size used is larger.

Table 3: The predicted, biased, variance, and MSE values for parameter k with initial value k = 0.001 of Generalized Gamma distribution

Sample Size	$\hat{k}$	Bias $\hat{k}$	Variance $\hat{k}$	MSE $\hat{k}$
5	9.99128	9.98128	8.54105	108.167
10	9.62705	9.61705	8.02417	100.5118
25	9.1823	9.1723	7.89802	92.02911
50	8.06921	8.05921	6.81571	71.76658
100	6.27371	6.26371	5.23102	44.46508
500	4.20023	4.19023	4.00163	21.55966
1000	2.14125	2.13125	1.97423	6.516457

4.6 Fitting Parameter Estimation on Water Quality Data

Fitting on water quality data in several rivers in Coastal Area of Bandar Lampung City is known to have Generalized Gamma distribution with parameter b = 0.14, d = 3.28 and k = 0.001. This simulation result of parameter estimation with Least Squares method indicates that the larger the sample size used, the better the parameter estimation is.

These results provide the foundation that the environmental quality data of several rivers in the Coastal Area of Bandar Lampung City follow the more Generalized Gamma or Generalized Gamma distribution. To obtain information for both modeling and distribution, parameter estimation with Probability Weighted Moment Methods gives better results for larger samples. Therefore, in using Generalized Gamma distribution as distribution in modeling of water quality data especially in Coastal Area of Bandar Lampung City it is required to do continuous or routine sampling so that the number of samples used is larger and gives better estimation results with Probability Weighted Moment Method.

5. CONCLUSION

The water quality data on several rivers in the coastal area of Bandar Lampung follow the Generalized Gamma distribution with parameter value $b = 0.14$, $d = 3.28$ and $k = 0.001$. The simulation result for parameter estimation with Probability Weighted Moment method for parameters b, d and k is better if the sample size used is larger based on the evaluation value of bias estimation, the variance and the MSE approaching zero.

For the modeling of environmental quality data that has Generalized Gamma distribution, regular (routine) sampling is necessary because the parameter estimation on the distribution with Probability Weighted Moment method will be better if the number of samples used is larger. The Probability Weighted Moment method can be an alternative method of estimation used in Generalized Gamma distribution.

ACKNOWLEDGMENTS

The authors would like to thank the Directorate of Research and Community Service at the Ministry of Research, Technology, and Higher Education which has funded this research through DIPA BLU fund of University of Lampung Fiscal Year 2017. Thanks also to the Head of Institute of Research and Community Service of University of Lampung whom supported the research such that the reseach can be conducted on time.

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