AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Irrigation and Hydraulics Department

Investigating Parent Distribution for Maximum Daily Rainfall in Arid Regions

A Thesis Submitted in Partial Fulfillment for the Requirements
of Master of Science Degree in Civil Engineering
(Irrigation and Hydraulics)

By

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A thesis Submitted for the partial fulfillment of the
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STATEMENT

This thesis is submitted to the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University to fulfill all the requirements needed to obtain the Master of Science degree in civil engineering.

The work in this thesis was carried out in the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University from 2013 to 2019.

I hereby confirm that the thesis component hasn't been submitted in any other university or educational institutions in order to get any educational degrees.

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Table of Contents

List of Tables

List of Figures

Nomenclature

AD	Anderson-Darling Criterion
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
C_k	Coefficient of Kurtosis
Cs	Coefficient of Skewness
Cv	Coefficient of Variation
GEV	Generalized Extreme Value Distribution
GIS	Geographic Information System
GOF	Goodness of Fit
IDF	Intensity, Duration and Frequency
IDW	Inverse Distance Weighting
KS	Kolmogorov-Smirnov
LP III	Log-Pearson type 3
MEWA	Ministry of Environment, Water and Agriculture
PME	Presidency of Meteorology and Environment

Abstract

Hydrologists need effective procedures to assist them in predicting the implications related to high rainfall risks, both at gauged and ungauged areas. The first step for any assessment is estimating the rainfall values associated with various return periods in years. This information is obtained using rainfall frequency analysis techniques based on observed maximum daily rainfall values.

The existence of a regional distribution for the rainfall frequency within a certain region is considered as a precious information for the hydrologists to estimate – with confidence – the expected rainfall at high return periods.

The main aim of this research is to determine the regional statistical distribution for various regions in Saudi Arabia.

Saudi Arabia was selected to represent arid regions as it covers a large area of the Arabian Peninsula in addition to the availability of rainfall data compared with other similar countries. The data of 394 rainfall gaging stations were included in the study, which cover all Saudi Arabia in its 13 administrative regions.

The data was analyzed using multiple frequency analysis methods and was subjected to various statistical tests, including Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Anderson-Darling Criterion (AD), Station-Year Analysis, and Index Flood Method, in order to determine the best regional statistical distribution and define the homogenous regions using regional analysis.

The study concluded that Saudi Arabia could be sub-divided into seven homogeneous regions and that the Log-Pearson type III distribution was the best model to describe the distribution of the

daily maximum rainfall in these regions. Contour maps for the 2-, 5-, 10-, 25-, 50-, and 100-year rainfall were also produced to predict the rainfall at any point within the Kingdom of Saudi Arabia.

Chapter 1 : Introduction

1.1. Background

Designing of different hydraulic structures, especially urban stormwater drainage elements, necessitate conducting statistical analysis to identify the probability of daily maximum rainfall occurrence for durations that vary from several minutes to days. The result of the statistical analysis is usually presented by the IDF curves which is a relation between the rainfall Intensity, Duration and Frequency (Chow 1964).

In order to initiate the elaboration of IDF curves, the daily maximum rainfall series measured on yearly basis are required to carry out the rainfall frequency analysis. This is due to the simple structure of the curves when compared to others peak threshold series (Lang et al., 1999; WMO, 2009a; WMO, 2009b).

One of the key choices in frequency analysis is the selection of the best distribution to fit the yearly extreme rainfall recorded data. However, this step is considered as a challenging task for hydrologists and remains a main uncertainty issue in engineering practice, due to substantial spatial variability of the precipitation maximum values.

Moreover, many probability models were proposed to represent the distribution of maximum yearly records at single station record scale (Chow, 1964; Kite, 1977; Stedinger et al., 1993; Hosking and Wallis, 1997; Rao and Hamed, 2000; WMO, 2009a; Salinas et al., 2014a; 2014b).

Each country/code of practice adopts different distributions as a regional distribution to be used within each country. The Log-