AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
IRRIGATION AND HYDRAULIC DEPARTMENT

UNCERTAINTY REDUCTION IN RUNOFF ESTIMATION USING RAINFALL DATA

A Thesis Submitted for Partial Fulfilment of the Requirements
for the Degree of
Doctorate of Philosophy in Civil Engineering

By

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M.Sc., Hydro-informatics and Water Management (EUROAQUAE), [2011]
B.Sc., Civil Engineering, Ain Shams University, [2004]

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Cairo, Egypt
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Date: ----/----/2018


وَقُل رَّبِّ زِدْنِي عِلْمًا

To my parents
who always give their full support at all times;

To my sisters Azza and Mona
who shared with me good and bad times;

To my father in-law and mother in-law
who gave me their happiness source;

To my soulmate, beloved and treasured wife Aya
who gives me inspiration, passion and dreams to life;

To my smile, heart beat and lovely son Yassin
who gives me hope, ambition and desire to continue.

Statement

This dissertation is submitted to Ain Shams University for partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Civil Engineering.

The work included in this dissertation was carried out by the author of this thesis in the department of Irrigation and Hydraulics, Faculty of Engineering, Ain Shams University.

No part of this work has been submitted for a degree or a qualification at any other university or institution.

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Curriculum Vitae

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Short Biography:

Ahmed Lotfy was born on 12th of February, 1982, in Cairo, Egypt. He received his education at Tabry El-Hegaz secondary school in Cairo, Egypt. In June 2004, he graduated from Ain Shams University, obtaining his B.Sc. in civil Engineering. In June 2005, he joined the Water Resources Research Institute to start his career in water resources field. However his passion about structures analysis did not stop where in 2007, he obtained a diploma in civil engineering from Ain Shams University with emphasizing on structures analysis. In August 2009, he awarded a scholarship from the European Commission (Erasmus Munds grants) to study for master degree in Europe for full two years. In 2011, he obtained his M.Sc. in hydro-informatics and water management from EUROAQUAE consortium, submitting his M.Sc. research thesis to Newcastle University. In 2014, he started his PhD at Ain Shams University.

Ain Shams University
Faculty of Engineering
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Thesis: Uncertainty Reduction in Runoff Estimation Using Rainfall Data

Abstract

In hydrological modeling, there are several sources of uncertainties associated with runoff estimation. Rainfall, which is the main input for these models, has a large impact on the runoff uncertainties. The objective of this research is to develop a monitoring rainfall network design method to reduce uncertainties associated with runoff estimation by reducing the uncertainty in rainfall data. This method depends on measuring the variations of the mean areal precipitation over any watershed of interest. Two sources of rainfall data were used; data recorded by existing rain gauges networks and data retrieved from GSMaP satellite product. This work includes two main parts; the assessment of reducing the number of rain gauges of predefined locations and developing the method for designing monitoring rainfall network. The differences between deterministic and geostatistical interpolation methods were investigated. Various statistical performance measures were used for achieving this assessment and selecting the optimal group(s) of rain gauges. Python scripts were developed and then used wherever needed throughout the work to complete the computations and to develop the method. Results reveal that the flexibility of the developed method is suitable for application in any ungauged watershed of interest and for any number of rain gauges according to the budget. The optimal rain gauge network design was achieved for various rain gauges number. Results also illustrate that the interpolation method does not affect the estimation of the mean areal precipitation for catchments having small areas. Additionally, both interpolation methods give similar results when the number of rain gauges increases over the watershed. The critical value of error increases by decreasing the probability of exceedance. By increasing the number of rain gauges in the investigated scenario, the values of resultant errors significantly decrease.

Keywords: Rainfall, Uncertainty, Runoff, Rain Gauge Network, Mean Areal Precipitation, GSMaP, Watier watershed, statistical measures, Python.

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