Sahol Hamid Abu Bakar · Wardah Tahir
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ISFRAM 2014

Proceedings of the International Symposium on Flood Research and Management

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Preface

The world is frequently being devastated by unpredictable disasters. Years of civilization of a nation can simply be shattered by a disaster such as tsunami in a matter of hours. Flooding has been one of the most disastrous natural hazards striking many parts of the world. The increasing trend in flood disasters has resulted from the combined impacts of several factors including global warming effects (e.g., increasing frequency of intense rain, glacier melting, and sea-level rise), land-use changes, and growing population in flood-prone areas.

International Symposium on Flood Research and Management 2014 (ISFRAM2014) is organized by the Flood Control Research Center (FCRC), Faculty of Civil Engineering, Universiti Teknologi MARA, to promote advances in flood research and management in finding solution toward reducing flood disasters. The objective of ISFRAM2014 is to provide a forum to researchers, scientists, and engineers to share and exchange their views, experiences, and researches in flood-related areas and sustainable management in Malaysia and worldwide. The symposium presents innovative work and best practices in managing flood and recommendation of flood solutions.

The full paper submissions were reviewed by national and international panel of reviewers before final acceptance. The selected papers were evaluated based on originality, research content, and relevance to contributions. Papers selected cover the fundamentals and latest advancements in related areas to flood research and management. The book proceedings to be published by Springer will serve as the source of knowledge and state-of-the art technology in managing flood for the betterment of the quality of life.

This symposium is supported by IEEE Malaysia IE/IA Joint Chapter and FCRC collaborators—Colorado State University, IIT Roorkee, AIT Thailand, Stuttgart University, National Hydraulic Research Institute, and the Drainage and Irrigation Department. I would like to express my deepest gratitude to all committee

members, panel of reviewers, authors, chairpersons, delegates, and everyone who had contributed to make ISFRAM2014 a success. I wish all participants a beneficial symposium, valuable experiences, and a pleasant stay at Sabah.

Selangor, Malaysia Wardah Tahir

About FCRC

Flood Control Research Center was founded by the Vice Chancellor of Universiti Teknologi Mara, Tan Sri Dato' Sri Prof. Ir. Dr. Sahol Hamid Abu Bakar, in collaboration with Stuttgart University, Colorado State University, Asian Institute of Technology (AIT), and Indian Institute of Technology (IIT) Roorkee as a five-university collaboration. The objectives of the center are:

- To identify important issues on flood
- To provide the solutions for flood problems in Malaysia
- To train young researchers and staff
- To share the pool of expertise
- To go beyond Malaysian border
- To get national and international research grants

The national research collaborators include the National Hydraulic Research Institute Malaysia (NAHRIM), Drainage and Irrigation Department (DID), Lembaga Urus Air Selangor (LUAS), Malaysian Meteorological Department (MMD), Department of Environment (DOE), National Security Council, and Local City Councils. These agencies would contribute:

- To share resources, data, and expertise
- To act as the pushing factor to the government for implementation of the proposed flood solution
- Joint research and supervision
- Joint publication
- Co-organizers of events and activities

Current and future activities of FCRC include:
Establishing a Flood Library which has:

- Library of models (e.g., HEC-RAS, HEC-HMS, Infoworks, Mike-11)
- Collection of structural solutions and key methodologies for flood problem

- Repositories of technical papers
- Open access to libraries especially to the five universities

Defining flood master planning methodology

- Flood risk and damage assessment
- Flood plan to incorporate entire flood hydrological regime
- Economic cutoff point for extending flood plan by using nonstructural method
- Nonstructural flood planning

Providing training program

- To increase capacity building for those involved in flood control and management
- To enable access to experts in the consortium of the five-university collaboration

Organizing annual meeting and symposium

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Keynote Speaker

Pierre Y. Julien

Dr. Julien is professor of Civil and Environmental Engineering at Colorado State University. As Professional Engineer, he has completed projects for 50 different agencies including UNESCO and the World Bank. Dr. Julien authored more than 500 scientific contributions including two textbooks, 20 lecture manuals and book chapters, 170 refereed journal articles including 90 full papers in scientific journals, 150 professional presentations, 190 conference papers, and 120 technical reports. He supported and guided more than 100 graduate students (including 37 Ph.D.) to complete engineering degrees. He delivered 15 keynote addresses at international conferences. He received the H.A. Einstein Award for his research on sedimentation and river mechanics.

Contents

Part V Weather and Climate

Keynote: Analysis of Extreme Floods in Malaysia

Pierre Y. Julien, Jazuri Abdullah, and Nur Shazwani Muhammad

Abstract This article reviews some of the recent advances in the analysis of extreme flood events in Malaysia. First, a detailed analysis of daily rainfall precipitation measurements leads to new understanding regarding Malaysian monsoons: the conditional probability of rainfall steadily increases as a function of the number of successive rainy days. The probability of multiday rainfall events has also been analyzed using stochastic models like DARMA(1,1) to demonstrate lower periods of returns of large precipitation amounts for rainfall events between 4 and 12 days. Advances in numerical modeling of surface runoff using the TREX model allowed improved simulations of large floods when considering rainfall amounts between the 2- and 100-year events and the PMP for extreme floods on both small to large watersheds in Malaysia. Examples on Lui, Semenyih, and Kota Tinggi have also been possible with GIS data at 30–90 m resolution. The recent floods of the Kota Tinggi and Muda River are also briefly discussed. Finally, a brief overview of the DID River Management Manual is also presented.

Keywords Monsoon precipitation • Extreme floods • Flashflood modeling • River management

1 Introduction

Southeast Asia has long experienced a monsoon climate with dry and wet seasons. With a mean annual rainfall precipitation around 2,500 mm and locally in excess of 5,000 mm, the very intense rainstorms in the steep mountains of Malaysia have caused frequent and devastating flash floods. In the valleys, floodwaters spread over very wide flood plains developed for agriculture, predominantly rice paddies and oil

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palm. Urbanization and deforestation exacerbate flooding problems due to the increased runoff from impervious areas. The industrial developments fostered a new way of urban life, and flood control in Malaysia is undergoing significant changes.

The objective of this article is to provide a brief description of recent developments in the analysis of new engineering methods for the analysis of extreme floods. The first objective is to describe developments in the analysis of daily rainfall precipitation data under monsoon climates. The second objective is to share some of the developments in hydrologic modeling of extreme surface runoff from exceptional rainstorms on small to large watersheds. The third objective is to illustrate some of the implications in terms of direct applications to recent flood events in Malaysia and specifically on the Muda River and near Kota Tinggi. Finally, a brief overview of the DID manual of River Management will be presented.

2 Extreme Rainfall Precipitation

2.1 Analysis of Daily Rainfall Precipitation

Muhammad [1] recently reviewed the daily rainfall precipitation data at Subang Airport from 1960 to 2011. During this period of 18,993 days, there were 10,092 rainy days with more than 0.1 mm of precipitation. The average daily rainfall is 13 mm and standard deviation 17 mm. She demonstrated that the distribution of rainfall precipitation followed a gamma distribution. The equation of the probability density function can be approximated as

$$f(x,t) \cong \frac{1}{|24.0|\Gamma(0.6t)}\left(\frac{x}{24.0}\right)^{0.6t-1}\exp\left(-\frac{x}{24.0}\right) \tag{1}$$

where x is the daily rainfall depth in mm, and t is the number of consecutive rainy days. The cumulative distribution function is the integral of Eq. (1). As shown in Fig. 1, there is a 37 % probability that the total precipitation from six consecutive rainy days will exceed 100 mm. It is interesting to note that the NE and SW monsoons produced fairly similar rainfall distributions at that location.

One of the main findings from her research was that the conditional probability of rainy days increased with the number of consecutive rainy days as shown in Fig. 2. Monsoon rainfall events cannot be considered to be independent.

Muhammad [1] then developed a detailed DARMA(1,1) model for the simulation of long sequences of wet and dry days including the amount of daily precipitation. The main results of this analysis have demonstrated that the periods of return of the amount of precipitation from multiple rainy days vary with the number of rainy days as shown in Fig. 3. The agreement between the DARMA(1,1) model