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Flood Forecasting with Machine Learning Technique on Hydrological Modeling

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Abstract

Urban flooding is a major problem in Thailand. An essential countermeasure towards better flooding management is to forecast flood water levels in the real-time manner. Most existing early warning systems (EWS) in Thailand contain a lot of miscalculations when they face with real situations. Towards prediction improvement, this paper presents hydrological modeling augmented with alternative five machine learning techniques; linear regression, neural network regression, Bayesian linear regression and boosted decision tree regression. As the testbed system, the so-called MIKE-11 hydrologic forecasting model, developed by Danish Hydraulic Institute (DHI), Denmark, is used. To test error reduction in runoff forecasting, the water-level records during 2012-2016 data are used for training and the derived model is tested on the record of 2017, in the experiments.

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Keywords: Flood forecasting; Machine learning; Yom river

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1. Introduction

The flooding problem in Thailand normally happens due to heavy rainfall which overflows from the Yom River in the middle of the rainy season in the floodplain area between the middle part and the lower part of the basin, especially in Sukhothai, Phitsanulok, Phichit, and Nakhon Sawan Provinces. Furthermore, after the problem of flooding happens, it is then followed by drought occurring in the dry season. Besides this, due to many non-negotiable problems of landowners at the dam site, local people have resisted the plan for the dam construction [13]. As a result, the construction of a huge dam for challenging flood and drought problems in the upstream area of this river is not possible.

This study focuses on the natural river without human buildings. The study area is the main basin in Thailand, the Chao Phraya basin. We focused on the Yom River, one of four headwaters of the Chao Phraya River, which flows from north to south. There are 7 significant water stations located from the upper Yom River to Sukhothai City, namely Y.20, Y.1C, Y.6, Y.3A, Y.33, and Y.4. Station Y.1C is the flood monitoring station of this area. The study aimed at forecasting runoff at Y.1C station then used the results to predict water levels at Y.4 in Sukhothai City. [10]

From a previous study [6], it was found that some machine learning techniques, for example, Bayesian linear regression, Neural Network, Decision Forest, Boosted Decision Tree and Linear Regression can be used for forecasting errors. In this study, a machine learning technique to forecast errors in runoff simulations was developed. It was expected that the hybrid model based on MIKE11 and a machine learning technique could give better runoff forecasting than only a single model MIKE11 [15].

A current warning system in Thailand is presented in Figure1. However, there are many limitations in the current flood forecasting system. The implementation of flood preparedness and planning is only one level, not a full system. There is also a weakness in the database system involved in risky areas; therefore, it is not complete enough. It is important to plan for the readiness of the disaster to minimize damage, especially in urban areas with high economic importance. The development of a flood preparedness system is to make it more effective in responding to flood disasters in a timely manner. This system is needed to be the center of information for Sukhothai Province, which holds the main responsibility for flood forecasting. It can also be used in planning decision-making for actions to be taken before the disaster. During and after the disaster, the system must be easily accessible for people to use to alleviate flooding as well. Sukhothai Province, one of the provinces that has experienced flooding over the past 10 years, has a flooded area at Kong Kra Klang, which is a water catchment area where villagers do fishing in the rainy season. It is also flooded in the areas of Pak Mueang, Muang and Thanee Districts. Sukhothai Province is located in Muang District, and it is a commercial area, which is situated along the main riverbanks. At present, there is a flap nearly 2 meters high built in front of Sukhothai City Hall to prevent flooding [9].