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Bhumibol Dam Operation Improvement via Optimization modelling and Satellite Information Technology to reduce drought risk under NRCT-TSRI Spearhead Research Program on Water Management

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Abstract

Drought is a serious issue of water related disaster in Thailand and caused huge damages to both social and economic sectors. This study aimed to apply technologies to increase dam water storage before dry season to mitigate drought risk in the Central Plain (about 1.92 M hectares). The technologies for rainfall prediction, demand and runoff estimation were developed and coupled with dam operation optimization module. The results showed that, with dam reoperation, cultivation area control and river runoff utilization, dam storage can be increased by 20 % before dry season which will help reduce drought risk in the study area.



- Introduction
- Objectives
- Approach
- Procedures
- Results
- Conclusions
- Spearhead Research Program Introduction (presentation speech at https://youtu.be/8lqUlxn8Amk)

Introduction

Drought is an serious issue of water related disaster in Thailand and caused huge damages to both social and economic sectors. Up to now, there were many attempts to develop estimation/forecast technologies for water management but separately. In the study, the technologies for rainfall prediction, demand and runoff estimation were developed and coupled with dam operation optimization module to test counter drought measures.



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Farmers pumped irrigation water during drought period



Objectives and scope

Objectives

- To increase dam storage at the end of rainy season by 15% in average,
- Develop integrated dam operation system (with demand, dam and surface runoff estimations)

Scope

- Bhumibol Dam (one of the four main dams in the Basin)
- Benefit area : Central Plain with 33 irrigation projects (1.92 M ha.)
- Simulation period: 2000-2018, Test period 2012-2018.

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Study area : Chao Pharaya Central Plain



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Approach

- Integrated Dam Water Operation System Development comprised of Rainfall forecast, Water Demand estimation River runoff simulation and Dam operation optimization modules.
- The modules were developed and calibrated by using actual daily data during 2000-2018 and counter measures were tested with daily data during 2012-2018 to compare dam storage results with and without measures.



CO-RUN for Dam Operation under Research Program

PROCEDURES





Rainfall Prediction module



สถาบันสารสนเทศทรัพยากรน้ำ (องค์การมหาชน)





Agricultural Water Demand Estimation module via Satellite Images technology and Deep

Learning Approach



River Runoff Simulation module (to estimate Side flow)





Mahidol University Wisdom of the Land

ผลการดำเนินงานวิจัย



1.Two week forecast results compared with observed (2012-2017)



aau



2.1 Agricultural water demand estimation

via Satellite Images and Deep Learning techniques





2.2 Agricultural water demand estimation

via Satellite Images and Deep Learning techniques

Net Irrigation Water Requirement

seasonal (during 2012 – 2019)

Ratio dry:wet = 65:35

Net Irrigation Water Requirement

Annual (during 2012-2019)

Annually average= 9,298.28 MCM







3.2 Case A Side flow estimation without water allocation









Counter measure	Simulation conditions	duration	Bhumibol Dam Storage (increase/decrease) (%Active Storage)			
			November	Rainy season	Dry season	Annual
Using Conventional Fuzzy Logic Model (from past to present situations)						
1	Using Planned Water Demand from Dam (actual past records) with dam operation optimization scheme	2000-2018	+6.09	+18.37	+11.57	+14.70
2	Control cultivation area in the Basin(during 2012-2018) based on water year	2000-2018	+9.86 (∆3.77) ^{2/}	+24.50 (∆6.13) ^{2/}	+16.1 <mark></mark> 3 (∆4.56) ^{2/}	+19.98 (∆5.28) ^{2/}
3	Used Side flow from station W.4A and in the Basin as another water sources to reduce water release from the dam	2000-2018	+14.55 (∆8.46) ^{2/}	+25.69 (∆7.32) ^{2/} Meet	+19.37 (∆7.80) ^{2/} the target of ase before dry	+22.28 (∆7.58) ^{2/} 15% season

3.3 Case B River runoff simulation with Bhumibol Dam Release



Main Findings

- Two weeks rainfall forecast via CFSV2 model after bias correction can forecast daily rainfall effectively (with R2 = 0.88)
- Agricultural demand in irrigation projects via satellite images can estimate annual irrigation demand (at 9298 M cum in 2020).
- DWCM-AgWU simulation program can estimate runoff at main stations in the Basin effectively for both with/without dam release.
- Three measures including Bhumibol dam operation optimization can increase dam water storage before dry season near to 20 % using past conditions during 2012-2018.

Conclusions

- The integrated dam operation system was developed and proved to work effectively from the past actual daily data.
- The integrated system comprised of rainfall forecasting, demand and river runoff estimation and dam release optimization.
- Three measures (dam optimization, cultivation area control and river runoff utilization) were tested and found that the measures can increase dam storage before dry season in average near to 20 %.

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Spearhead Research Program on Water Management

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