APPENDIX D1

INSTITUTE FOR INFRASTRUCTURE AND ENVIRONMENT (IIE)

Simulation-Optimisation of Ubonratana reservoir operational control in northeastern Thailand

Chuthamat Chiamsathit (PhD Student), Supervised by Dr. Adeloye Adebayo and Dr. Scott Arthur

INTRODUCTION

Droughts and floods have been causing damages in North-eastern Thailand in recent years. Consequently, the effective control of these through better operational management of the region's main Ubonratana reservoir is critical.

Table 1 Summary Characteristics of Ubonratana Reservoir

Hydrometeorological data		Reservoir physical data	
Catchment area (km²)	12,000	Reservoir capacity (MCM)	2,431
Annual Rainfall (mm/y)	1,200	Active storage (MCM)	1,850
Annual inflow (MCM/y)	2,604	Dead storage (MCM)	581
Annual release (MCM/y)	1,834	Max.WL (m msl)	186
Annual Municipal demand (MCM/y)	49	NWL (m msl)	182
Annual Industrial demand (MCM/y)	29	Min.WL (m msl) for Hydropower	175
Annual Irrigation (MCM/y)	622	Min.WL (m msl) for Irrigation	168
Annual Downstream Control (MCM/y)	128		

AIM

The purpose of this study is to develop a simulation-optimisation operational control model, enhanced with effective inflow forecasting, for the Ubonratana reservoir in north-eastern Thailand to mitigate the region's drought and flooding problems.

METHODOLOGY

Proposed Approach

This is summarised in Figure 1.

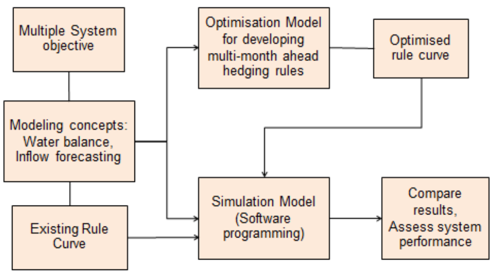

Figure 1 Flow chart of proposed methodology

Study Area

Ubonratana reservoir is the largest multi-purpose reservoir in Chi River Basin, northeastern Thailand (Figure 2). Rainfall variability (see Figure 3) has been intensifying in recent years, leading to recurring droughts and floods. The main characteristics of the reservoir are summarised in Table 1.

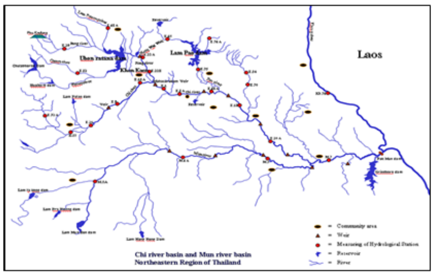

Figure 2 The Ubonratana reservoir (Source: Electricity Generating Authority of Thailand)

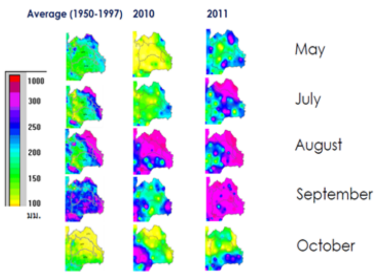

Figure 3 Rainfall in Northeast Thailand (Source: www.gfdr.org)

Progress to Date

•Literature review on reservoir optimisation and simulation studies.

•Collection of data for the basin including inflows, rainfall evaporation, existing rule curves.

•Building a simulation model of the reservoir in WEAP to assess the effectiveness of currently used rule curves. A paper on the results is being prepared for Journal submission.

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APPENDIX D2

INSTITUTE FOR INFRASTRUCTURE AND ENVIRONMENT (IIE)

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INTRODUCTION

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Annual Irrigation (MCM/y)	706	Min.WL (m msl) for Hydropower	175
Annual Downstream Control and other (MCM/y)	224	Min.WL (m msl) for Irrigation	168

AIM

The purpose of this study is to develop a simulation-optimisation operational control model, enhanced with effective inflow forecasting, for the Ubonratana reservoir in north-eastern Thailand to mitigate the region's drought and flooding problems.

METHODOLOGY

The methodology being applied is summarised in Figure 1.

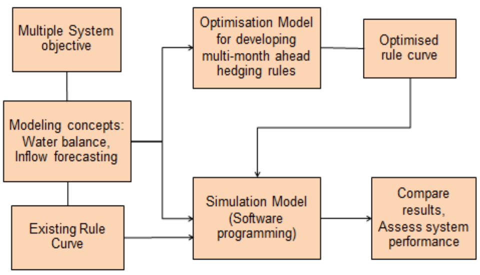

Figure 1 Flow chart of adopted methodology

Study Area

Ubonratana reservoir is the largest multi-purpose reservoir in Chi River Basin, northeastern Thailand (Figure 2). Rainfall variability has been intensifying in recent years, leading to recurring droughts and floods. This study used the reservoir inflow data of 384 months (1980-2012). The main characteristics of the reservoir are summarised in Table 1.

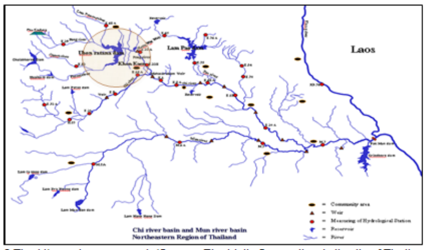

Figure 2 The Ubonratana reservoir (Source: Electricity Generating Authority of Thailand)

ANALYSES & PRELIMINARY RESULTS

- Single-stage (H1) and 2-stage (H2) hedging policies were developed using Genetic Algorithms (GA) to obtain the rule curve monthly ordinates as shown in Figure 3;
- Significant reduction in the large, single-period water shortage (i.e. vulnerability) can be achieved by rationing/hedging when compared to the no-hedging policy (H0);
- Effects of hedging on other reservoir performance measures are summarised in Table 2- R_v is largely unaffected but R_t is reduced!

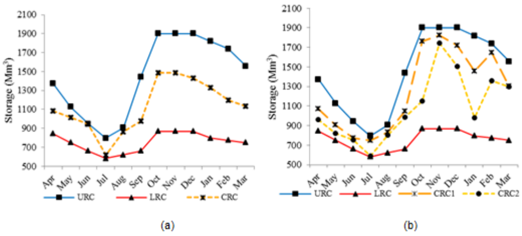

Figure 3 Optimised hedging rules at Ubonratana for (a) single-stage(H1) and (b) two-stage(H2)

Table 2 Summary of evaluated reservoir performance indices for the tested hedging policies

Policy	Total period demand (Mm³)	Total period release (Mm³)	Total period deficit (Mm³)	f_d	R_t (%)	R_v (%)	η
H0	30140	28640	1500	31	91.93	95.02	0.70
H1	30140	28412	1728	82	78.65	94.27	0.29
H2	30140	28333	1807	99	74.22	94.00	0.26

f_d= Total number of failure, R_t = Time-based reliability, R_v =Volumetric reliability; η = Vulnerability

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APPENDIX D3

INSTITUTE FOR INFRASTRUCTURE AND ENVIRONMENT (IIE)

Simulation-Optimisation of Ubonratana reservoir operational control in northeastern Thailand

Chuthamat Chiamsathit (PhD Student), Supervised by Prof Adebayo Adeloye and Dr Scott Arthur

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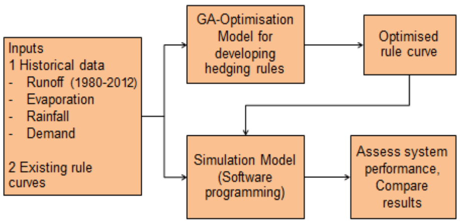


Figure 1 Flow chart of adopted methodology

STUDY AREA

Ubonratana reservoir is the largest multi-purpose reservoir in Chi River Basin, northeastern Thailand (Figure 2a). Rainfall variability (Figure 2b) has been intensifying in recent years, leading to recurring droughts and floods. The main characteristics of the reservoir are summarised in Table 1.

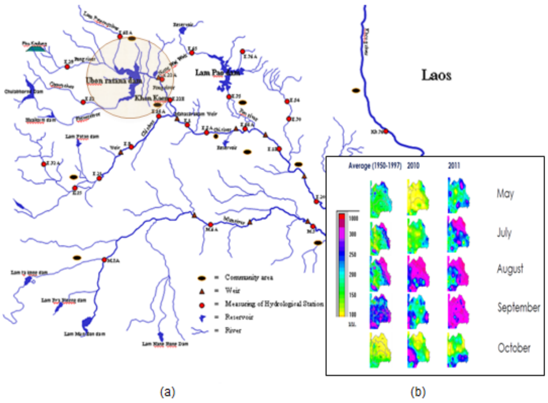
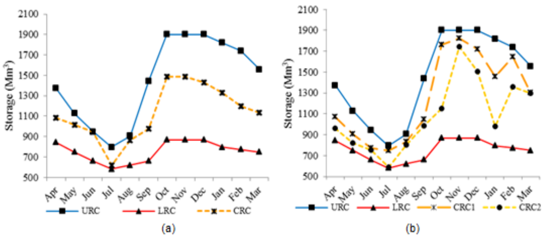


Figure 2 (a) The Ubonratana reservoir in Chi river basin (Source: Electricity Generating Authority of Thailand) and (b) Rainfall in Northeast Thailand (Source: www.gfdrr.org)

ANALYSES & PRELIMINARY RESULTS

- Single-stage (H1) and 2-stage (H2) hedging policies were developed and are shown in Figure 3;
- Compared to the no-hedging policy (H0), significant reductions in large, single-period water shortage (i.e. vulnerability) were achieved with H1 and H2;
- Effects of hedging on other reservoir performance measures are summarised in Table 2- R_v is largely unaffected but R_t is reduced!



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