APPLICATION OF MATHEMATICAL MODEL FOR STUDYING FLOOD IN XEBANGHIENG RIVER BASIN

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INTRODUCTION

Introduction Study Area

Xebanghieng is one of major tributaries of Mekong River which has created livelihood and colorful of ethnic-tribes of local for long time. The river of Xebanghieng begins in Savannakhet province and flows with contribution of nine tributaries before confluence into the Mekong River. Most of Xebanghieng River Basin is plateau and scattered of mountainous area to the Lao-Vietnamese border, which cover by light forest and water resources as well as variation of biodiversity. Its total common area of about 19,712 Km^2, the total length is about 370Km and the river discharges of 497m^3/s (at Kengdone station during 1960-1997).

Though there is high rate of poverty in this area, the Xebanghieng River Basin is strong in that the basin is still rich in land, water, forest, biodiversities and other natural resource, and rich in cultures and colorful of ethnic-tribes. The use of water, land, forest and related natural resources for economic development are un-sustainable due to poor management and inadequate practice. The forest lost has been reported very high in this basin.

However, the government policy and regional cooperation for water resources management study is ongoing. There are great opportunities for development in the basin, including forestry development, agriculture and animal husbandry, fisheries, eco-tourism, small scale of hydropower, river transports, multi-sector development. The more income for local people through non-timber products trade and overall development facts will help in poverty eradication of the region.

As water resources is the key factor for agricultural production in this river basin and in the past there is no study in details on the potential of water resources and opportunities for development in Xebanghieng Basin. Therefore this case study will provide knowledge base and report for water resources planning and development in Xebanghieng River Basin.

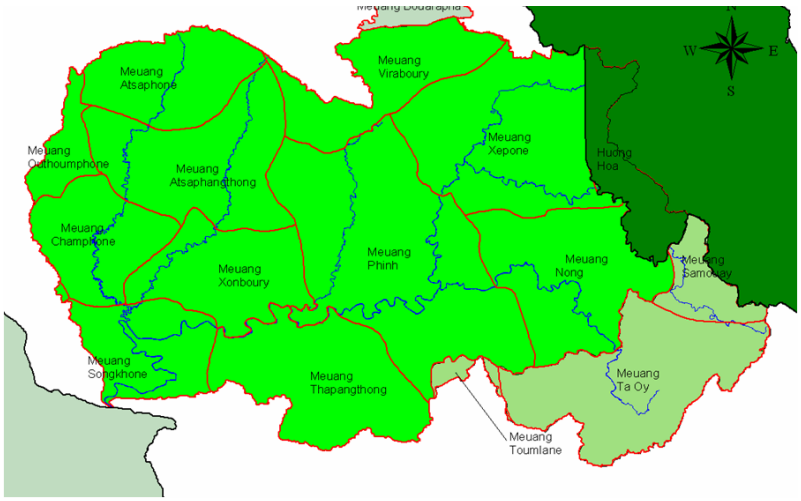

Figure 1: Overview map of Xebanghieng Basin

Objectives of case study

The ultimate objectives of the case study are to build capacity of LNMC modelers in applying the DSF in real case study.

- Assessment of available potential of water resources and hydrological regime of Nam Sebang Hieng River Basin
- Assessment of hydropower developments and climate changes in Xebanghieng River Basin
- Application of DSF, models and tools to support water resources planning in the Xebanghieng River Basin
- To identify rooms for other supplementary models and tools
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Scope of the case study

- Hydrological regime change of the basin using Soil Water Assessment Tool (SWAT)
- Hydrological regime and water use of the basin using Integrated Quality & Quantity Model (IQQM)
- Hydrodynamic (hydrological movement/flood) of the basin using Hydrodynamic Model (ISIS)
- Results interpretation using Impact Analysis Tool
- Reporting work

MODEL APPLICATION

Hydrological Model

Soil Water Assessment Tool (SWAT) is the hydrological model used for study on hydrological regime change against the development projects growth cause to the changes of other factors in Xebanghieng basin.

Data used

Requires rainfall data is collected from rainfall stations appear below:

Table 1: Rainfall data used

Rainfall data used

No	Name	From MRC & DMH
1	**Seno**	1985-04
2	**Donghen**	1986, 88-05
3	**Kongkok**	1989-2005
4	**Khemarat (Thailand)**	1985-2004
5	**Meuang Phine**	1991-2005
6	**Xepone**	1990-2005
7	**Saravan**	1987-2005
8	**Khe Sanh (Vietnam)**	1980-1995

The daily water level and run off of the basin is collected from hydrological station located in and outside of basin "in case data gap filling is needed". Data are obtained from the Department of Hydrology & Meteorology, Ministry of Agriculture and Forestry (now under the Water Resources & Environment Administration 'WREA'), Waterways Administration Division, Ministry of Communication, Transport, Post and Construction (now Ministry of Communication & Transport). Besides the two main agencies, most data were received from Mekong River Commission Secretariat "MRCS".

Other data requirements for the study are as follow:

- Geological map
- Climatic and meteorological data: temperature, relative humidity, wind speed, solar radiation, evaporation…
- Irrigation structures includes: existing and planning irrigation areas, irrigation's schemes, pump capacity, water requirement in m^3/ha…
- Water supply
- River long profiles & cross-sections

SWAT Model setup

The Xebanghieng Basin is delineated into 24 sub-basins with the total area of 19,712 Km^2. The figure below shows the result of Xebanghieng Basin after delineation into.

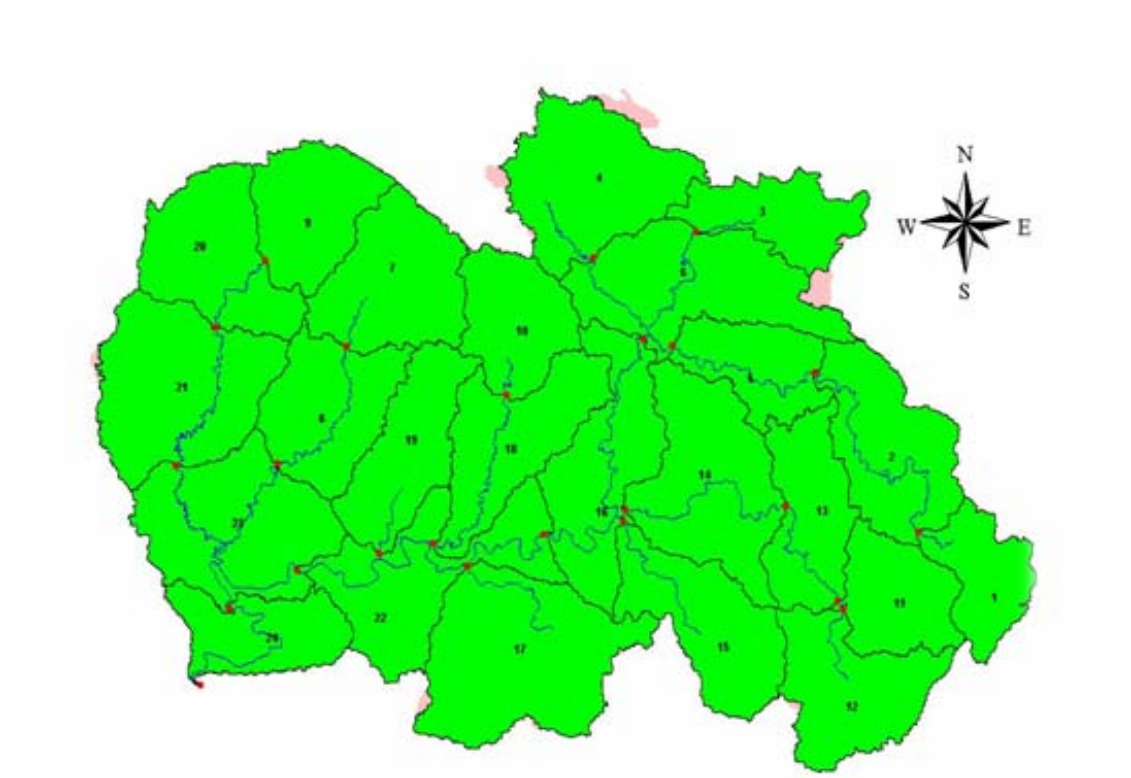

Figure 2: Delineation of Xebanghieng Basin into 24 sub-basins.

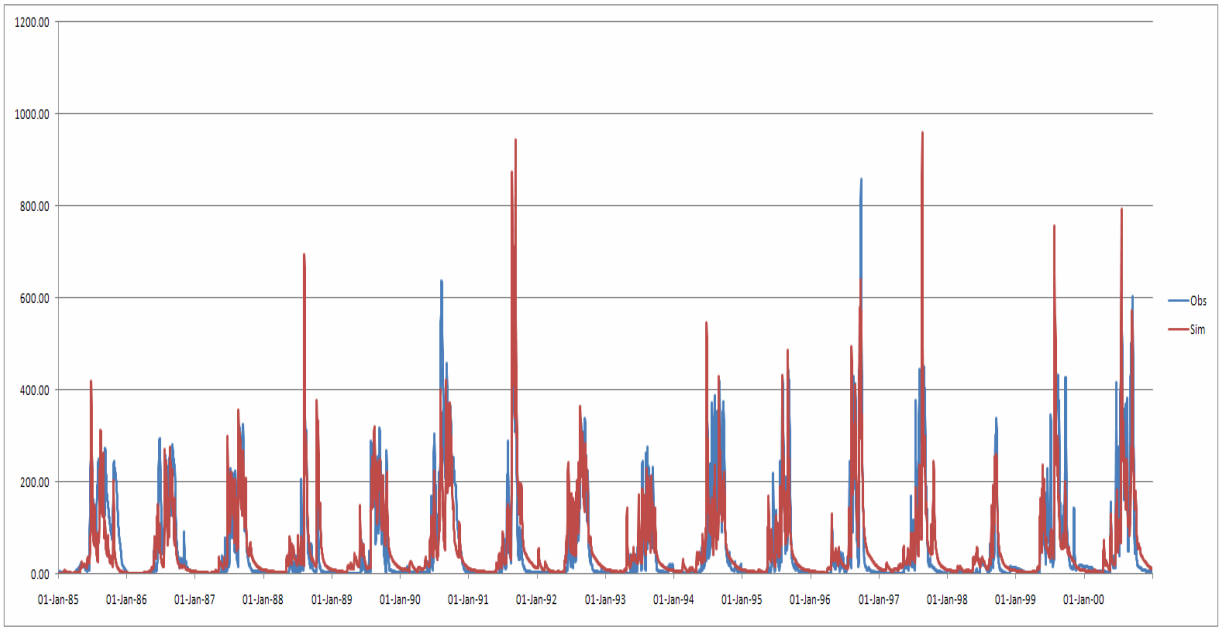

Figure 3: SWAT Calibration Result at Kengkok station

Hydrodynamic model

ISIS is hydrodynamic model, it function is possible to use for calculation the inundated area (flood depth and duration) of Xebanghieng Basin,

ISIS Model set up

Due to location of Xebanghieng, particularly Ban Kengdone and the neighbor villages is flat and the Luang pone connects to the Xebanghieng river by a small sub-tributary, therefore this region have been flooding regularly. The study on the flood behavior of this area is referred to the flood map which was produced in 1996 by the Department of Irrigation, Ministry of Agriculture and Forestry (MAF).

Figure 4: River cross-section (34- measured & 56-interpolated)

The study area covers from upper boundaries (Sechamphone, Sexamsay and Xebanghieng) down to the junction with Mekong River. The derived river cross-sections from the survey about 34 and from interpolation of about 56, in total of the whole area is 90 cross-sections were applied to simulate the flood duration and flood depth of the area. There is no gauging station for water level at the river mouth of Xebanghieng, therefore the calculation of water level by slope from Khemmalat station, which is located upstream of the junction (Xebanghieng river mouth) about 15 Km.

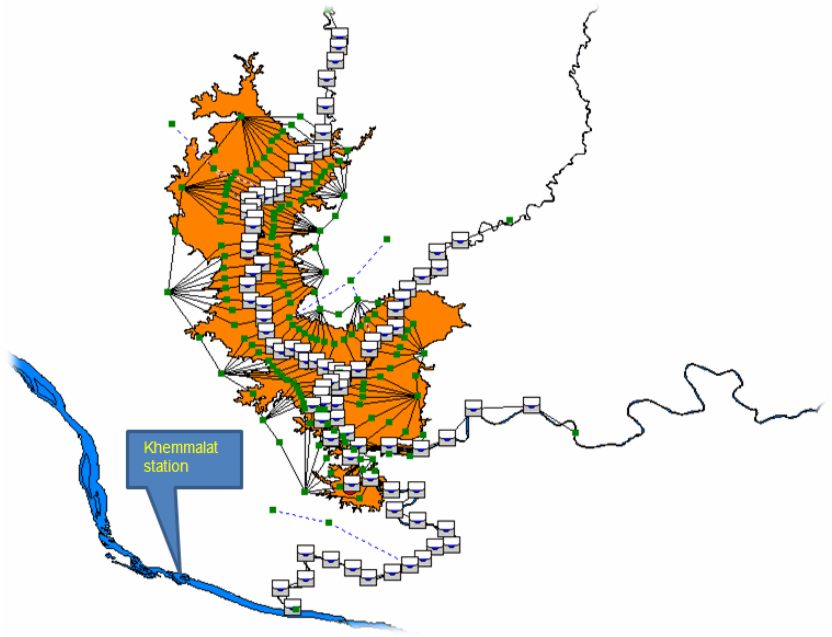

Figure 5: ISIS Schematization.

ISIS model result

The model result by comparing the simulated and observe data at selected station, the results hydrograph can show the differences between simulated water level and the observe water of the year 1996.

Kengkok St.	Period	COE	Vol. Ratio
Flow	1996	0.895	100.76
Stage	1996	0.743	100.34

Kengdon St.	Period	COE	Vol. Ratio
Flow	1996	0.981	100.39
Stage	1996	0.955	100.32

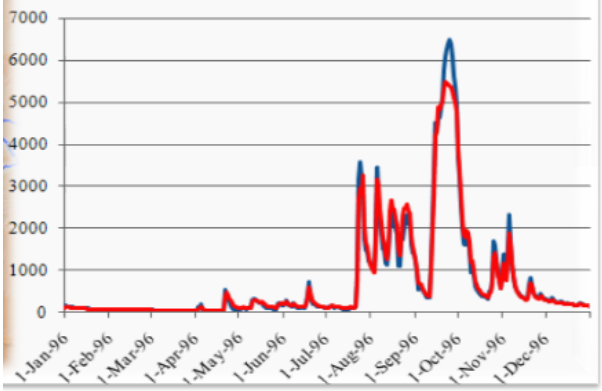

Figure 6: Calibration results of ISIS

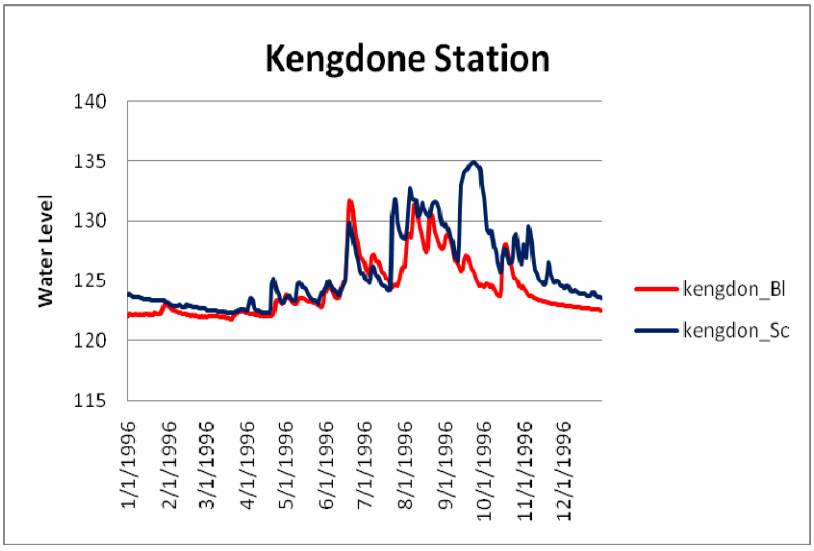

Figure 7: Hydrograph of ISIS result compared between Base Line & Scenario @ Kengdone

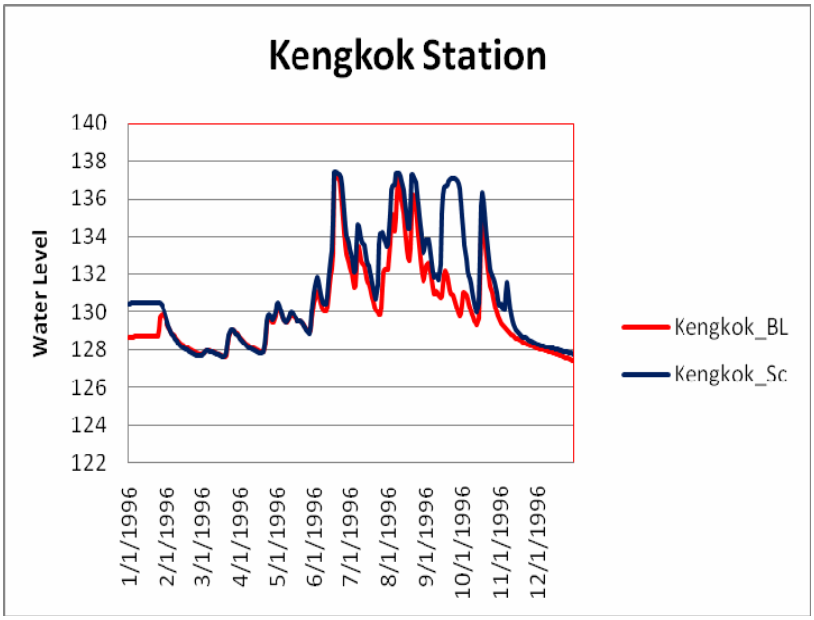

Figure 8: Hydrograph of ISIS result compared between Base Line & Scenario @ Kengkok

The purpose of ISIS application in Xebanghieng Basin is to analyze of flood behavior flood this area, particularly flood duration and flood depth, using ISIS model result to produce flood map by using Delta-Mapper and compare with the base line. Base line condition is based on flood map of the year 1996, which produced by Department of Irrigation, Ministry of Agriculture & Forestry.

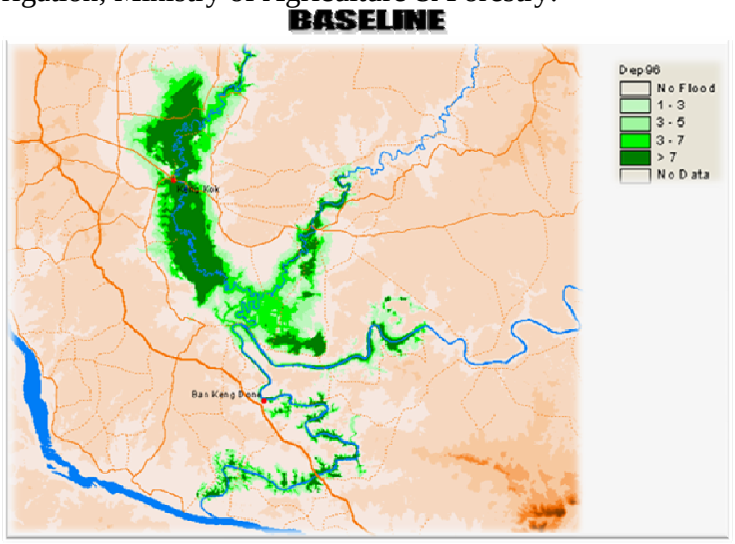

Figure 9: Base line condition of ISIS Scenario (flood map)

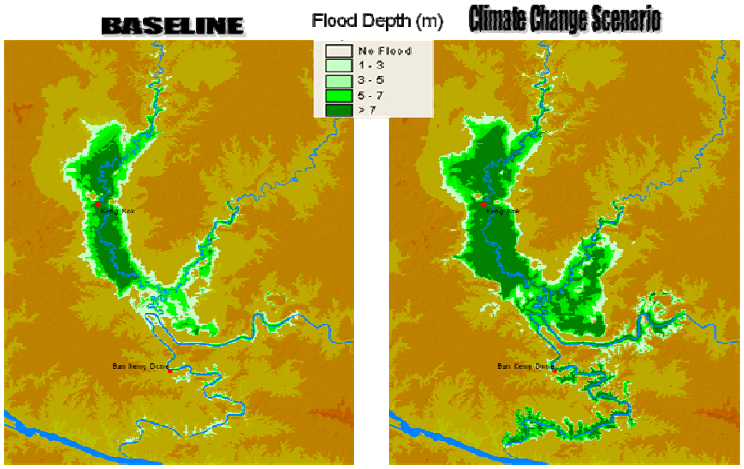

Figure 10: Map of flood depth comparison between base line condition & climate change scenario

Table 2: Summary of flood depth Values

No.	Depth(m)	Area(ha)		% of Increased
		Baseline	Scenario	
1	1-3	15,780	14,776	(6.36)
2	3-5	10,021	9,876	(1.45)
3	5-7	6,869	14,022	104.13
4	>7	11,082	33,036	198.11
Total:		**43,752**	**71,710**	**63.90**

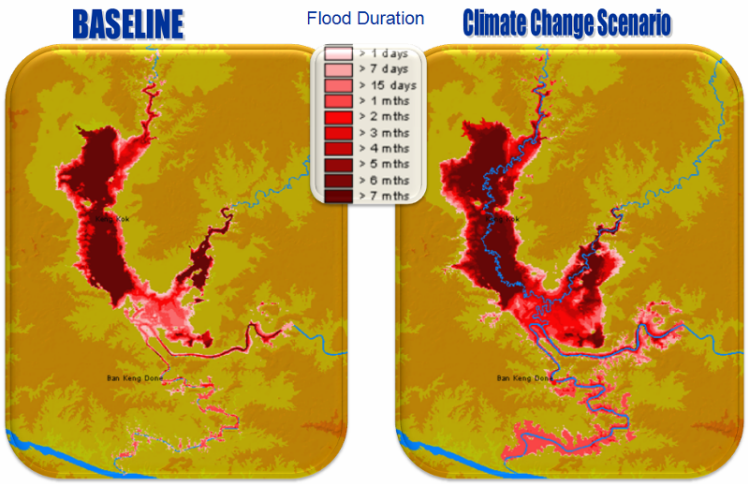

Figure 11: Map flood duration comparison between base line condition & climate change scenario

Table 3: Summary of flood duration

No.	Duration	Area(ha)		% of Increased
		Baseline	Scenario	
1	1days	112,140	94,158	(16.04)
2	7days	4,034	3,602	(10.71)
3	15days	4,255	5,282	24.14
4	1mths	5,541	5,847	5.52
5	2mths	6,656	14,323	115.19
6	3mths	3,508	8,050	129.48
7	4mths	2,269	5,920	160.91
8	5mths	2,508	4,984	98.72
9	6mths	867	3,364	288.00
10	7mths	17,397	24,143	38.78
Total:		**159,175**	**169,673**	**~7**

CONCLUSION

1 Results obtained from the Xebanghieng Case Study can show the area under risk of flood in baseline, hydropower and climate change scenario.

2 Dam Scenario; by adding one dam at Xepone and two dams at Xelanong, the peak flow in the wet season is cut off natural flow regime, thus make opportunity of flood reduction for the risk area, and flow increase in the dry season, this mean the availability of water use also increase due to the dam operation. The data use is taken from real development plan.

3 Similar case study in other river basin throughout the Lao PDR, namely Nam Ngum, Nam Ou, Xebangfai, Xekong and Xedone river basins were carried out by national modeling team.

RECOMMENDATION

In order to make the flood hazard map, it is required to have satellite images of the study area. Further in-depth study of flood in the Xebanghieng Basin as well as dissemination to local communities is recommended.