Comparative Analysis of HEC-HMS and SWAT Model in Simulating Daily Streamflow of Stung Sen River Catchment, Cambodia

Kong Chhuon*[1)], Sokchay Heng[1)], Sarann Ly[1)], Marith Mong[1)], Sarit Chung[1)]
[1)]*Department of Rural Engineering, Institute of Technology of Cambodia*
** chhuon.k@itc.edu.kh*

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Introduction

The use of hydrological models has been of interest for water resources assessment and now become increasingly important for water resources management. Currently, there are numerous hydrological models simulating the hydrological process at different spatial and temporal scales. The comparative analysis of different models can be useful to get satisfactory result. Therefore, the comparison can be done by applying of different models in a particular watershed and using statistics indicators between observation and simulation to evaluate their performances. This study aims to simulate the daily stream flow of a river watershed in Cambodia by using two different hydrologic models which are Hydrologic Modelling System (HEC-HMS) and Soil and Water Assessment Tool (SWAT) modelling. Then, the performance of both models were compared through the statistic evaluation between observe and simulated result.

Material and Methods

This study was applied to watershed of Stung Sen River which is tributary of the Tonle Sap Lake. The Stung Sen River has catchment area of 14,138 km^2 located at the Northern part of Cambodia (Figure 1.1.). First, all the required data such as land use maps, soil map, digital elevation model (DEM) and weather data were collected (Table 1.1. and Figure 1.3) and prepared with ArcGIS software version 10.1. HEC-HMS version 4.0 (U.S. Army Corps of Engineers, 2013) and ArcSWAT model version 2012 (Arnold et al. 2012) were set up to simulate daily discharge.

Table 1.1: Information of data collection

Data type	Information	Period	Source
DEM	Resolution of 30 m x 30 m	-	ASTER-GDEM
Land-use	Resolution of 250 m x 250 m	2003	JICA
Soil type	Resolution of 250 m x 250 m	2002	MRC
Weather	Recorded at 3 stations (Figure 1.2.)	2002-2011	MOWRAM
Observed Flow	Gauging at 1 station (Figure 1.2.)	2002-2011	MOWRAM

ASTER-GDEM: Advanced Spaceborne Thermal Emission and Reflection Radiometer-Global Digital Elevation Model
JICA: Japan International Cooperation Agency
MRC: Mekong River Commission
MOWRAM: Ministry of Water Resources and Meteorology of Cambodia

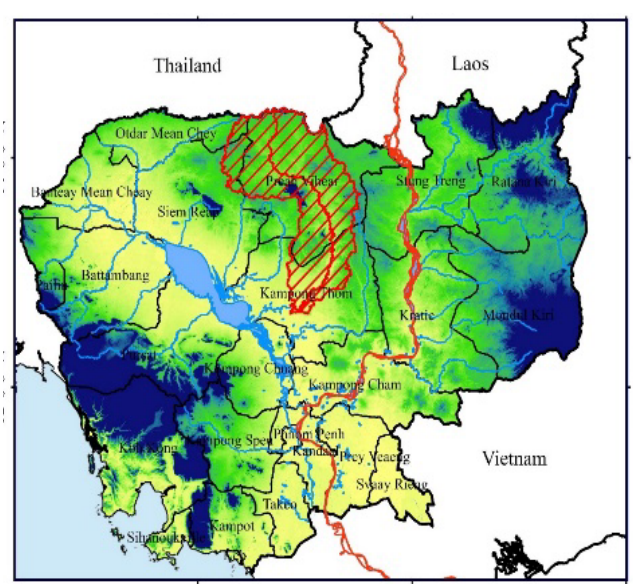


Figure 1.1. Location of study area

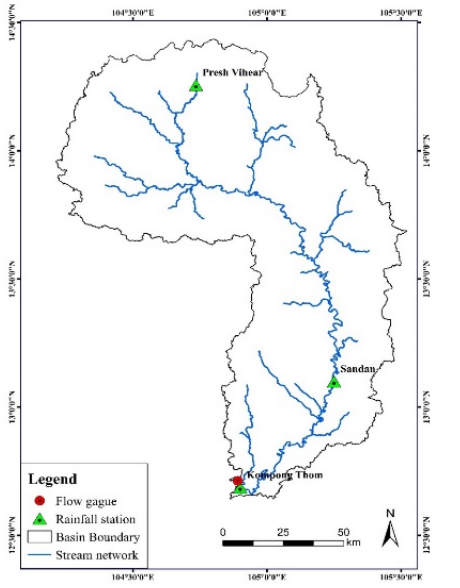


Figure 2.2. Location of weather stations

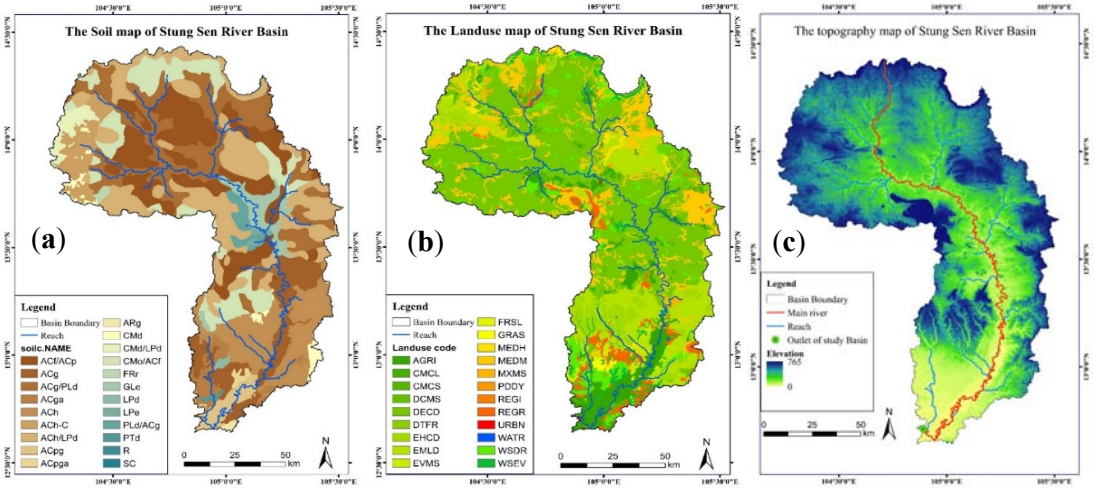
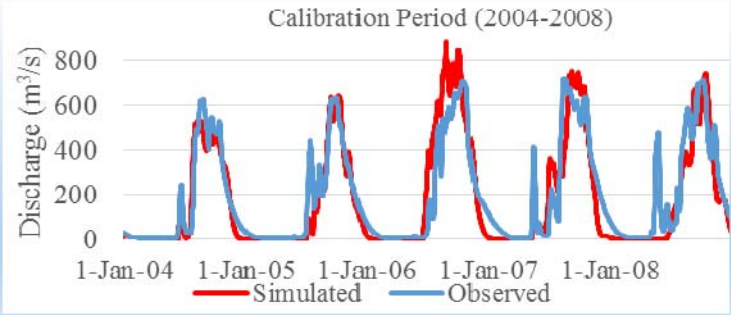


Figure 1.3. Spatial data inputs of Stung Sen River watershed: (a) Soil map, (b) Land-use map, (c) Topographic map

The calibration and validation were taken from 2004-2008 and 2009-2011, respectively for both models with observed data from Ministry of Water Resources and Meteorology of Cambodia. The SWAT model was calibrated by SWAT-CUP software and manual calibration interactively. In order to evaluate the model performance, statistic indicators such *Nash Sutcliff Efficiency* (*NSE*) (Nash & Sutcliffe, 1970), *Percentage bias* (*PBIAS*) and *Root Mean Square Error-Observed Standard Deviation Ratio* (*RSR*) were computed and discussed based on the agreement between observed and simulated daily river discharge.

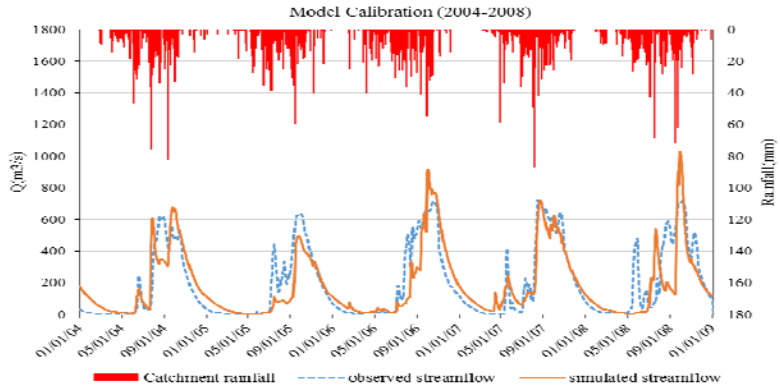
Results and Conclusions

During the wet season, Stung Sen River discharges up to 700 m3/s but it decreases to lower than 10 m3/s during dry season. The comparison indicated that HEC-HMS (*NSE=0.78 and 0.77, PBIAS=+8.3% and +4.7%, RSR=0.46 and 0.47 respectively for calibration and validation*) (Figure 1.4.) can have better agreement between observation and simulation than SWAT (*NSE=0.7 and 0.68, PBIAS =+5% and -18.8%, RSR=0.55 and 0.61 respectively for calibration and validation*) (Figure 1.5.).



Statistical indicator	Value
NSE	0.78
RSR	0.46
PBIAS	+8.3%

Figure 1.4. River discharge calibration for HEC-HMS



Statistical indicator	Value
NSE	0.70
RSR	0.55
PBIAS	+5%

Figure 1.5. River discharge calibration for SWAT

In this study, the application of SWAT had difficulty in simulating peak flow and low flow as indicated by overestimated bias mainly in validation period. However, both calibration and validation periods for both models performed well with satisfactory criteria. Information of land use changes and water extraction need to be considered for improving model verification. This study provided useful information system on water resource availability which is very important for water resources management in the watershed context. The models were successfully calibrated and ready to a supporting tools for river basin management and further study such as scenario analysis on water uses.

References

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