APPLICATION OF HYPE MODEL FOR RUNOFF SIMULATION AT UPPER SREPOK RIVER BASIN IN VIETNAM

Tokyo Metropolitan University Student Member ○Thao Thi Phuong Bui
Tokyo Metropolitan University Regular Member Akira Kawamura
Tokyo Metropolitan University Regular Member Hideo Amaguchi
Vietnam Ministry of Natural Resources and Environment Duong Du Bui
Tokyo Metropolitan University Student Member Jean Margaret Mercado

1. INTRODUCTION

Vietnam is currently facing many challenges related to water resources, especially when some of its river systems traverse adjacent countries. One of the most important transboundary river basins in Vietnam is the Srepok River Basin. The Srepok River Basin's upstream is in Vietnam while its downstream traverses Cambodia until it merges to Mekong River. Currently, this river basin is confronted by challenges on water resources such as surface water depletion, rapid increase in water demand and water exploitation, and increasing number of hydroelectric reservoirs. Moreover, transboundary water resource management for this river basin is still very weak, and so issues on sustainable water resources are becoming critical.

In this study, we focus on the Upper Srepok River Basin (USRB) which is located in the Central Highland of Vietnam. The USRB lacks data on water resources, while the number of monitoring stations is also insufficient (NCWR, 2010). Hence, in this study, we attempt to simulate the discharge in the USRB using Hydrological Predictions for the Environment (HYPE) model. The HYPE model is an open-source model that simulates hydrological processes and water resources development such as, reservoir operation, irrigation, water use, and wastewater discharge in a river basin (Lindström et al., 2010). The HYPE model has not yet been considered for discharge simulation in USRB, although it has a potential for discharge simulation of river basins that have dammed tributaries.

2. STUDY AREA

The Srepok River (Vietnamese: Sông Serepôk) is one of the major tributaries of the Mekong River and one of 13 major river basins in Vietnam with a total area of 18,500 km^2 (encompassing Vietnam only). The length of the Srepok River basin stretches about 406 km to 450 km in which the 281 km course downstream is within Cambodia (MNRE, 2016). The Srepok River has three main tributaries namely, Krông Nô, Krông Ana, and Ea H'leo Rivers. The Krông Nô and Krông Ana are the upstream tributaries located on the western side of Vietnam's Central Highlands while the Ea H'leo River is the downstream tributary located in Cambodia. In this study, we focus on the USRB that encompasses parts of Gia Lai, Dak Lak, Dak Nong and Lam Dong. The USRB has a total area drainage area of 12,000 km^2. There are 4 water discharge stations, 10 rainfall stations, 6 temperature stations and 4 reservoirs within the USRB, as shown in **Figure 1**.

3. METHODOLOGY

3.1 Hydrological Predictions for the Environment (HYPE) Model

The HYPE model is a semi-distributed dynamic model that integrates rainfall-runoff and nutrient transfer. This model was developed and maintained by the Swedish Meteorological and Hydrological Institute (SMHI) in 2003. It models the flow and transformation of water, nutrients, and organic carbon in soil, lake, river. It includes processes like, processes above ground, deep processes in groundwater, water management, land routines, and routing through rivers and lakes (Strömqvist et al.,2012).

3.2 Data Input

The HYPE model was set up for the 57 subbasins of the USRB. The data inputs include the 30×30m DEM derived from U.S Geological Survey (USGS) and the 36-year daily hydro-meteorological data collected from 1980 to 2015. The hydro-meteorological data includes: average air temperature, highest and lowest air temperature, rainfall, and river discharge.

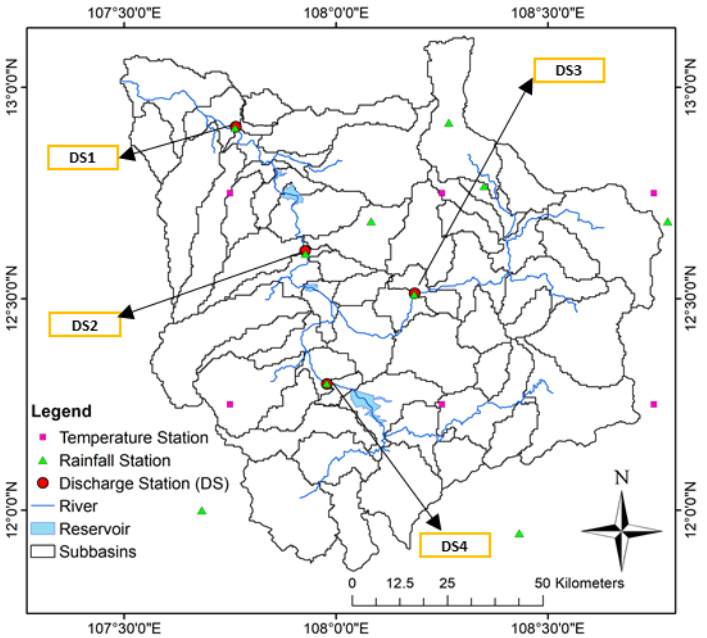

Fig. 1 Location Map of Upper Srepok River basin.

Keywords: discharge simulation; HYPE model; Vietnam
Contact address: 1-1 Minami-Osawa, Hachioji-shi, Tokyo, 192-0397, Japan, Tel:+81-80-7698-7902 E-mail: thaobtp26@wru.vn

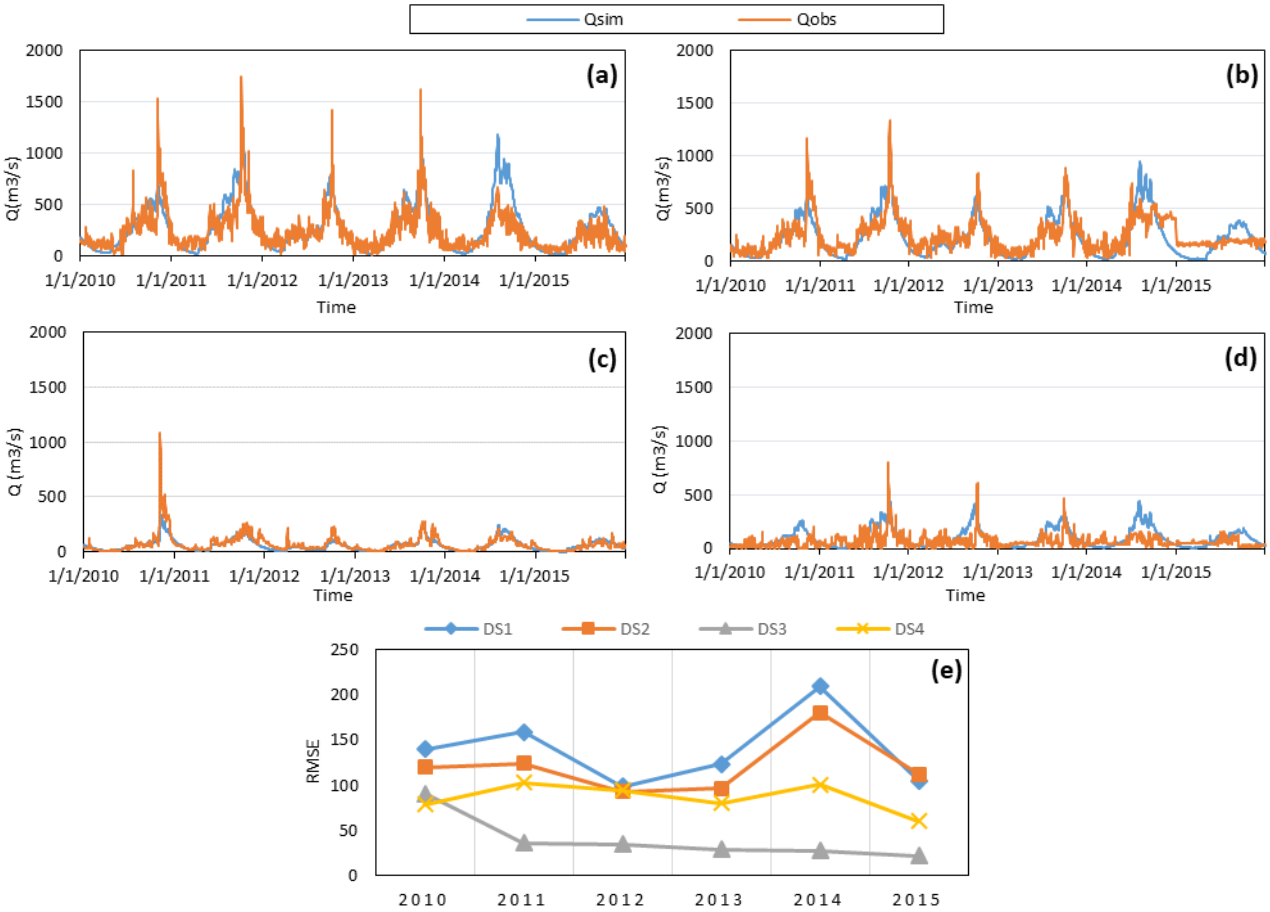

Fig. 2 Observed and Simulated Discharge for a) DS1, b) DS2, c) DS3, d) DS4, and e) RMSE for each discharge stations.

4. RESULTS AND DISCUSSION

The daily discharge from 2010 to 2015 in USRB was simulated using the HYPE model. The observed and simulated discharge at the four water level stations are shown in **Figure 2(a to d)**. By visual inspection, the simulated flows in DS1, DS2, and DS4 vary with the observed flow while the simulated flow in DS3 shows relatively closer results with the observed discharge. The root means square error (RMSE) for these simulations was also calculated as shown in **Figure 2e**. The results show that DS1 has the highest RMSE, while DS3 station has relatively good results with RMSE = 36.225. In the model simulation, the information on the 4 reservoirs within the USRB was not yet included, and this caused the high RMSE in DS1, DS2, and DS4. Meanwhile, the RMSE in DS3 is low because there is no reservoir upstream of this discharge station.

5. CONCLUSIONS

Based on the simulations, there is a need to include reservoir information to attain accurate model results. Nonetheless, the HYPE model can simulate runoff for each sub-basin in the USRB. The HYPE model aids the user in setting up hydrological variables easily and export results in both large and small river basins. The HYPE model shows the potential for calculating hydrologic factors and discharge simulations in ungauged sub-basins.

REFERENCES

Lindström, G., Pers, C., Rosberg, J., Strömqvist, J., and Arheimer B.: Development and test of the HYPE (Hydrological Predictions for the Environment) model – A water quality model for different spatial scales., Hydrology Research, 41(3–4), 2010, pp. 295–319.

Ministry of Natural Resources and Environment (MNRE): National Water Resources Strategy towards the year 2020, http://www.gwp.org/globalassets/global/gwp-sea_files/nwrs_final_version---viet-nam.pdf, 2016.

National Center for Water Resources Planning and Investigation (NCWR): Setting up planning tasks for the Srepok River Basin (Vietnamese), 2010.

Strömqvist, J., Arheimer, B., Dahné, J., Donnelly, C., and Lindström, G.: Water and nutrient predictions in ungauged basins: set-up and evaluation of a model at the national scale, Hydrological Sciences Journal – Journal des Sciences Hydrologiques , 57(2), 2012, pp. 229-247.