SIMULATION OF SUSPENDED SEDIMENT CONCENTRATION AT UPPER SREPOK RIVER BASIN IN VIETNAM USING HYPE MODEL

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1. INTRODUCTION

Vietnam has been facing many challenges related to water resources, such as transboundary water resources management, increasing water demand, degradation of water quality and quantity due to climate change and human activities, among others. Human activities, such as watershed deforestation and construction of hydroelectric power plants, have the most visible impact on Vietnam's water resources in terms of water quality and quantity. One of the most crucial issues from these human activities is excessive sediment transport due to erosion and runoff, which can lead to poor water quality, algal bloom, and sediment built-up. In this study, we attempt to simulate the suspended sediment concentration (SSC) in one of the most critical transboundary river basins in Vietnam, Srepok River Basin. We focus our study on the Upper Srepok River Basin (USRB) which is the portion of Srepok River Basin located within the jurisdiction of Vietnam. We attempt to simulate the SSC within 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, G. et al., 2010). The HYPE model has not yet been considered for SSC simulation in USRB, as far as the authors know.

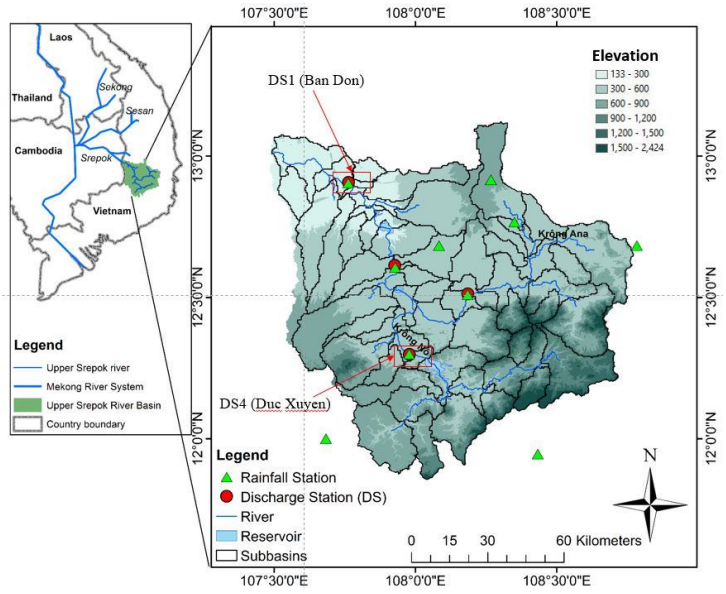

Fig. 1 Location map of Upper Srepok River Basin

2. STUDY AREA

The USRB is one of the tributaries of the Srepok River Basin, one of the most important transboundary river basins in Vietnam as its lower drainage area is in Cambodia, as shown in **Fig. 1**. The Srepok River merges with Sesan River and Sekong River before draining to the Mekong River. The Srepok River Basin has a total area of 30,965 km^2 and about 18,000 km^2 of this lie in Vietnam, in which about 12,000 km^2 is the USRB (NCWRP, 2010). Within the USRB, there are four multipurpose dams, which are used for water supply, irrigation, and hydropower. There are also several observation stations within the USRB, which includes 4 water discharge stations and 10 rainfall stations, as shown in **Fig. 1**.

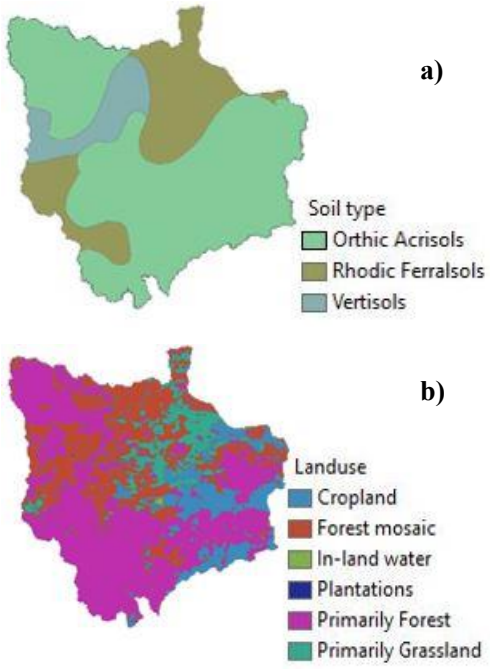

Fig. 2 Map of Soil type a) and Land use b) in USRB

3. METHODOLOGY

3.1 Hydrological Predictions for the Environment (HYPE) Model

The HYPE model was developed and maintained by the Swedish Meteorological and Hydrological Institute (SMHI) in 2003. It is a semi-distributed dynamic model that integrates rainfall-runoff and nutrient transfer by modeling the flow and transformation of water, nutrients, and organic carbon in soil, lake, and river. HYPE Model can also simulate sediment using the Morgan-Morgan-Finney (MMF) soil erosion model which calculates mobilized particles as functions of rainfall energy, surface runoff, and catchment properties (slope, soil erodibility, etc.).

Keywords: Suspended sediment concentration simulation; HYPE model; Vietnam
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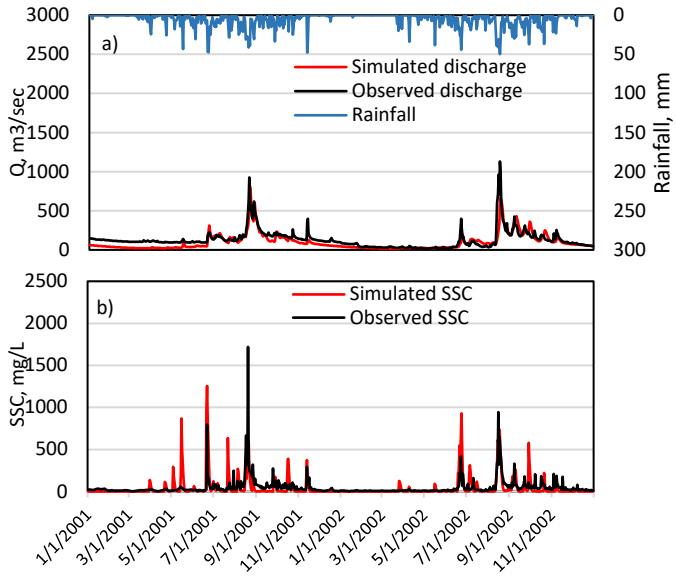

Fig. 3 Observed and simulated discharge a) and SSC b) for DS1

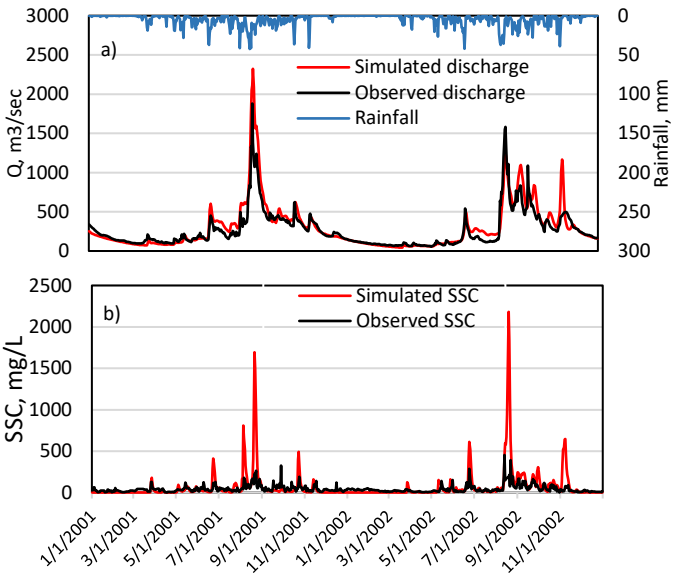

Fig. 4 Observed and simulated discharge a) and SSC b) for DS1

3.2 Data Input

Input data for simulating SSC include digital elevation model, land use type, cohesion of soil surface, observed rainfall. We utilized 30×30m DEM obtained from U.S. Geological Survey (USGS); soil type and land use data from ESA Climate Change Initiative – Land Cover project (ESA) shown in **Fig. 2**; and 35-year daily rainfall data from 1980 to 2015 which were collected from the 10 rainfall stations in **Fig. 1**. For the sediment data, we utilized the only available data from observation stations DS1 and DS4 in **Fig. 1**, which was collected from 2001 and 2002. The HYPE model was set up from 1980 to 2015 for the discharge simulation and from 2001 to 2002 for the SSC simulation.

Table 1 Model evaluation for Discharge and Suspended Sediment

Station	Discharge		SSC	
	CC	RMSE(m3/s)	CC	RMSE(mg/L)
DS1	0.69	65.2	0.569	118.42
DS4	0.72	120.5	0.583	171.78

3.3 Parameter Setup

There are nine parameters necessary for the MMF-based erosion model, which include general parameters (*Sreroexp, Pprelmax, Pprelexp*), soil independent parameters for each soil type (*Soilerod, Macrofilt, Soilcoh*), and parameters related to land use (*Innerfilt, Otherfilt, bufferfilt*). The description of these parameters can be found at the HYPE website (http://www.smhi.net/hype/wiki/par.txt). Some data for the soil type and land use parameters in USRB are not available, so the default value are used instead.

4. RESULTS AND DISCUSSION

HYPE model was applied for daily SSC (mg/L) and discharge (m^3/sec) estimation in Duc Xuyen Station (DS1) and Ban Don Station (DS4). **Figs. 3** and **4** show the results of the daily discharge and SSC estimation from 2001 to 2002 at DS1 and DS4, respectively. **Table 1** shows the model evaluation for the discharge and SSC by Pearson correlation coefficient (CC) and Root Mean Square Error (RMSE). From **Figs. 3** and **4**, the SSC estimations do not show good results compared with the discharge estimation especially for DS4. RMSE for SSC of DS4 is much higher than DS1, while CC is almost the same as shown in **Table 1**. The performance for SSC can be improved in the next step when the data for some soil type and land use parameters become available. The initial results of the simulated SSC show that the HYPE model has great potential in estimating the sediment for the study area.

5. CONCLUSIONS

This study shows the potential of the HYPE model in estimating the SSC in the USRB. However, there is still a need to further improve the model in terms of parameter setting to achieve higher model accuracy. We should improve the model performance so that HYPE can be applied in locations with less observed data since this model has a potential for predicting hydrologic data in ungauged basins.

REFERENCES

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