Runoff analysis in Laos PDR using a distributed hydrological model

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1. Introduction

The Mekong River is the largest river basin in the Southeast Asia, and is shared by the six countries of China, Myanmar, Laos, Thailand, Cambodia and Vietnam. In the last decade a lot of researches have been done in Mekong River especially its flood component are expected to have significant impacts on several key functions of the river but none of those researches are focus on flood in Laos. The Laos PDR has experienced a range of floods of different magnitudes and duration. Particularly in three consecutive years -1994, 1995 and 1996- the flood were large and disastrous. In the last decade flood have occurred on a greater scale and more frequently, leading to an increasing number of casualties and further compromising food security and livelihood in rural area. To understand the flood phenomena in Laos, first of all we have understand and analysis the rainfall-runoff in Laos, in this study will evaluated the performance of distributed hydrologic model By using hydrological rainfall-runoff model developed by Kashiwa et al. (2010) in 3 basins names by Ou sub-basin, Sane basin and Sedone sub-basin.

2. Data set

The Topographic data, soil data, land use, DEM data, these data will get from National Geographic department of Laos (NGD). The weather parameter like precipitation, maximum and minimum temperature, wind speed are from Department of Meteorology and Hydrology of Laos (DHM), steam flow data from DHM will be use to calibration and validation process of the model.

3. Method

In this study I use rainfall-runoff model to simulated river flow, it is includes a direct flow and base flow models and used to estimate the river flow. Surface flow and subsurface flow are calculated by using Kinematic wave method and the base flow is analyzed by using a storage function of two stage layer model.

Kinematic equation:

$$\Delta h = \frac{\Delta t}{B\Delta x}(Q_{in} - Q_{out}) + (r_e - ET)\Delta t \qquad (1)$$

Where $\triangle h$ is variation of depth (m), $\triangle t$ is time interval of flow direction (s), Q is flow rate (m^3/s), r_e is precipitation (m/s), and B is width of flow path (m).

The flow rate can calculate from the manning equation:

$$Q = \frac{1}{n} B \Delta h^{\frac{5}{3}} I^{\frac{1}{2}} \qquad (2)$$

Here Q is flow rate (m^3/s), $\triangle h$ is water depth (m), B is mesh width (m), I is gradient and n is the Manning roughness coefficient(s/ [$m^{1/3}$]).

The infiltration water was determined by the following equation:

$$R_{in} = k_a * h \qquad (3)$$

Where R_{in} is the amount of infiltration (m/s), k_a is the infiltration coefficient (s^{-1}) and h is water depth (m).

Storage function method

$$\frac{ds}{dt} = R_{in} - q;\ s = kq^p;\ q = \left(\frac{s}{k}\right)^{\frac{1}{p}} \qquad (4)$$

Where s is apparent storage level (m) q outflow level of base flow (m/s), k (s) and p are constant.

Model performance measures

Key Word: rainfall, Runoff, distributed hydrologic model, Laos

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The performance of this model was determined using 2 commonly statistical performance measure Coefficient of determination, R^2 and Nash-Sutcliffe efficiency, E by (Nash and Sutcliffe 1970)

4. Results & Discussion

The Model simulated performance was tested in 3 basins from north part of Laos Ou sub-basin, central sane basin and south part is Sedone sub-basin.

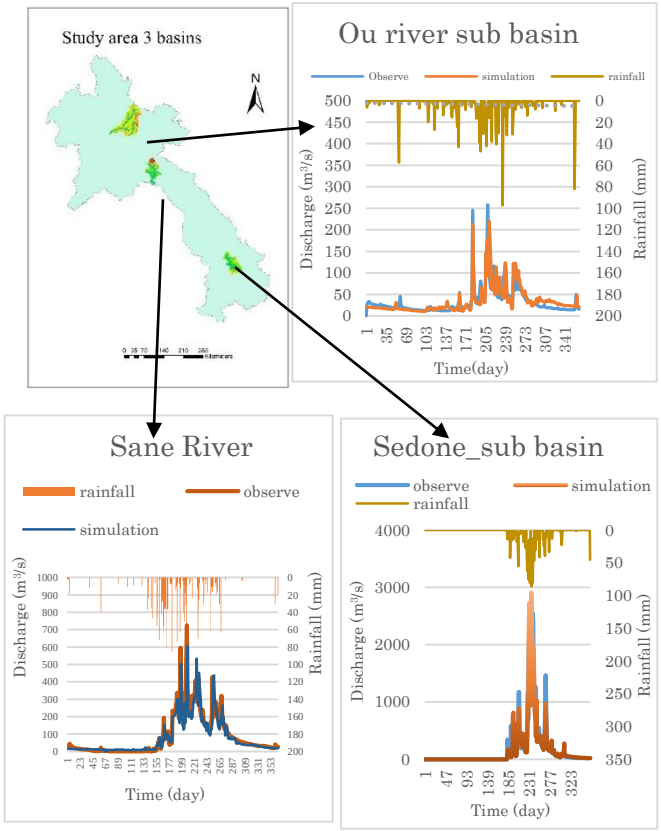

Fig 1: Observed and simulated river discharge.

The value of R^2 and E after calibration and validation of distributed model for an hourly rainfall data are show in below:

Table 1 Model performance on 3 basins

Basin name	R^2	Nash
Ou sub-bain	0.72	0.66
Sane basin	0.80	0.79
Sedone sub-basin	0.79	0.77

From the result above Sane basin show the highest value of R^2 and E, other results also very satisfy according to all the value are above 0.6 indicate a satisfactory fit between observed and simulated hydrographs (Moriasi et al., 2007). The result of two basins are poorer than Sane basin because of the data from Ou sub-basin and Sedone sub-basin is insufficiency especially for sedone sub river, the rainfall data from January to June was miss because of the problem form the rain gauge station in that area (Lower Mekong Hydrology year book 1992) but they still show well results. Hence this model can run on the specific study area.

5. Conclusions

this study provides hydrological distributed model that reliable in the study area, the result show rainfall-runoff simulate data are reliable enough to use in other research or use in other hydrology study in Laos area and it is very important in the future for developing country such as Laos.

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