Task Result Report

Submitted to
Prof. Marie-Amelie Boucher
Prof. Hongli Liu

By: Sujan Maharjan

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Task 1 Model setup and results

The results for the computation of discharge using the given default parameter values are shown in Figure 1-1.

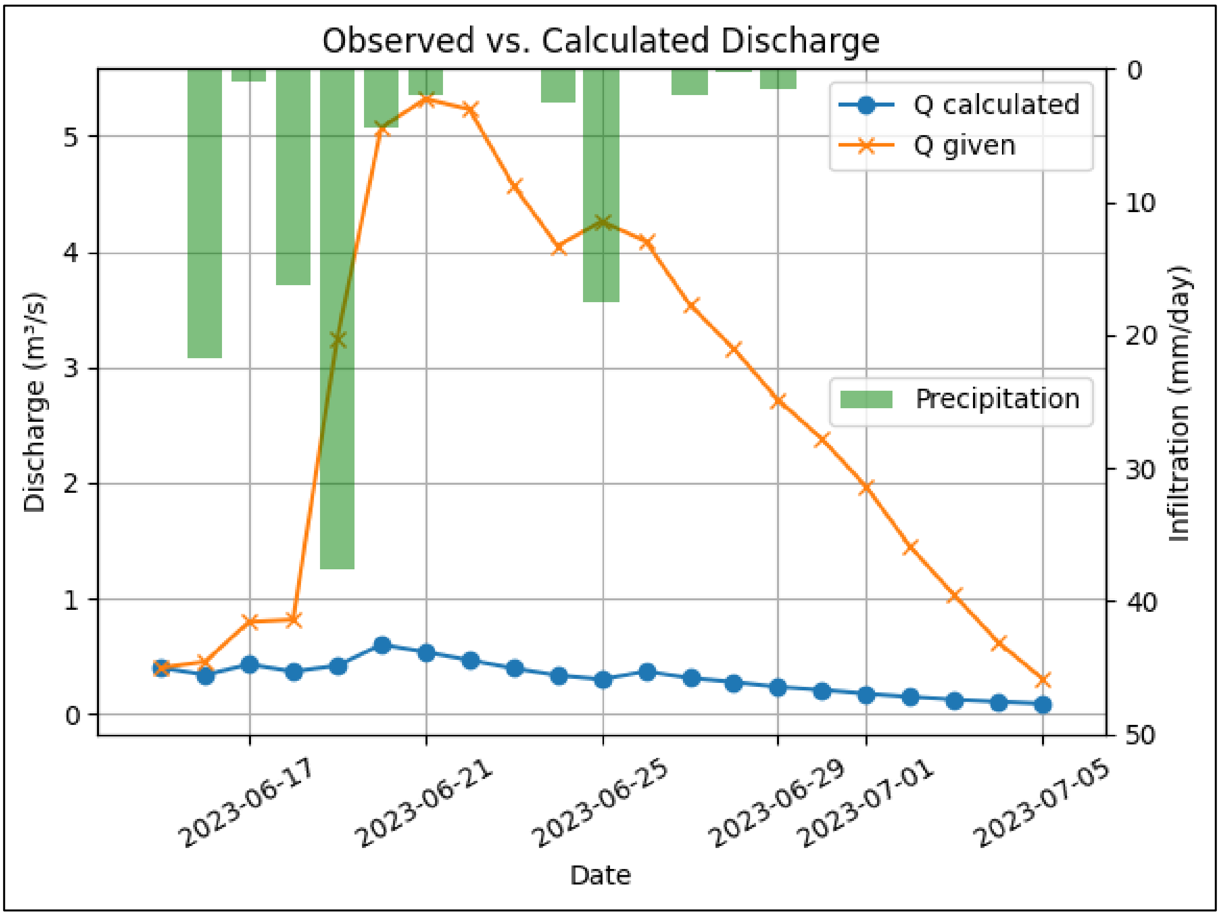

Figure 1-1 Model performance with default parameters

The plot illustrates the discharge produced by the respective precipitation event with a time step of 1 day.

The root mean squared error (RMSE) is 2.8 m^3/s and the Nash-Sutcliffe efficiency (NSE) is -1.73. For it to make sense of these statistics, the mean of the simulated outflow is 0.317 m^3/s. Thus, the RMSE indicates a very large error in the outliers. Additionally, the NSE of -1.73 indicated that the model is performing very poorly.

Though the model performs poorly, it can produce discharge timeseries which follows the trend of the observed discharge. This suggests that the physics behind the outflow calculation is correct. The model consistently produces low outflow which suggests that there is a systematic error in the model. There are a few reasons why the model performs so poorly and produces these insufficient flows. Other than the constant parameters and observations such as the area of the basin, precipitation and initial flow, the factors which highly affect the discharge outflow are the runoff coefficient (c) and resident time (Tr). The lack of proper parameter input could have led to poor precipitation to runoff conversion. This can be checked by testing the sensitivity of the model towards these parameters. Additionally, finer spatial resolution with sub-basins and smaller precipitation timestep could improve the model results.

Task 2 Calibration

The model has been calibrated by changing the c and Tr values since the other parameters are observations and cannot be calibrated. This is, however, assuming that the data observed from the rain gauge and basin area have maximum confidence. The value of c ranges from 0-1, where 0 means that there is no runoff resulting from the precipitation and 1 means that all of the precipitation leads to complete runoff from the catchment. The Tr gives an idea of on average how long a quantity of water will stay within the system.

As a part of calibrating the model, the c is set as 0.7 and Tr as 4 days. A coefficient of correlation of 0.7 is feasible in highly urban areas where there are lots of roads and pavements with little vegetation. Furthermore, a residence time of fewer days to minutes results in higher runoff but the flow hydrograph tends to be more extreme, which, the observed flow hydrograph does not reflect.

The RMSE and NSE are 2.11 m^3/s and -0.51. There is an overall decrease in the error after the calibration but it is still not good enough compared to the observed outflow. The results of calibration is shown in Figure 2-1.

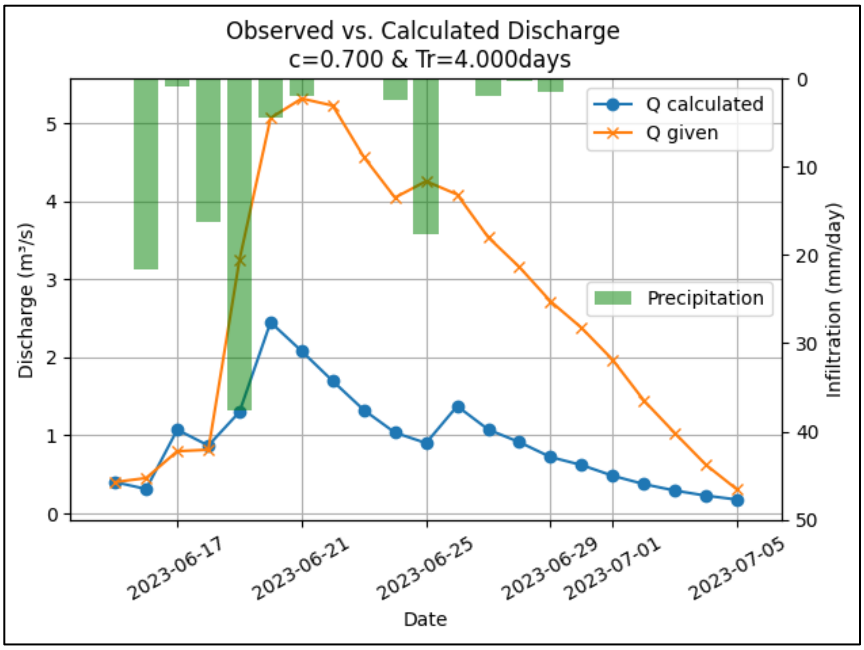

Figure 2-1 Calibrated model results

Task 3 Sensitivity

Sensitivity analysis is done using the c and Tr parameters. The parameters are setup using extremes of their values. The setup of the sensitivity analysis with four cases is shown in Table 3-1.

Table 3-1 Sensitivity analysis parameter setup

	Case 1	**Case 2**	**Case 3**	**Case 4**
c	1.000	0.172	0.172	1.000
Tr (days)	5.96	0.1	10	0.1

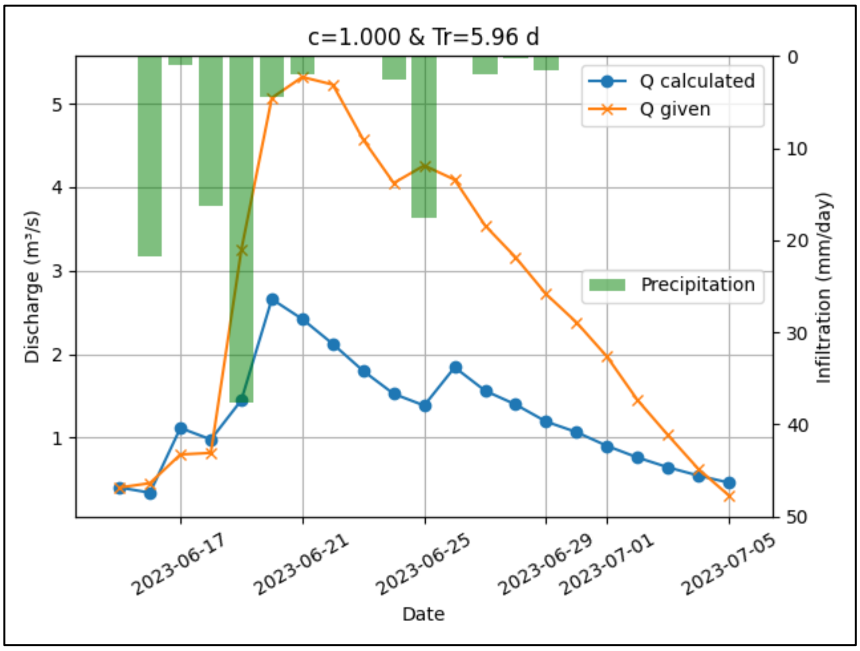

Figure 3-1 Sensitivity analysis Case 1

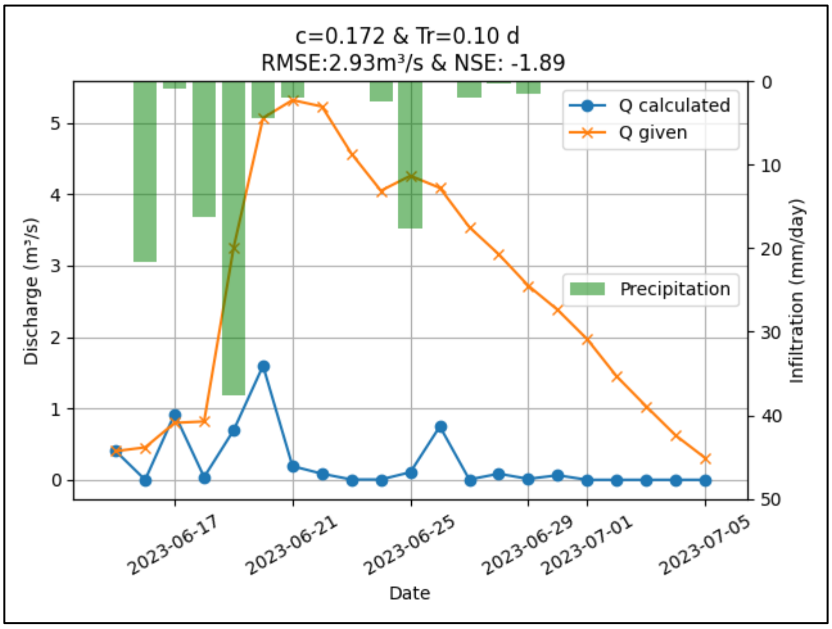

Figure 3-2 Sensitivity analysis Case 2

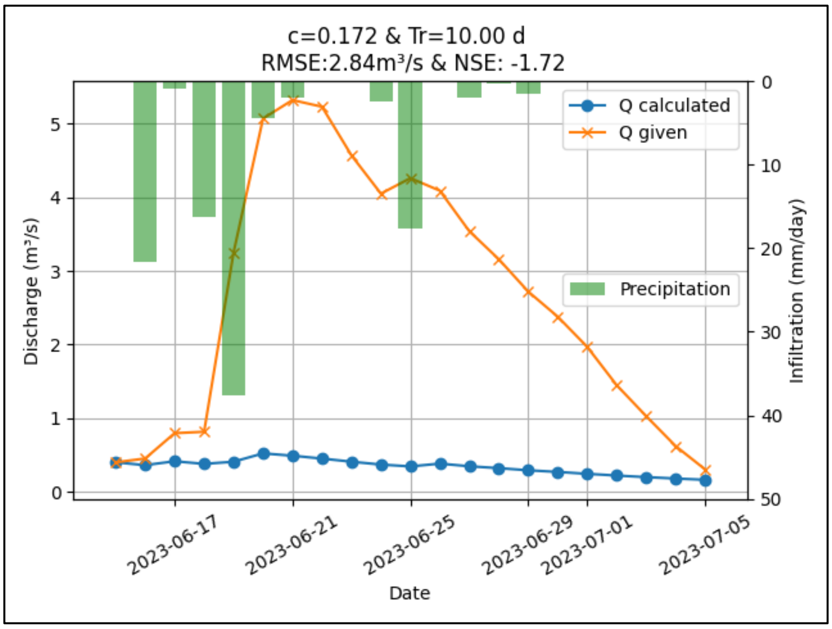

Figure 3-3 Sensitivity analysis Case 3

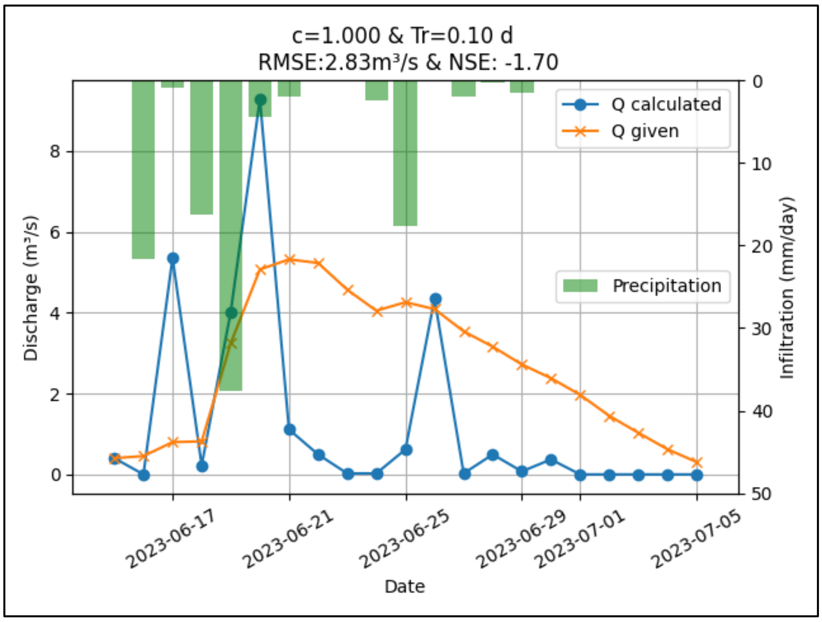

Figure 3-4 Sensitivity analysis Case 4

From figures Figure 3-1, Figure 3-2, Figure 3-3 and Figure 3-4, it can be observed that the model is in fact sensitive to the runoff coefficient and the resident time.

An increase in runoff coefficient leads to higher discharge outflow, similar to a decrease in resident time. The main difference is in the slope of the peak discharge points where smaller resident times lead to extremely sharp increases and decreases in discharge. This could be used as a discharge during flash flooding event, which is not the case in this study as evidenced by the observed outflow discharge.

Task 4 Uncertainty analysis

The Monte Carlo simulation is used to test the uncertainty of the c and Tr parameters. The uncertainty range using these parameters is shown in Figure 4-1 by a blue-filled polygon. For this, a random c is chosen between 0.1 to 0.8 and Tr is chosen randomly between 1 to 10 days. 100 simulations are conducted using a random selection of these parameters. A snippet of the code is presented below:

```
c=np.random.uniform(0.1,0.8)     #Random Runoff coefficient
Tr=np.random.uniform(1,10)       #Residence time in days
```

The uncertainty range around the mean of the simulated discharge line accounts for the variability of the model parameters. The uncertainty range still cannot produce the observed discharge flow which points towards a systematic error or some systematic parameter insufficiency. These parameters could be the area of the basin or the precipitation and or finally the observed discharge.

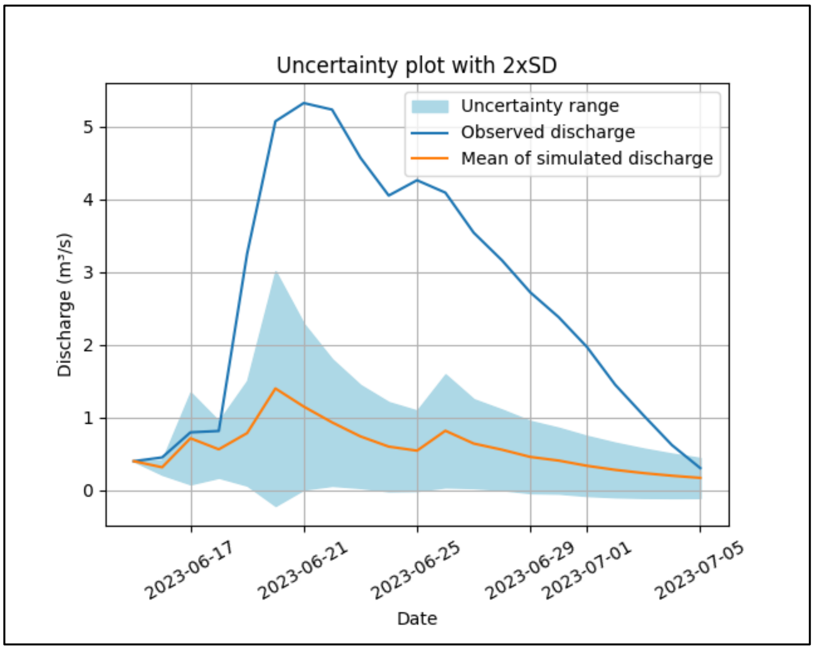

Figure 4-1 Uncertainty analysis