SWAT Soil & Water Assessment Tool

Analysis of Baseflow through Application of SWAT-BFlow β Parameter by Flow-Conditions

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Table of Contents

I. Introduction

II. Methods

III. Result

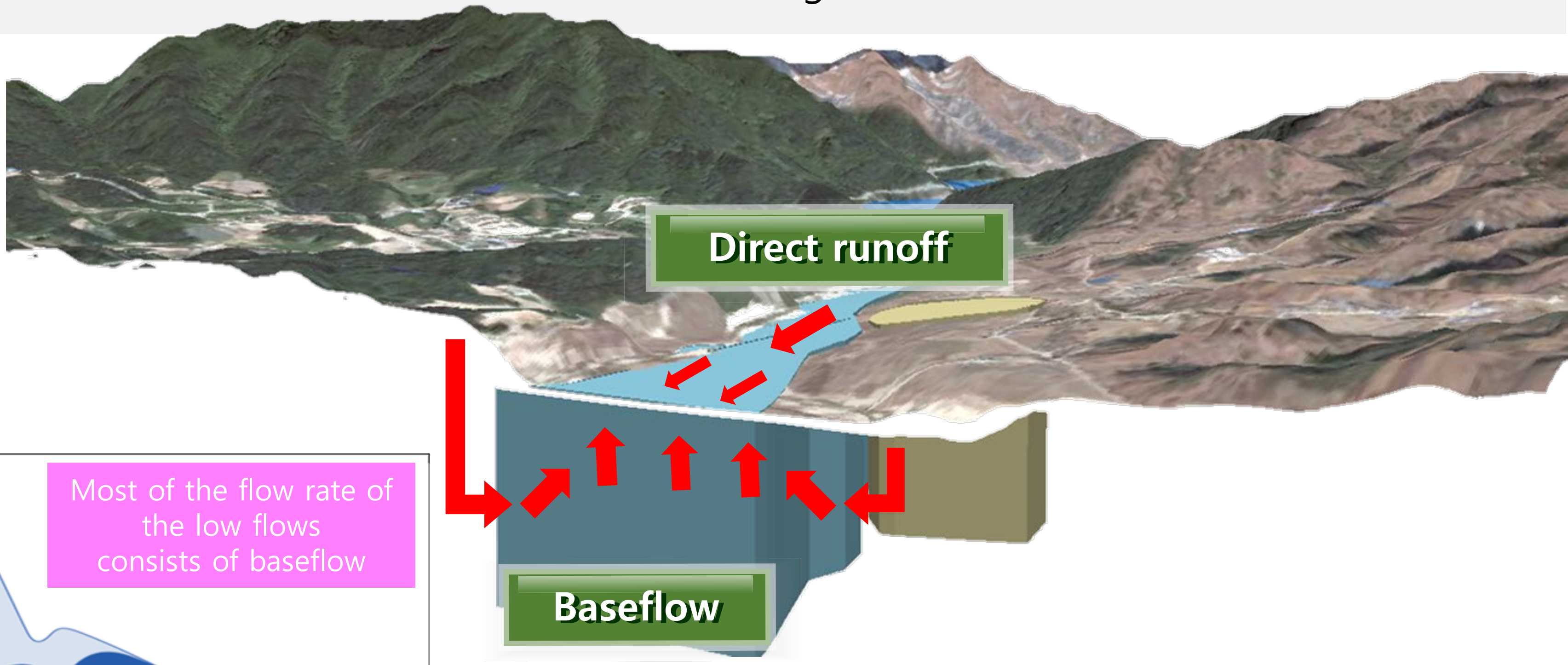
IV. Conclusion

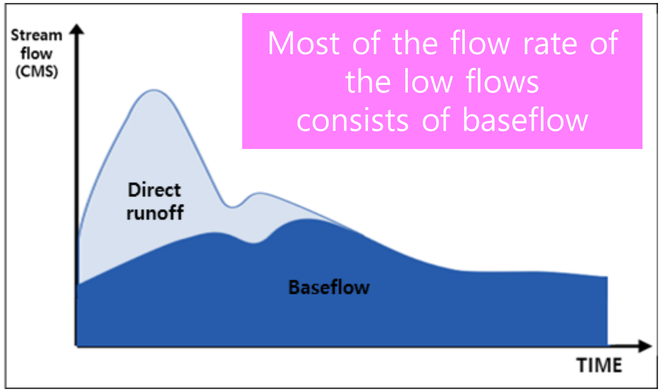
PART 1

Introduction

❖ What are direct runoff and baseflow?

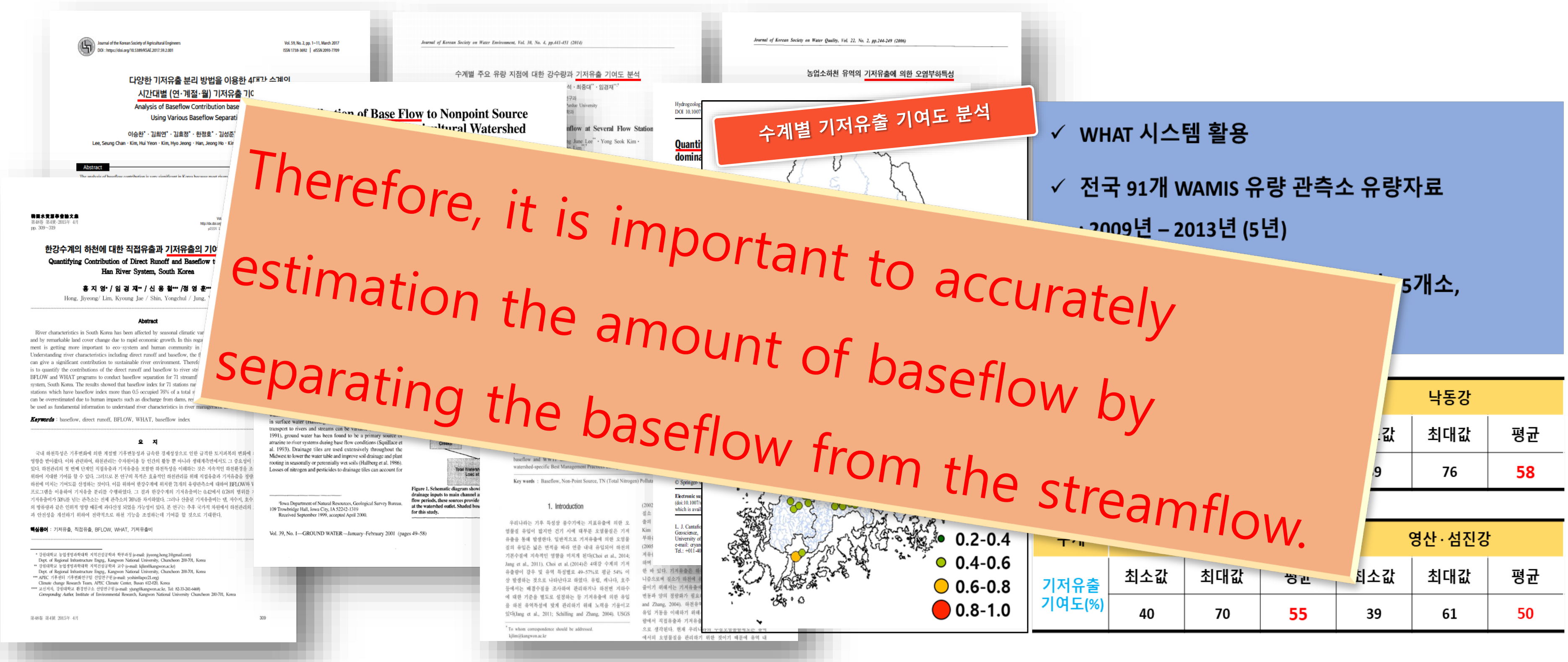
- Streamflow can be divided into direct runoff and baseflow.
- Direct runoff is the precipitation into a river in a relatively short period of time.
- Baseflow is flows into rivers after rainfall infiltrate to groundwater.





❖ Definition of baseflow and Necessity to manage it

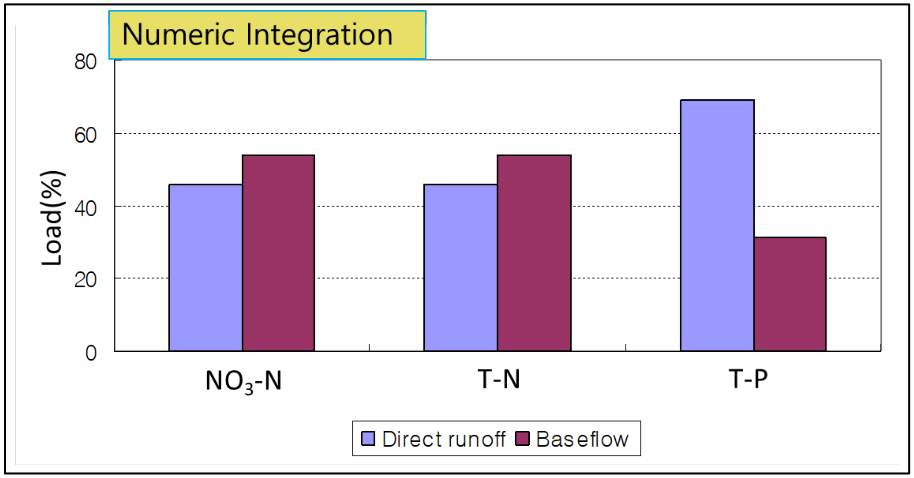
- In the past, many studies direct runoff from rivers were conducted and relatively few studies on baseflow.
- According to studies on baseflow, the proportion of baseflow in stremflow accounts for more than 50% of each of the four major rivers in South Korea.
- In other words, the proportion of baseflow in streamflow is higher than that of direct runoff.

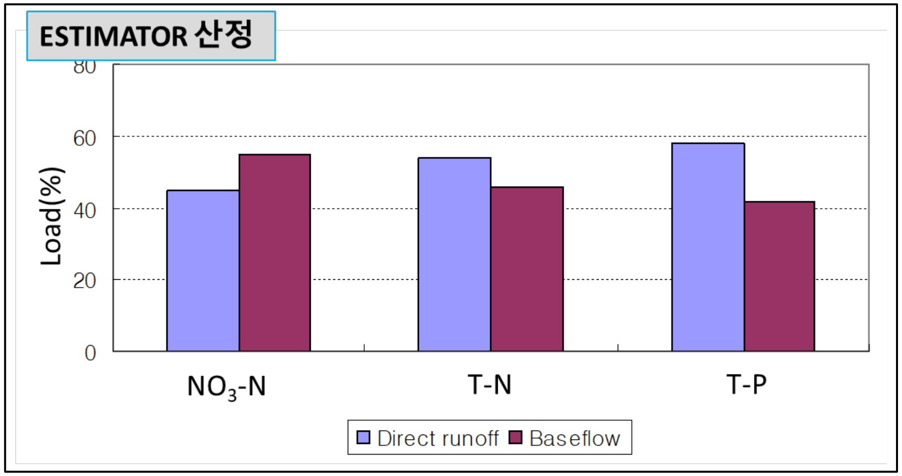


Therefore, it is important to accurately estimation the amount of baseflow by separating the baseflow from the streamflow.

❖ Definition of baseflow pollutant load and Necessity to manage it

- There is a study comparing the NI method and the Estimer method, which are methods of calculating the amount of pollutant load in South Korea(Shin, 2006).
- According to the study, the amount of pollutant load caused by the baseflow is also not small.





In the management of stream water quality, you need to calculate and manage the amount of pollutant load caused by baseflow.

❖ The purpose of this study

Baseflow separation

- Use Pass 1 where the baseflow peak stick to falling lomb of the recession curve among the three result values for BFlow
- Filter parameters that are sensitive to the falling lomb when separating baseflow are applied by flow-conditions

Calculation pollutant load

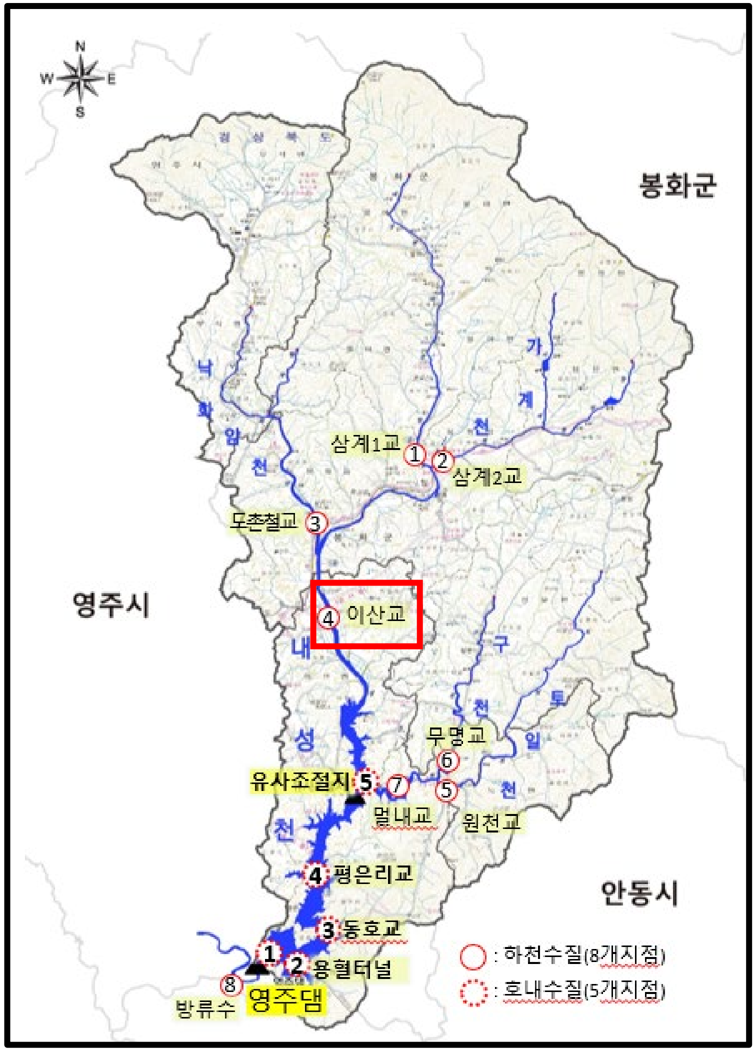
- Calculation of pollutant load using base water quality values

Calculation of Total/Base Pollutant Load Considering the Characteristics of the falling lomb Program WAPLE4 Development

PART 2

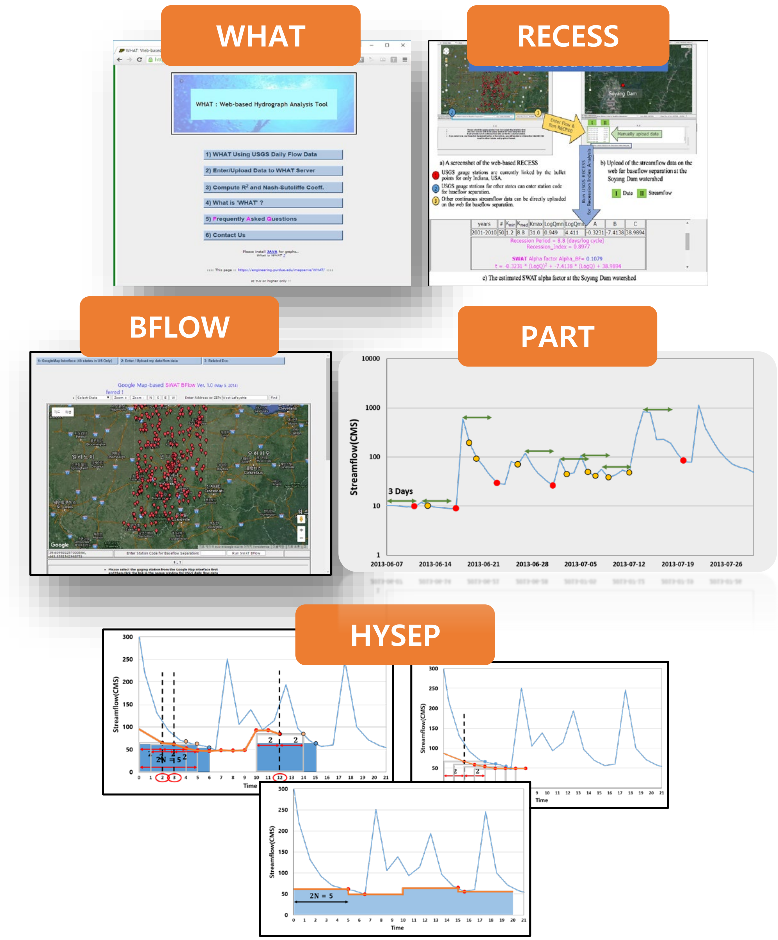
Methods

❖ Research target area



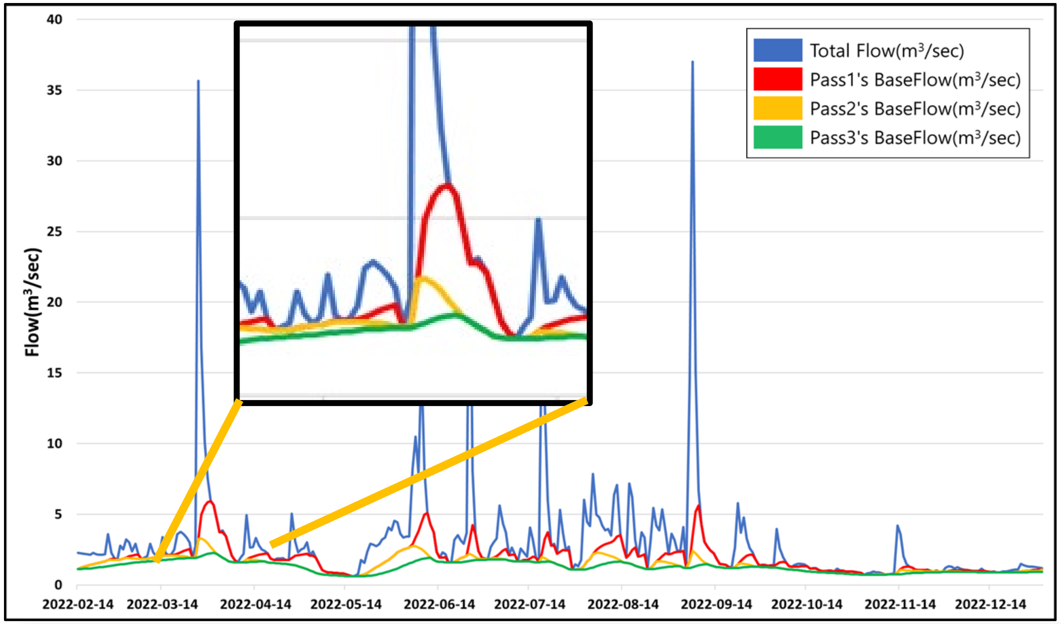
- **Research target area : Isan Bridge, Andong City, South Korea**
  Area : 648.97 km^2
  Maximum elevation : 860 m
  Minimum elevation : 40 m
  Average elevation : about 176 m
- **Gapcheon land use status**
  Forest : about 67.39%
  Urbanization/ Dry area: about 18.36%
  Agricultural land : about 7.68%
- **The simulation period 2019 to 2021**
- Flow gauge station: Mulgyo Bridge in Munpyeong-dong, Daedeok-gu, Daejeon / Shingu Bridge, Bonsan-dong, Yuseong-gu, Daejeon
- Weather gauge station: Daejeon Regional Office of Meteorology

❖ Baseflow separation methods



- There are various algorithms such as Recursive Digital Filter(WHAT), Master recession curve(RECESS), Local Minimum(HYSEP) for separate the baseflow from the streamflow.
- In this study, BFlow, which can be intergrated with the SWAT model used in various ways for watershed management, is used.
- BFlow separates the baseflow from the streamflow by applying a filter method (One parameter filter) that separates the low frequency from the high frequency.

❖ BFlow Characteristic and Problem 1



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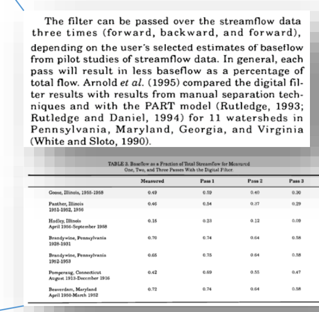
AUTOMATED METHODS FOR ESTIMATING BASEFLOW AND GROUND WATER RECHARGE FROM STREAMFLOW RECORDS

J. G. Arnold and P. M. Allen



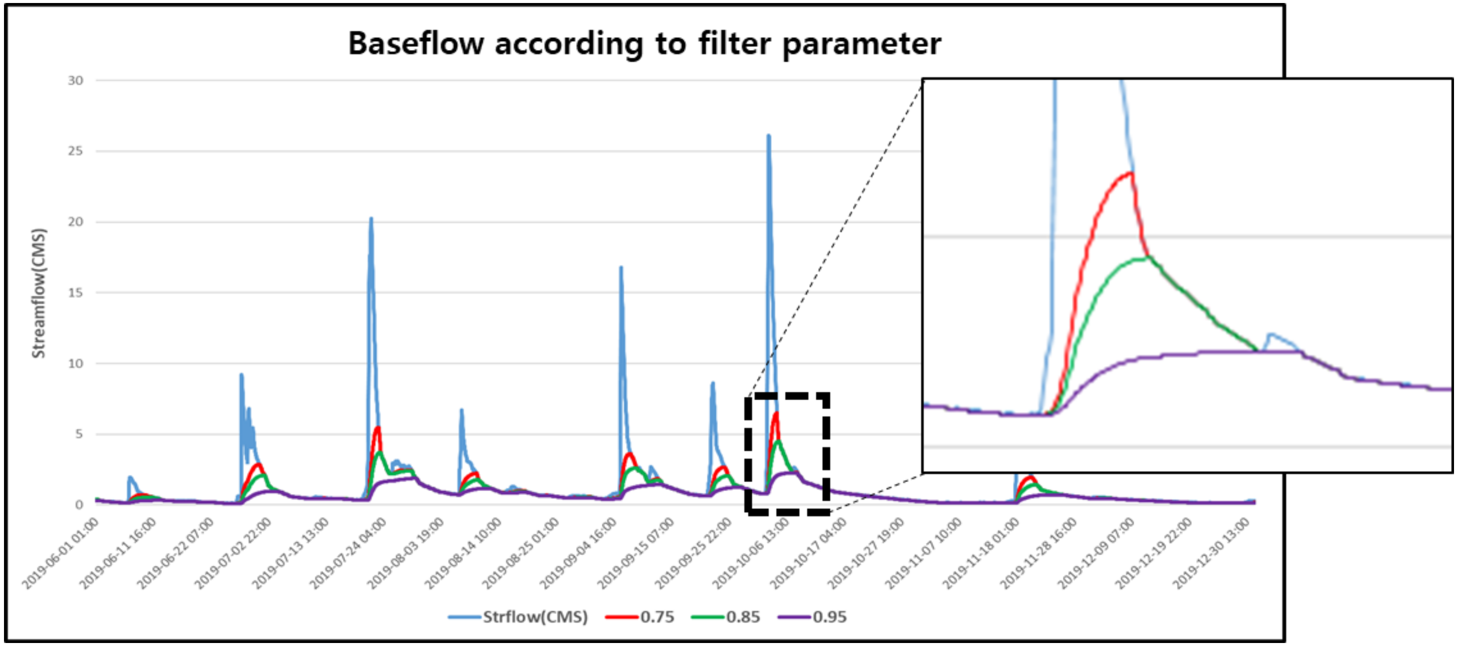
The filter can be passed over the streamflow data three times (forward, backward, and forward), depending on the user's selected estimates of baseflow from pilot studies of streamflow data. In general, each pass will result in less baseflow as a percentage of total flow. Arnold *et al.* (1995) compared the digital filter results with results from manual separation techniques and with the PART model (Rutledge, 1993; Rutledge and Daniel, 1994) for 11 watersheds in Pennsylvania, Maryland, Georgia, and Virginia (White and Sloto, 1990).

TABLE 3. Baseflow as a Fraction of Total Streamflow for Measured One, Two, and Three Passes With the Digital Filter.

	Measured	Pass 1	Pass 2	Pass 3
Goose, Illinois, 1955-1958	0.49	0.59	0.40	0.30
Panther, Illinois 1951-1952, 1956	0.46	0.54	0.37	0.29
Hadley, Illinois April 1956-September 1958	0.15	0.23	0.12	0.09
Brandywine, Pennsylvania 1928-1931	0.70	0.74	0.64	0.58
Brandywine, Pennsylvania 1952-1953	0.65	0.75	0.64	0.58
Pomperaug, Connecticut August 1913-December 1916	0.42	0.69	0.55	0.47
Beaverdam, Maryland April 1950-March 1952	0.72	0.74	0.64	0.58

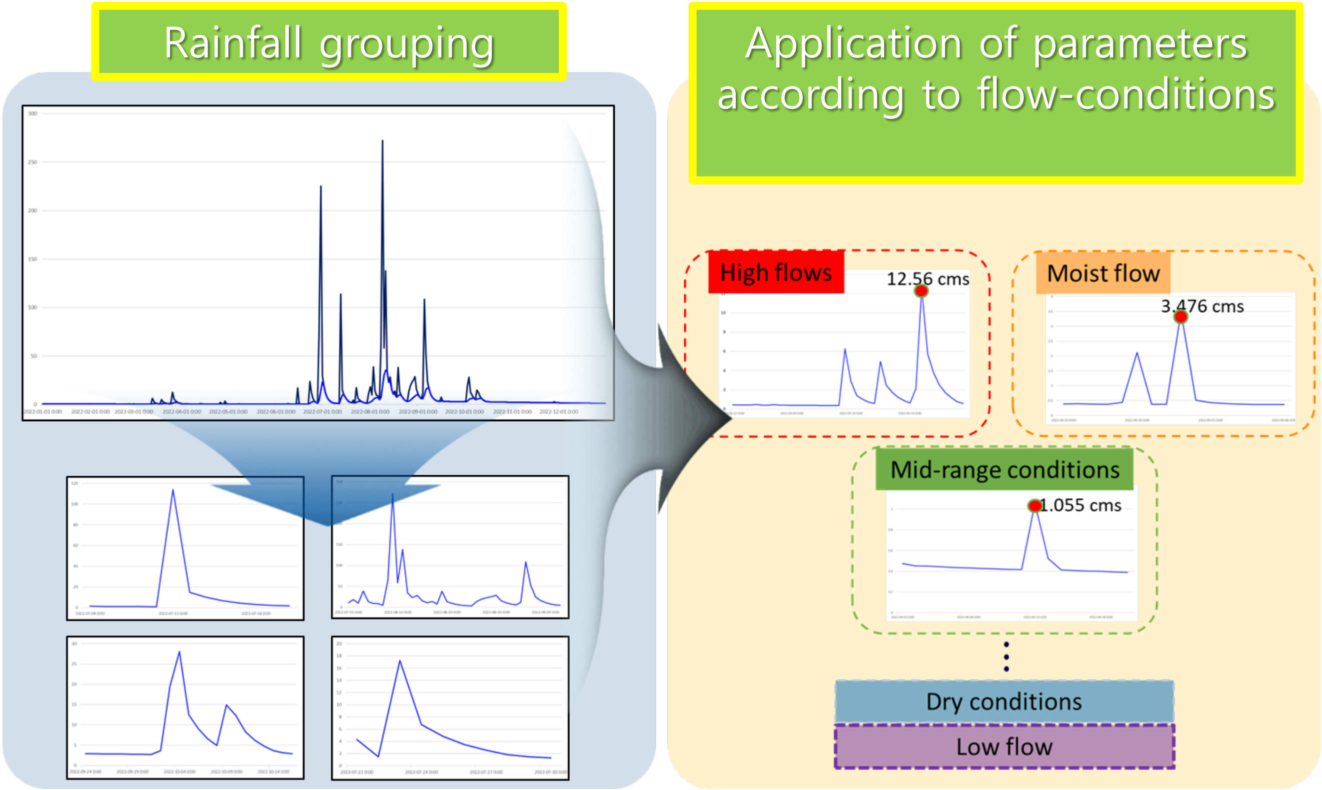
- The result of BFlow comes out as pass 1 ~ 3 depending on how the filter is applied.
- In the paper of Arnold and Allen (1999), it is recommended to use the pass 2 value among the filter results, and most people use the pass 2 value.
- However, as a result of the BFlow pass, pass 2 has an inflection point of recession curve in the rising part, which separates the baseflow.
  As the result of pass 1, the peak of baseflow stick to the inflection point of recession curve, and the baseflow is separated.

❖ BFlow Characteristic and Problem 2



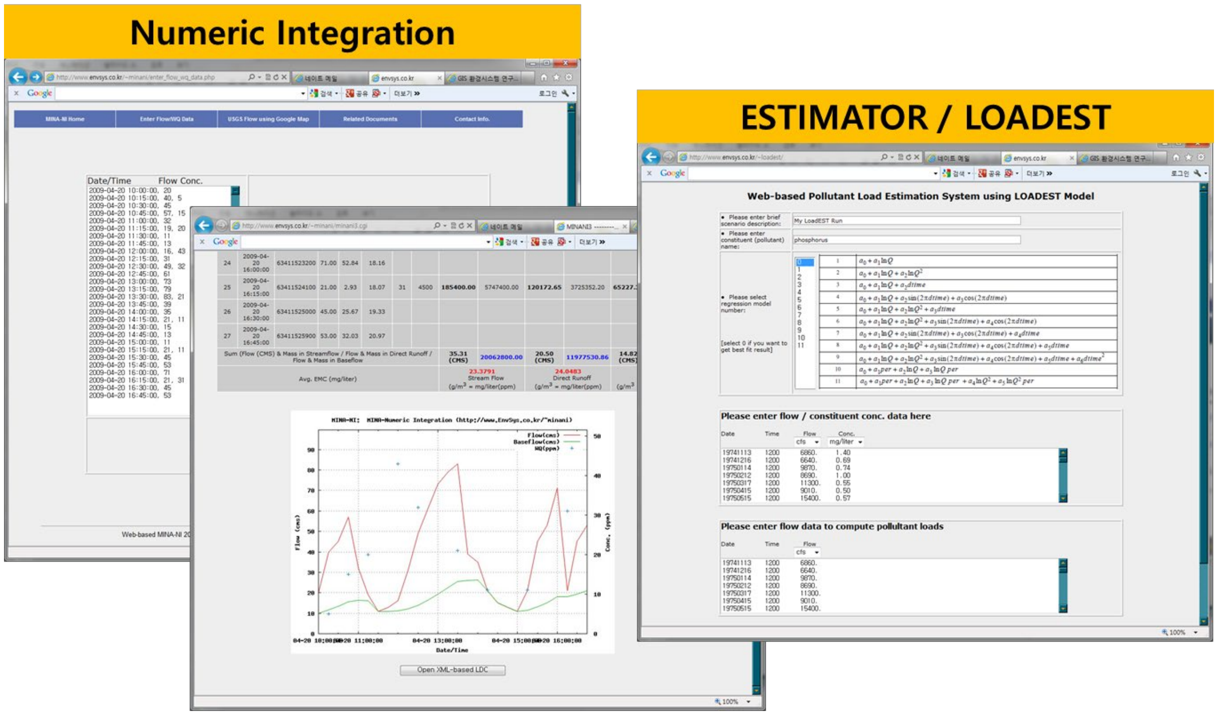
- ✓ Filter parameters utilized for baseflow separation in BFlow use a fixed value of 0.925 and cannot be modified by the user.
- ✓ However, as shown in the graph above, the separated baseflow depends on the Filter parameter.
- ✓ Therefore, Filter parameters should be selected differently for each flow-conditions.

❖ Improvements: Apply flow-conditions parameter



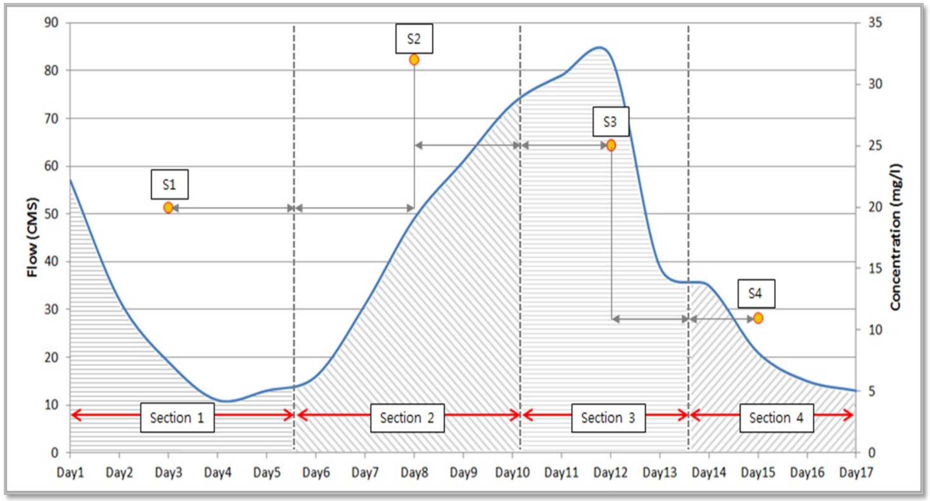
- ✓ First, we had found out the rainfall event throughout the simulated period.
- ✓ Separate the baseflow by applying the filter parameter differently for each flow-conditions.

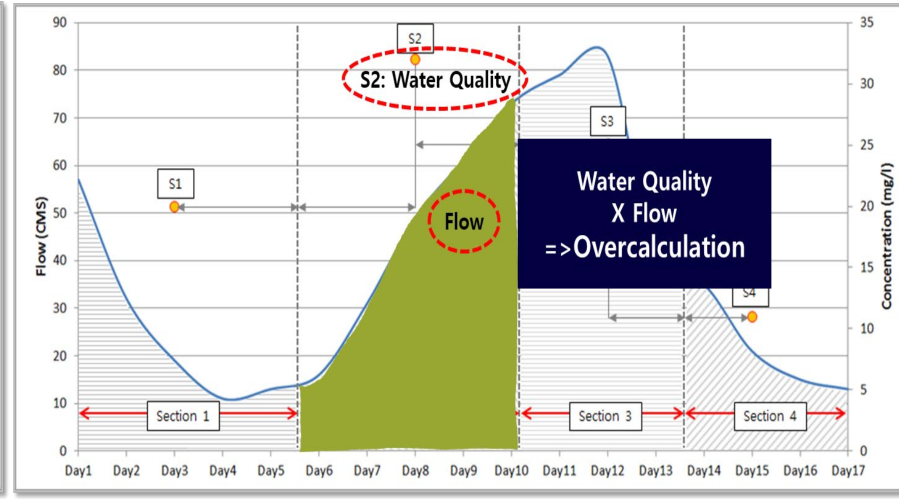
❖ How to pollutant load



- ❖ Methods for calculating the amount of pollutant load include the Numeric Integration(NI) method, ESTIMATOR, LOADEST, etc.

❖ Numeric Integration Characteristic and Problem





- ✓ The NI method can simply calculate the amount of pollutant load by the following equation.

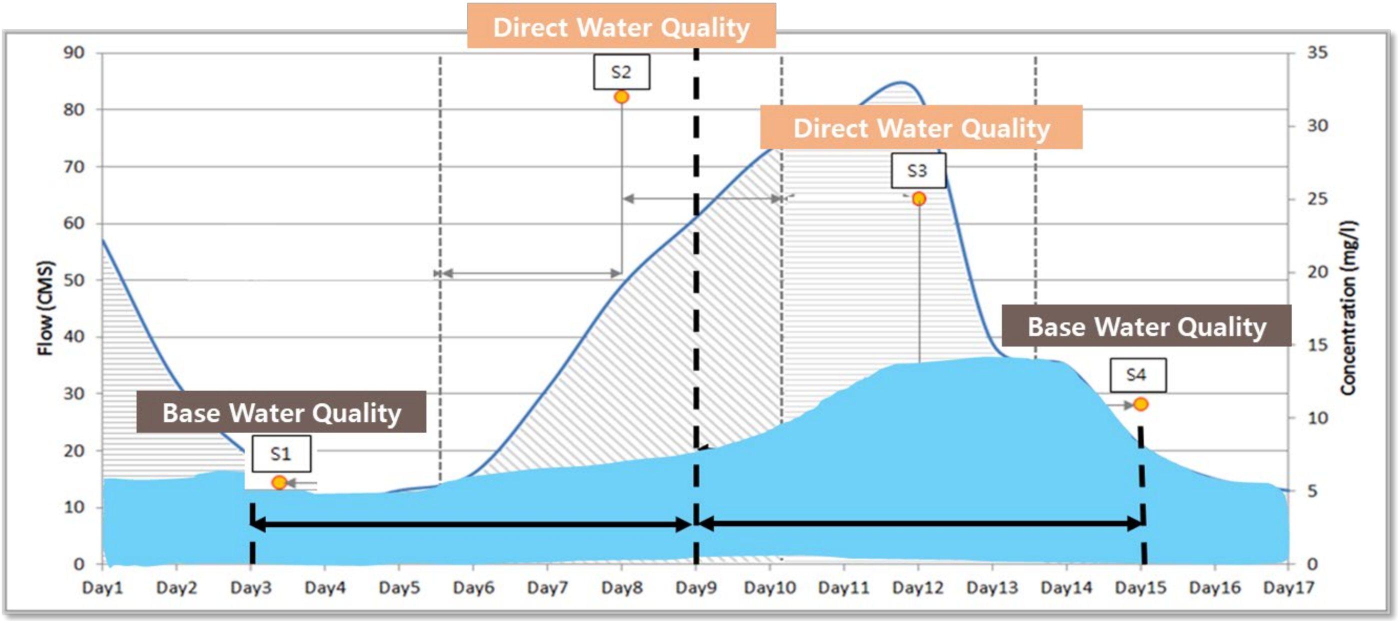
$$Load = \sum_{i=1}^{n} c_i q_i t_i$$

- ✓ C_i : Concentration of the i-th sample, q_i : flow of the i-th sample,
  t_i : i-th time interval $(t_{i+1} - t_{i-1})/2$

If the pollutant load is calculated with a h[illegible] value in the baseflow, there is a problem

02 Methods

❖ Total/Baseflow Pollutant Load



- ✓ In this study, water quality was classified according to the amount of baseflow separated by BFlow.
- ✓ In addition, the total pollutant load and the baseflow pollutant load were calculated, respectively.

❖ Flow chart of the study

Use **Pass 2** among BFlow result values

Use **a single parameter** throughout the simulated period

When calculating the baseflow pollutant load,
Calculation using **water quality value**

Use **Pass 1** among BFlow result values

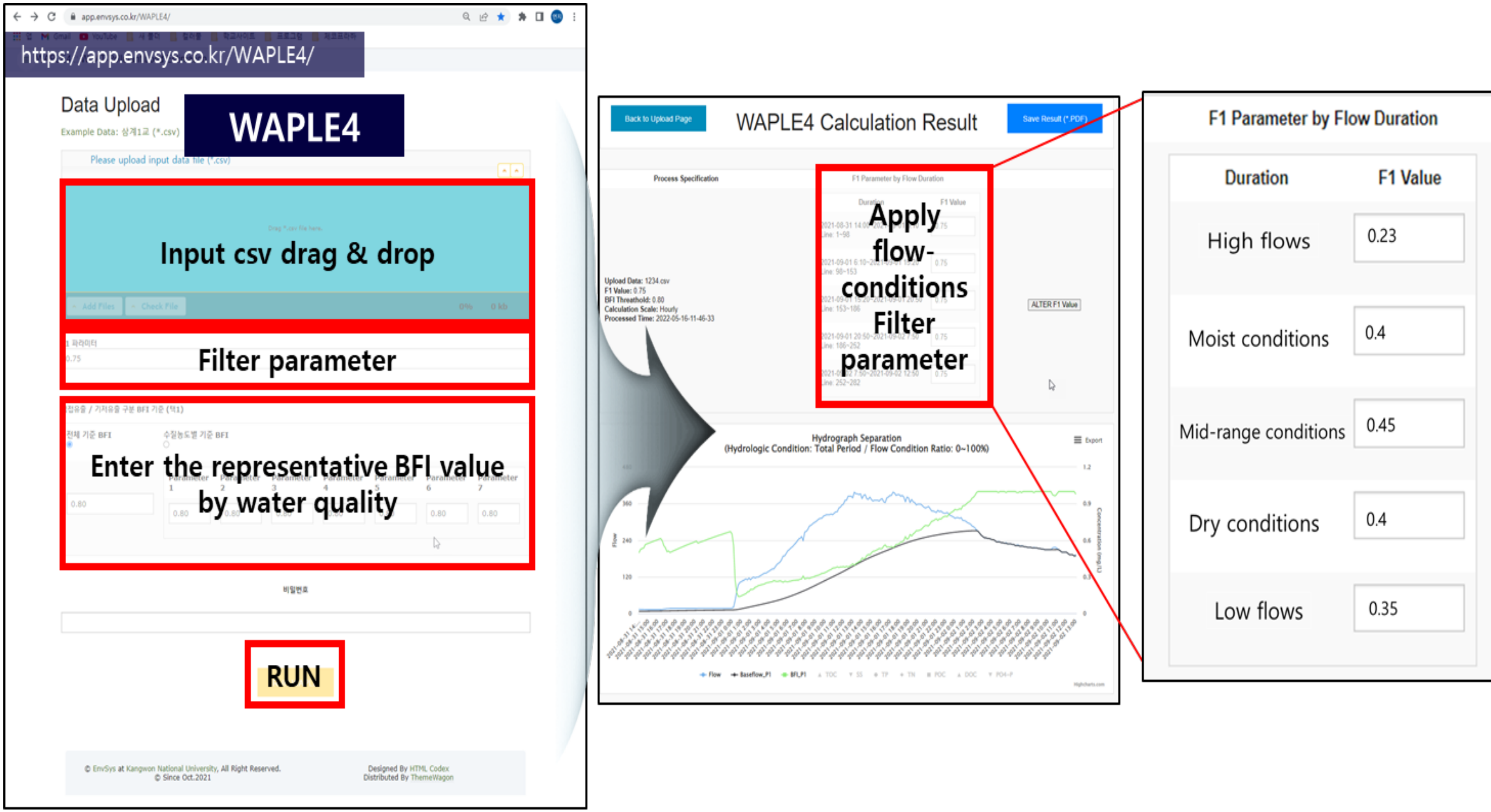
Apply **flow-conditions parameters**

When calculating the baseflow pollutant load,
Calculation using **base water quality value**

WAPLE4

WAPLE(WHAT-Pollutant Load Estimation)

❖ WAPLE4 usage developed in this study by Web



PART 3

Result

❖ Parameters and duration of simulation of WAPLE4

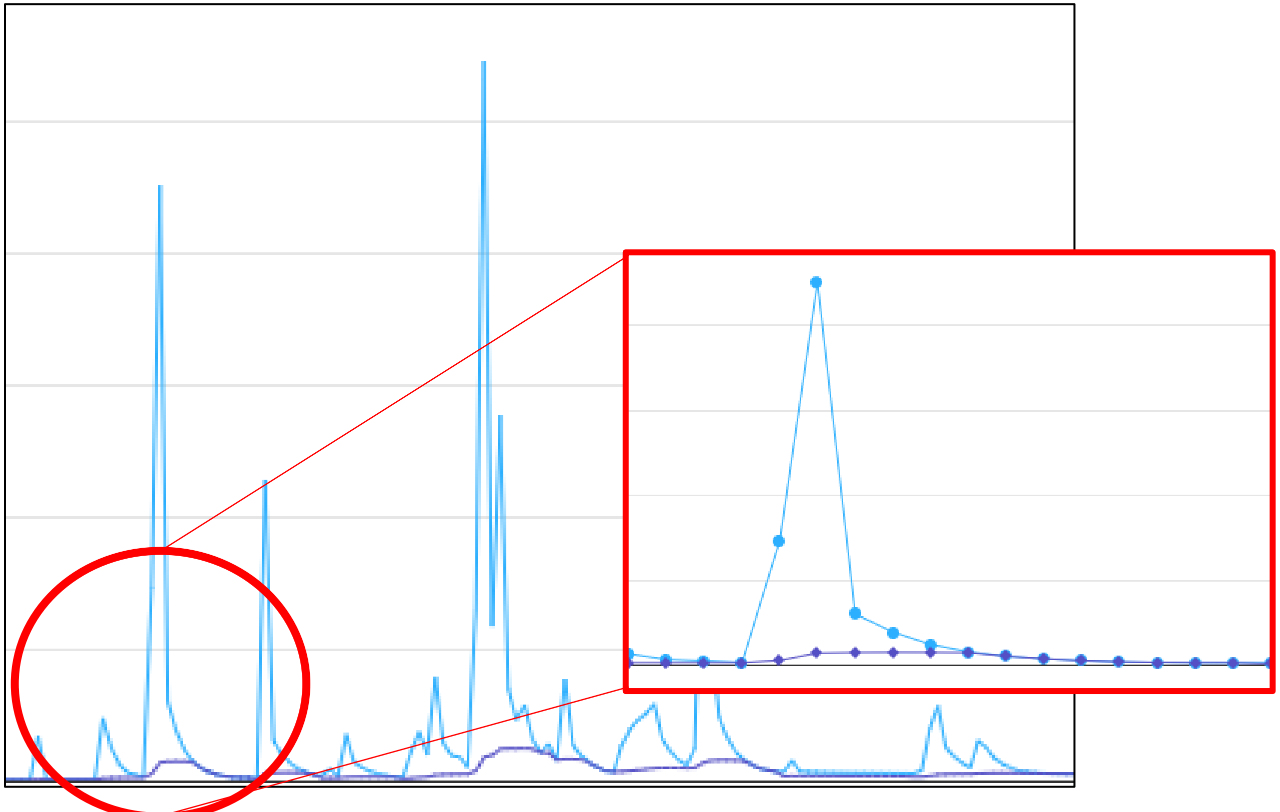
- Representative Filter parameter: 0.925
- BFI: 0.9
- Simulated period: Jan 01, 2022 ~ Dec 31, 2022

Filter parameter by Flow-conditions

Duration	F1 Value
High flows	0.9
Moist conditions	0.8
Mid-range conditions	0.8
Dry conditions	0.7
Low flows	0.925

❖ Comparison of WAPLE4 and WAPLE2 Baseflow Separation

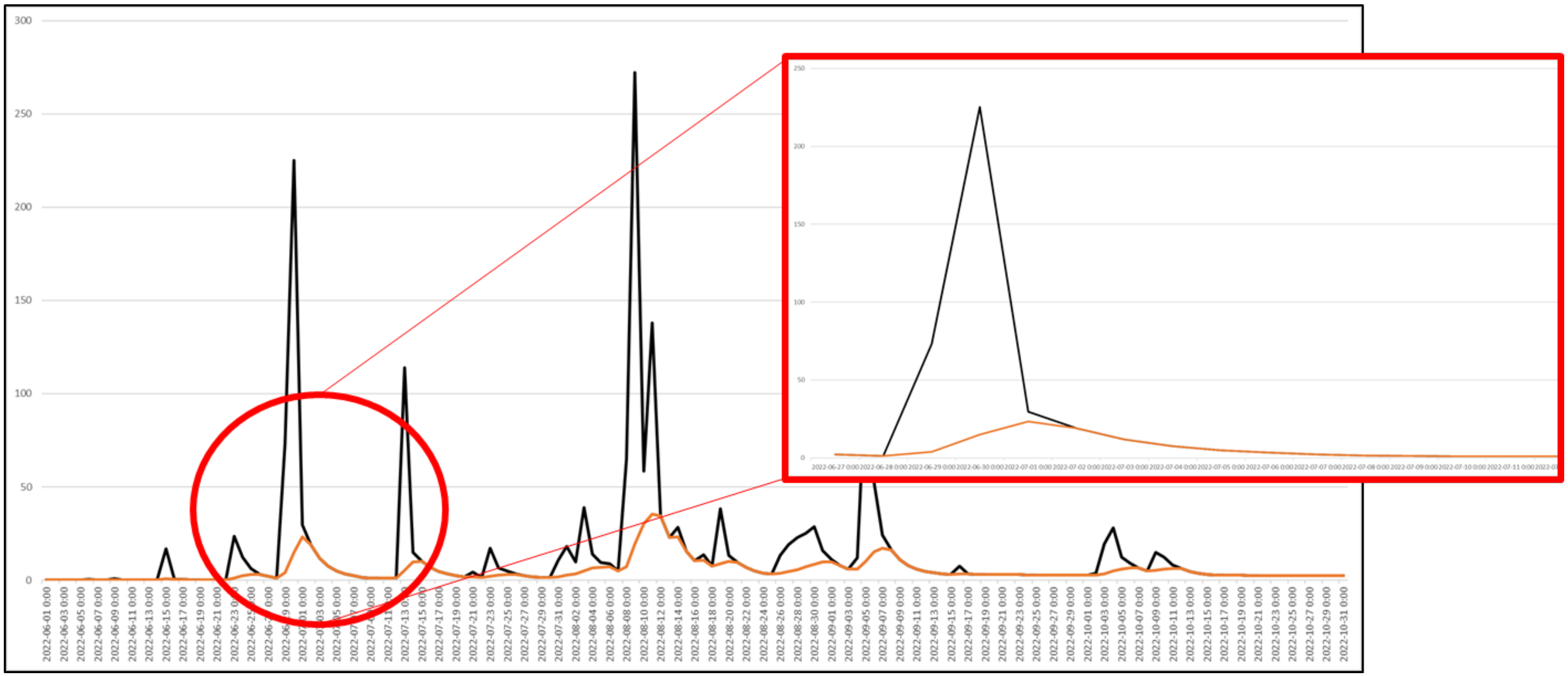
WAPLE2 Baseflow separation using WHAT



✓ **In WAPLE2, the peak of the baseflow graph does not stick to the inflection point**

❖ Comparison of WAPLE4 and WAPLE2 Baseflow Separation

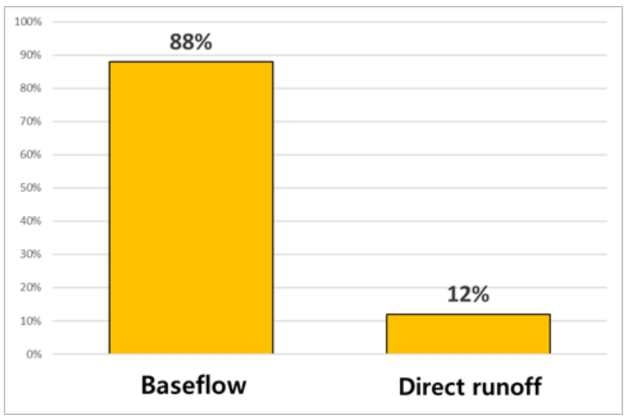
WAPLE4 Baseflow separation using BFlow



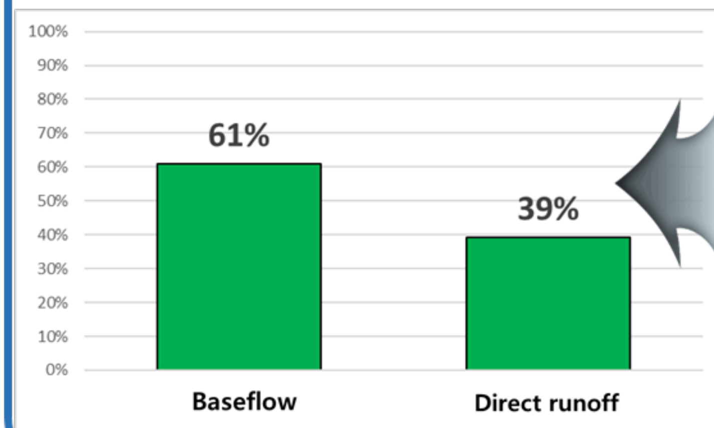
✓ **In WAPLE4, the peak of the base flow graph stick to the inflection point**

❖ Baseflow separation with single/flow-conditions parameters

Single filter parameter : 0.925



Flow-conditions filter parameter



F1 Parameter by Flow Duration

Duration	F1 Value
High flows	0.9
Moist conditions	0.8
Mid-range conditions	0.8
Dry conditions	0.7
Low flows	0.925

❖ Comparison of WAPLE4 and WAPLE2 calculation results

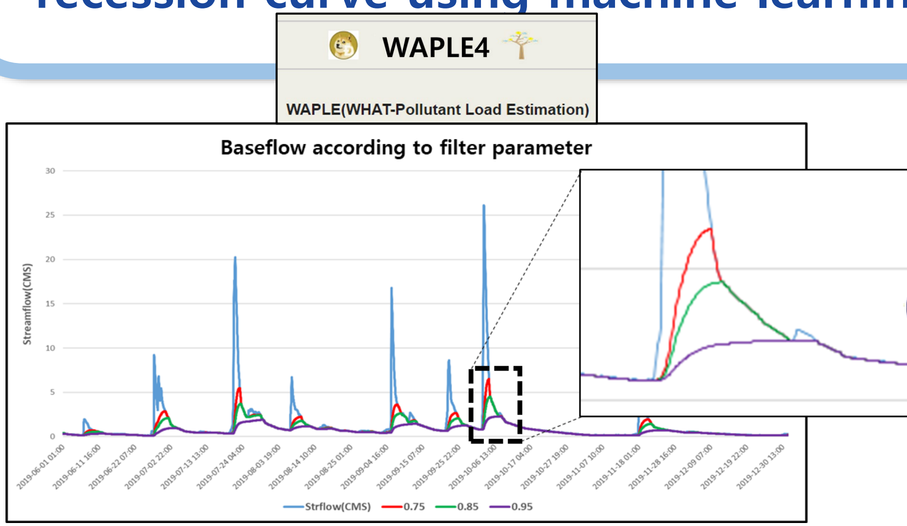
	BFI			
	Baseflow		Direct runoff	
WAPLE2	1,838 m^3/s	**76%**	577 m^3/s	24%
WAPLE4	1,447 m^3/s	**61%**	931 m^3/s	39%

	T-N Pollutant Load			
	Baseflow		Direct runoff	
WAPLE2	472,012 kg	**81%**	107,599kg	19%
WAPLE4	319,688 kg	**56%**	246,549 kg	44%

PART 4 Conclusion

❖ Conclusion and Research limitation

- **In this study, we developed WAPLE4, which can separate baseflow from streamflow, and estimates the baseflow pollutant load and streamflow pollutant load, more accurately.**
- **In addition, the baseflow was separated from the streamflow by applying the filter parameter for each flow-conditions.**
- **In the future research, we plan to find out to inflection point in the recession curve using machine learning.**



Thank you

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