



KYOTO UNIVERSITY

Development of Ultra-High Resolution Distributed Rainfall-Runoff Model to Flash Floods in Ungauged Urban Catchments

THA 2022 International Conference

2022/01/27

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Graduate School of Engineering

Kyoto University

2008, Toga river, Kobe



2012, Midajiro river, Kyoto

2013, Hata river, Kyoto

...

Climate Change
Urbanization

Flash floods

Ungauged, poorly ungauged !!

Discharge predictions in Ungauged Urban Catchments

Rational Formula Method

$$Q = \frac{1}{3.6} f \times r \times A$$

A: Catchment area (km²)

r: Rainfall intensity (mm/h)

f: runoff coefficient

Q: Discharge (m³/s)

fi

Mountainous forest f: 0.5

Urbanized area f: 0.9

...

1K-DHM (2013)

Distributed Rainfall-runoff model

$$q(h) = \begin{cases} v_c \times d_c \left(\frac{h}{d_c}\right)^\beta & 0 \leq h \leq d_c \\ v_c \times d_c + a(h - d_c) & d_c < h < d \\ v_c \times d_c + a(h - d_c) + \alpha(h - d)^m & d \leq h \end{cases}$$

Hydrological parameters

Nr Ns Dm Da Ka

Rational Formula Method

$$Q = \frac{1}{3.6} f \times r \times A$$

Simplified hydrological process

f : Runoff coefficient Land use

f_1 -----

f_2 -----

...

f_n -----

1K-DHM



Natural condition

Land use information

Land use 1: Ns, Nr, Da, Dm, Ka

Land use 2: Ns, Nr, Da, Dm, Ka

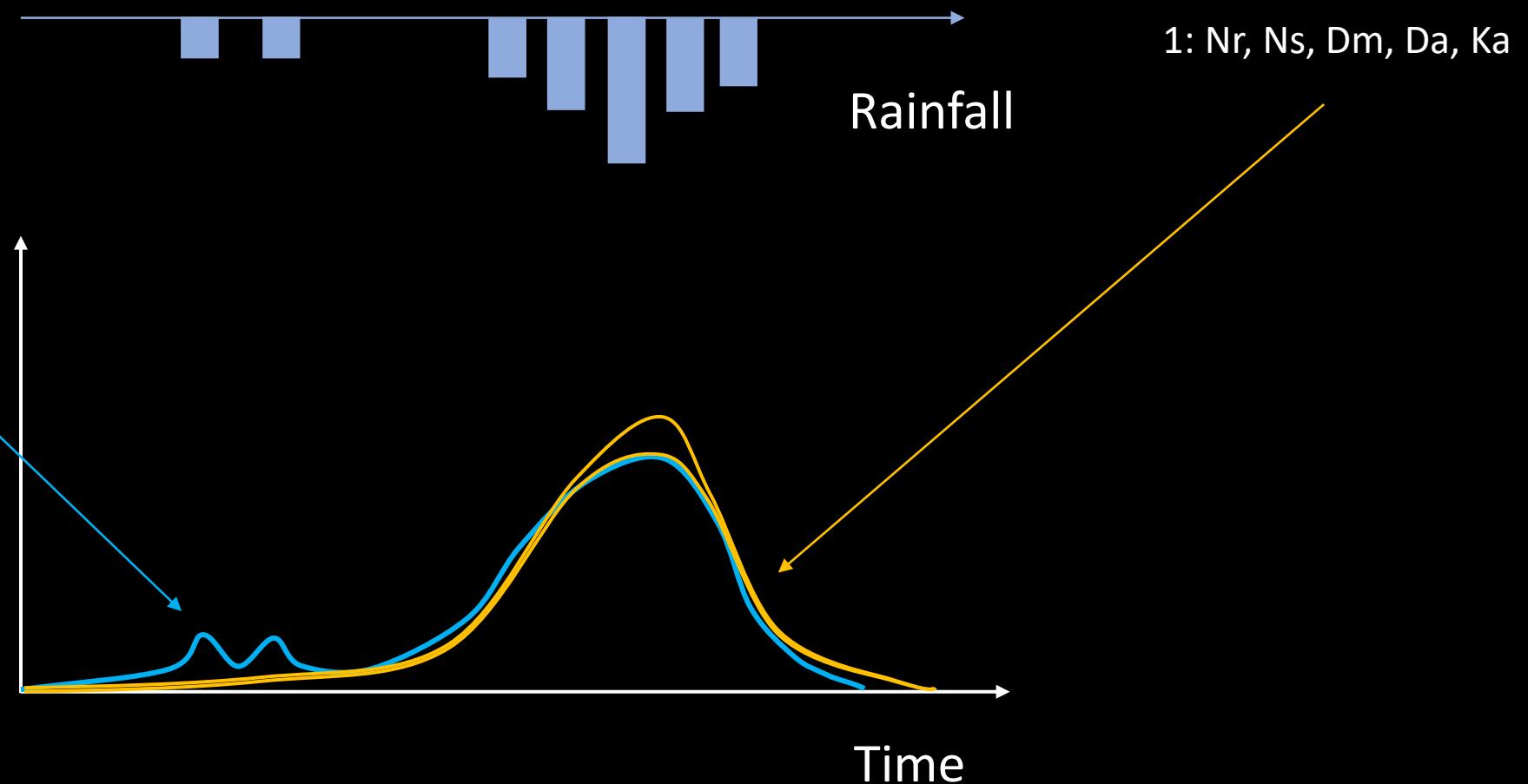
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Land use n: Ns, Nr, Da, Dm, Ka

Experiment design

Rational Formula Method

Mountainous area
 $f = 0.5$



Experiment design

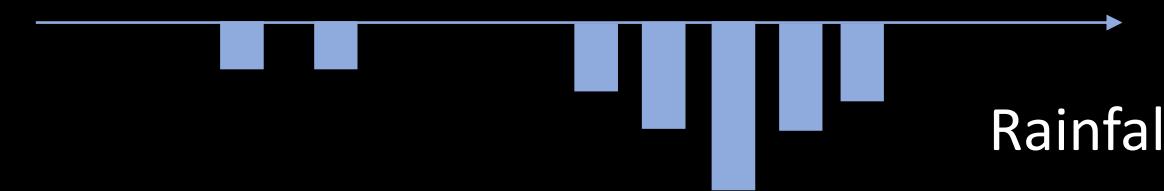
Rational Formula Method

Mountainous area
 $f_1 = 0.5$

Urbanized area
 $f_2 = 0.9$

...

f_{14}



Rainfall

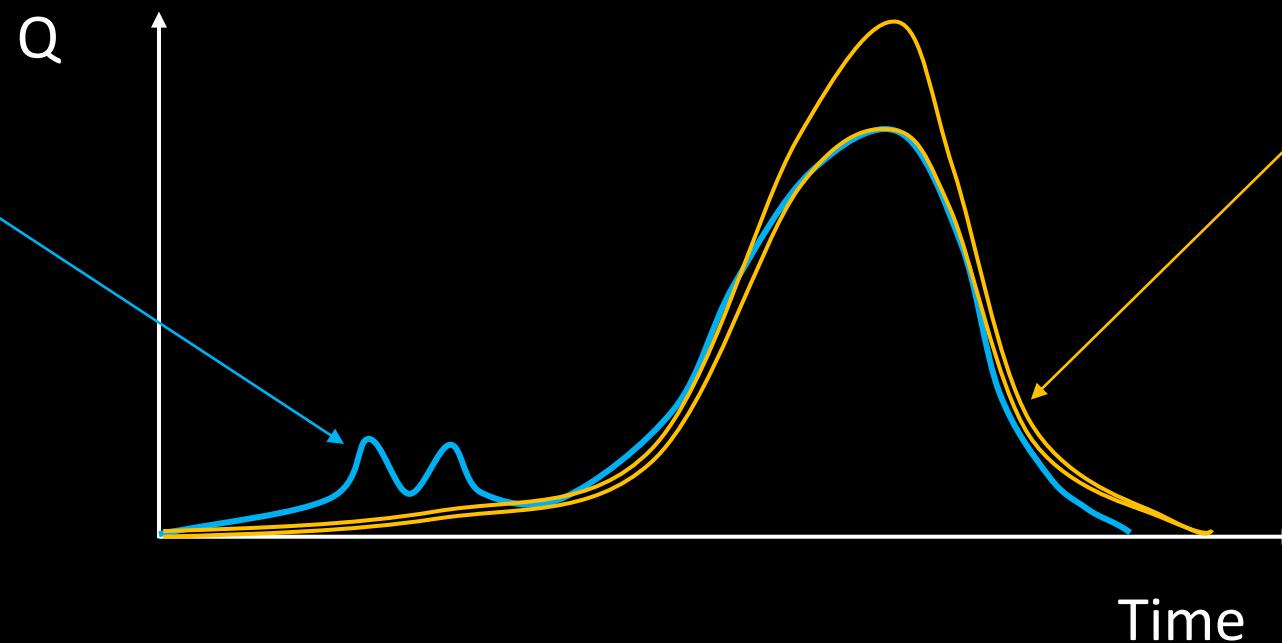
1K-DHM

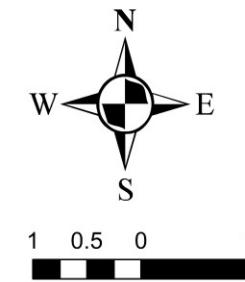
1: Nr, Ns, Dm, Da, Ka

2: Nr, Ns, Dm, Da, Ka

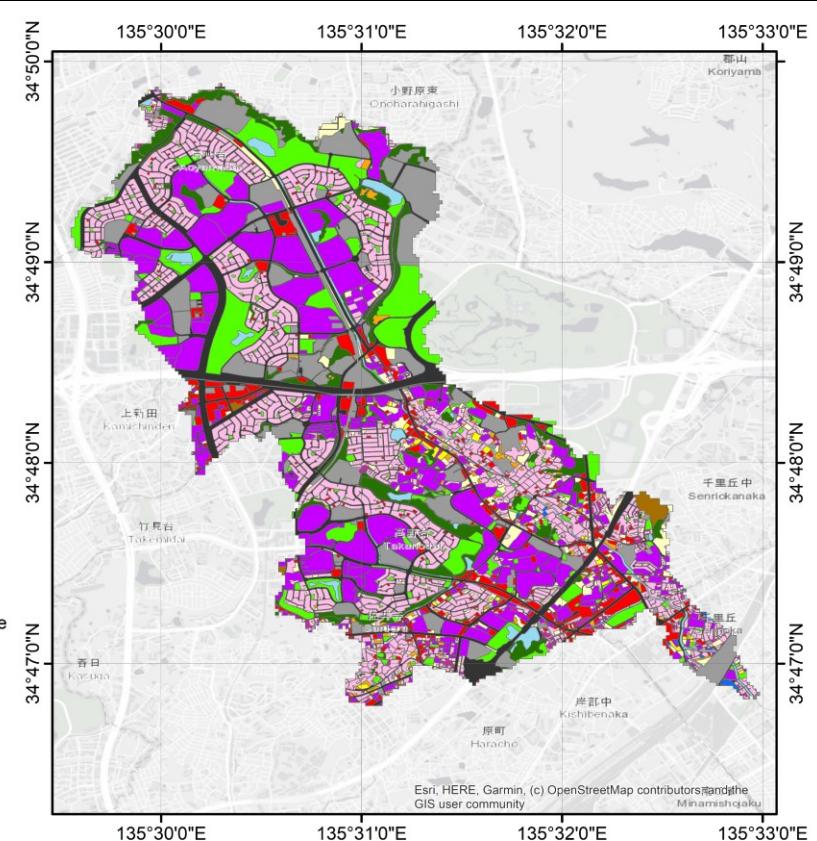
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14: Nr, Ns, Dm, Da, Ka

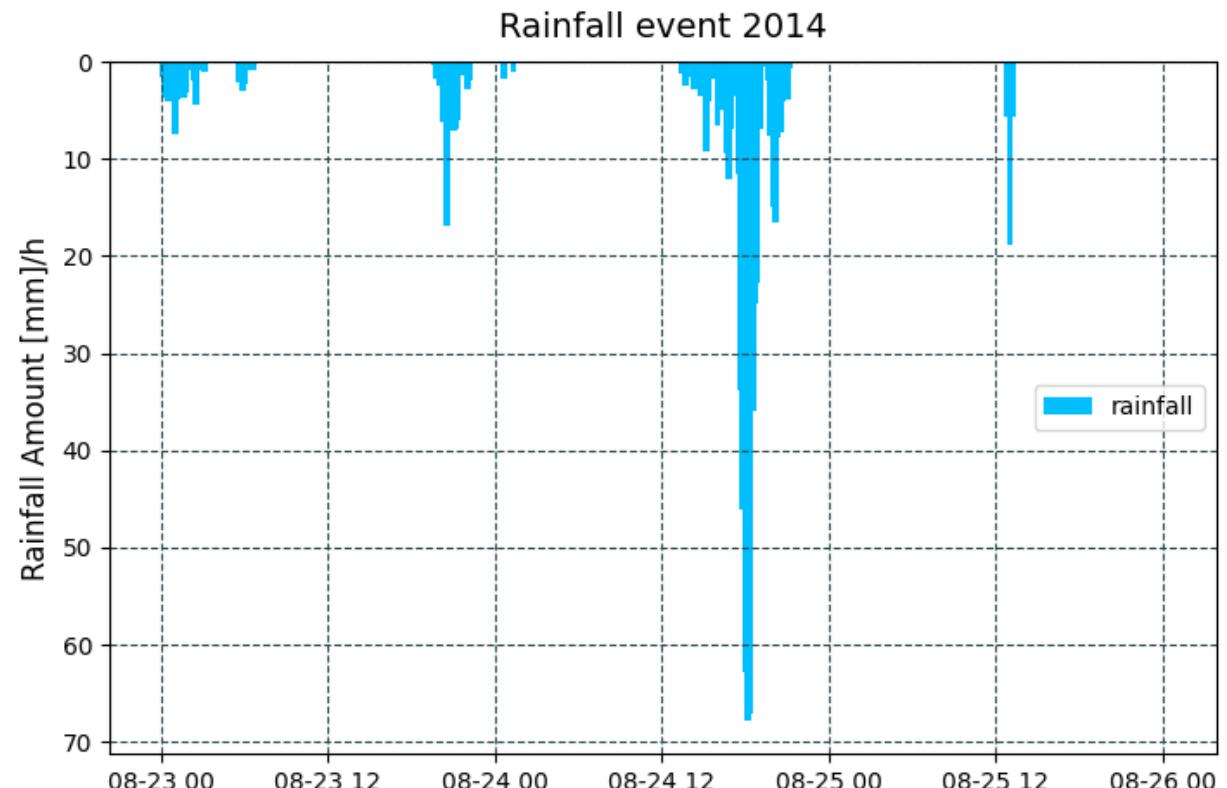




Land Use Type	
Mountainous Forest	
Paddy Field	
Other Cropland	
Open Area	
Under Construction	
General Low Rise Residence	
Middle-High Rise Residence	
High-Density Lower Residence	
Commercial Area	
Industrial Area	
Road	
Parks and Green Area	
Water Body	
Other Public Facilities	



Yamada river catchment

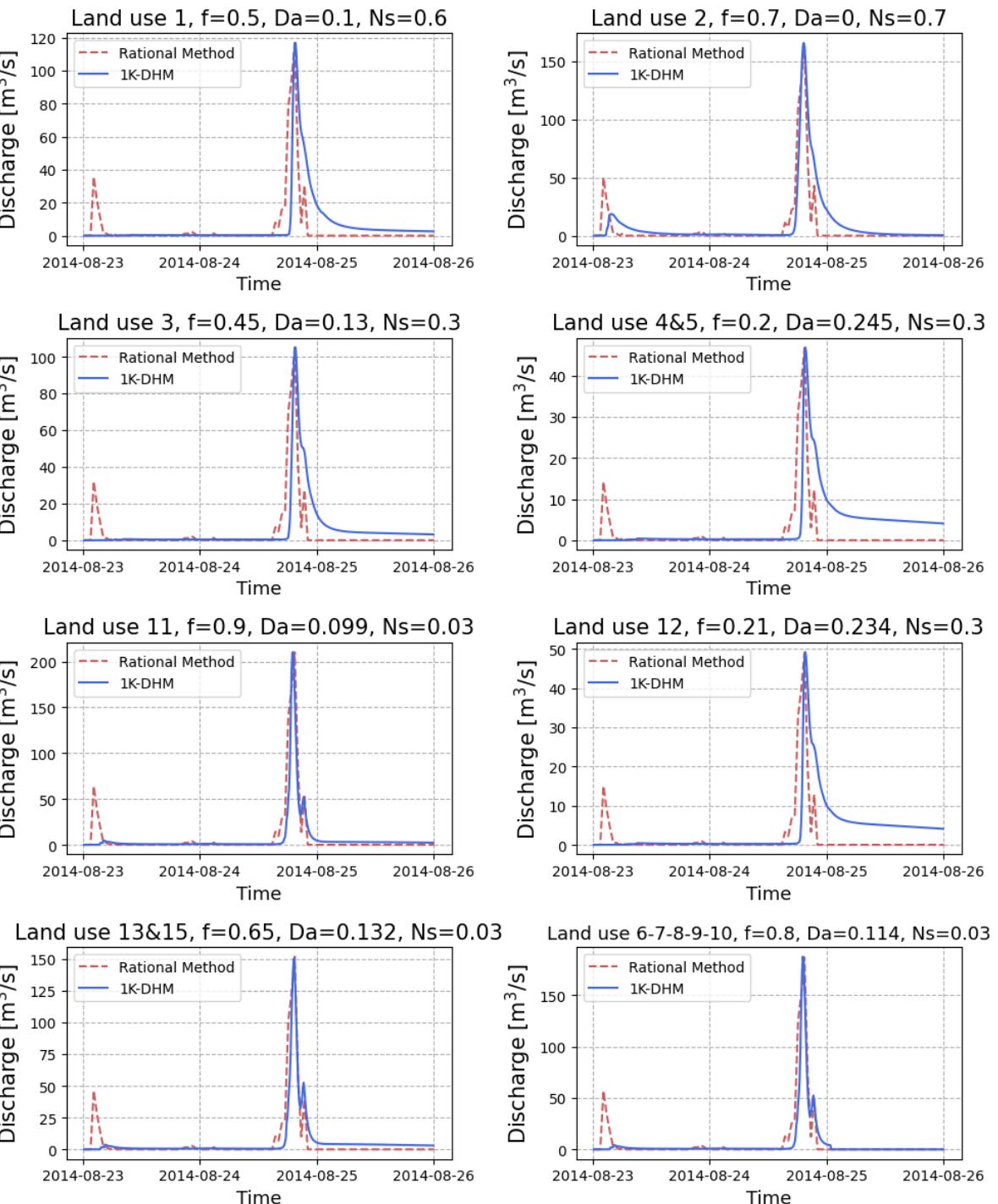


Rainfall event 2014

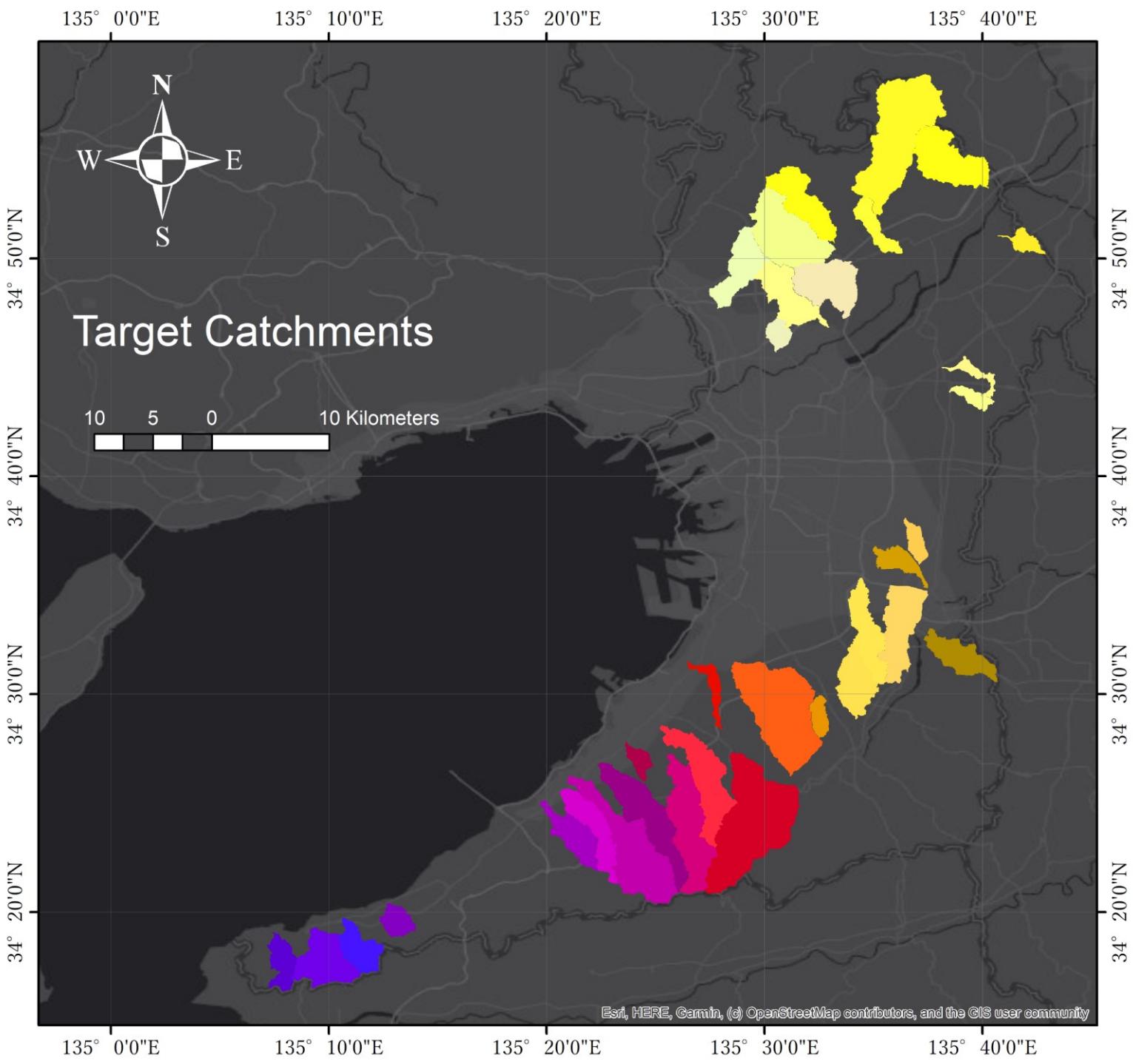
Land Use Type	Ns	Ka	Da
No.1	0.6	0.002	0.1
No.2	0.7	0.002	0
No.3	0.3	0.002	0.13
No.4 - No.5	0.3	0.002	0.245
No.6 – No.10	0.03	0.002	0.114
No.11	0.03	0.002	0.099
No.12	0.3	0.002	0.234
No.13	0.03	0.002	0.132
No.14	0.027	0	0

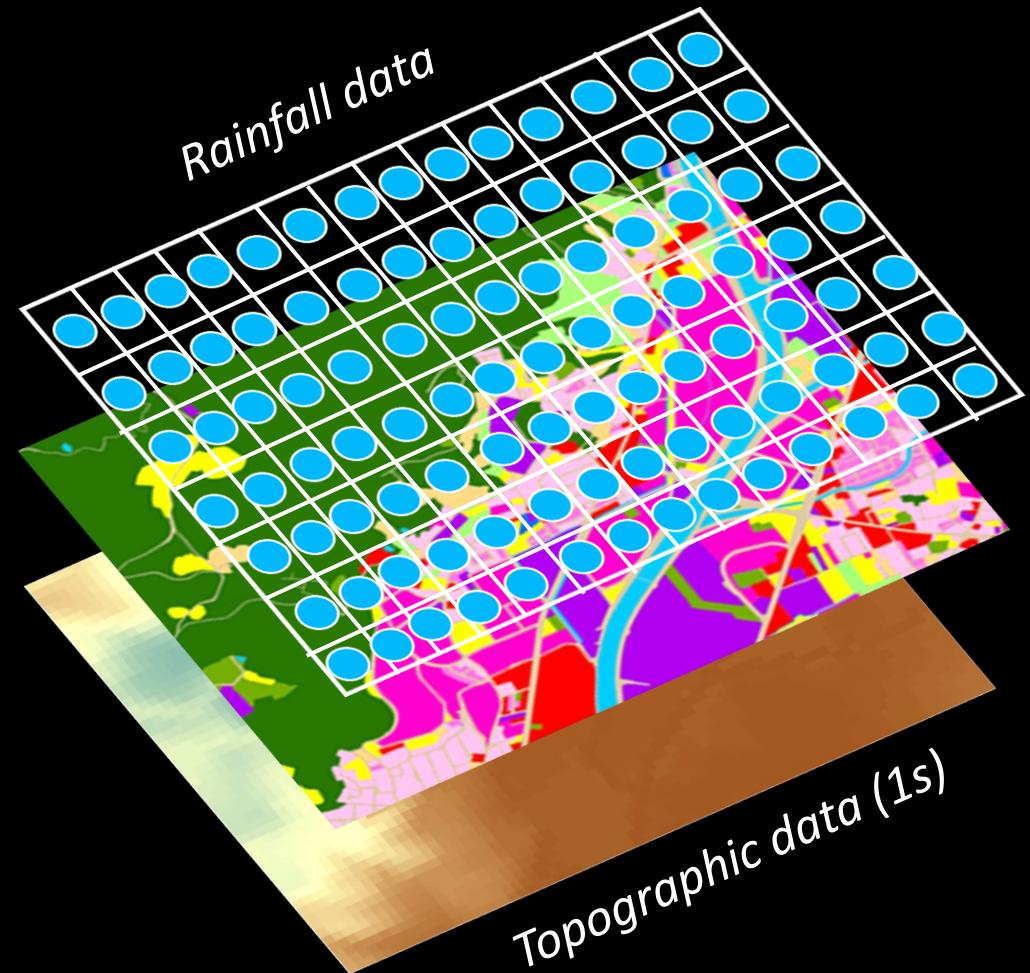
Dm = 0

Nr = 0.027



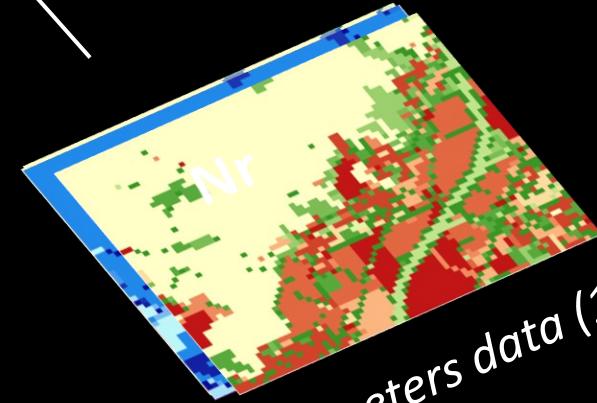
33 catchments
in Osaka Area



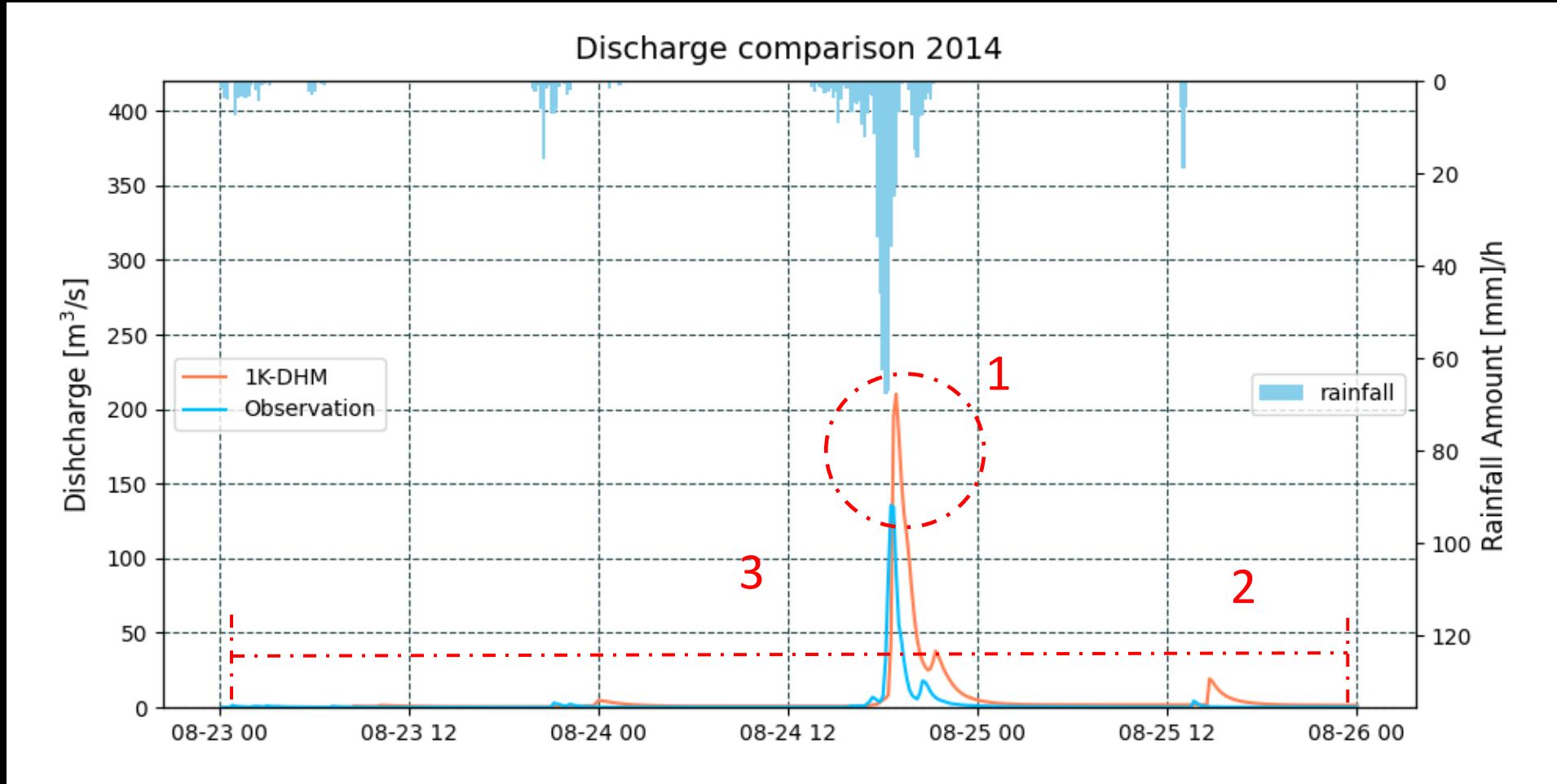


Rainfall data

Topographic data (1s)



Parameters data (1s)
 Nr, Da, Ka

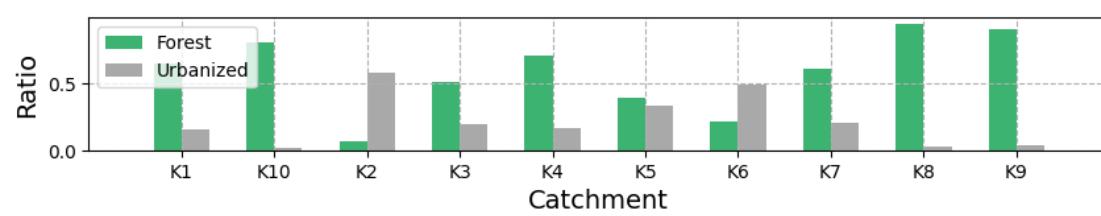
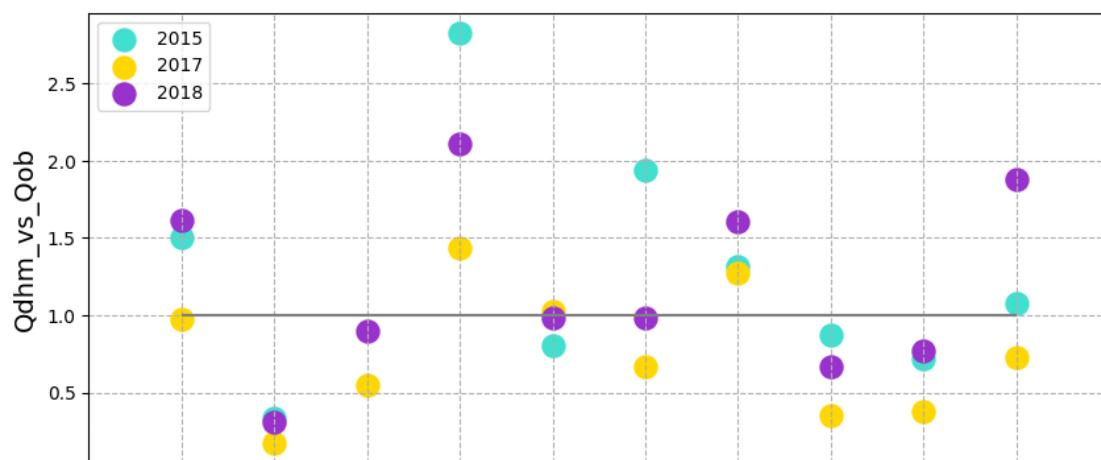
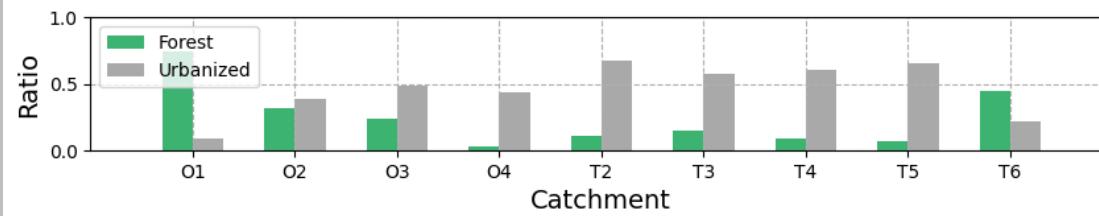
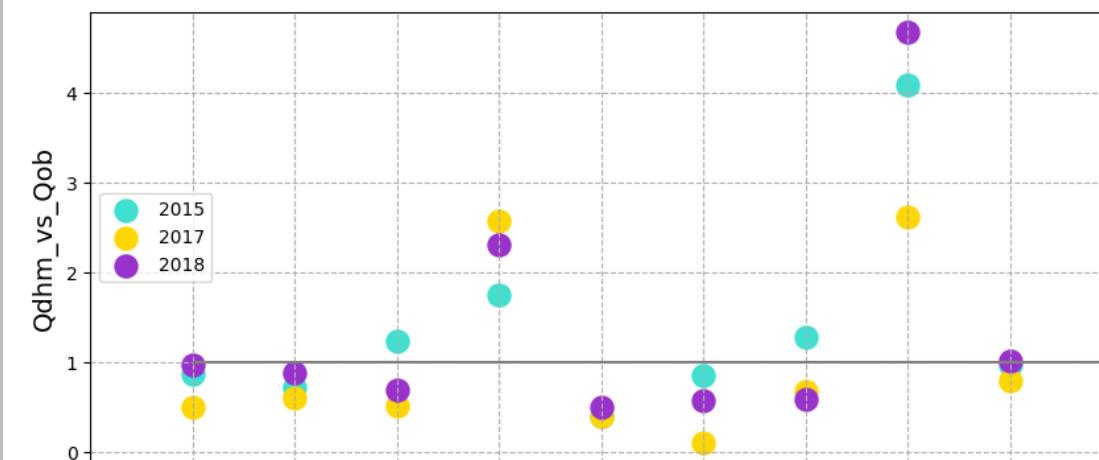
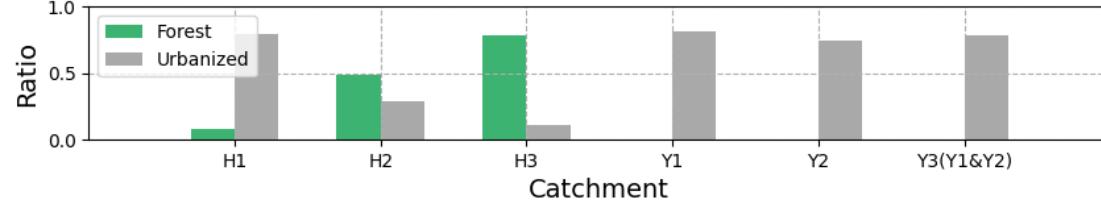
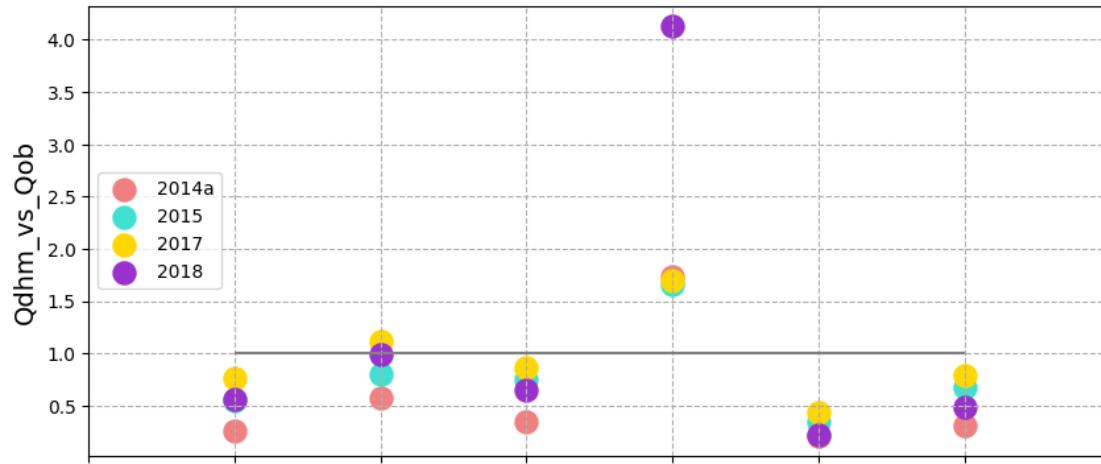
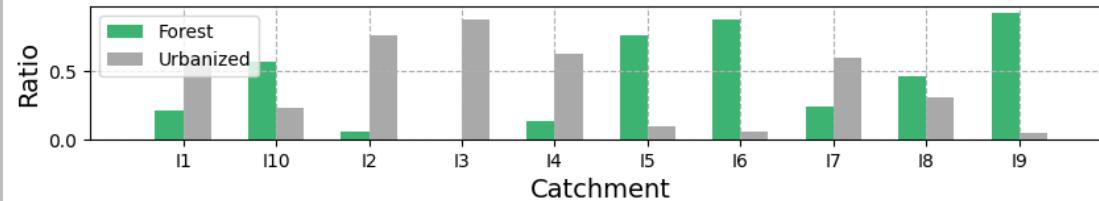
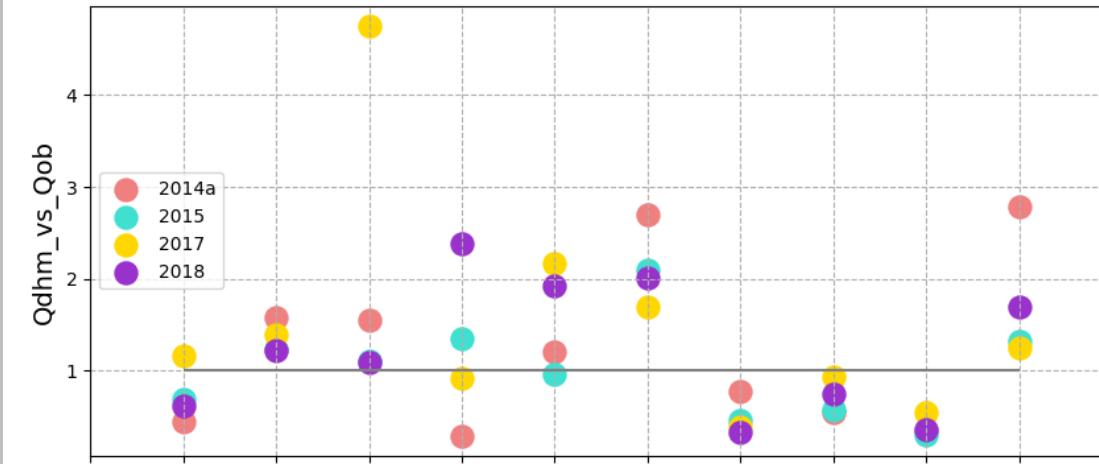


4 rainfall events

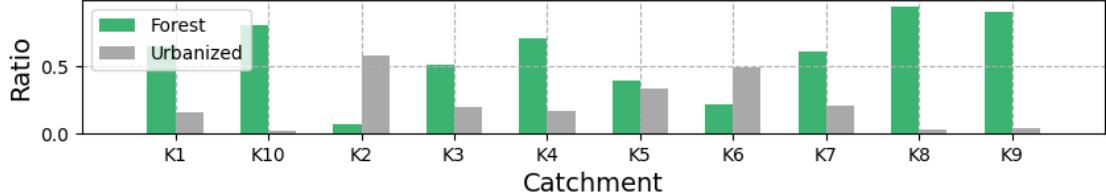
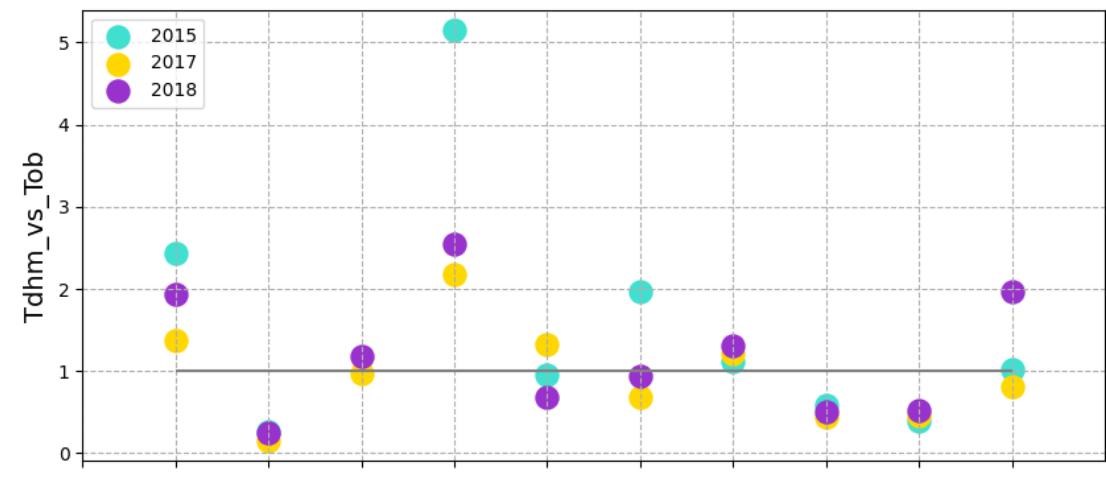
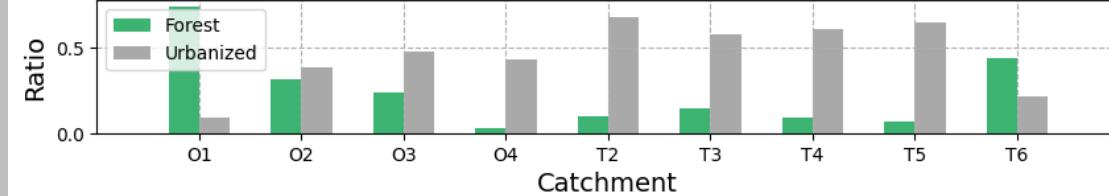
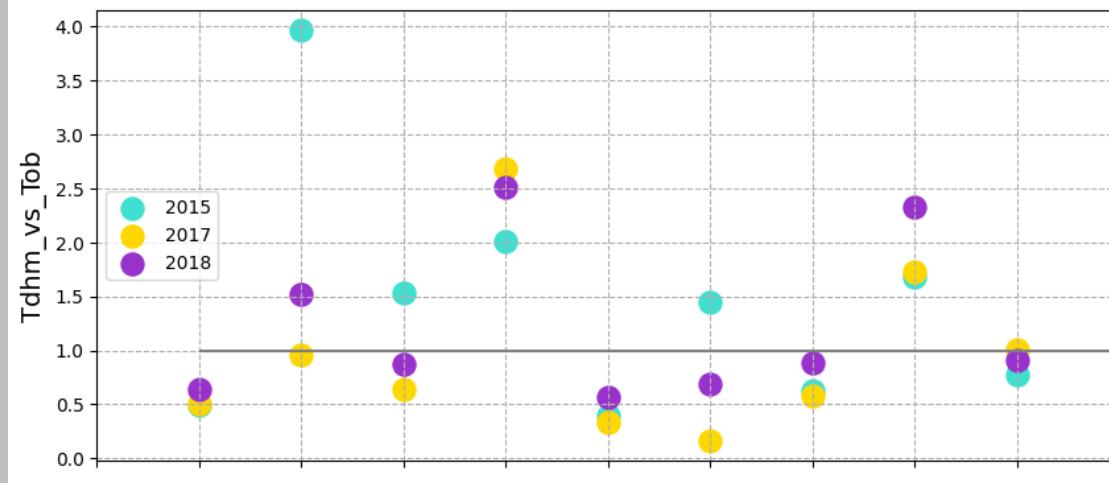
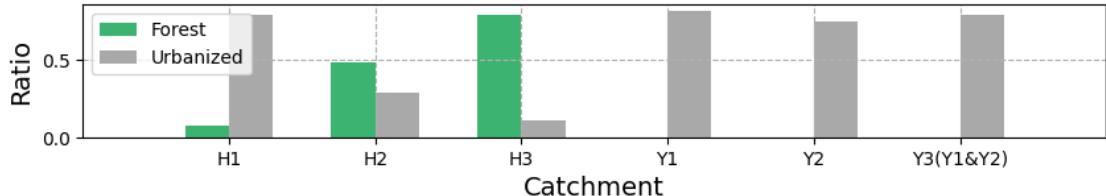
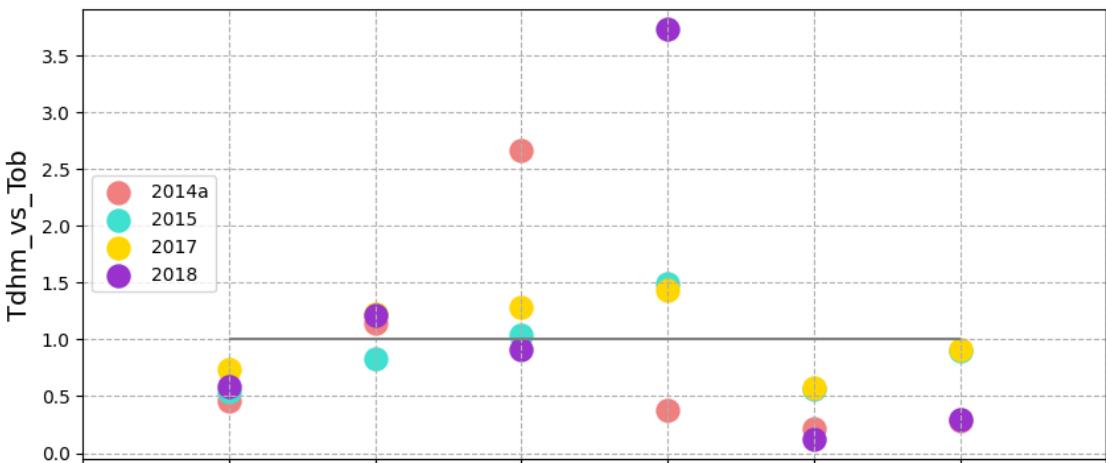
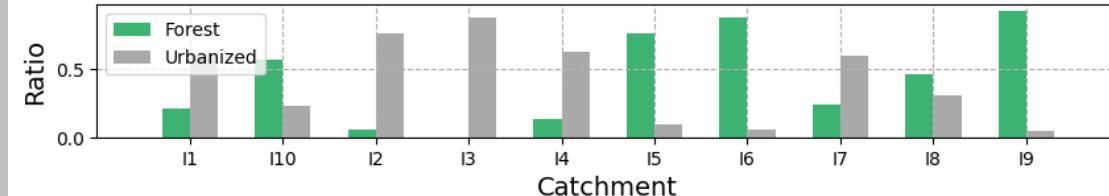
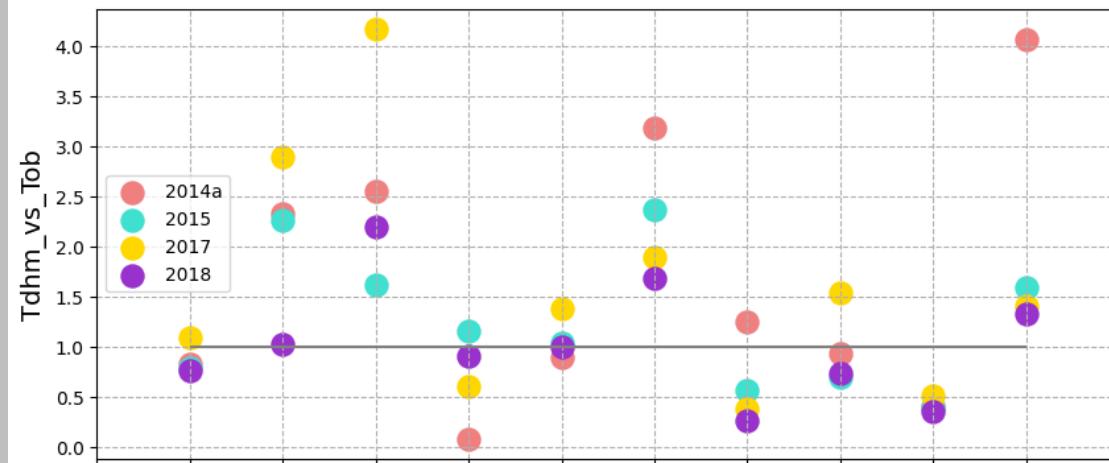
33 catchments

1. Peak discharge
2. Total discharge
3. NSE coefficient

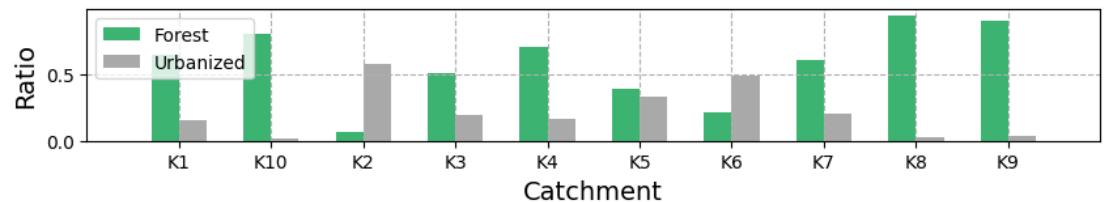
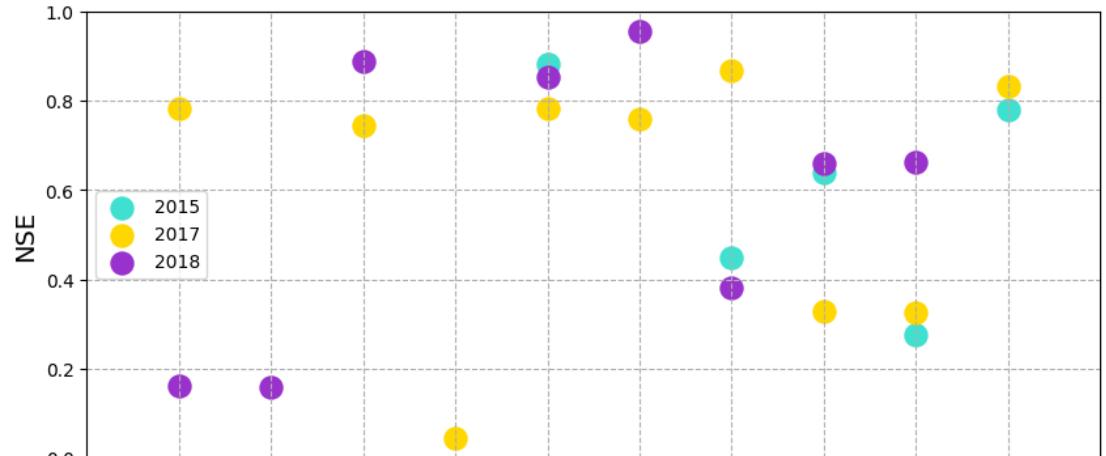
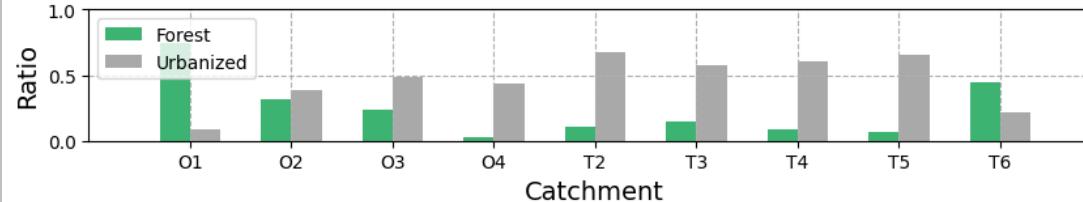
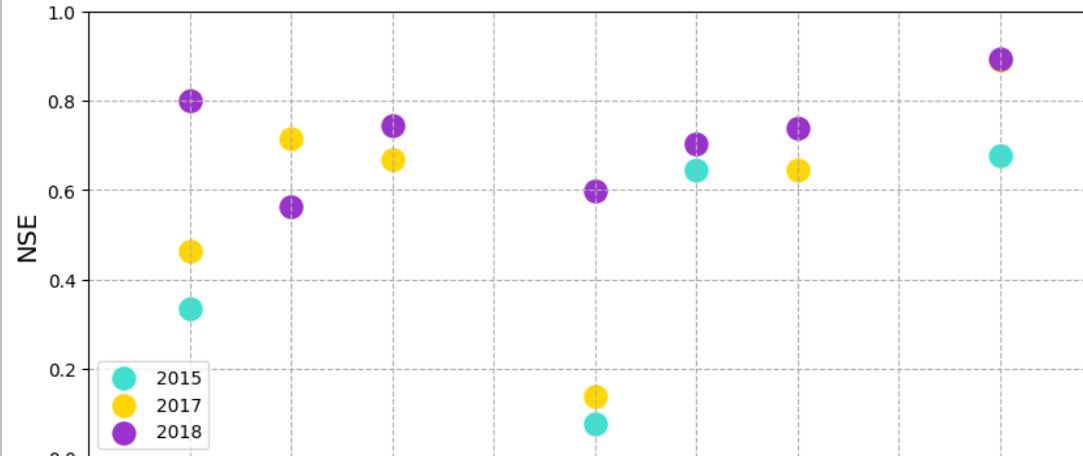
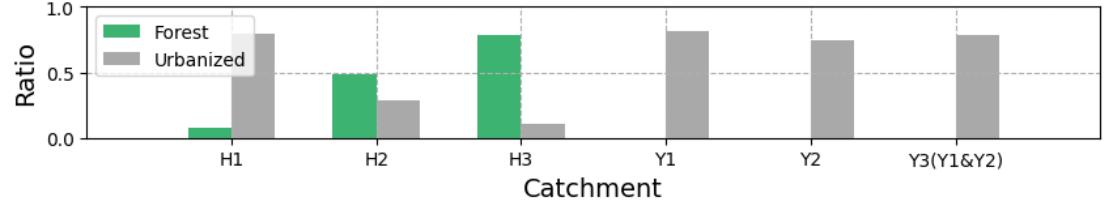
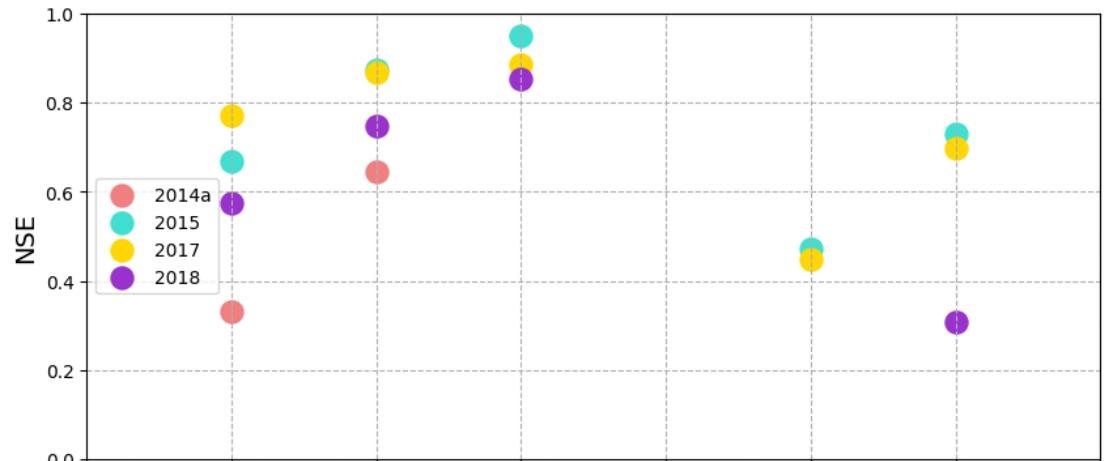
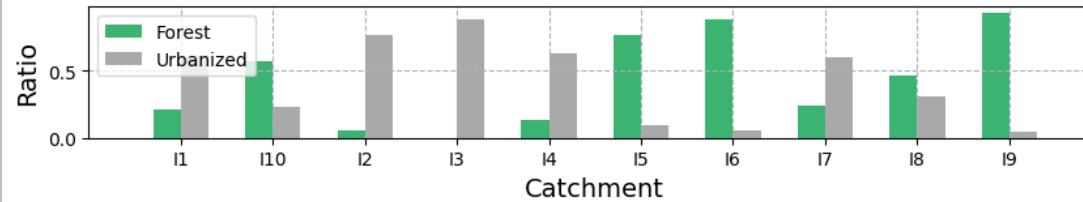
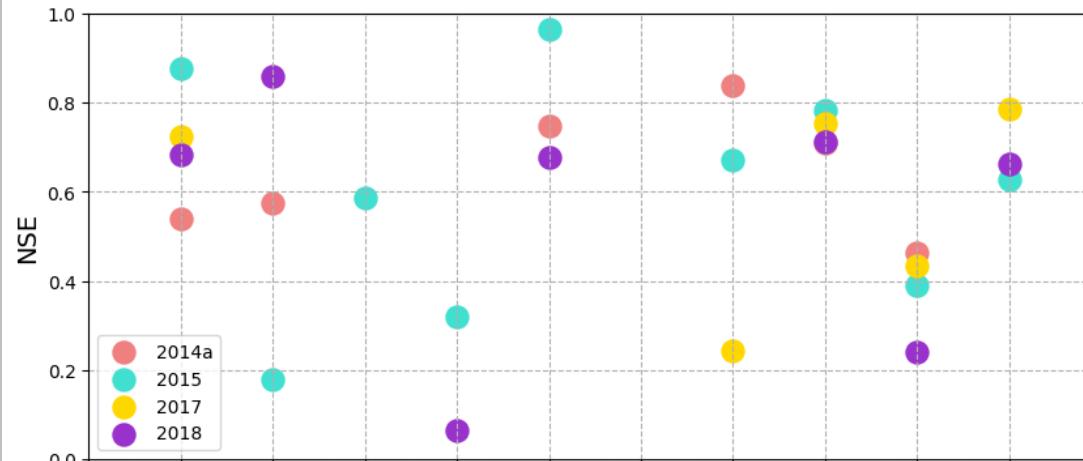
Peak discharge comparison



Total discharge comparison



NSE coefficient



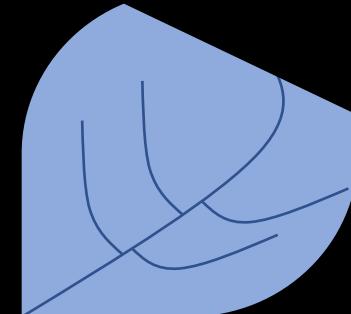
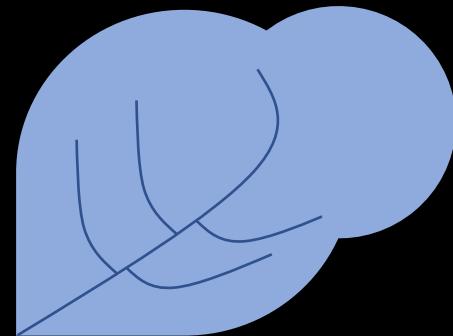
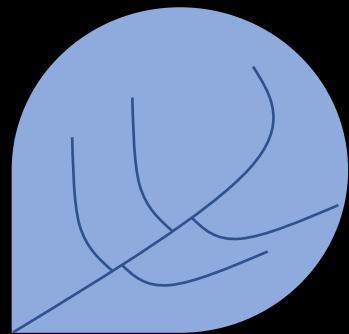
Possible problems

1. Observation data Water level + H-Q equation
- H-Q equation was completed in a sunny day
 - Given suitable water levels range  Rainfall events
 - H-Q equation used should be changing each year

Possible problems

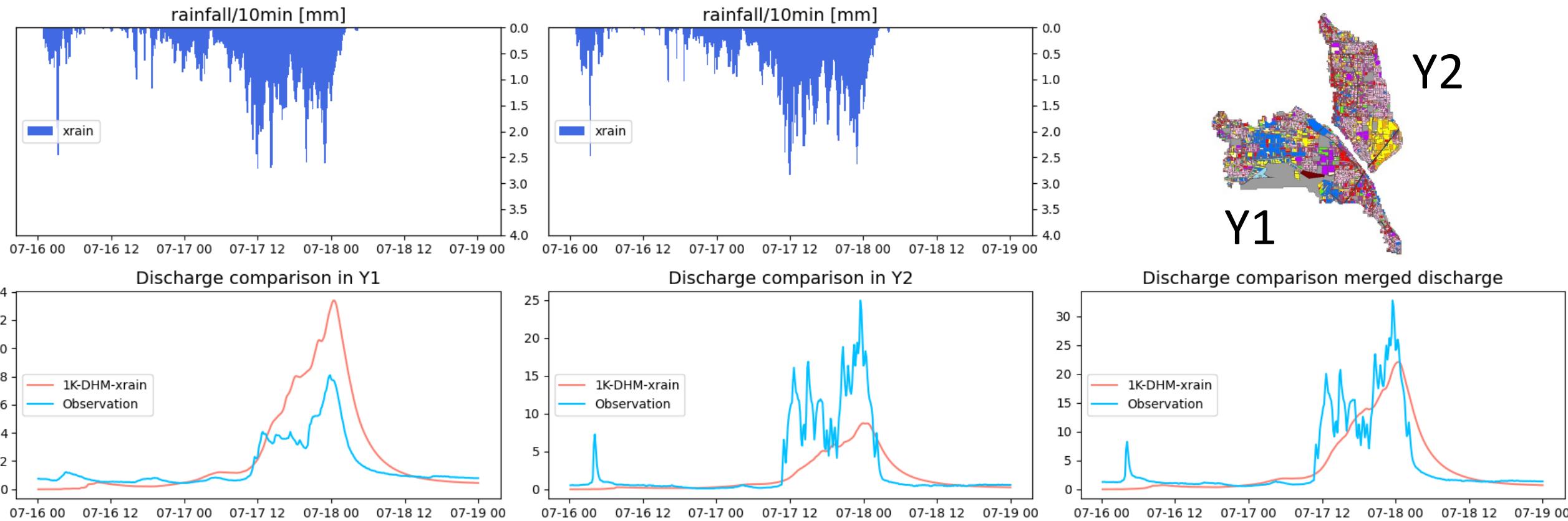
2. Topographic data

- The area we generated is not the real size of target catchment



Possible problems

3. Sewerage system



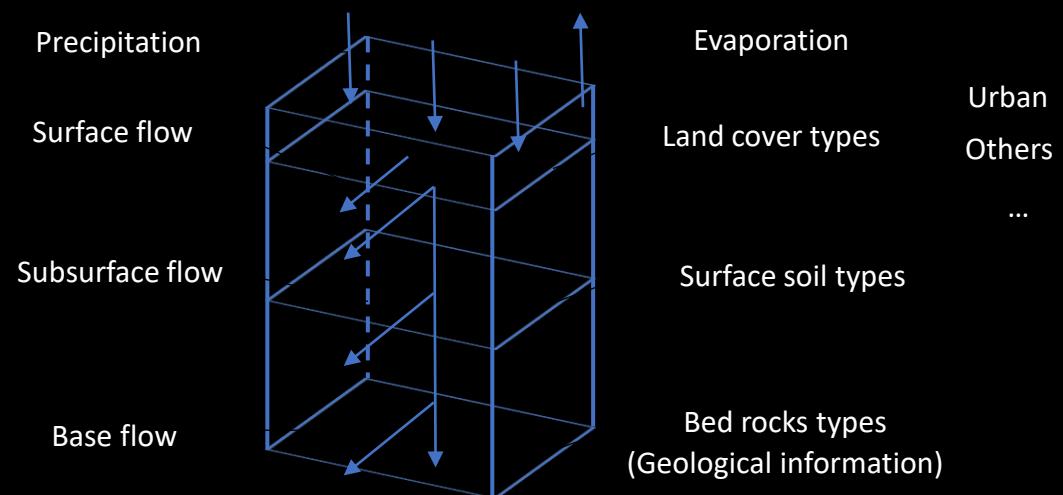
Possible problems

4. Model structure

- Limitations in the model structure

5. Land use information

- Vegetation types
- Top soil types
- Geological information (Bed rock)





Thank you for your attention

2022/01/27

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