FUKUOKA *lab.*
RIVER ENGINEERING
— CHUO UNIVERSITY —

# Water Balance Map of the Toyohira River Basin during Heavy Rainfall and Its Application to Flood Control


○Shoji FUKUOKA
Yutaro ISHII
Daisaku SAITO

## Objective of the present study

In response to the increasing frequency and severity of floods, basin flood control measures are being implemented to reduce flood damage in the entire basin, including the main river and its tributaries.

1. A new model of basin flood control is developed for the Toyohira River basin in the Ishikari River system,

2. A basin water balance map is created as follows: the upstream mountainous watershed is divided into subwatersheds, and a tank model is used for each subwatershed to obtain runoff, storage, and infiltration volumes for the entire watershed.

3. Based on these analyses, the water balance distribution for the entire watershed is obtained, showing that the watershed water balance is an important tool for studying watershed flood control.

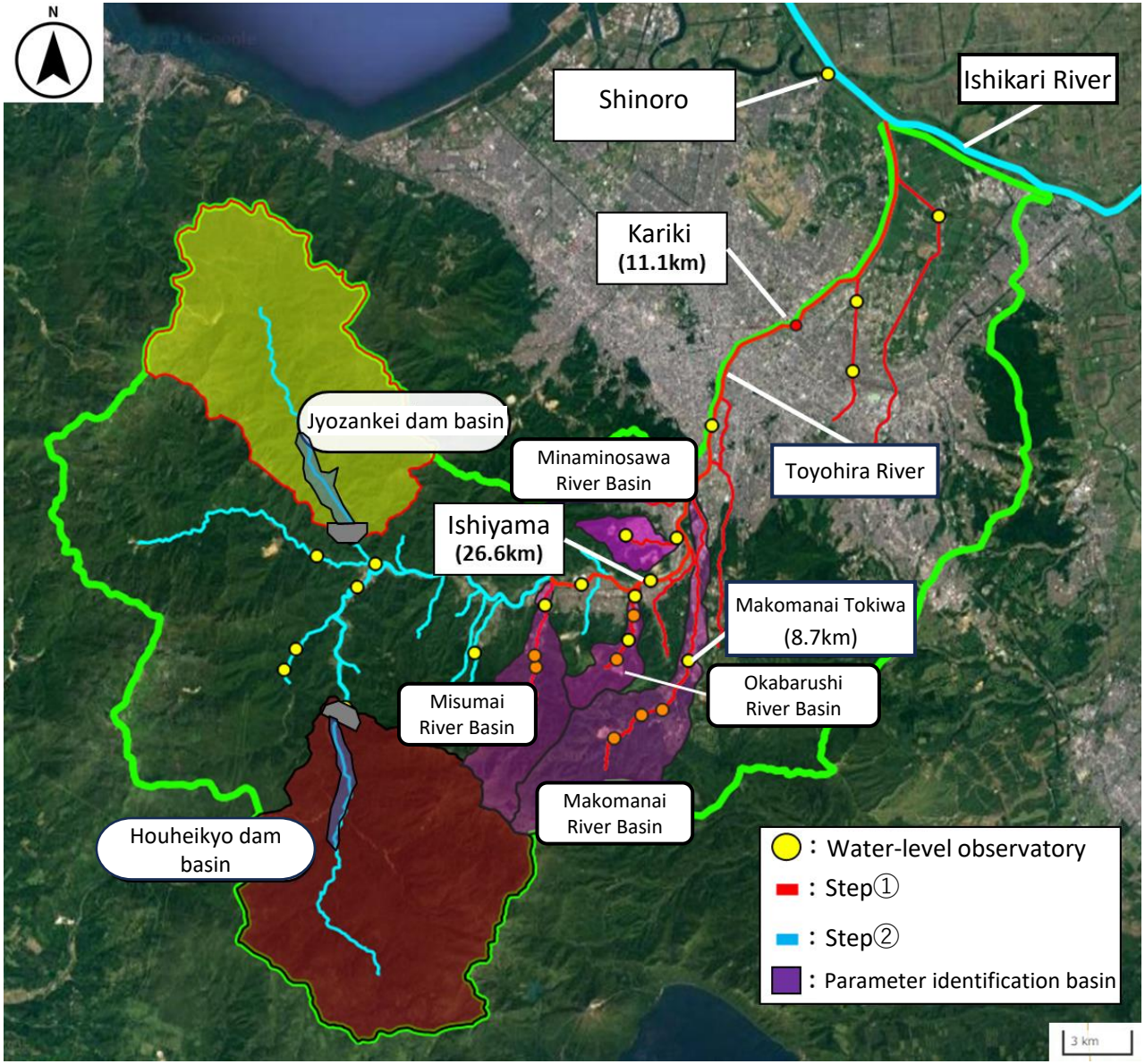



Figure 1　Toyohira River Basin

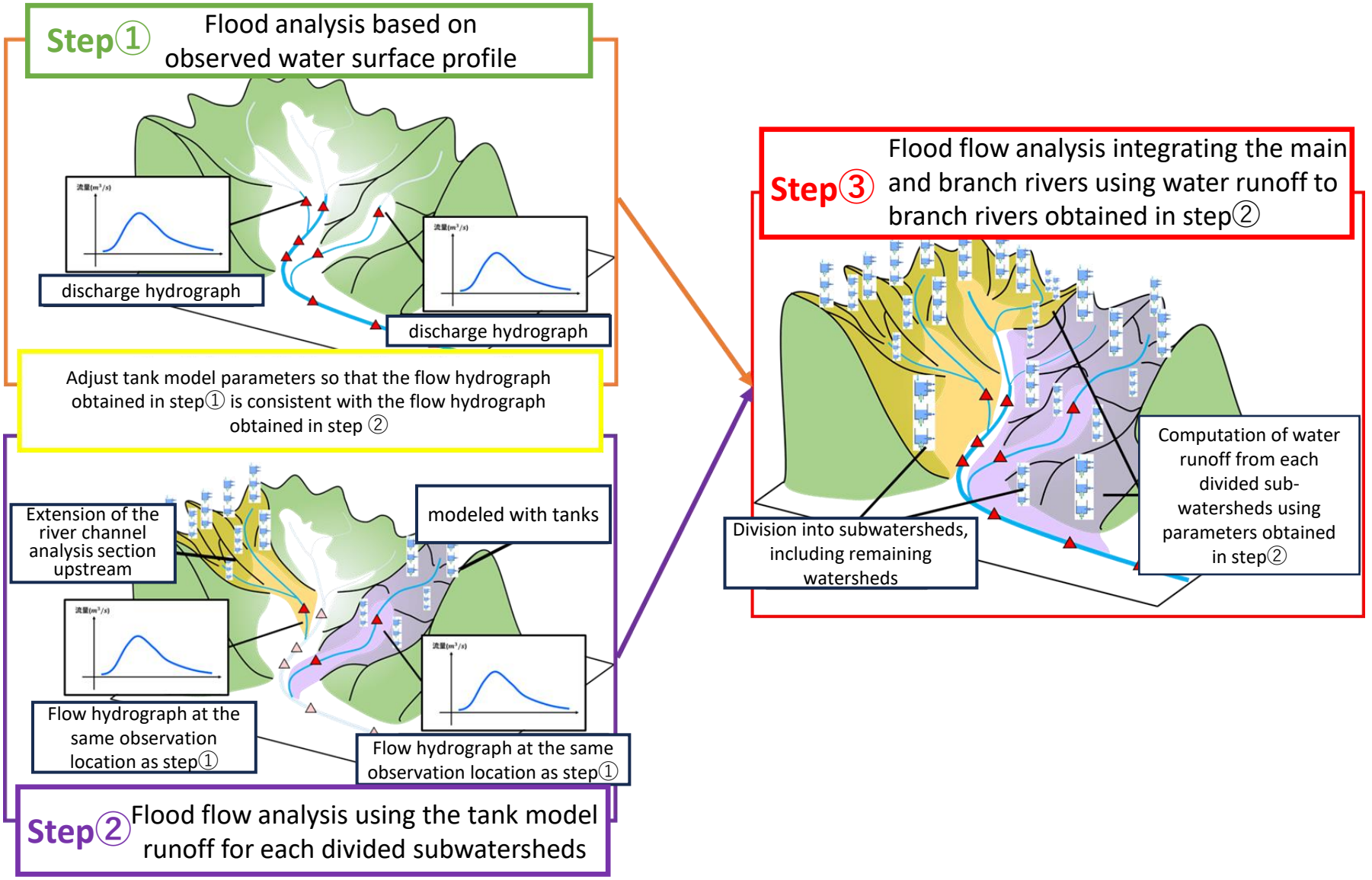



Figure 2　Analysis flowchart

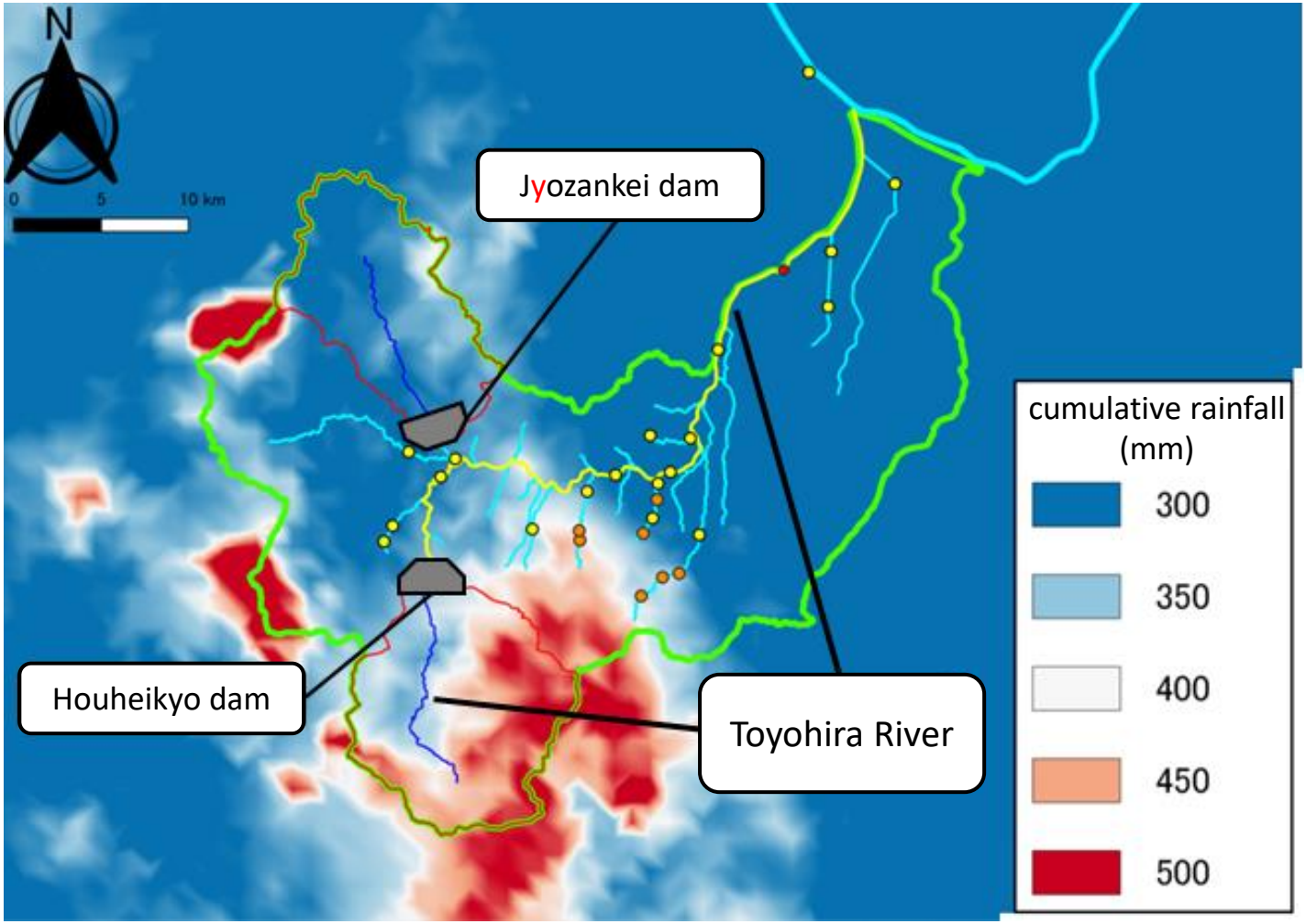



Figure 3　Cumulative rainfall distribution at the time of heavy rainfall in September 2011

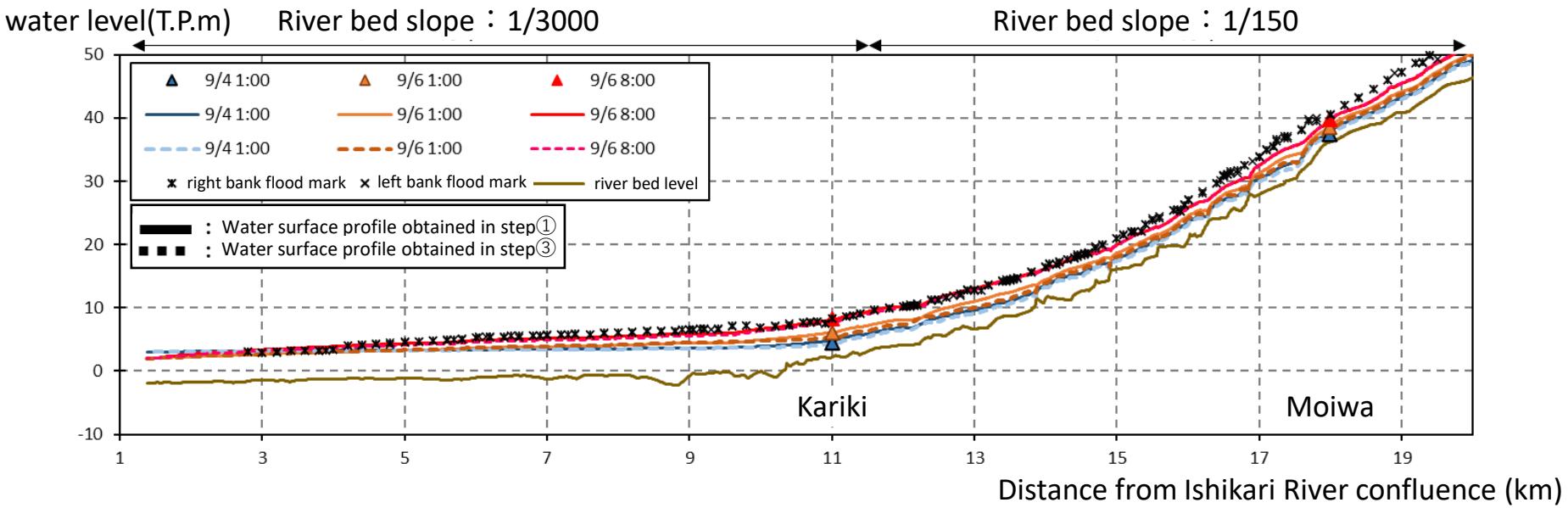



Figure 4　Temporal variation of flood water surface profile

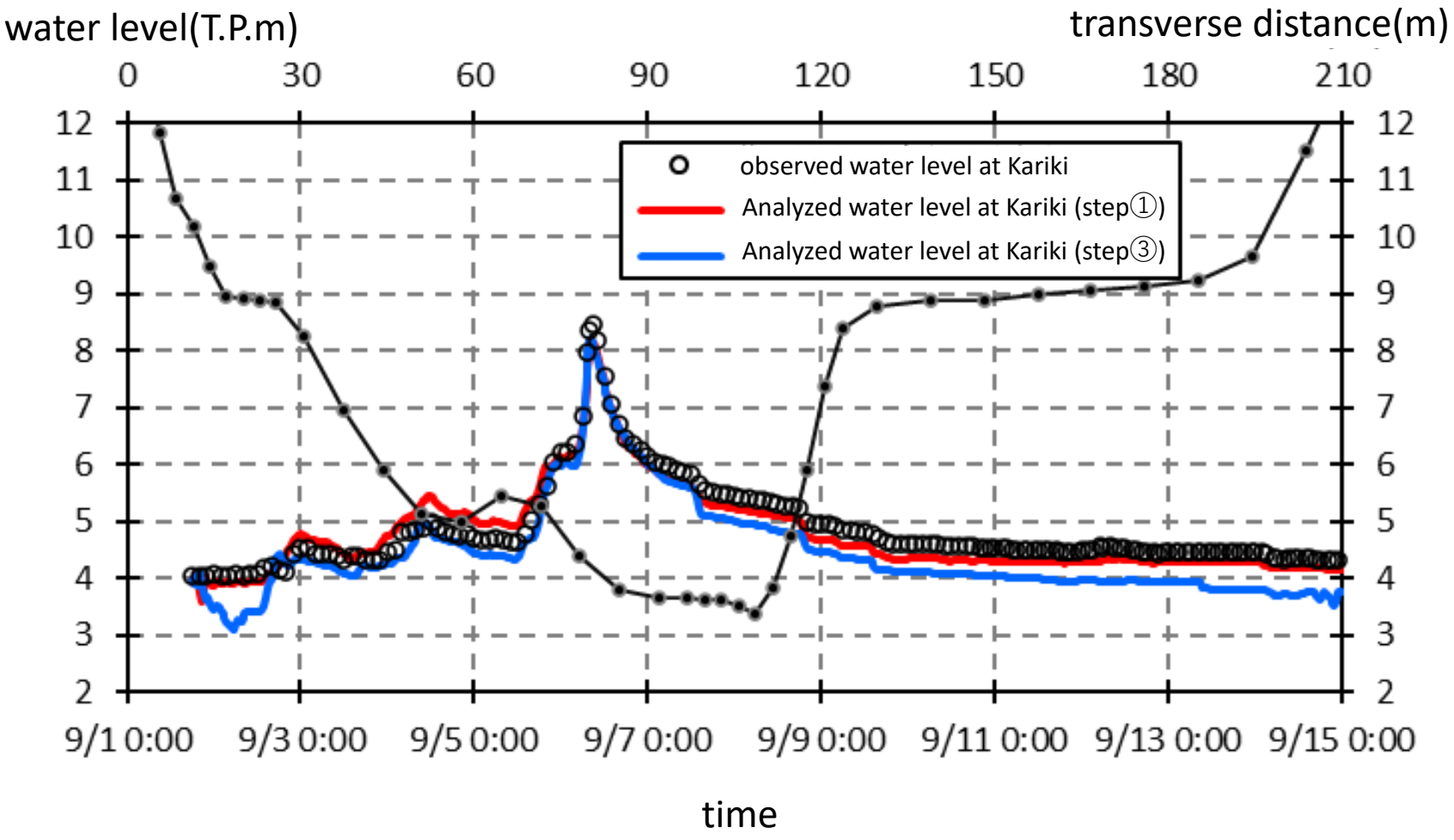



Figure 5　Water level hydrograph at Kariki station(11.1 km)

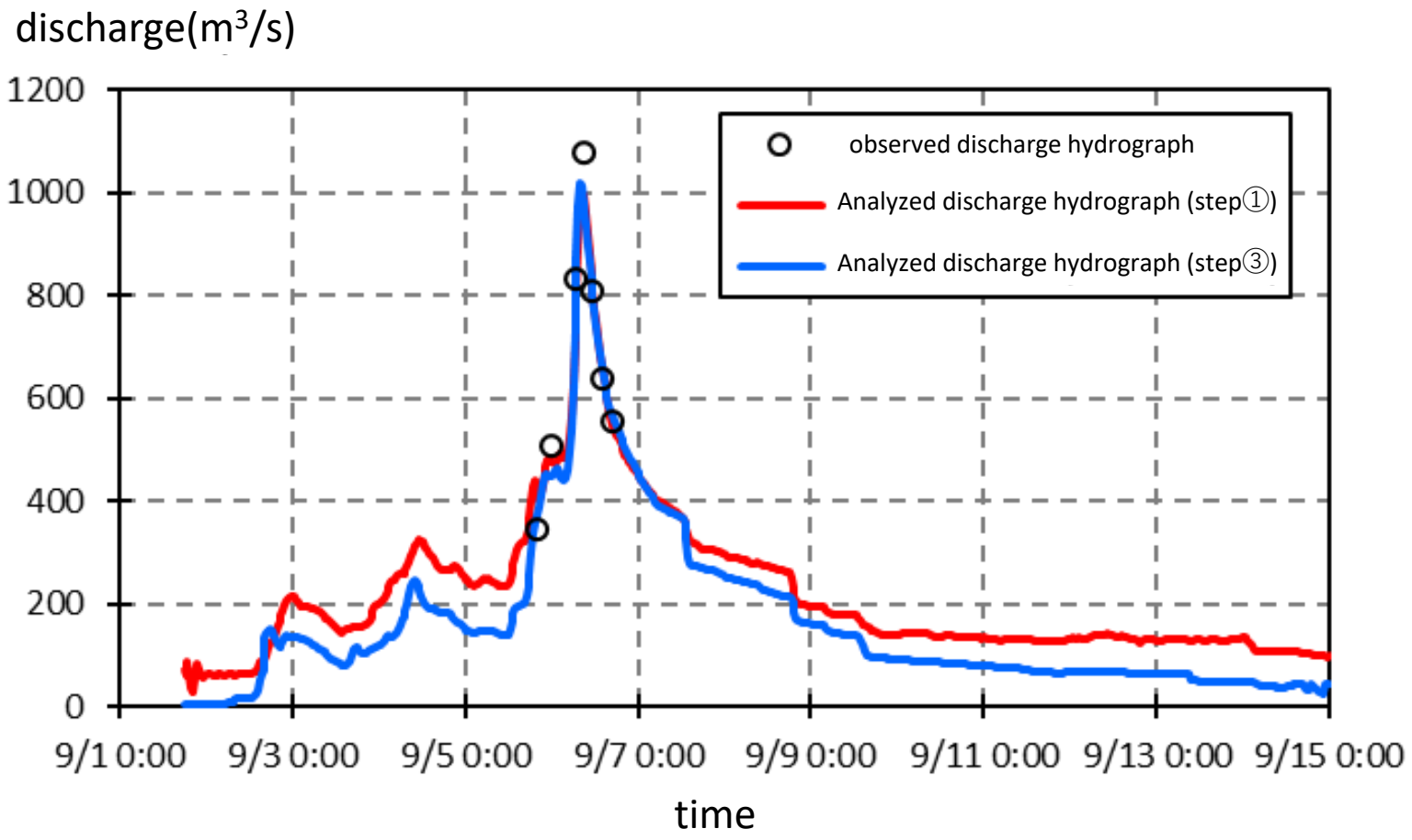



Figure 6　Discharge hydrograph at Kariki station(11.1 km)

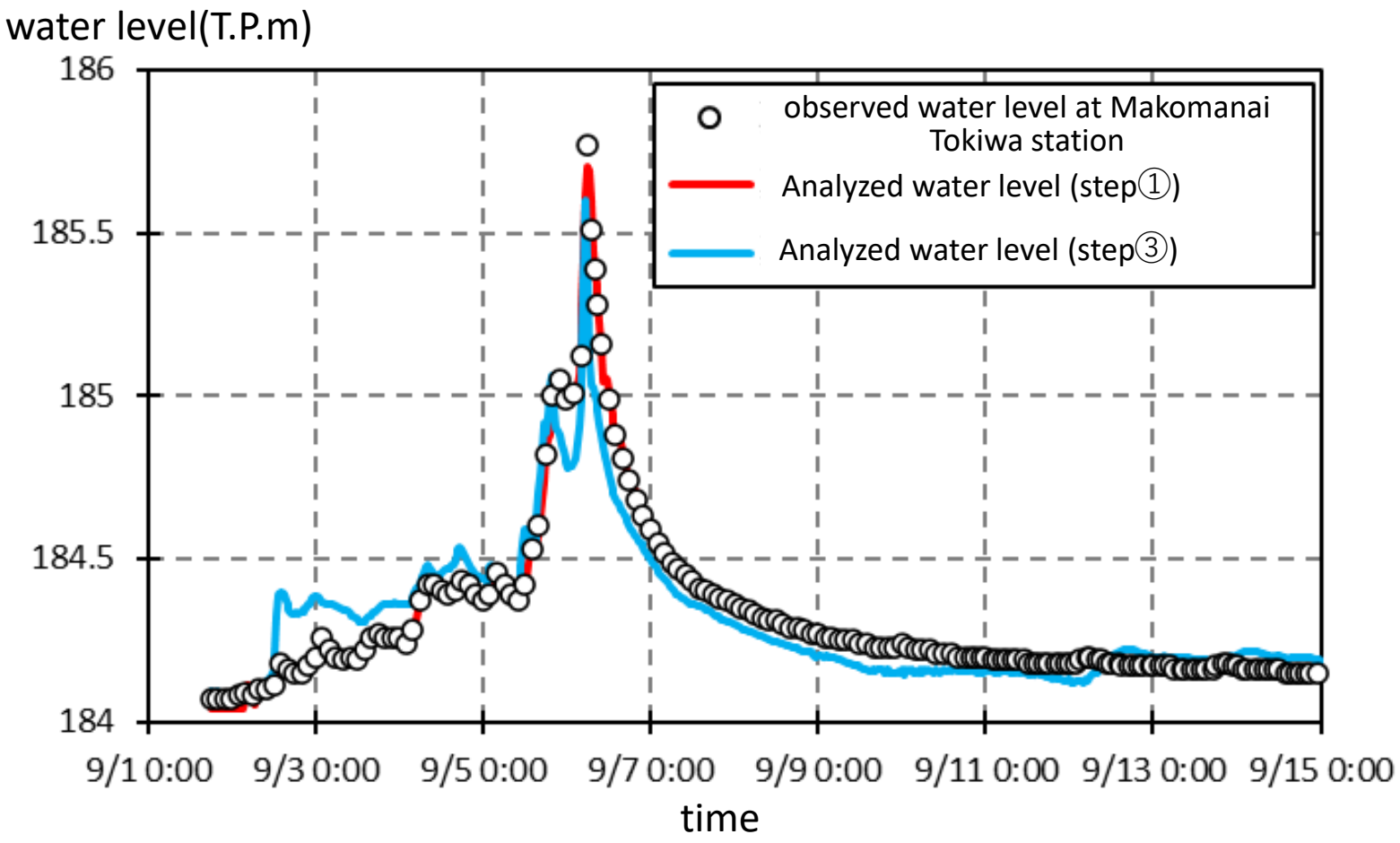



Figure 7　Water level hydrograph at Makomanai Tokiwa station(8.7 km) of the Makomanai River

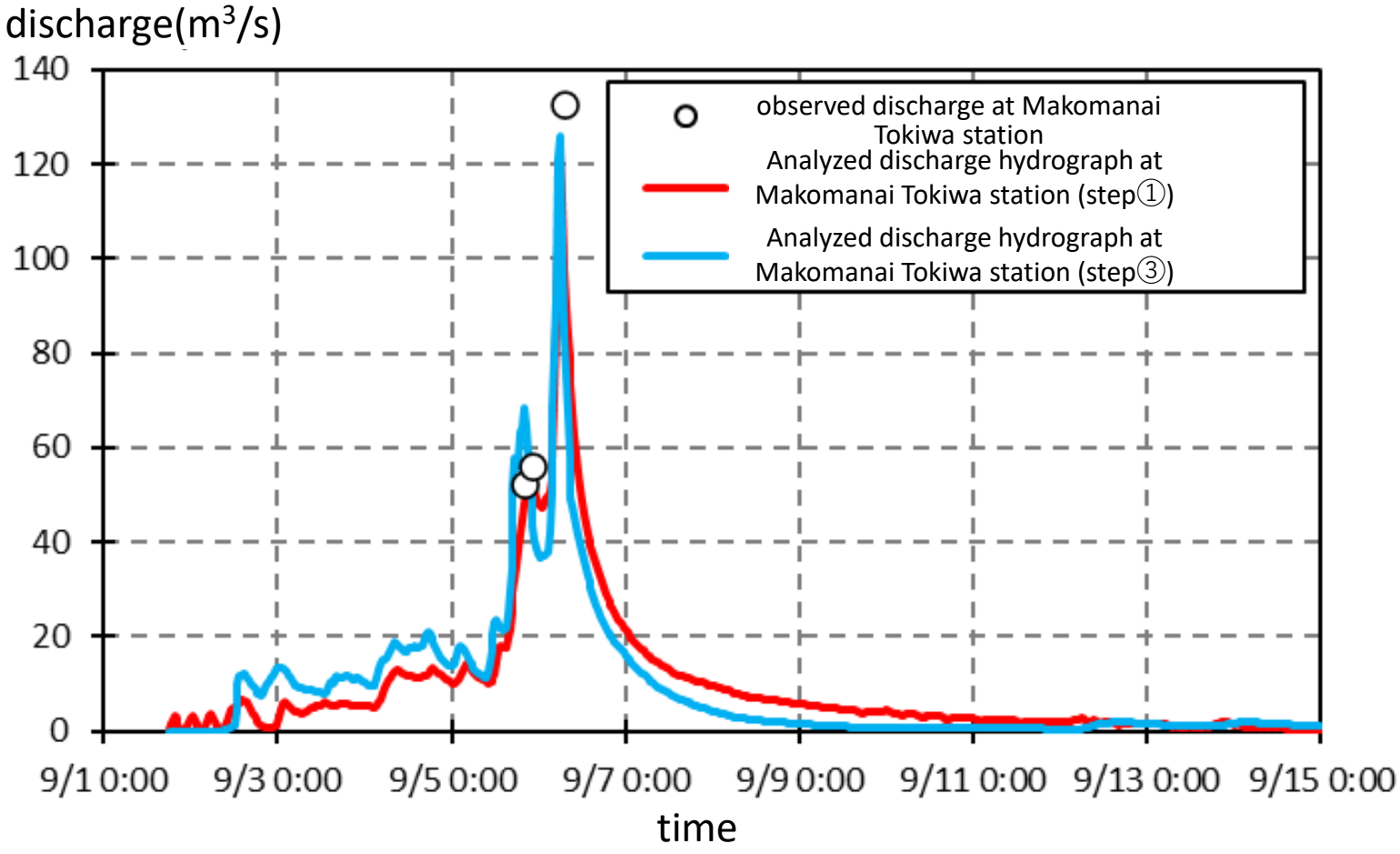
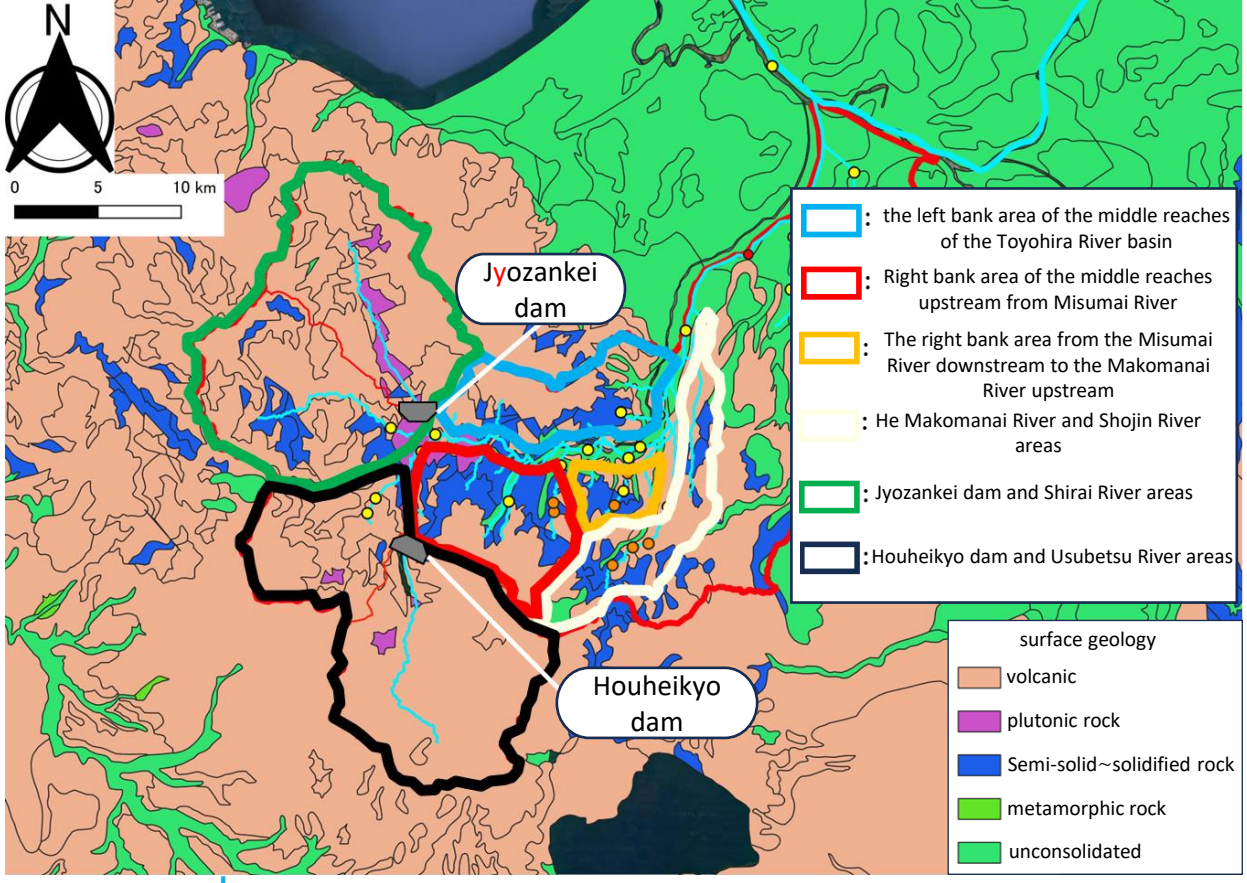
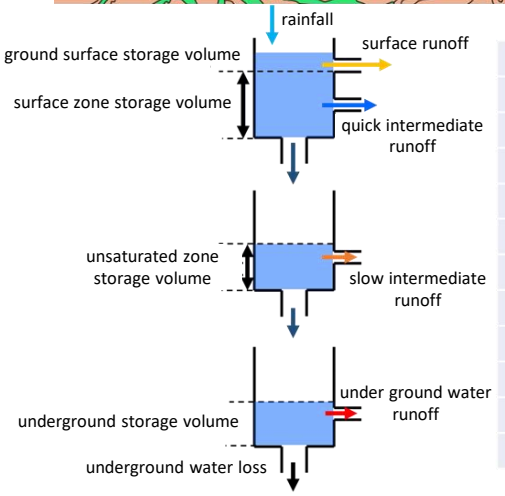



Figure 8　Discharge hydrograph at Makomanai Tokiwa station(8.7 km) of the Makomanai River




| | Miusmai | Okaparushi | Makomanai | Minaminosawa | Jyozankei | Houheikyo |
|---|---|---|---|---|---|---|
| α1 | 0.8 | 0.15 | 0.8 | 0.2 | 0.2 | 0.4 |
| α2 | 0.09 | 0.13 | 0.15 | 0.12 | 0.12 | 0.1 |
| α3 | 0.05 | 0.08 | 0.08 | 0.08 | 0.05 | 0.08 |
| α4 | 0.01 | 0.03 | 0.03 | 0.03 | 0.01 | 0.06 |
| Y1 | 36 | 40 | 35 | 24 | 32 | 35 |
| Y2 | 8 | 8 | 9 | 10 | 15 | 9 |
| Y3 | 15 | 10 | 5 | 10 | 15 | 5 |
| Y4 | 15 | 5 | 5 | 0 | 8 | 5 |
| β1 | 0.26 | 0.2 | 0.12 | 0.2 | 0.2 | 0.12 |
| β2 | 0.08 | 0.02 | 0.04 | 0.04 | 0.06 | 0.04 |
| β3 | 0.005 | 0.02 | 0.005 | 0.005 | 0.01 | 0.005 |

Figure 9 Geological map of Toyohira River basin and the tank model parameters in each watershed

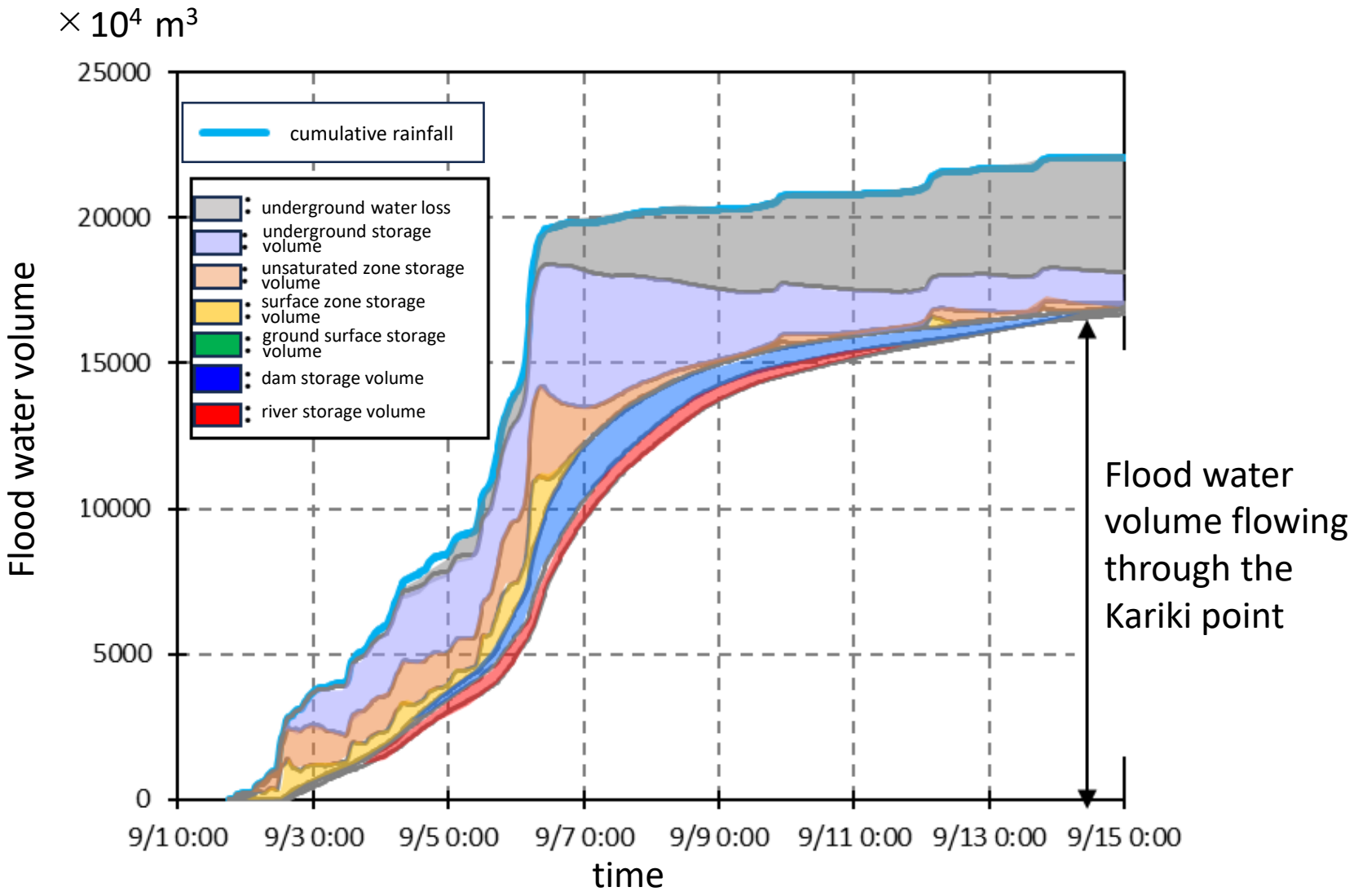



Figure 10 Basin water balance distribution map focusing on storage volume upstream from the Kariki point

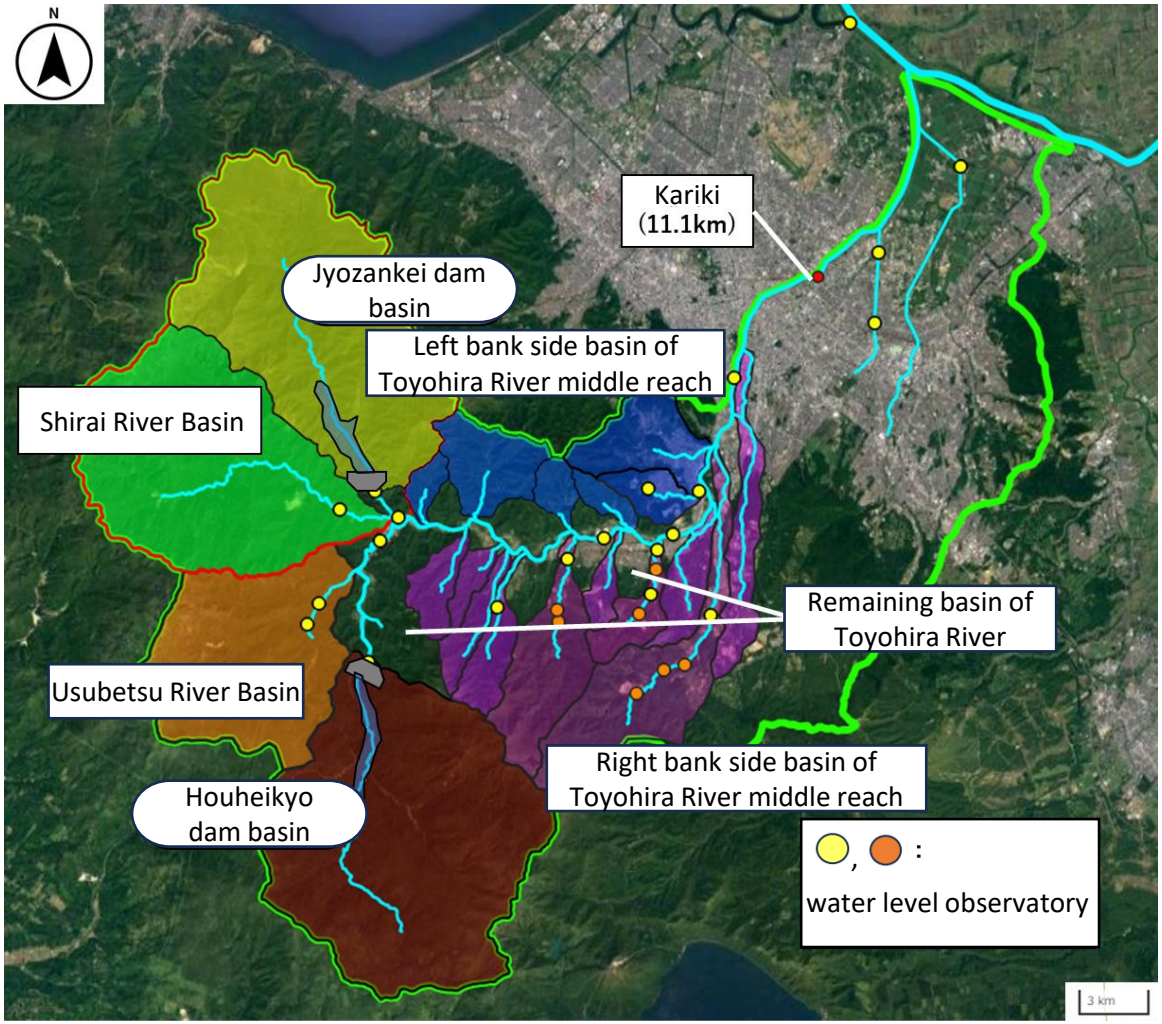



Figure 11 Toyohira River basin classification upstream from the Kariki point

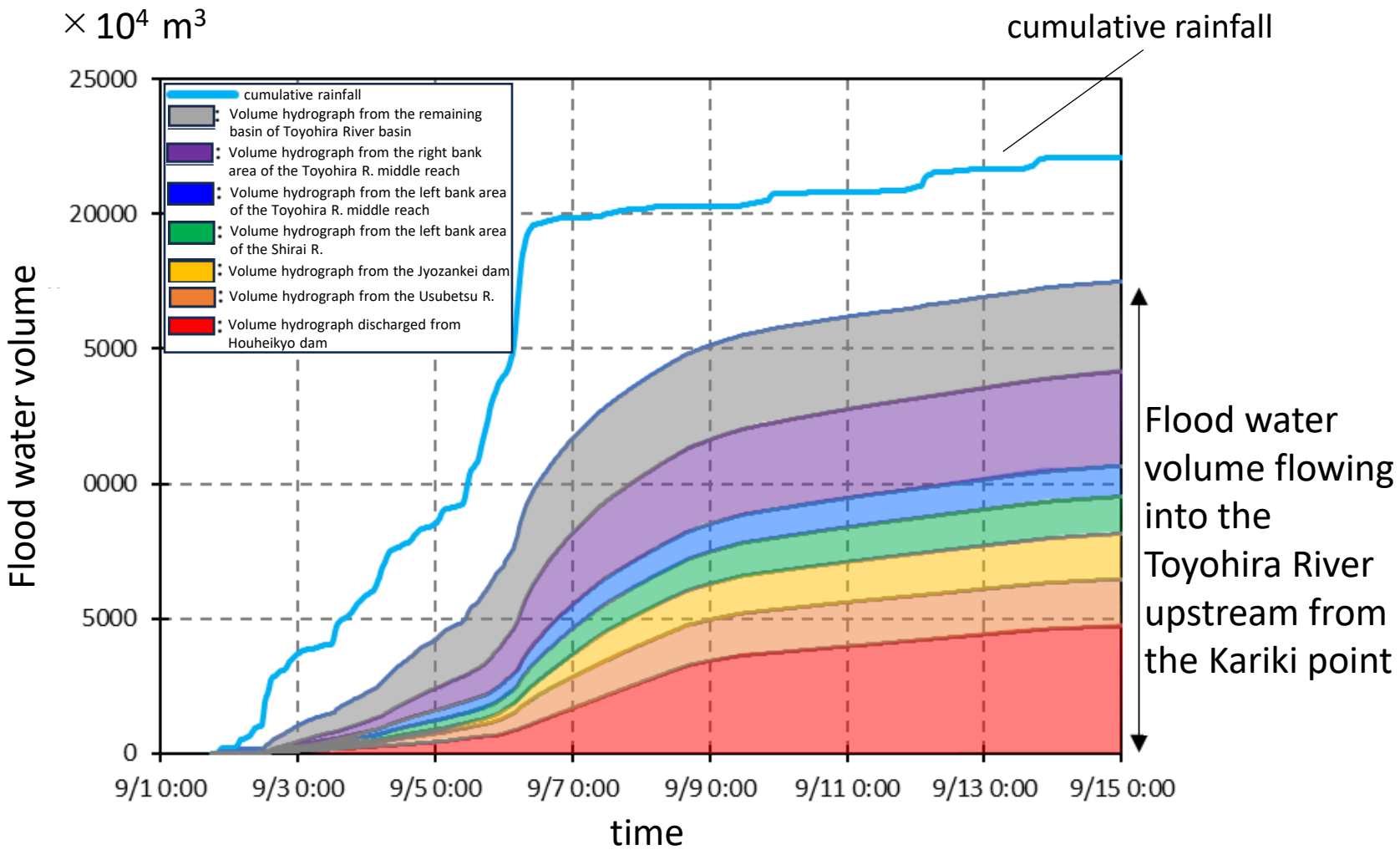



Figure 12 Toyohira River basin water balance distribution map forcusing on the inflow into the Toyohira River from each basin upstream of the Kariki point

**Conclusions**

1. The infiltration, storage, and runoff volumes from small watersheds of the tributaries were estimated by determining parameters of the tank model so as to be consistent with the analysis results of the flood discharge of the river at the upstream end based on the observed flood water surface profile .

2. Then, water balance distribution maps in tributary basins were obtained.

3. By applying tank model parameters to remaining tributary basins with similar geological structures, it was shown that it is possible to reproduce the flood discharge distribution and propagation mechanism of the Toyohira River under a given rainfall condition in the basin. .

4. These analyses enabled estimation of the water balance distribution for the entire watershed, including small watersheds in mountainous areas. The use of water balance distribution maps is an important tool for considering flood control for the entire watershed.