Flood analysis using distributed hydrological models
- Case study for Doki and Yoshino Rivers in Shikoku Island -

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I INTRODUCTION

Flood and droughts are problems to solve for many regions. The risks of severe flooding and drought are expected to increase during 21st century mainly due to climate change. However, in countries where river improvements are not sufficient, good forecasting can reduce losses caused by flooding in the rainy season, or can solve water-lacking problems in the dry season. The great flood of Thailand's Chao Phraya River (160,400 km^2) in 2011 was such an example and the motivation for this research.

In 2011, a massive flood struck Chao Phraya River basin in Thailand from August to December. The total flood volume was estimated to be 15 billion m^3, and the total losses were estimated 1.36 trillion baht. Local people had to live with 2 meters of water in their homes for more than 2 weeks. The case essentially had 2 problems: 1) The flood caused severe damage, even though it was not an instant flood and most of flood masses came from the north, which should have been able to predict. 2) People could not access flood information, which created panic. Therefore, in response to these problems, the objective of this research is to predict floods or discharges of rivers, which are mainly located in Asian countries such as Japan and Thailand by using open source flood analysis software.

II METHODOLOGY

The Doki River (140 km^2) and Yoshino River (3,750 km^2) on Shikoku Island were chosen to perform simulations as references before moving on to Chao Phraya River (160,400km^2) in Thailand. Previous observed input data used in this research was downloaded from the "Water Information System" website (http://www1.river.go. jp/), then used to perform simulations by using open source flood analysis software. CommonMP (Common Modeling Platform for water-material circulation analysis) and IFAS (Integrated Flood Analysis System) were used in the study cases.

1. Flood Analysis Software

A. CommonMP

CommonMP acts like a platform with multiple modules connected together. The modules in CommonMP have many different functions, which can also be developed by CommonMP users. In other words, one river simulation project may have many different patterns depending on the modules selected.

B. IFAS

IFAS is developed by ICHARM (International Centre for Water Hazard and Risk Management under the auspices of UNESCO). IFAS provides interfaces to input both satellite-based and ground-based rainfall data, as well as GIS functions. The calculation concept of IFAS is a tank model. The latest version was updated in June 2014.

2. Study area

1) DOKI RIVER

Doki River (length: 33 km, basin area: 140 km^2, average discharge: 5 m^3/s) is a small and steep river located in Kagawa prefecture (Fig.1). And it's almost branchless characteristic made it simple for any simulation.

2) YOSHINO RIVER

Yoshino River (length: 194 km, basin area: 3,750 km^2, average discharge: 170 m^3/s) covers a large area of Shikoku Island including Tokushima, Kagawa, Ehime, and Kochi prefectures (Fig.1). There are many dams in Yoshino River, and in the simulation models, Sameura dam and Ikeda dam were also considered.

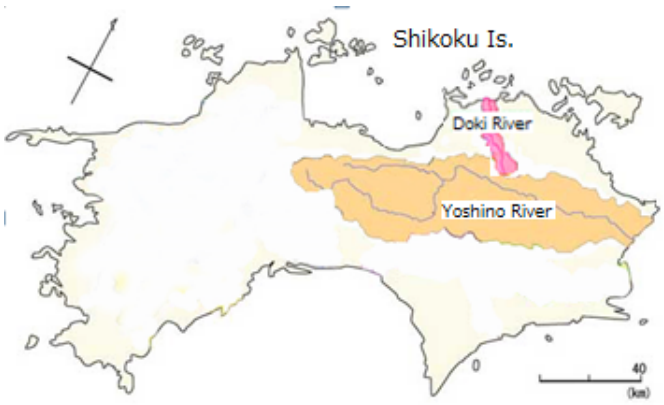

Fig. 1. Doki River and Yoshino River basins in Shikoku Island.

III RESULTS

Hydrographs in Fig.2 show simulation discharges at the Haraigawa-bashi point of the Doki River. The discharge observed by MLIT can be seen in white circles.

After performing parameter calibrations, both the CommonMP and the IFAS simulation results show a similar trend, which can be considered good results in term of peak discharge.

Fig.3 shows simulation discharges at Ikeda dam of Yoshino River. Despite the use of calibrated parameters, accuracy differences remain, especially for the higher discharge. Parameter adjustment for flood control will be needed in addition to normal calibration.

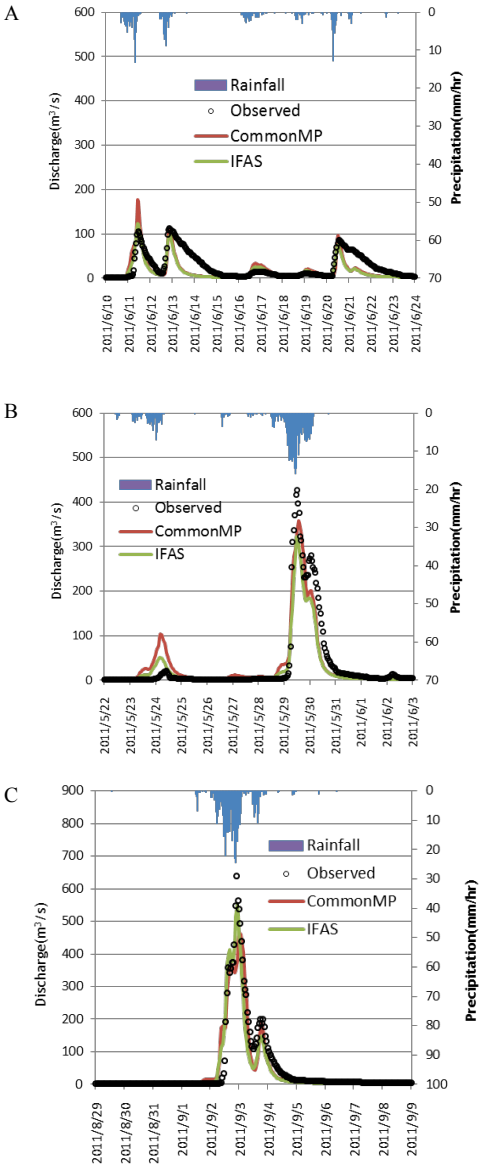

Fig. 2 Simulation result at Haraigawa-bashi in different peak condition. (A: Peak 100 m^3/s, B: Peak 400 m^3/s, C: Peak 650 m^3/s)

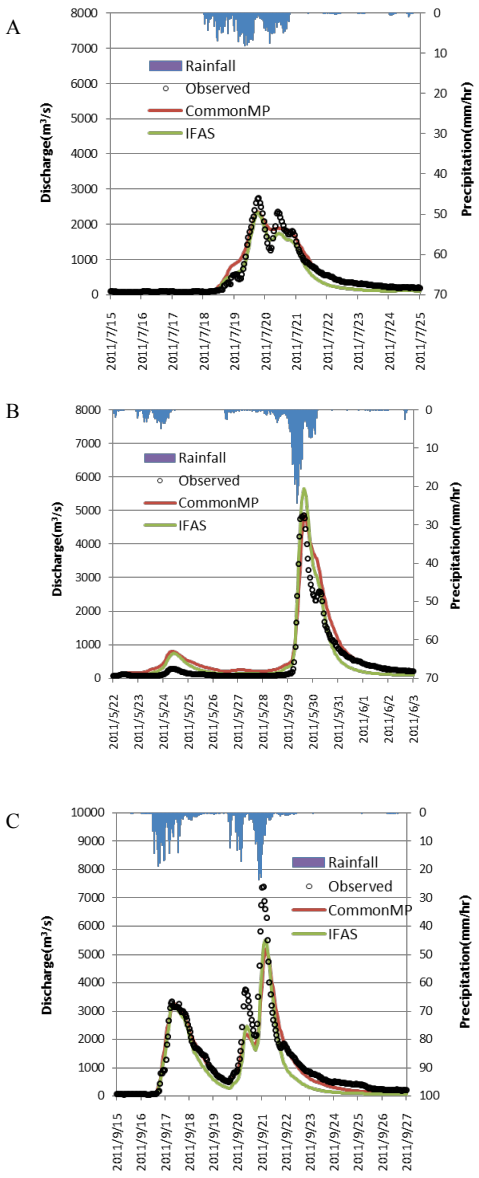

Fig. 3 Simulation result at Ikeda dam in different peak condition. (A: Peak 3000 m^3/s, B: Peak 5000 m^3/s, C: Peak 7500 m^3/s)

IV SUMMARY

In small-scale cases like the Doki River, open source flood analysis software can be used to estimate river discharge in most conditions. However, in larger scale cases like the Yoshino River, parameter adjustments for flood control cases may be needed. These can be applied for both CommonMP and IFAS despite having different simulation concepts and processes.

The goal of this research is to simulate the discharge of Chao Phraya River in Thailand. However, in Chao Phraya River case, previous ground-based precipitation data may not be available. "The correction of satellite-based precipitation at Chao Phraya river basin" by Tanuma et.al (2013)[1] indicate that Saavedra el.al (2010)[2] correction method can obtain reliable for flood simulation, which will be the reference for the next step of the research.

REFERENCES

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[2] Saavedra, V. O. C., Koike, T., and M. Rahman, "Towards Global River Discharge Assessment Using a Distributed Hydrological Model and Global Data Sets," Investigación & Métodos, Journal of the Bolivian Private University, Vol. 9, pp.95-102, 2010.