Book of Extended Abstracts
41st IAHR World Congress
22-27 June 2025
Singapore

ESTIMATING THE DISCHARGE FROM THE DISTRIBUTION OF SURFACE VELOCITY USING THE MAXIMUM ENTROPY METHOD

Sangjin Han[1], Sung-Uk Choi[2]

[1,2] Yonsei University, Republic of Korea
email: v8070@yonsei.ac.kr
email: schoi@yonsei.ac.kr

ABSTRACT

Nowadays, various instruments are being used to measure the discharge in the river. They include microwave water surface current meter, Acoustic Doppler Current Profiler (ADCP), Acoustic Doppler Velocity Meter (ADVM), and Ultrasonic Velocity Meter (UVM). Recently, a new non-contact method is introduced for estimating the discharge in small-sized rivers in Korea. This method estimates the discharge by multiplying the mean velocity by the cross-sectional area, where the mean velocity is assumed to be the average of the surface velocity distribution multiplied by a constant.

This study proposes a method of estimating the discharge by generating the velocity field in the river cross section. The maximum entropy method proposed by Chiu and Said (1995) is used. This method uses a velocity distribution formula that maximizes entropy. The formula is a function of the velocity ratio, the ratio of the mean velocity to the maximum velocity.

A parameter study is carried out by applying the method to two rivers in Japan (Omori et al., 2024). The two rivers are Nakamura River and Ohta River, a small-sized and a mid-sized river, respectively. Using the surface velocity distribution measured by Space Time Image Velocimetry (STIV), the velocity distributions over the cross section are generated by MEM with various values of the velocity ratio. It is found that the velocity ratio in the range of 0.6 and 0.8 yields the discharge estimate with an accuracy of ±10%, compared to the discharge measured by ADCP.

Finally, the method is applied to the discharge measurement in KICT-River Experiment Center (Lee et al., 2018; Tranmer et al., 2024). The outdoor stream has a trapezoidal cross section, 150 m long with a base width of 4.5 m and a symmetric side slope of 1:1.5 (V:H). The LSPIV is used for the distribution of the surface velocity and the ADV for the velocity distribution and flow depth. The method predicts the correct discharge (by ADCP) with a velocity ratio of 0.64. In addition, the method predicts the discharge in the range of – 2.5% and 10% with the velocity ratio from 0.6 to 0.8.

Keywords: discharge measurement; surface velocity; maximum entropy method; velocity ratio; ADV

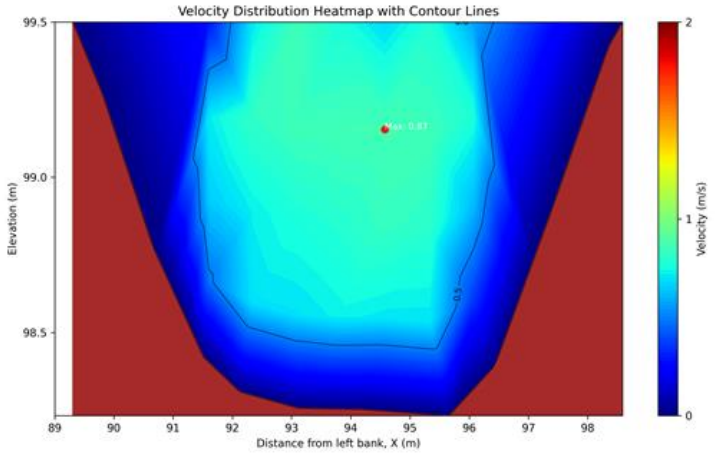

Fig.1. Velocity distribution by measured ADV

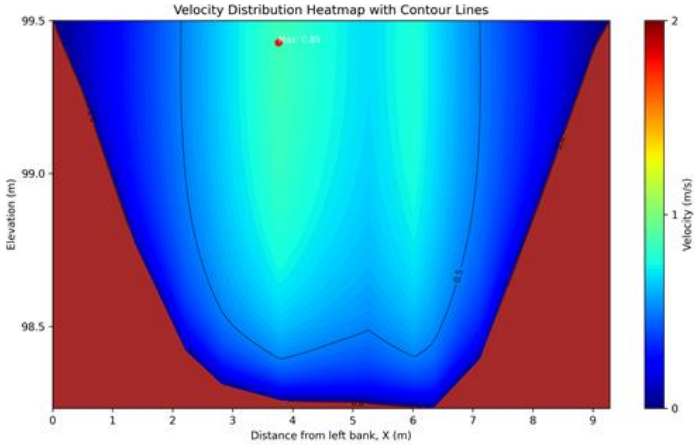

Fig.2. Velocity distribution predicted by MEM

.

Acknowledgements

This work was supported by Korea Environment Industry & Technology Institute(KEITI) through「Research and Development on the Technology for Securing the Water Resources Stability in Response to Future Change(RS-2024-00335281)」Program, funded by Korea Ministry of Environment(MOE). Thanks are also due to Dr. Ji, Un in KICT, who provided the LSPIV and ADV data for this study.

References

Chiu CL, Said CAA (1995) Maximum and mean velocities and entropy in open-channel flow, Journal of Hydraulic Engineering, 121(1), 26-35.

Omori, Y., Yoshimura, H., Fujita, I., Watanabe, K. (2024) Flood Discharge Measurement by STIV Coupled with Maximum Entropy Method Using Parameter Estimation by Numerical Analysis, KSCE Journal of Civil Engineering, 28(3), 1122-1131.

Lee, C. J., Kim, D. G., Kim, S. J., Ji, U., Kim, J. H., Ko, D. W. (2018) Flow structure around an actual willow patch under different depth conditions, River Flow 2018, E3S Web Conf. 40, 02049.

Tranmer, A. W., Ji, U., Ahn, M., Jung, S. H., Yager, E. M. (2024) Characterizing erosion and deposition in and around riparian vegetation patches: Complex flow hydraulics, sediment supply, and morphodynamic feedbacks, Water Resources Research, 60, e2023WR034859.