




Control-Oriented System Identification of Urban Drainage Dynamics for Flood Mitigation

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Introduction

Need:

- A control-oriented modeling framework that bridges the gap between complex hydrodynamic simulators (like EPA-SWMM) and system-level analysis.

Challenge:

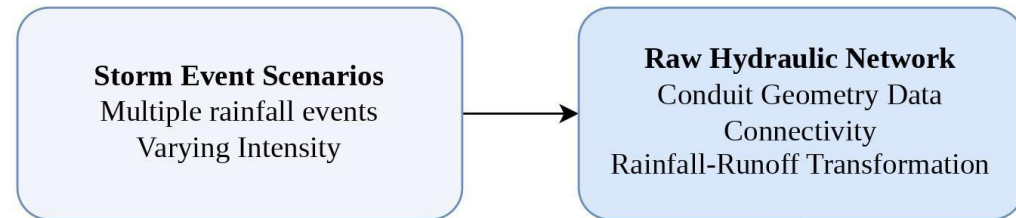
- Hydrodynamic simulators (e.g., SWMM) are computationally intensive and obscure the dominant dynamics required for real-time control.
- Linearizing local storage-outflow dynamics while maintaining physical interpretability.

Goal:

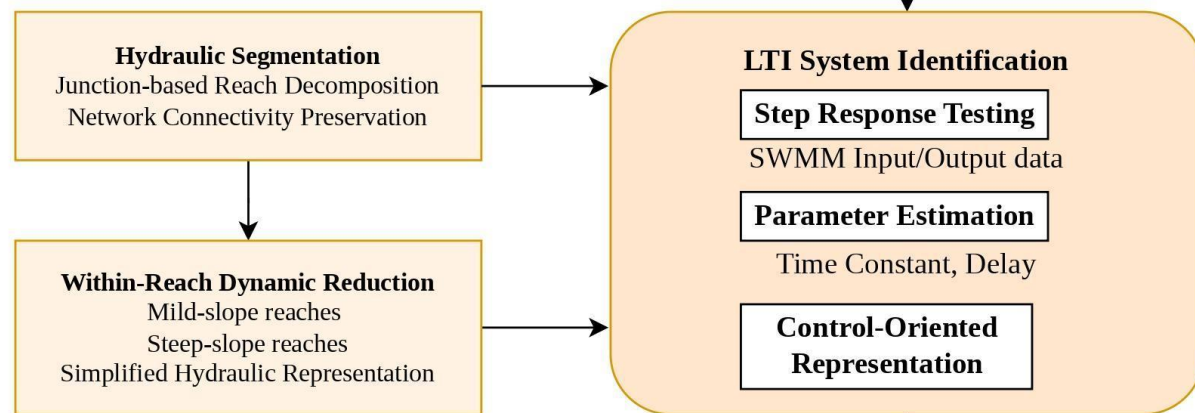
- Developing a compact linear emulator of drainage dynamics that captures dominant inflow-depth sensitivities and storage behavior.

Overall Methodology and Input Phase (Storm Events)

Input Phase

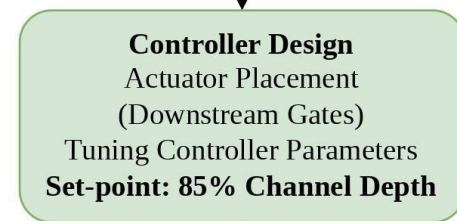


Modelling Phase

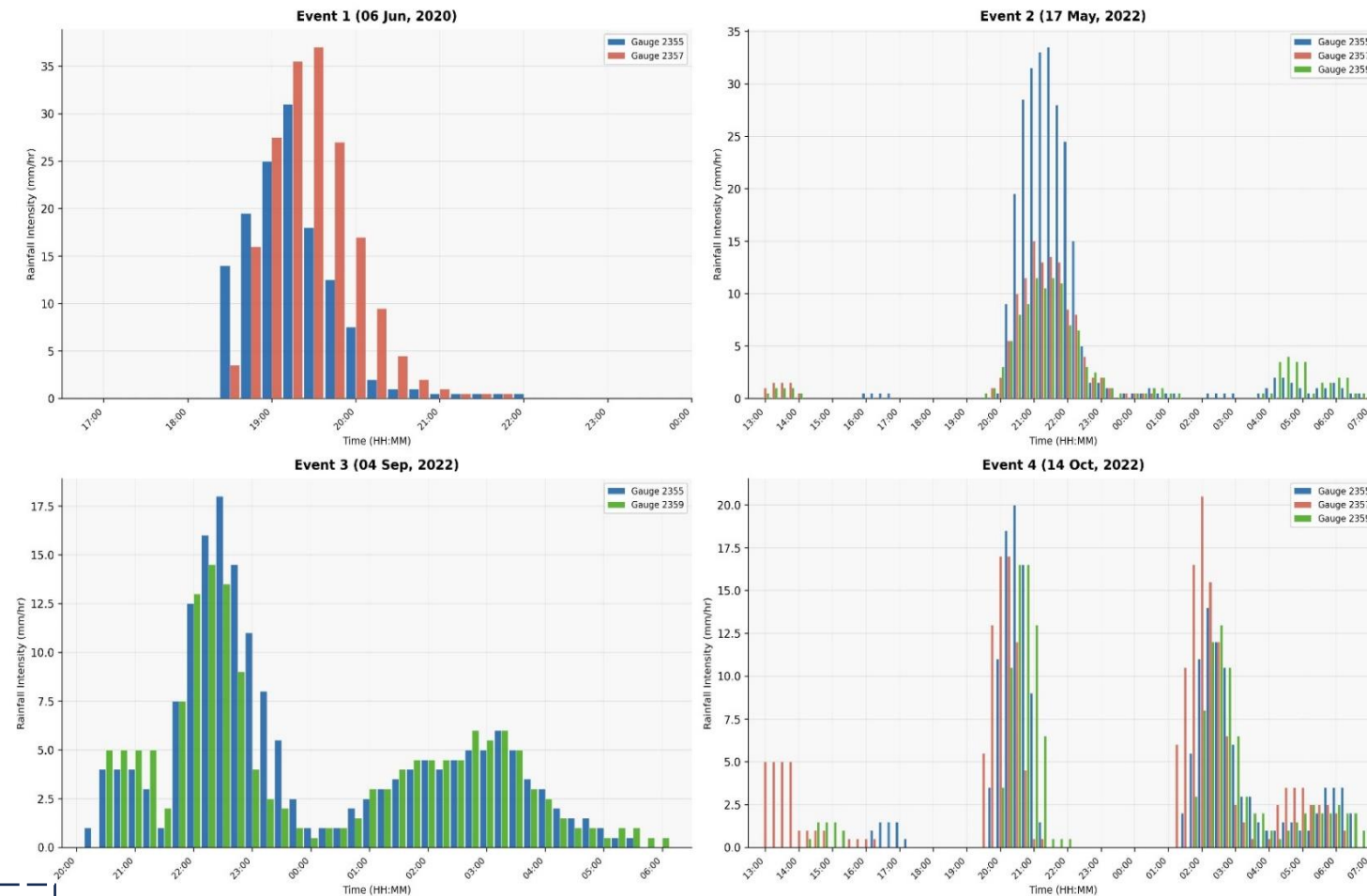
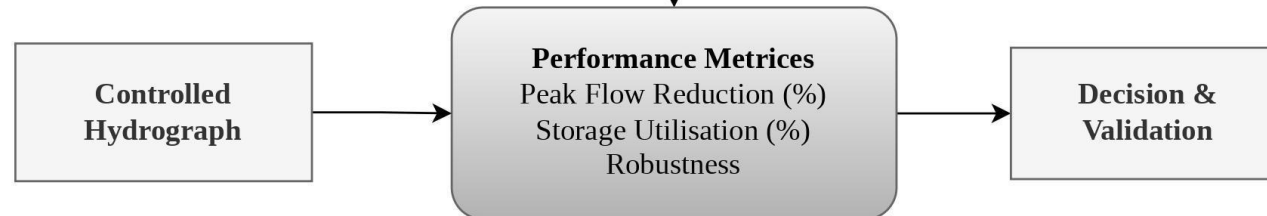


Future Work

Control Phase

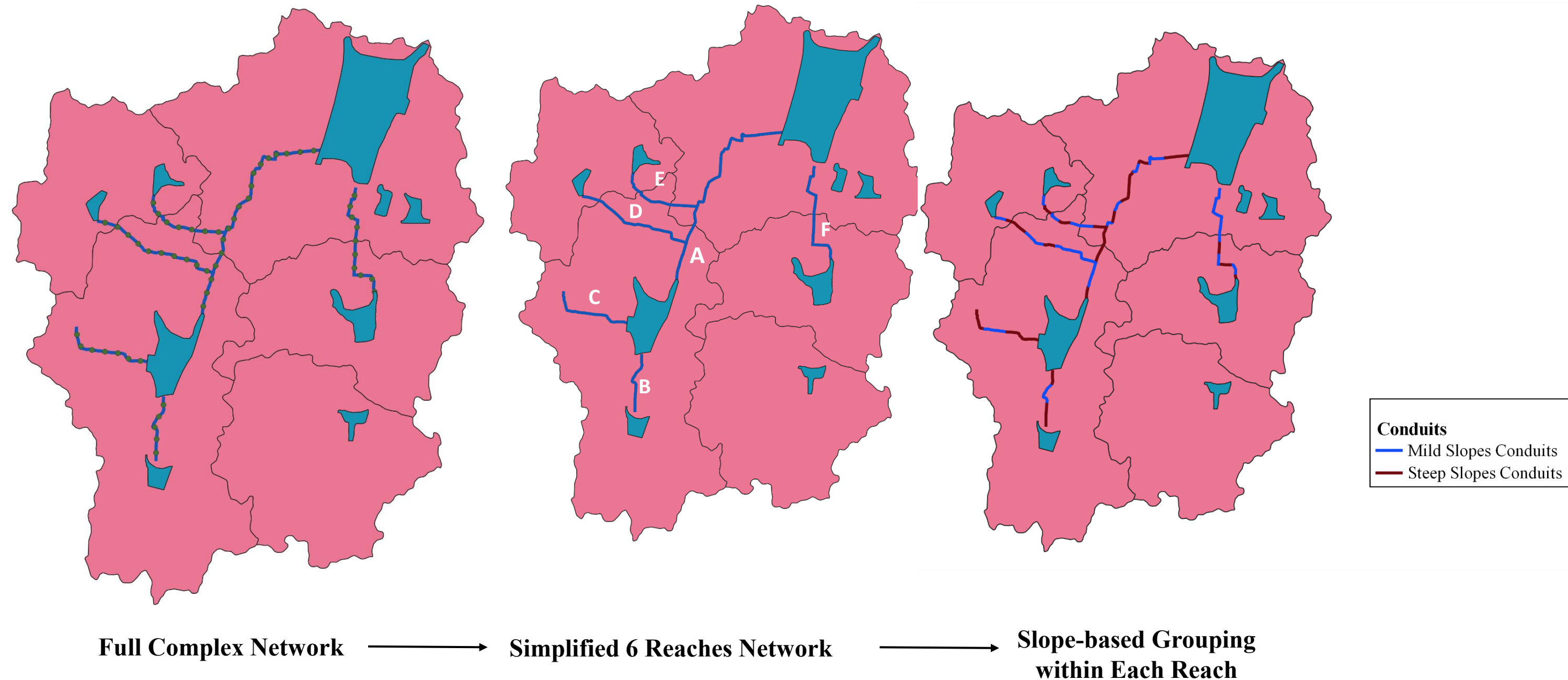


Output Phase

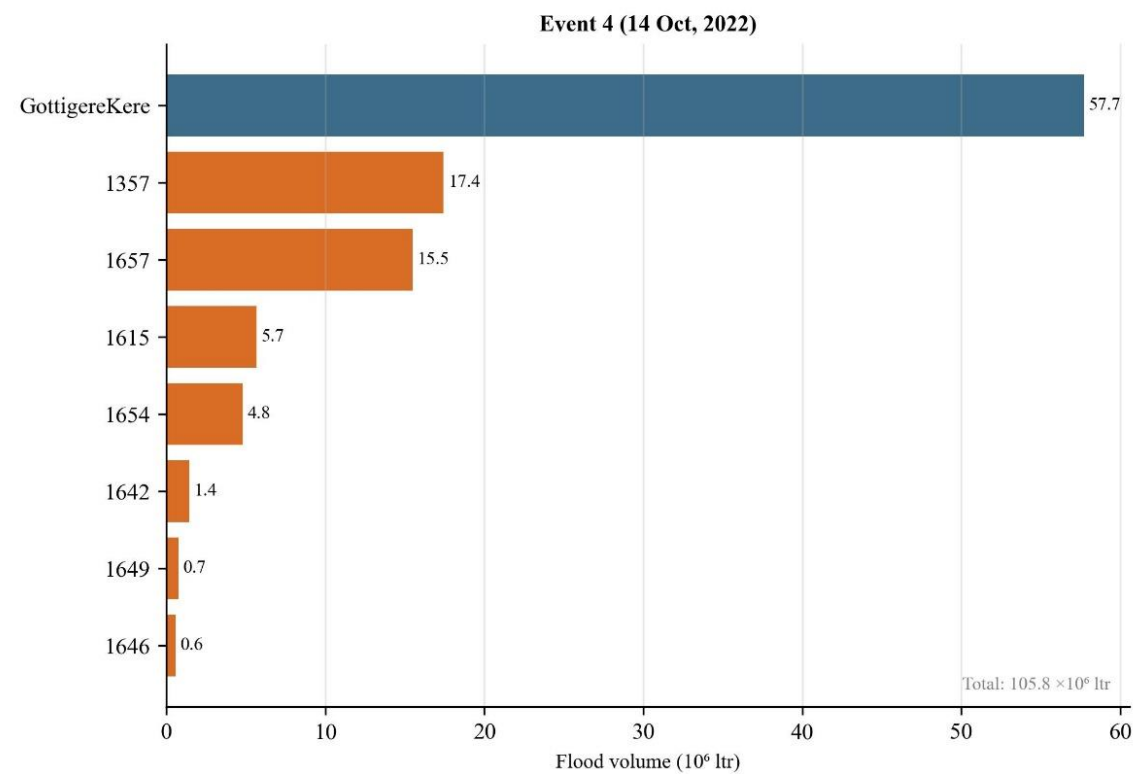
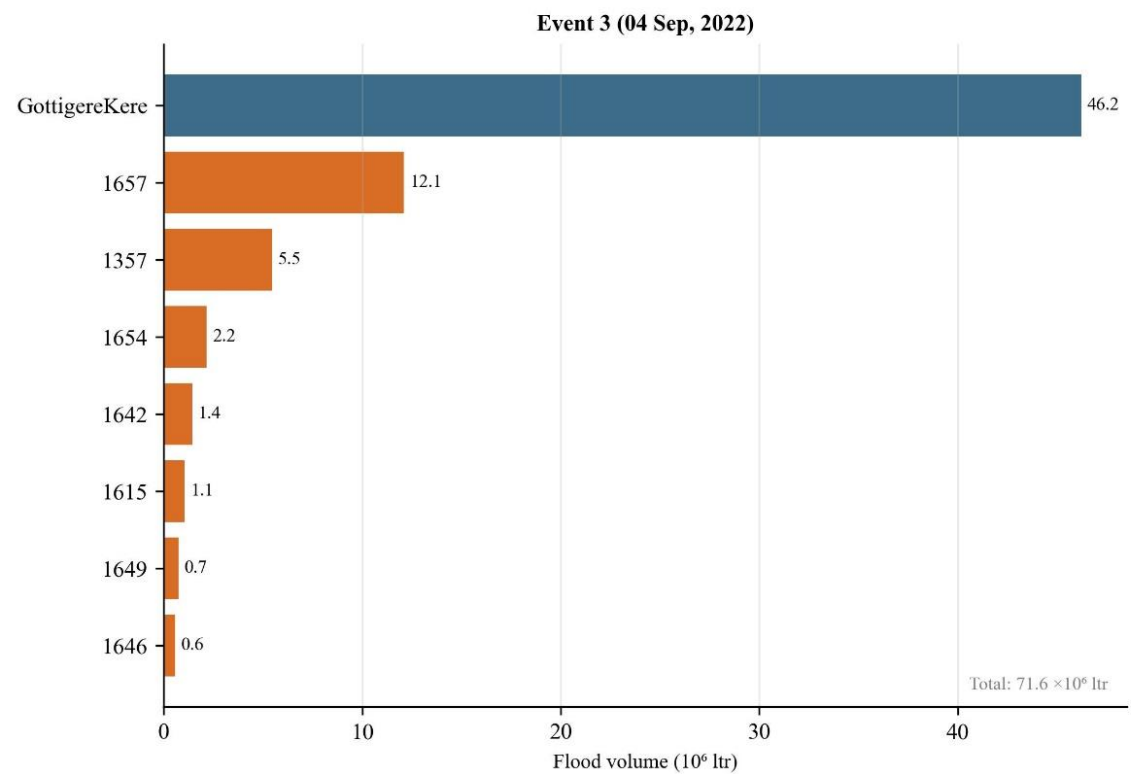
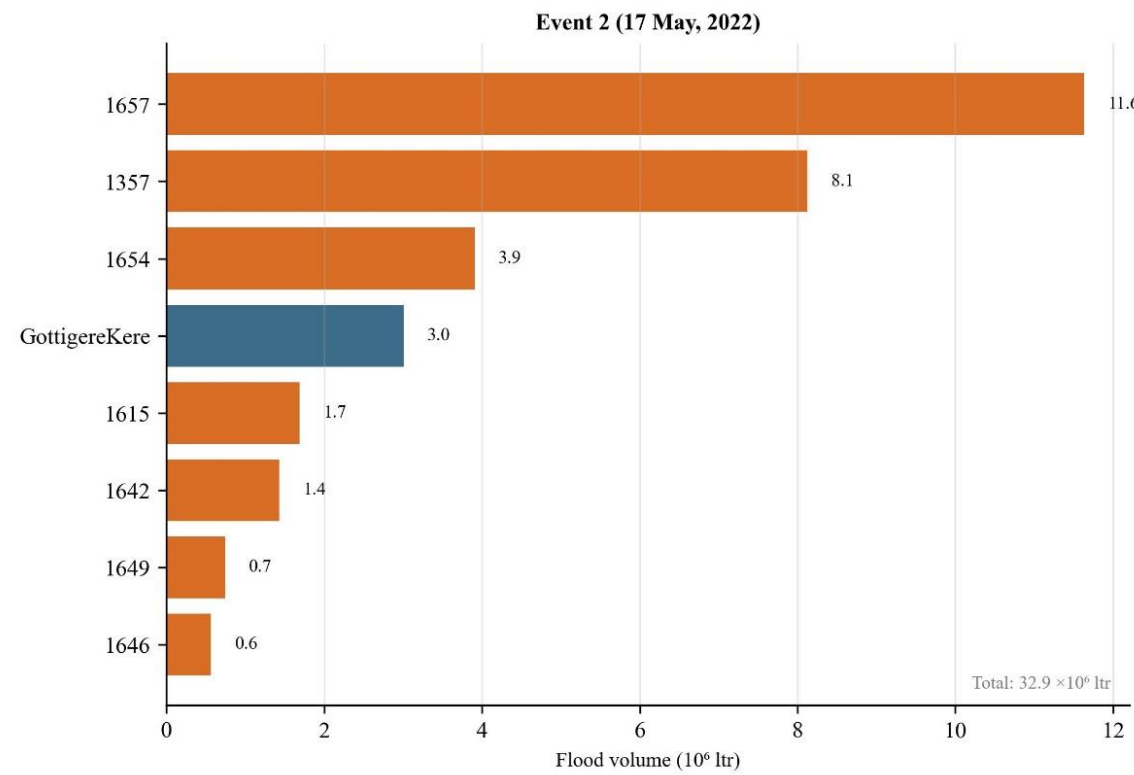
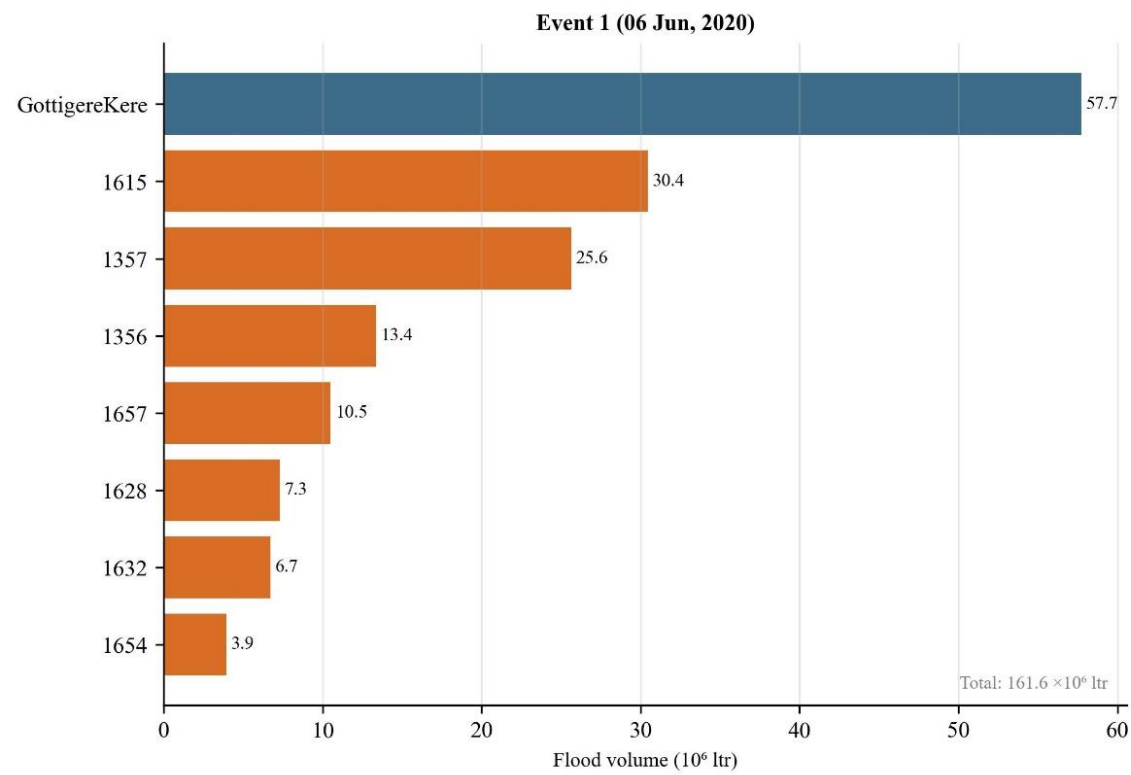


Rainfall Storm Events

Network Simplification: Study Area (Hulimavu Madiwala Sub-catchment)



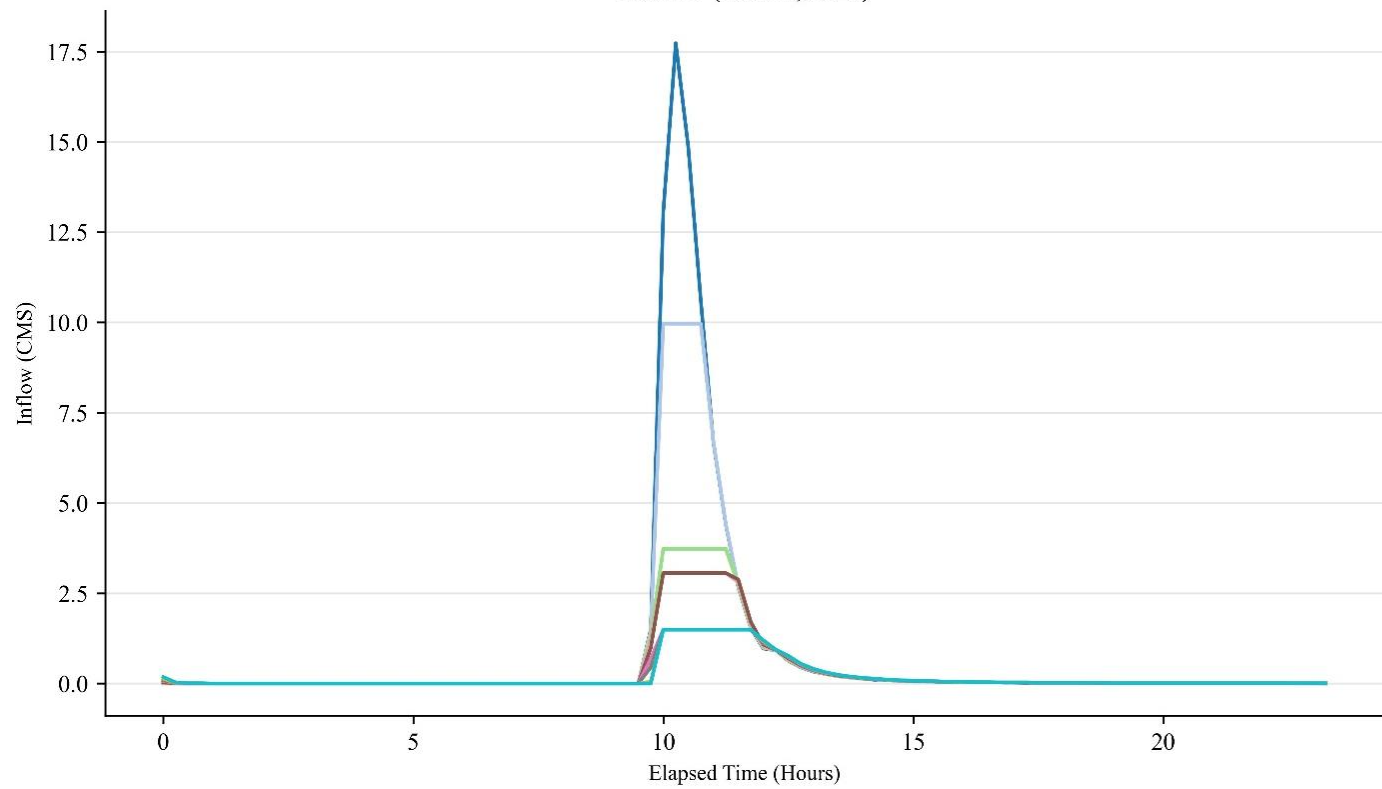
Flood Nodes and Flood Volume



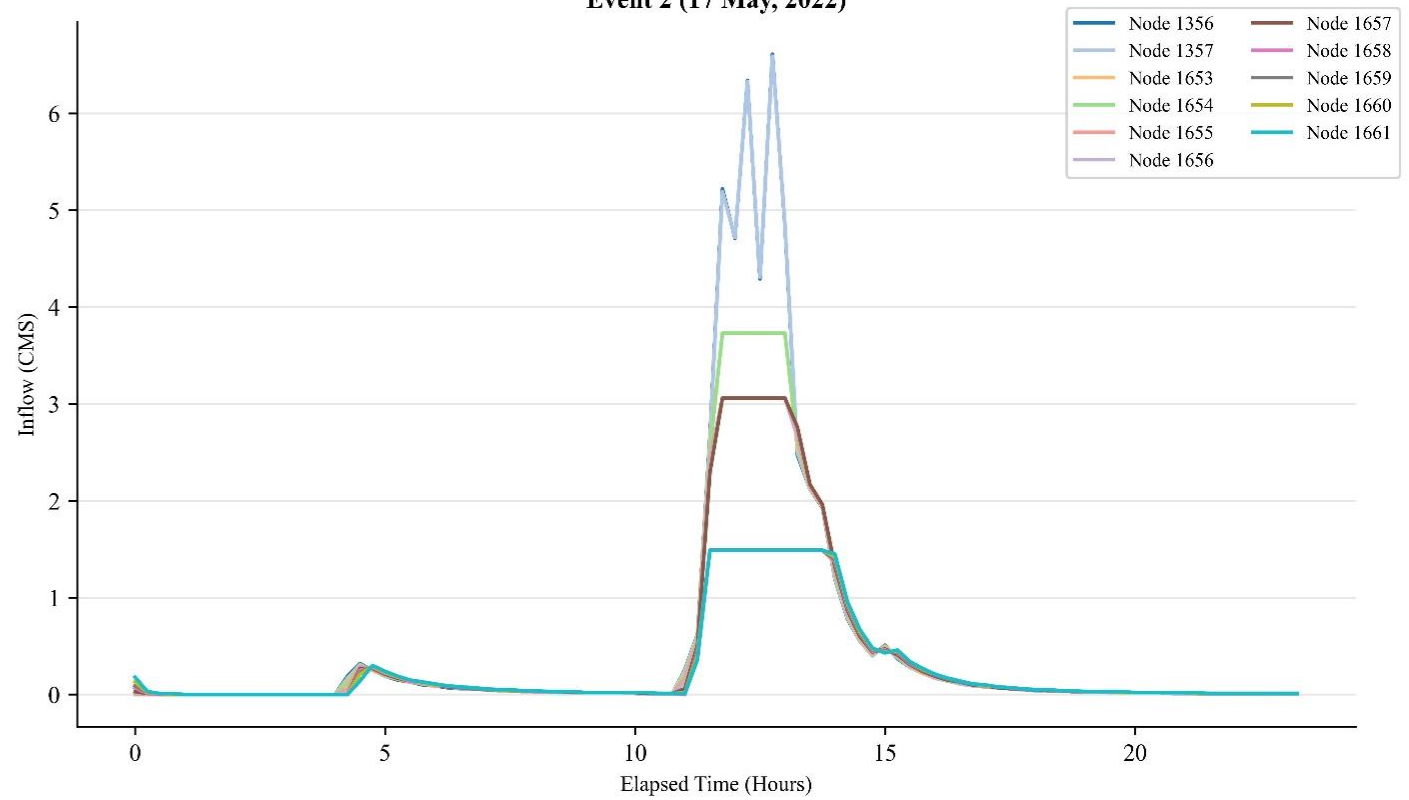
Legend: Lake node (blue bar), Conduit node (orange bar)

Inflow Data Analysis for Input Selection

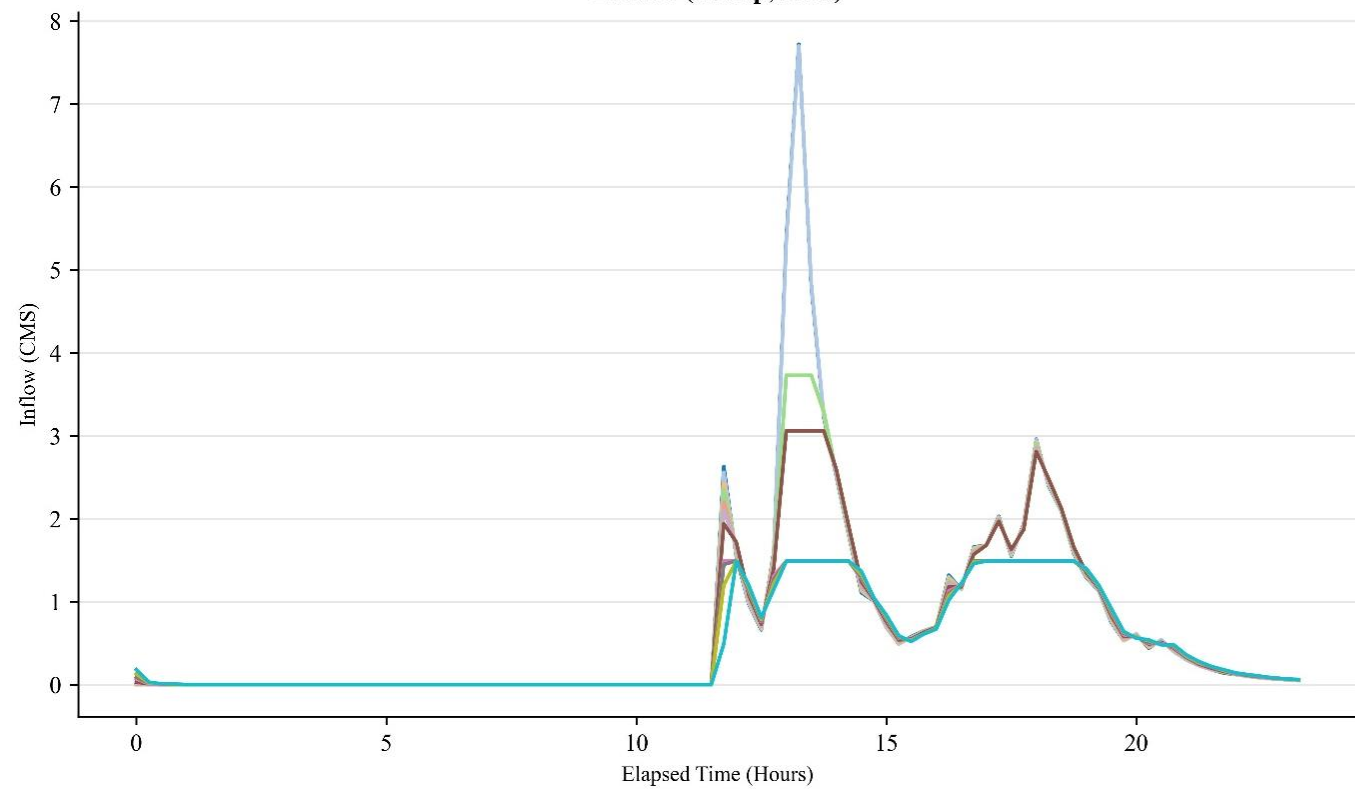
Event 1 (06 Jun, 2020)



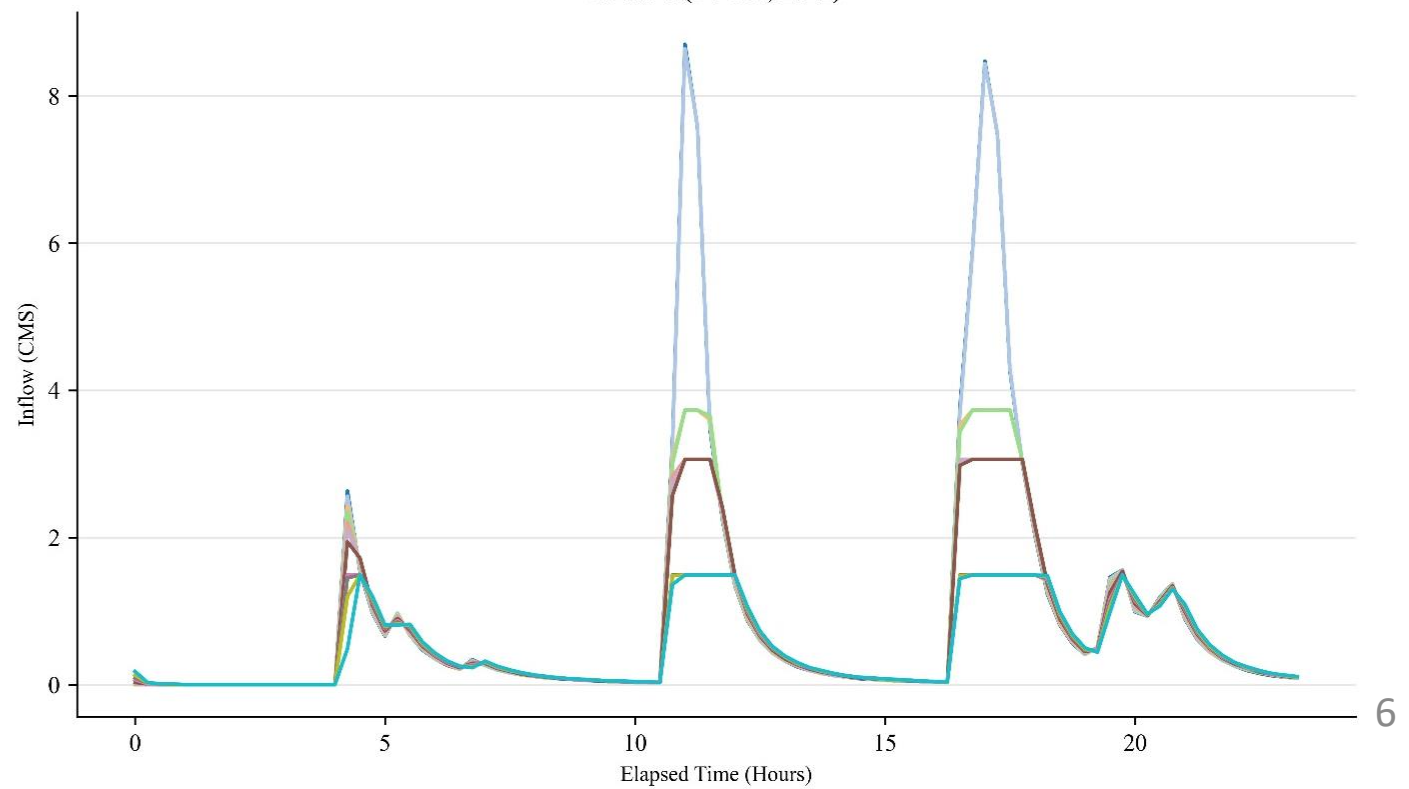
Event 2 (17 May, 2022)



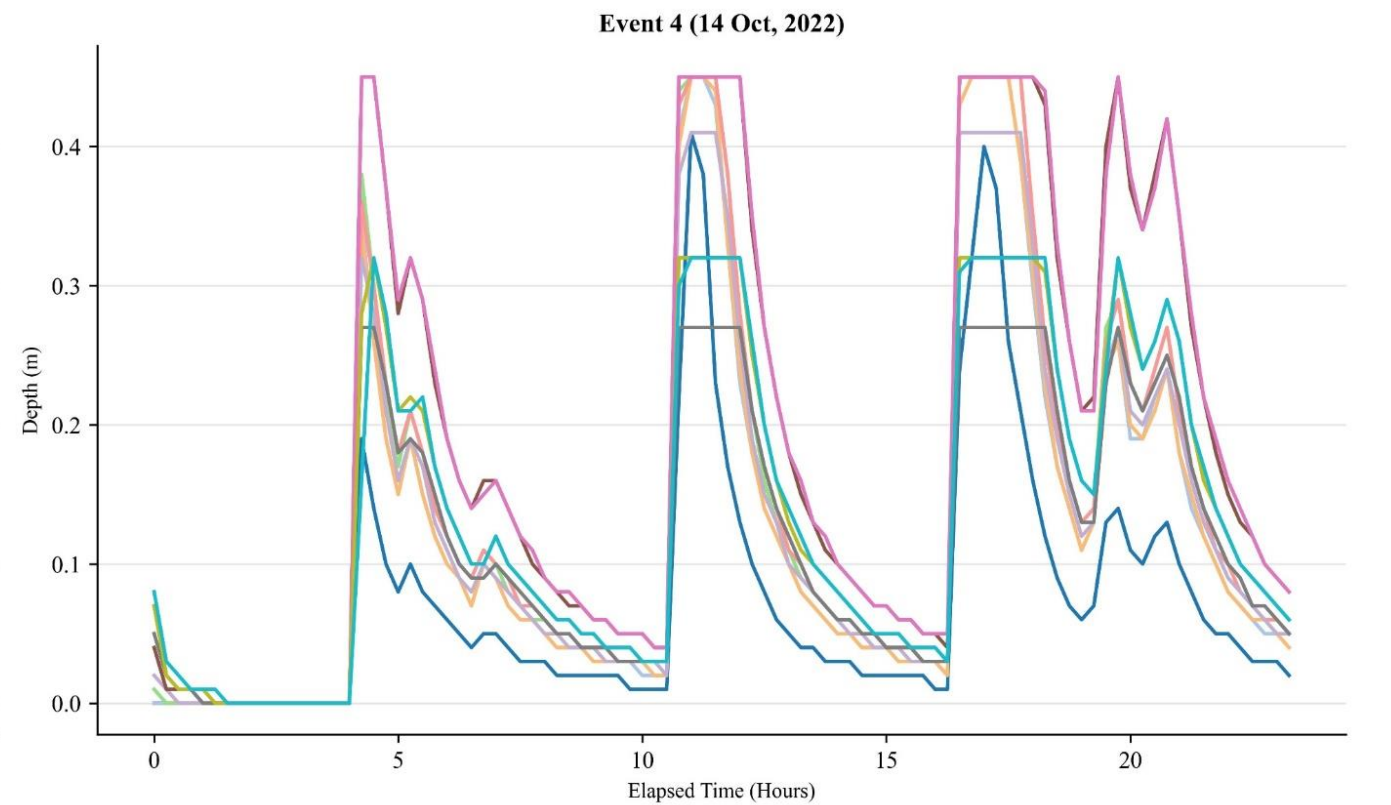
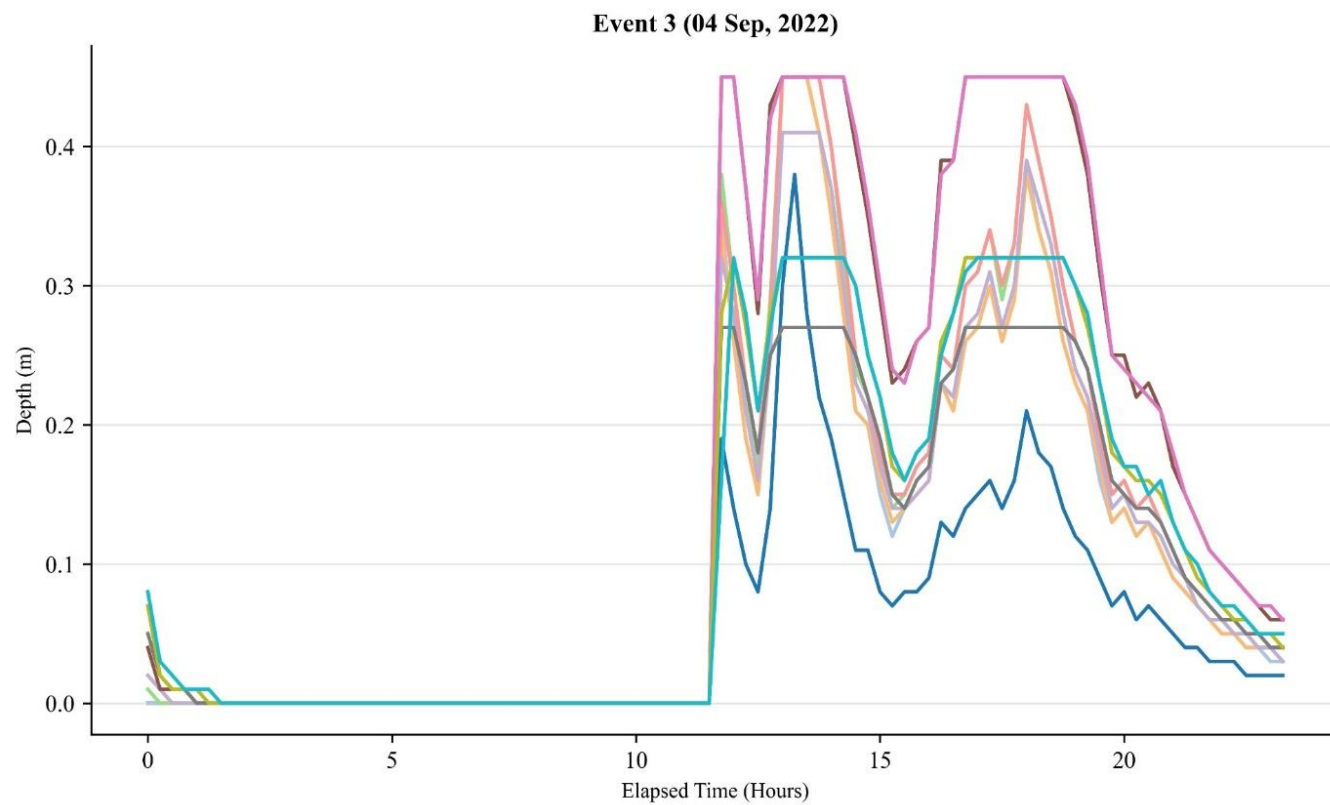
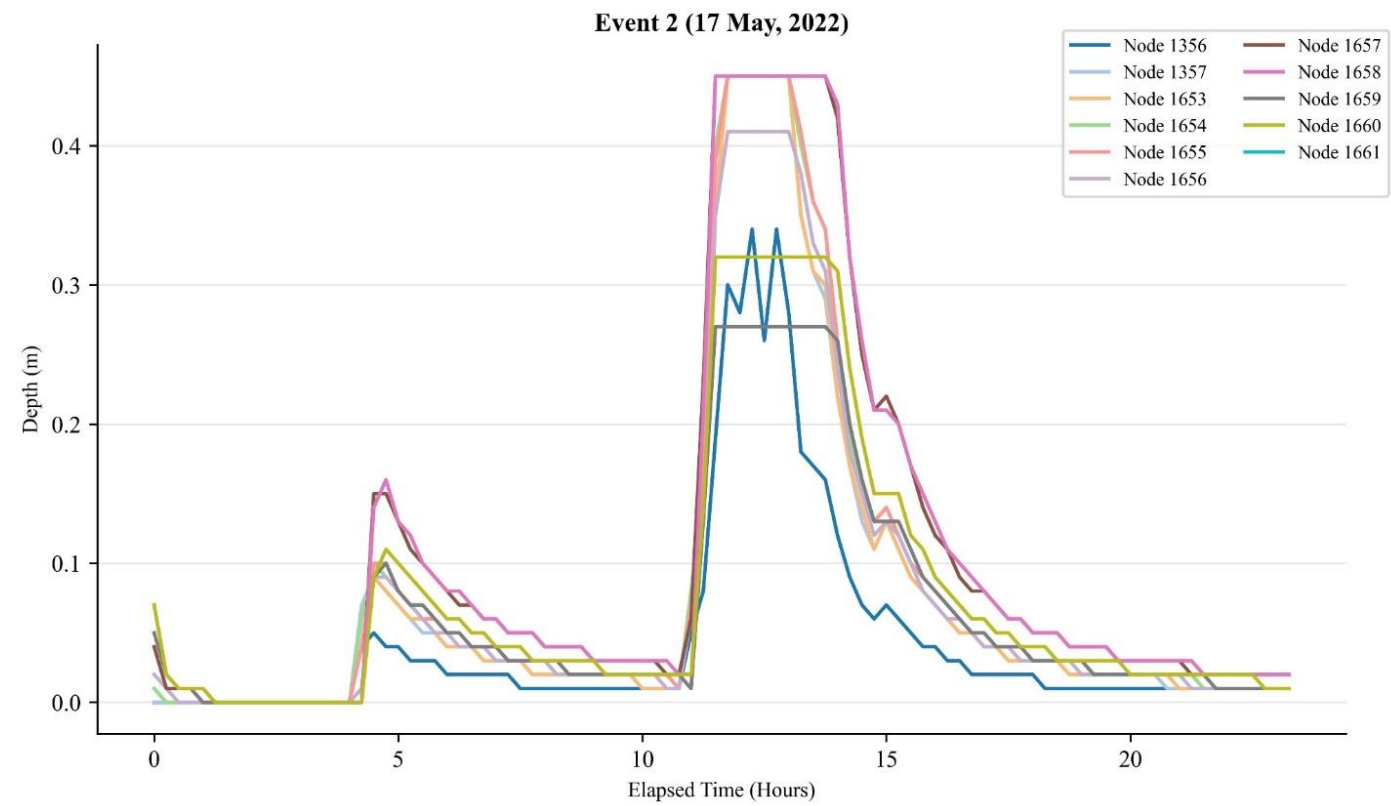
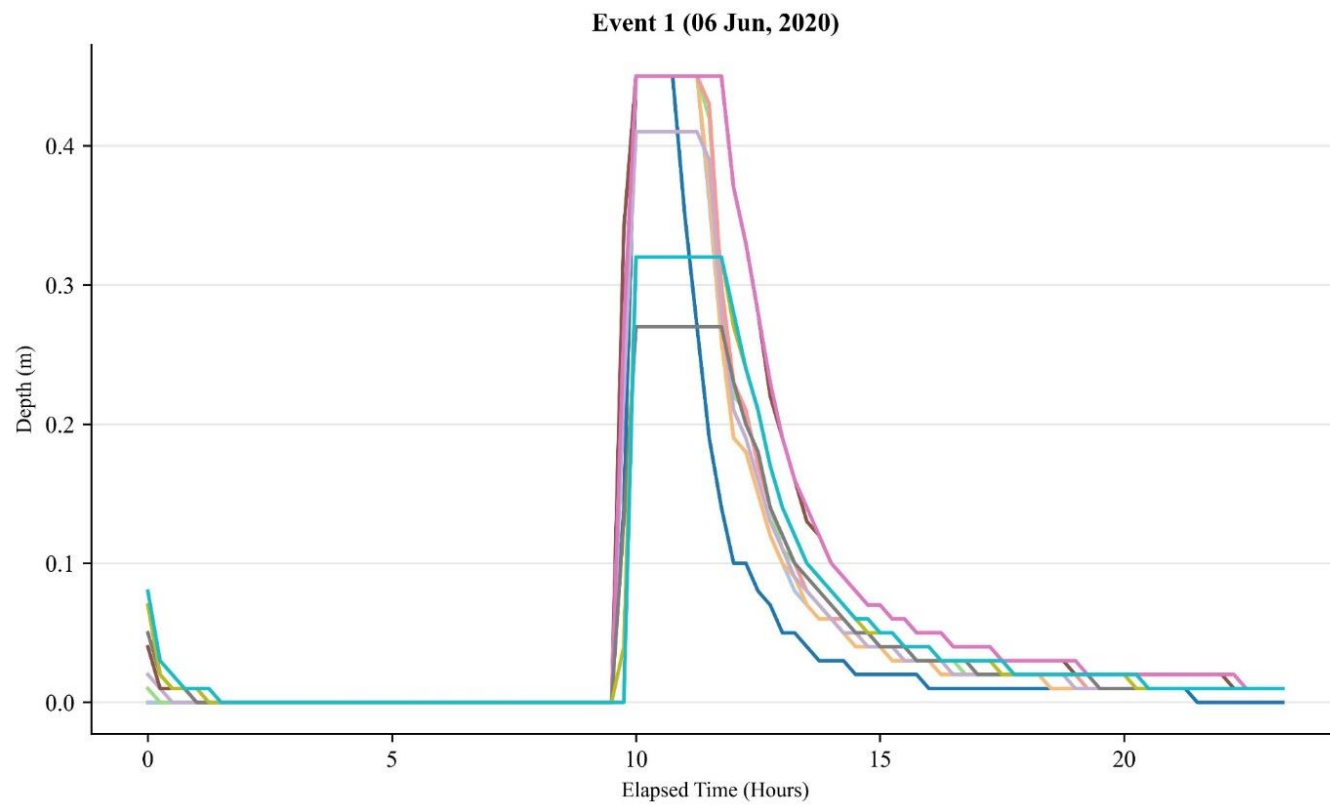
Event 3 (04 Sep, 2022)



Event 4 (14 Oct, 2022)

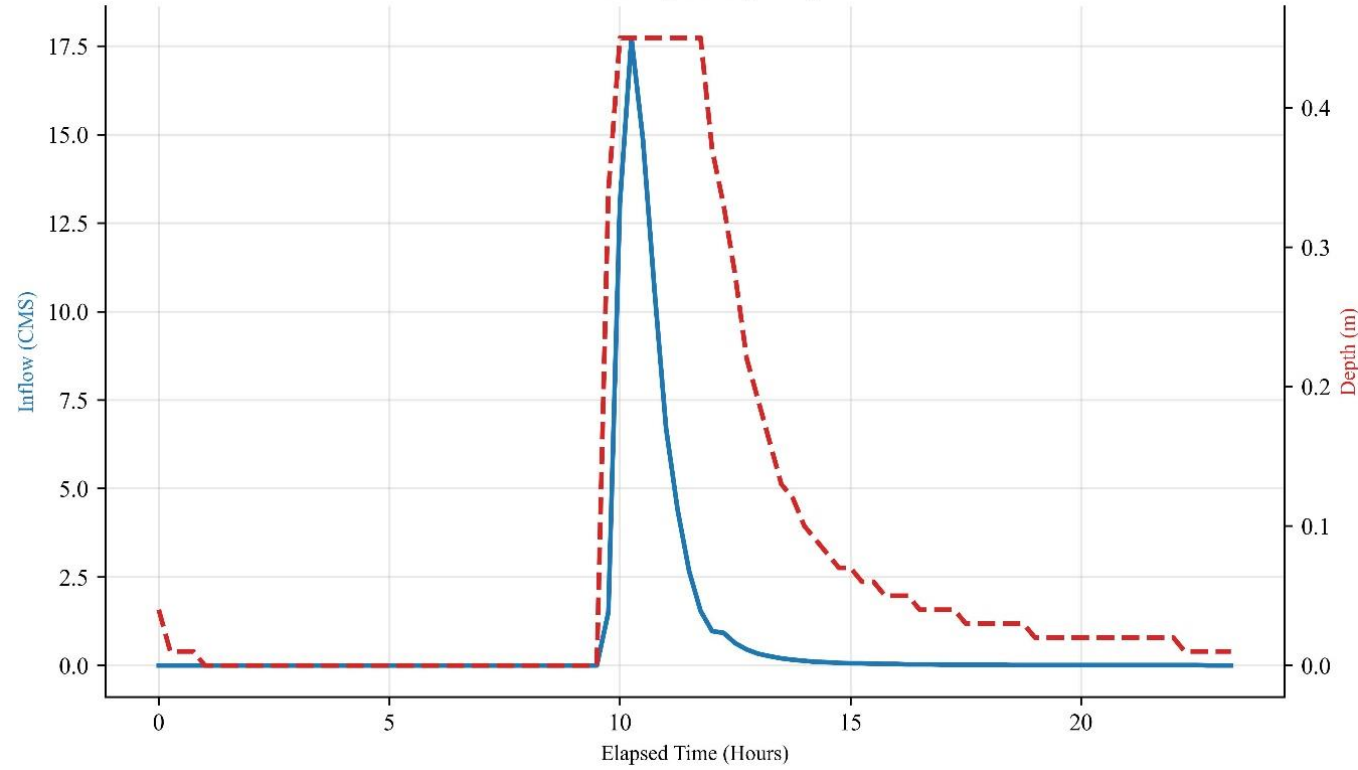


Depth Data Analysis for Output Selection

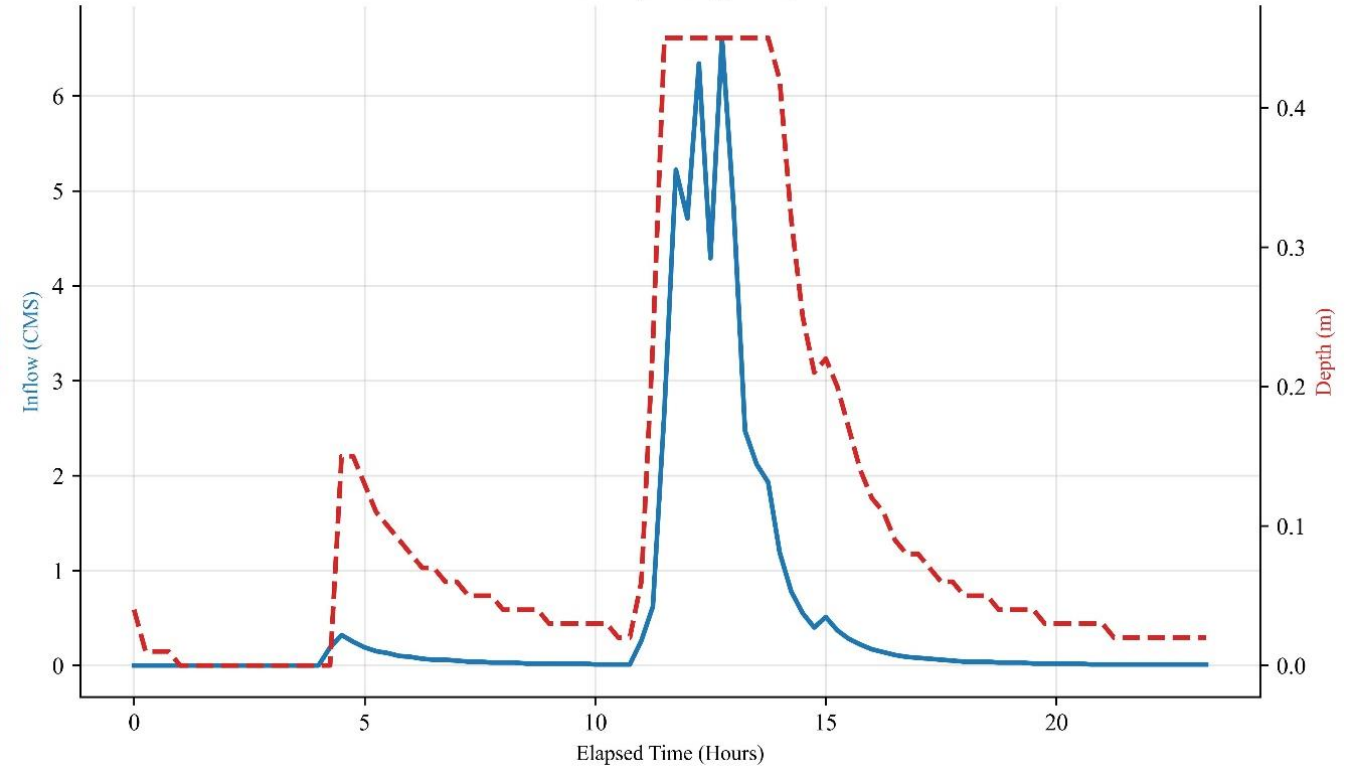


Identified Input-Output Data

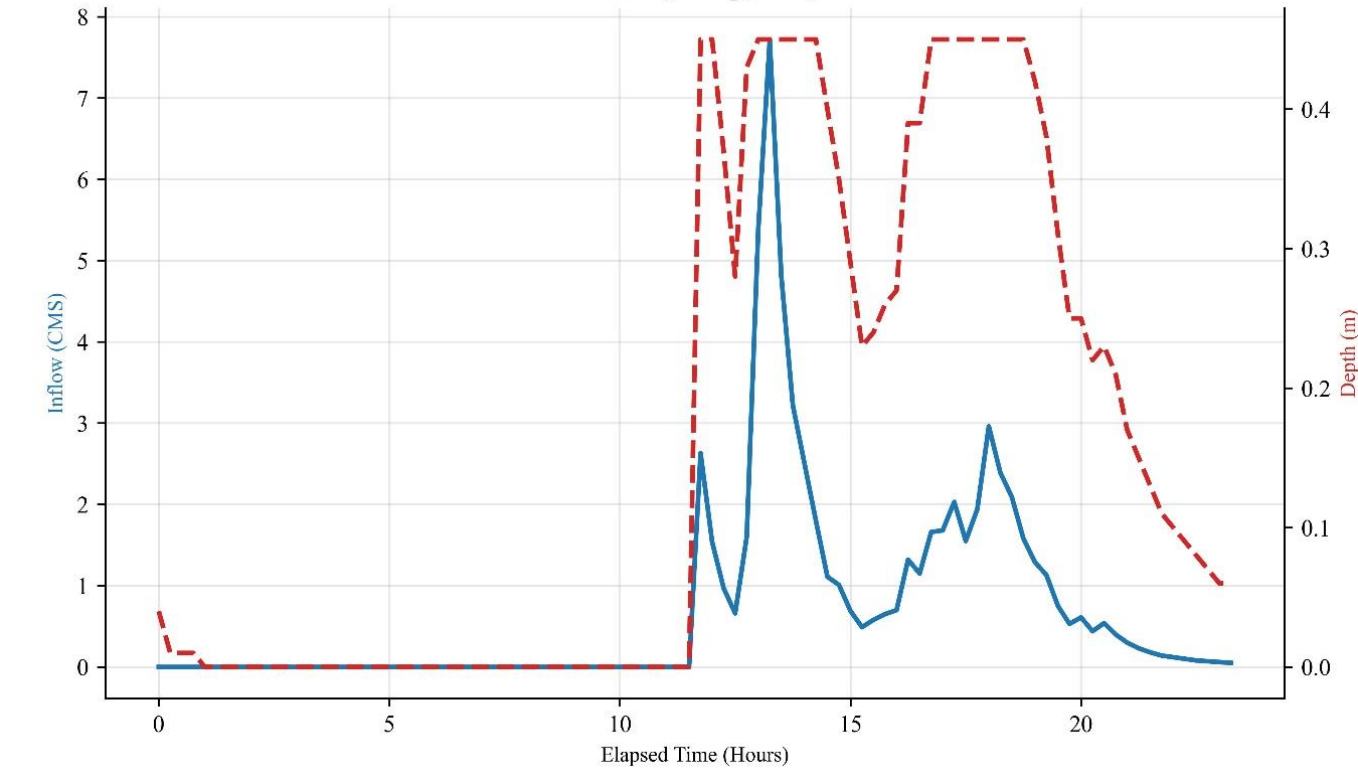
Event 1 (06 Jun, 2020)



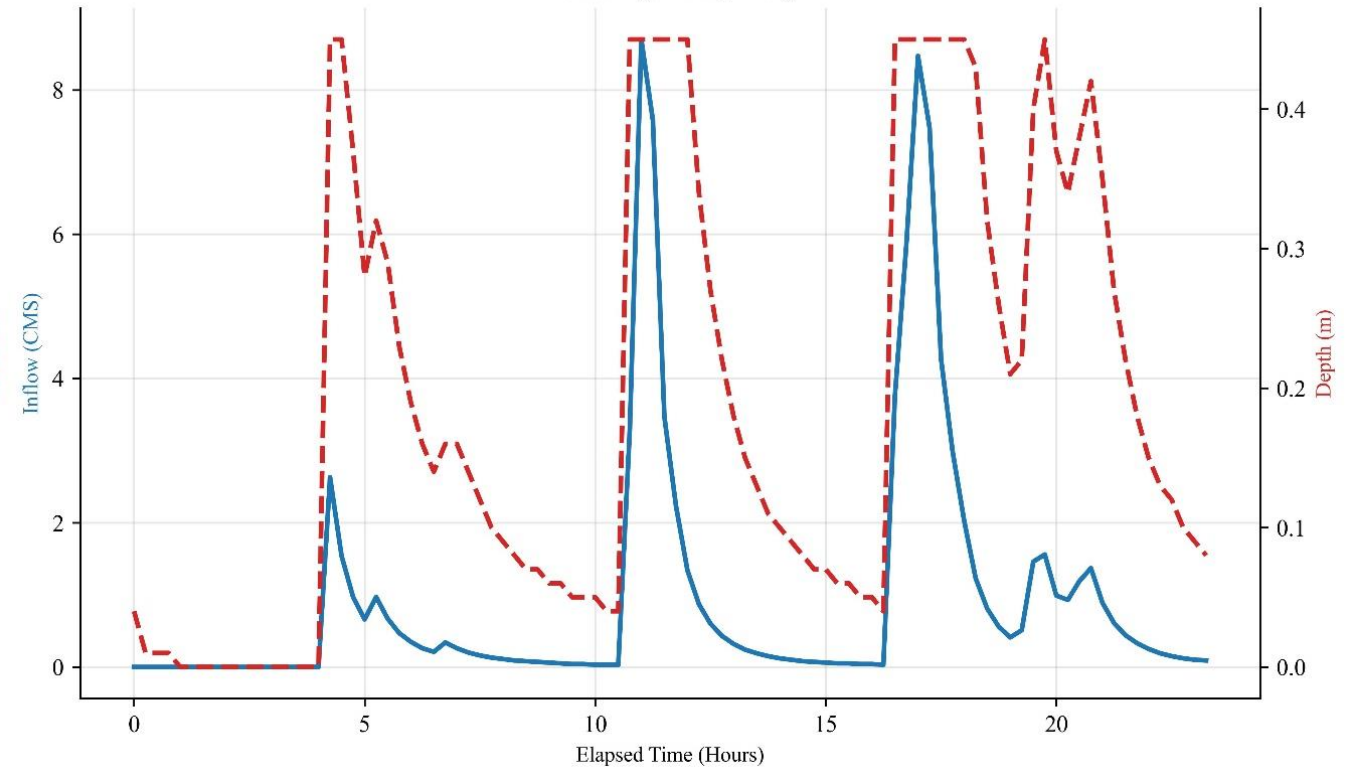
Event 2 (17 May, 2022)



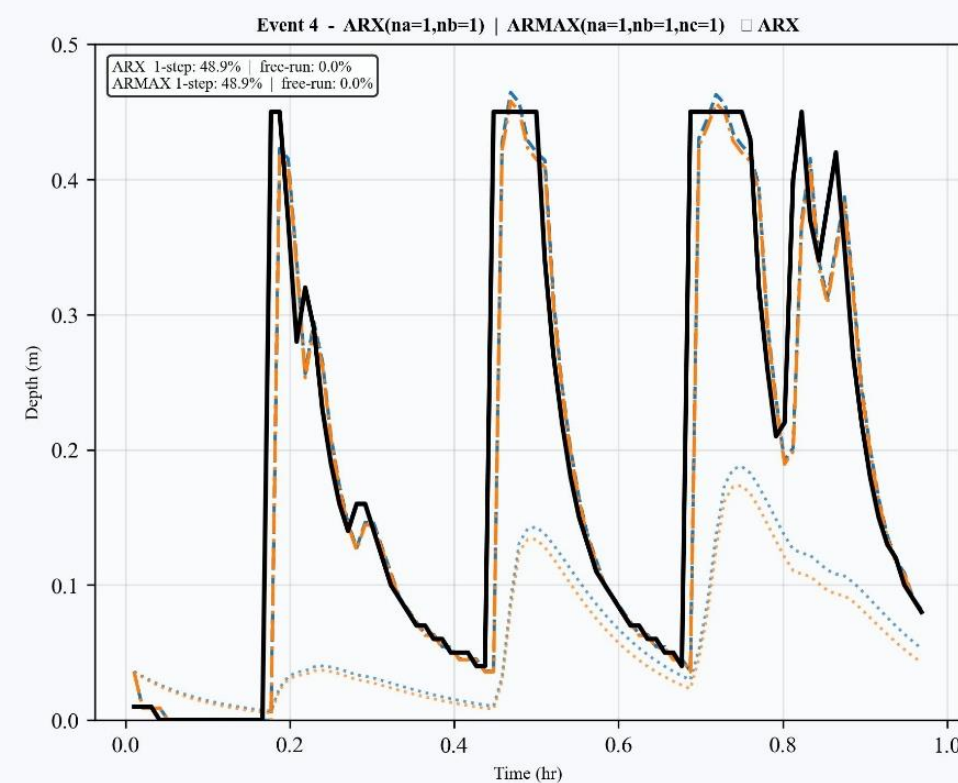
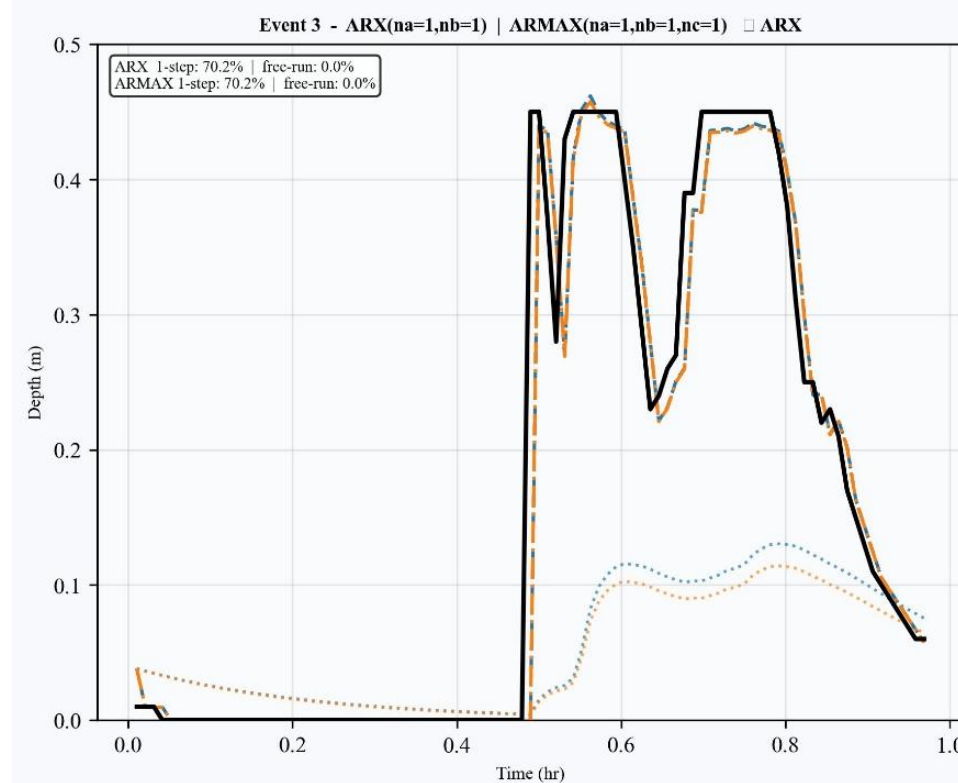
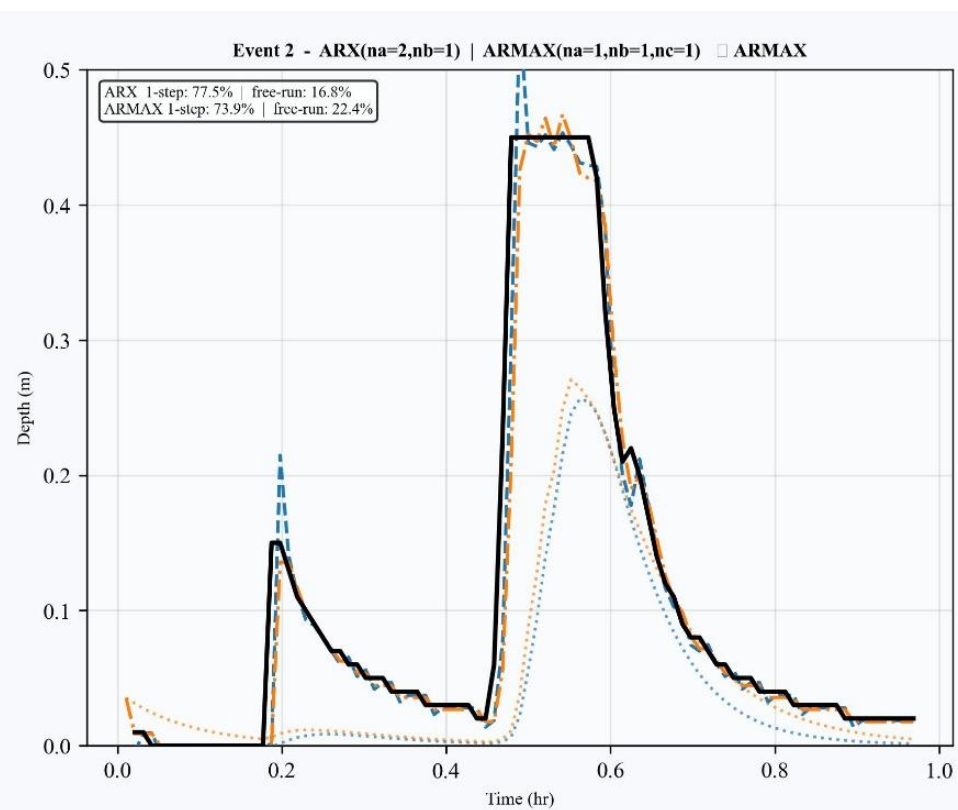
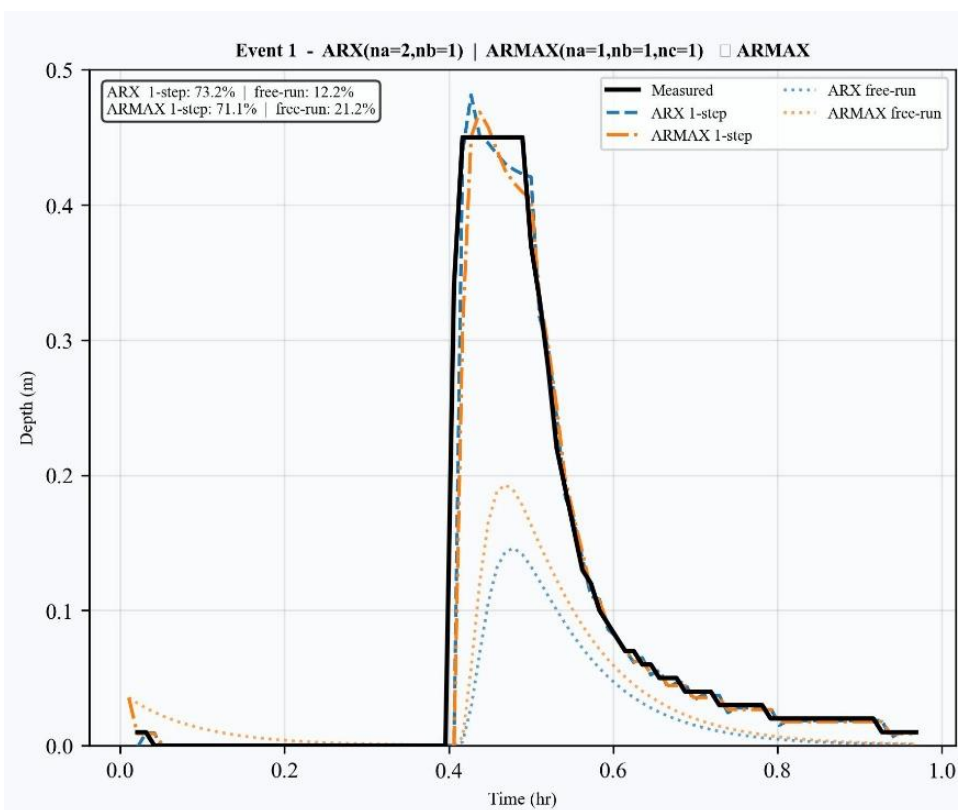
Event 3 (04 Sep, 2022)



Event 4 (14 Oct, 2022)



Result: Control-Oriented System Identification Model



1) Discrete Model

$$G(z^{-1}) = \frac{y(z)}{u(z)} = \frac{bz^{-nk}}{1 - az^{-1}}$$

Time domain

$$y(t) = a_1 y(t-1) + b_1 u(t-nk)$$

2) Continuous Model

$$G(s) = \frac{y(s)}{u(s)} = \frac{K}{Ts + 1} e^{-\tau s}$$

Time domain

$$\frac{Tdy(t)}{dt} + y(t) = Ku(t - \tau)$$



Thank you

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