

From Hours to Seconds - A Physics-Guided Scientific Interpolation Framework for Real-Time Urban Flood Prediction

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Urban flood prediction has required physically reliable simulations, yet the computational cost of high-fidelity hydrodynamic models remains a major obstacle to real-time forecasting because of its complex interactions among rainfall, drainage network, sewer surcharge, river conditions and surface topography. This keynote introduces **SIND (Scientific Interpolation for Natural Disaster)**, a physics-guided framework that rapidly reconstructs flood conditions by identifying hydraulic relationships among precomputed physics-based scenarios rather than repeatedly performing full simulations for each event. SIND preserves significant physical processes governing urban surface-water movement, drainage, and sewer surcharge while substantially reducing computational time. In an urban catchment in Seoul, Rep. of Korea, SIND reproduced major inundation patterns with a mean **CSI of 0.916** and **RMSE of 0.006 m**, while simulating five hours of flood evolution in approximately **6.0 seconds** for the surface calculation. By bridging high-fidelity physics and real-time prediction, it provides a promising pathway toward real-time urban flood prediction and reinforced resilient urban flood management.

Experience:

- National Water Resources Committee — Ministry of Environment, Korea (2025.04 – 2027.04)
- K-water Technical Review Committee (2025.04 – 2027.04)
- Ministry of Environment Flood-prone Area Development Committee (2025.05 – 2027.05)
- Ministry of the Oceans & Fisheries Technical Advisory Committee (2025.12 – 2027.11)
- Han River Flood Control Office Watershed Survey Performance Verification Committee (2025.09 – 2028.09)
- Ministry of Environment Environmental Standard Council Water Expert Committee (2026.01 – 2026.12)
- Korea National Land Safety Authority (2026.01 – 2027.12)
- Ministry of Oceans & Fisheries 8th Design Review Committee (2026.04 – 2027.04)
- Senior Editor — KSCE Journal of Civil Engineering (2021–2023)
- Editorial Committee Chair — Journal of Korean Society of Hazard Mitigation (2020–2022)
- MDPI Guest Editor — Special Issue: Short-term Forecasting in Civil Engineering (2019)
- Committee Chair — AI Application Division, Korean Water Resources Association (2025–2026)
- Committee Chair — Education Contents Special Committee, KWRA (2025 – 2026)
- Committee Chair — KSCE Technology Education Committee (2025)