

메타버스 얼라이언스 프로젝트 그룹 비즈니스 모델 개발

통합 물 관리 SI플랫폼으로의 메타버스 진화

K-waterverse



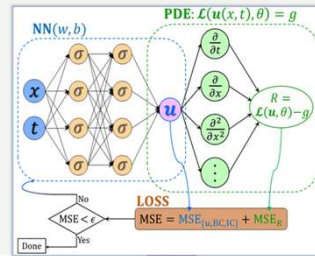
x



프로젝트 개요

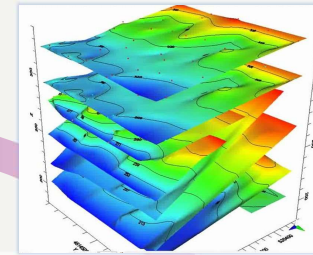


프로젝트 그룹 활동 최종 목표



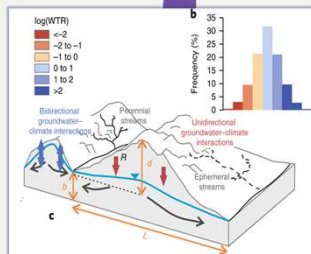
물리 정보 AI

- PINN 기반 물리 시뮬레이션 개발
- 강우 및 배수 분석
- 국소 단위 수문학적 환경 분석



실시간 시뮬레이션

- 수위 분포 예측
- 시간 단위 별 침수 단계 계산
- 디지털 트윈 기반 실시간 시뮬레이션

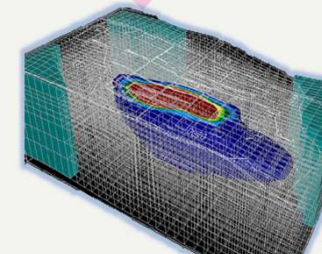


환경 데이터

- 국소 단위 데이터 수집
- 실시간 데이터 검증
- 지표 데이터 통합 플랫폼화



침수 시뮬레이션 시스템



웹 기반 디지털 트윈

- 침수 환경 실시간 시각화
- 정부/지자체 인프라 확대

추진전략 및 체계

협업 시나리오

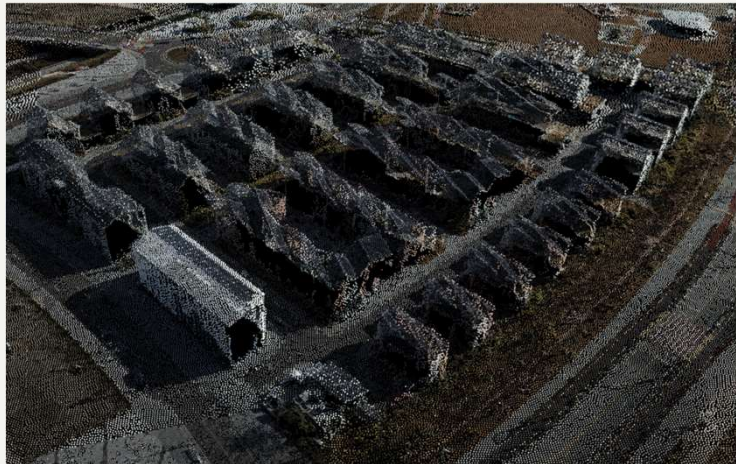


3D 모델 구축

2D 이미지



DEM 데이터

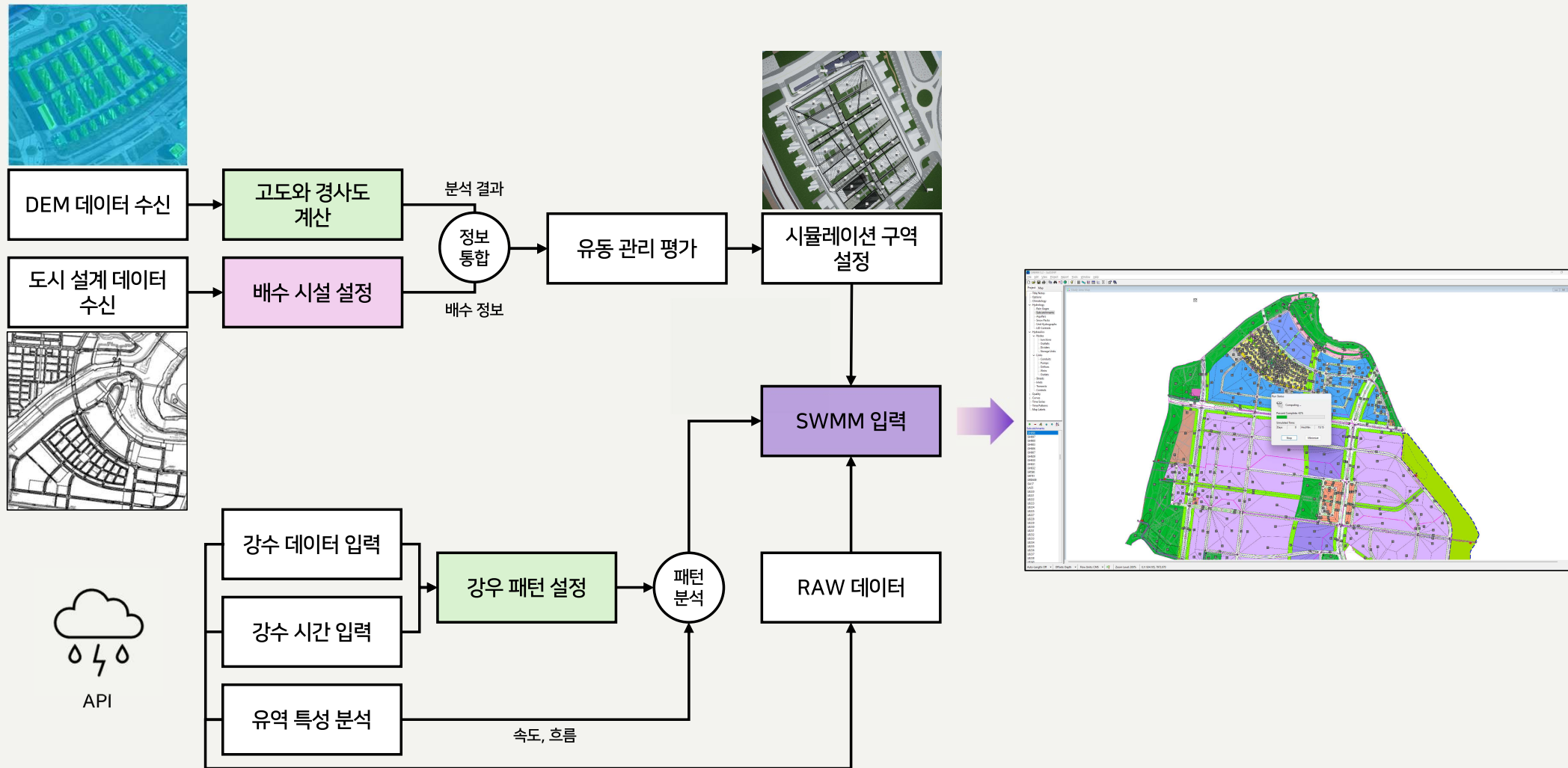


3D 포인트 클라우드

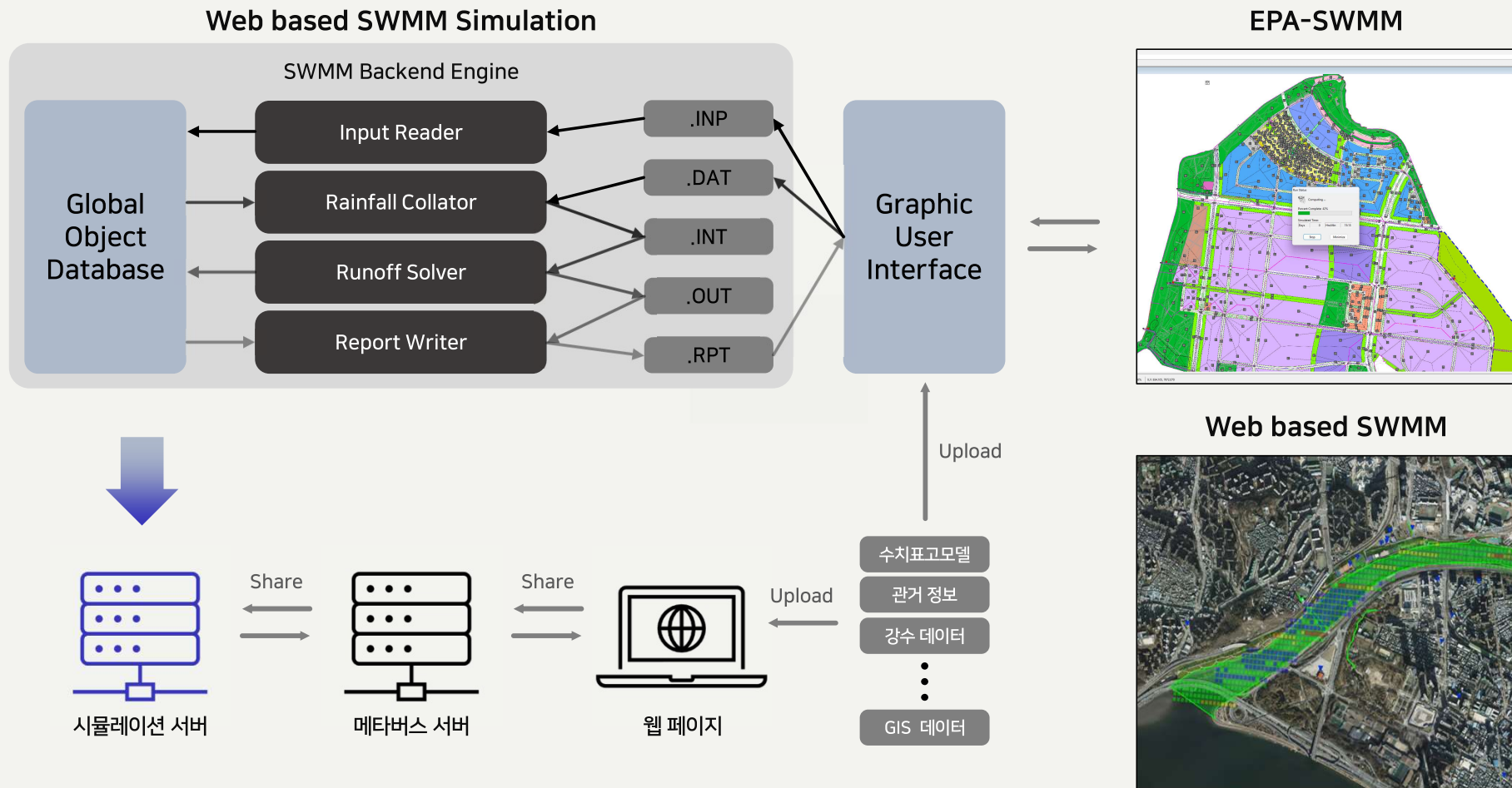


실사 데이터 기반 3D 모델 구축 및 최적화

환경 데이터 연동



SWMM 엔진



SWMM 엔진

전문가 자문을 통한 SWMM 알고리즘 고도화

- 고려대학교 지구환경과학과 이순재 교수(환경수리지질연구실)
 - EPA SWMM 시뮬레이션 데이터 처리 및 환경 변수 검증
 - EPA SWMM-PINN 모델 변환 수식 검증



2024-07-19

2024-07-19

2024-07-19

SWMM simulation 관련 자문 회의

2024.07.19 (금)
고려대학교 지구환경과학과 환경수리지질연구실 최이준

SWMM (Storm Water Management Model)

Defn: a dynamic rainfall-runoff simulation model used for single event / long-term simulation for runoff primarily on quality from primarily urban areas

1) Atmosphere - generates precipitation & deposits pollutants onto the land surface compartment
2) Land Surface - receives precipitation from the Atmospheric compartment in the form of rain/snow
 - Sends outflow in the form of infiltration to the GW compartment
 - Sends outflow in the form of surface runoff and pollutant loadings to the Transport compartment
3) Groundwater - receives infiltration from the Land Surface compartment
 - Transfers a portion of this inflow to the Transport compartment
4) Transport - contains a network of conveyance elements (channels, pipes, pumps, and regulators)
 - storage/treatment units that transport water to outfalls / treatment facilities

SWMM

Figure 1-4 Block diagram of SWMM's state transition process.

SWMM

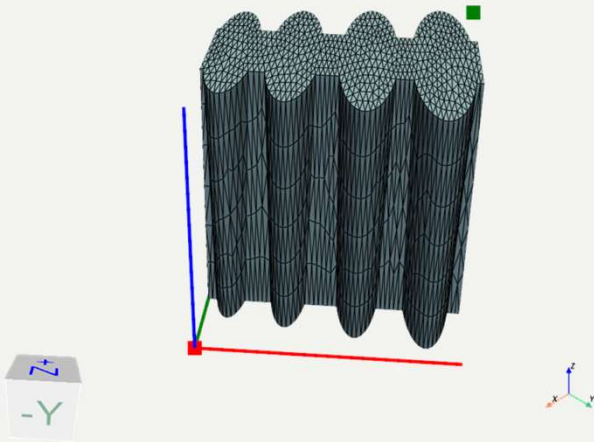
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PINN 침수 예측

물리 정보 구축

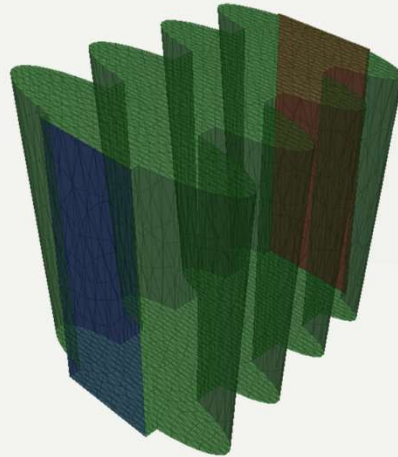
X-axis: min=0.00, max=1.00
Y-axis: min=0.00, max=1.00
Z-axis: min=0.00, max=1.00

Mesh with Inlet and Outlet

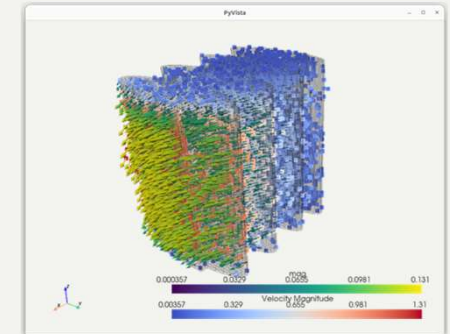
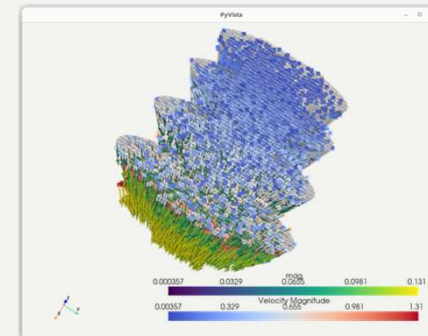
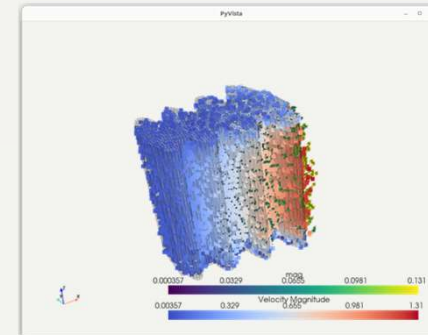


1. 3D Geometry 메시 변환

Boundary Conditions



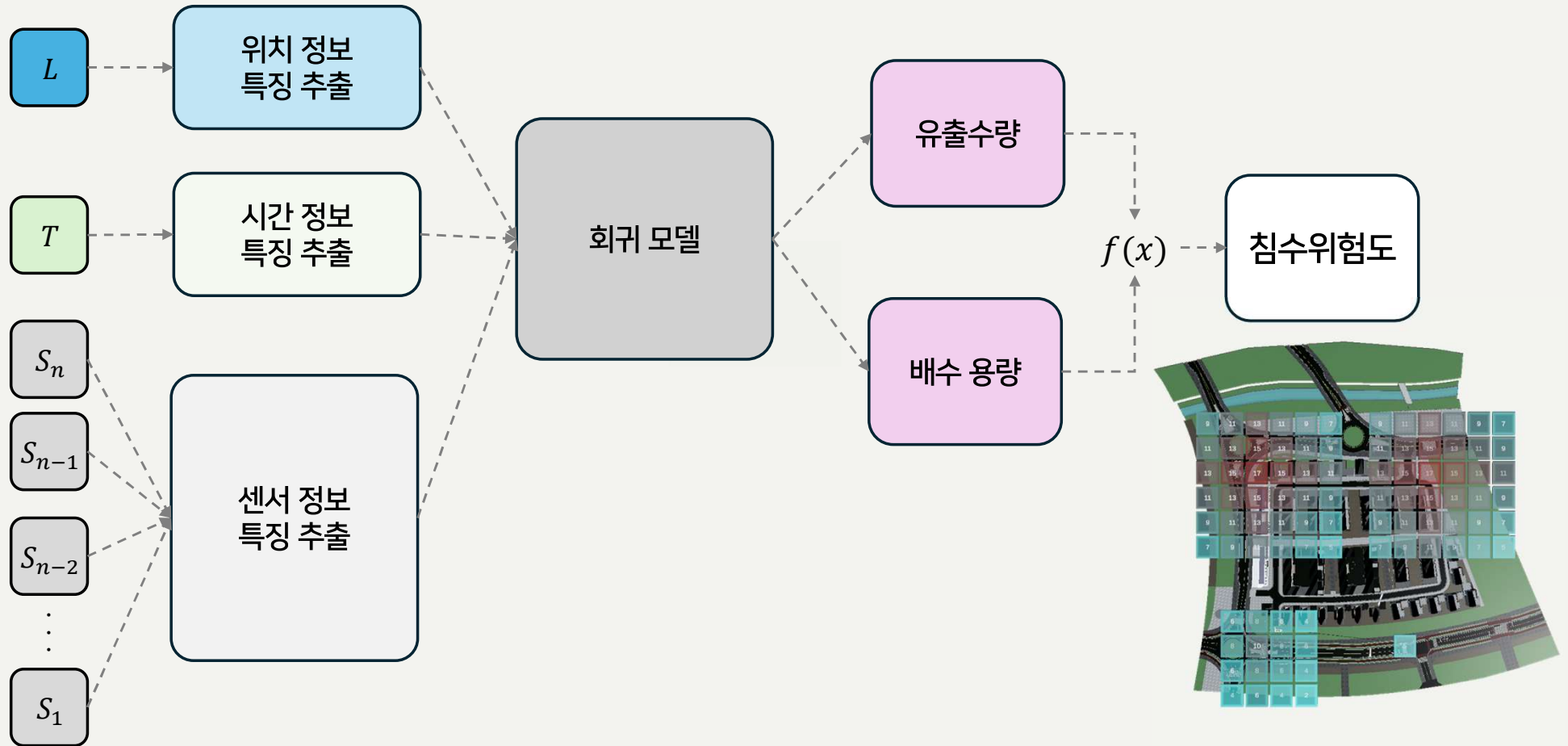
2. 경계조건 및 물리조건 설정



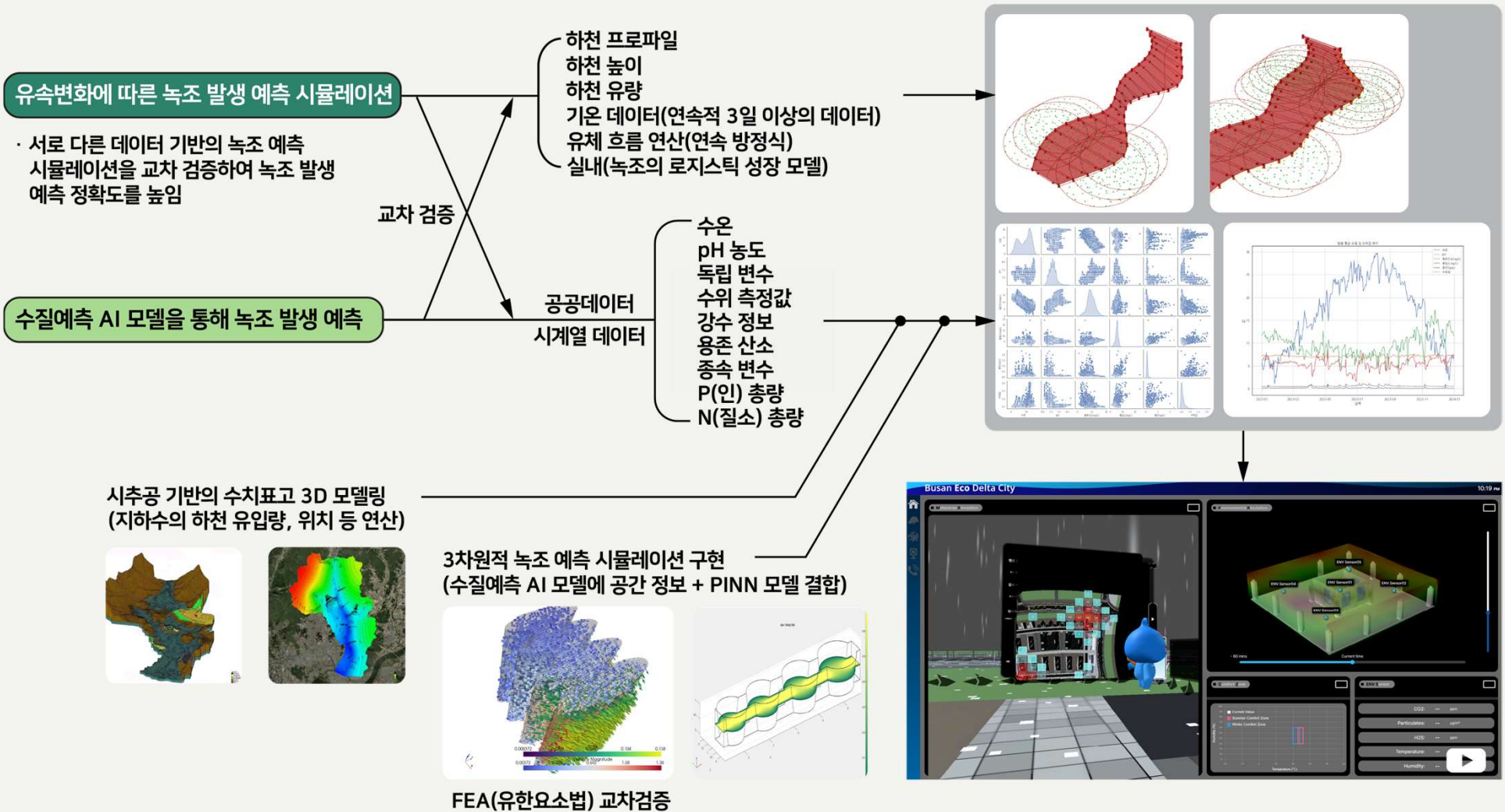
3. 공간정보 및 물리조건 AI 학습

PINN 침수 예측

AI 모델 기반 침수 예측

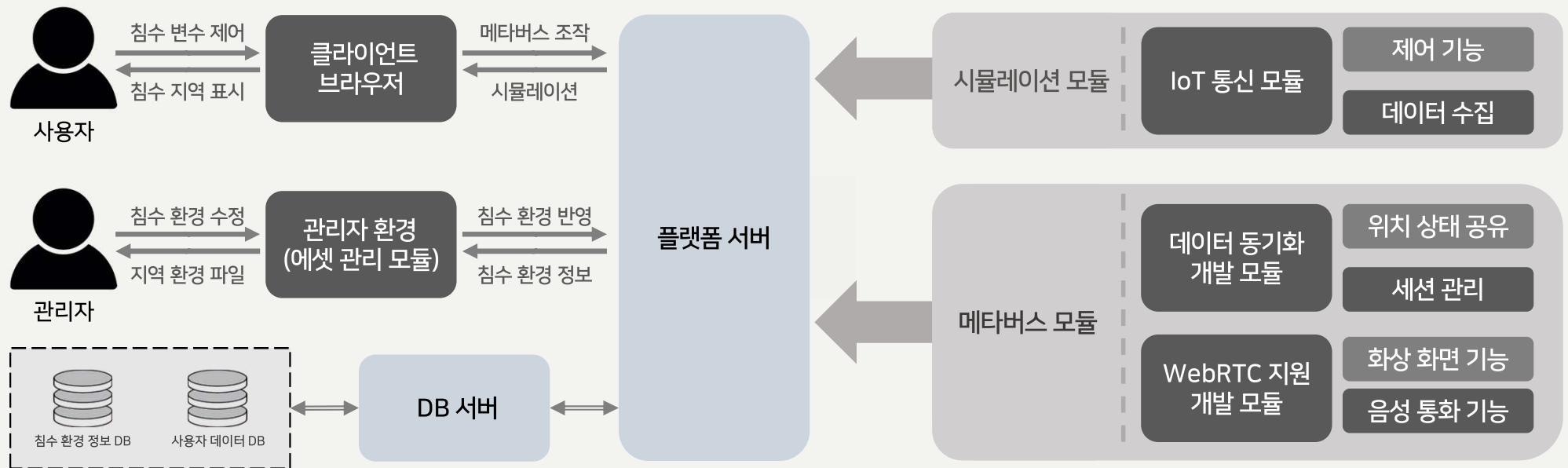


데이터 기반 실시간 녹조 발생 예측 AI 시뮬레이션



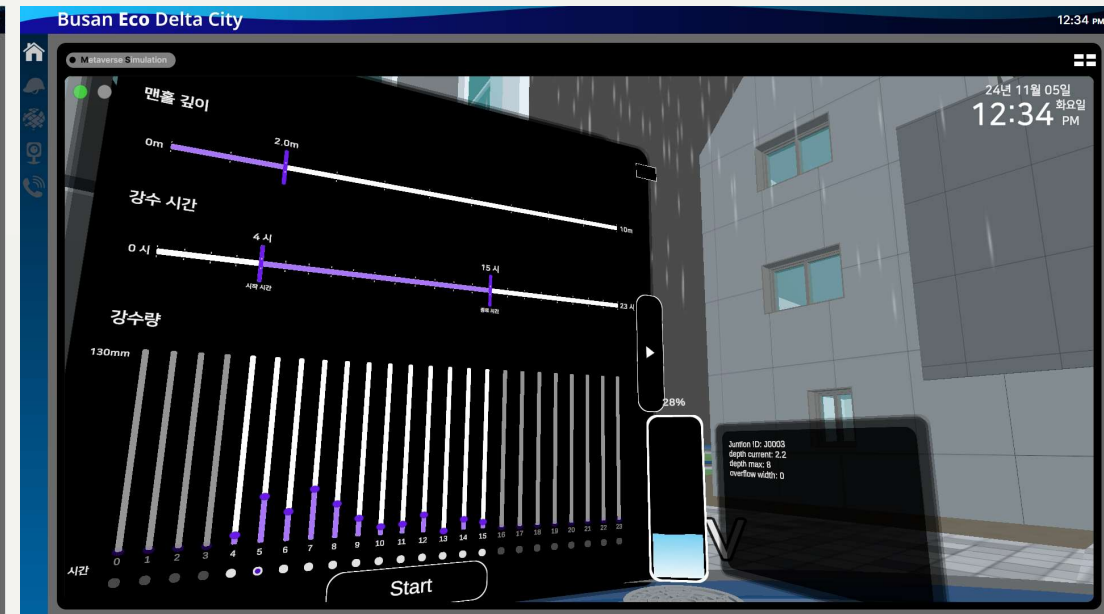
웹 기반 메타버스 환경 구축

메타버스 환경



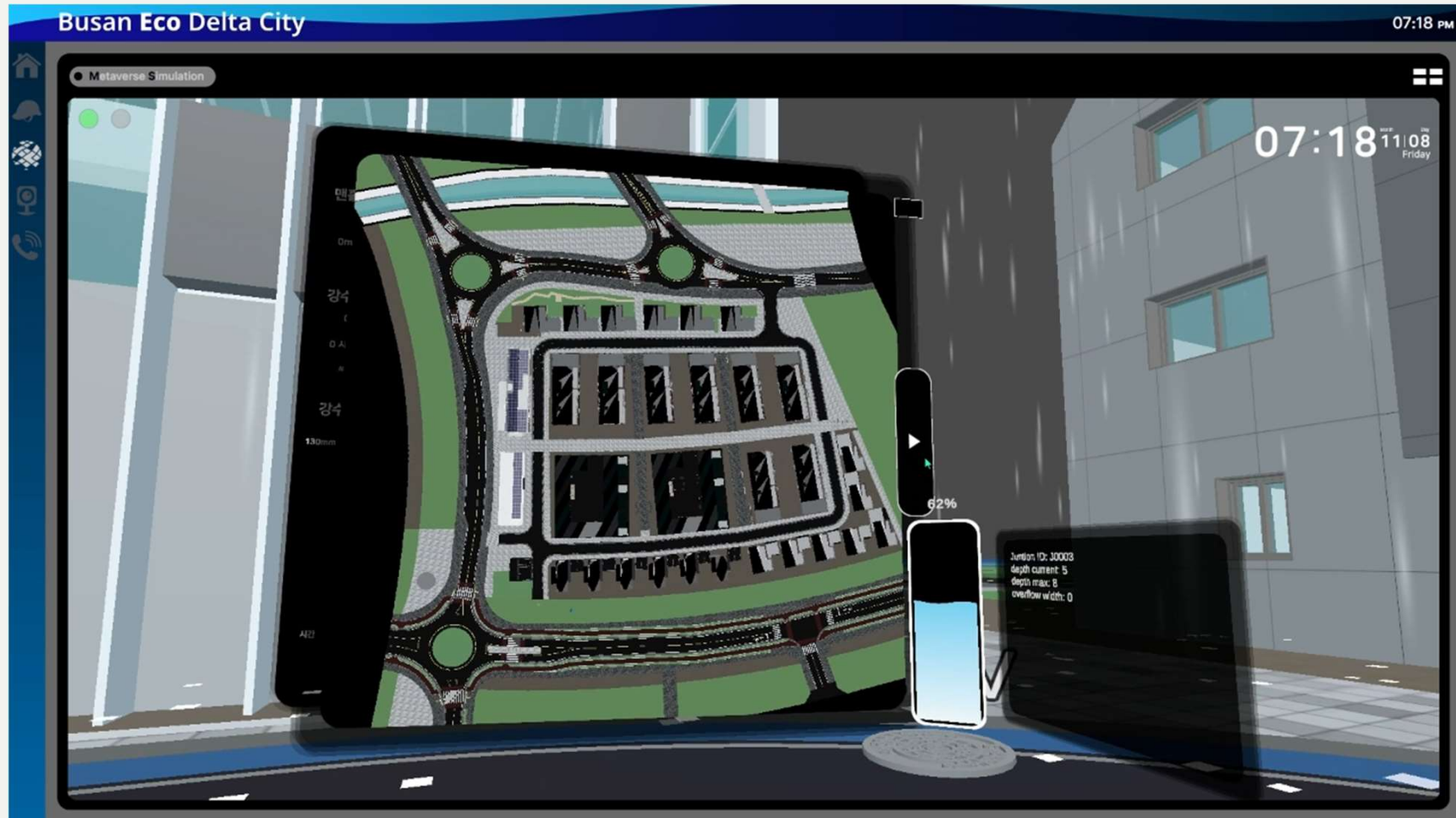
웹 기반 메타버스 환경 구축

웹 기반 메타버스 시각화



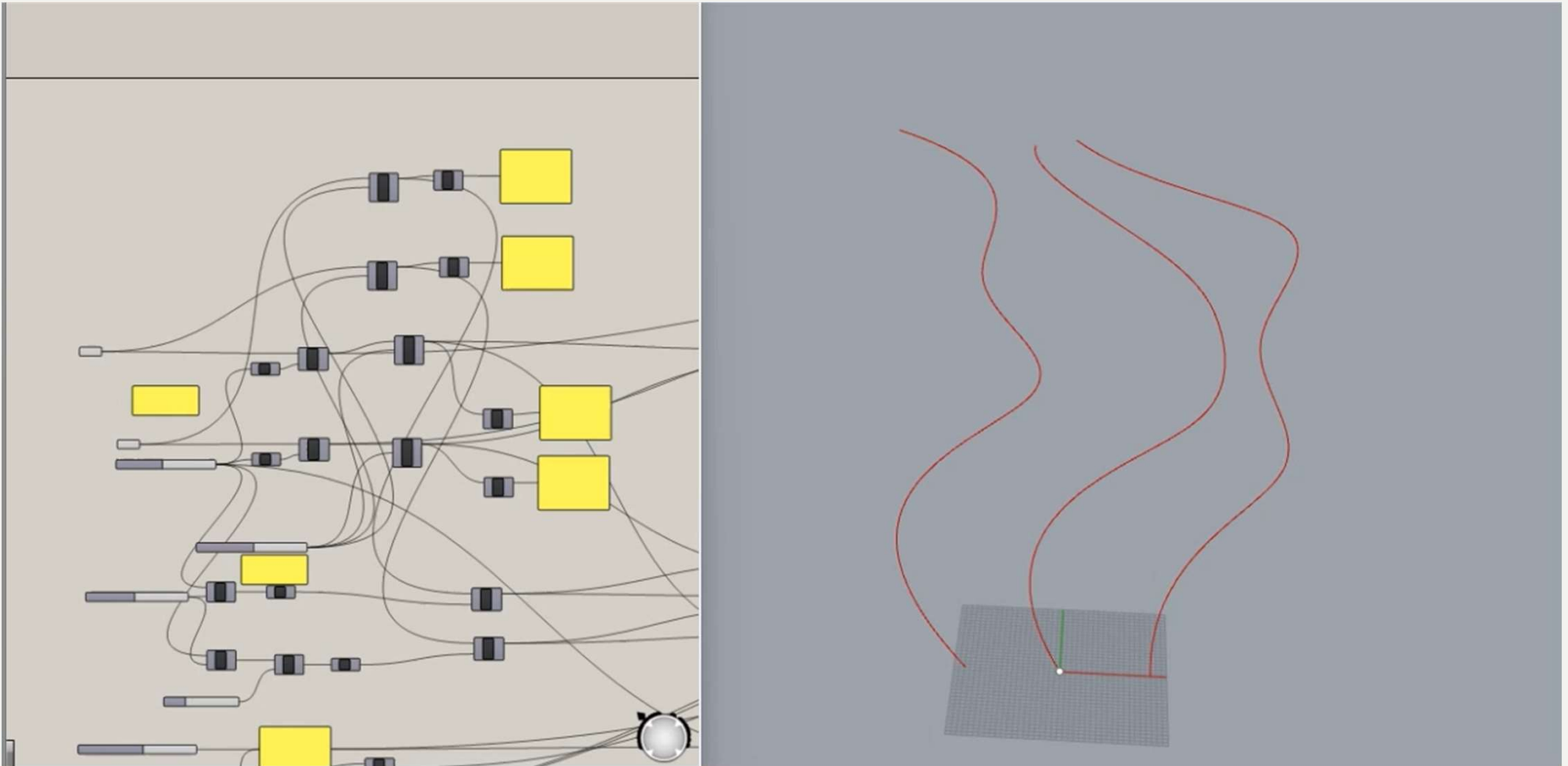
웹 기반 메타버스 환경 구축

시연 영상 - 침수 시뮬레이션



웹 기반 메타버스 환경 구축

시연 영상 - 녹조 시뮬레이션





Metaverse Simulation

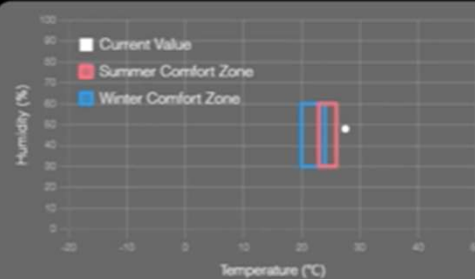


Environmental Simulation



Comfort Zone

A B C D E



EDC Sensor

1 2 3 4 5

CO2: 464 ppm

Particulates: 615 $\mu\text{g}/\text{m}^3$

H2S: 2846 ppm

Temperature: 27.50 $^{\circ}\text{C}$

Humidity: 48.00 %

정량적 목표 달성 현황

구분	성과지표	단위	달성치	비고
실증 목표	실시간 시뮬레이션 모델 속도	FPS	60	-
	물 3D 렌더링 속도	FPS	60	-
	침수 시나리오 구성	-	완료	사용자 커스텀 가능, 공공 API 연동
	녹조 시나리오 구성	-	완료	하천 기반 시뮬레이션
	재난 대응, 안전교육	식	1	시뮬레이션 기반 안전교육
	메타버스 다중 접속자 수	명	20	최대 20명, 실시간 동기화 안정성 10명
	웹 기반 메타버스 환경 제작	-	완료	목표 달성
사업 성과	국내 특허 출원	건	1	실시간 웹 기반 도시 침수 예측 및 시뮬레이션 시각화 시스템
	성과 홍보	건	6	국내 전시: NestRise, WSCE, KADEX, 소프트웨이브 해외 전시: WETEX, Expand North Star

사용자 피드백 및 개선 사항 분석

K-water 디지털전환추진단 미팅 및 적용, 활용 방법 협의

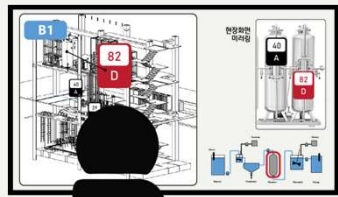


확장 계획

K-water 디지털 트윈 플랫폼 연동



K-테스트베드 활용, 실증 연계 인프라 확보



사용자

접속

디지털 트윈 Web

렌더링 결과

렌더링 연산

WebGPU/GL 모듈

User 데이터전송

시뮬레이션 보고서

외부 데이터

환경센서 메시네트워크

*온습도, 강수정보 등

공공데이터 API

*EDC 플랫폼 센터, 부산시 데이터

데이터 연동

디지털 트윈 Server

데이터 읽기

데이터 저장



디지털 트윈
데이터베이스

시뮬레이션 연산

시뮬레이션 결과

SWMM Backend

연산 요청

2D Sim 결과

시뮬레이션 Engine

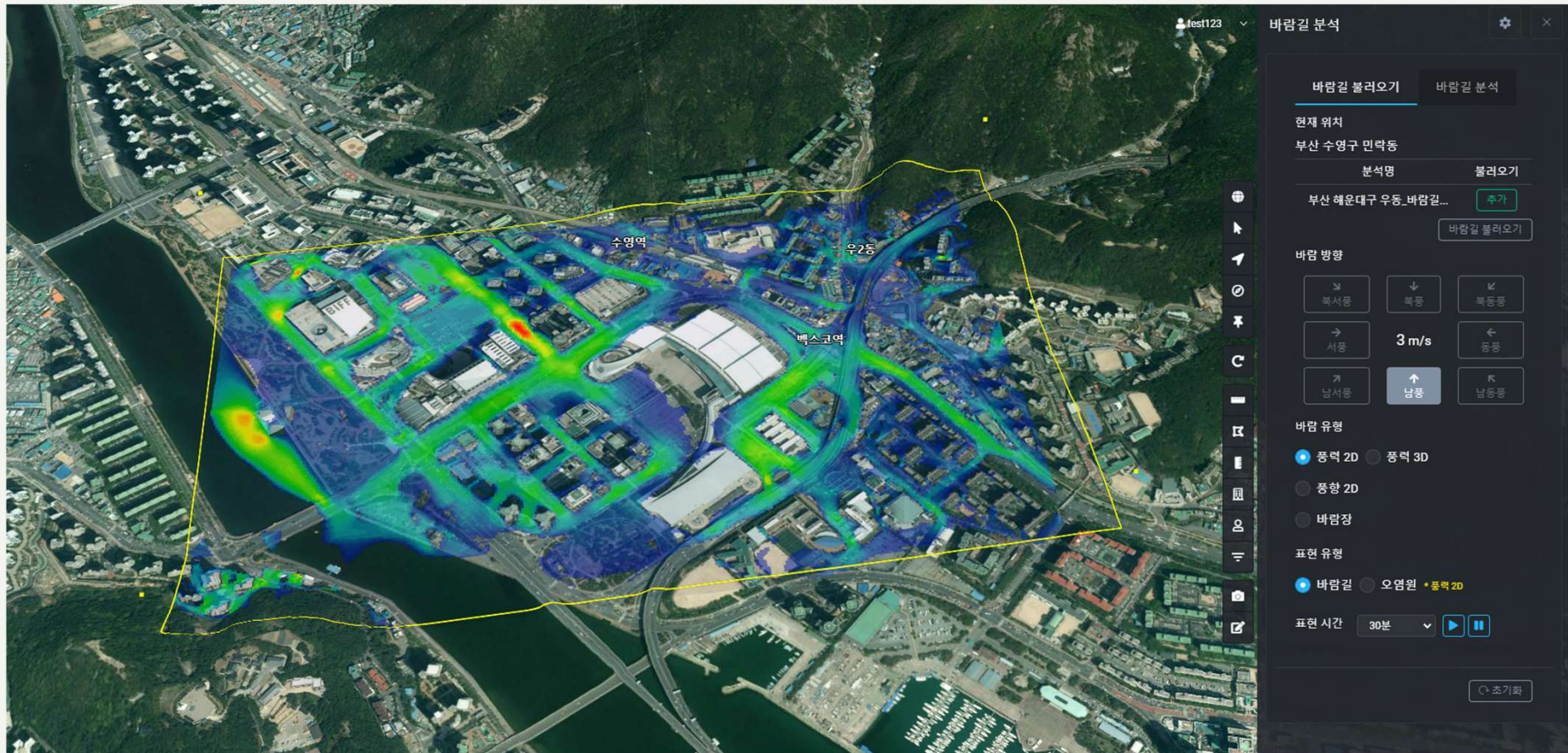
3D Sim 결과

연산 요청

PINN AI

확장 계획

바람길 분석 시뮬레이션





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