KICT REC
River Experiment Center

Digital Twin Based R&D for Social Problem Solving

:Building Sustainable Infrastructure through Digital Twins and AI

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Outline

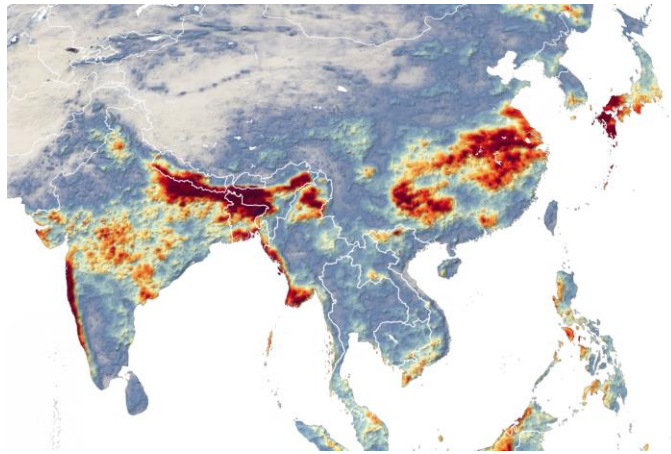
- Introduction
- Objectives and Alignment
- Technical Architecture
- Case Study: KICT REC
- Phased Plans
- Summary

Introduction (1/2)

- **Context and Motivation**
  - Global challenges: climate change, floods, waste management inefficiency.
  - Need for cost-effective and evidence-based decision support tools

- **Regional Context and Rationale**
  - Asia-Pacific faces water scarcity, floods, droughts, and aging infrastructure
  - Capacity gaps across member States limit adoption for policy decisions

Excessive Monsoon Rains Flood Asia



Images referenced from https://earthobservatory.nasa.gov/images/147006/excessive-monsoon-rains-flood-asia

Asia floods: Death toll climbs in severe monsoon season

Images referenced from https://www.bbc.com/news/world-asia-66197937

Introduction (2/2)

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• International Digital Twin Trends and Leading Cases

SG Singapore

Smart Water Grid

PUB Smart Water Grid Digital Twin

- 450 sensors across entire water loop
- AI-powered leak detection
- 24/7 pressurized network optimization
- 80%+ accuracy in real-time anomaly detection

450 Sensors | AI Leak Detection | 80% Accuracy

JP Japan

Flood Management

River Basin Digital Twins

- Multi-basin integration system
- Flood early warning capabilities
- Disaster scenario simulations
- "River Basin Disaster Resilience" policy

Multi-basin Integration | Flood Early Warning | Disaster Resilience

CN China

National Scale

Large-Scale Basin & Irrigation DT

- Major basin digital twins
- Real-time sensor data integration
- Algorithm-based operation optimization
- Pishihang Irrigation District case

Large Basin | Irrigation Optimization | Real-time Monitoring

TO Tonga (Small Island State)

Climate Adaptation

3D Urban Digital Twin

- UN-led project initiative
- Tongatapu Island 3D modeling
- Sea-level rise simulations
- Coastal disaster scenarios

3D Modeling | Sea Level Rise | Disaster Scenarios

4+	15+	5	2025
Major International Projects	Related Countries	Key Application Areas	Target Completion Year

Objectives and Alignment

- Build validated digital-twin frameworks with sensors and high-performance computing
- Run pilots for allocation, quality monitoring, and disaster response
- Support evidence-based policy using analytics

What we are working

KICT REC River Experiment Center

Digital twin frameworks with sensor networks and high-performance computing

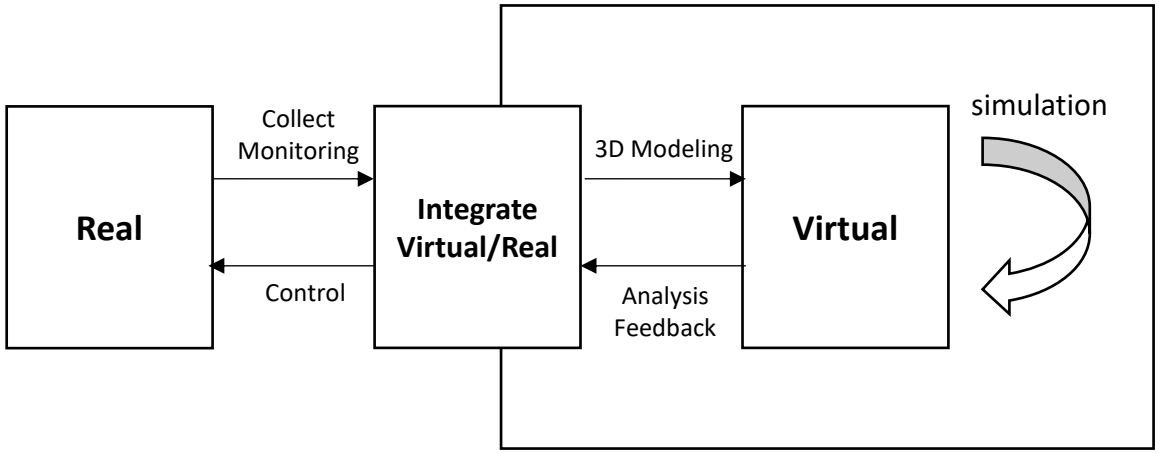
What we want to do

ESCAP APCTT Asian and Pacific Centre for Transfer of Technology

Customize to country context for relevance and efficiency for member States

Technical Architecture (1/3)

- **Digital Twins**
  - Continuously synchronized virtual representation of a physical asset, process, or system
  - Ingests live and historical data to monitor state, run simulations, and optimize decisions across the lifecycle
  - Integrate Internet of Things, satellite, hydrological data, and AI to optimize water systems

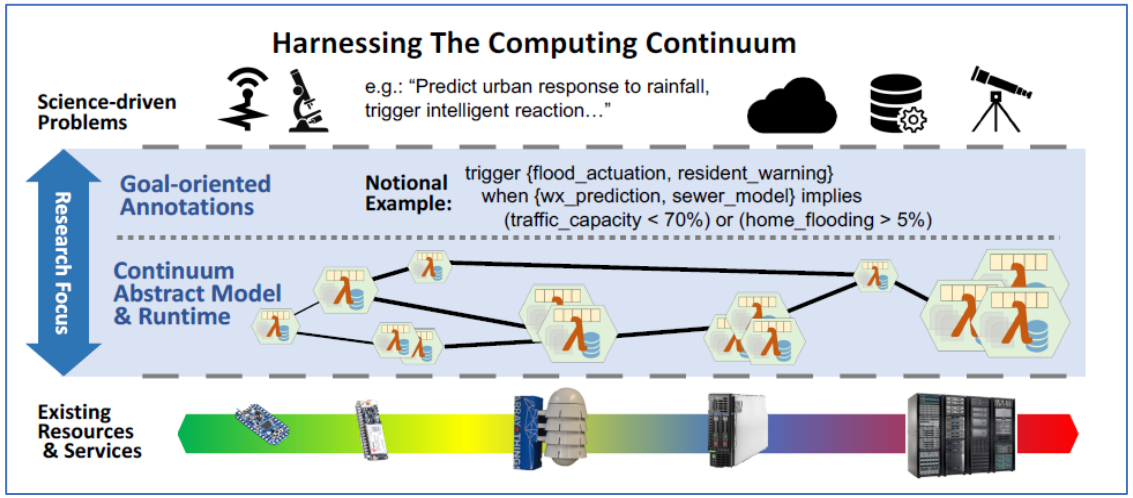


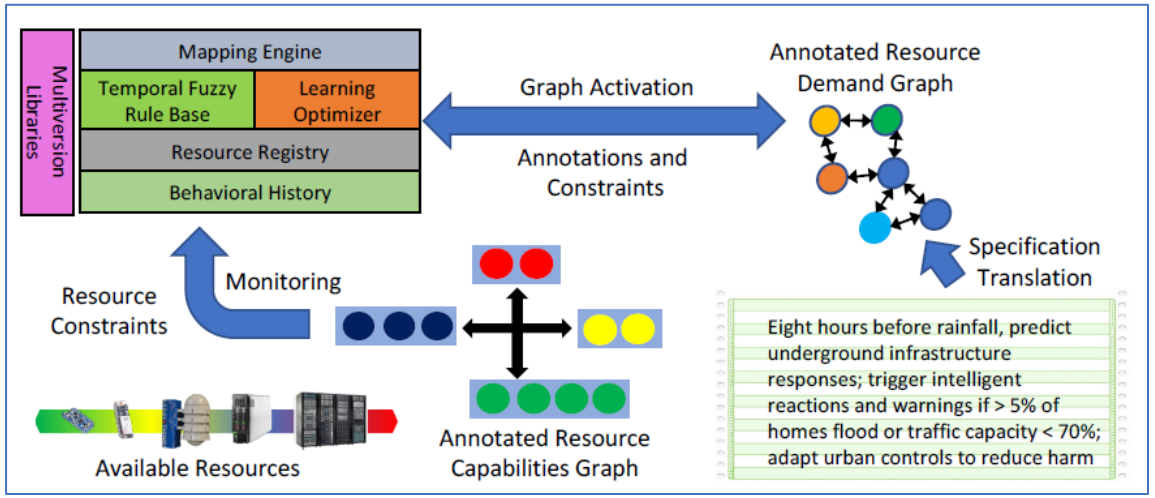
Apollo 13 the First Digital Twin

Image referenced from https://blogs.sw.siemens.com/simcenter/apollo-13-the-first-digital-twin/

Technical Architecture (2/3)

- **Computing Continuum**
  - Integrated compute environment that spans devices, edge, on-premises data centers, HPC, and public cloud
  - Heterogeneous hardware support: CPU, GPU, FPGA, AI accelerators.





- Pete Beckman; Jack Dongarra; Nicola Ferrier; Geoffrey Fox; Terry Moore; Dan Reed; Micah Beck, "Harnessing the Computing Continuum for Programming Our World," in Fog Computing: Theory and Practice , Wiley, 2020, pp.215-230

Technical Architecture (3/3)

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River Experiment Center

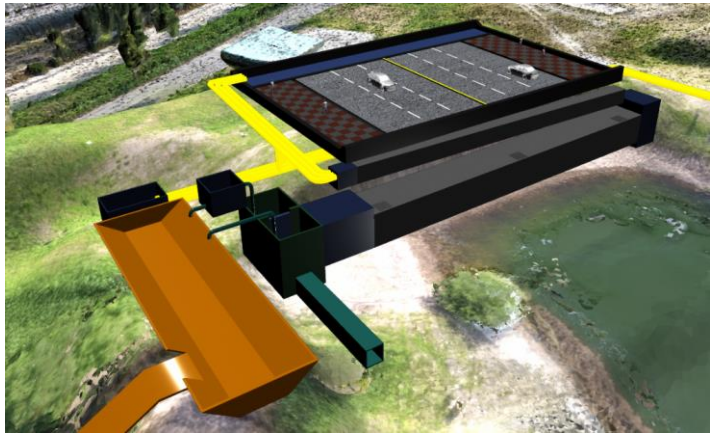
- **Artificial Intelligence & Simulation**
  - Estimate flood/landslide risk and lead time
  - Detect and classify waste in river to estimate volumes and prioritize cleanup
  - Performance drifts as conditions change, so continual updating is required.

Waste Detection using YOLO v5

Simulation for Workload planning integrated with AI

Case Study: KICT REC (1/2)

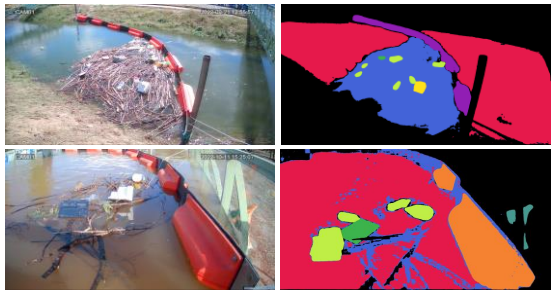
- KICT(Korea Institute of Civil Engineering and Building Technology) River Experiment Center
  - Need for a paradigm shift in river management under climate change
  - Supporting government policies through ecological experiments, full-scale river experiments, and large-scale hydraulic model tests that were previously impossible.
  - Promoting public technological research and development that is difficult for private companies or local governments to undertake independently



Case Study: KICT REC (2/2)

- Problem Solving
  - Technological
    - Applying Internet of Things, AI technology to solve the social problems
    - Applying zero-shot Learning to cut data labeling and training cost
      - Cooperation with Hanbat National University
  - Empowerment Programs
    - Helping others public organizations
    - Supporting local educational activities
      - Implemented an inclusive education program for children with and without disabilities at REC
      - Strengthened collaboration between REC, local schools, and community organizations through hands-on field programs.

KTNF Edge Server for Computing Continuum



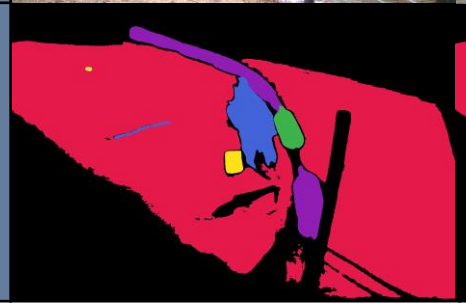
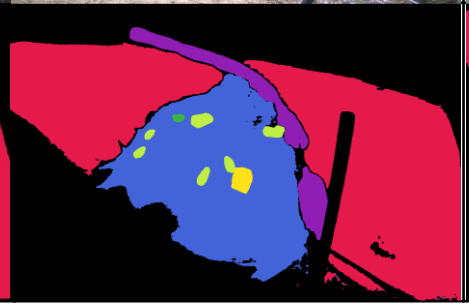
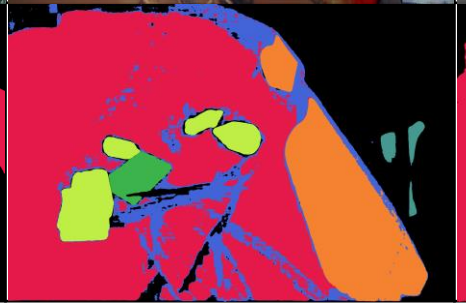
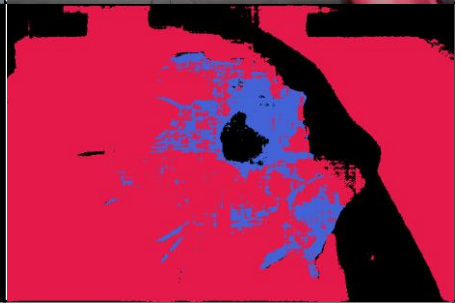
Waste Detection utilizing VLM(Zero-shot Learning)

Educational Programs

Phased Plans (1/3)

- **Phase I — Sustainable Experiment Digital Twin**
  - Apply zero-shot and few-shot learning to cut data labeling and training cost
  - Couple AI with physics-based models to build a sound experimental foundation
  - Verify and calibrate against River Experiment Center runs

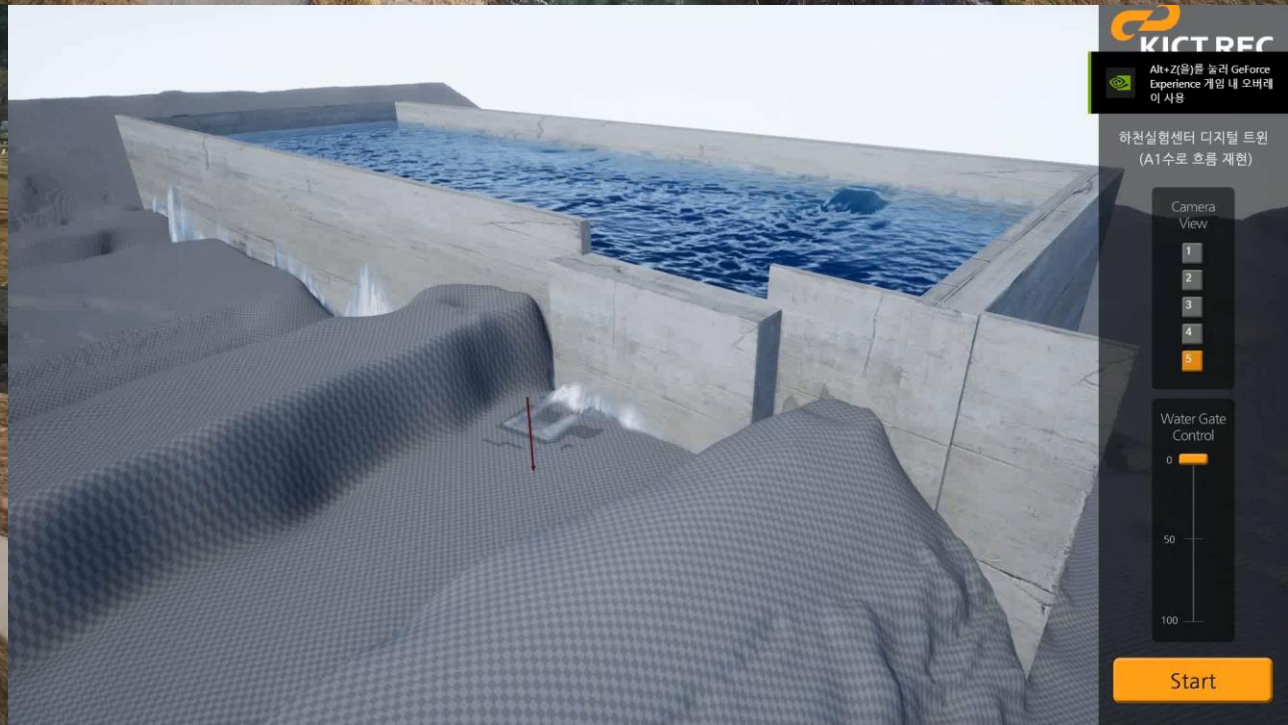
Water Plastic container Plastic bottle Buoy Human White Styrofoam box Floating wood debris Gas cylinder

Case	A	B	C	D	E
Image					
Result					

Upstream

Midstream

Downstream


KICT REC
Alt+Z(을)를 눌러 GeForce Experience 게임 내 오버레이 사용
하천실험센터 디지털 트윈
(A1수로 흐름 재현)
Camera View
1
2
3
4
5
Water Gate Control
0
50
100
Start

Phased Plans (2/3)

- **Phase II — Expanding boundaries**
  - Open the Digital Twin solutions and experiment environment for secure remote use by partner countries
  - Enable remote parameterization, scenario runs, and result sharing to save field effort

Experimental validation of pollutant dispersion modeling in a meandering channel, in cooperation with US

Analyzing flow characteristics of a full-scale river with vegetation patches, in cooperation with US, NL, and FN

On the technology front, the River Experiment Center is outfitted with a treasure trove of instruments, including ADCPs, electromagnetic and acoustic Doppler velocimeters (ADVs), an underwater laser particle size analyzer, a high-resolution 3D laser scanner for riverbed and vegetation measurement, multi-parameter water quality measurement equipment, and high-precision VRS GPS.

The unique control and measuring capabilities at the Center made it an ideal site for SonTek to alpha-test the RS5 and host a regional training for customers and staff from 20 countries. It has also been used by researchers from Korean universities, TU Delft in the Netherlands, the University of Idaho and National Science Foundation in the U.S., Finland's Aalto University, and others from Canada and France to address a wide range of hydrological questions over the years.

"The challenge with hydrological experiments is they don't always scale up accurately," notes Justin Stockley of Xylem Analytics' North Asia Surface Water Team. "This is as close to near-scale in a lab environment as you'll find anywhere in the world."

The River Experiment Center is home to an annual ADCP Technical Cooperation Workshop–often called the ADCP regatta–the Han River Flood Control Office, KIHS, and KICT organize. Recent regattas have drawn more than 90 attendees from 14 institutions to put their instruments through their paces, verify their ADCPs, compare notes, and learn new techniques. Junjae Won of Xylem Korea notes that seeing nearly 60 remote-controlled ADCPs plying the River Experiment Center's channels reveals a lot about Korea's passion for technology, hunger for top-quality data, and heritage of managing its water resources.

ADCP REGATTA

The annual South Korea ADCP regatta is held at the River Experiment Center in Andong. Organized by the Korea Institute of Hydrological Survey, the 2023 event had over 100 ADCP instruments making discharge measurements over two days. The event serves as a place to verify ADCP instrument operation after an intense measurement season as well as exchange information and best practices. The River Experiment Center is a special place where near-scale hydraulic research can be conducted in a facility that spans 193,000 m².

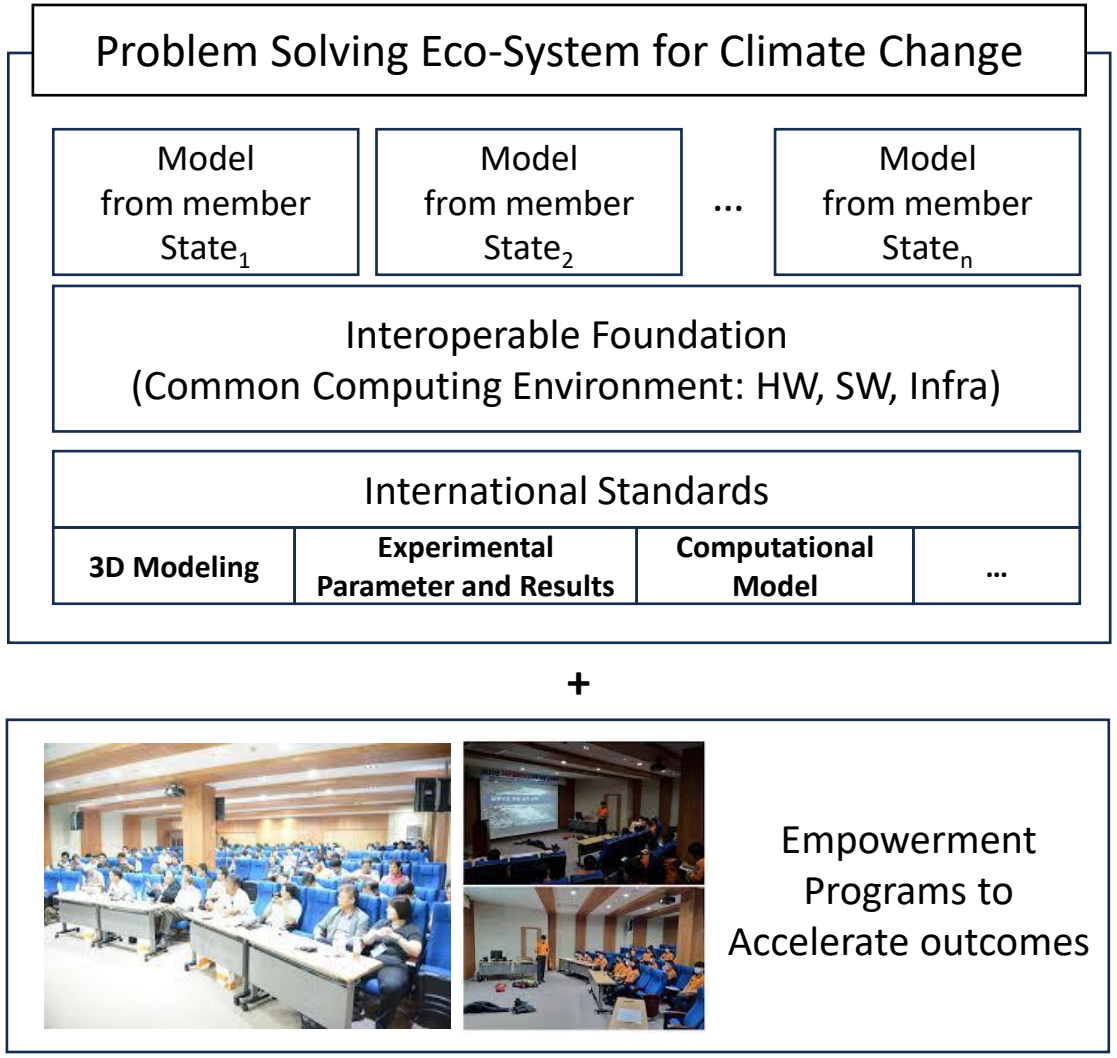
SONTEK DEALER MEETING AT THE REC

26

MISSION: WATER

Phased Plans (3/3)

- **Phase III — Accelerating outcomes**
  - Inbound program: invite policymakers and engineers for guided solution building
  - Outbound program: open a common platform to grow a multinational ecosystem
  - Develop reusable standards and reference simulation models for water Digital Twin use cases



Summary

- Problem
  - Costly and slow physical river experiments
- Solution
  - A digital twin deployed across the computing continuum that cuts time and budget while preserving fidelity
- Plan
  - Three phases from lab validation to regional scaling
- Outcomes
  - Pilot proof, capacity built, reusable standards, policy uptake