

Integrated Approach to Urban Inundation Risk Reduction : RAINSYS & RainMe

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1. Urban Flood Challenges

1. Urban Flood Challenges

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Why Urban Flood Risk is Increasing

- ✓ Climate change is intensifying typhoons and increasing extreme rainfall events.
- ✓ Short-duration, high-intensity rainfall has become more frequent, raising urban inundation risks.

Global Extreme Weather Events and Impacts in 2024 (KMA, 2025)

Nation	Date	Event	Damaged
Philippine	10.25.	Typhoon "TRAMI"	At least 85 deaths and 41 missing due to large-scale floods and landslides
Japan	9.20. ~ 9.22.	Heavy Rainfall	6 deaths and 498.5mm of rainfall in 48 hours
Vietnam	10.27.	Typhoon "TRAMI"	12 deaths and 7 injuries due to flooding
China	6.21.	Heavy Rainfall	47 deaths due to flooding in southern Guangdong Province
Thailand	12.3.	Heavy Rainfall	30 deaths and 660,000 homes inundated due to persistent heavy rainfall
Republic of Korea	7.8. ~ 7.10.	Heavy Rainfall	6 deaths and 2 missing due to inundation and landslides
	9.19. ~ 9.22.	Heavy Rainfall	Record-breaking autumn rainfall in Changwon City: 397.7mm/24hrs and 104.9 mm/hr

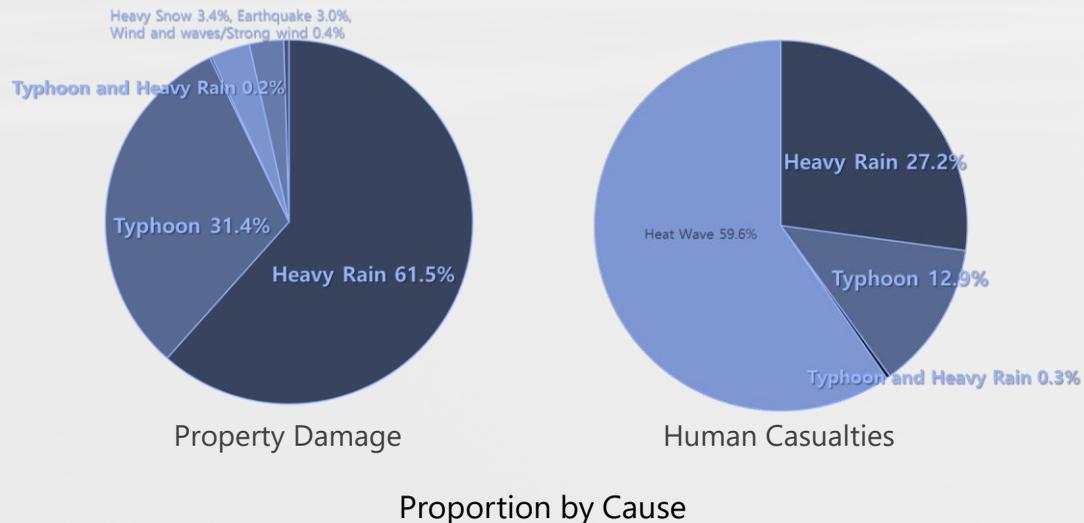
KMA "Abnormal Weather Report 2024" (2025)

1. Urban Flood Challenges

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Inundation Risk are Increasing in Korea

- ✓ **93.1% of property damage and 40.4% of human casualties** are due to **heavy rains and typhoons**, which account for most of the damage caused by natural disaster.
- ✓ Severe urban inundation events **occurred repeatedly**.
 - In 2022, Seoul suffered human casualties due to record-breaking heavy rainfall.
 - In 2023, 14 people died due to inundation of an underpass.
 - In 2024 and 2025, heavy downpours of over 100mm per hour and nearly 500mm in 24 hours caused Inundation of buildings and roads.



Inundation in Gwangju, Korea (July, 2025)

1. Urban Flood Challenges

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Need for Effective Inundation Response Information

Current Issues

Uniform warning criteria nationwide

Lack of field-measured inundation data

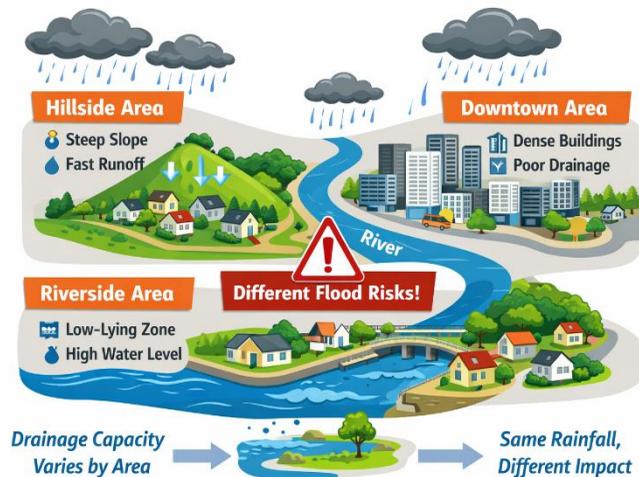
General non-specific alerts

Urban Flood Challenges

Localized inundation risk criteria

Real-time sensor based measurement & prediction

Decision-support alerts at the local scale



Practical and localized inundation information system is required

2. Localized Risk Criteria

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What is the Urban Inundation Risk Criteria

- ✓ **Threshold Rainfall** represents the minimum rainfall that can cause urban inundation*
- ✓ Rainfall thresholds are **estimated for each administrative "Dong"**
- ✓ **Risk Criteria** levels are defined as 50~80% of the threshold rainfall to provide sufficient lead time for evacuation

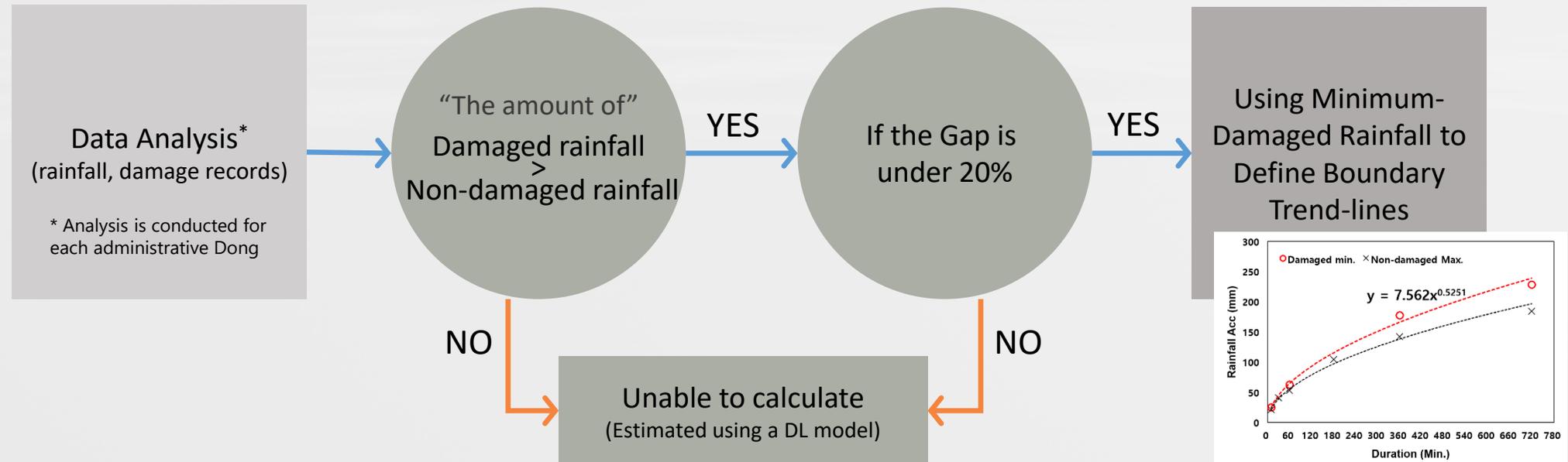


Road curb in Korea

* **Urban Inundation** : water depth exceeding approximately 20cm, corresponding to typical road curb height in Korea.

How to calculate Threshold Rainfall

① using historical rainfall data and damage cases



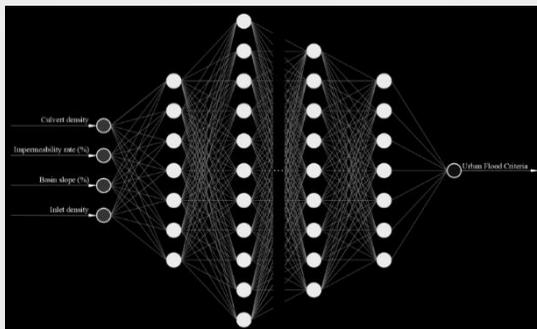
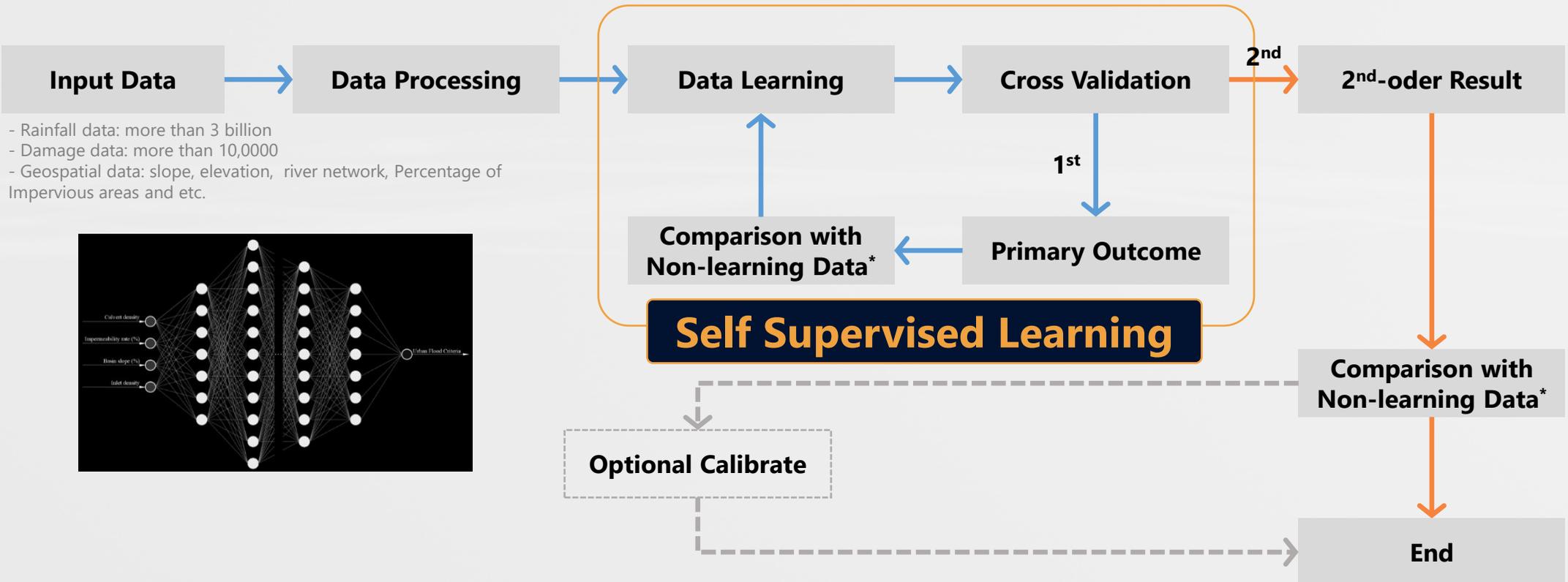
2. Localized Risk Criteria

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Estimating Threshold Rainfall in Data-limited Areas

② Assistance from Deep Learning

- ✓ Train data: Threshold rainfall (derived from damage records), Watershed characteristics
- ✓ Estimating threshold rainfall without damage records using only watershed characteristics



* If the conditions are met Non-damaged rainfall < Y < Damaged rainfall

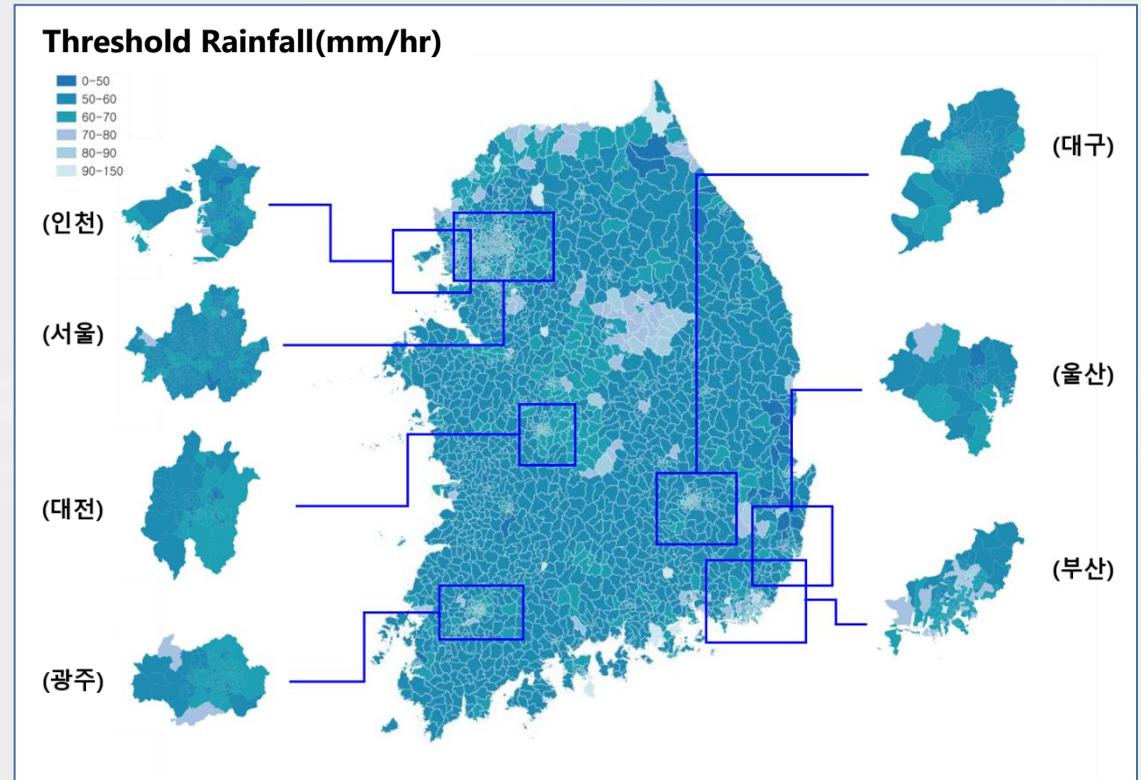
2. Localized Risk Criteria

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Urban Inundation Risk Criteria

Localized Risk Criteria

- ✓ Using this methodology, we calculated the threshold rainfall for 3,390 administrative Dong, except island areas.
- ✓ In order to provide a alert at least 10 minutes to 1 hour before inundation, the risk criteria was set in stages from 50% to 80% of the threshold rainfall.



3. Operational Framework



3. Operational Framework

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RAINSYS: Real-time Alert for Inundation SYStem

✓ Applying localized risk criteria in RAINSYS



* Trademark registered

- Cumulative rainfall by duration
- Inundation forecast map
- API-based data sharing (pilot areas)
- **Threshold-based risk alerts**

번호	시군구	행정동	침수위험도
1	서울특별시 강남구	삼성2동	위험
2	서울특별시 강남구	삼성1동	위험
3	서울특별시 강남구	대치1동	위험
4	서울특별시 강남구	개포1동	위험
5	서울특별시 강남구	도곡2동	위험
6	서울특별시 강남구	도곡1동	위험
7	서울특별시 강남구	역삼2동	위험
8	서울특별시 강남구	역삼1동	위험
9	서울특별시 강남구	개포2동	위험
10	서울특별시 강남구	논곡2동	위험
11	서울특별시 강남구	개포4동	위험
12	서울특별시 강남구	일원반동	위험
13	서울특별시 강남구	일원1동	위험

✓ Not only a monitoring tool, but a risk-informed decision support system

3. Operational Framework

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RainMe: Field-based Inundation Measurement

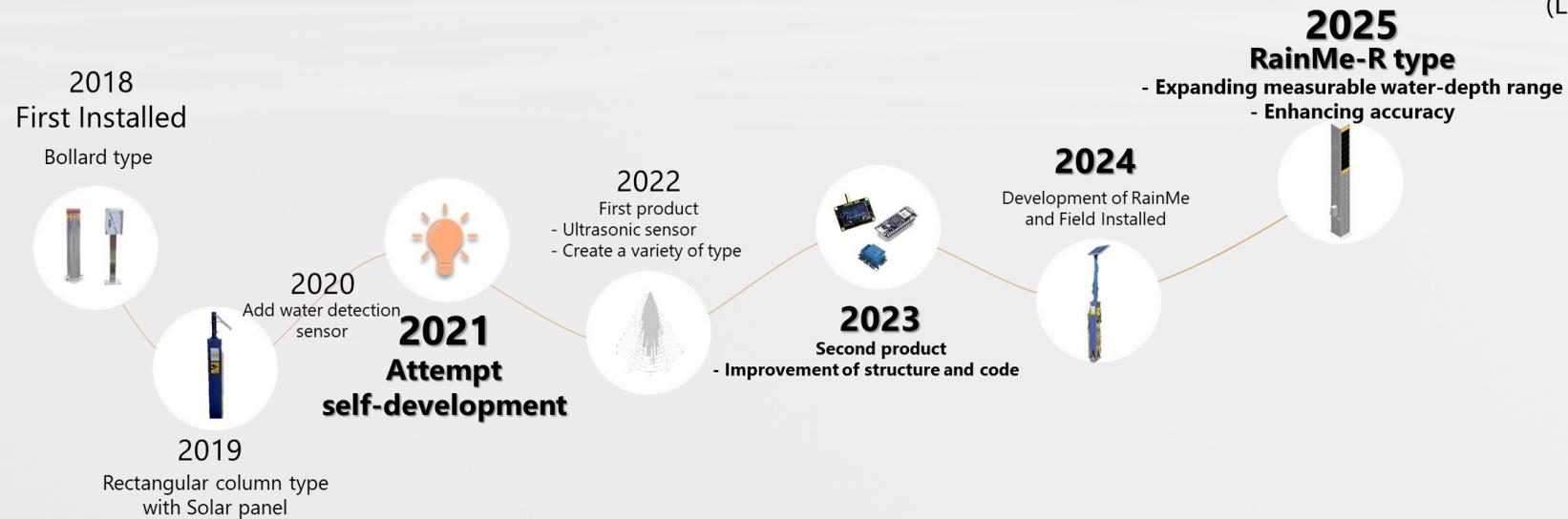
✓ **RainMe has evolved** through field testing and design improvements to provide reliable real-time inundation depth measurements.

- Measures real-time inundation depth*
- Installed on roads and curbs etc.
- Measured data used for DL model improvement and validation

* Real-time inundation depth data are currently accessible to RAINSYS administrators during the pilot phase.



(Left) 2025ver. (Right) 2024ver.



3. Operational Framework

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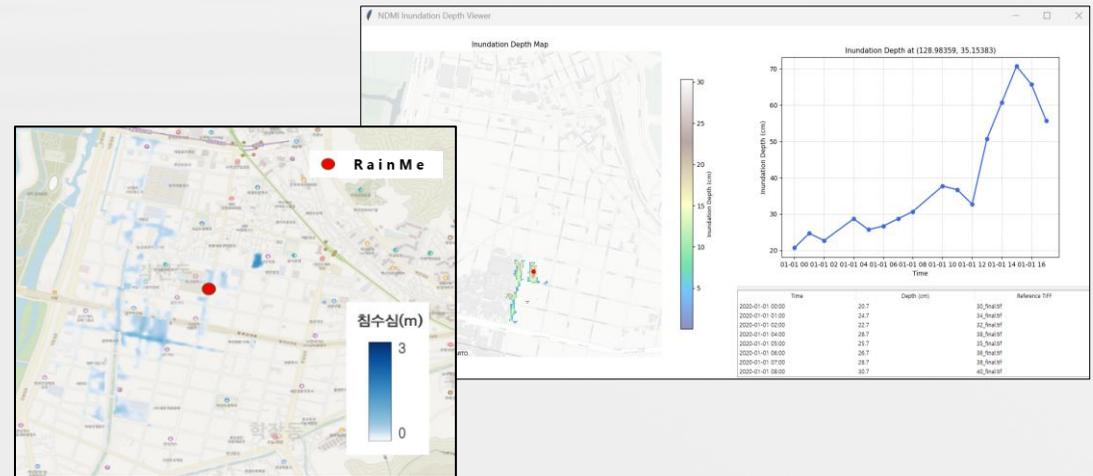
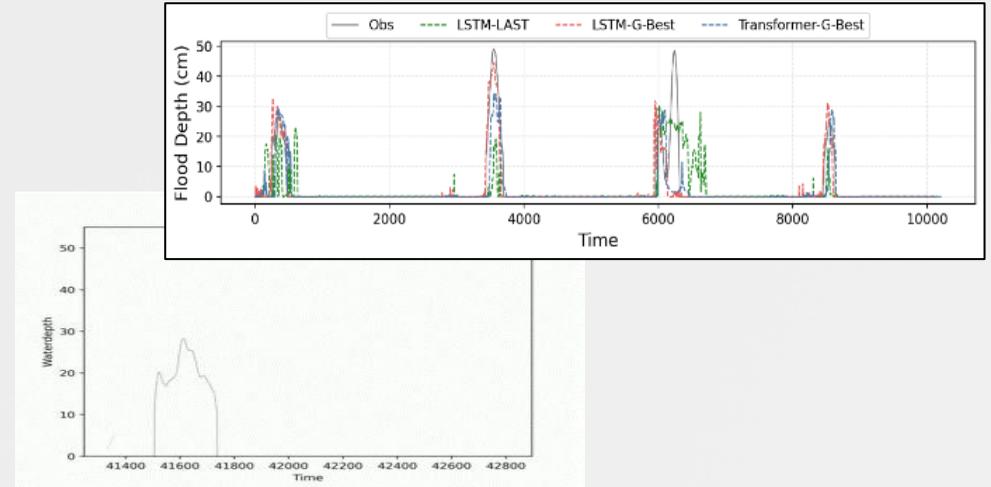
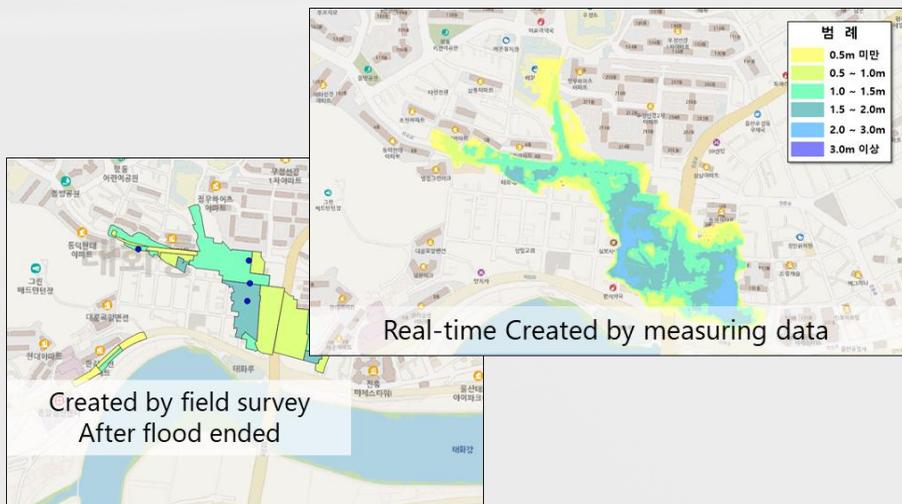
Application of RainMe

Inundation Prediction Model

- ✓ Measured inundation data are used as training inputs for our prediction models.
- ✓ We developed LSTM-based models that learn flooding behavior from historical measurements.

Inundation Maps

- ✓ Replace traditional inundation trace maps



- ✓ Generate inundation prediction maps

4. Implications for Risk Reduction

4. Implications for Risk Reduction

How This Approach Reduces Urban Flood Risk

- Enables earlier response before inundation occurs
- Provides localized, area-specific risk information
- Supports data-driven urban flood management

Key Messages

- Urban flood risk must be defined locally
- Risk criteria should be operationalized in real-time systems
- Integrated approaches are essential for climate-resilient cities

“ Climate change increases uncertainty, but localized and operational approaches can reduce urban flood risk today ”



Key Outcomes

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The first time in Korea!
And the world!

Over 30 domestic and international patents
and software copyrights registered



Thank you!

Q&A

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