MHA

Midlands Highway Alliance Plus

Digital and Environment

Wednesday 17 September 2025

Annual Event 2025

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Pilot study on Real-Time Surface Flood Warning for Nuneaton

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Tetsuya Tsuji – CTI Engineering

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Introduction by John Parkin

1. Background
2. Opportunity

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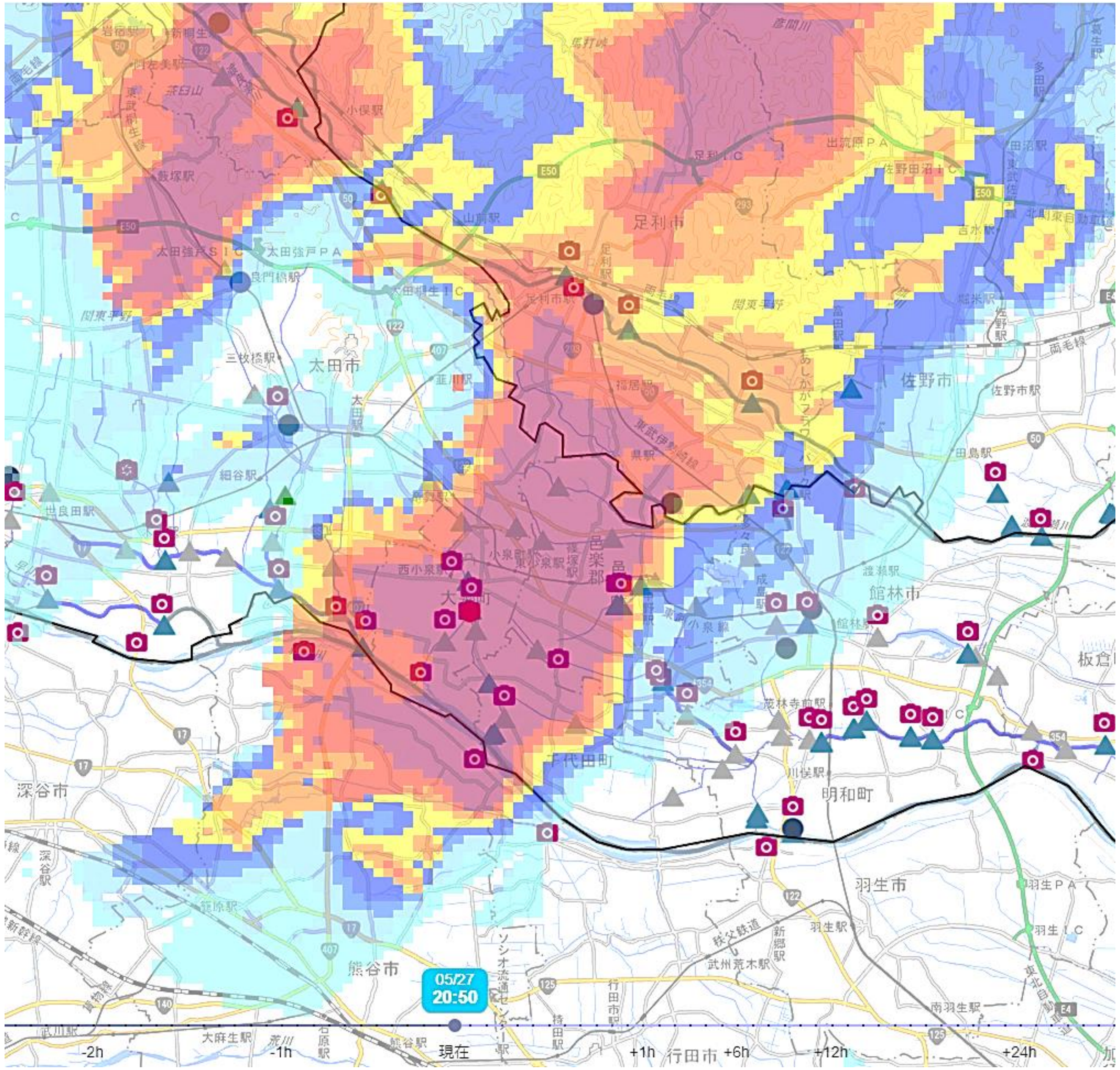
Pilot study on Real-Time Surface Flood Warning for Nuneaton

17th Sep 2025, MHA+

Tetsuya Tsuji
Senior Engineer,
CTI Engineering



Digital and Environment

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Agenda

1 What is RisKma?

2 Project Overview

3 2D-Simulation for Predicting Surface Water Flooding

4 Web-based Dashboard

5 Summary and Way Forward

Water Disaster Risk Mapping System

- Integrated management of observational and forecast data -

Weather Radar & Rainfall Forecasts

Display both real-time and forecasted rainfall information

Alert Emails

Automatically send alerts when risk thresholds are exceeded

Comprehensive Monitoring Data

View river and channel water levels, ground rainfall etc.
Optional sensors deployment

Weather Warnings

Receive notifications for official advisories and severe weather alert

Flood Risk Prediction

Predict inundation areas and depths from river and urban floods through simulation

Live Camera Images

Monitor conditions visually through connected camera systems

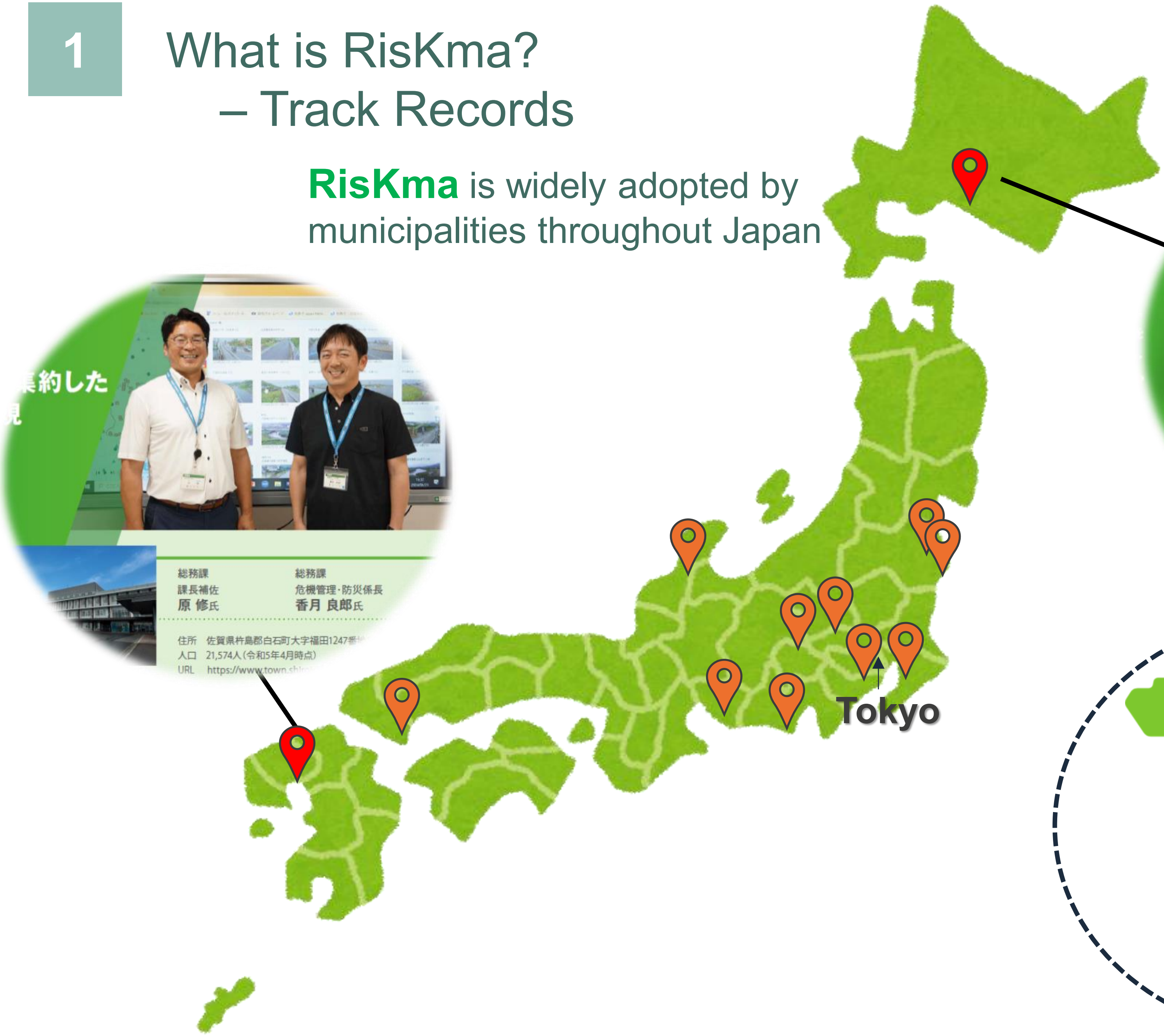
RisKma

Accessible on Smartphone

All Water-Related Disaster Data on One Screen

1 What is RisKma? – Track Records

RisKma is widely adopted by municipalities throughout Japan



2 Project Overview

Objective

To support local authorities in making informed decisions, including evacuation planning, by assessing future surface water flood risks.

Counterpart

Warwickshire City Council

Approach

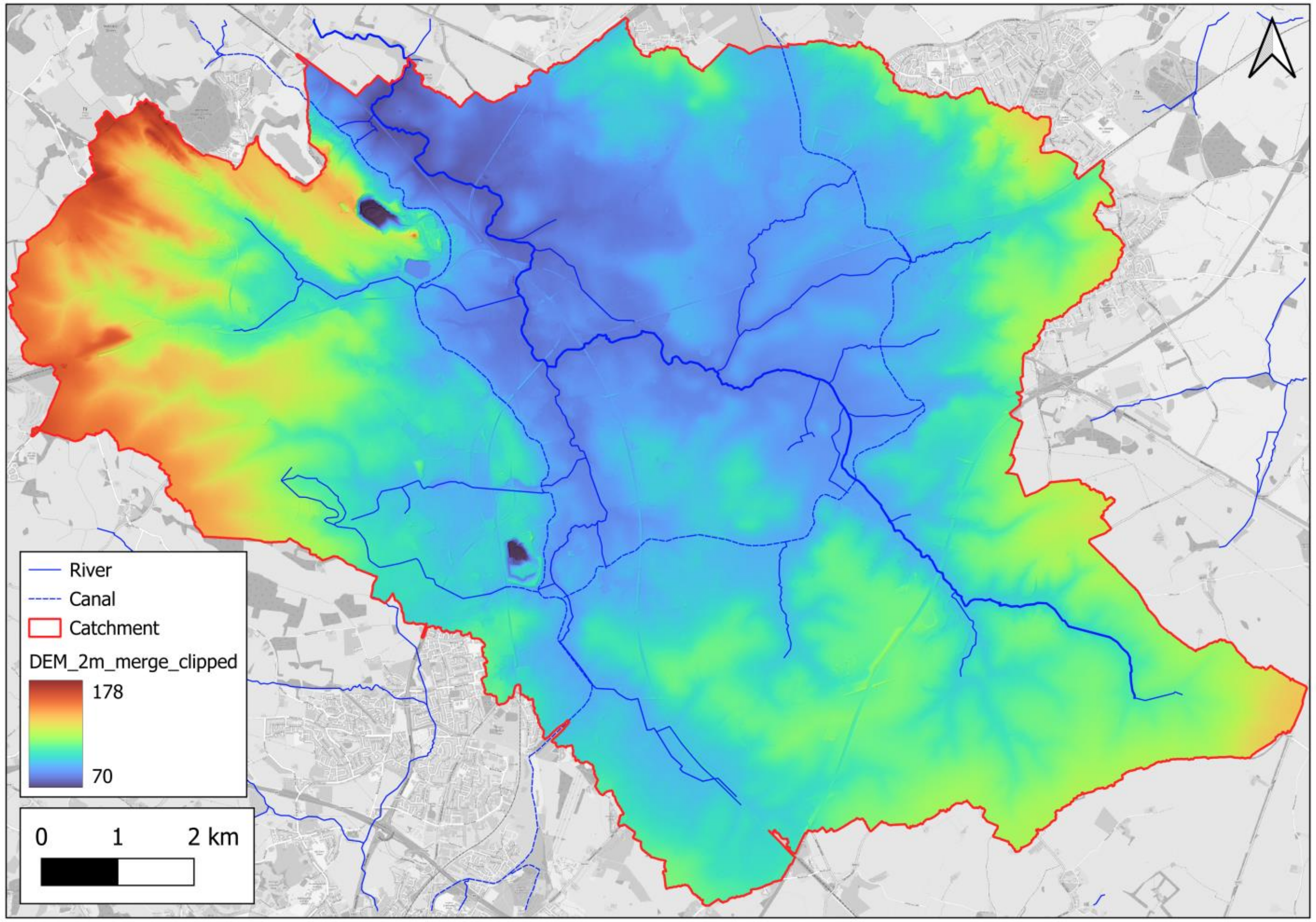
- Build a 2D hydraulic simulation model to predict high-risk flood areas in real time
- Provide access to real-time observation data (water levels, rainfall)
- Develop **RisKma**, a web-based platform

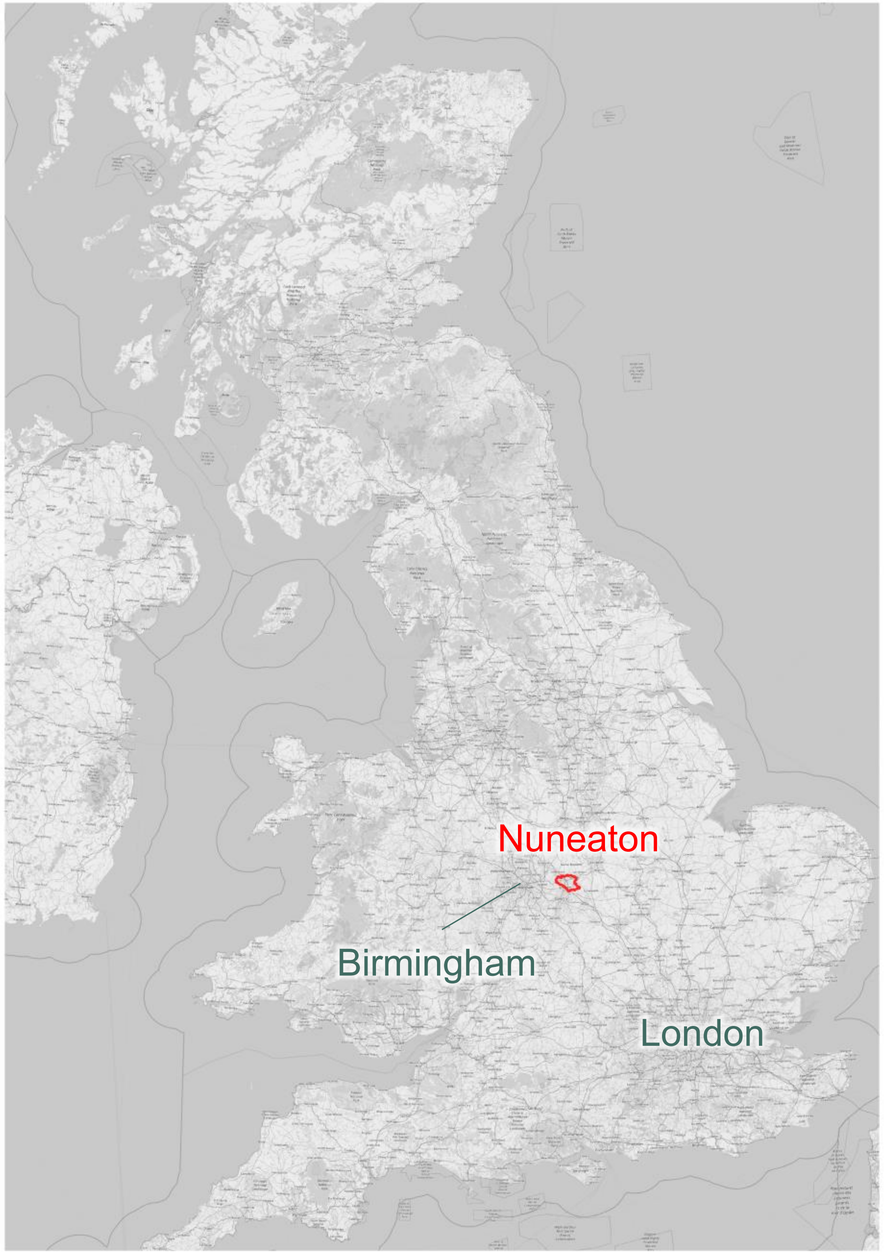
Outcome

Enhanced Decision-making capability for emergency response and evacuation

2 Project Overview

Target Area Nuneaton town, Warwickshire (112.28 km^2)

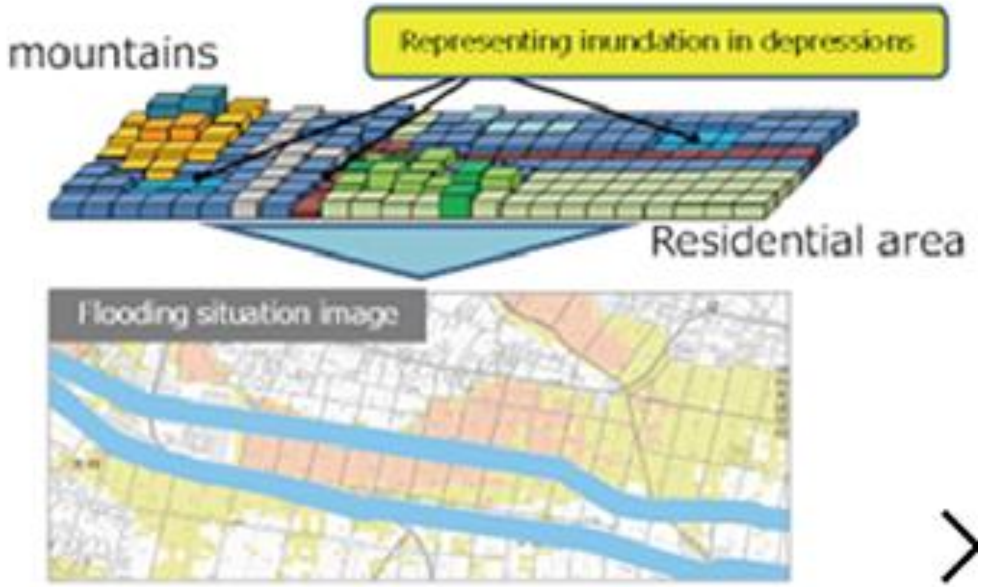




2D-Simulation for Predicting Surface Water Flooding

Build an in-house **2D Hydraulic Simulation Model**

- In-house 2D hydraulic model (developed by CTI)
- Built on approx. 15m grid resolution



Map: GSI Tiles
(https://maps.gsi.go.jp/development/ichiran.htm)

Flood forecasting model

The model solves the **dynamic wave equations** consisting of the **shallow water equations (2D Saint-Venant equations)**:

- **Continuity equation:**

$$\frac{\partial h}{\partial t} + \frac{\partial (hu)}{\partial x} + \frac{\partial (hv)}{\partial y} = r$$

- **Momentum equations:**

$$\frac{\partial (hu)}{\partial t} + \frac{\partial (hu^2)}{\partial x} + \frac{\partial (huv)}{\partial y} = -gh\frac{\partial z}{\partial x} - ghS_{fx}$$

$$\frac{\partial (hv)}{\partial t} + \frac{\partial (huv)}{\partial x} + \frac{\partial (hv^2)}{\partial y} = -gh\frac{\partial z}{\partial y} - ghS_{fy}$$

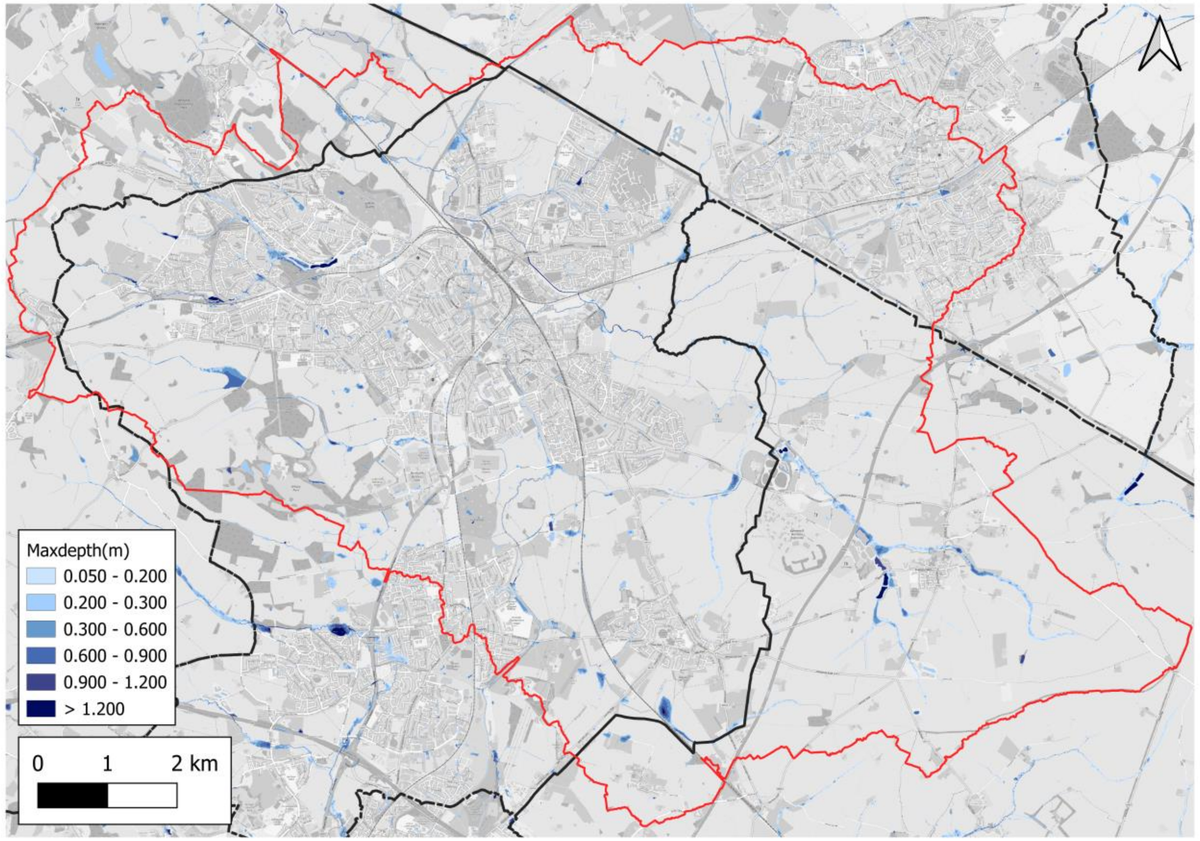
where:

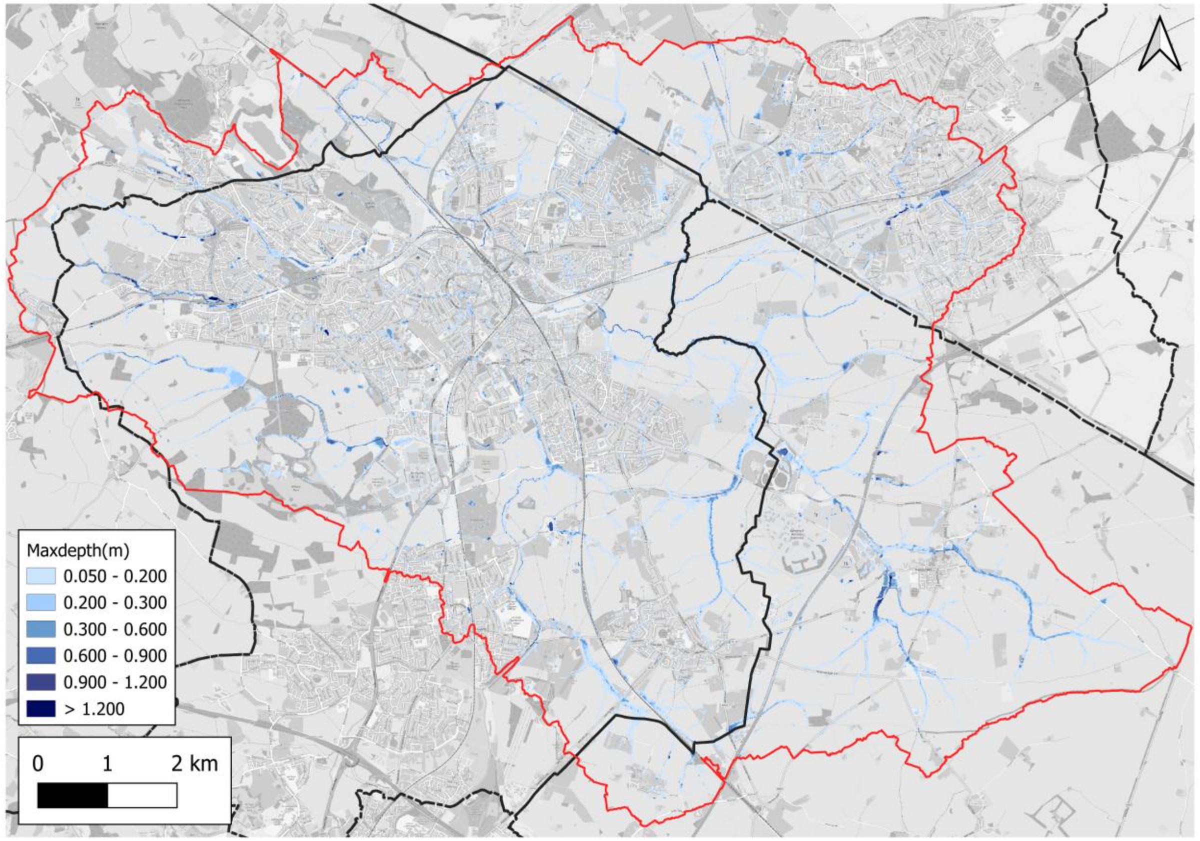
- h: water depth
- u, v: velocity components in x and y
- z: ground elevation
- r: rainfall or lateral inflow
- S_{fx}, S_{fy}: friction slope components in x and y directions
- g: gravity acceleration

3 2D-Simulation for Predicting Surface Water Flooding

- Simulations carried out using 30-, 100-, 1000-year design rainfall events
- Results compared against the EA's official flood risk maps for validation

EA Flood Risk Map, 1 in 30	Result from our model, 1 in 30





3 2D-Simulation for Predicting Surface Water Flooding

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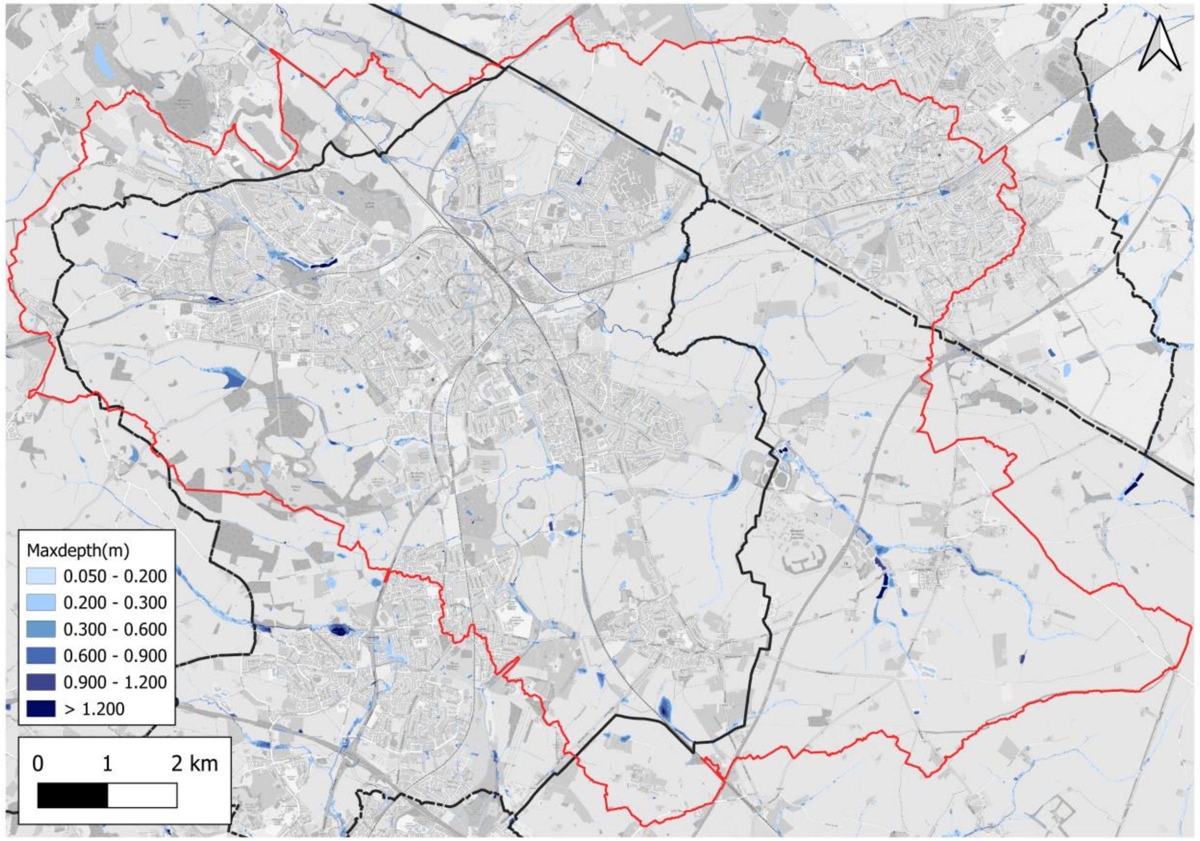
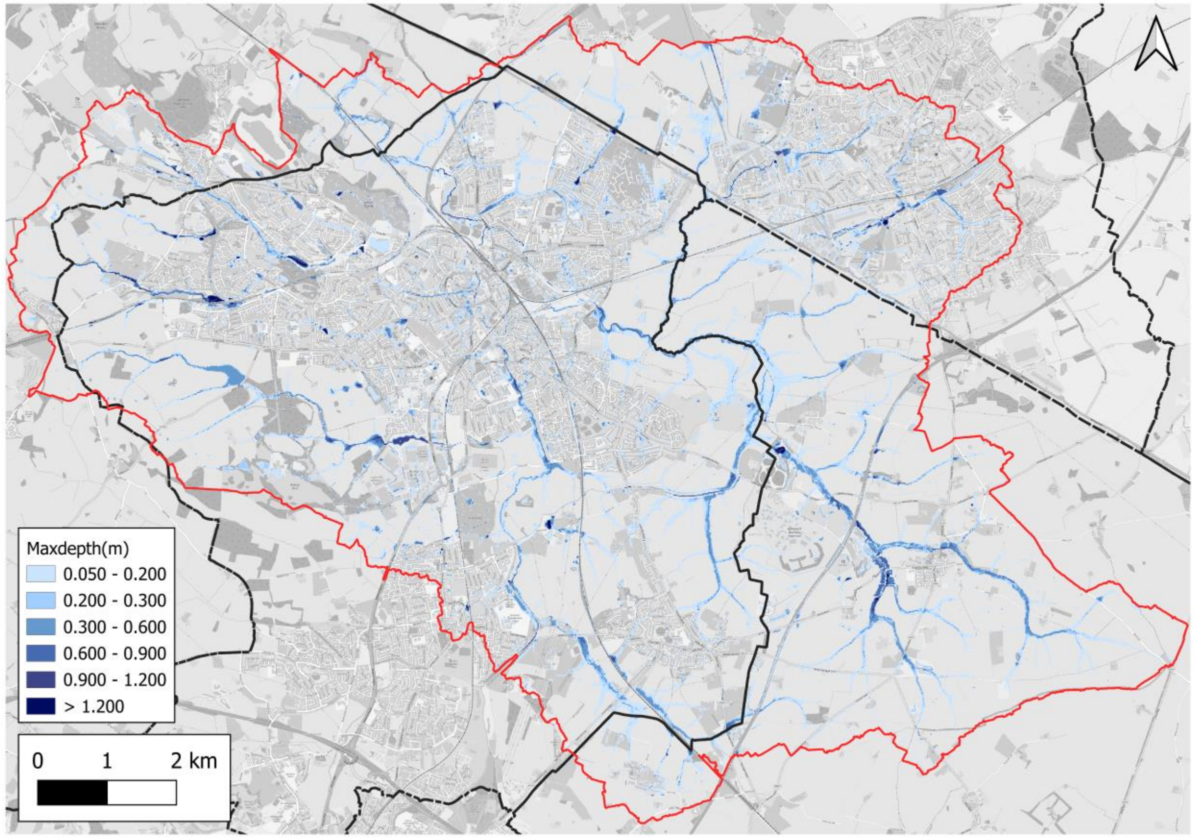
EA Flood Risk Map, 1 in 100



Result from our model, 1 in 100

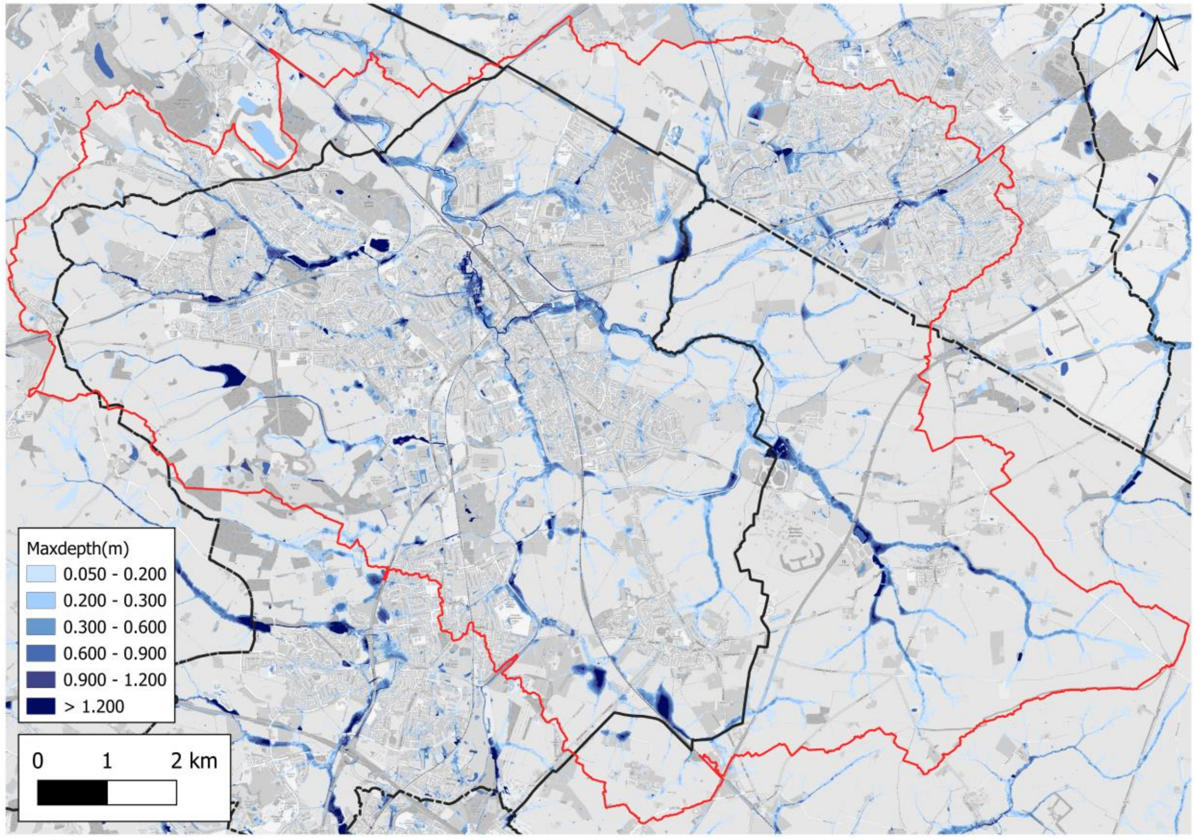


3

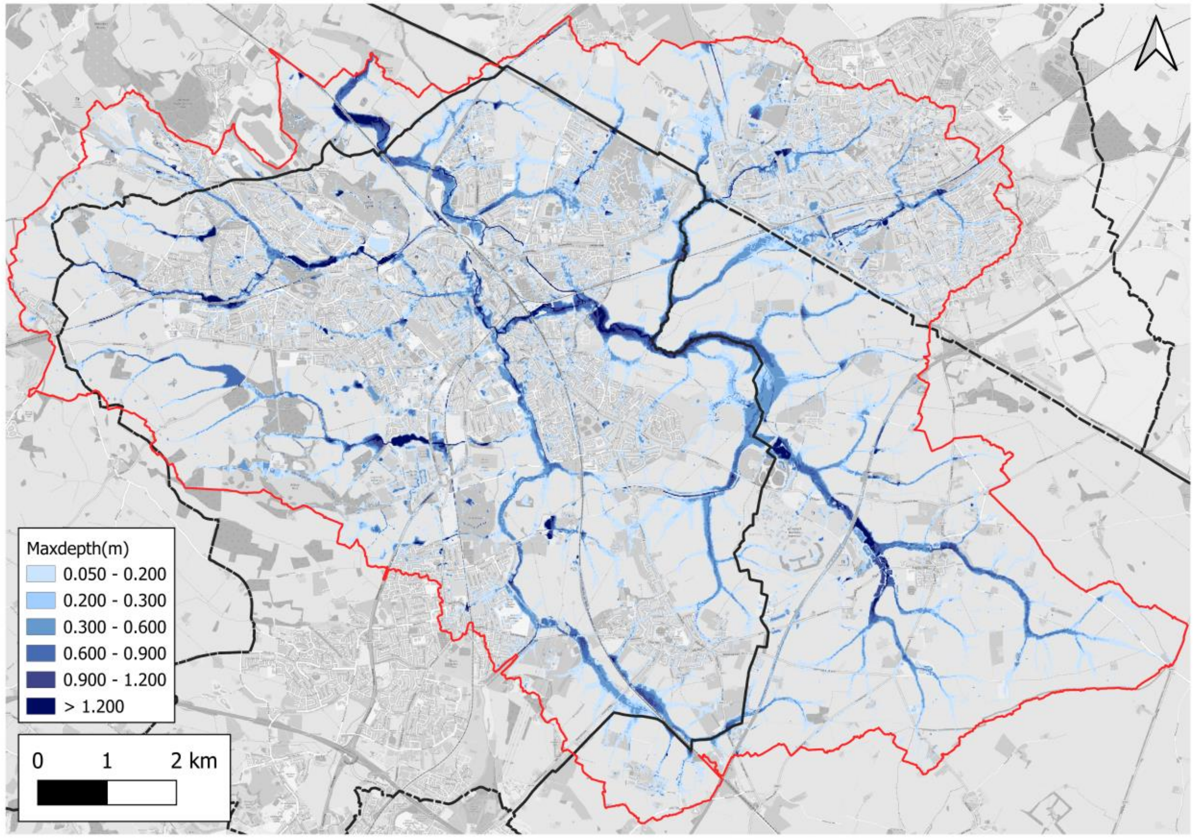
2D-Simulation for Predicting Surface Water Flooding

- Simulations carried out using 30-, 100-, 1000-year design rainfall events
- Results compared against the EA's official flood risk maps for validation

EA Flood Risk Map, 1 in 1000

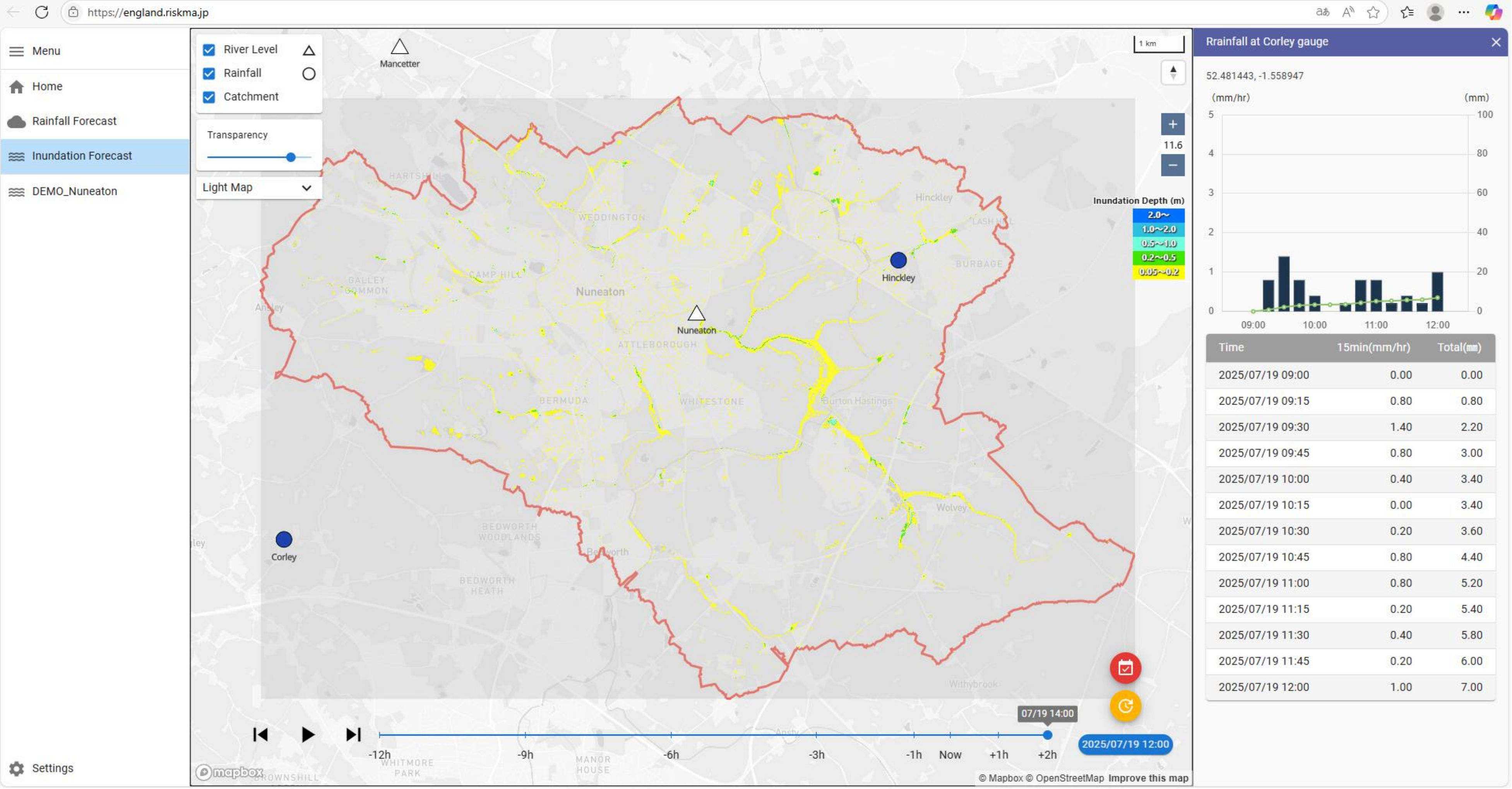


Result from our model, 1 in 1000



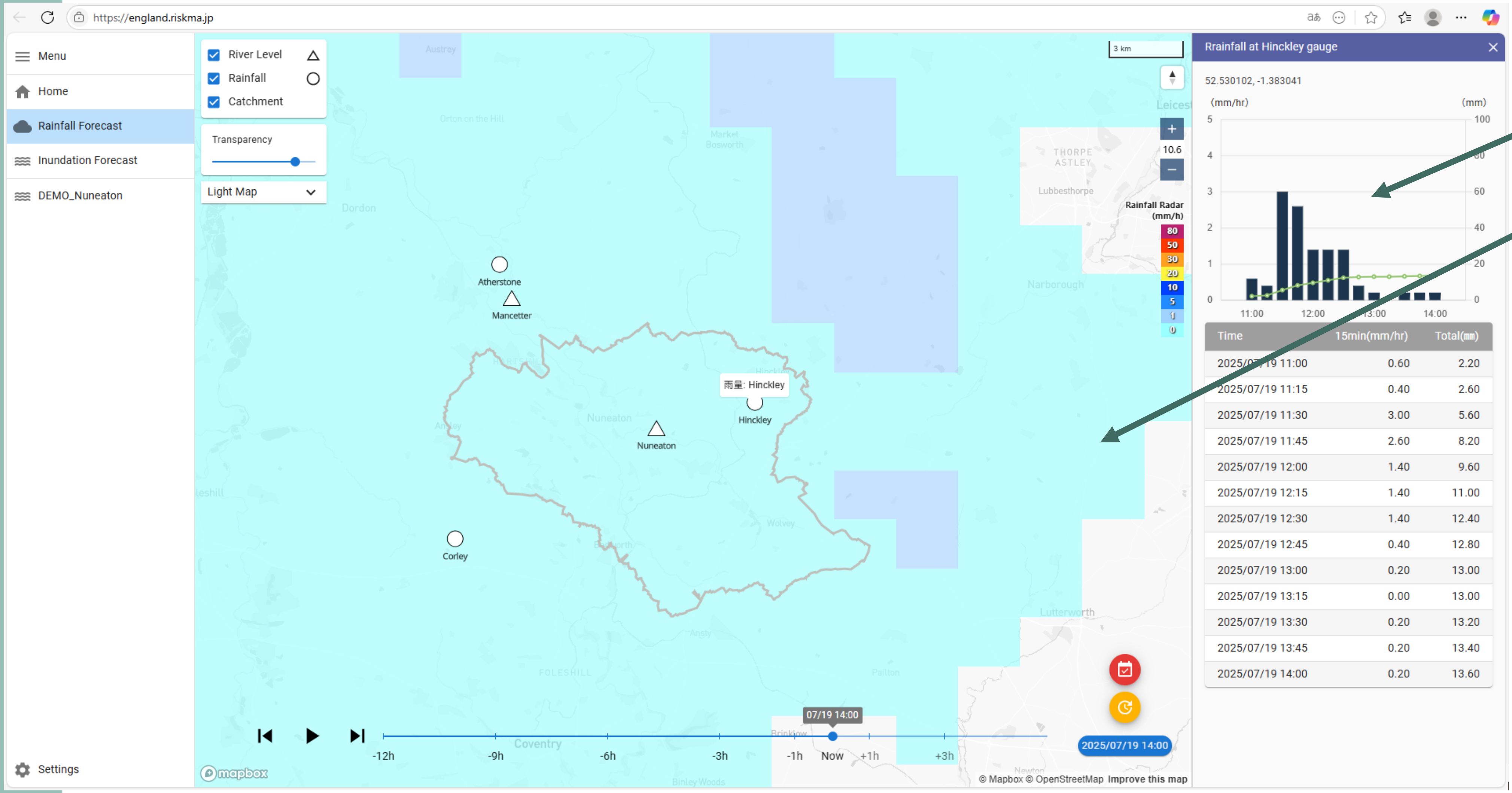
3 2D-Simulation for Predicting Surface Water Flooding

- This system was able to predict the flooding in advance, even for the flood damage that occurred on 19 July.



Time	15min(mm/hr)	Total(㎜)
2025/07/19 09:00	0.00	0.00
2025/07/19 09:15	0.80	0.80
2025/07/19 09:30	1.40	2.20
2025/07/19 09:45	0.80	3.00
2025/07/19 10:00	0.40	3.40
2025/07/19 10:15	0.00	3.40
2025/07/19 10:30	0.20	3.60
2025/07/19 10:45	0.80	4.40
2025/07/19 11:00	0.80	5.20
2025/07/19 11:15	0.20	5.40
2025/07/19 11:30	0.40	5.80
2025/07/19 11:45	0.20	6.00
2025/07/19 12:00	1.00	7.00

4 Web-based Dashboard



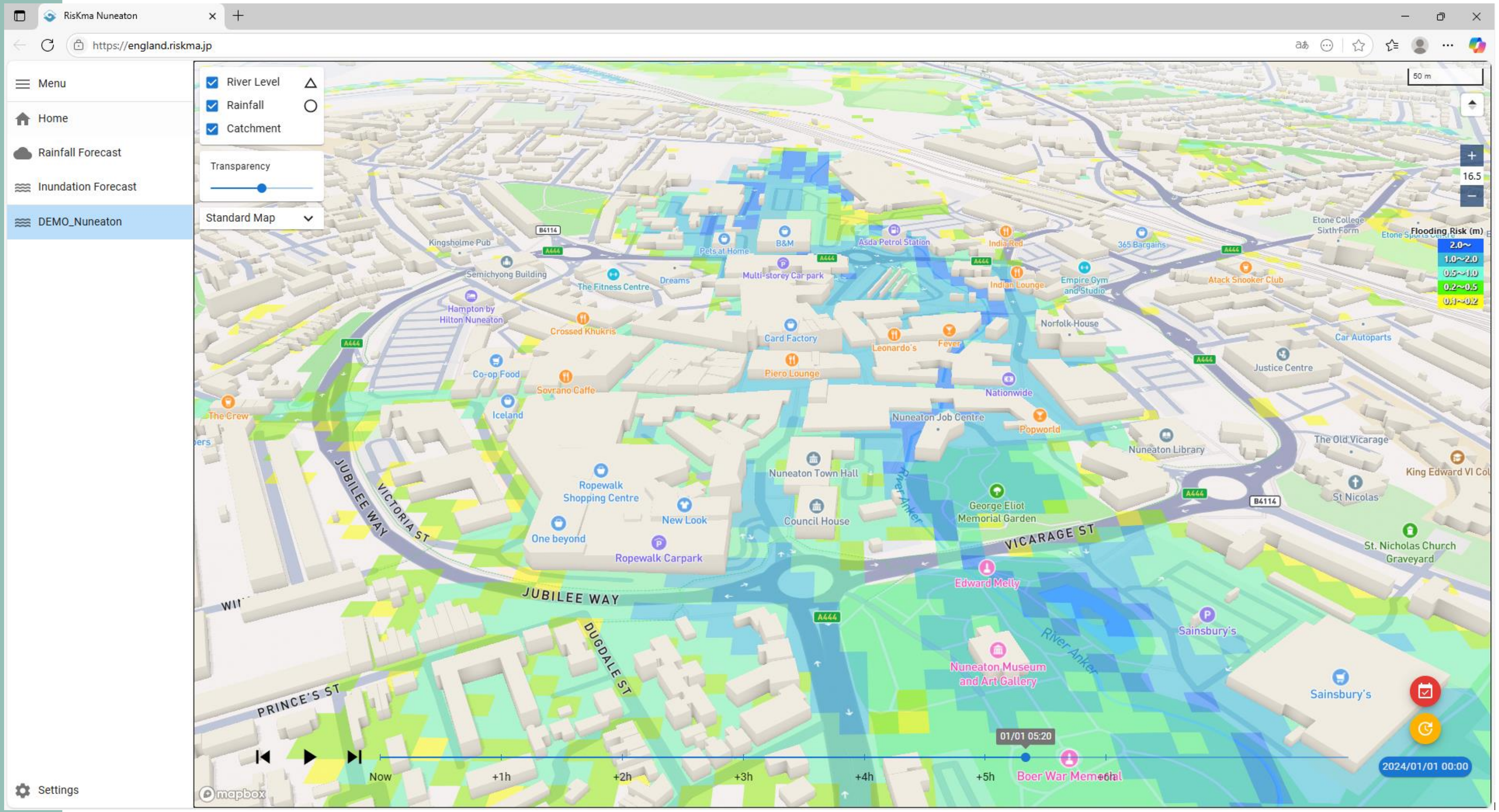
Key Features

Observation Data

Forecast Rainfall Data

Simulation Result

4 Web-based Dashboard



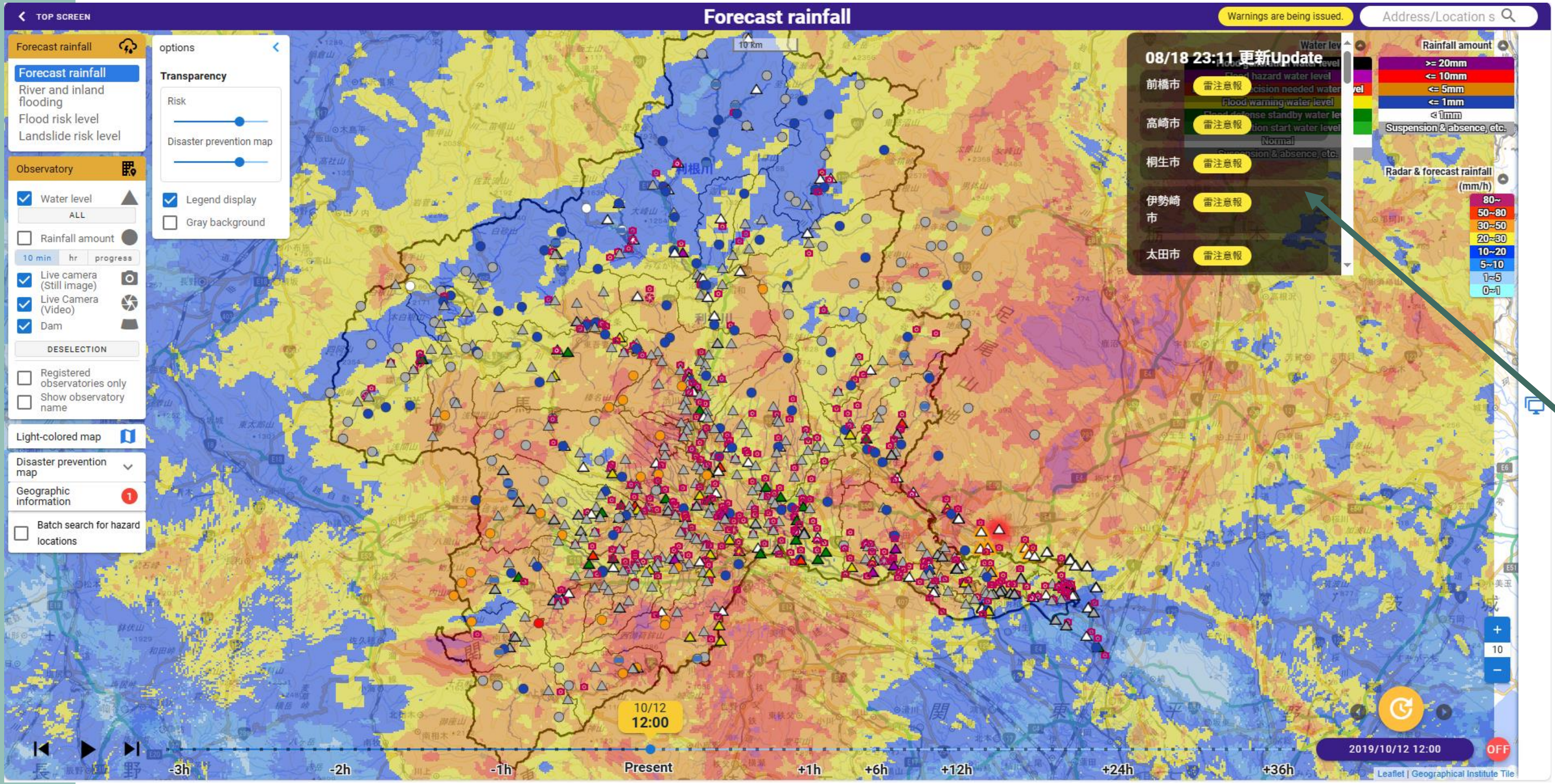
Key Features

Observation Data

Forecast Rainfall Data

Simulation Result

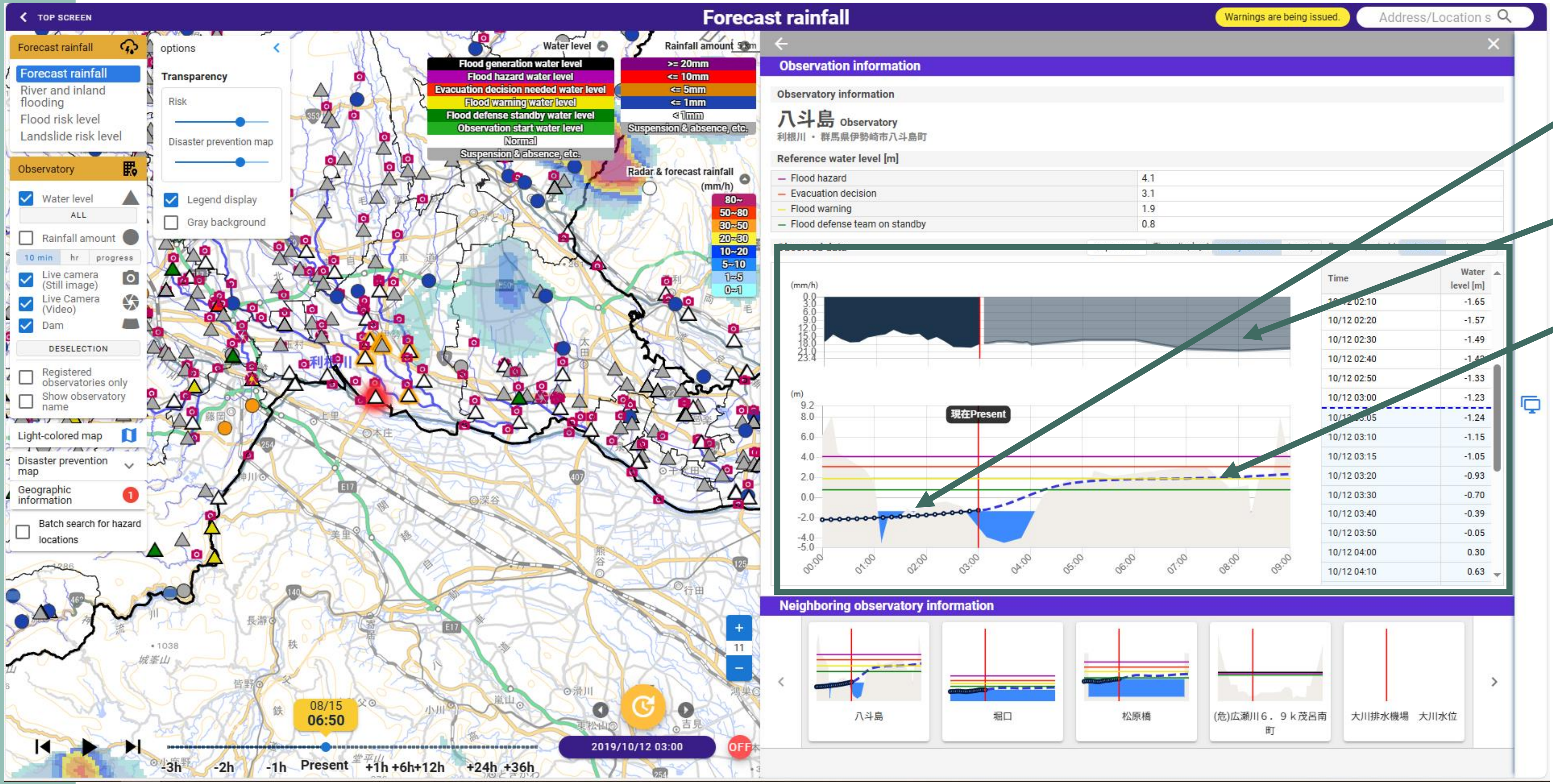
4 Web-based Dashboard (Application in Japan)



Key Features

- Observation Data
- Forecast Rainfall Data
- River Water Level Prediction
- Alert Information
- CCTV camera

Web-based Dashboard (Application in Japan)



Key Features

- Observation Data
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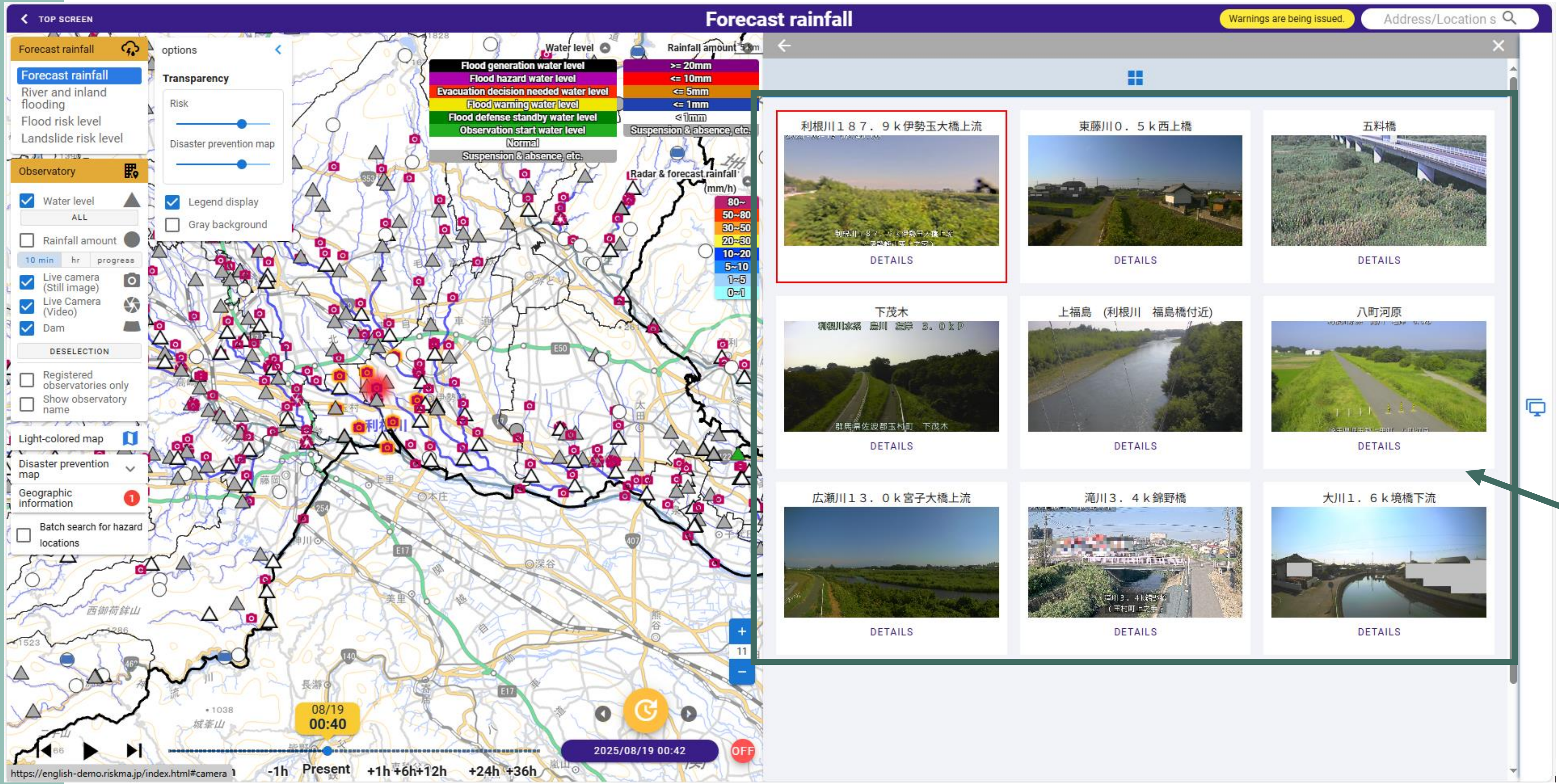
- River Water Level Prediction
- Alert Information
- CCTV camera

4

Web-based Dashboard (Application in Japan)



Key Features

- Observation Data
- Forecast Rainfall Data
- River Water Level Prediction
- Alert Information
- **CCTV camera**

5 Summary and Way Forward

Summary

- Developed the **RisKma** system in Nuneaton, Warwickshire
- Built a flood inundation model to predict future surface water flood risks in real time

Way Forward

- Expand the types of information available on RisKma (e.g., camera images, water level gauges, rainfall data)
- Strengthen decision support functions, including automatic alerts and evacuation guidance

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CTI / Waterman Initiative

Naoki Fujiwara
Director & Managing Executive Officer, CTI Engineering
Executive Director, Waterman Group
President & CEO, CTI Engineering International

Acoustic Visual Inspection & Analysis for Sewerage

AVIAS
ACOUSTIC VISUAL INSPECTION & ANALYSIS FOR SEWERAGE

- Unknown water infiltration detection technology using AI-based acoustic data analysis -

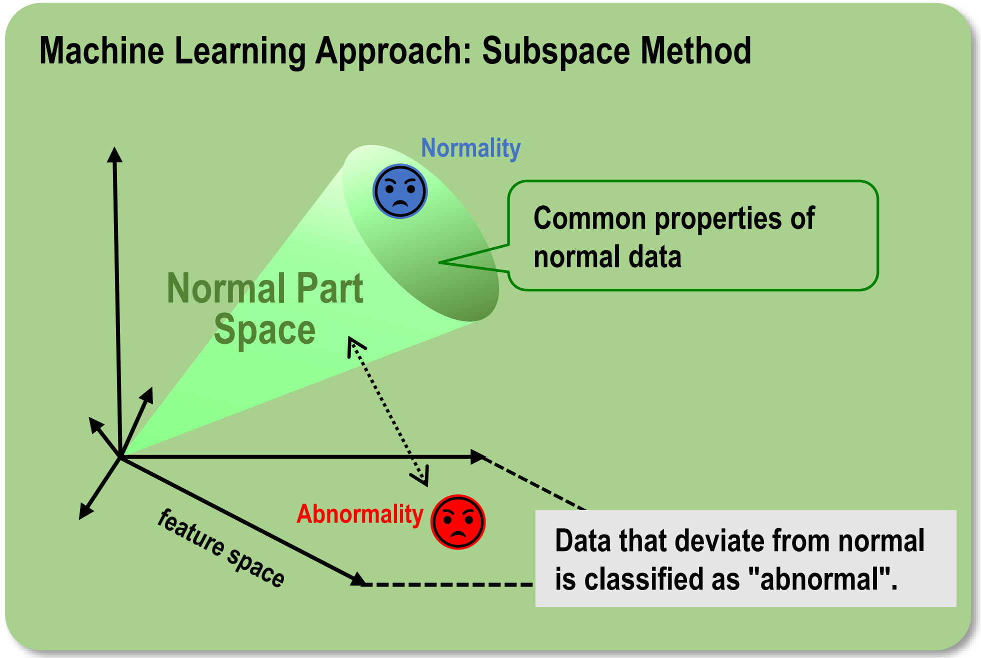
Acoustic vs Traditional Methods

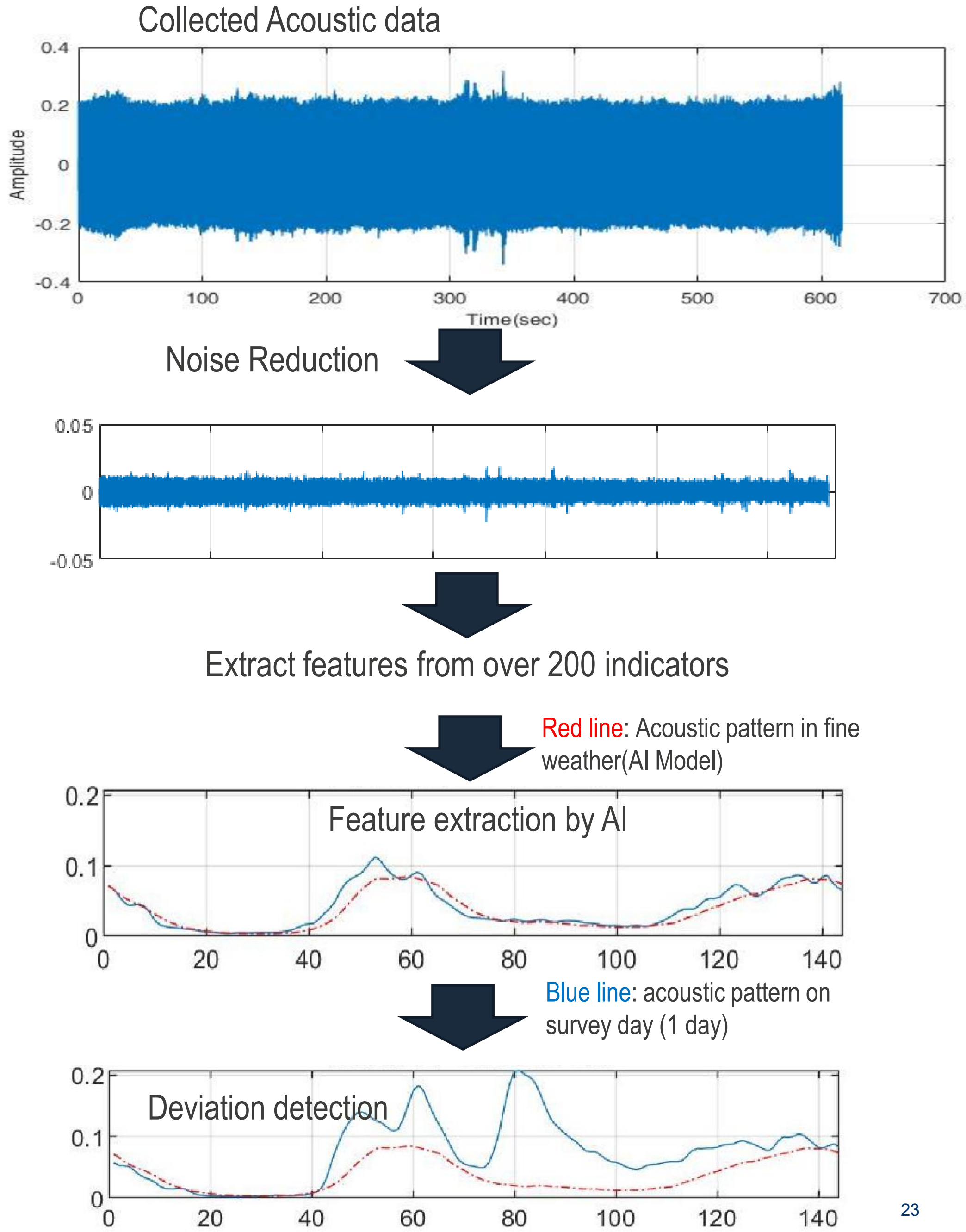
- Fast deployment into manholes. Larger catchment coverage.
- No manhole entry by personnel - surface access.
- No interference with flow - less chance of blockage.
- Quick and accurate AI analysis vs lengthy manual analysis of flow logs.
- Cost - considerably cheaper.
- Secured ATEX certification for UK

	Proposed Technology	Conventional Technology
Extensive survey by reducing unit survey costs	Multi-point observation over a wide area using inexpensive instruments	Limited observation due to expensive instruments
Accurate and quick analysis by AI	Determination of normality/abnormality by AI Weather / Normal / Abnormal The sound will be different from the normal sound due to rainwater entry.	Determination of normality/abnormality by Engineers Weather / Normal / Abnormal The water level (flow) will be different from the normal level due to rainwater entry.
Considerable improvement of safety in field work	 Installation and removal work inside the manhole is not essential.	 Installation and removal work inside the manhole is essential.

How does the AI work?

- The equipment is installed into the manhole.
- Sound data is collected for Approx. 1 month.
  - Dry and wet weather scenarios
- The sound is then abstracted and submitted to the CTI server for analysis.
- Over 200 parameters feed into the AI inc. rainfall data, groundwater levels.
- Approximately 2 weeks of AI Analysis to provide an accurate baseline and identification of abnormalities that indicate infiltration.





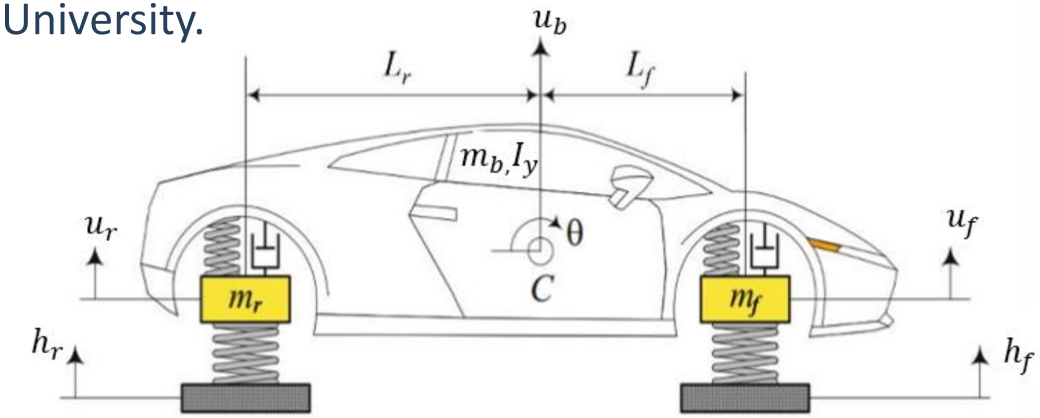
DRIMS® Dynamic Response Intelligent Monitoring System

- Extensive and economical collection of road surface condition using only two smartphones placed in the vehicle -

IRI Analysis

IRI

- IRI: International Roughness Index
- Use sensors in the smartphone.
- Evaluation of road surface roughness widely and quantitively.
- Half-car models are used, which have less variation in accuracy depending on the installation location compared to conventional quarter-car models.
- DRIMS's IRI analysis algorithm was developed at Tokyo University.

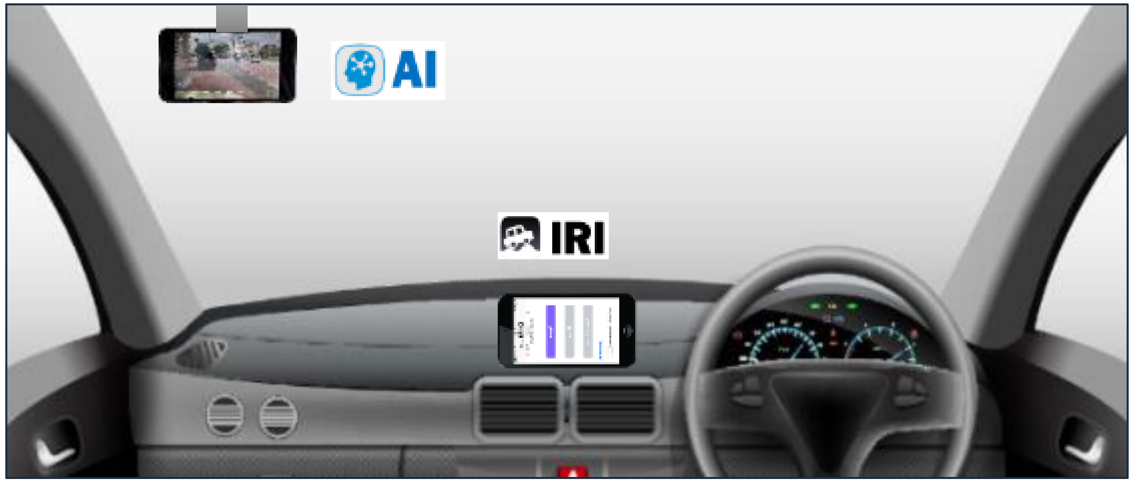


Half-car model

AI Analysis

AI

- Using actual road defects images as teaching picture, AI engine is optimized by deep learning.
- Learnt defects are identified by the system from shot video during drive.
- Uses an AI analysis engine built on 100s of thousands of UK image data.



Maps & Dashboard

- By analysing data measured by sensors mounted on smartphones, road surface conditions can be accurately and quantitatively evaluated.
- By applying AI to images taken while driving, road surface defects such as potholes and cracks can be detected.

Examples of anomaly detection

Lane Detection

Pothole

Localised Cracking

Patch

Surfacing Joint