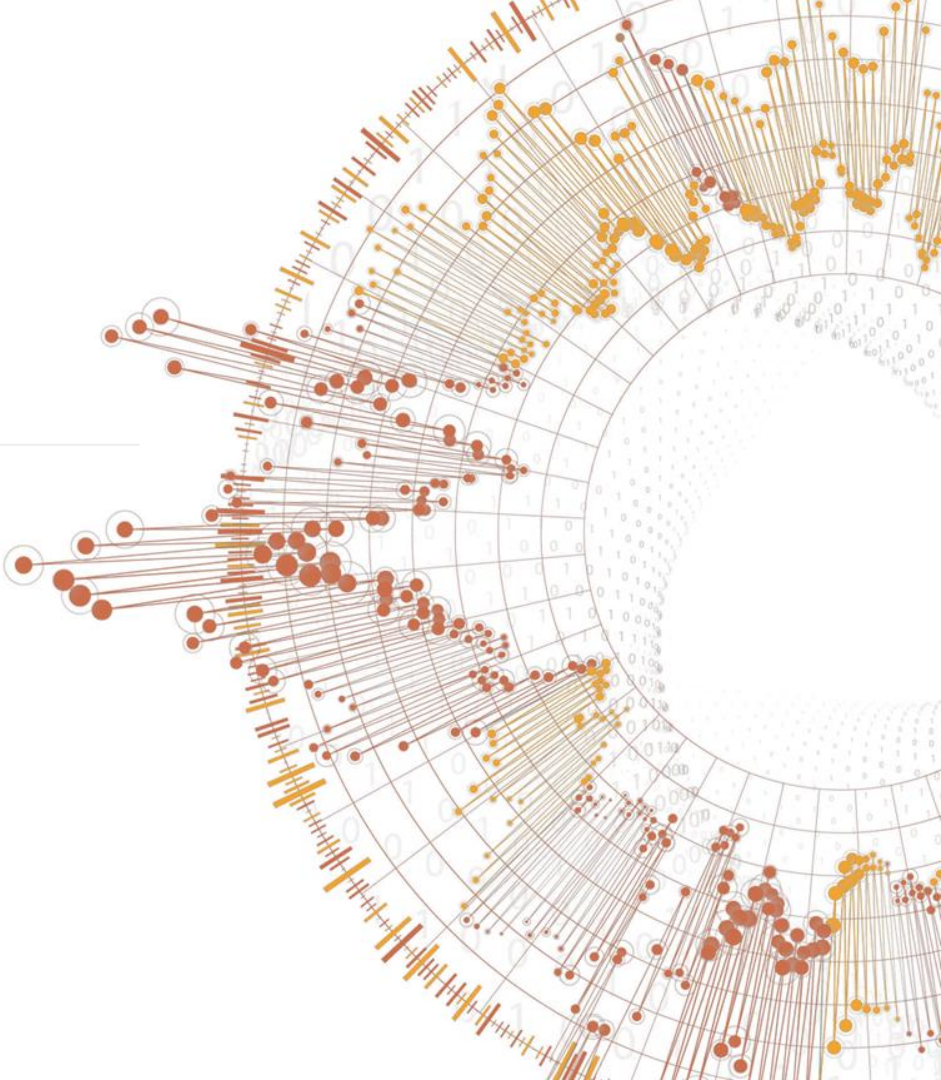
one concern

Applications of AI in flood prediction

June 23, 2021



Natural disaster modelling at One Concern

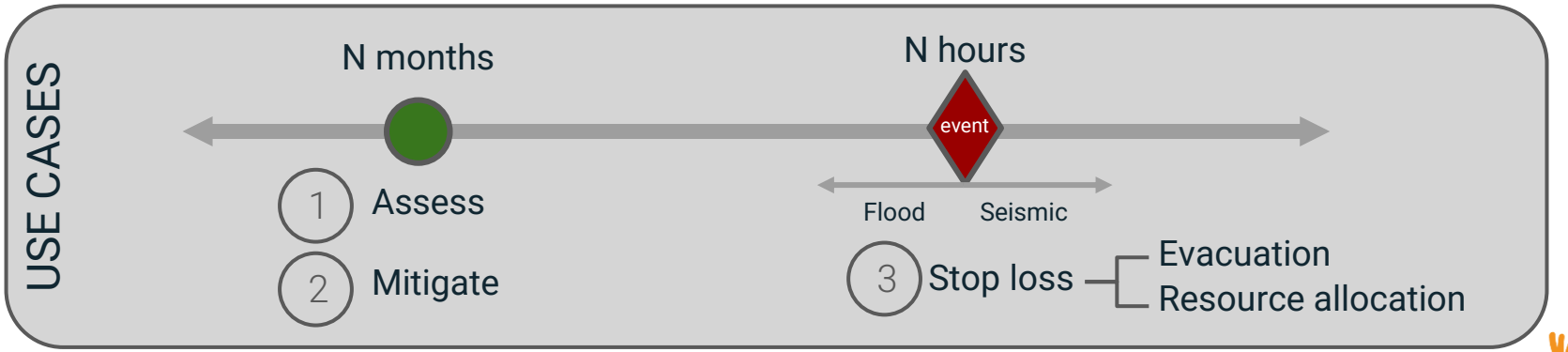
Given a **peril** … tell me **what** is most **vulnerable** … so I can **act**

Current ongoing
Simulated
Historical

Seismic
Flood
Wind
…

People and communities
Buildings and locations
Lifelines (transport, power, water)
Business operations

Evacuation
Resource allocation
Reduce and mitigate risk

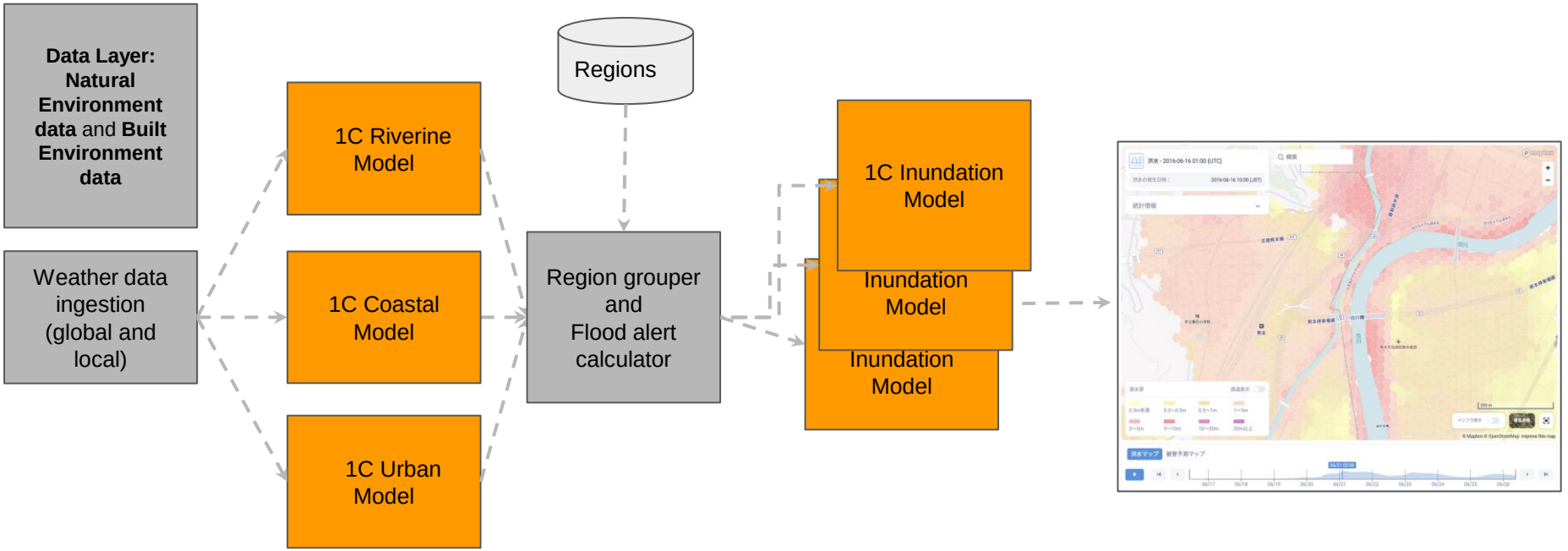


Contents

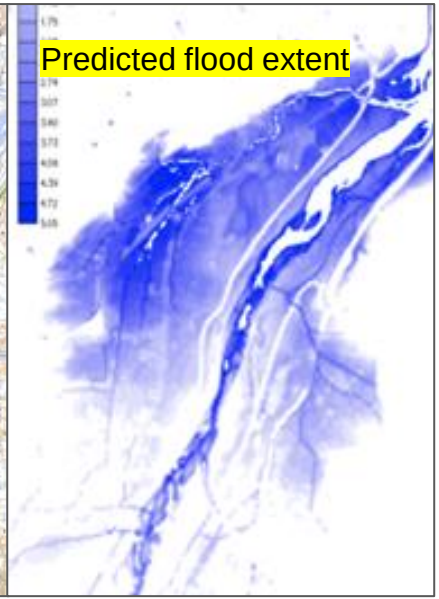
- Compound flood prediction
- Applications of ML in flood modelling

Compound Flood Prediction

Compound and Scalable Flood Prediction System



Hagibis 2019 flood in Chikuma River, Japan



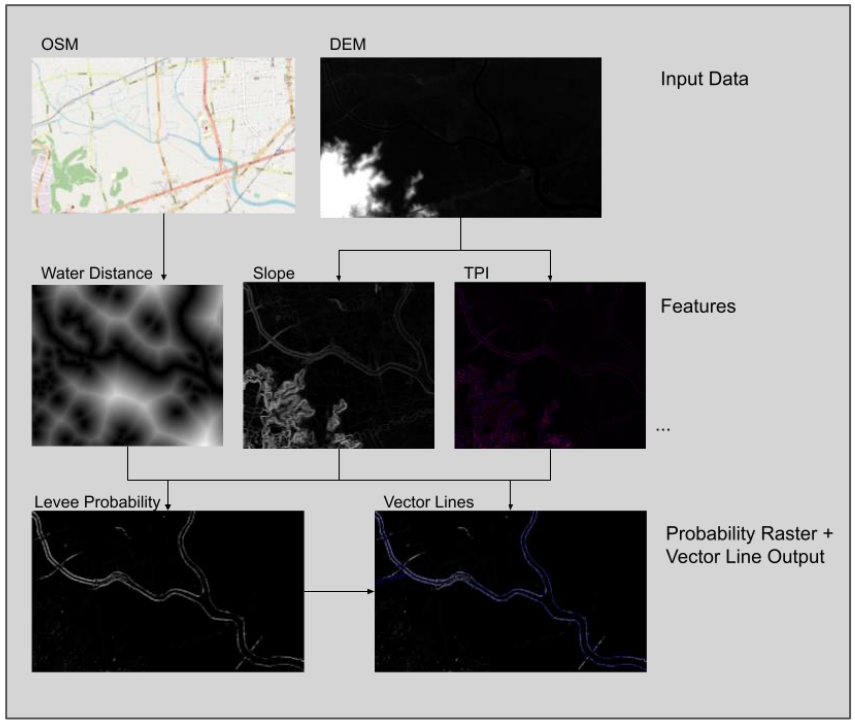
Predicted flood extent was produced by **1C Japan-wide compound flood model.** The predicted maximum flood map was plotted against the GSI estimated flood map. The overall hit rate for the flood extent is 0.82.

Application of ML in flood modelling

- Generate synthetic riverine levee data
- Improve streamflow prediction

Riverine Levee Generation

Flood defense: riverine levee



Levee generation from DEM and land cover features

Riverine levee data challenges

Levee crest elevation and location is important for accurate flood risk prediction.

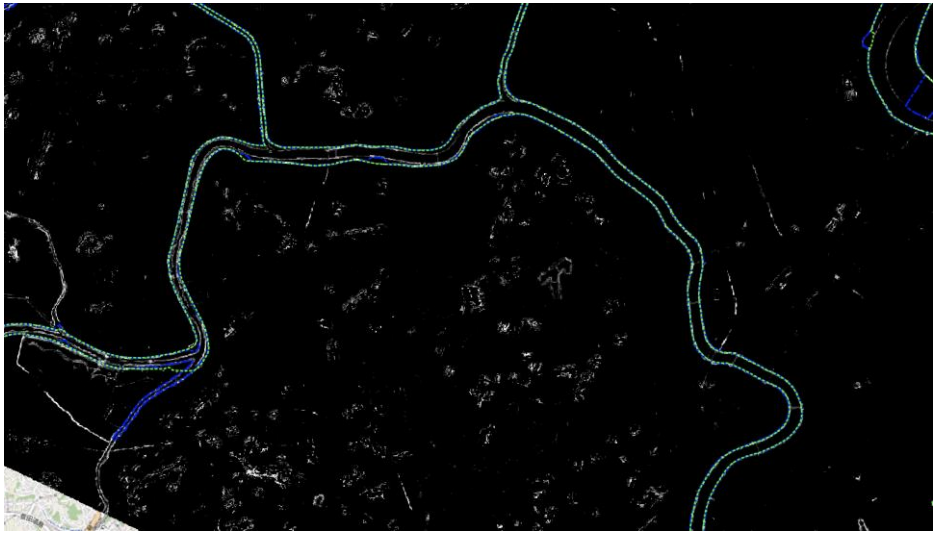
Large-scale flood models are run at a **coarse resolution**, not adequate to accurately capture flood defense or require a DEM resampling that **reduces the crest elevation**.

ML to accurately estimate levee location and elevation

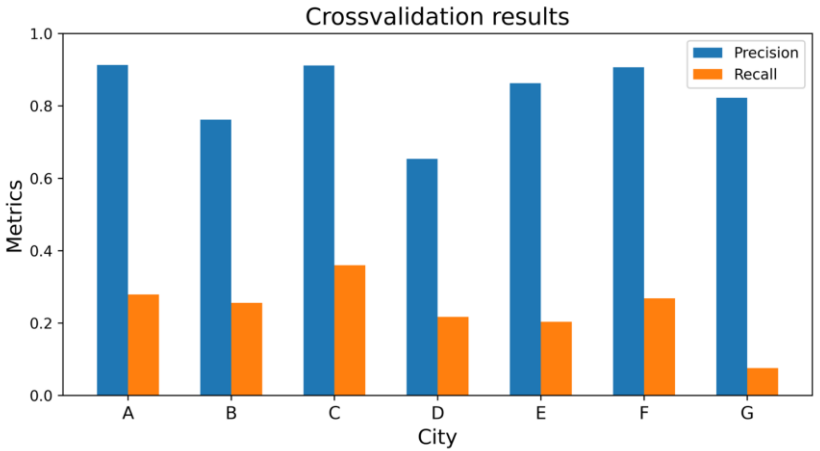
The pixel-level levee classifier: A random forest model, trained to produce a pixel-level probability of levees.

The vectorization model: produces a shapefile of levee lines from the probability outputs the river flowlines, and river width data.

Riverine levee: pixel-level levee classification



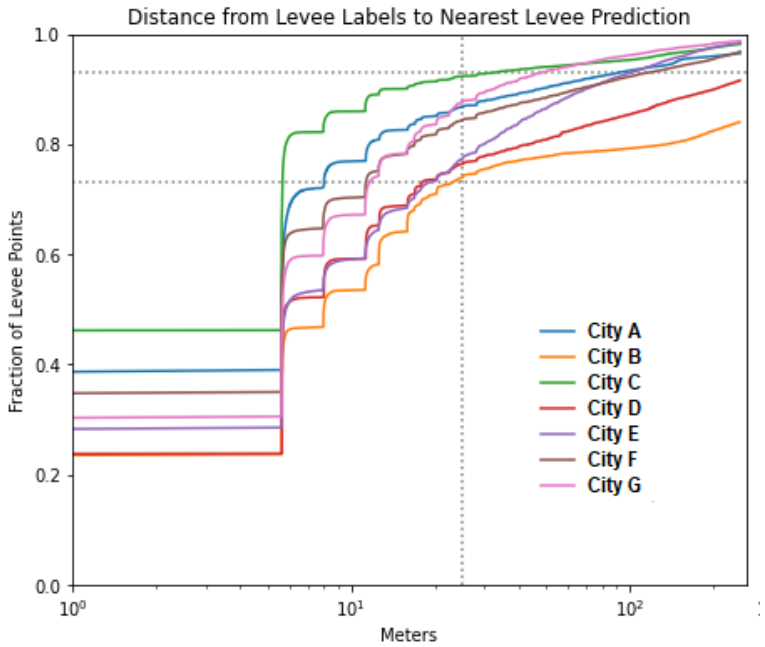
Estimated (blue) vs manually labelled (green) levee in a city C, Japan



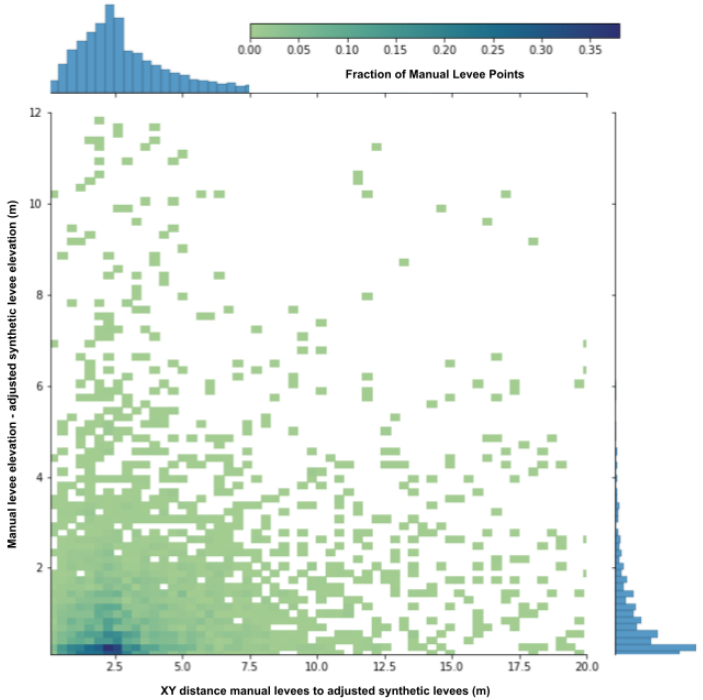
Results from 7 cities in Japan.

- Leave-one-out cross validation was used.
- Precision was given more focus during the pixel-level model training. Recall can be improved using the vector model.

Riverine levee: vector lines



XY distance between labelled and predicted levee lines



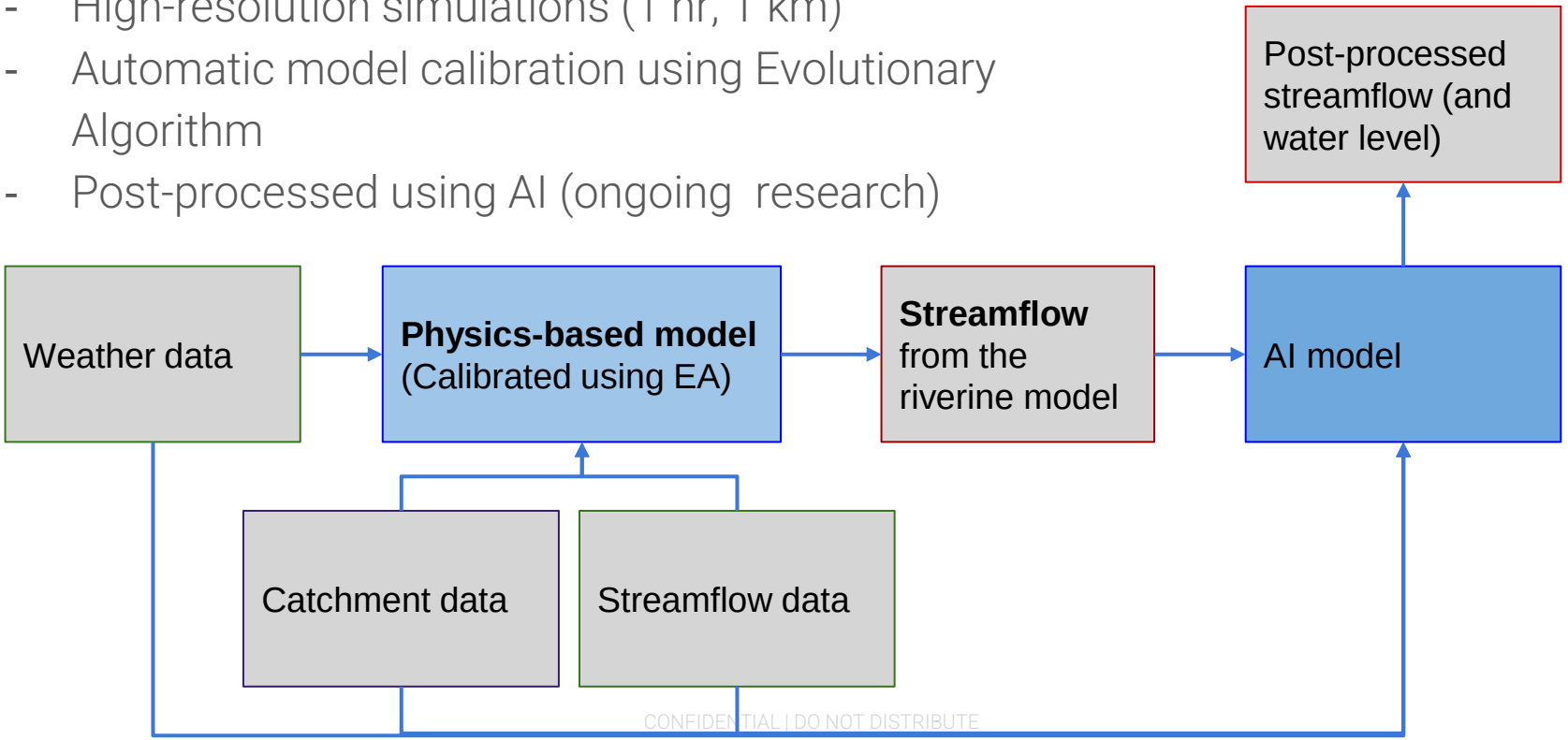
XY offset vs elevation offset in City A

- Between 23% and 46% of the true levee labels lie exactly on a predicted levee vector.
- Between 73% and 93% lie within 25 meters (5 pixels) of a vectorized levee output.
- The mode of XY offset is 2.45m and elevation offset is 0.59m.

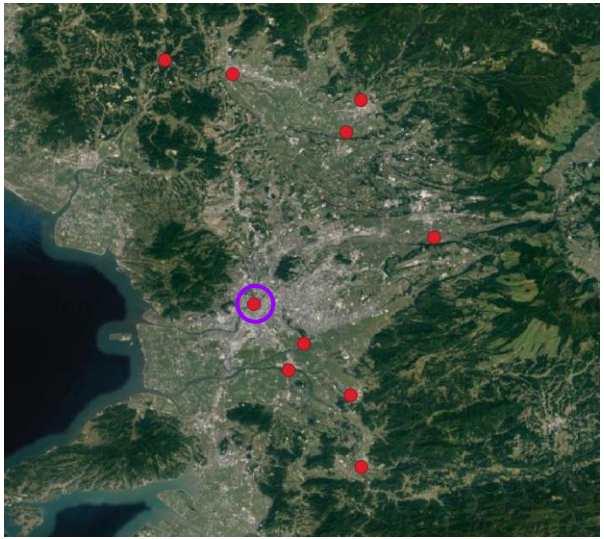
Riverflow Prediction

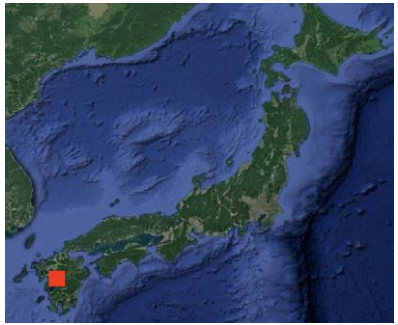
Riverine model

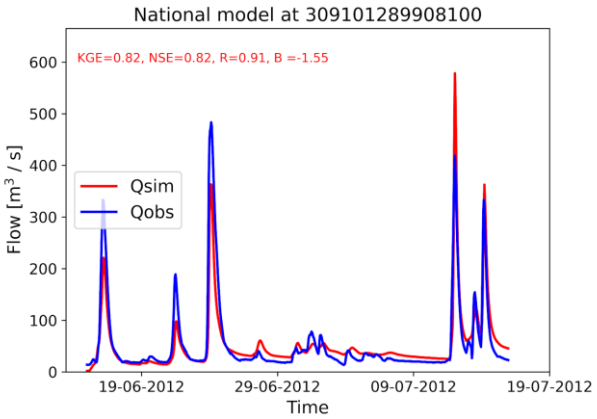
- Distributed hydrological model
- High-resolution simulations (1 hr, 1 km)
- Automatic model calibration using Evolutionary Algorithm
- Post-processed using AI (ongoing research)

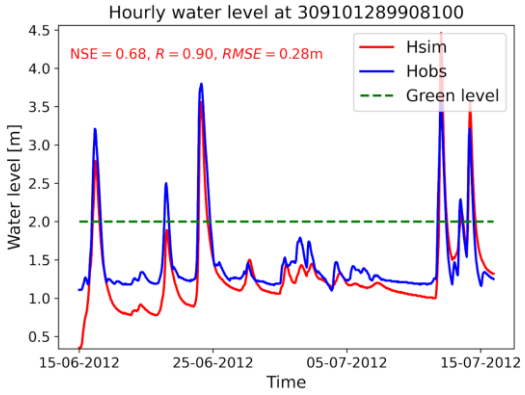


Kumamoto City (Japan) flood in 2012









July 2012 Flood

- 250000 displaced
- 25 dead
- Several buildings flooded

Water level	RMSE (m)	R	NSE
Average (n=10)	0.48 (0.22)	0.93 (0.03)	0.57 (0.22)

Threshold exceedance Hit Rate is 92% (12 out of 13). The False Alarm was 0%

Thank you!

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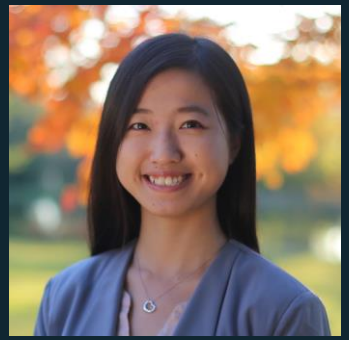

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