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Flood Simulation System
About DioVISTA

株式会社 日立パワーソリューションズ

Features of DioVISTA

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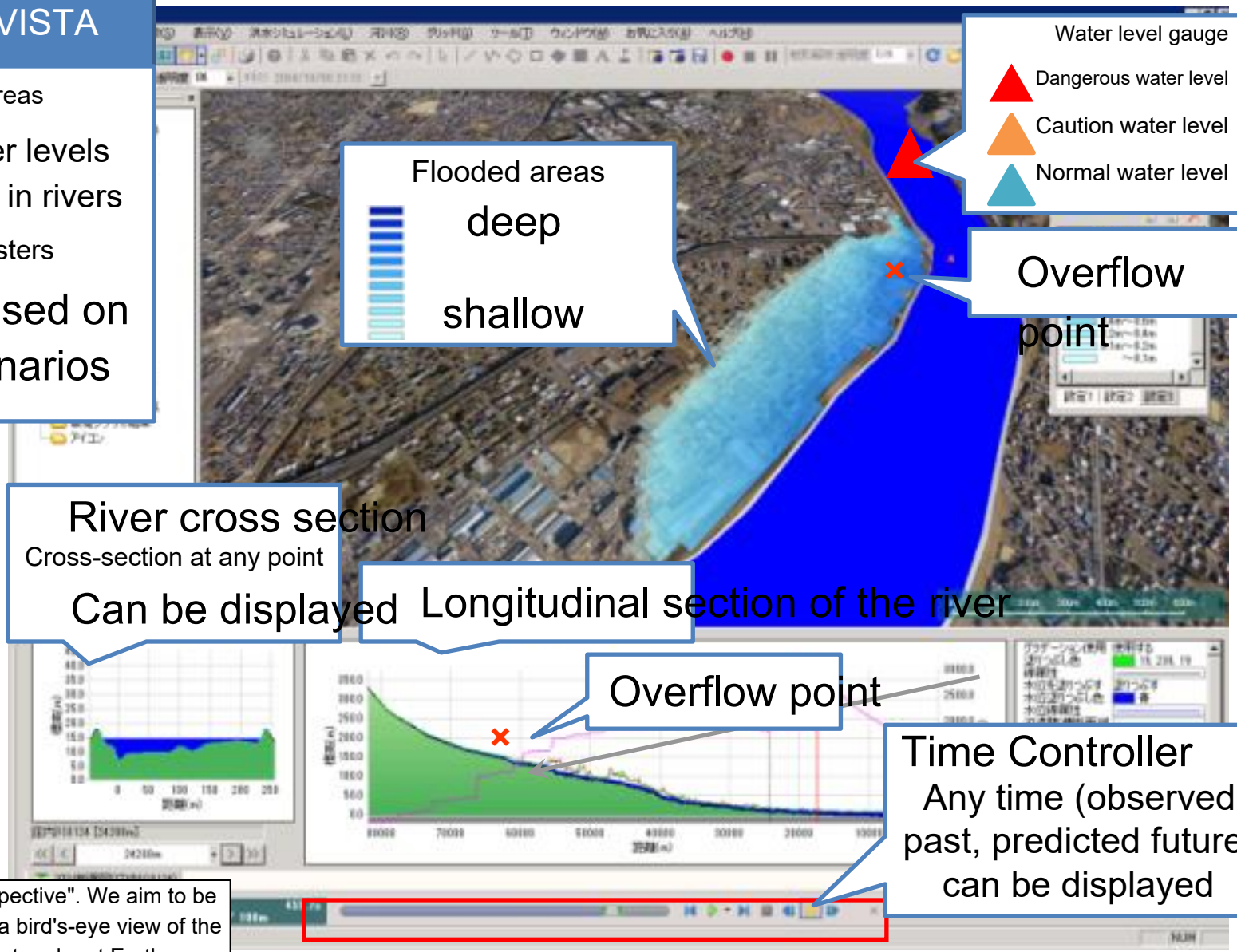
Key features of DioVISTA

1. Prediction of flooded areas
2. Prediction of water levels at arbitrary points in rivers
3. Analysis of past disasters
4. Simulation based on assumed scenarios



DioVISTA: Italian for "God's perspective". We aim to be a business system that can take a bird's-eye view of the past, present, and future of the water planet Earth.

Features of DioVISTA

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forte

(1) High-precision simulation in a short time

Applies proprietary high-speed arithmetic algorithms

(2) Advanced simulation is possible with simple operation

You don't need to be an expert to simulate

(3) Simulation using rainfall as input condition is possible

Danger areas are displayed on maps and route maps to support rapid response

Feature 1 : High-precision simulation in a short time

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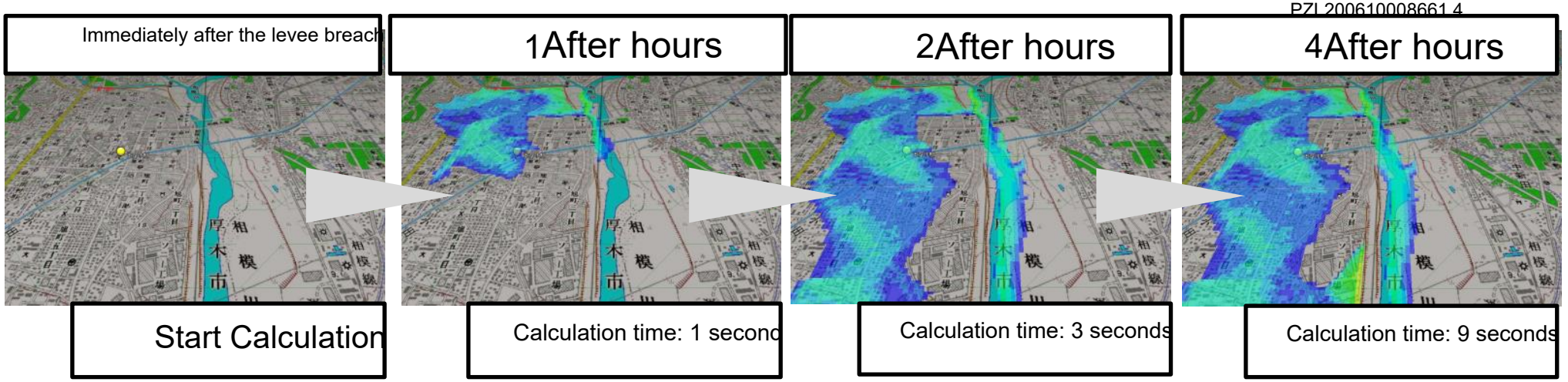
- Applying Hitachi's proprietary high-speed calculation algorithm, Dynamic DDM
  - Patented in Japan, USA and China
- Perform flood analysis based on fluid equations
  - The error in the flooded area is relatively small (1 Verified by the Asuwa River flood in Fukui Prefecture in 2004)

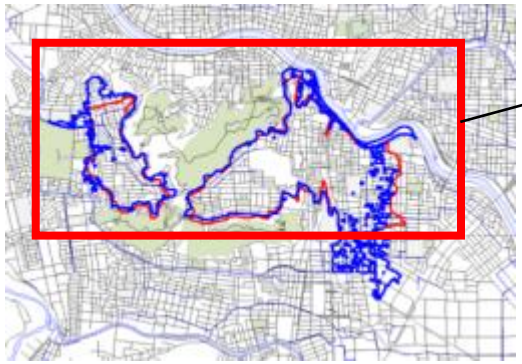
Japan Patent 4761865
United States Patent 7603263 Chinese Patent PZL 200610008661.4



OS: Microsoft Windows 7 Professional (64-bit)
CPU: Intel® Core™ i7-2700 (3.50 GHz)
Memory: 16 GB

Flood simulation accuracy ver

- Verified by the 2004 Asuwa River flood in Fukui Prefecture • The extent of flooding is almost the same.



Scope of field survey Missed rate: 9% Empty swing rate: 13%

Inundation area by field survey Inundation area by simulation

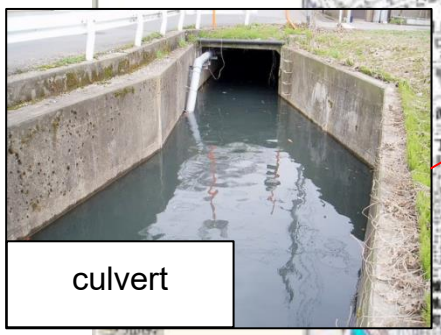
Yamaguchi and Iwamura: Accuracy Verification of Flood Simulation by Asuwa River Flood Case in 2004, Proceedings of the 61st Annual Annual Conference, Japan Society of Civil Engineers, 2006.

http://library.jsce.or.jp/jsce/open/00035/2006/61-2/61-2-0027.pdf

Features of flooding in cities

Grade separation

Railway embankment



culvert

Water flow is affected by railway embankments, roads, grade separations, etc.

Conventional method

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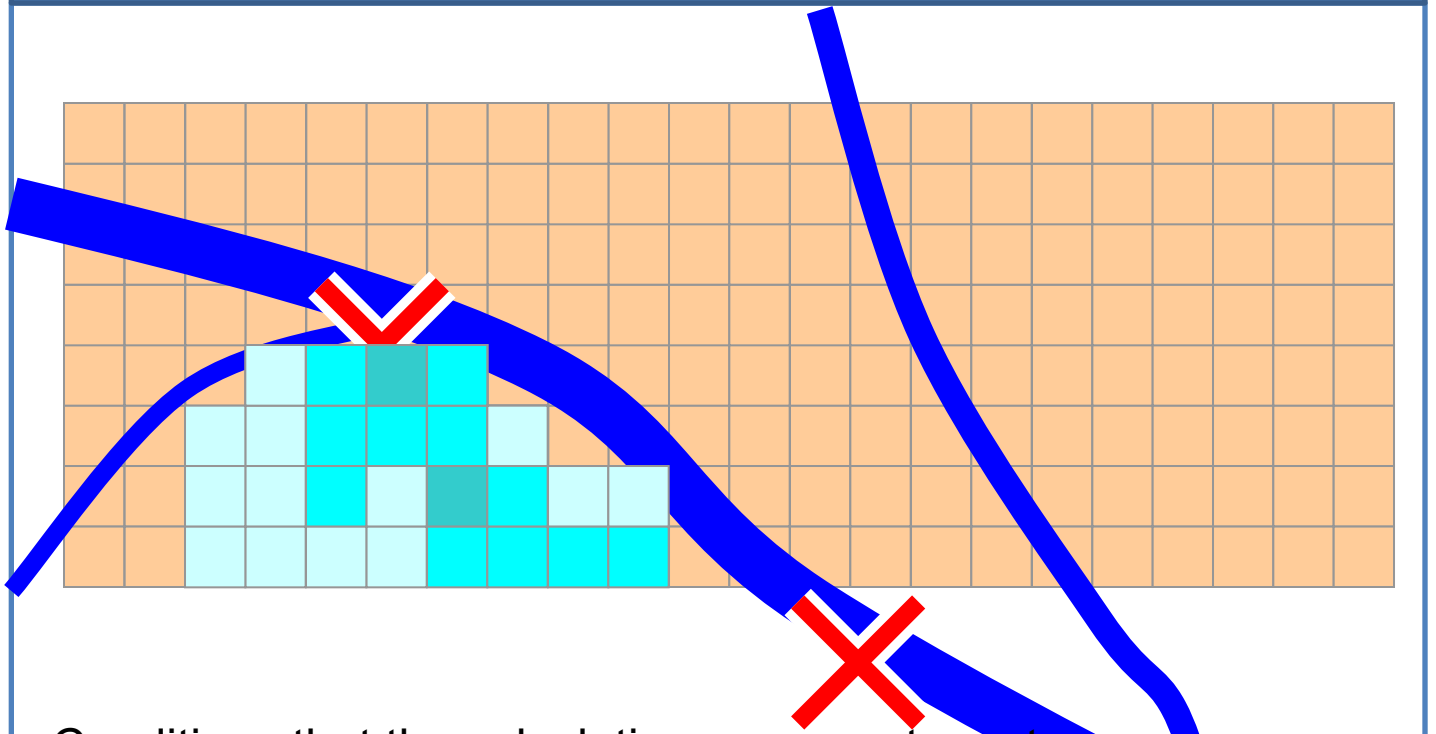
Flood Model



Conditions that the calculation area must meet

1. Flow must not reach the boundary of the computation area
2. Embankment failure must not occur outside the calculation area
3. The calculation area should be as small as possible

Dynamic DDM

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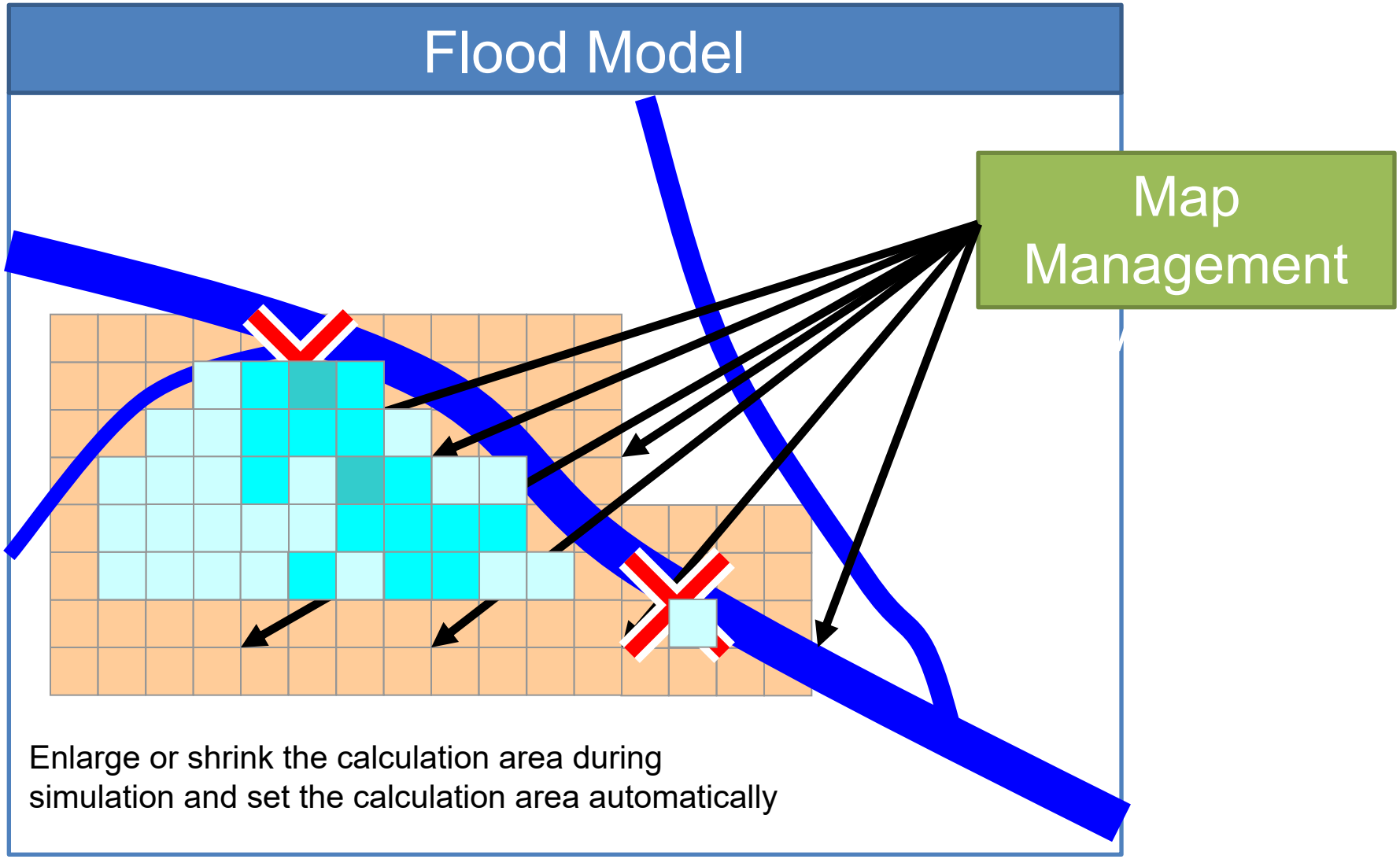
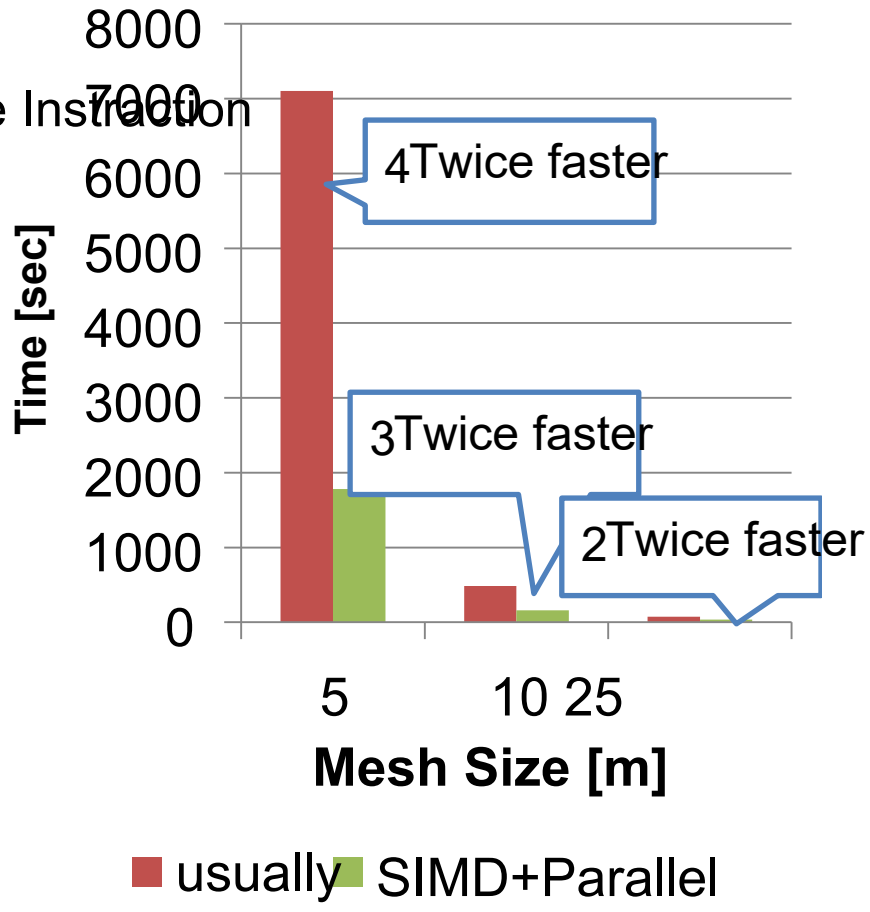


Yamaguchi , Iwamura: Mathematical Modeling and Applications, Vol. 48 (SIG_6, TOM_17), pp.92-103, 2007.

Implementation level acceleration

- Acceleration with SIMD
  - SIMD:99990101000000+0000Single Instruction Multible Data
  - SSE, SSE2
- Parallelization
  - PPL: Parallel Patterns Library
- Compare with and without SIMD+ parallelization
  - Flood calculation in K City (18 hours from levee break)
  - The faster the number of meshes increases, the more pronounced the speeding effect



Yamaguchi & Yamaho, Optimizing Two-Dimensional Flood Model with SSE and Concurrent, Proc. of 12th ICHE 2016, Taichung, Taiwan, pp. 08-0001,2016.

Using the Cloud

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- Parallel processing using Microsoft Azure
- Uses 192 CPU cores
  12 simultaneous processes in parallel
- Processed Yodogawa analysis case (ME L2 76 shsize 25m) in 13 hours

	Computational resources used
Total Cores	192
Total memory (GB)	384
Number of virtual machines	12
CPU	Intel Xeon E5-2673 v3 @ 2.4 GHz
Number of CPU cores	16
Memory (GB)	32
Disk (GB)	SSD 64

Yamaguchi, Kusuda, Acceleration of Flood Analysis by Cloud Computing, Proceedings of the 72nd Annual Conference of the Japan Society of Civil Engineers, Vol. 72, No. 2-001, 2017.

Application examples of high-speed arithmetic algorithms

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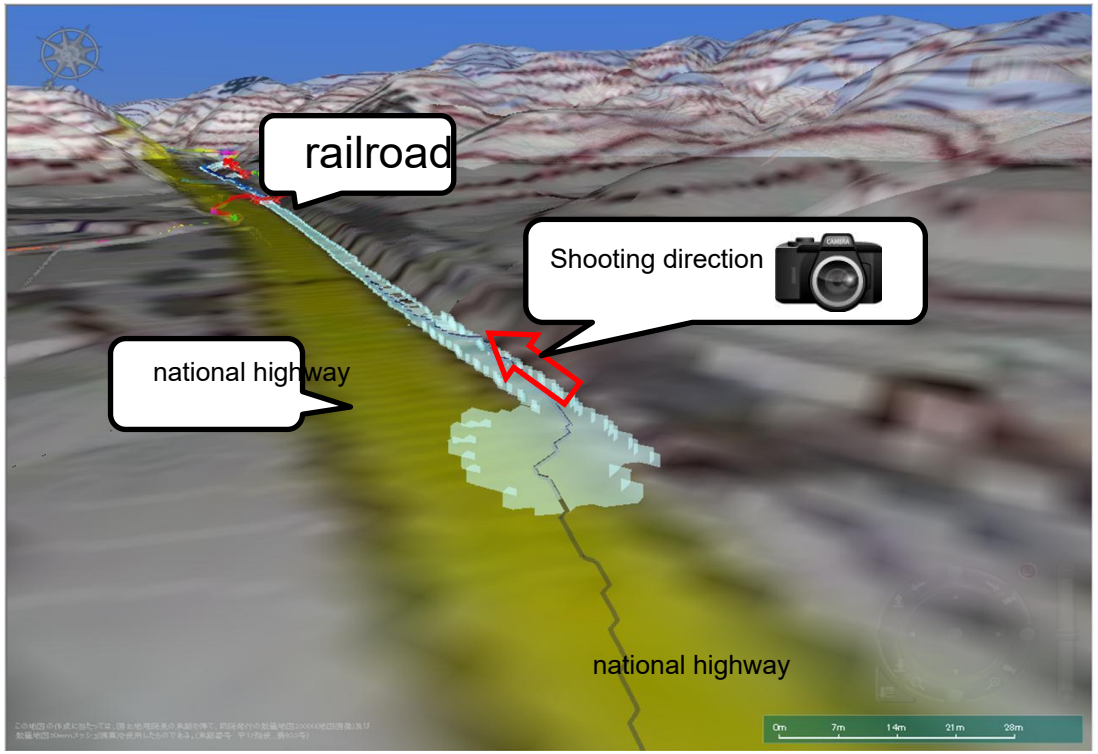
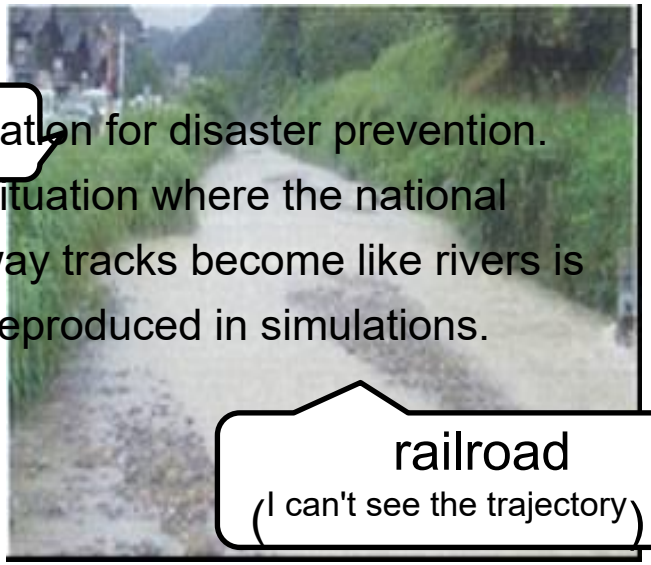
- Extremely high resolution (1m) topographic data that was previously difficult
- Reproduce embankments, cuts, gutters, streams, etc. around the track
- Successfully recreated the flood conditions at that time



Photos at the time of flooding



foundation for disaster prevention.
The situation where the national highway tracks become like rivers is also reproduced in simulations.

railroad
(I can't see the trajectory)

Target area: Near Sayo Station on the Himeshin Line

DioVISTA is used for research by the Railway Technical Research Institute, a public interest incorporated

Sugiyama, Recent Research and Development on Disaster Prevention Technology, The 256th RTRI Monthly Conference, http://bunken.rtri.or.jp/doc/fileDown.jsp?RairacID=0011002100

Feature 2 : Advanced simulation is possible with simple operation

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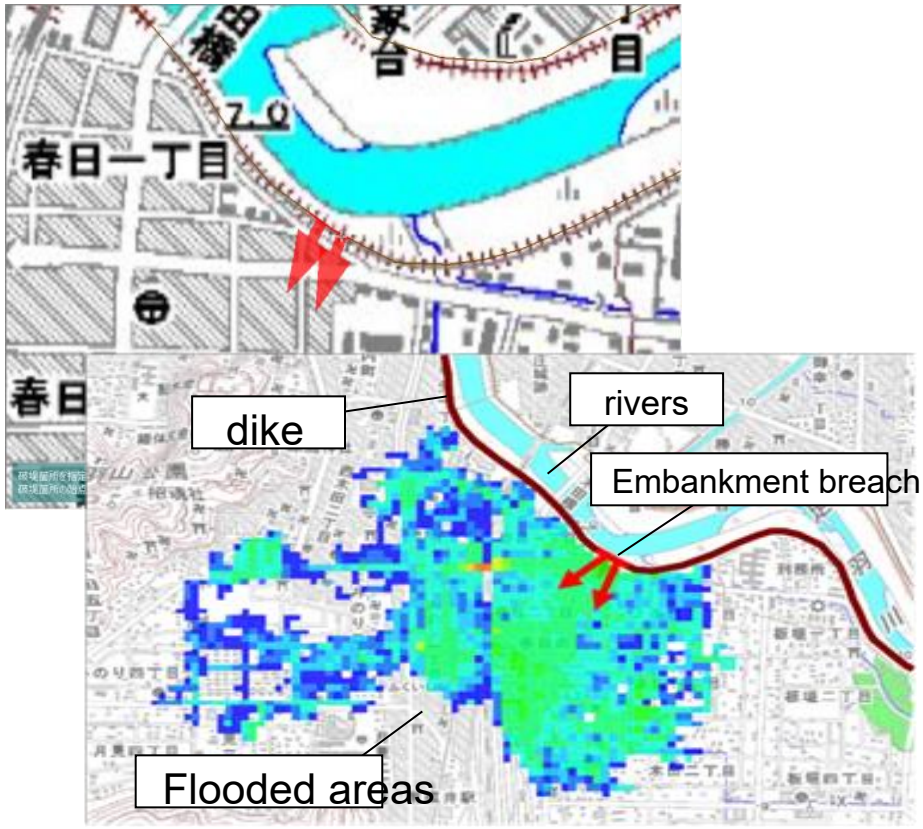
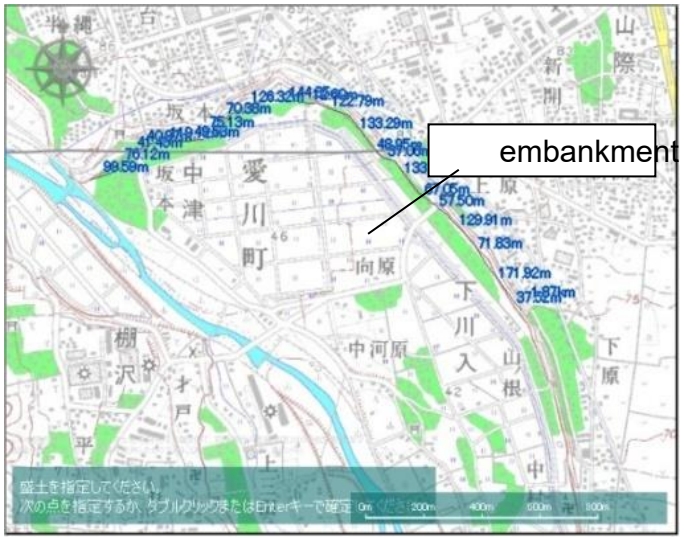
Setting the location of the levee breach

- Click on the map to create an embankment
- Click on an embankment to specify where the levee breaches
- Intuitive operation using maps



- Similar operations allow detailed urban structure configuration
  - Embankment
  - Culverts
  - Culvert



- Advanced simulation is possible without being an expert in hydrological analysis

Feature 3: Simulation of rainfall input is possible

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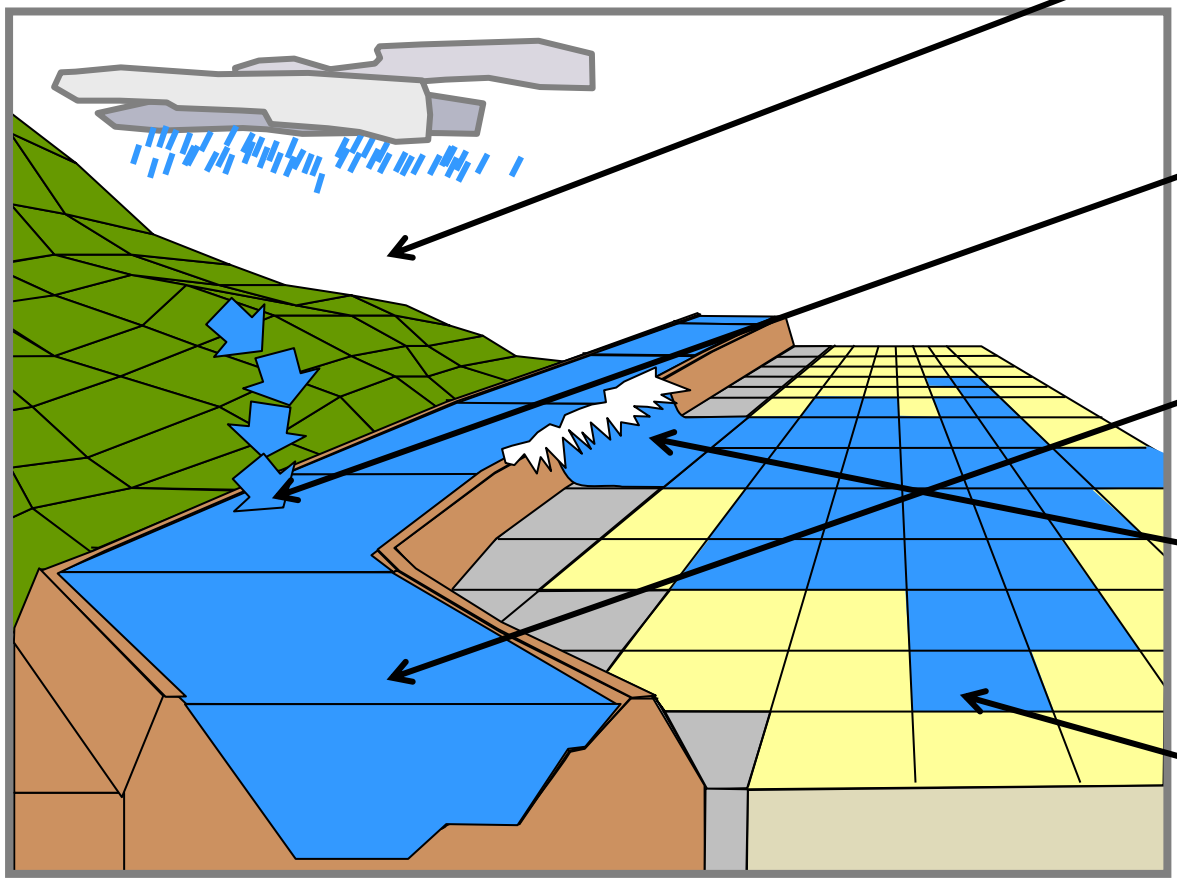
- Integrated simulation of phenomena from rainfall to flooding
- Automatically build the models you need from map data



Distributed outflow model

Outflow and river connections

1river model

River and flood connections

2flooding model

How to build a model

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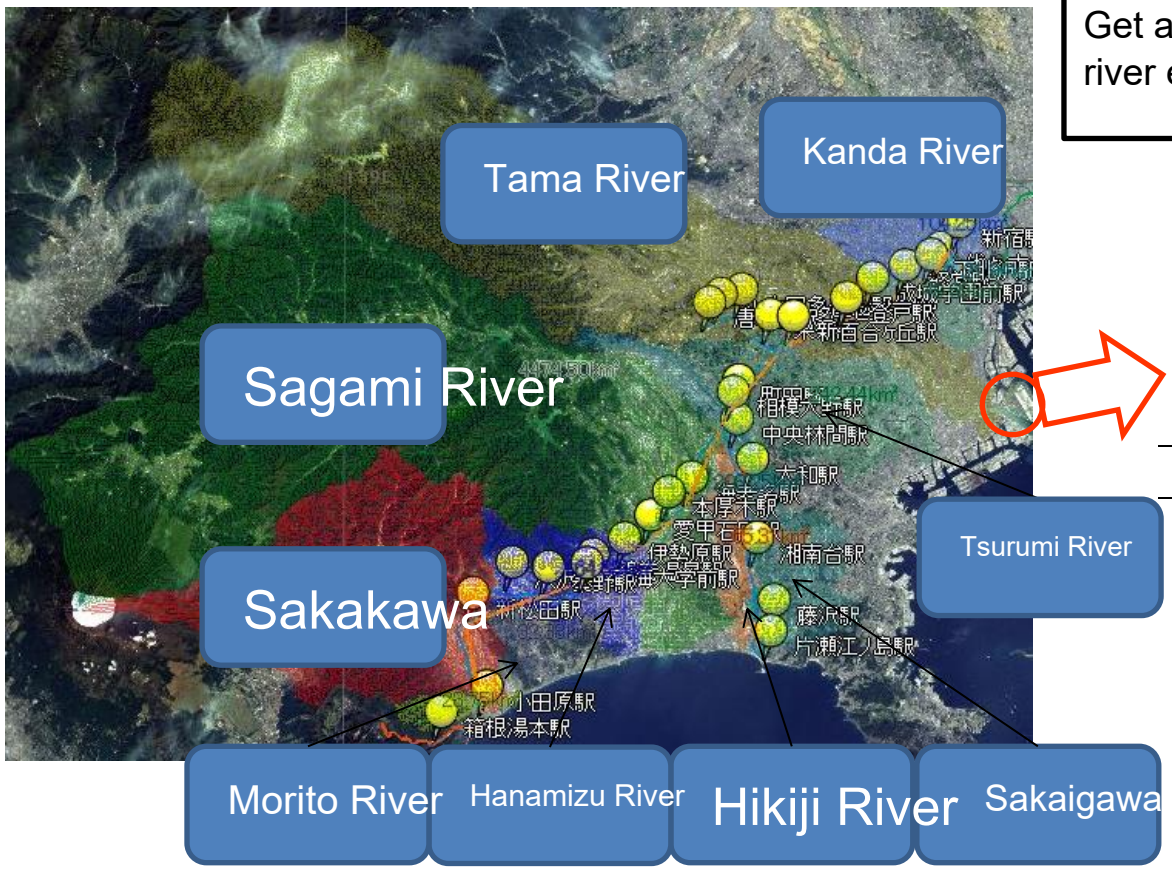
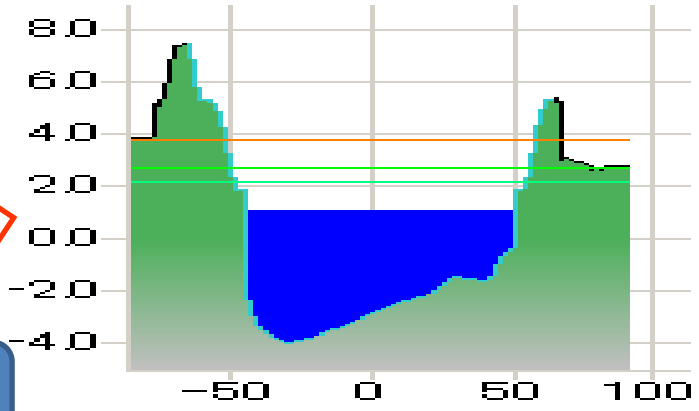
Model rivers in the area of interest

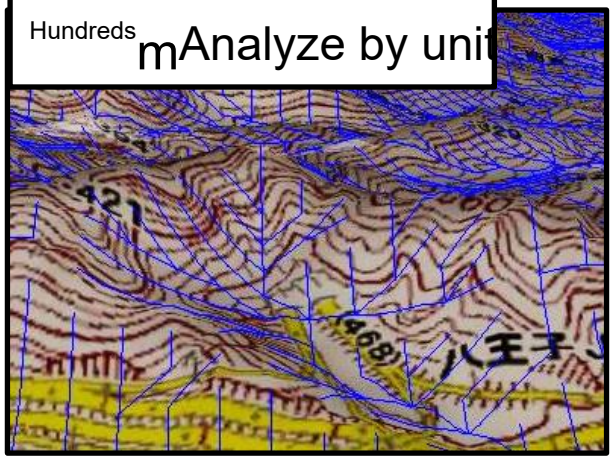


Get a river cross-section along the river every few hundred meters



Direction of rainwater flow

Hundreds mAnalyze by unit



Example of rainwater flow direction analysis

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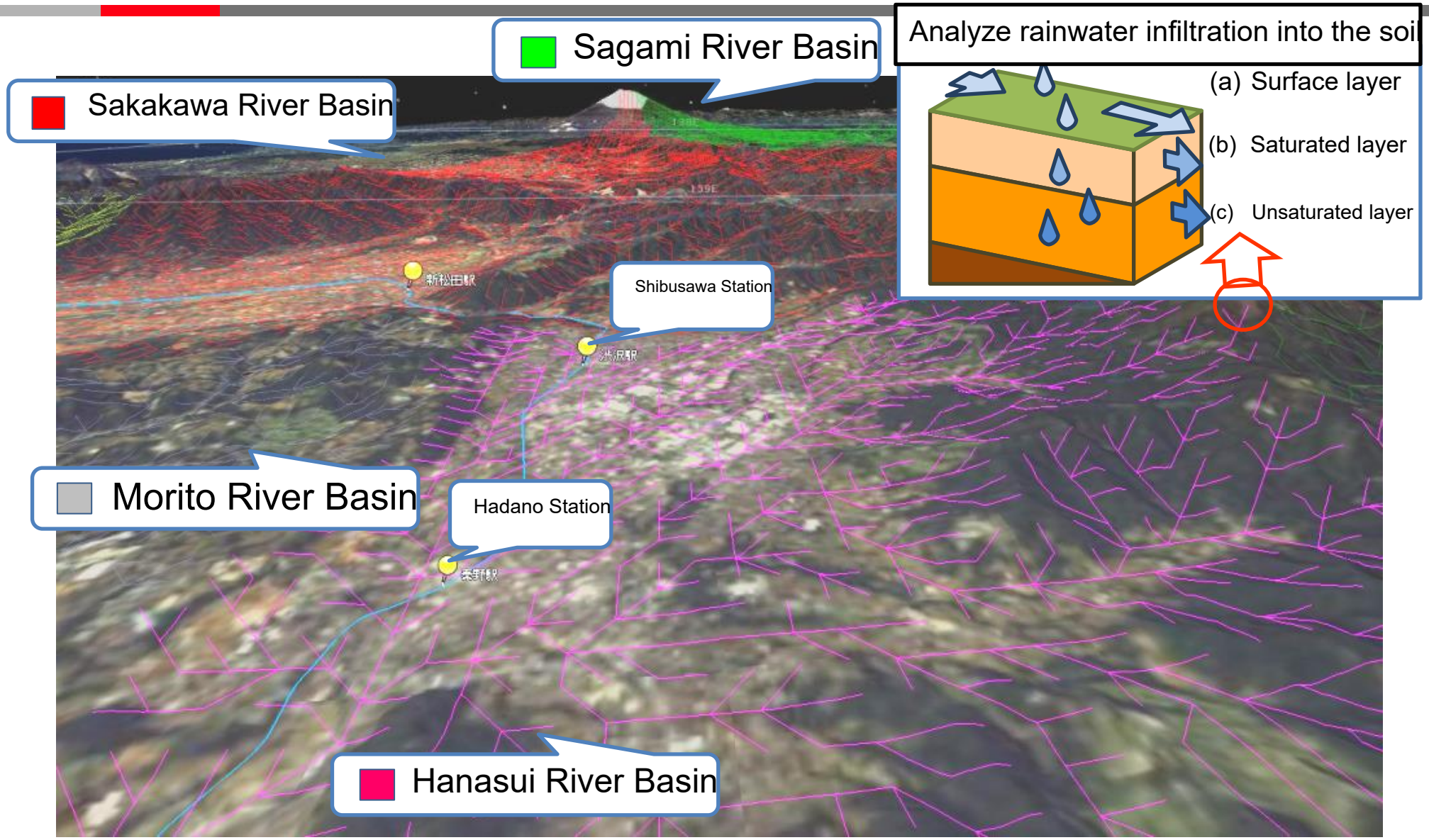

Product system and implementation results

System/Software

Edition Features	use	achievements
Enterprise 24/365 flood forecast [Enterprise]	• Convening staff • Assistance in determining the location of the monitoring • Support for issuing evacuation advisories	• Municipalities
Professional Flood simulation assuming heavy rain [Professional]	• Quantitative assessment of flood risk • Analysis of disaster mechanisms	• Property and casualty insurance companies • Construction consultants • Universities, research institutes
Flood simulation assuming a standard levee failure Standard]	• Check flooded areas • Preparation of documents for disaster prevention plans	• Municipalities • Universities, research institutes

service

Service Items	substance	achievements
Video Creation	• Flood simulation videos for disaster prevention education	• Municipalities
Calculation Agency Reporting	• Perform simulations based on assumed scenarios	• Property and casualty insurance companies • Large factories and broadcasting stations • Construction consultants

Enterprise Edition Features

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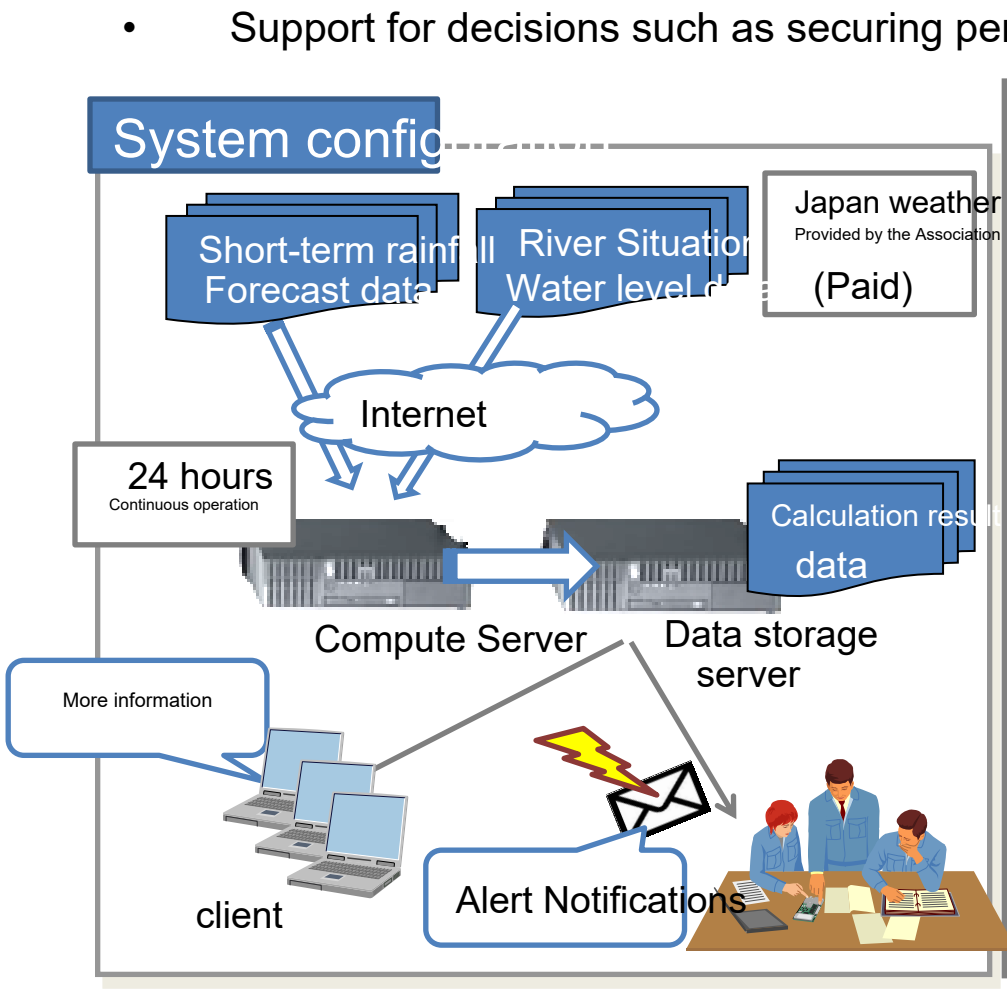
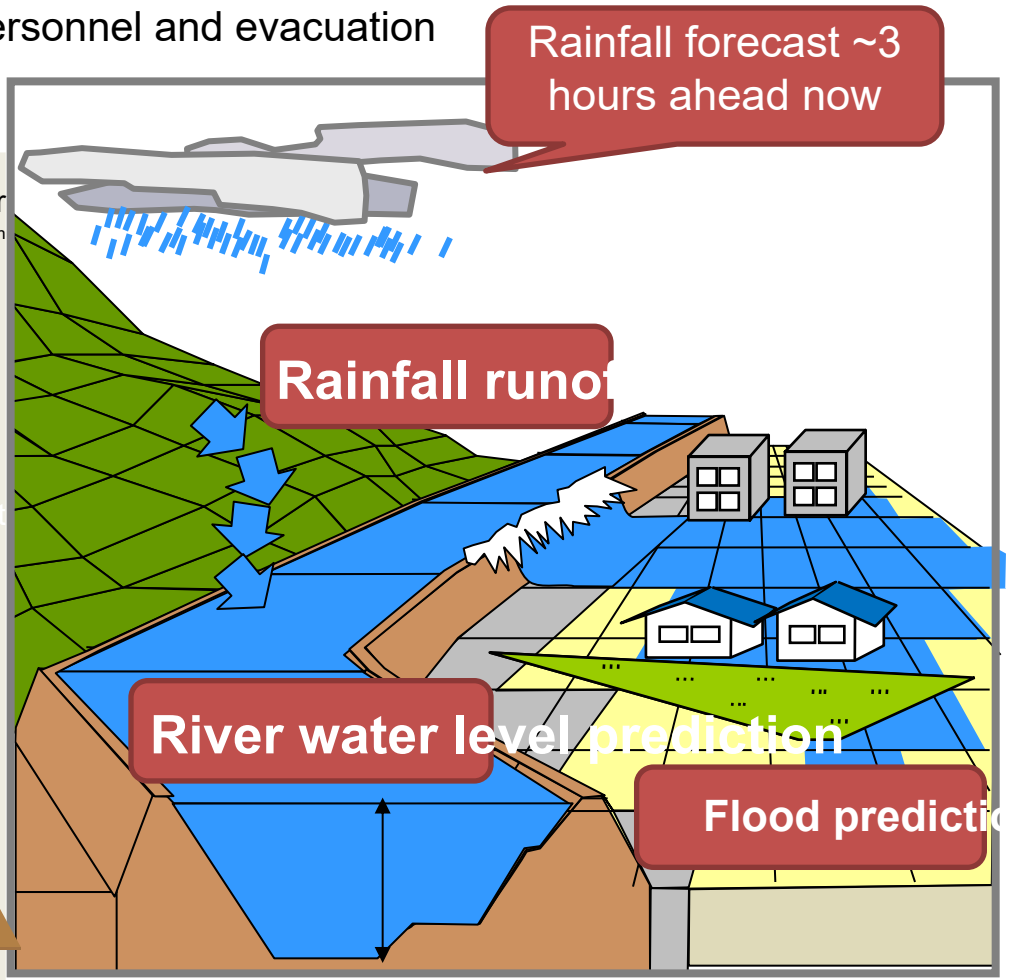
Enterprise

- Predict river water levels and flooded areas based on predicted rainfall
  - Updated every 10 minutes up to 3 hours ahead
- Notify early of the risk and possibility of flooding
  - Support for decisions such as securing personnel and evacuation





Professional Edition Features

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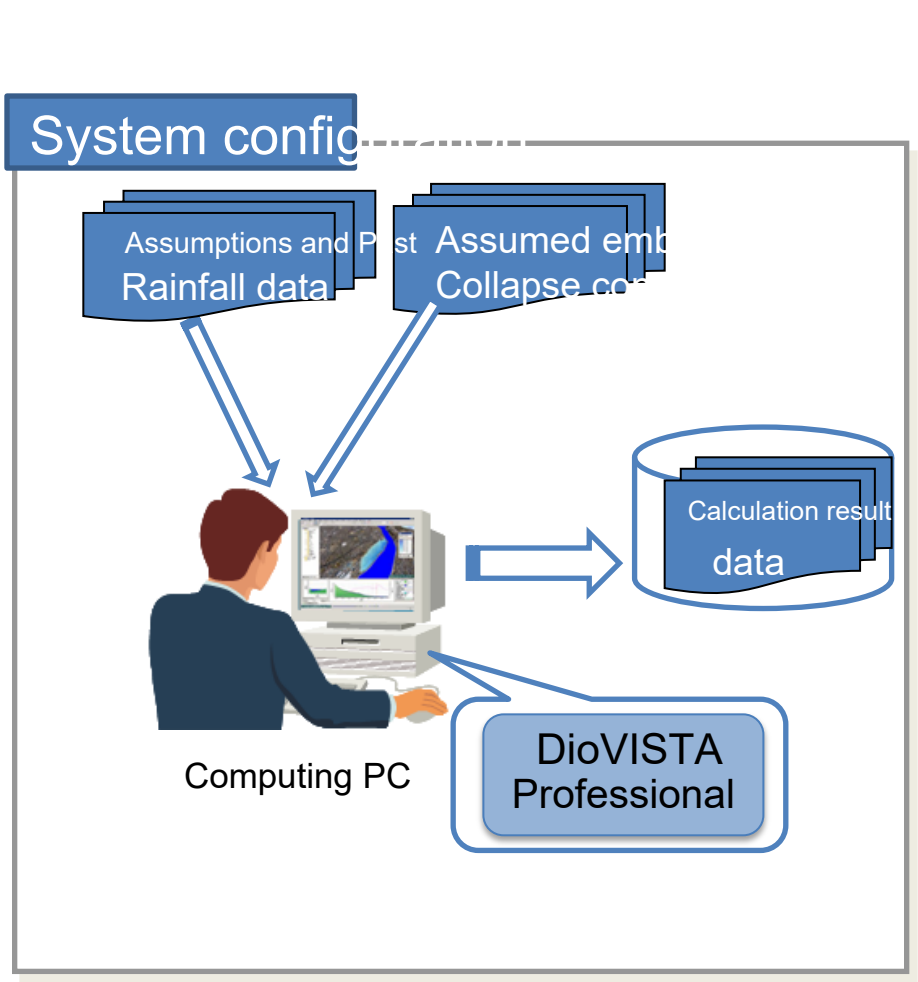
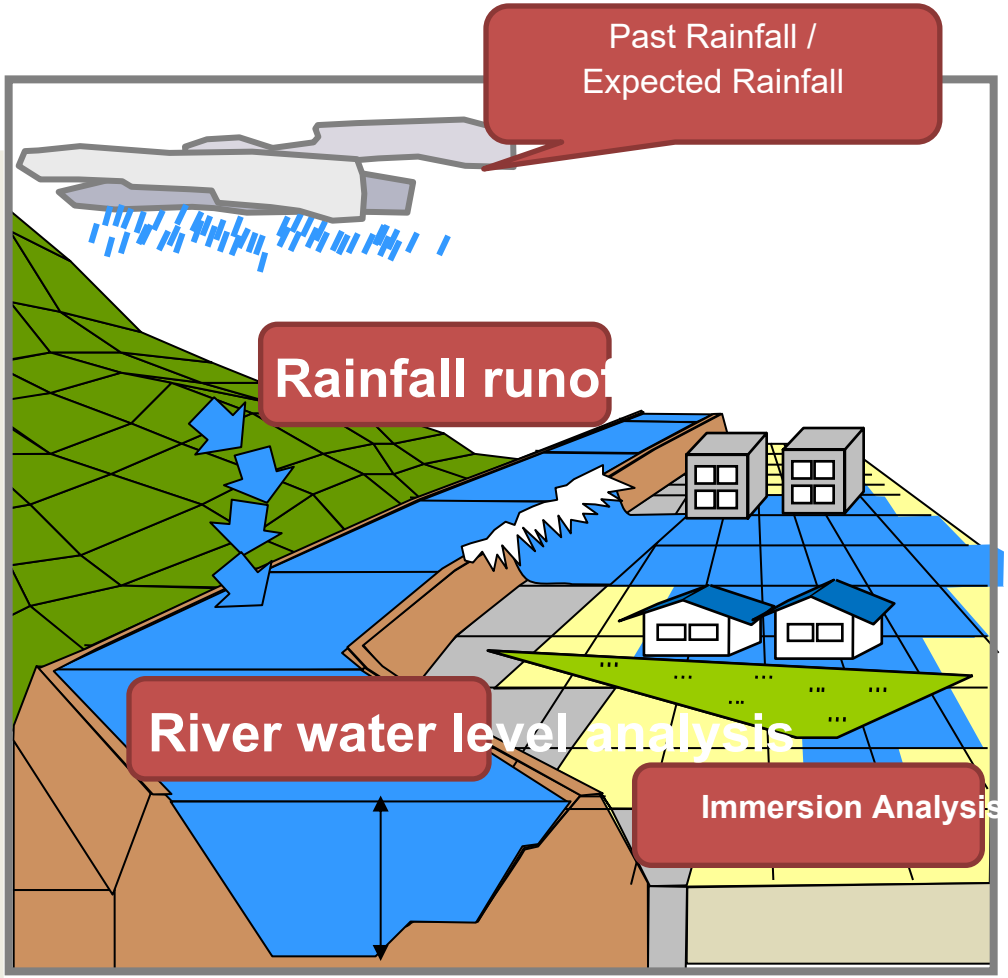
Professional

- Estimate river water levels and flooded areas based on expected rainfall
  - Verification of past accident cases
  - Create a flood risk curve





Standard Edition Features

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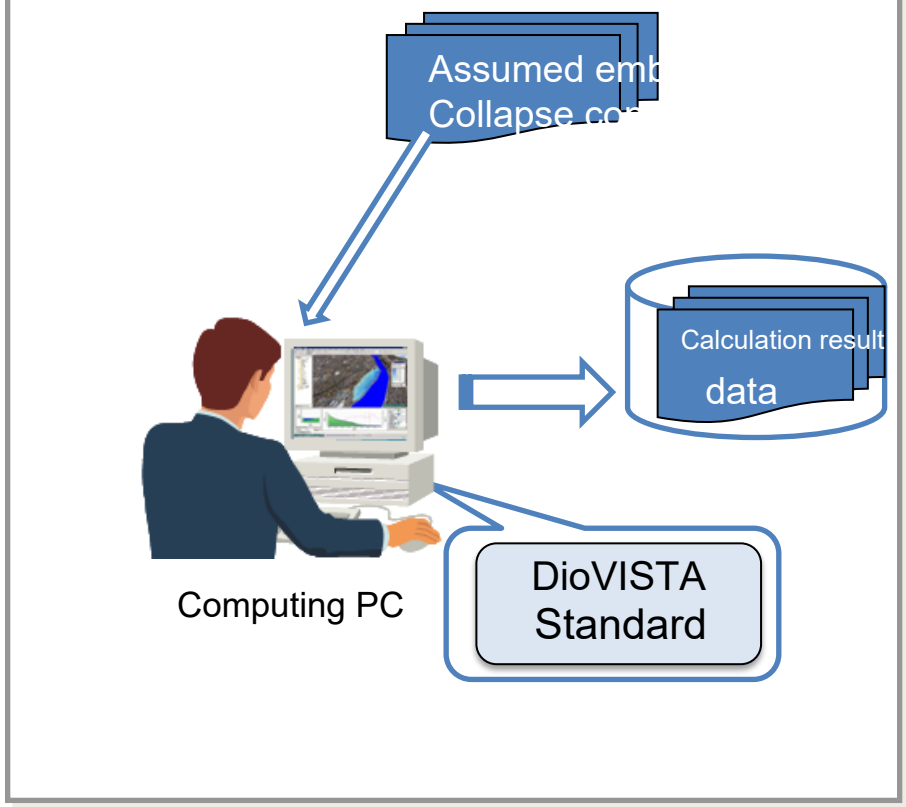
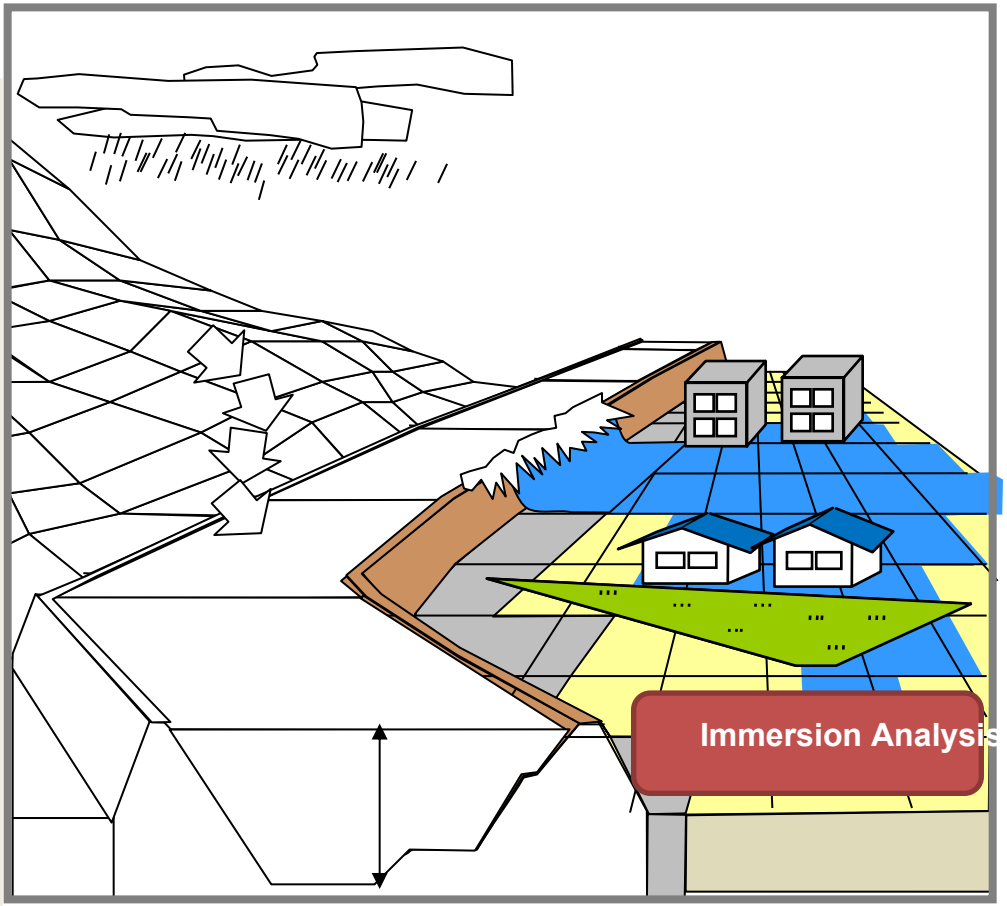
Standard

- Estimate flooded areas based on expected failure conditions
  - Flood-specific analysis is realized with simple operation
  - Rapid risk estimation for specific sites
  - Support for the formulation of disaster prevention plans

System config





Simulation Auxiliary Functions

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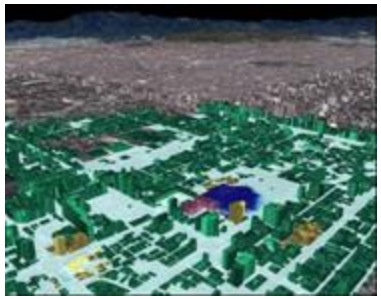
Contour display function

Displays specified inundation depth and inundation area over time

Building flood display function

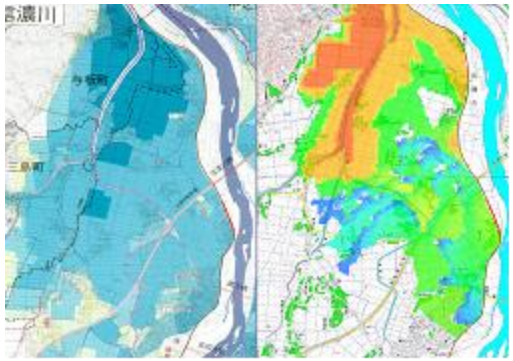
Analyze the flood situation of each building. The number of above- and below-floor flooded houses was tallied, and a list of addresses, dwelling names, and flood depths was created.



Example of flood display of urban buildings using a house map

Hazard map comparison function

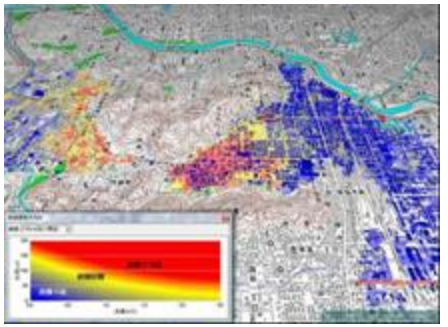
You can import the image image of the hazard map and compare it with the flood simulation result.



Example of displaying two screens with hazard map on the left and flood results on the right

Danger display function

Displays the level of danger when evacuating on foot in relation to inundation depth and current velocity by adult male, adult female, and child.



3DioVISTA 3D GIS Engine

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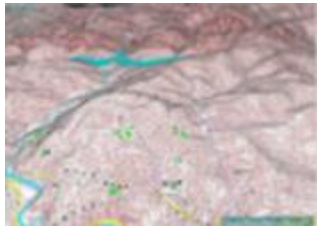
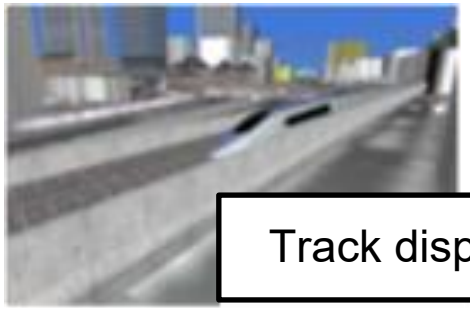
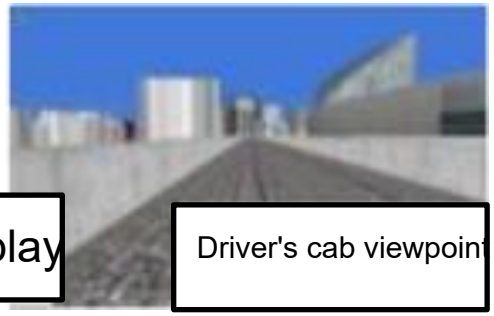
- 3D + time management
- Seamless display of the entire globe ~ facility details
- Quick and flexible customization to suit your business
  - Independently developed by Hitachi
  - Supports a large number of map data

Entire Planet Facility Details





Track display

Driver's cab viewpoint

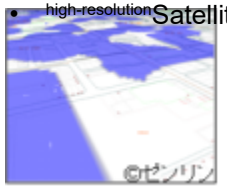
Supported map data

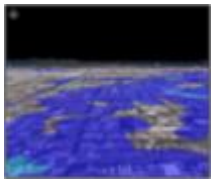
Standard map
Shape and KML• Global Satellite Imaging (NASA)

- Global Topographic Data (SRTM-3)
- Geospatial Information Authority Numerical Map 25000 (Map Drawing) Statue)
- Geospatial Information Authority of Japan Numerical Map 50m Mesh (Elevation)
- Geospatial Information Authority of Japan

Numerical Map 5m Mesh (Elevation) Options

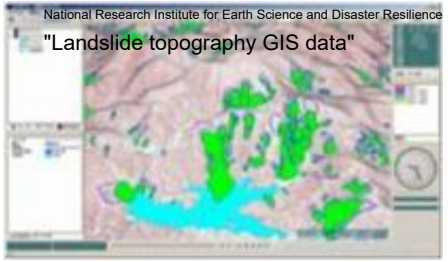
- Zenrin Housing Map Zmap-TownII
- Shobunsha Mapple25000
- high-resolution Satellite Imagery CAD Data

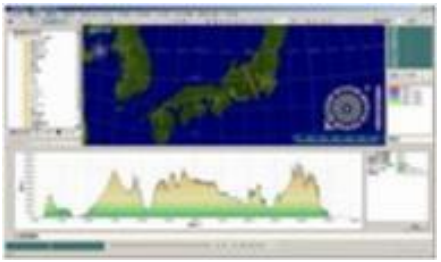




Zenrin Housing Map Zmap-TOWNII Shobunsha MAPPLE25000 High Accuracy Satellite Photo

cross-section view





< Supplementary > Simulation examples for the Tone River

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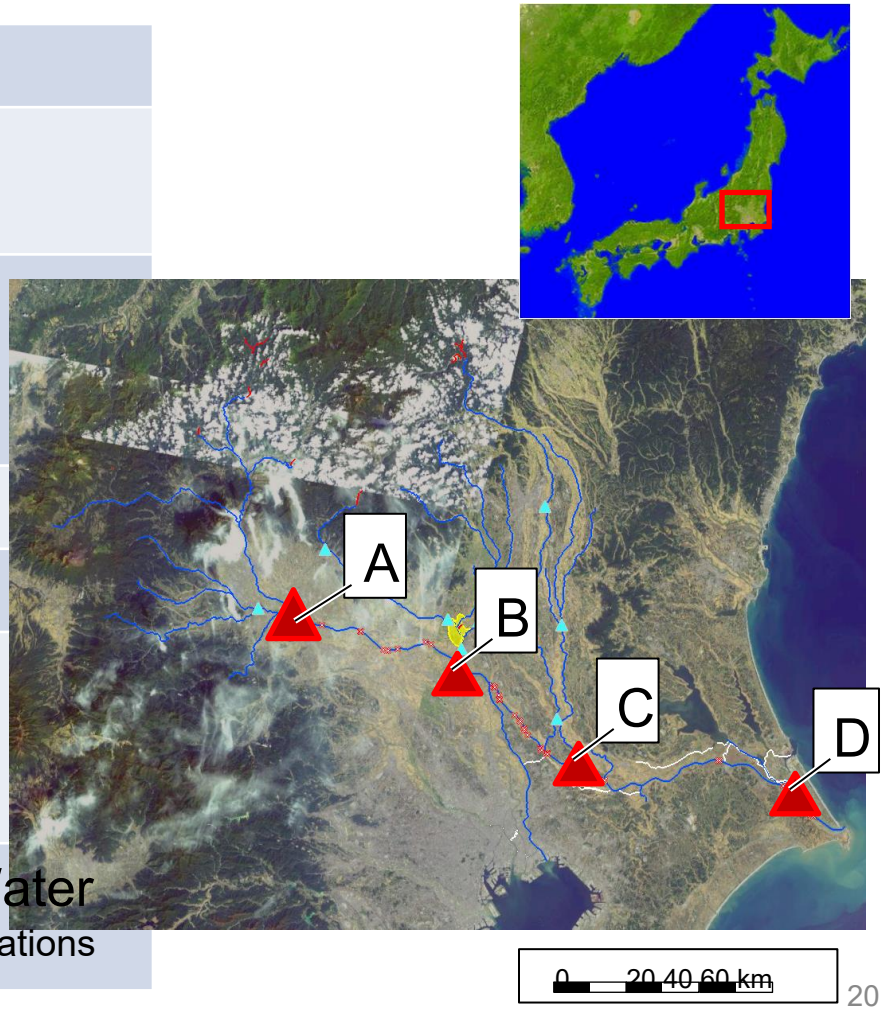
Grade 1 river Tone River: The largest basin area in the Japan and the second longest in the Japan. It has numerous dams, reservoirs, tributaries and spillways.

One of the most difficult rivers to simulate in Japan.

target	Tone River
Spillage model	Basin area: 16,840 km2, Distributed type, Cell size: 100m
River model	Main River 1, Branch River 20, Spillway 2 Using survey cross section 1, cell size 50m
Flood Model	2, cell size 50m
Drainage Basin Model	2 locations
Input conditions	Rainfall radar (1km, 30 min) Dam discharge (hourly) Estuary tide level (hourly)
Verification methods	2007 Typhoon No. 9 High Water 10 with water level observation at 10 locations



Simulation example for the Tone River - Result 1

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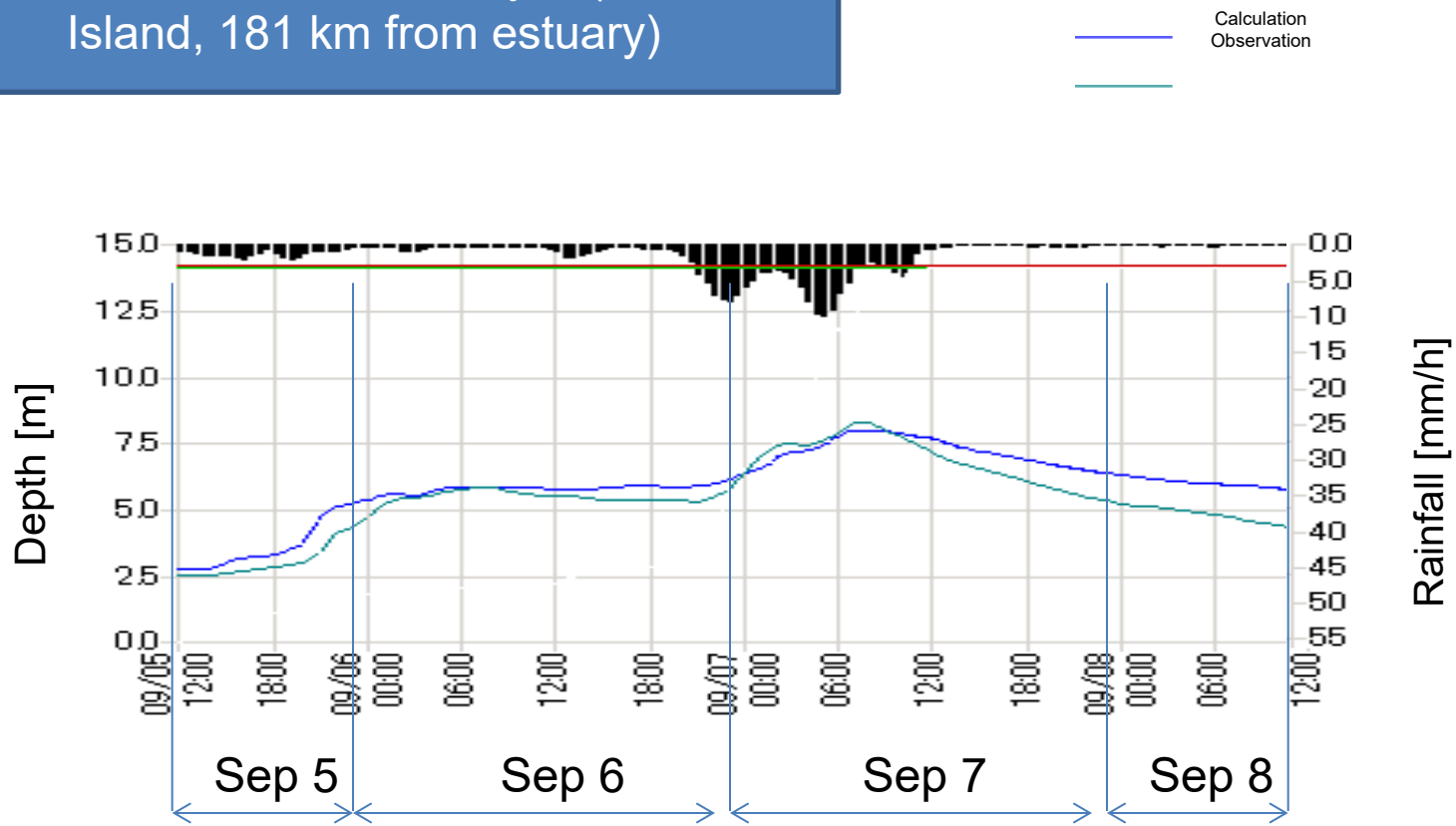
Re-enactment of the 2007 Typhoon No. 9 High Water Event

Water Level Observatory A (Yato Island, 181 km from estuary)



Simulation example of the Tone River - Result 2

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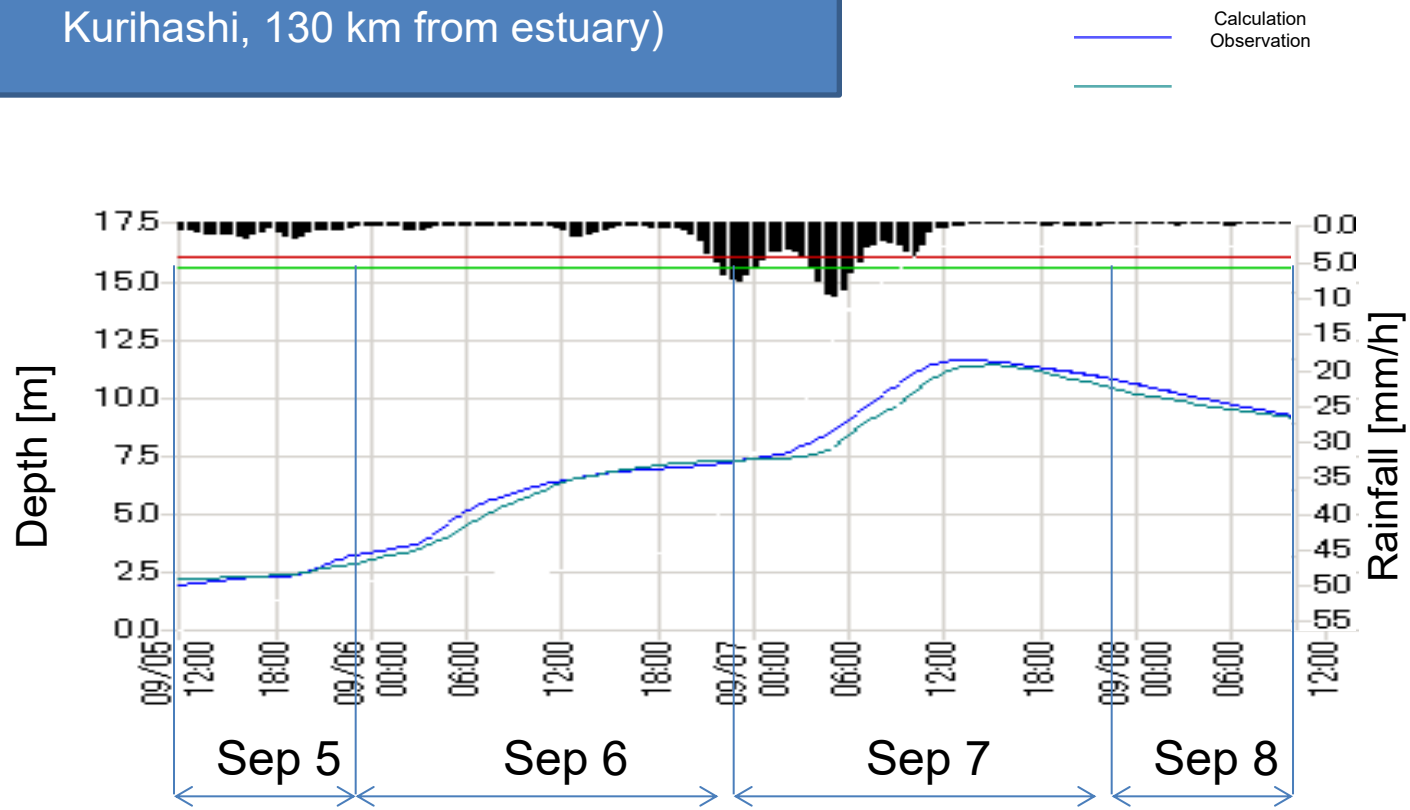
Re-enactment of the 2007 Typhoon No. 9 High Water Event

Water Level Observatory B (
Kurihashi, 130 km from estuary)



Simulation example of the Tone River - Result 3

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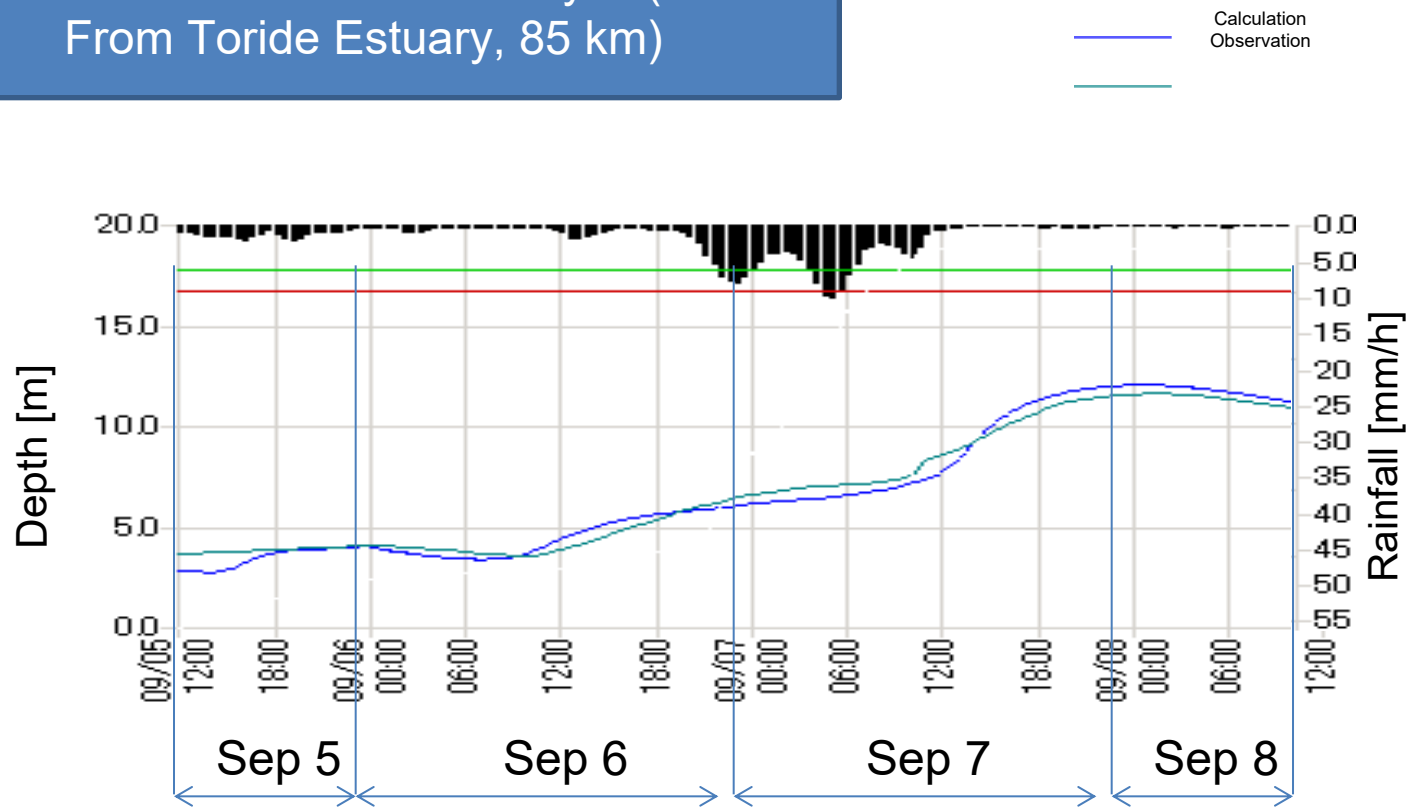
Re-enactment of the 2007 Typhoon No. 9 High Water Event

**Water Level Observatory C (
From Toride Estuary, 85 km)**



Simulation example of the Tone River - Result 4

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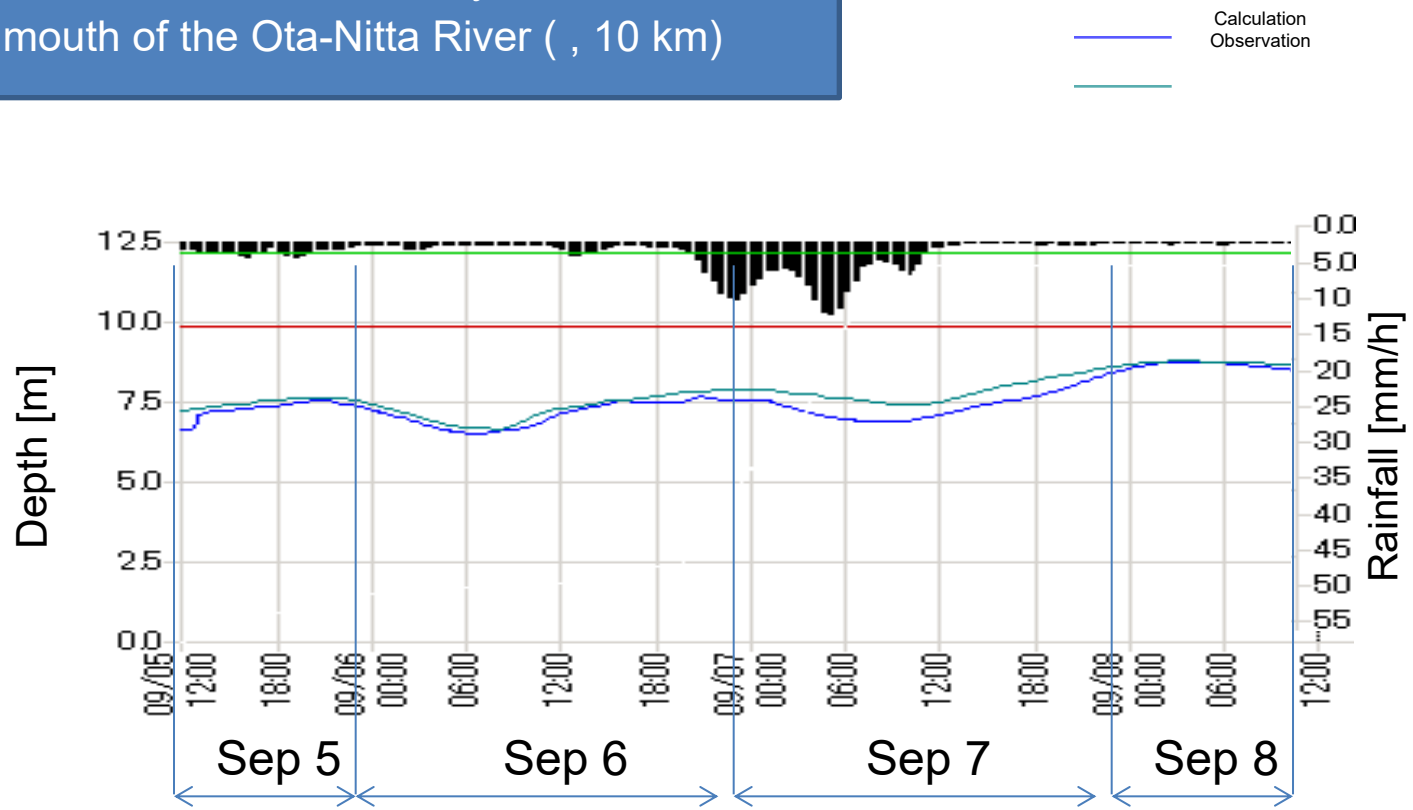
Re-enactment of the 2007 Typhoon No. 9 High Water Event

Water Level Observatory D from the mouth of the Ota-Nitta River (, 10 km)



10water level error at 10 points : 0~0.4 m

- Reproducibility is reasonable

Simulation example of the Tonegawa River - Result 5

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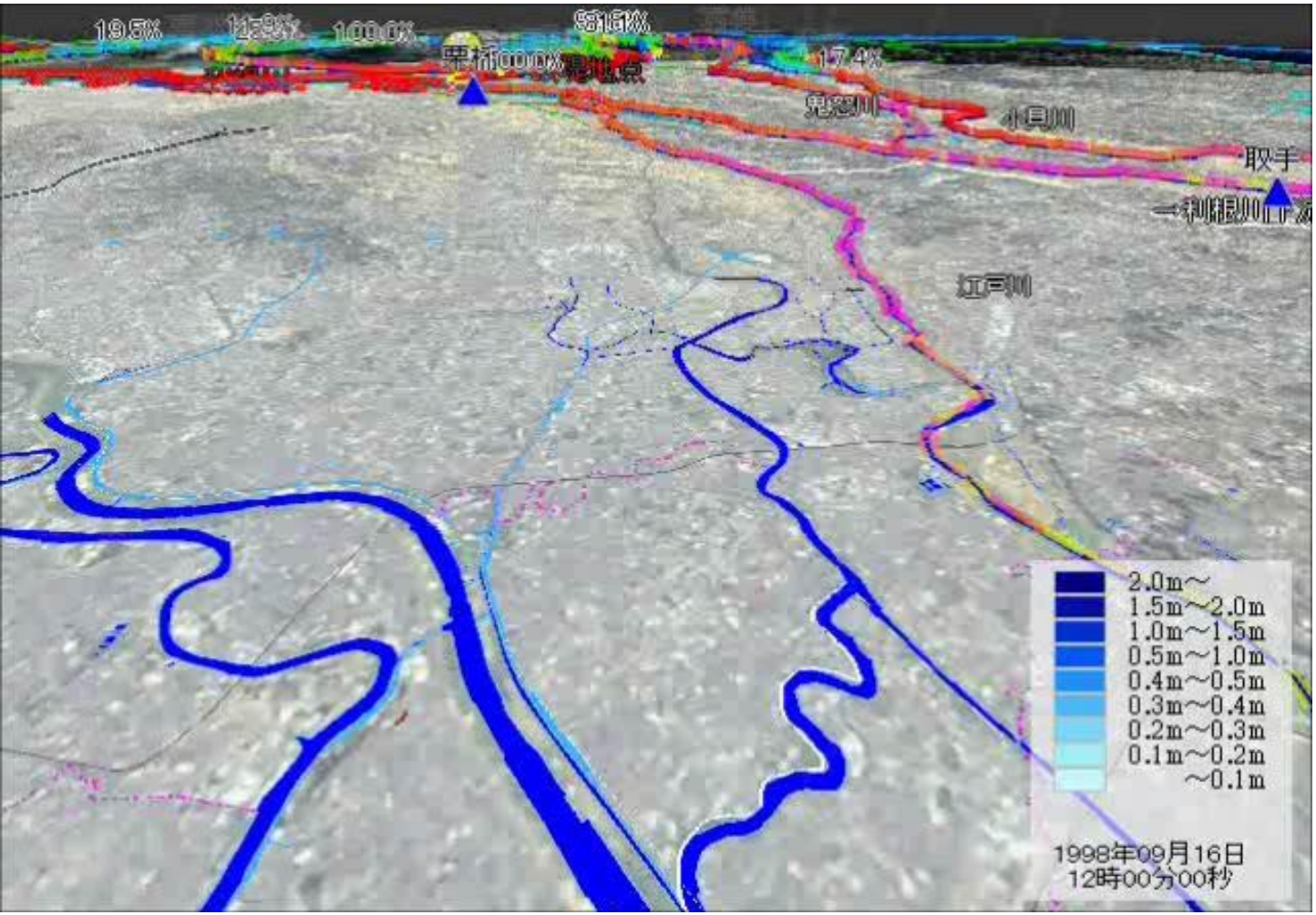

Created by DioVISTA video output function

Rainfall with an annual excess probability of 1/200 in the Tone River basin and large-scale flood damage in the Tokyo metropolitan area expected due to levee failure

Example of reproducing water level (Yodo River basin)

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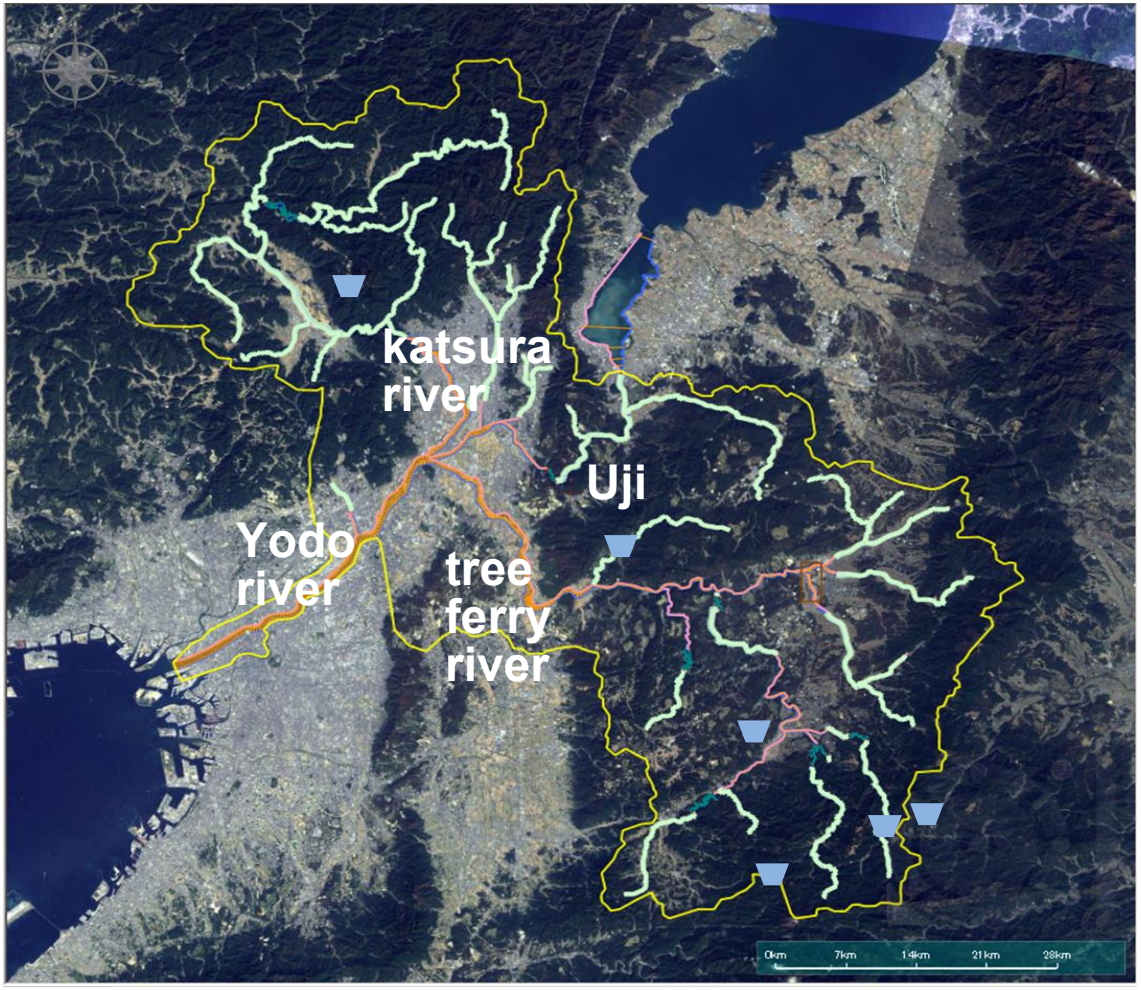
Target rivers	Yodo River Basin Area: 4,392 km2 (excluding Lake Biwa basin)Honkawa 1, Tributaries 28, Dam 7

Spillage model
Distributed type, 100m

River model
1D Irregular flow, 50m

Flood Model
2D Irregular Flow, 25m



Reproduction water level of Hirakata