National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure, Transport and Tourism
Asahi1, Tsukuba-shi, Ibaraki, 305-0804, Japan

A river water level prediction system using virtual reality technology of NILIM received the “Best Industrial Practical Application Award”

February 10th, 2023

- At the time of disaster, there is an indication that residents do not evacuate by a normalcy bias: an assumption that they will not suffer a disaster.

- For that reason, NILIM has developed a river water level prediction system with 3D viewer using virtual reality technology with the aim of communicating a sense of urgency and realism of the disaster more clearly to residents and preventing delays in evacuation.

- NILM received the "Best Industrial Practical Application Award" in SAT Technology Showcase 2023* held in Tsukuba on January 26th, 2023.
  This award is given to a presentation that is recognized as advanced application to industrial technology out of approximately 100 presentations.
- The introduction movie of this technology can be watched at the following URL.
  http://www.nilim.go.jp/lab/feg/index.htm

* SAT Technology Showcase 2023 is an interdisciplinary exchange meeting for researchers and engineers in the Tokyo metropolitan area and elsewhere to bring and share their latest research results, ideas and technologies each other.
https://www.science-academy.jp/showcase/22/index.html

2023/2/20
The 9th International Conference on Flood Management

Developing a river water level prediction system with 3D viewer using virtual reality technology

National Institute for Land and Infrastructure Management
Department of Rivers, Water Cycle Division

Y. MOROOKA, S.TSUCHIYA and T. TAKESHITA

国土交通省
国土技術政策総合研究所
National Institute for Land and Infrastructure Management

Outline

1. Introduction
2. Developing technology notes
    1. Operability
    2. Visual effects
    3. Accessibility
3. Developed technology
4. Summary
5. Future plans

Introduction ~ Research Background~

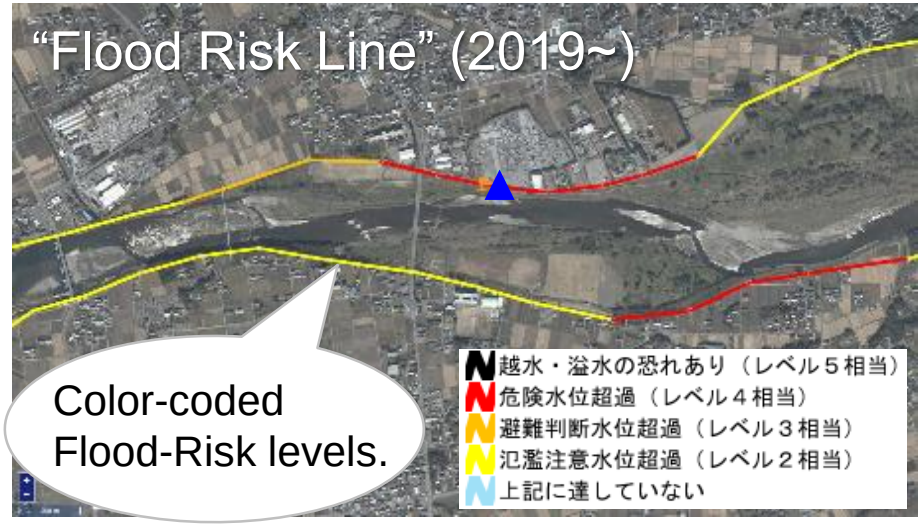
The Social Infrastructure Improvement Council (2015)

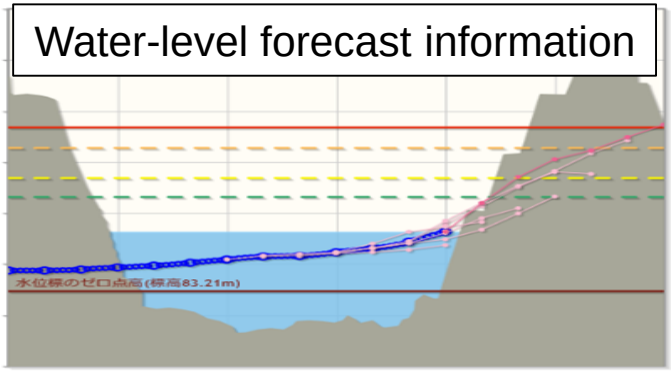
"Promotion of the technology development for improving the accuracy of flood forecasting"

The Social Infrastructure Improvement Council (2018)

"To improve the sophistication of flood forecasting and enhance provision of flood forecasts and water level information"

Developed by NILIM





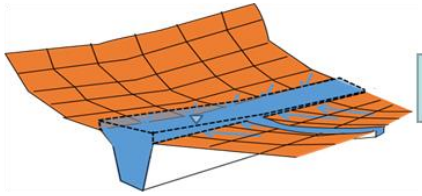
【Introduced Technologies】

- High accuracy river channel models
- Particle filters, etc.

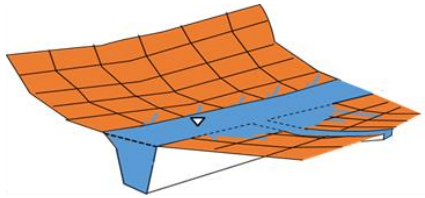
Introduction ~ Research Background~

Flood risk line (Under improvement)

Before

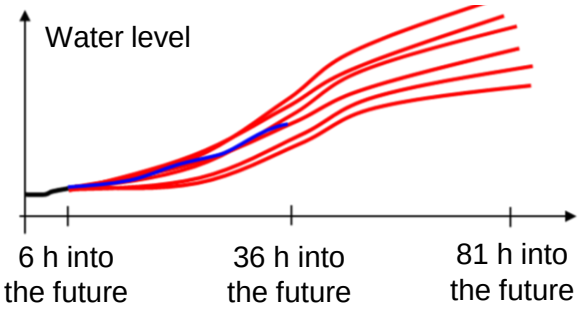


After



Water level prediction considering inundation

Utilize JMA ensemble forecasts



Developing technologies for longer and more accurate forecast information

Cabinet Office's study group (2022)

・Residents do not evacuate appropriately even if evacuation information is issued due to insufficient communication of a sense of urgency and realism of the disaster.

・Flood Risk Line also needs to be improved to more clearly convey the sense of urgency and realism of a disaster to residents in an easy-to-understand way.

・We developed technology for 3D displays of visualizing Flood Risk Line.

Confirm the validity and feasibility of the VR display

Introduction ~Preliminary investigation~

① Effectiveness of VR display of forecast information for evacuation

Example of a case

※Quoted and added from the website of Cabinet Office

・Approximately 10,000 accesses/month have been reported.

Residents want to check the video of the dangerous places.

Previous researches

Kakimoto et al.（2020）

・Residents' evacuation behavior was facilitated by a sense of urgency and realism of the disaster situation at the site.

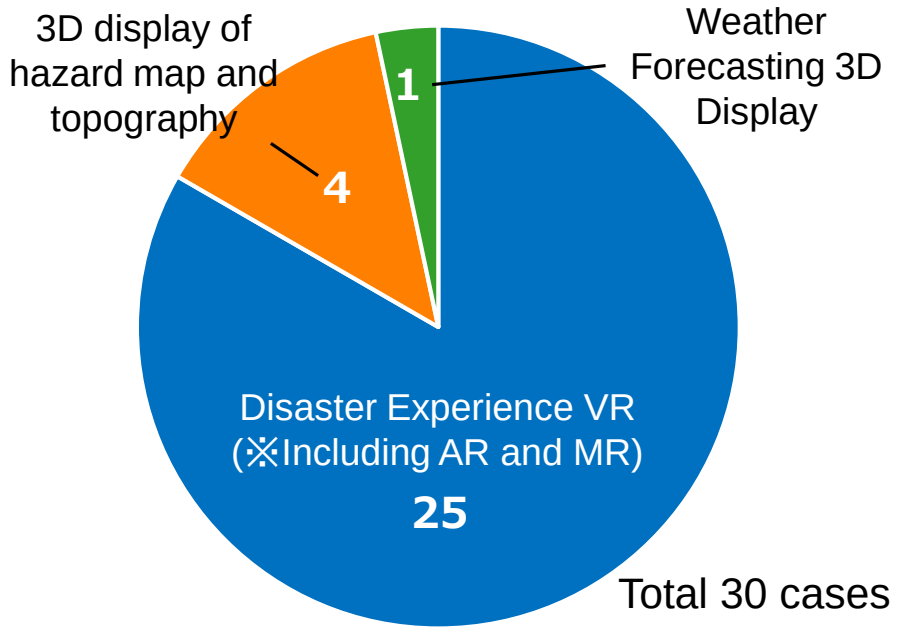
Fujimura et al.（2019）

・<u>There is an evacuation promotion effect on the visual recognition of flood by evacuation experiments using VR.</u>

The 3D forecast information leads to facilitation of evacuation and communicates the dangers of disasters to residents.

Introduction ~Preliminary investigation~

② Examples of the use of VR technology in the field of flood prevention

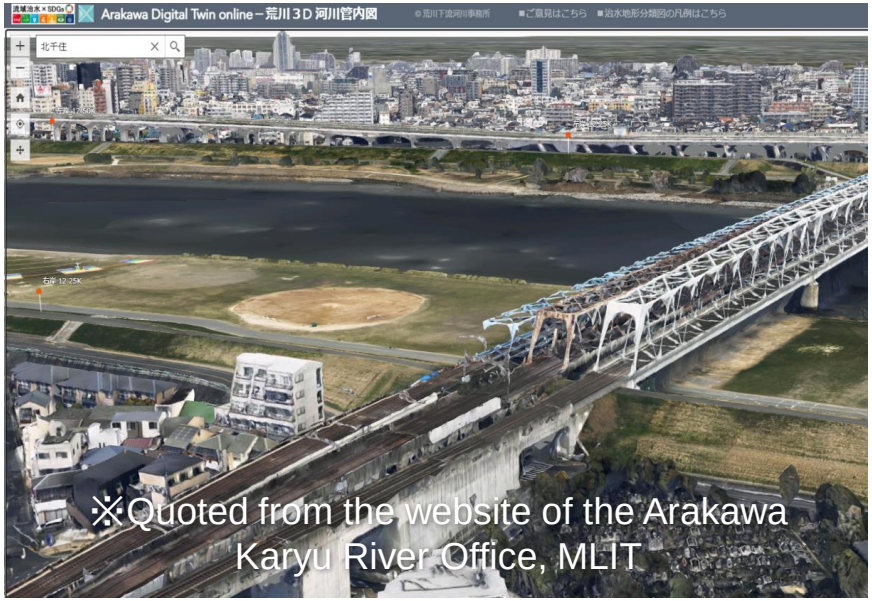


Classification of existing case studies using VR to promote evacuation behavior

- 3D display of forecast information is only for the purpose of safe aircraft operations.

No efforts have been seen to display river water level forecast information using VR.

③ Possibility of collecting 3D data



3D jurisdiction map（Arakawa 12KP）
https://www.youtube.com/watch?v=Mvg0P6X632o

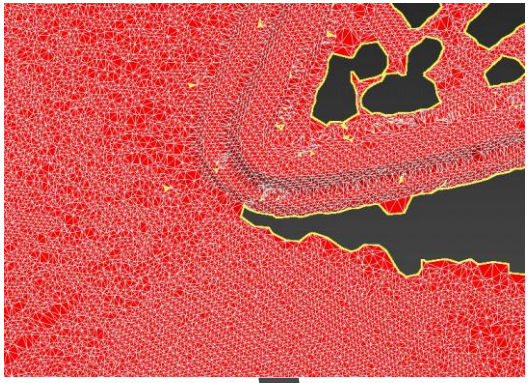
- This map and 3D urban model will be developed for all government managed rivers.

3D data necessary for this technology development will be prepared in the near future.

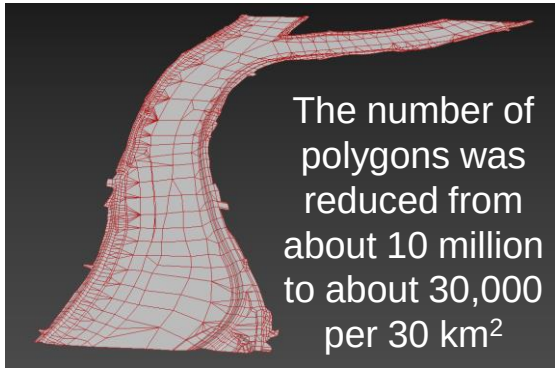
Points to note when developing technology

① Operability (speed of information display)
② Visual effects (to enhance the sense of urgency and realism)
③ Accessibility (accessible on various devices and operating systems)

3D terrain mesh created Directly from LP data

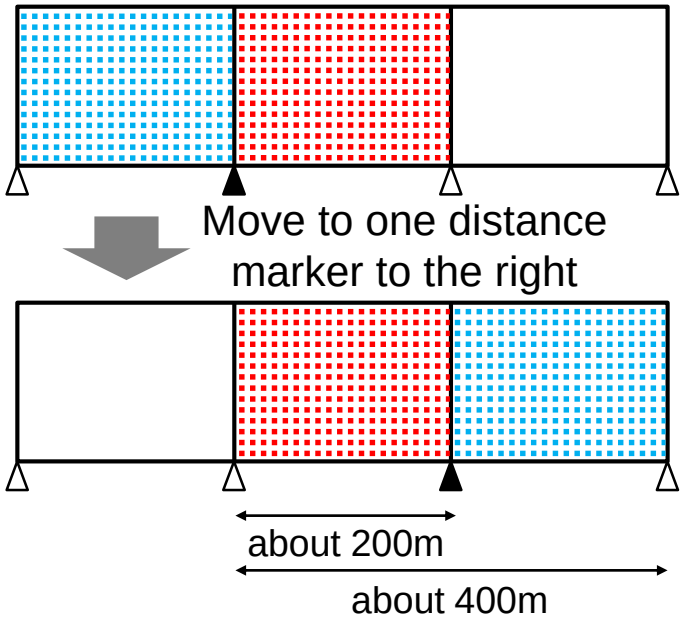


3D terrain mesh after retopology



Re-topology
(reattachment of the surface to fit the shape)

The amount of data is reduced to 1/500, and the time required to draw one screen is reduced from about 1 minute to about 0.1 of a second.



Duplicate data (red dots) are not loaded again when switching screens.

Reduced display load

Points to note when developing technology

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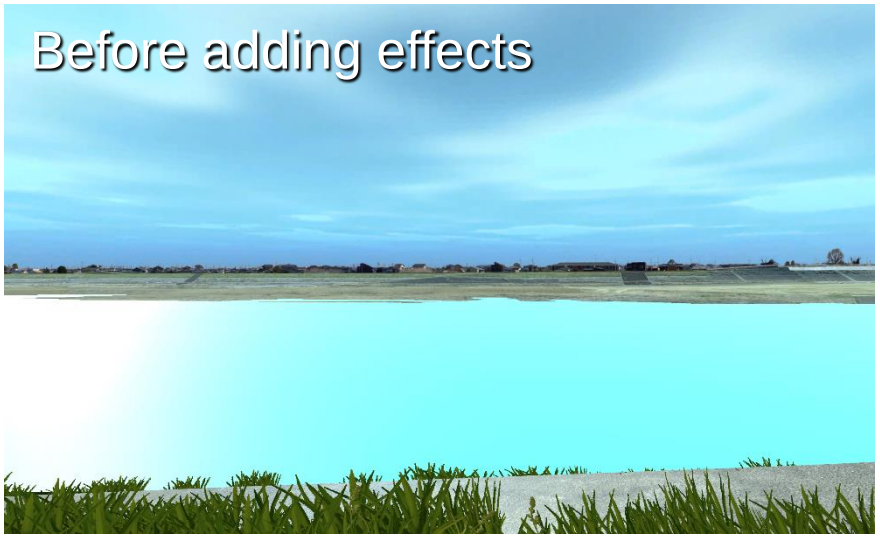
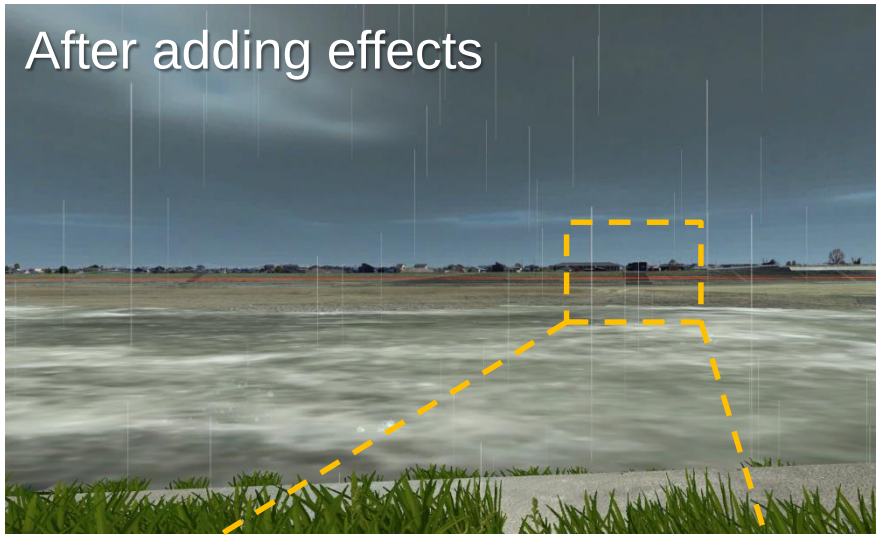


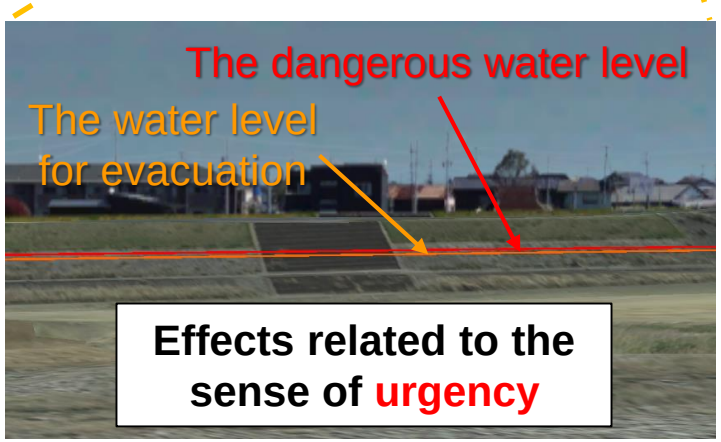


Fujimura et al.(2019) VR experiment results：
Evacuation rate increased during times when the "river turbidity is remarkably" visible.

Effects related to the sense of realism

- Water surface turbidity
- Water surface oscillation
- Cloudy weather
- Rainfall etc.

Zoom



Points to note when developing technology

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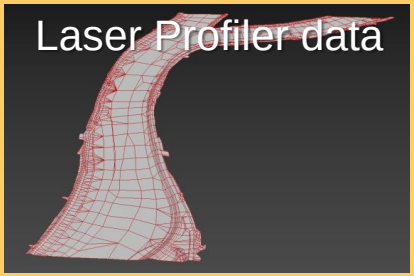
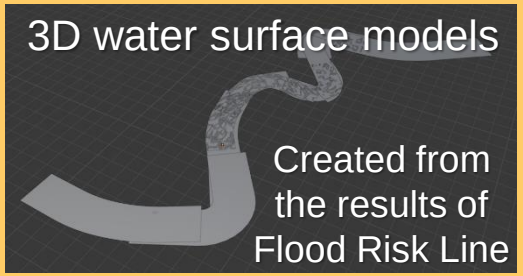
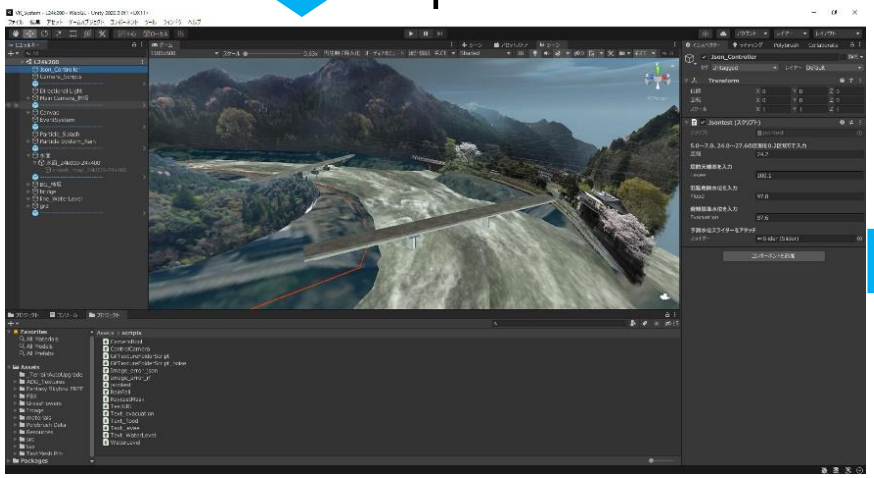




Input

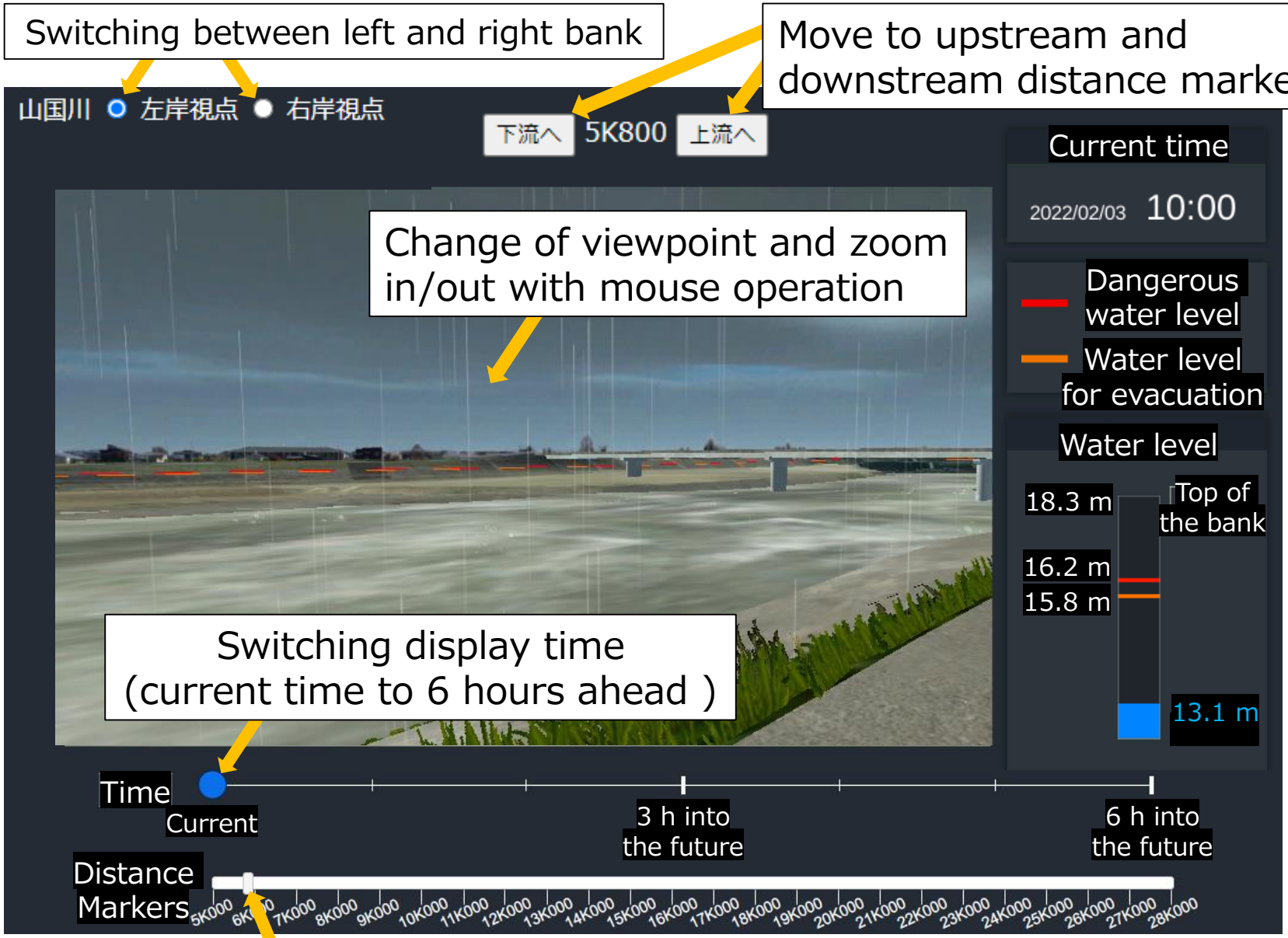


Develop VR environment with “Unity”, a multi-platform game engine

Output

WebGL format (standard specification for VR display in a web browser)

Developed operation screen for VR display



Demonstration video

Advantages and issues of VR display

① Advantages other than conveying a sense of urgency and realism

CCTV camera image

VR display image

Comparison at the same time at night
（2022/9/19 0:00 Yamakuni river 26.8KP）

- Even if it is difficult to confirm the local situation by CCTV cameras, the VR display enables visualization of the flood situation.
- VR display can freely change the angle of view, zoom, and switch display to areas where CCTV cameras are not installed.

Advantages and issues of VR display

② Visual effects of VR are not enough

- There are not enough effects in the VR simulation.

  ➡ It is necessary to create effects for normal conditions (sunny, no spray, etc.) and switch effects between normal and flood conditions.

- Visual effects on the sense of urgency and realism of the disaster are unclear.

  ➡ Gathering opinions from local government and feedback on this technology to make new improvement.

Example of opinions

”Hard to see how many hours later the dangerous water-level will be exceeded”.

”We want to know how close to the dangerous water level”.

Advantages and issues of VR display

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③ Issues related to forecasting accuracy and risk communication during disaster

- We can’t imagine easily what happens to residents when forecasts differ significantly from actual conditions.

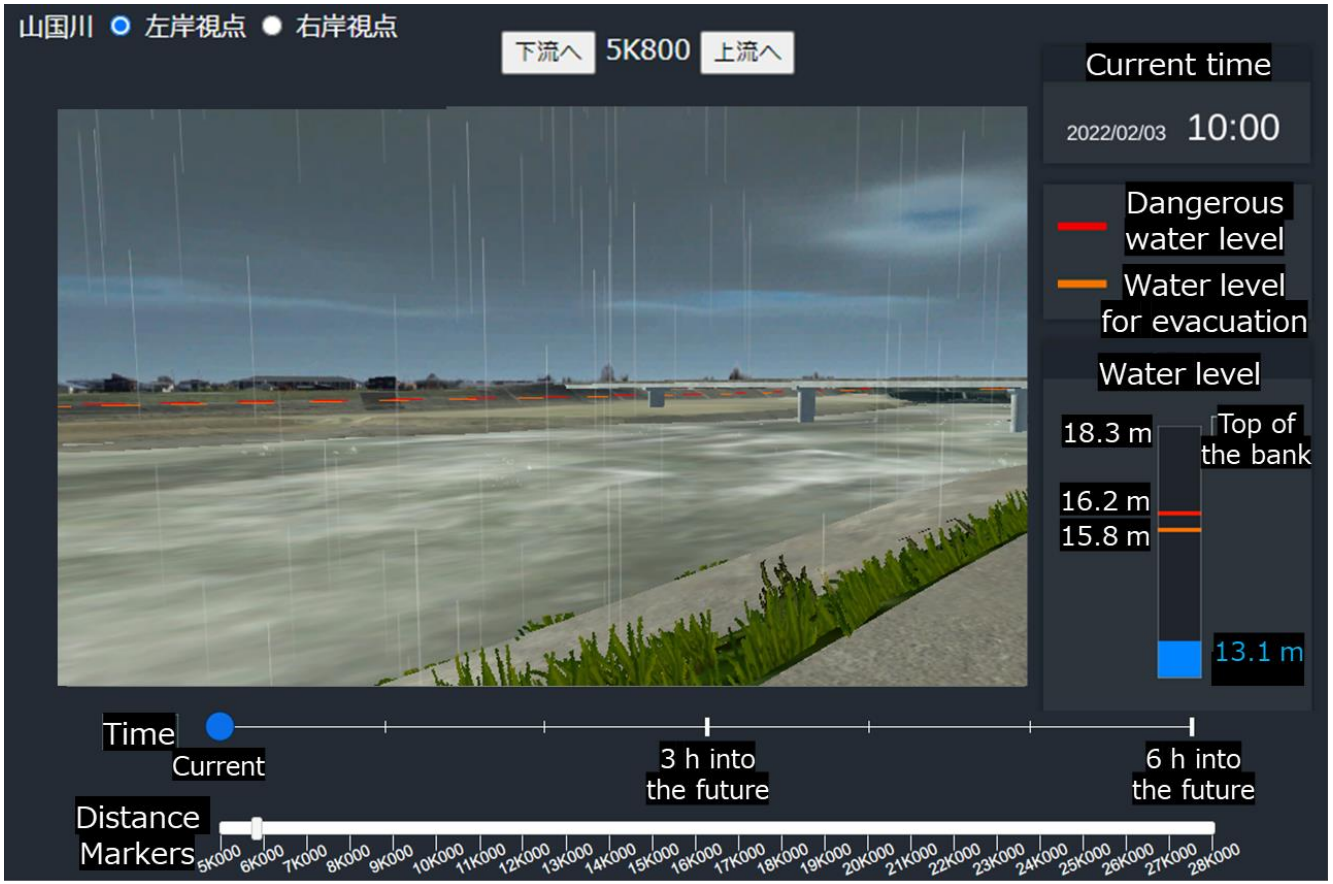
  ➡ Limit the display to sections where a certain level prediction accuracy can be confirmed.

- Server downtime due to high network traffic during disaster.

  ➡ Addition of function to output clipped video with limited data volume and video duration.

Summary

We have developed a technology for 3D display of river water level forecasts using VR technology.

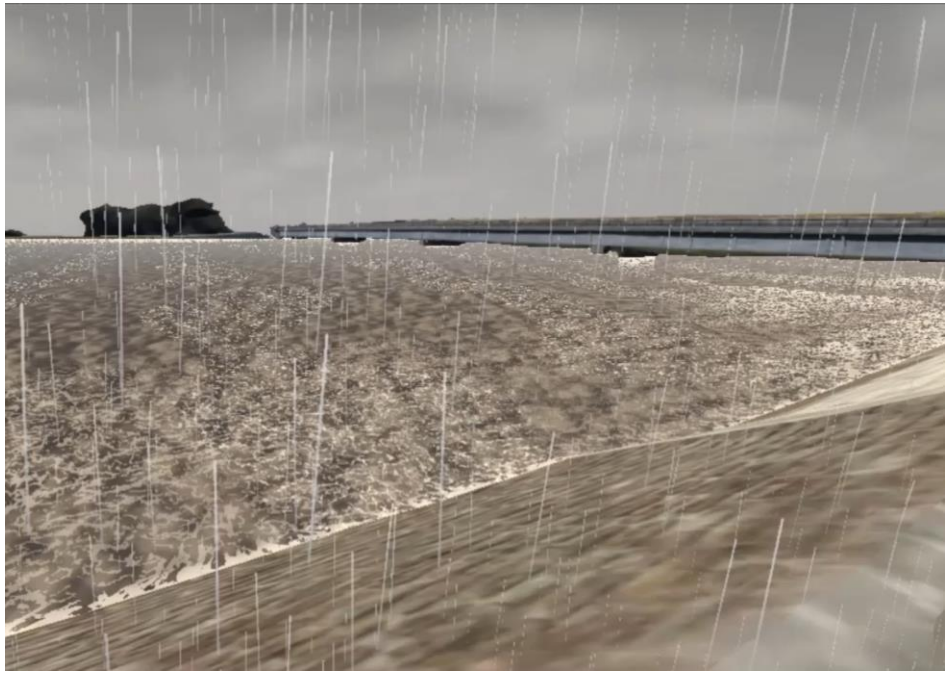


The results of this study will be compiled into a draft specification to enable the addition of a VR display function as an optional function for Flood Risk Line.

Future plans

- Implementation of improvements to current issues.
  (For example, improving the quality of VR.)

Normal condition



Flood condition

- Longer forecasting time (from 6 hours ahead to 36 hours ahead), etc.