

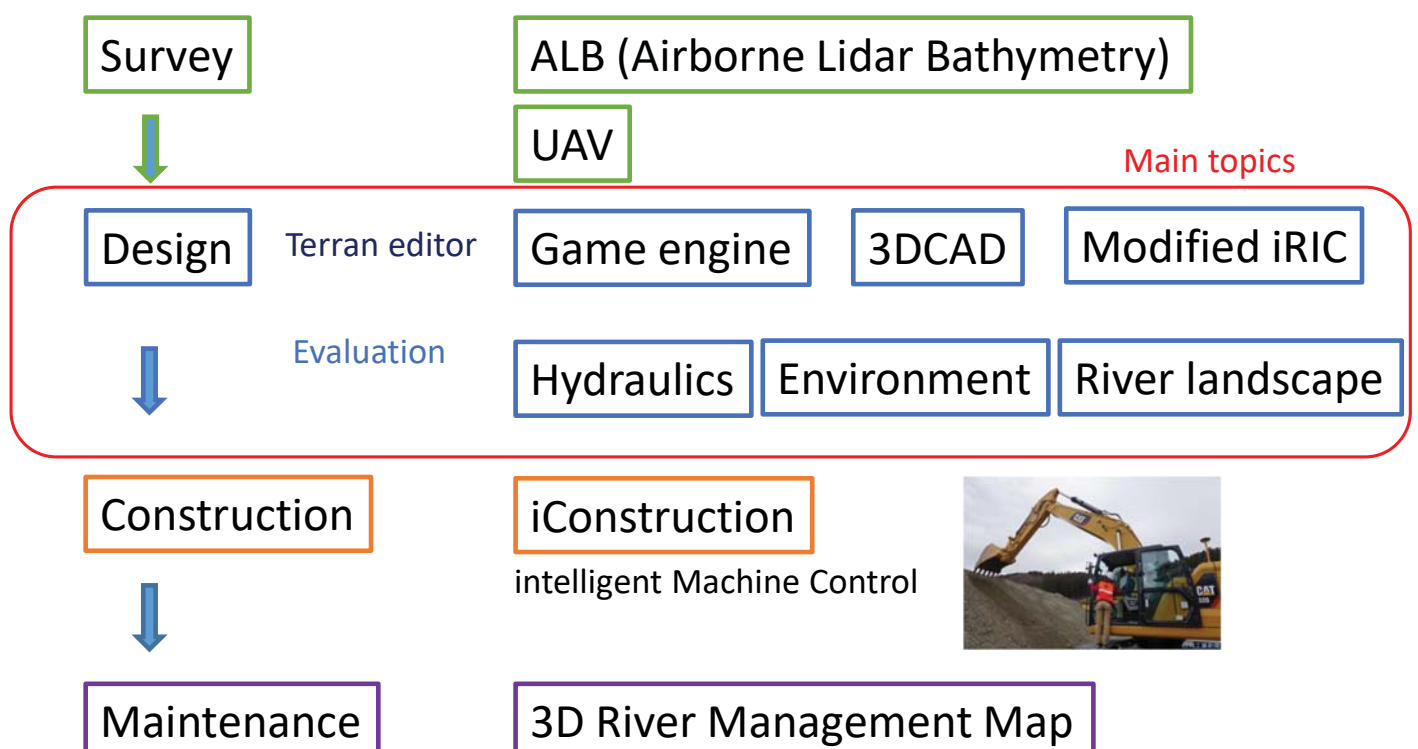


# 3D River Restoration toward digital twin river management

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## Process of 3D River Restoration & engineering



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## Survey

# History of point cloud data (3D data) for river management

- 2005 LiDAR started to use (but not for water).
- 2011 MLIT started to study Airborne LiDAR Bathymetry (ALB)
- **2016 First official survey by ALB (in Fukui)**
- 2019 The standard method of surveying rivers becomes a point cloud.
- 2020 Manual for Utilization of 3D Data for River Management

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## Airborne LiDAR Bathymetry (ALB)

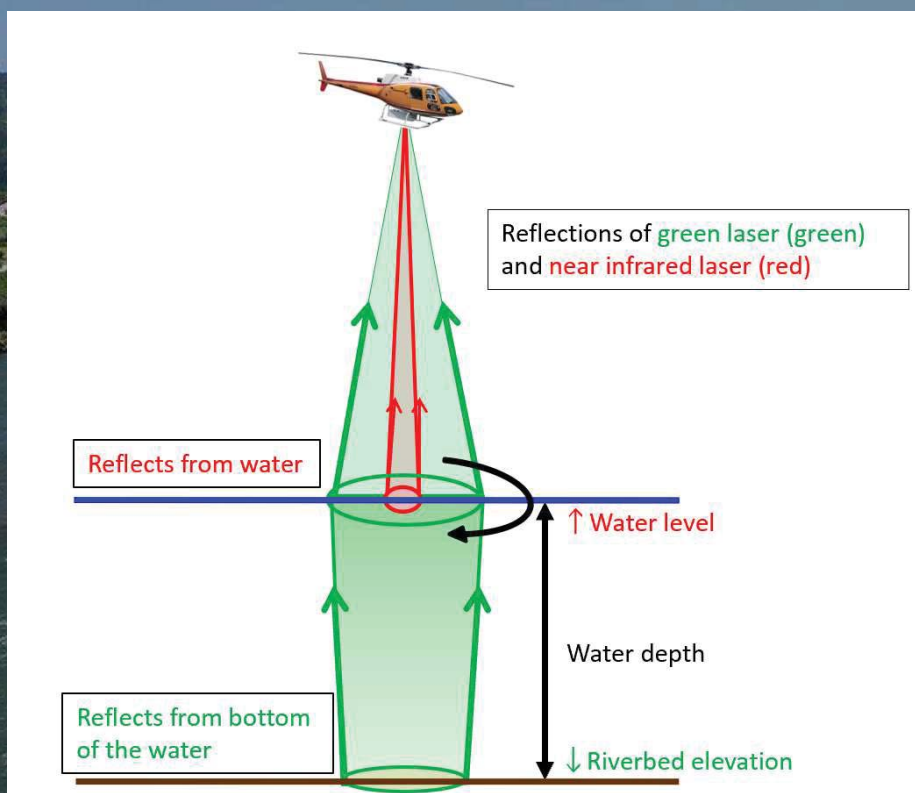
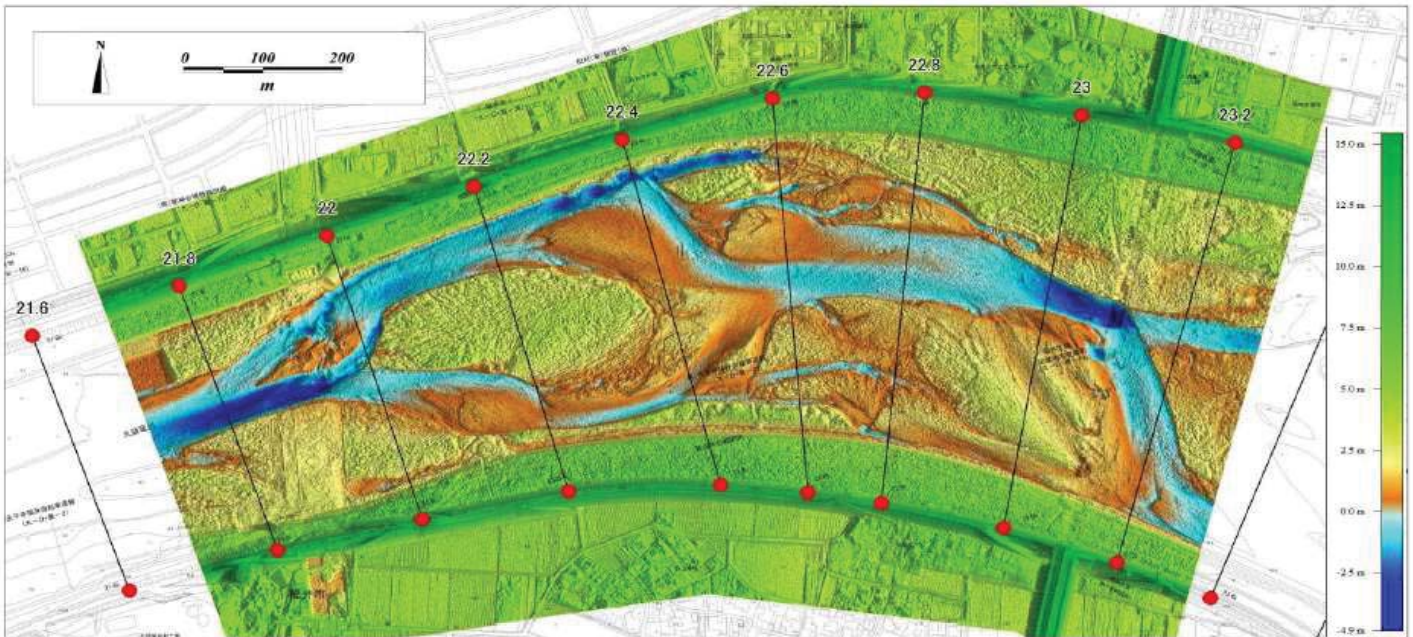


Figure 1. Illustration of depth measurement using ALB

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# ALB leads 3D river restoration in Japan

- ALB officially started to use in Dec. 2016
- About 50 rivers out of 109 Class A Rivers in Jpn already measured by ALB.
- Abundant ALB data enhances 3D river planning and management.



K. Nakamura et al. (2018) River survey using airborne laser bathymetry (ALB) and its applications, eco-hydraulics. [https://www.researchgate.net/publication/327321756\\_RIVER\\_SURVEY\\_USING\\_AIRBORNE\\_LASER\\_BATHYMETRY\\_ALB\\_AND\\_ITS\\_APPLICATIONS](https://www.researchgate.net/publication/327321756_RIVER_SURVEY_USING_AIRBORNE_LASER_BATHYMETRY_ALB_AND_ITS_APPLICATIONS)

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# Green Laser Drone Developed on Feb 1. 2019



[https://amuse-oneself.com/data/development\\_report.pdf](https://amuse-oneself.com/data/development_report.pdf)

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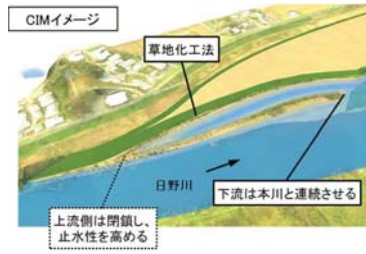
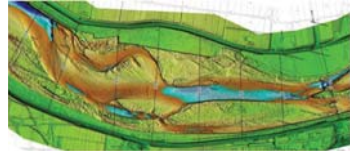
3D survey by ALB



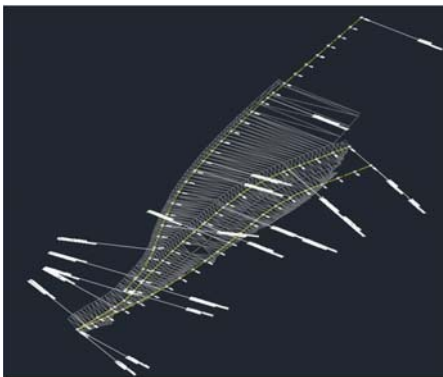
3D design???



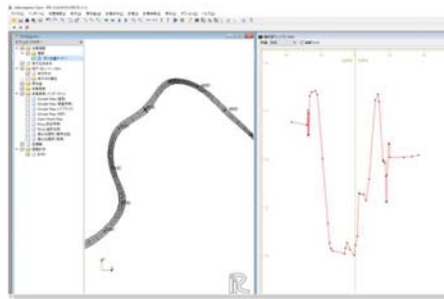
3D construction  
(intelligent Machine Control)



### Three kinds of 3D design methods



3D CAD



Improvement of iRIC\*

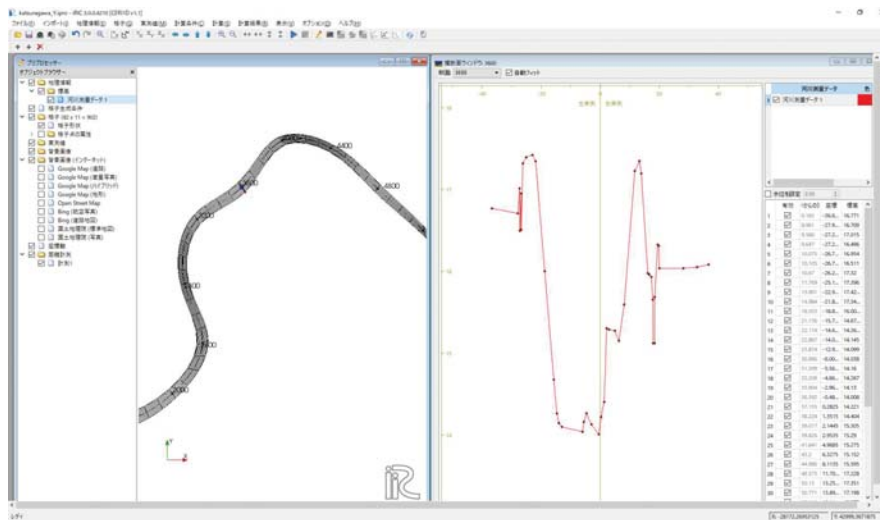
\*Hydraulic software



Game engine (UE4)

# iRIC as Terran editor

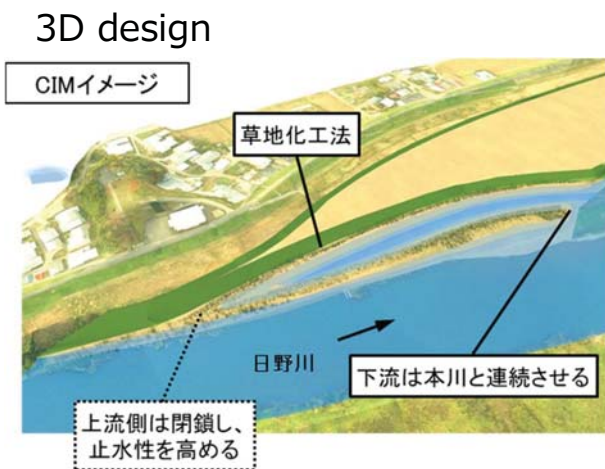
## Cyber Terran editor based on conventional cross section



- 3D design tool that utilizes conventional 2D skills
- Editing is possible while confirming the constraints on the plane in a cross-sectional view.

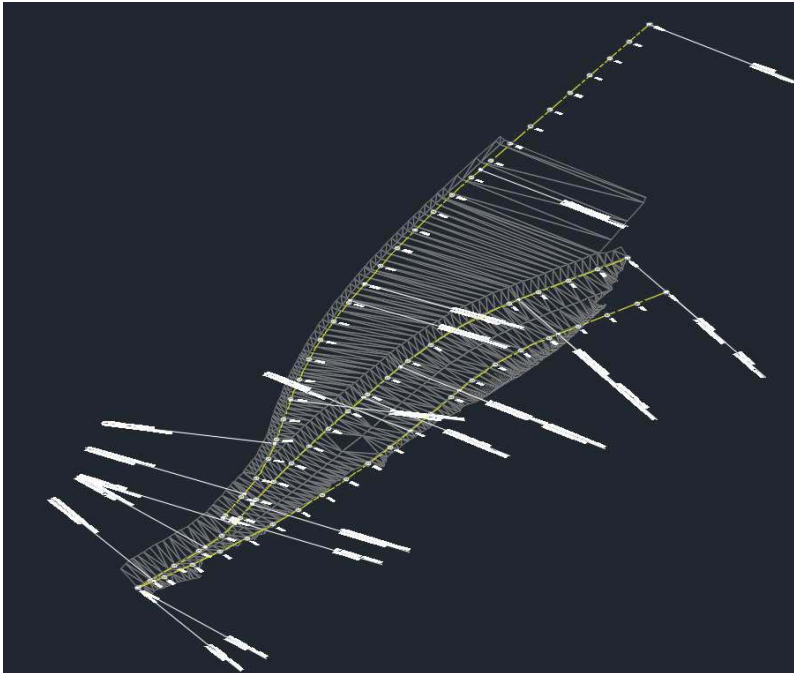
## 3D CAD: wetland creation by ICT construction

All channel excavation & wetland creation work is performed in 3D.



# Wetland design with 3D CAD

- 3D CAD (such as CiVIL3D) are common tool for 3D design.
- Designing complex shapes requires skill and ingenuity.

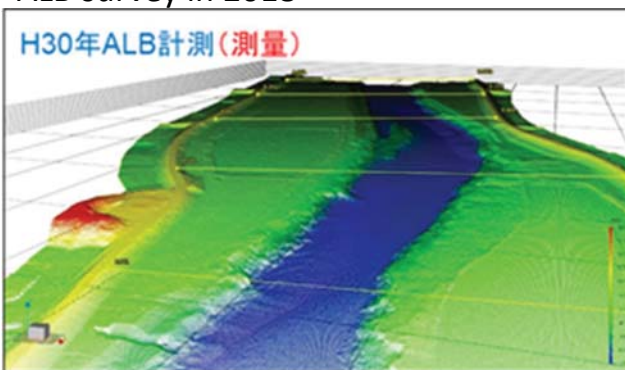


The software is for construction, and data handover to subsequent construction is smooth.

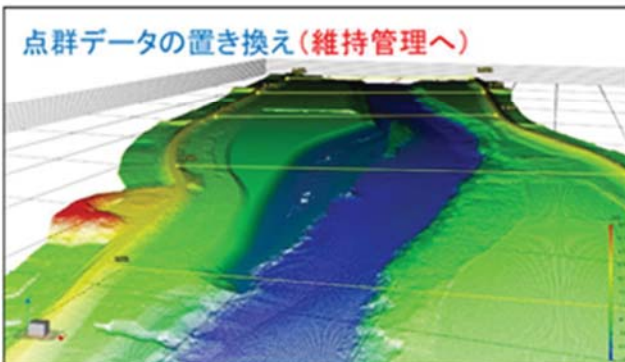
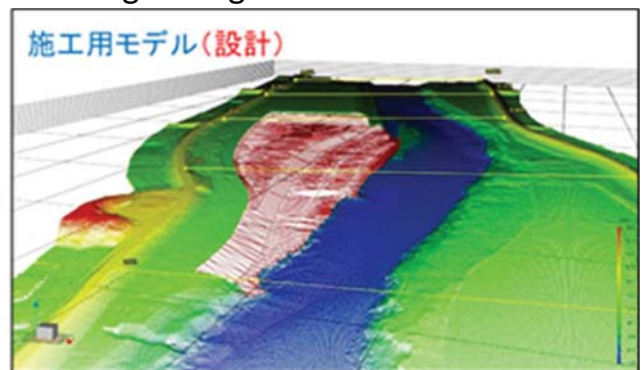
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# Data circulation for river restoration

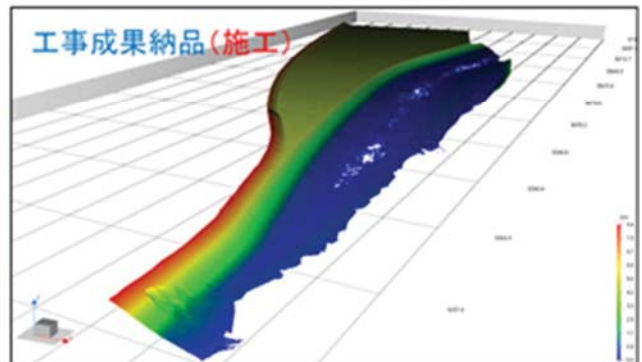
ALB survey in 2018



3D design using 3D CAD



Replace old topology for new one



Excavation with intelligent machine control

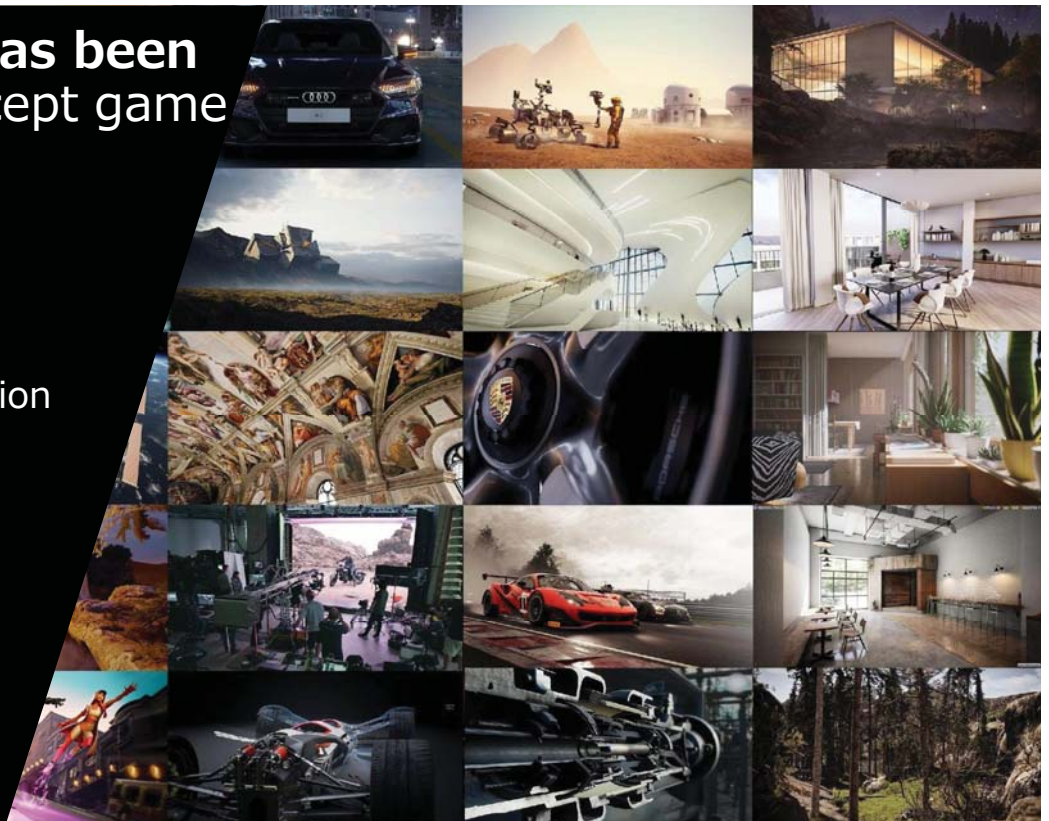
# Designing riverine landscape by game engine (Unreal Engine 4)

\*Unreal engine and Unity are the most popular software as game engine.

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**Game engine has been used in field except game creating.**

- Architecture
- Construction
- Automotive
- Film & TV
- Training & Simulation
- Games
- Broadcasting
- Live Events
- Manufacturing
- Advertising



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# Features of game engine

## Creating natural shape



- The surface includes not only the colormap, but also normal (direction of surface facing) map.
- GE has a great ray-tracing algorithm.
- They allow to get the model visualization more realistic with low LOD (level of detail)

- Terrain is consisted by fine raster data.
- You can reform it as you draw pictures with brush tool.



**Realistic but low LOD**

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<https://www.youtube.com/watch?v=mjr7sXTRAcw&t=22s>

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# Features of game engine

- Space-sharing at remote location.
- Unaffected by mobility restrictions in the real world



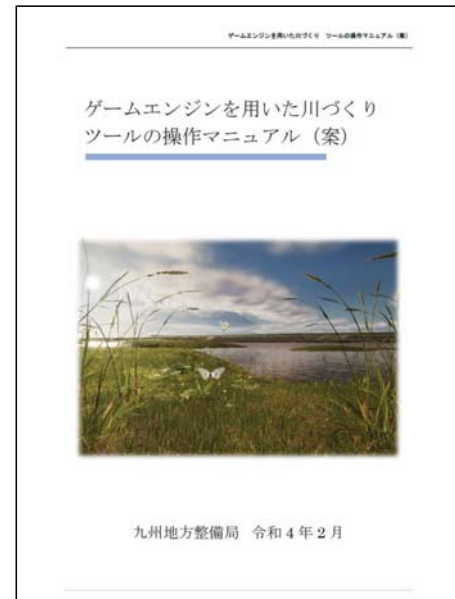
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# River designing by Game engine (MLIT, Kyushu)

- They also released tools and a draft manual for river designing by the game engine (Unreal engine) to share the how-to.
- You can enjoy it if you bring DEM and areal photo data.
- **The tool includes a data converter for introducing DEM to UE working as a plugin of QGIS.**
- It also includes digital data assets of domestic (Japanese) riparian plants.



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# River designing by Game engine



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# Evaluation

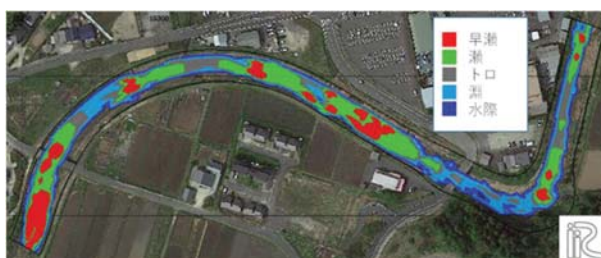
## hydraulics & Environment

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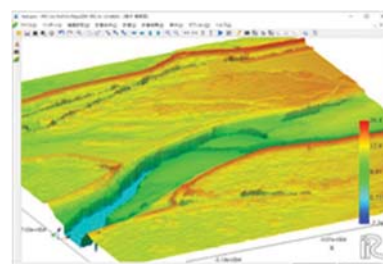
### EvaTRiP Pro (written in Python) (Evaluation Tools for River environmental Planning)

- EvaTRiP Pro is the free solver of iRIC software developed by Aqua Restoration Research Center, PWRI and Masahiko Sekine Dr.Eng. Professor of Yamaguchi University.
- This tools can evaluate followings
  - – the necessity of river bank protection
  - – the area of critical grain size (sediment evaluation)
  - – the area of terrestrial plant grows
  - – the area of fish habitat (PHABSIM, mesohabitats)

**DOWN LOAD**



Evaluation of mesohabitats with 3D data

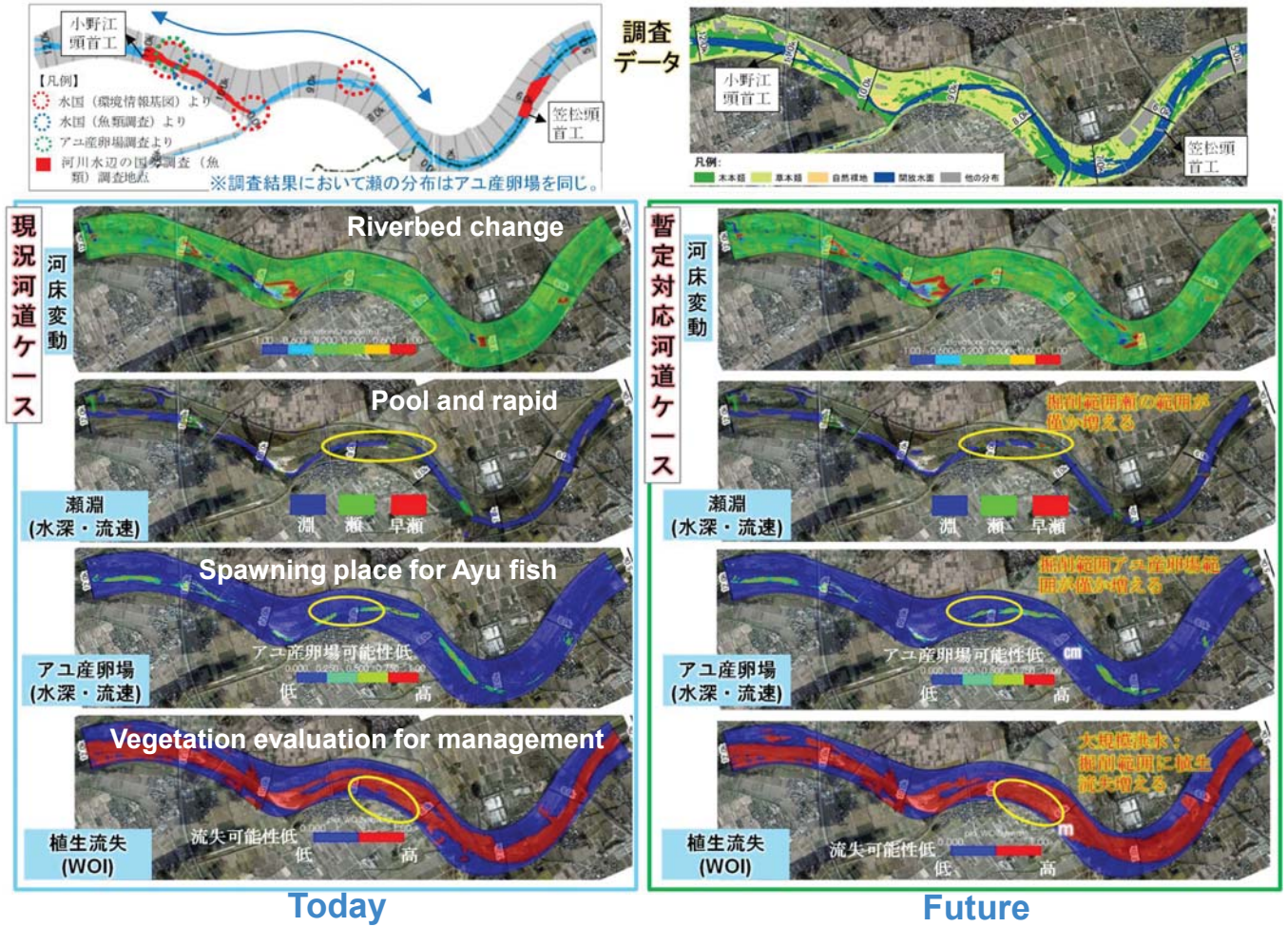


Seamless evaluation for flood control and environment

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# Evaluation example of flood and environment with 3D data

\*Mie Road & River office



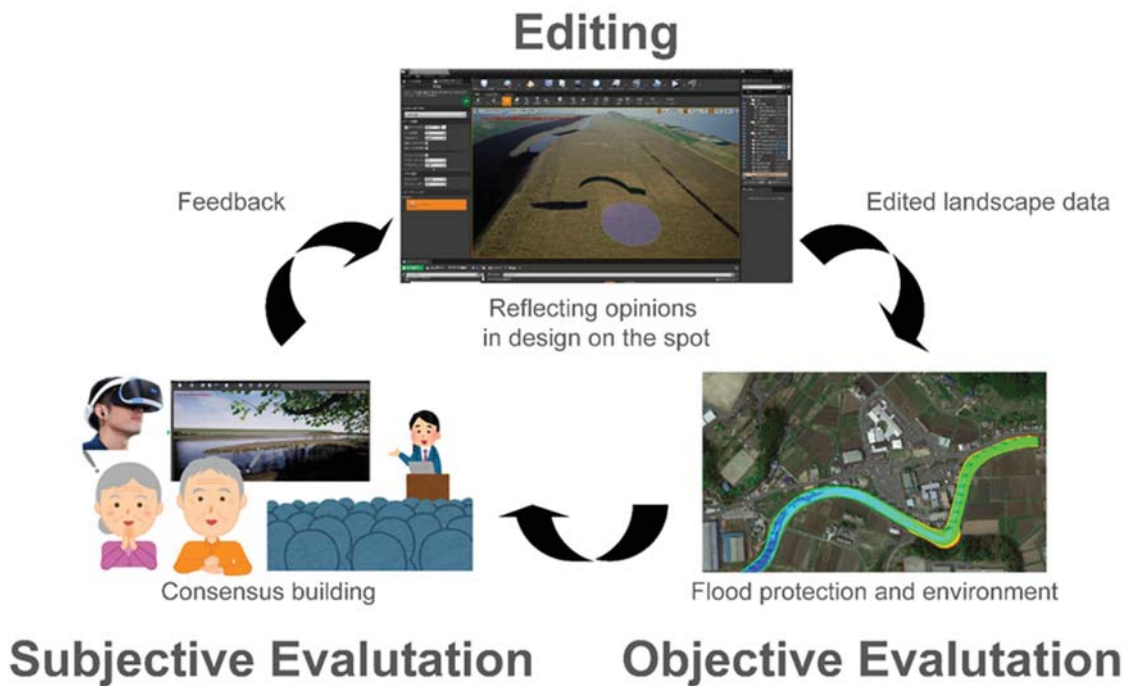
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## Digital Twin River Management (in Arakawa downstream River Office)



3D River Management Map

# Future Consensus building by Realtime River Design



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## Conclusion

- 3D point cloud data by ALB opened the 3D era for river management.
- The challenge lies in 3D design, but several methods (3D CAD, Game engine, etc.) are already proposed.
- 3D evaluation for river design became more common.
- 3D River Management Map is used in practice.
- This cutting edge field is a mountain of treasure from an R&D perspective

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