The Introductions of RIAD (River Image Analysis for Debris transport)

― Applicability & Case Study in Brunei ―

20th – 25th May, 2024

World Water Forum 10 @ BNDCC

YACHIYO Engineering

Problem of Marine Plastic Pollution

Marine Plastic Pollution →

- Adverse effects on living creatures
- Pollution of the natural environment
- Landscape Destruction
- Navigation hazard
- ⋮

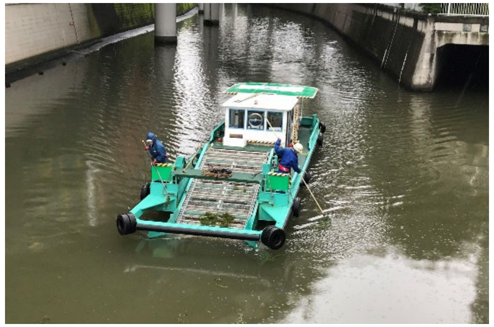
→

- Destruction of ecosystems
- Decrease in visitors and tourists
- Increase in plastics removal costs
- Decline of the fishing industry
- ⋮

Source：United Nations “Plastic pollution choking world’s oceans”（2018）

Source：OCEANS ASIA “MASKS ON THE BEACH”（2020）

How to Reduce Marine Plastics?



Institutional and legal development

Use of alternatives to plastics

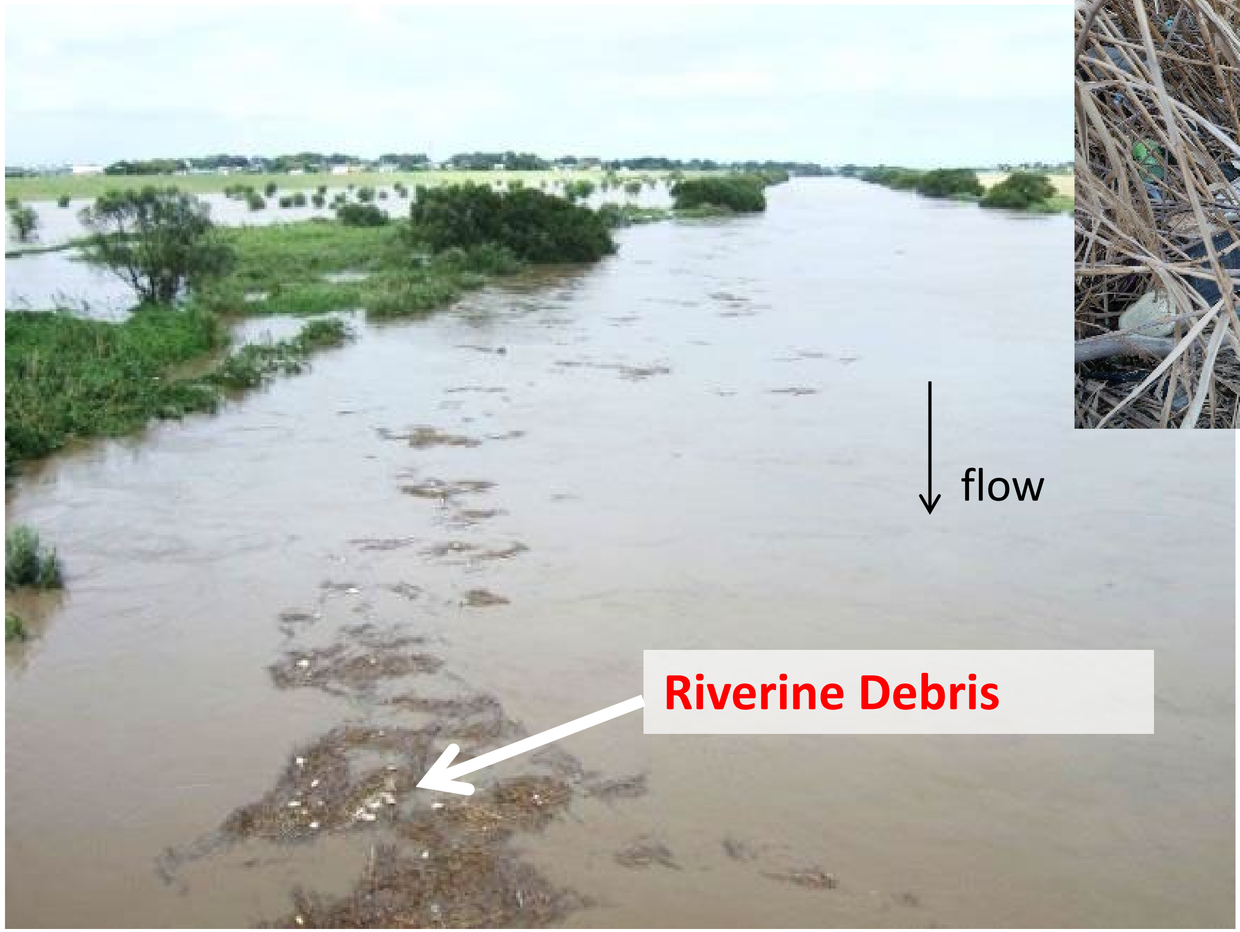
Collection of Plastics

Environmental Education and promotion

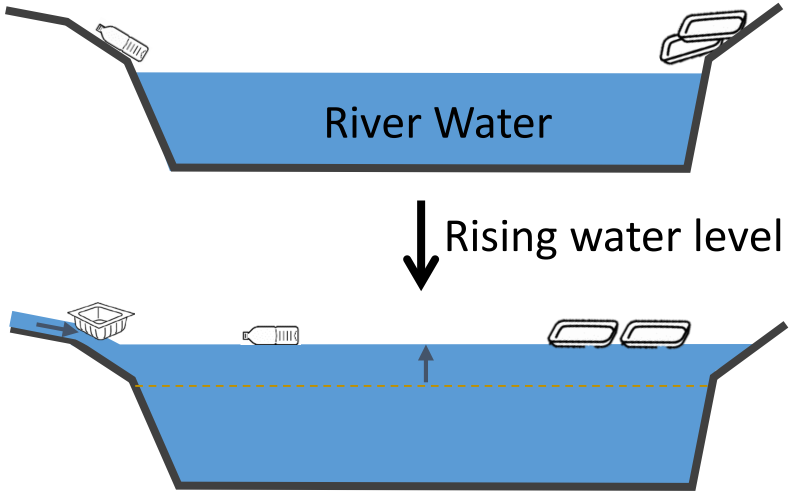
Improvement of Waste management

https://hirakata-kankyou.net/report/

Much riverine debris during overflow



Edo River Noda Bridge
Overflow caused by Typhoon No.9 (Sep.7.2007)
Photo by Prof. Nihei Yasuo (Tokyo University of Science)

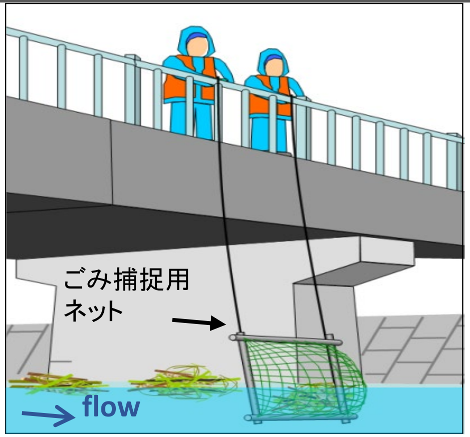


Plastics on riverside spills into river

1. Introduction

Imaging Video, Grasping Transport Amount of Natural/Human-made debris (RIAD : *River Image Analysis for Debris transport*) [Kataoka & Nihei（2020）]

Conventional Method

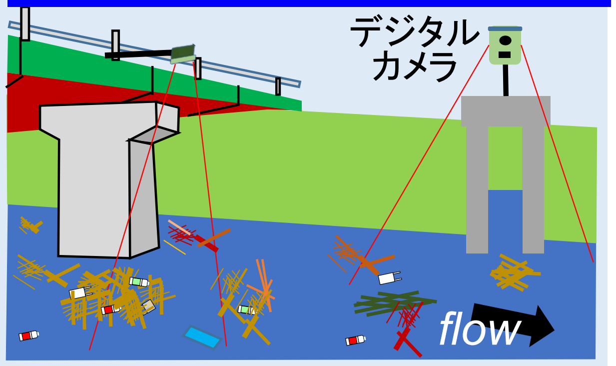


Ex) Direct Sampling

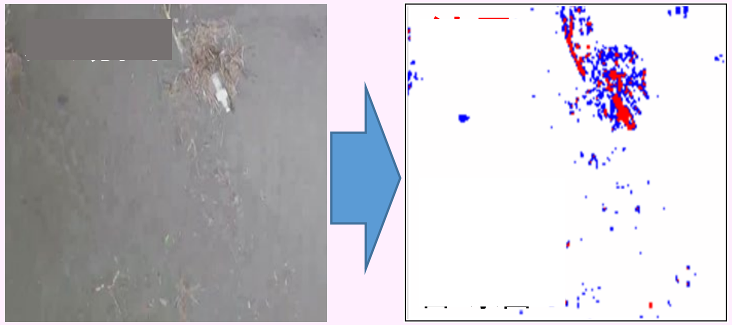
Issues: Safety or Task Burden

Our Solution

1, Imaging River Surface



2, Analisys with Imaged Data



Blue : Natural
Red : human-made
White : River Water

・**Taking video for river surface (Ordinary Video Camera Aplicable)**

Developped by Prof. Nihei (Tokyo Univ. of Science) & Assoc. prof. Kataoka (Ehime Univ.)
Socielly implemented and Commericialized by Yachiyo Engineering Co., Ltd.
（from Jul, 2021）

Details on QR code blow
https://www.yachiyo-eng.co.jp/government/pickup/RIAD/

2. What is “RIAD” system ?

RIAD Development system

Developer	Systematization
Tokyo Univ. of Science Prof. Nihei Ehime Univ. Assoc. prof. Kataoka	Yachiyo Engineering Co., Ltd. Environmental Planning Dep. Consulting Headquarters

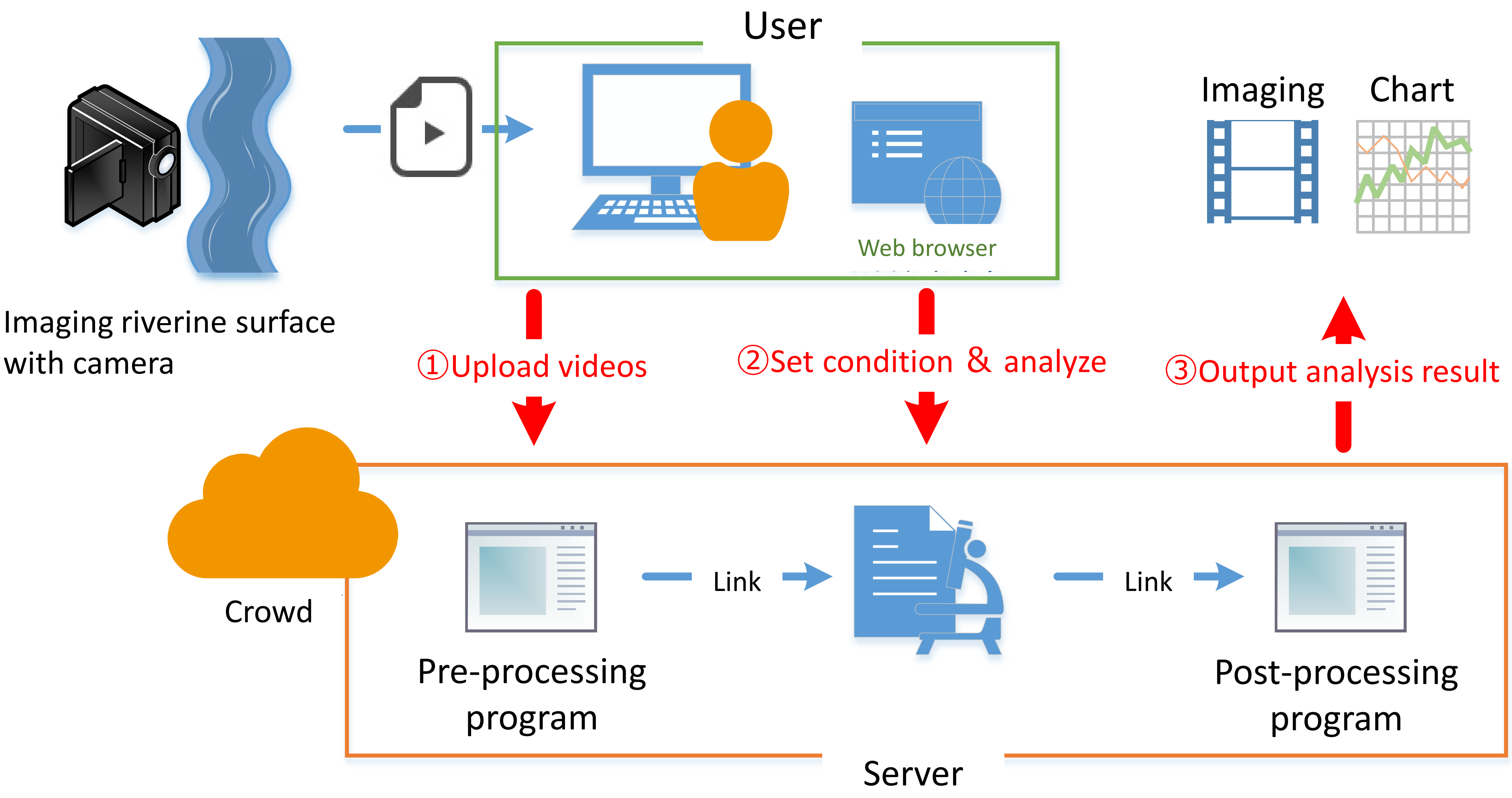
- Develop automated way to identify riverine debris (River Image Analysis for Debris transport)
- Global technology publication (Journal, etc...)

- RIAD systematization
- RIAD popularization, Societal implementation

Improve RIAD accuracy based on demand ⟷ **Realizing user demand & societal implementation**

Academia-Industry Cooperation &
Accelerate solving social issue on plastic

2. What is "RIAD" system ?



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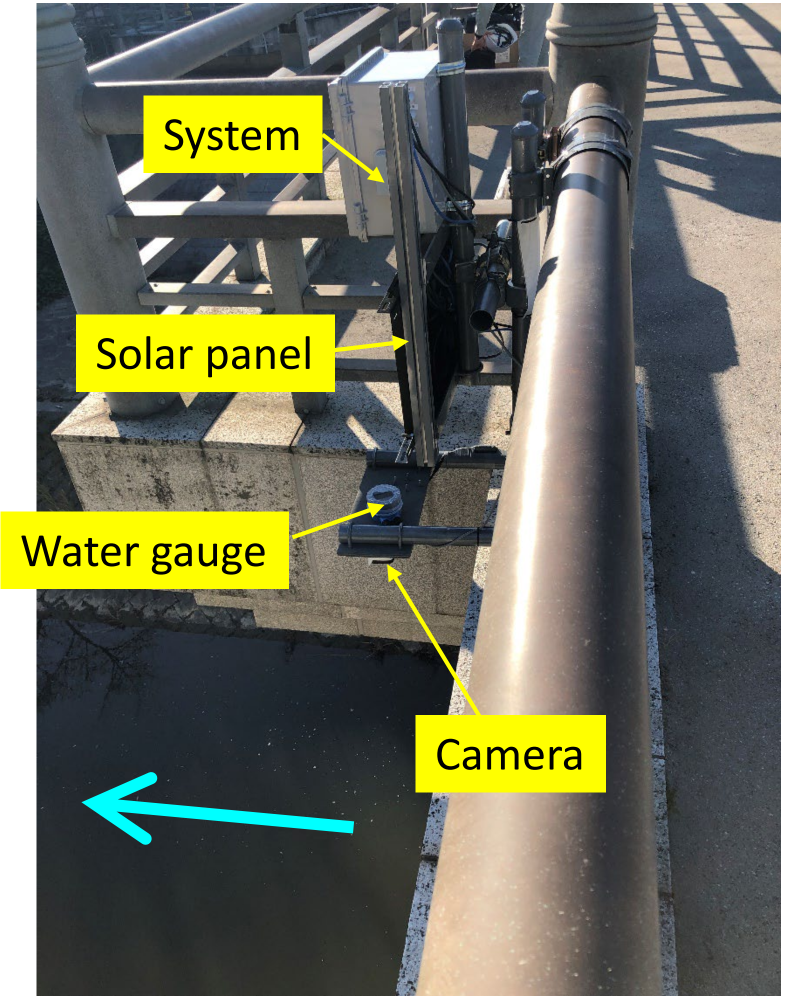
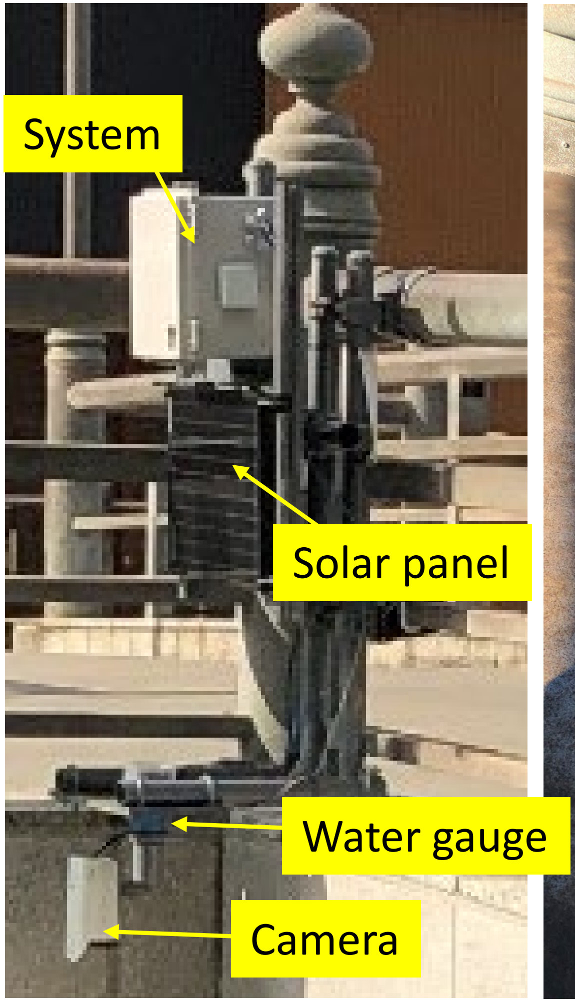
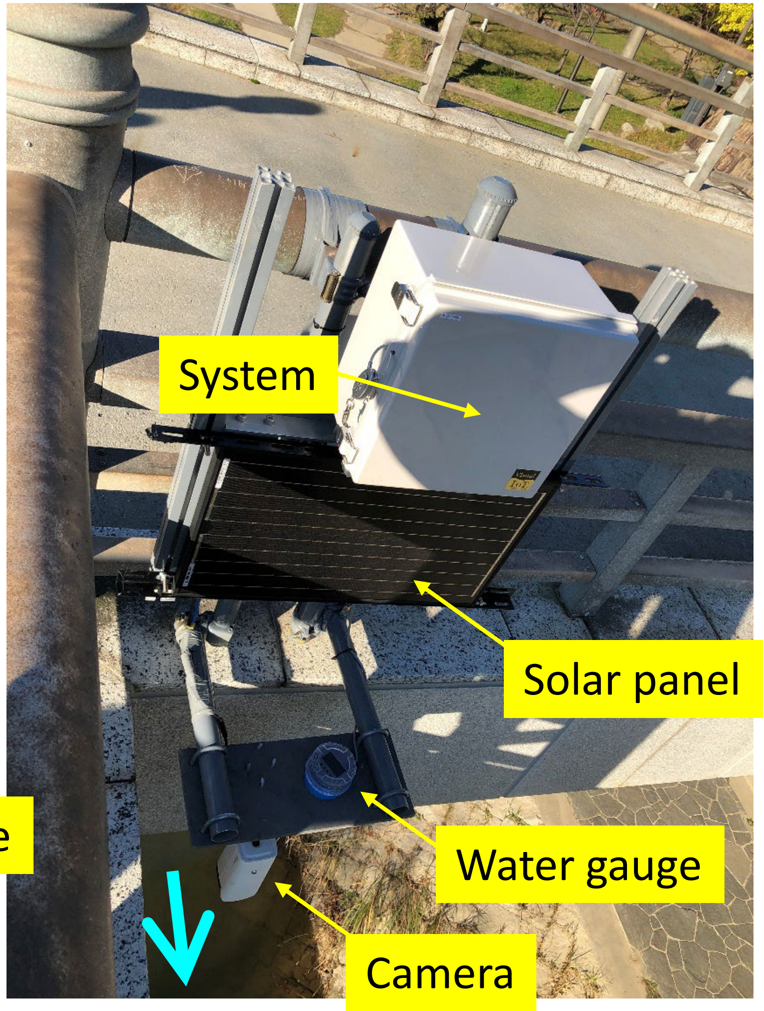
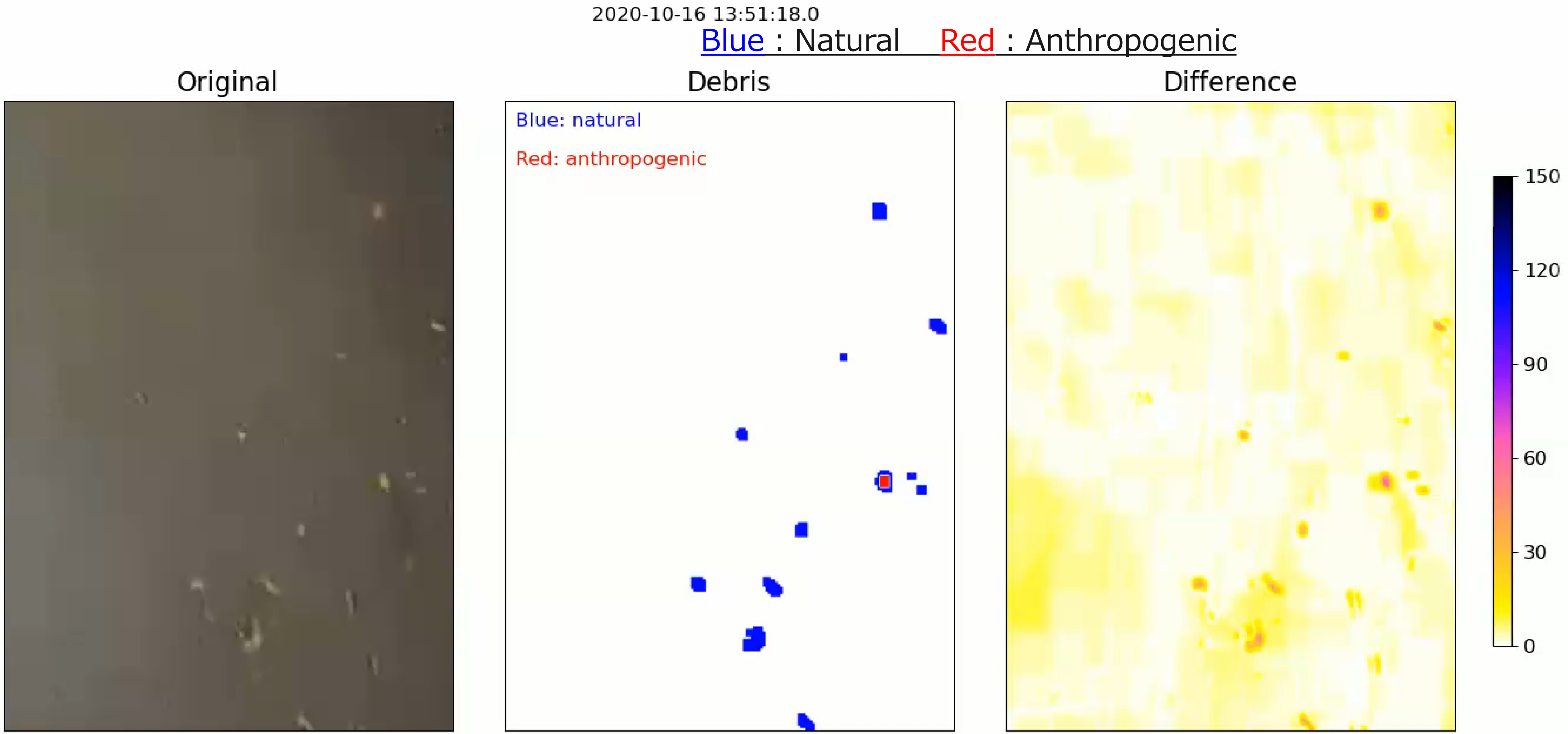






Case of Video Camera without Network

2. What is “RIAD” system ?

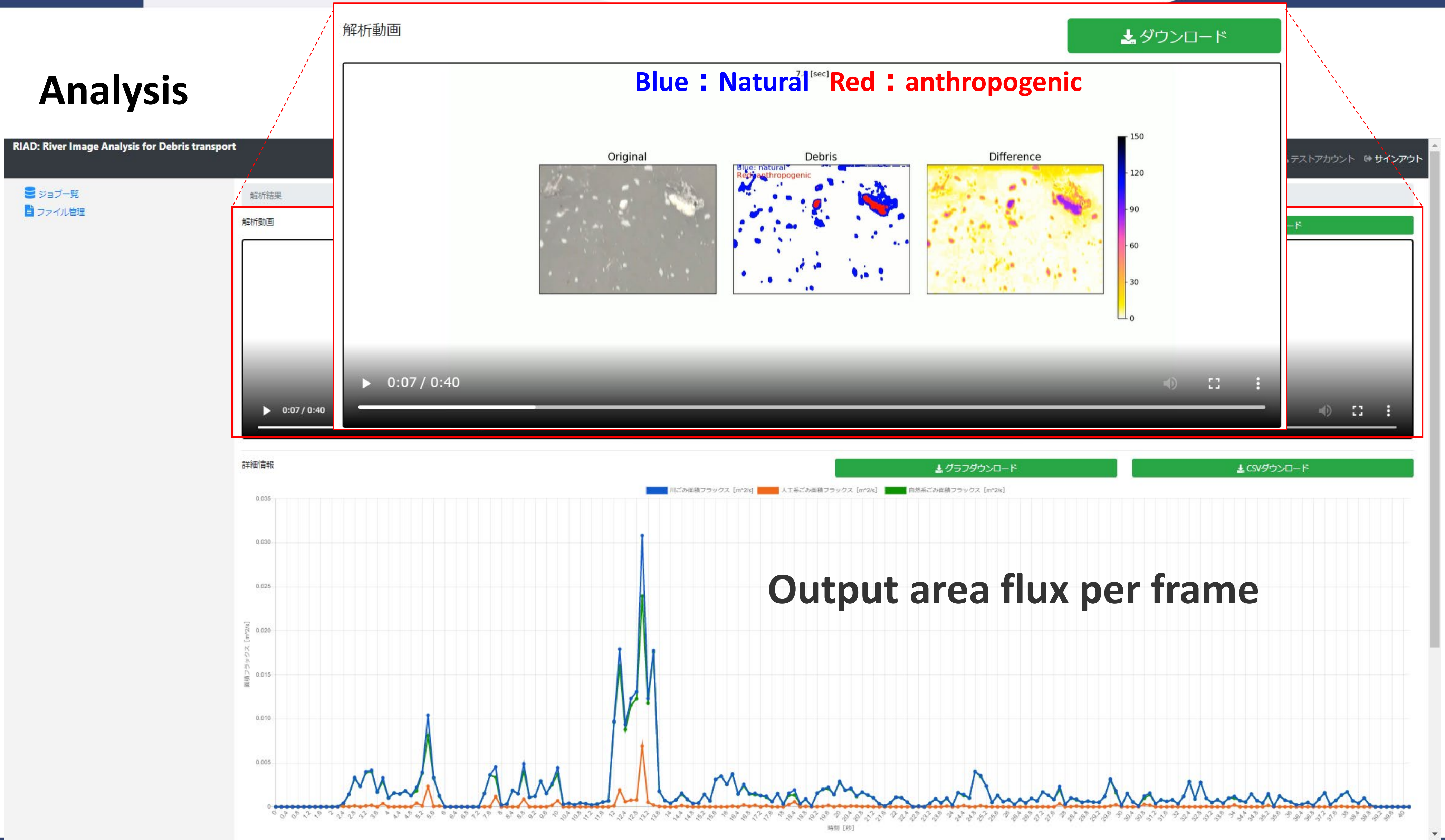


Riverine debris continuously extracted.

Natural（driftwood, leaf, etc.) & **anthropogenic（plastics, empty can, etc.）** debris generally well-categorized respectively.

2. What is “RIAD” system ?

Analysis

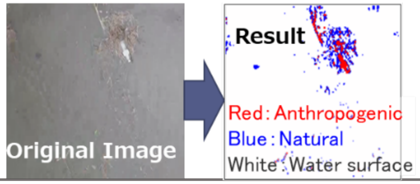


3. What we can achieve by RIAD system

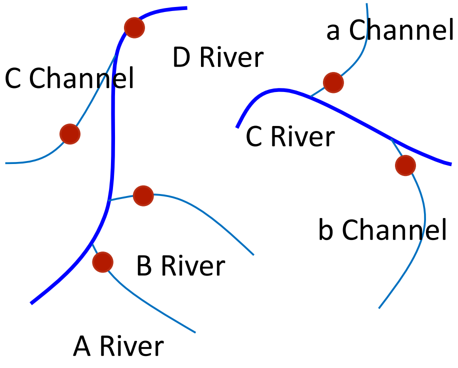
【RIAD】

Results at observation “point”

⇒**Information at a point**



Establishment of monitoring network



observation point

【Physical Properties】

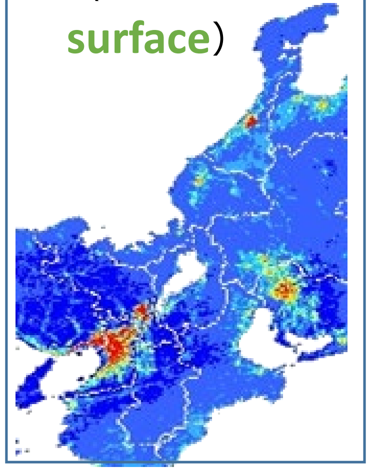
- Land Use
- Population density
- Cross-section of a river
- Riparian vegetation

・・・etc.

City OS Utilization

Visualization of results

(Information on the **surface**)



【Society & Economy】

- Human abortion
- Waste Collection Status
- Scholarly ability
- Age structure
- Regional character
- Corporate activities
- Standard of living

・・・etc.

City OS Utilization

Countermeasures (Example)

✓River improvement

✓Collected in river (Oil fence etc.)

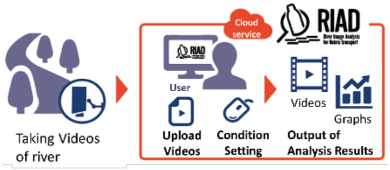
✓Countermeasures in lands (Civic activity, etc.)

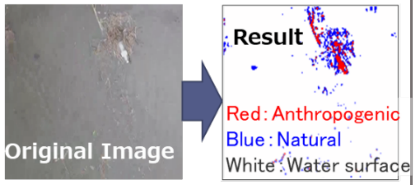
✓Based on the amount of waste generated in the region Sharing of disposal costs

・・・etc.

【RIAD】

Confirmation of effectiveness (scientific basis)





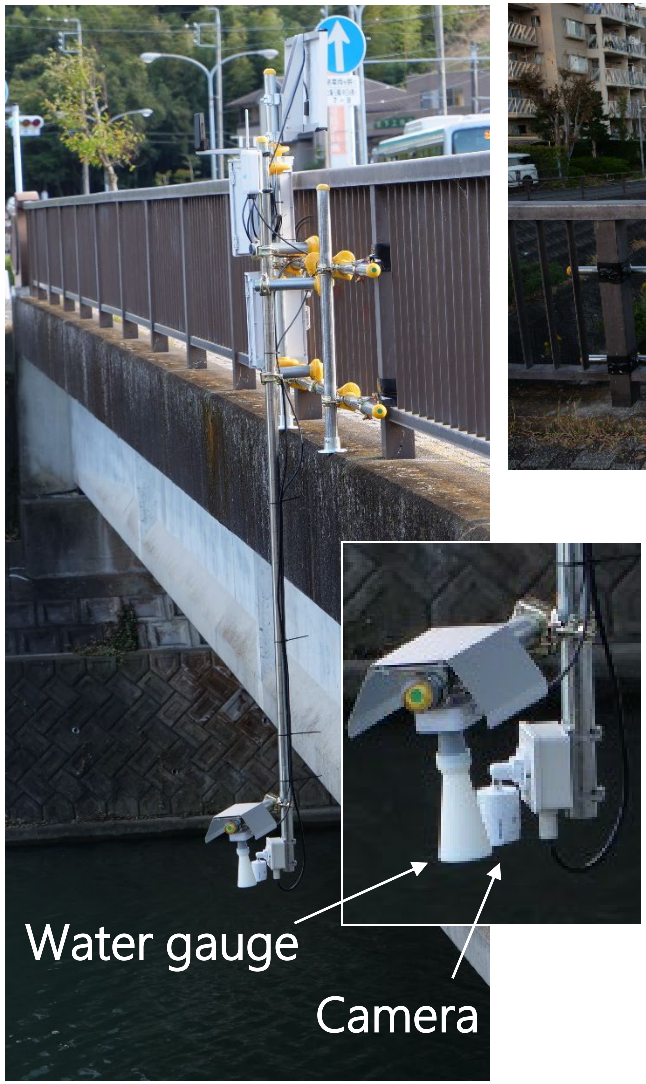
Goal

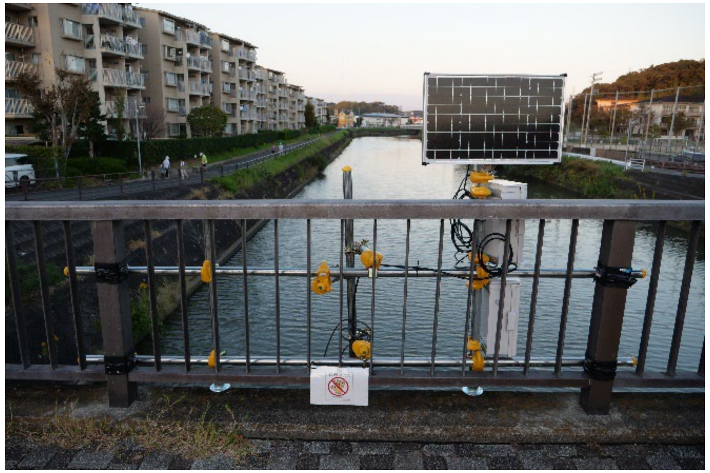
Reduce the amount of plastic discharged into the ocean to zero as much as possible.

14 LIFE BELOW WATER

4. RIAD introduction case in Hamamatsu, Japan

River





Drainage canal

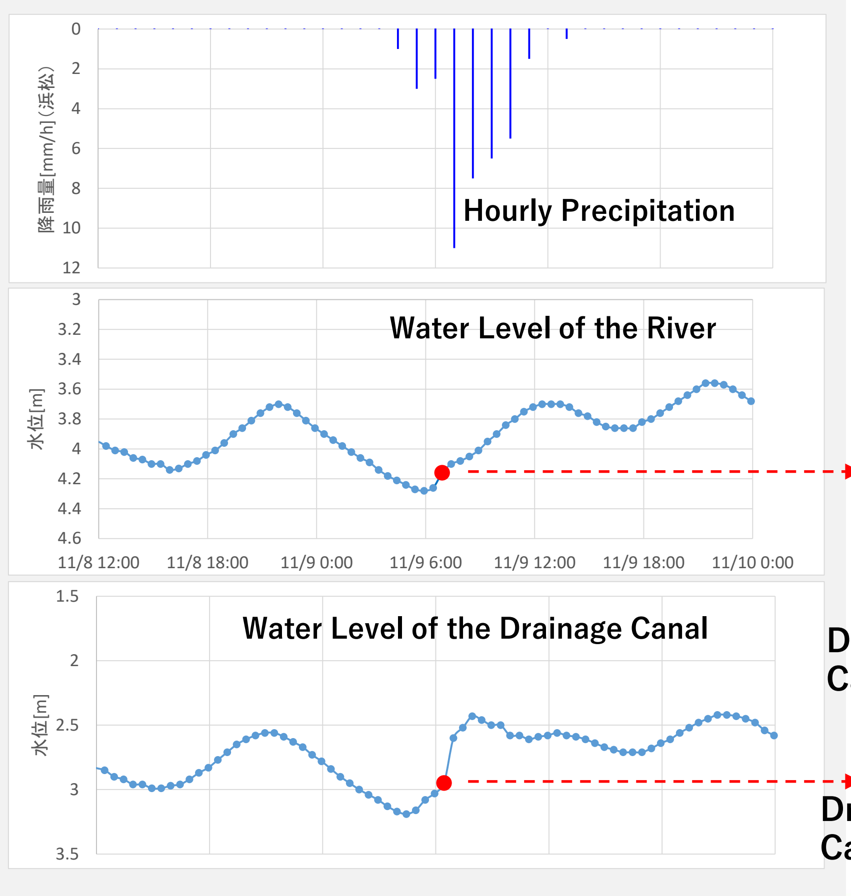
4. RIAD introduction case in Hamamatsu, Japan

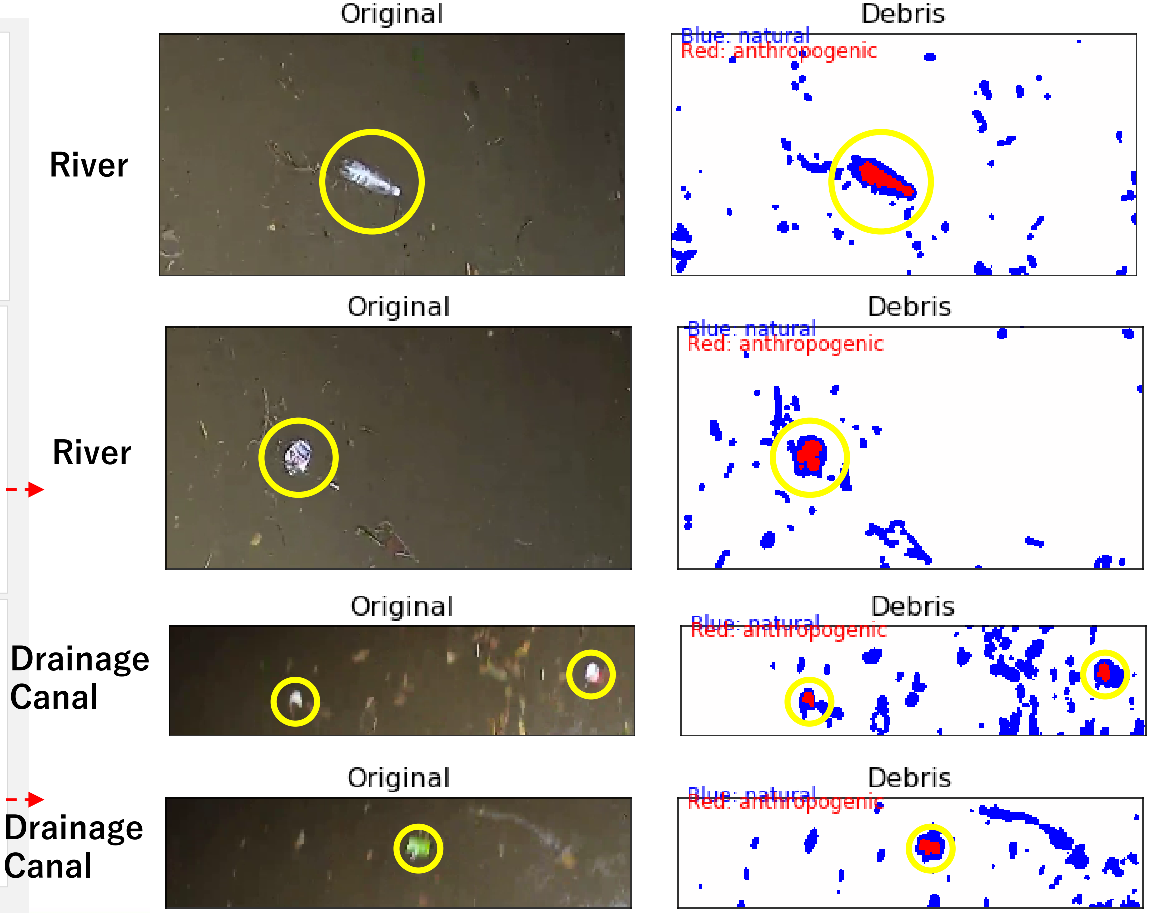
Debris runoff situation

- Debris were observed to occur mainly during water outflows.
- RIAD was able to identify anthropogenic debris from the debris on the water

Debris on the water (photo) and identification of debris by RIAD (right)

Blue：Natural Red：Anthropogenic





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Plans for future consideration

- Initiatives utilizing data linkage infrastructure, such as visualization of debris discharge status, etc.

Data by RIAD

- Natural Debris Transport
- Anthropogenic Debris Transport
- All Debris Transport
- Speed of moving fluid

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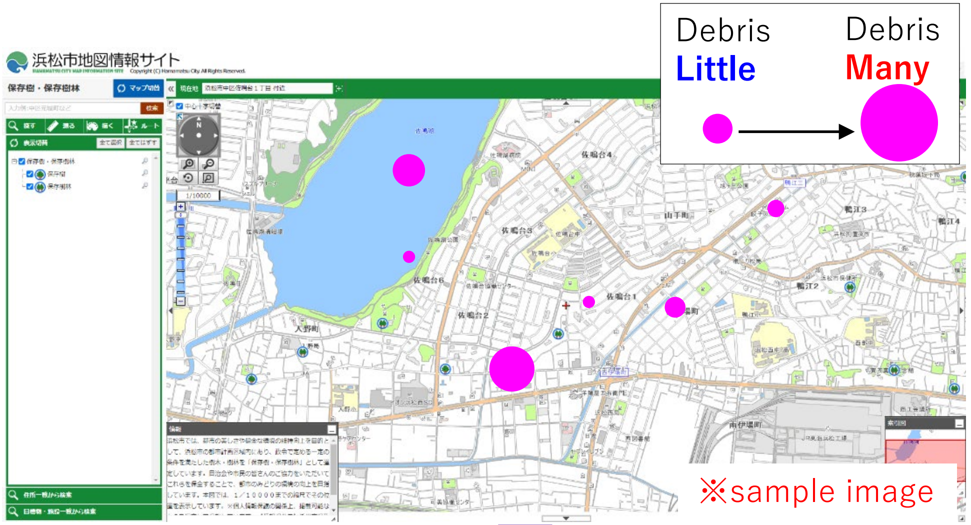
Data Integration Platform →

↑

Visualization

Visualization using map information



✓Effective citizen activities

✓New awareness-raising materials

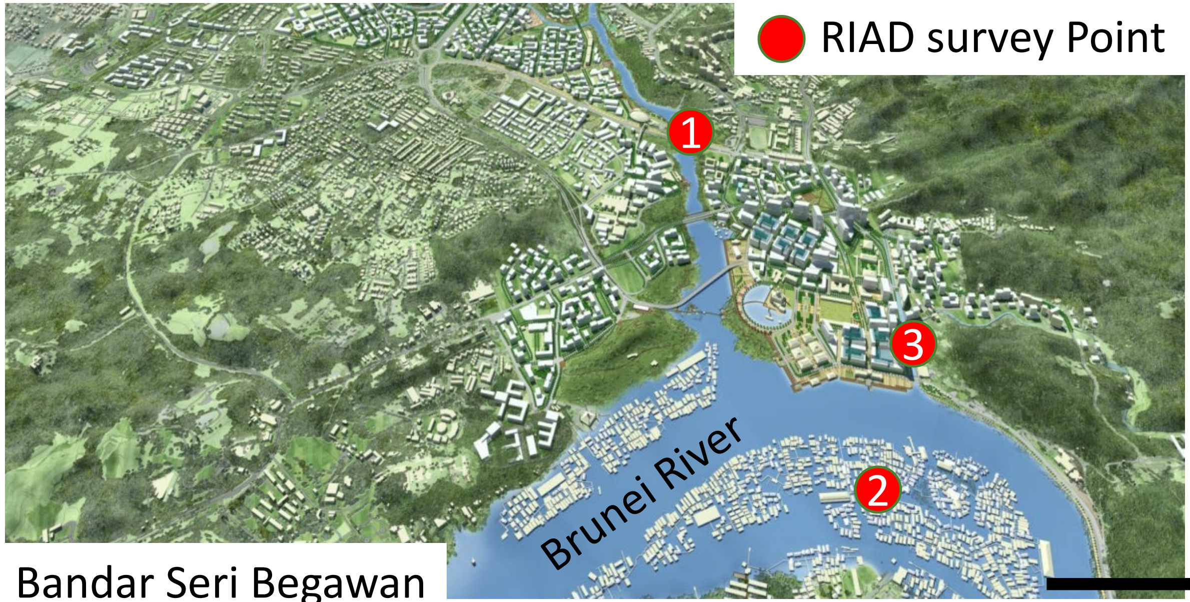
✓Requests from citizens

Feedback

5. RIAD introduction case in Brunei

Brunei Darussalam

Capital	Bandar Seri Begawan
Population	Approx. 430,000 (2021*1)
Official Language	Malay
Land Area	5,765 km^2
Religion	81% Sunni Islam (2016*2)

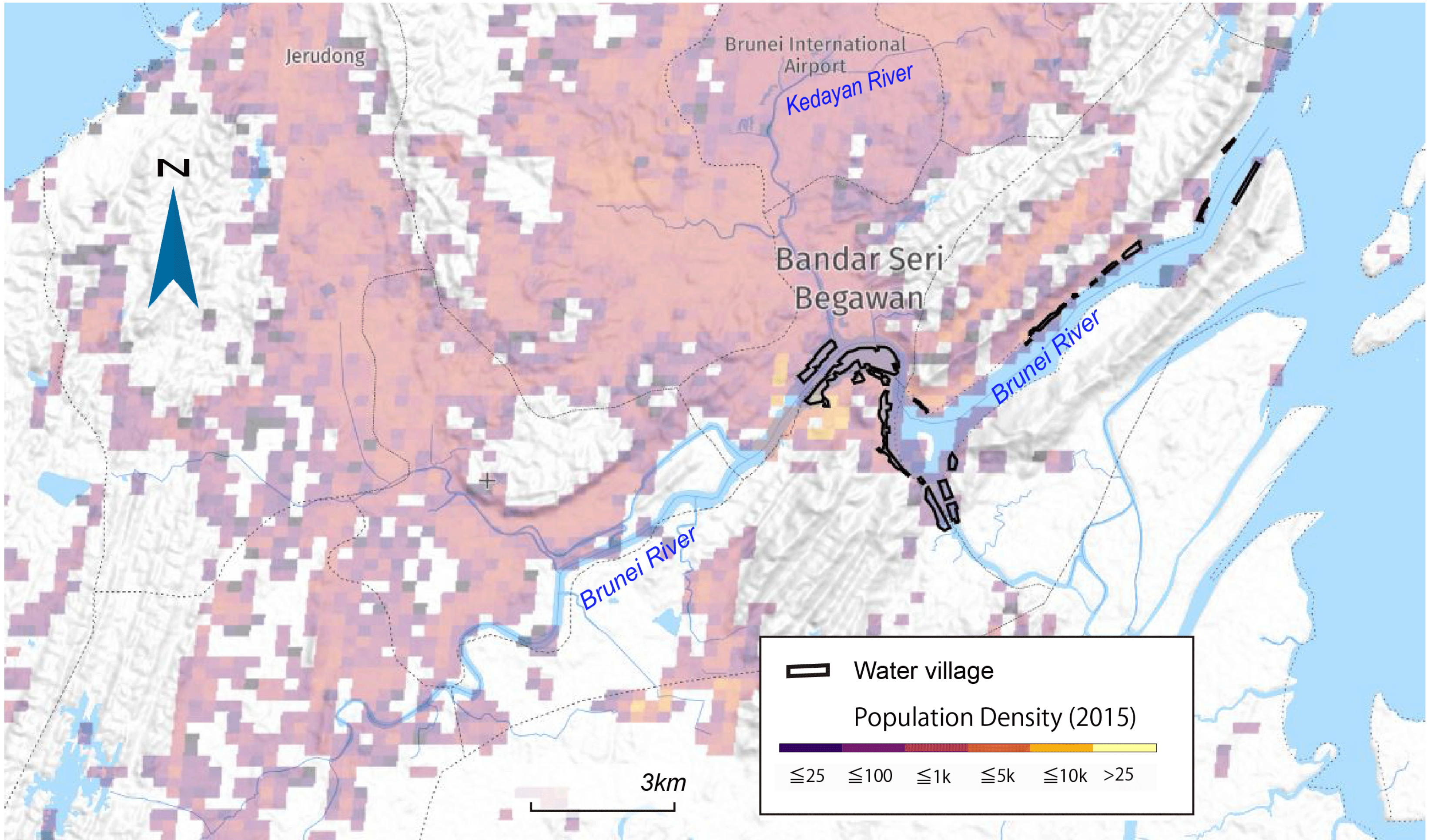


Source: Ministry of Home Affairs

Water Village

*1:https://deps.mofe.gov.bn/SitePages/Population.aspx
*2:https://deps.mofe.gov.bn/SiteAssets/Time-Series3.html

Population Density and Locations of Water Village

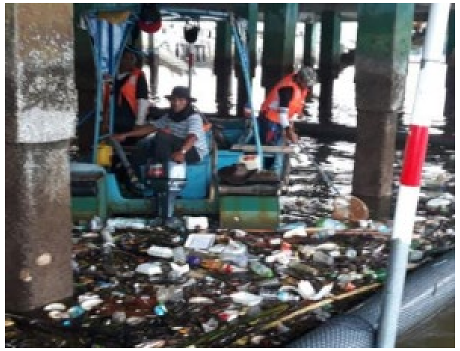


Data source: European Commission, Joint Research Centre (JRC); Columbia University, Center for International Earth Science Information Network - CIESIN (2015)

Present Condition

Cleaning activities are conducted almost every day (2018～)

But still there are lots of debris under houses and on riversides



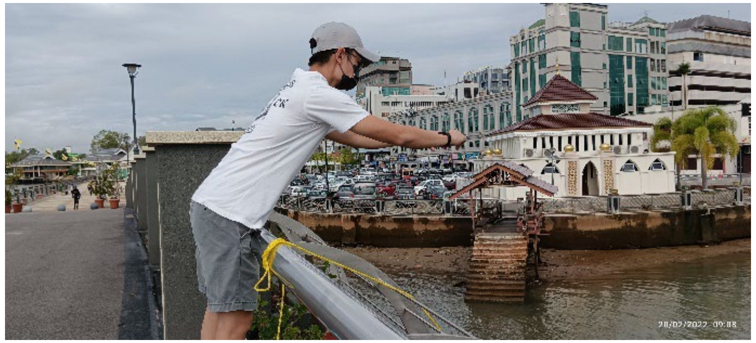
Water Area Cleaning

Land Area Cleaning

5. RIAD introduction case in Brunei

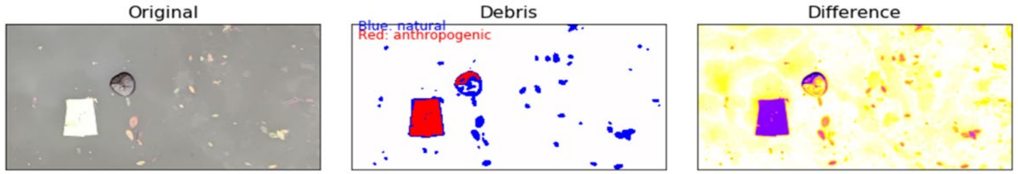
5. RIAD introduction case in Brunei

Taking Videos at 3 Points (Different Rivers)
Every one hour



Taking Videos by Smartphone

Captured Video



Analysis

Point ❶

Point ❷ (Brunei River)

Point ❸

Captured Plastics (during 30 minutes)

5. RIAD introduction case in Brunei

Examples of future RIAD utilization

RIAD System → **Visualization**

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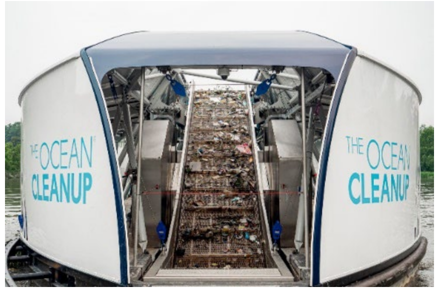
Efficient implementation of measures (example)

- River debris scavenger machine
- Trapping, Oil fence
- CCTV to monitor illegal dumping
- Trash Box ... etc.

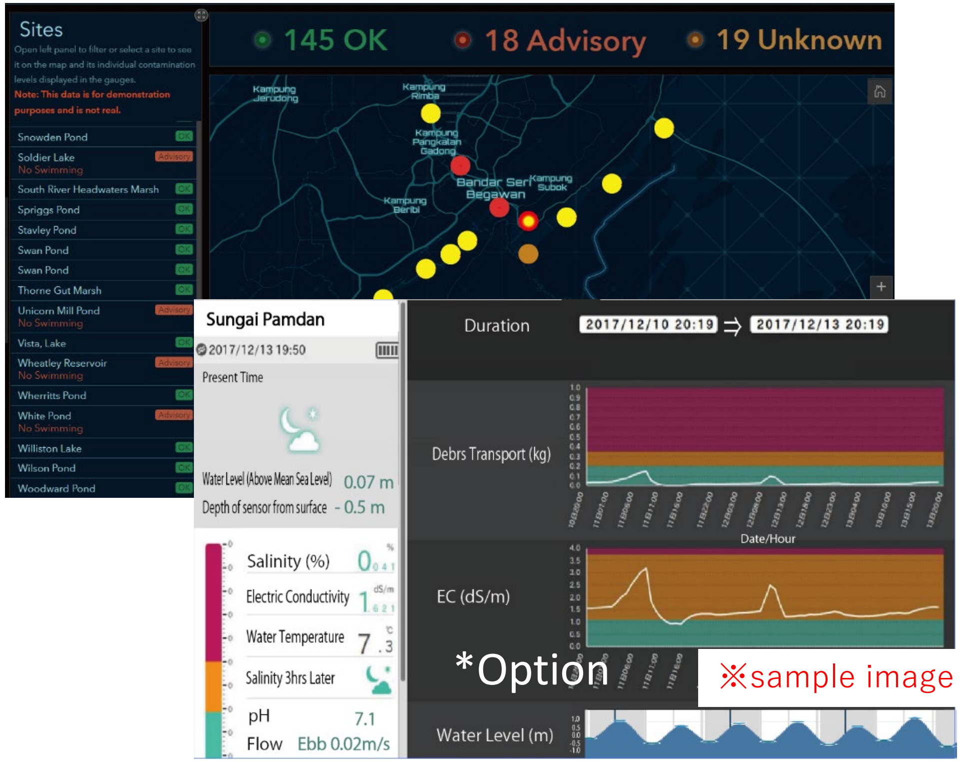
Example of Oil fence



Example of clean up machine
Interceptor by The OCEAN CLRANUP

https://theoceancleanup.com/dashboard/#interceptor002

Monitor image of fully-equipped RIAD



Raising Environmental Awareness

@ Field

@ school

6. Conclusion

Dangerous Conventional Methods

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Less Data
Less Actions

Yachiyo Engineering Co., Ltd.

RIAD
River Image Analysis for Debris transport

- Safe and Enough Data Collection
- Proposing Measures
- Reducing Reverine Debris

Thank you for your attention

Simple flow to grasp riverine debris transport amount with Camcorder

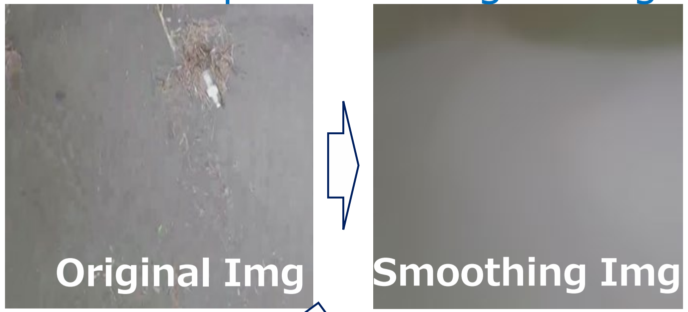
RIAD **Area transport amt [m^2/s] computation**

Distinguish natural & anthropogenic debris by color difference from water surface

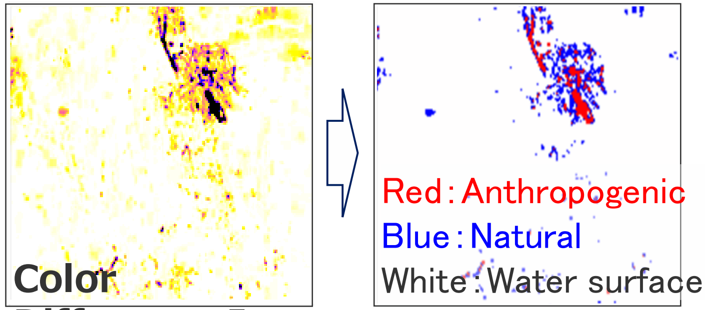
→

Based on debris transport distance per frame, compute area transport amt

Take a spatial moving average



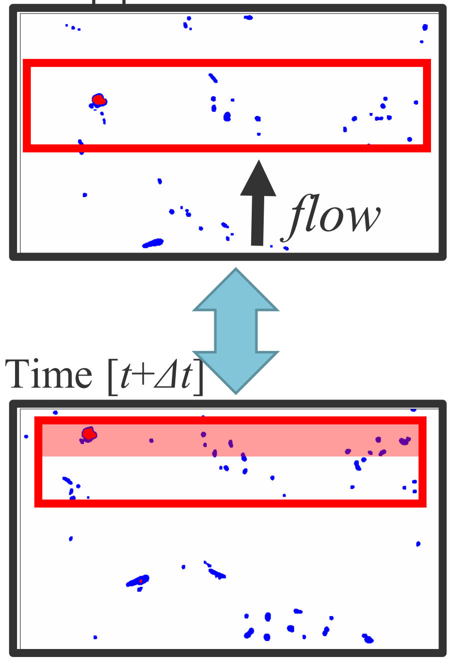
Gap b/w Orig & Smot
CIE*Luv* color space



Color Difference Img

Ternarizing

Time [*t*]



Time [*t*+*Δt*]

With template matching, compute transport amt of **Red Frame**

Mass transport amt [g/s] computation

Based on area flux & M/A, Compute mass flux

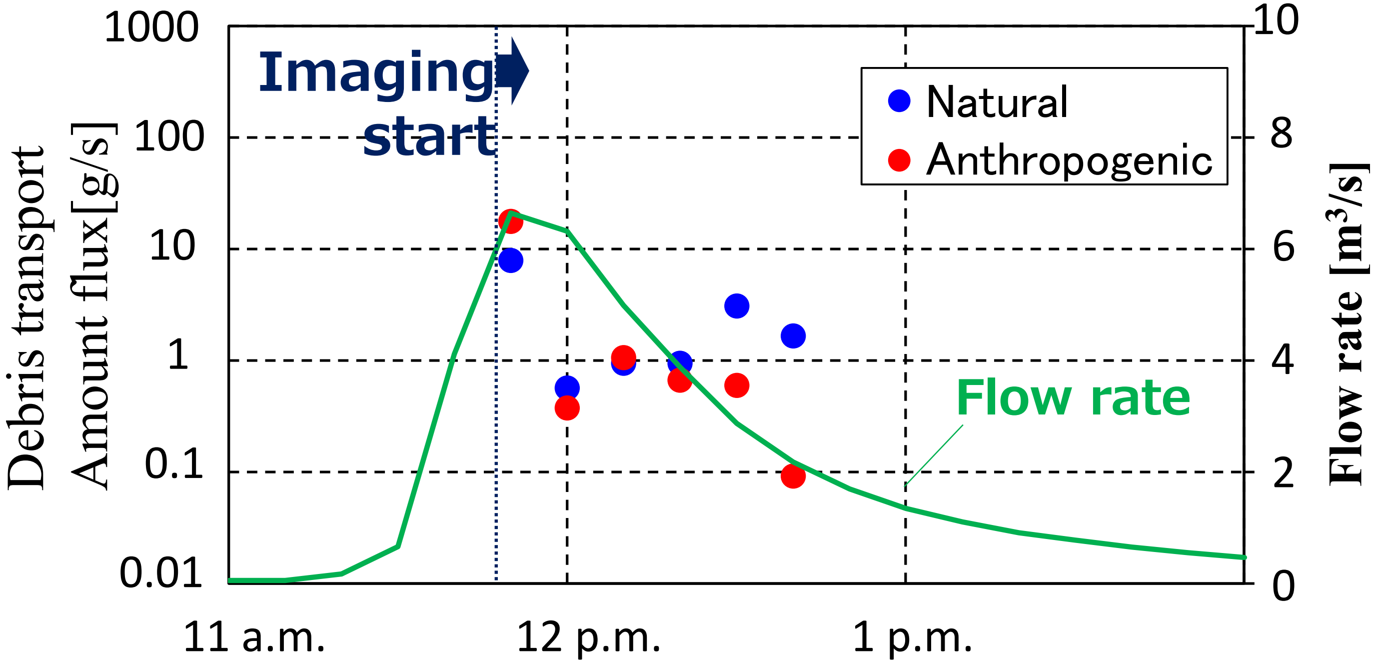
Result reflection

Extra field study

Grasp relation b/w floating debris Area; A[m2] & Mass; M[g]

River in Kinki Region : Overflow at Aug 21 2019

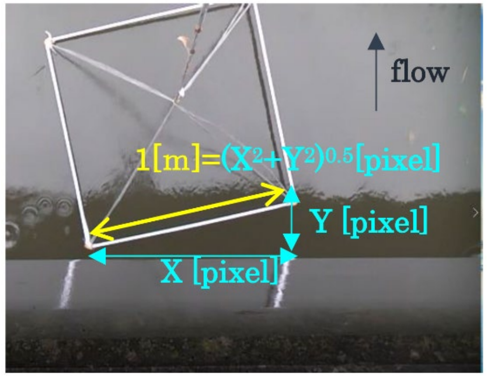
Transport amount of riverine debris on entire water surface per unit time [g/s]



■Confirm *First Flash Phenomenon* caused by natural & anthropogenic debris
■Find out relation b/w flow rate & debris transport amount

Field study requirements for mass flux

■Acquire # of pixels per 1m & distance to water surface



・Setting up length per pixel beforehand for computing debris area with the system is necessary. As shown in a picture on right, extra imaging with something as a scale is required. At that time, measuring distance from a camcorder lens to water surface must be done.

・It can be expected that water level, or length per pixel changes during imaging. So, measuring distance from a camcorder to water surface at the imaging moment.

■Acquire information on riverine width

・Implementing analysis in a certain area of imaged picture requires evaluation across entire riverine surface. So, measuring riverine width is necessary.

■Acquire data on water level (flow rate) around imaging point

・Analysis above just produce result with temporary imaging duration. To take measures hereafter, estimating debris amount through a year is required. So, we need to acquire annual data on water level and flow rate.

■Collect debris around imaging point【Optional】

・RIAD can compute natural or anthropogenic debris area. For this computation, we need to evaluate mass flux, in other words, evaluate Coefficient; a[g/m^2] to convert Area; A[m^2] into Mass; M[g]. So, it is required to collect debris around imaging point, acquire information on its area and mass, and then evaluate Coefficient; a[g/m^2] with dividing Mass; M[g] by Area; A[m^2].

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