Real-time landslide warning system maintenance and management manual

July 2021 Atami Izuyama in Japan debris flow disaster
(occurred after peak rainfall)

March 2024

Geophone solutions

Contents of the material

◎ Overview of real-time landslide warning system
◎ Overall equipment system configuration
◎ Device roles and settings
◎ On-site maintenance

Attachments (data collection & monitoring)

- IOT device system usage guide
- IOT device cloud operation manual

What is a GEOPHONE （crisis management sediment meter）?

Introduction

◎ Catches the warning signs of landslides that could happen anywhere and at any time.

◎ Landslide disasters caused by landslides and debris flows occur differently depending on the type of ground. For example, soft ground, fill ground, sandy ground, etc.

◎ Landslides and debris flows cannot be accurately predicted by only rainfall and soil rainfall indexes (groundwater level stored in the hillside), which are triggers.

◎ Wire sensors have been installed in many landslide hazard areas. However, They are sometimes cut by falling rocks, fallen trees and driftwoods. These cause malfunctions to the wire sensors. They are not broken by sediment runoff caused by landslides.

Warning of debris flow and landslides!

The importance of measuring flow rate and sediment

◎ In order to protect lives from landslides, the amount of flow rate and sediment that flows out caused by hillside slope collapses should be constantly monitored to catch any signs of landslides and debris flows.

◎ Crisis management sediment meters use a microphone to detect the sound of sediment impacting a steel sensor, and the sound pressure energy (voltage) is integrated and converted into the amount of sediment moved.

◎ They also measure the amount of sediment at all times and detect abnormal sediment discharges that differ from normal conditions, which allows them to catch the warning signs of landslide disasters.

◎ They also have a sensors installed as part of a real-time early warning system.

REAL TIME LANDSIDE EARLY WARNING SYSTEM

FEATURES

◎ When the Crisis Management Sediment Meter detects an unusual amount of sediment, the Real-time Landslide Early Warning System sends warning information to the necessary locations.

◎ The System checks the situation at the site using camera images.

◎ Basic components (Composition)

- Sensor (microphone, integrating board)
- Camera
- MCU (data processing, data storage, control)
- Communication part (antenna, data distribution)
- Power supply (solar panel, controller, battery)

◎ The system uploads time-series data to a cloud server for viewing from anywhere.

◎ Three thresholds can be set for the amount of sediment, and when the threshold is exceeded, an alarm can be sent by e-mail to the necessary locations.

◎ Three levels of thresholds and information provision: caution, warning, and evacuation

◎ It is expected that the Real-time Landslide Early Warning System will be installed with priority given to areas with a high risk of landslides.

REAL TIME LANDSIDE EARLY WARNING SYSTEM

CONFIGURATION

① Sensor & Camera

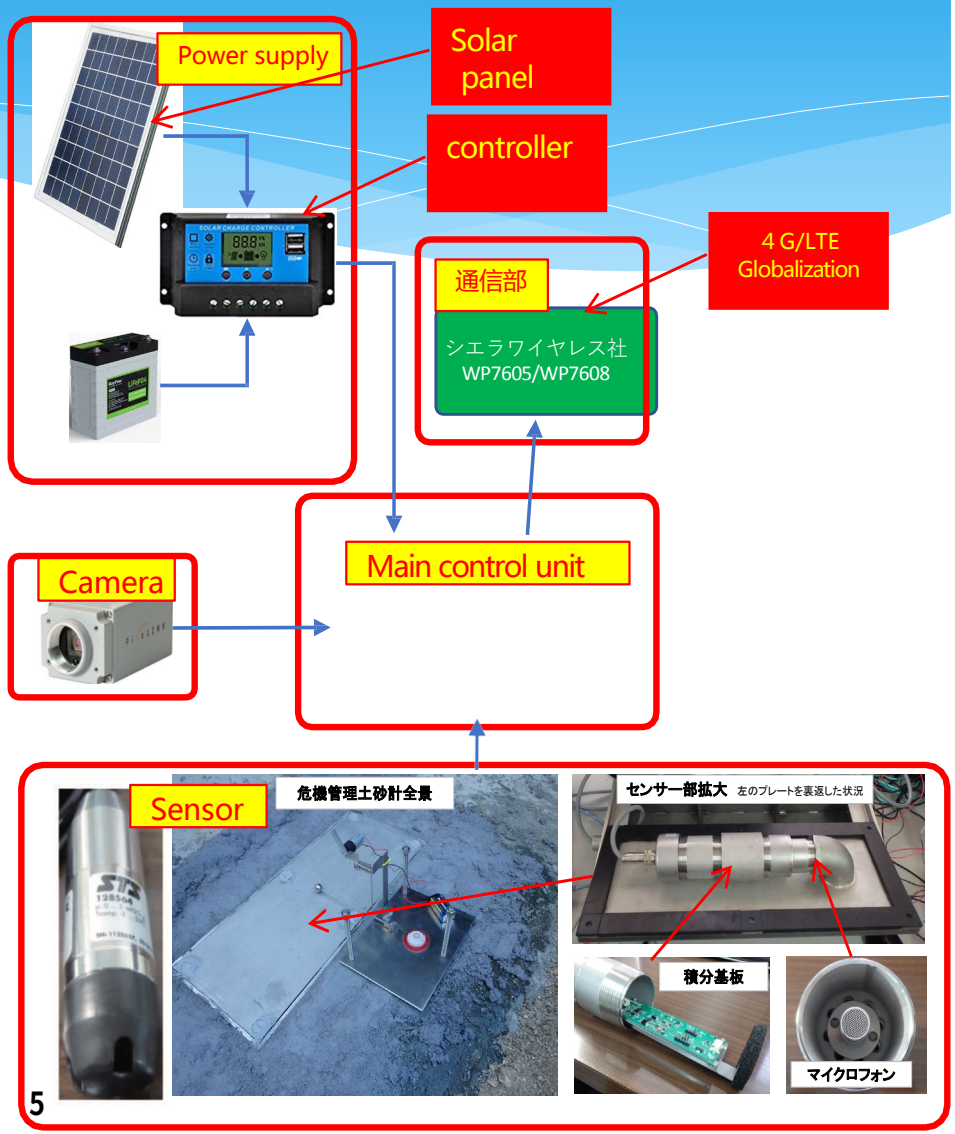
- Crisis management sediment meter (microphone, sound pressure integral)
- Pressure type water level gauge (water level and voltage value)
- Camera (still image)

② MCU section

- Data processing:

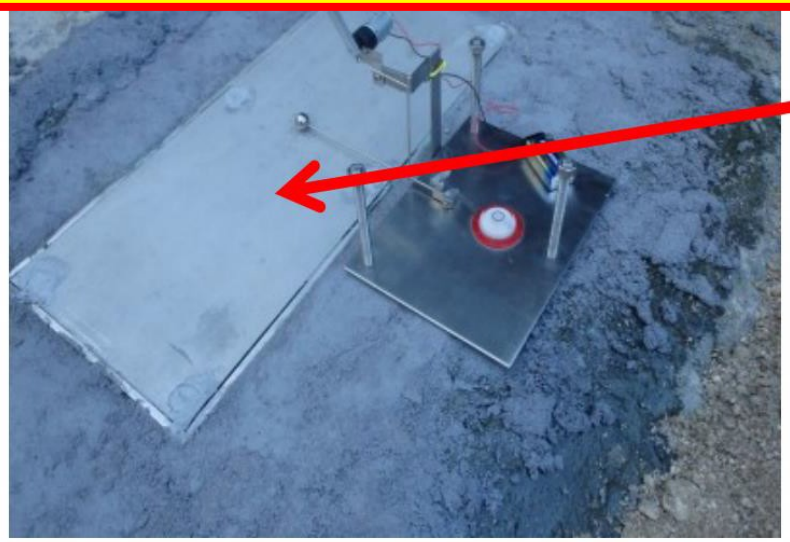
  Sediment volume conversion
  water level-water discharge conversion

- Camera image processing
- Data accumulation
- Control (alarm judgment, trigger switch)

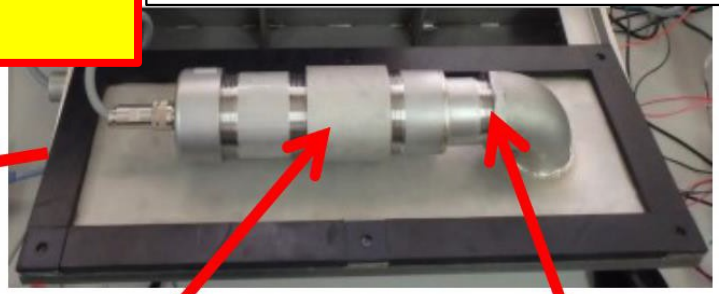


Geophone sensor with microphone *and soundwave integration circuit*

Water level sensor & Geophone sensor



Geophone beneath steel plate

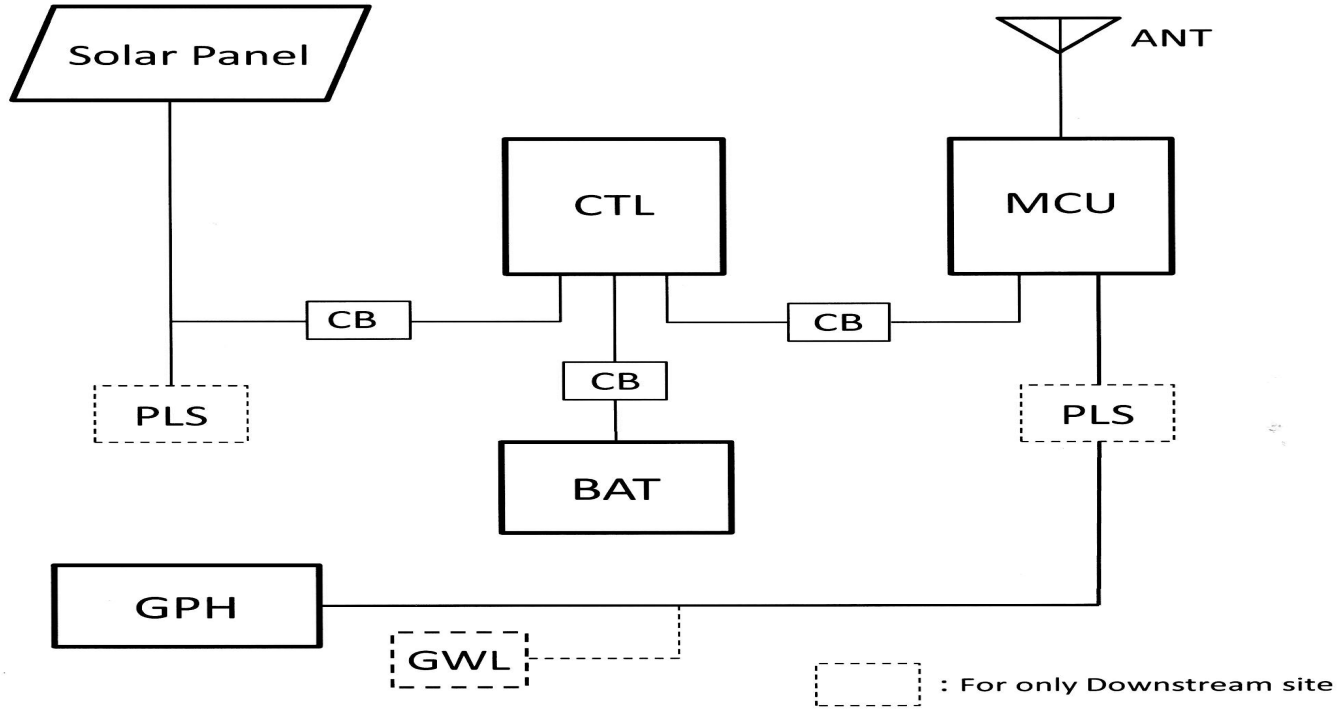


Integration circuit

microphone

Outline of Equipment

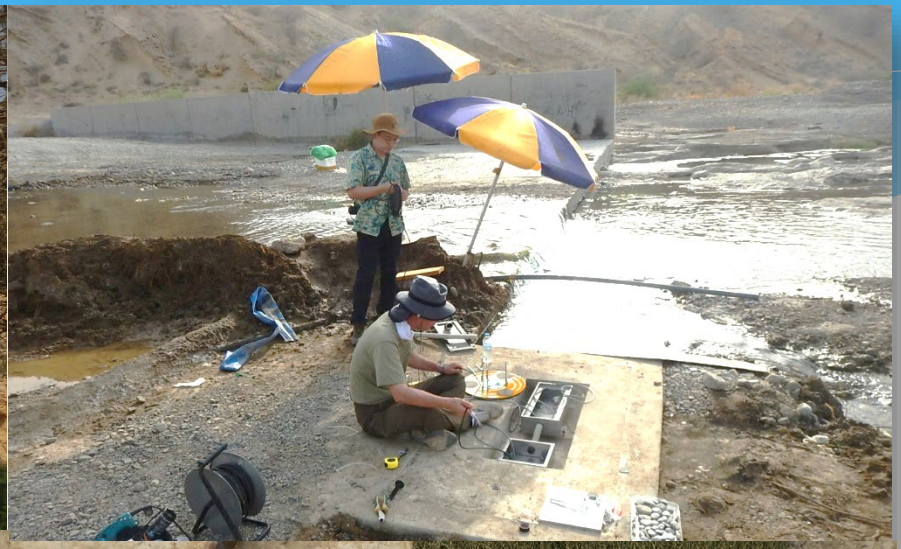
Block Diagram

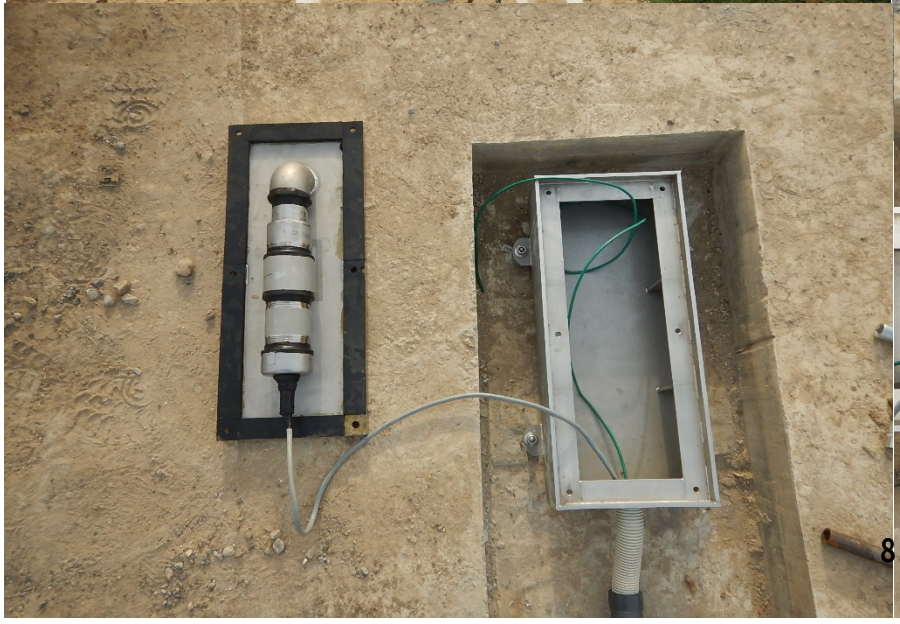


Abbreviations (alphabetical order)

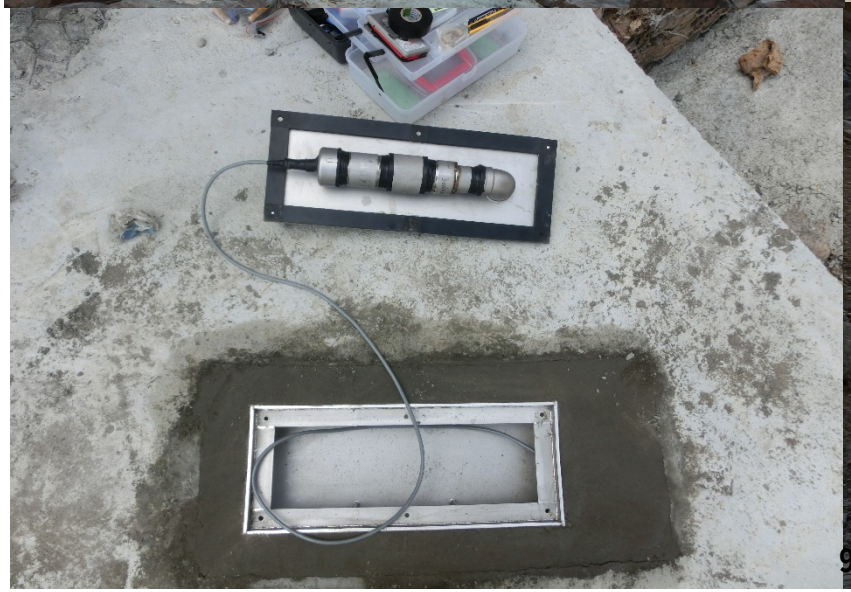
1. ANT : LTE Antenna
2. BAT : Main Battery
3. CB : Circuit Breaker
4. CTL : Solar Power Charge Controller
5. GPH : Geophone Censor & Integration Circuit
6. GWL : Water Level Gauge
7. MCU : Main Control Unit
8. PLS : Lightning Surge Protector

Equipment installation (downstream site)



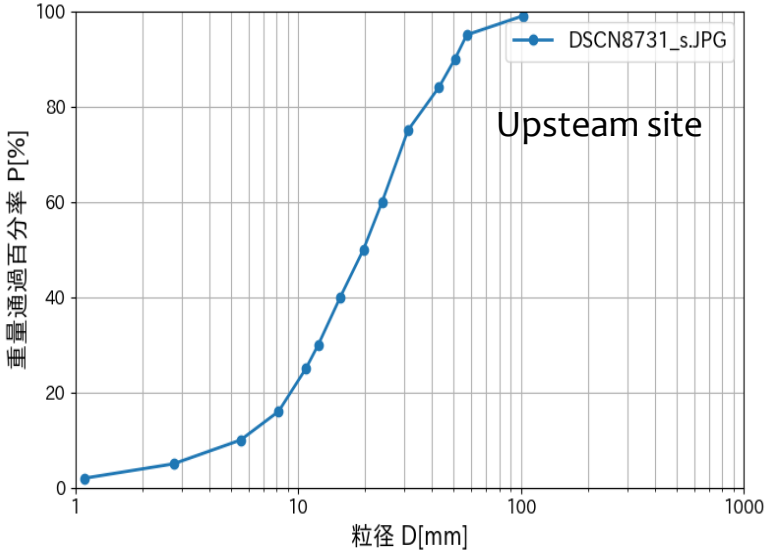


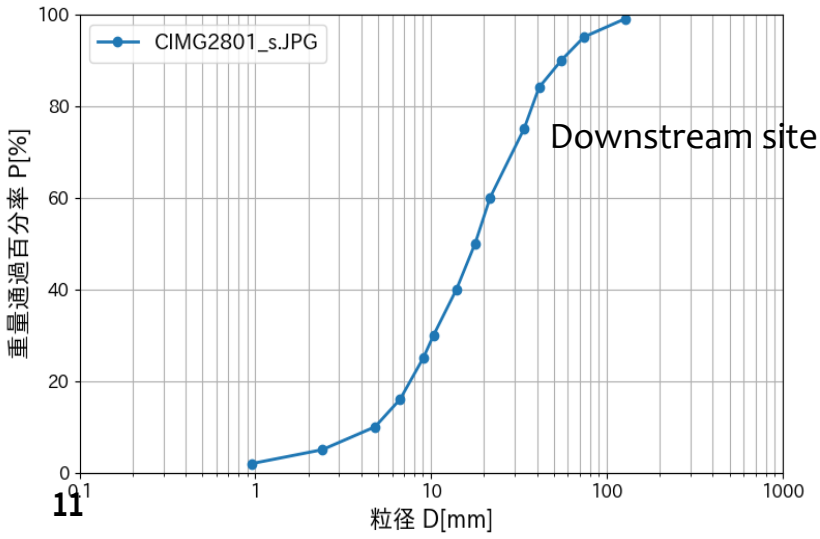
Equipment installation (upstream site)

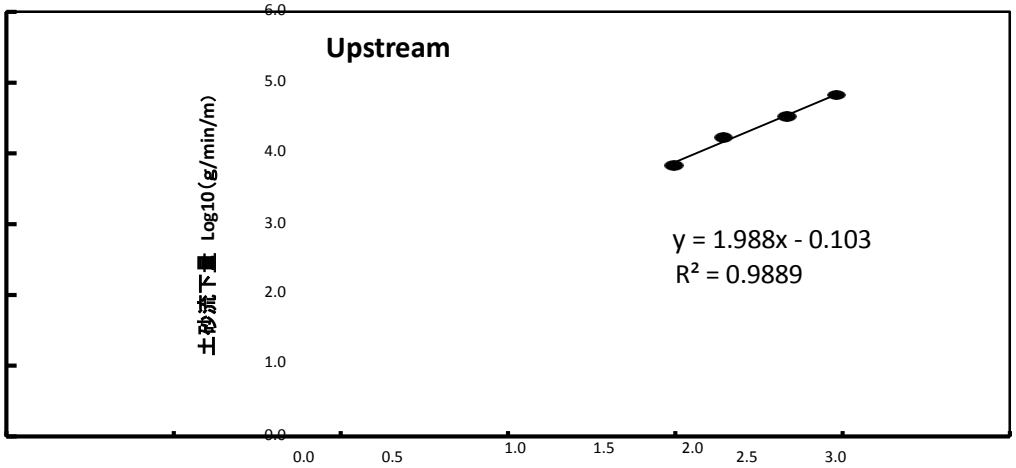


Controller & MCU kit in observation box

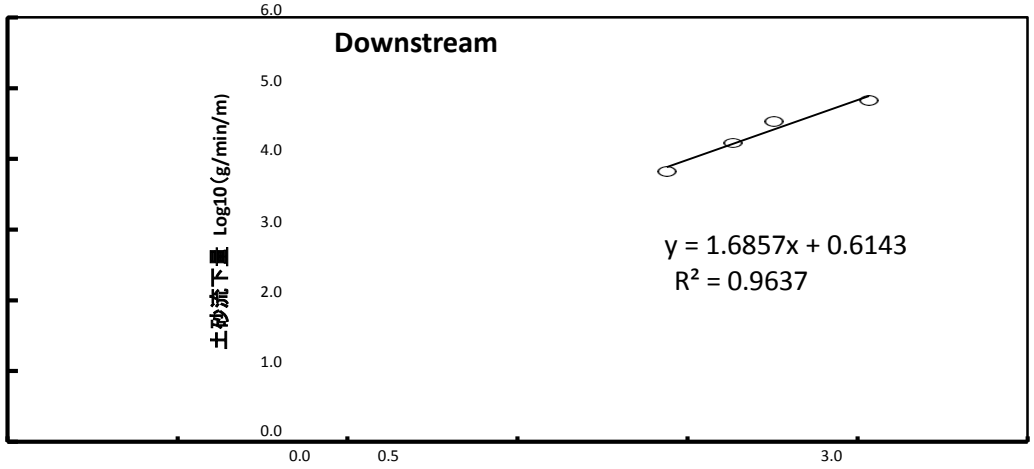
On-site waterway sediment experiment







Integral value increase amount per minute **Log10（mV）**



Integral value increase amount per minute **Log10（mV）**

Conversion formula to sediment volume
(calibration formula)

Overview of this IoT device/system

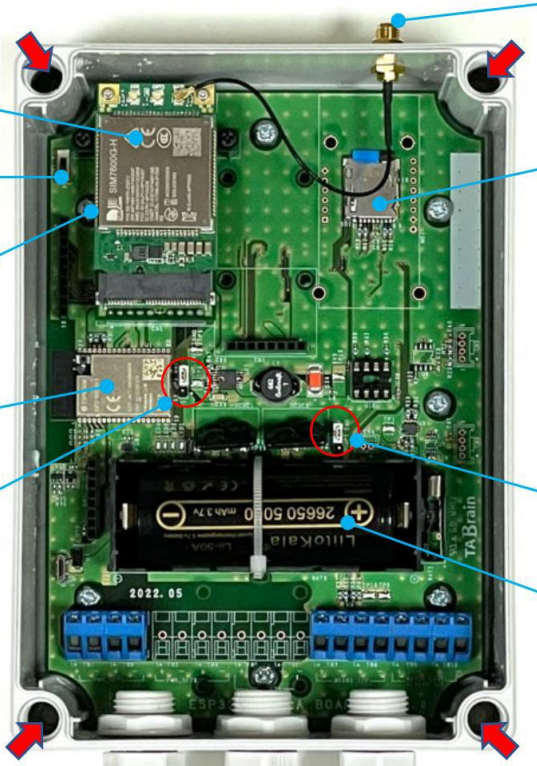
This IoT device for disaster prevention is equipped with a 32-bit microcomputer board ESP32, is capable of LTE communication, and has the ability to sequentially upload data to the cloud. Below is an overview of the functions on the device side and cloud side.

1. This IoT device side -

Obtains sensor values, etc. (integral value related to sediment volume, water level measured by water pressure sensor, temperature inside the case, internal power supply voltage (3.7V system), external power supply voltage (12V/24V) - Integral sensor detects approximately every minute•The device identification number is the IMEI of the installed communication module (the last 7 digits out of 15 digits).•A cumulative number is added to the data uploaded from this device to the cloud.

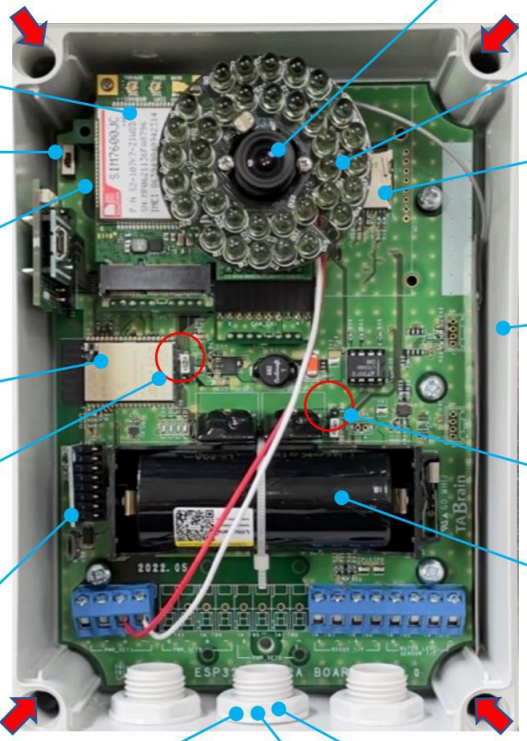
Overview of this device (1) Oman compatible version

Note: When transporting, please put shock absorbing material etc. before closing the lid.



Overview of this device (2) Oya Okawa version

Note: When transporting, please put shock absorbing material etc. before closing the lid.



SPI camera

A 1m extension cable and antenna are included as accessories.

Infrared LEDs (ring light)

communication module

SD memory (equipped with 4GB)

Main power switch

SIM card (back)

flexible antenna

MCU(ESP32)

External power supply selection (jumper pin) 12V or 24V

Internal power supply selection (jumper pin)

USB5V power supply or internal battery?

Internal battery 26650 (3.7V 5Ah)

lithium ion battery

Acceleration sensor

A case lid and four corner screws are included separately.

External power supply 12V

integral sensor

water pressure sensor

The mark is the screw hole.

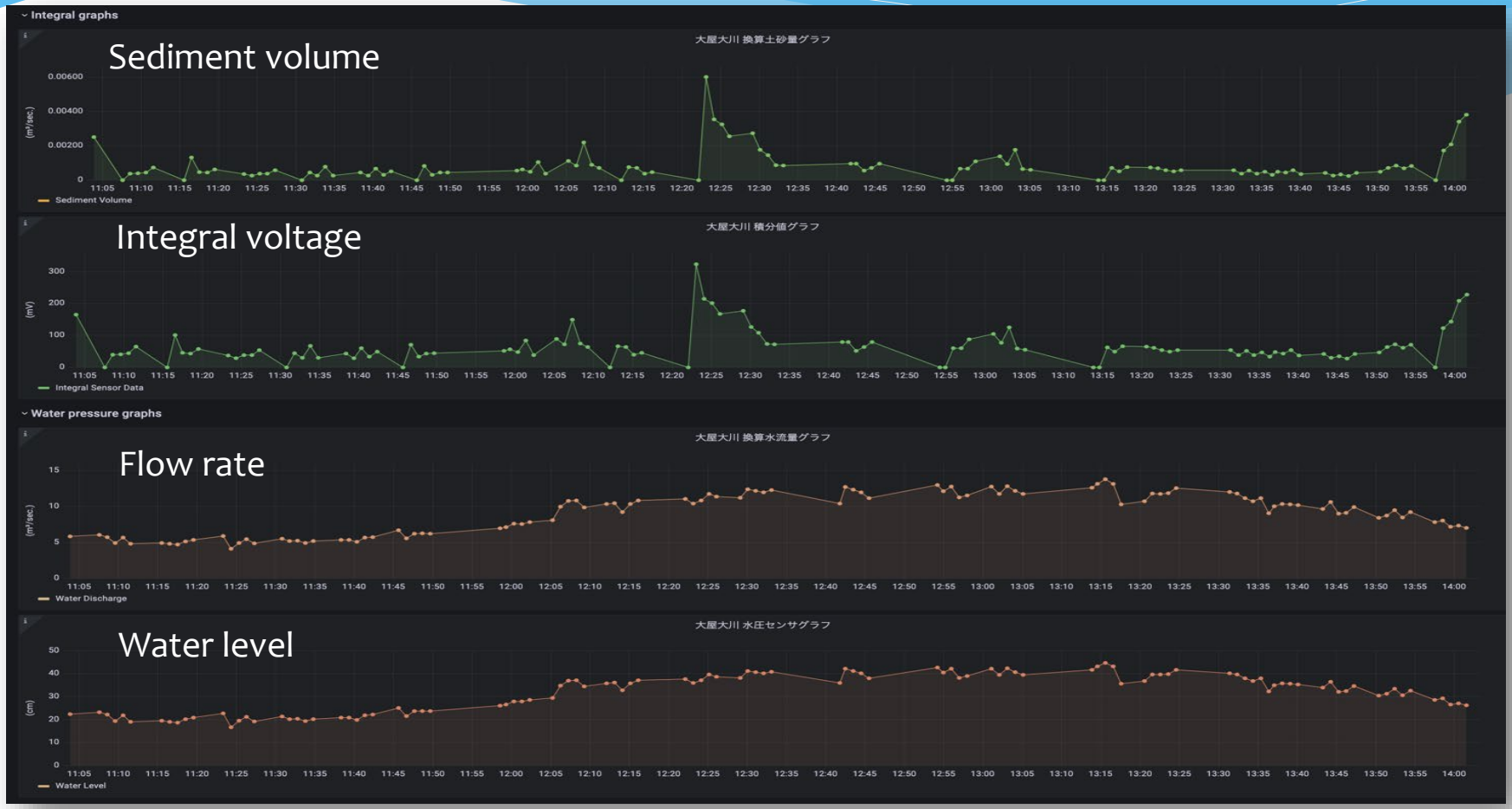
Also, the screw hole on the lid.

Disaster prevention iot device system

Real-time Data Uploaded to Cloud Server (Japan)

Disaster prevention iot device system

Time series charts of water level, flow rate & sediment volume (Japan)



Disaster prevention iot device system

Monitoring of supply voltage & radio wave strength (Japan)

Disaster prevention iot device system

Uploaded river picture to the cloud server (Japan)

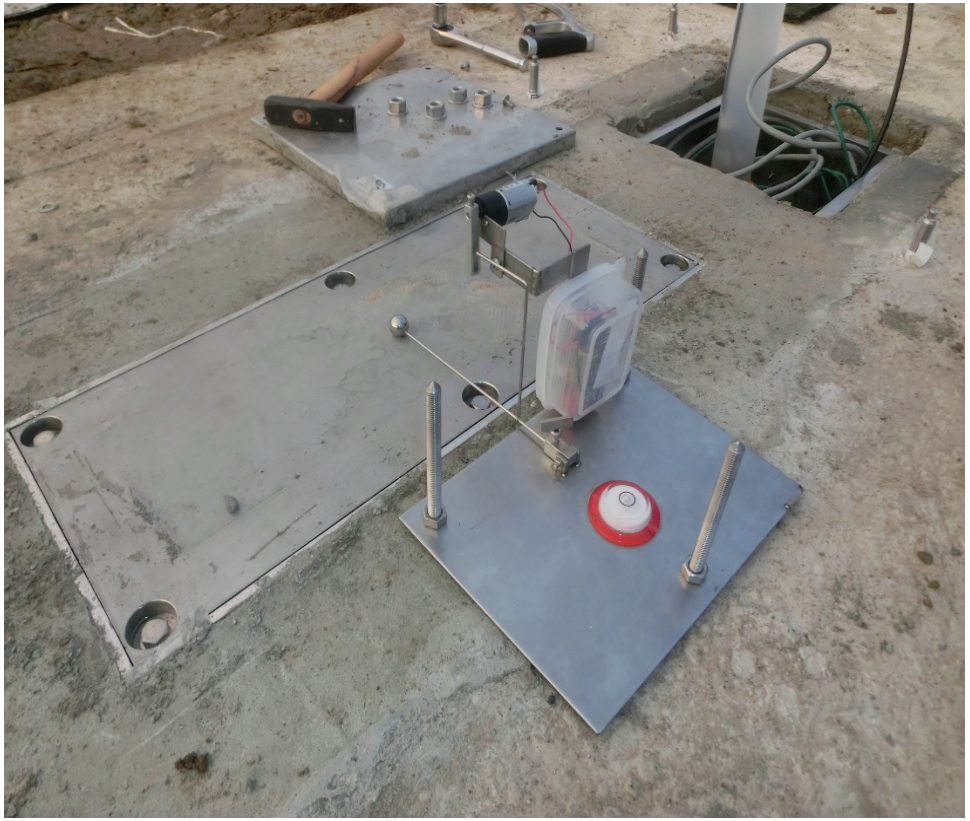
Maintenance (1)

* (1) Points to note regarding maintenance and management
* Perform regular inspections. Do this once a month.
* Careful inspections are carried out especially before the rainy season.
*
* (2) Sensor inspection (geophone inspection)
* •Damage of the plate (such as after a large-scale sediment outflow)
* •Abrasion or damage to the concrete where the plate is installed
* •Damage due to water leakage to the microphone or integral circuit, or damage due to lightning strikes
* •Cable disconnection
*
* (3) Inspection of data storage device (inspection of MCU kit)
* •Damage due to water leakage in the integral circuit, damage due to lightning strikes
* •Damage due to water leakage of MCU kit, damage due to lightning strike
* •Non-restart after shutdown due to power outage

Maintenance (2)

* (4) Inspection of alarm device
* As for the alarm system, it has not been installed this time, but if it is installed in the future, it will be necessary to keep the following in mind.
* •Damage due to water leakage, damage due to lightning strikes
* •Checking the setting values
* •Blow sound, operation confirmation
*
* (5) Inspection of power supply equipment
* •Damage due to strong winds, heavy rain, flying stones, etc., damage due to lightning strikes
* •Battery remaining capacity
* •Check the operation of the charger controller
*
* (6) Inspection of equipment box
* •Damage due to natural disasters (lightning, strong winds, heavy rain)
* •Damage due to human damage
* •Lock management
* Create a checklist based on the above inspection items.

Geophone drop test & water level gauge check



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1st Sediment amount observation facility inspection table

Inspection points Observation points: Downstream site

Survey item		Check	Value	Comment	Remarks
Exterior inspection	Geophone				
	water level gauge				
	observation box				
	power supply				
	Piping				
investigation	Input voltage				
data check	integral value				
	Sediment amount				
	Observation water level				
	Local water level				

Legend ○ : No abnormality ● : Abnormality -: Not applicable

Date of implementation		Worker	

Oya Okawa observation results in Japan (July 2020)