Resilience Agricultural Sciences starting from Fukushima, Japan

-The Role of Agricultural informatics in Rural area-

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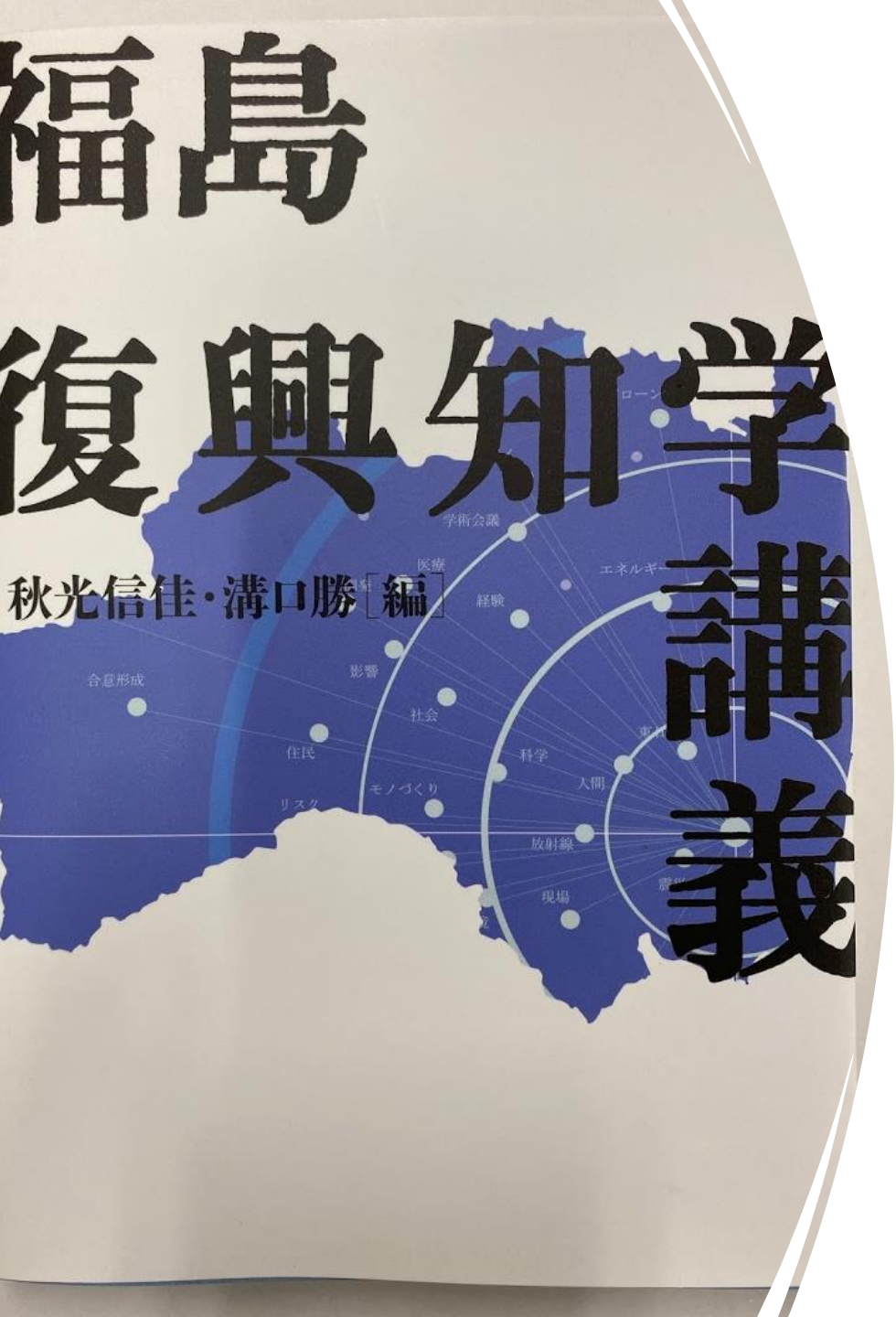
INTRODUCTION

- Ten years have passed since the nuclear power plant accident.
- Researchers from various fields have been involved in agricultural issues in Fukushima since the accident.

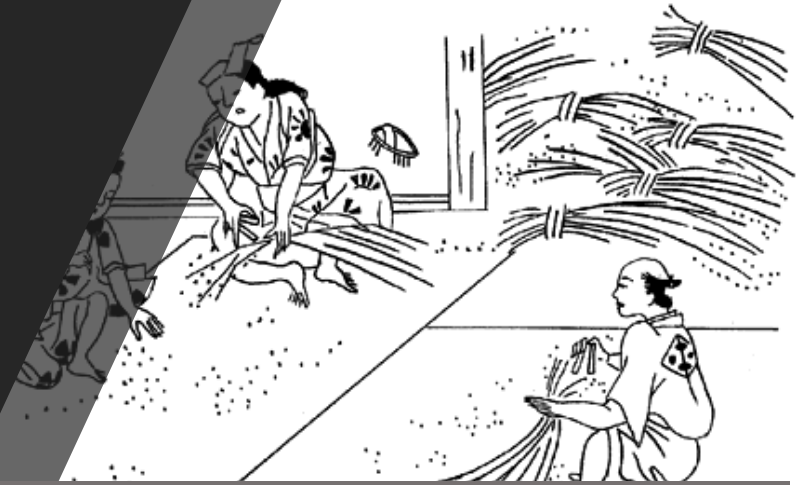


INTRODUCTION-2
-Reconstruction knowledge -

- Researchers' efforts have been accumulated as reconstruction knowledge which is about to be revived as an old but new agricultural science to solve problems in the field.

HISTORY OF JAPANESE AGRICULTURAL TECHNOLOGY

- Dedicated farmers developed during the Edo and Meiji eras (1600-1900).
- Dr. Tokiyoshi Yokoi (1860-1927: a graduate of Komaba Agricultural School) in the Meiji era
  - saw that the agricultural scientists of the time, who had learned Western science, were trying to do things without seeing the actual field
  - ridiculed them at a lecture, saying, "Agricultural science flourishes, but agriculture dies".



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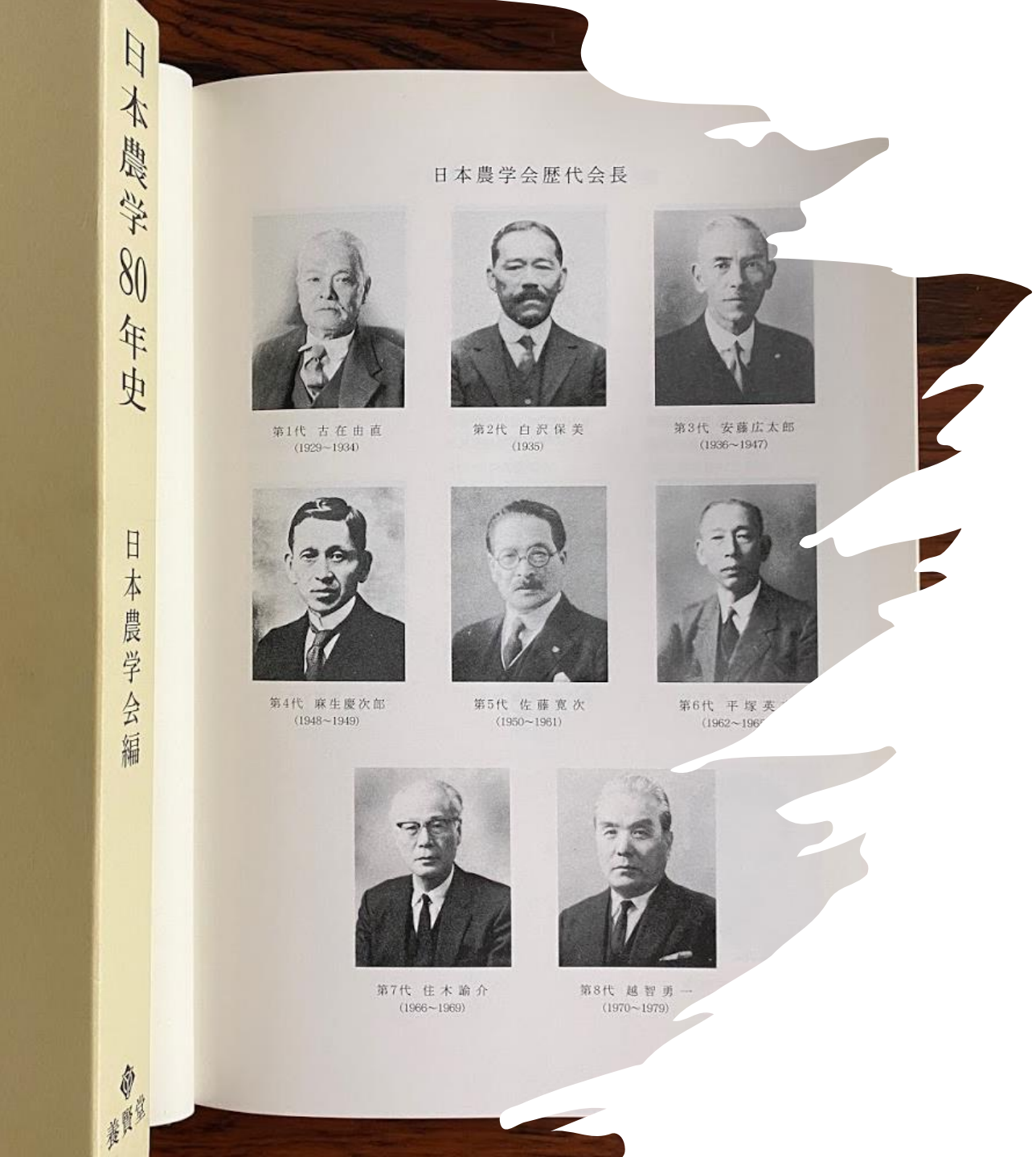
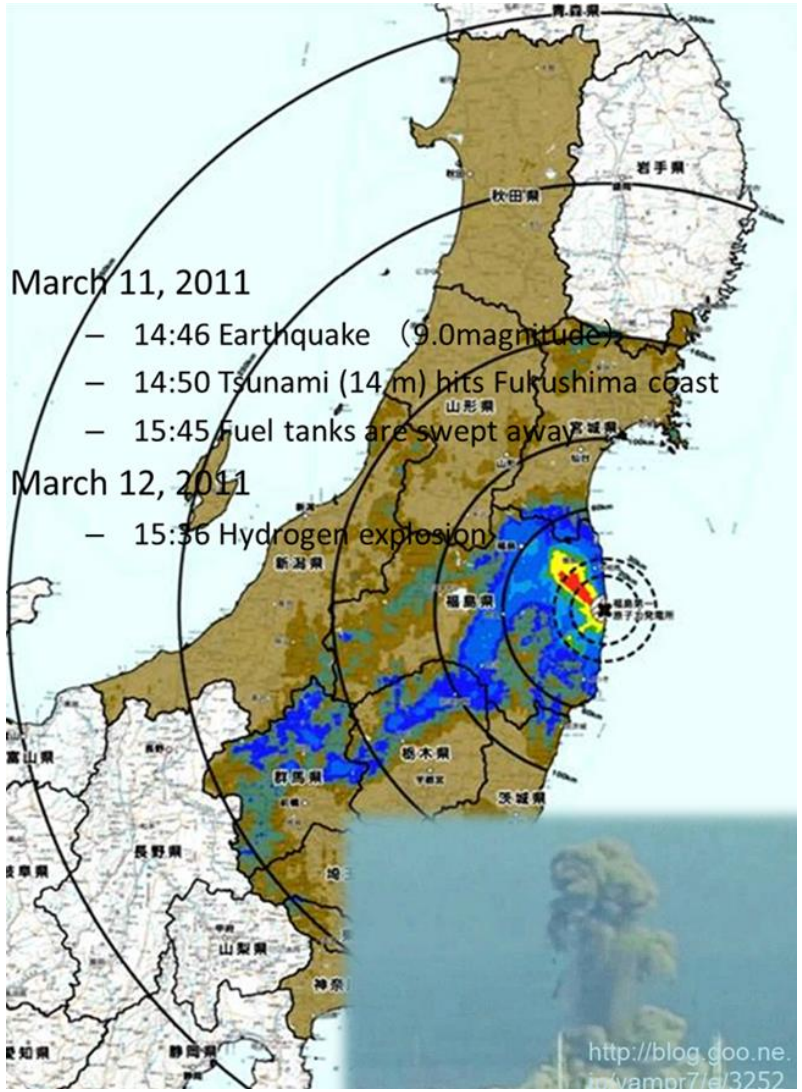


THE JAPAN SOCIETY OF AGRICULTURAL SCIENCES

- Modern agricultural science in Japan started
  - with the Veterinary Society in 1884,
  - and by 1929, 16 societies had been established,
  - and now consists of more than 50 societies reflecting the subdivision of research fields.
- The Society for Reconstruction and Agricultural Sciences became the 53rd society to join the Japan Society of Agricultural Sciences in 2020.

NUCLEAR POWER PLANT DISASTER IN FUKUSHIMA

- In March 2011, the Tohoku region was devastated by the tsunami caused by the Great East Japan Earthquake, and the coastal area of Fukushima Prefecture was contaminated by radioactive materials due to the nuclear power plant accident.
- While the 1986 Chernobyl accident was brought to an end with the sarcophagus treatment, the first human challenge to revive the region continues in Fukushima and accumulate its experiences as reconstruction knowledge for ten years.
- The Reconstruction Agency in the Japanese government, is trying to create an international education and research center that will be the core of creative reconstruction, including an attempt to disseminate such reconstruction knowledge to the world.



WHAT IS AGRICULTURAL SCIENCE?

- RURAL AREAS
  - are places of food production and living environments
- AGRICULTURAL SCIENCE
  - is a discipline that works with the people who live there.
  - In science, we normally search for a lot of literatures and set a research theme
  - But in Fukushima, there are many issues arising from the nuclear power plant accident.
- We have a CHANCE
  - to ask dedicated farmers who have returned in the areas where evacuation orders have been lifted without defeated by adversity.
  - "Ask the rice about rice, and ask the farmers about agriculture." (Professor Yokoi)
- Only faculty members and students go to the fields in Fukushima and talk with the farmers, we will be able to see the real issues and come up with research themes

WHAT IS RESILIENCE AGRICULTURAL SCIENCES?

- Resilience: the ability to be happy, successful, etc. again after something difficult or bad has happened （Cambridge Dictionary）

Reconstruction → Resilience

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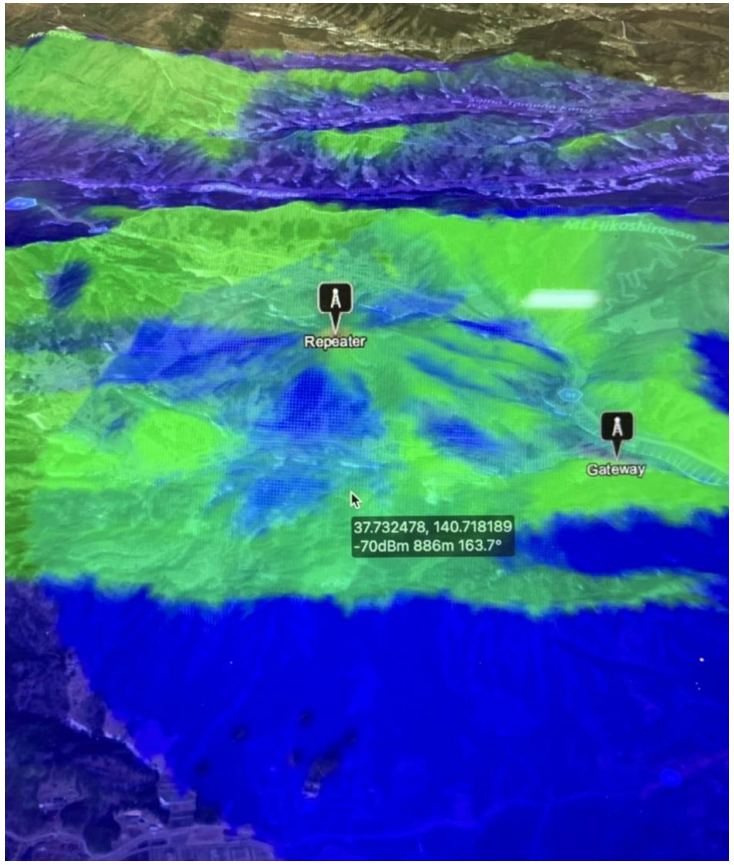
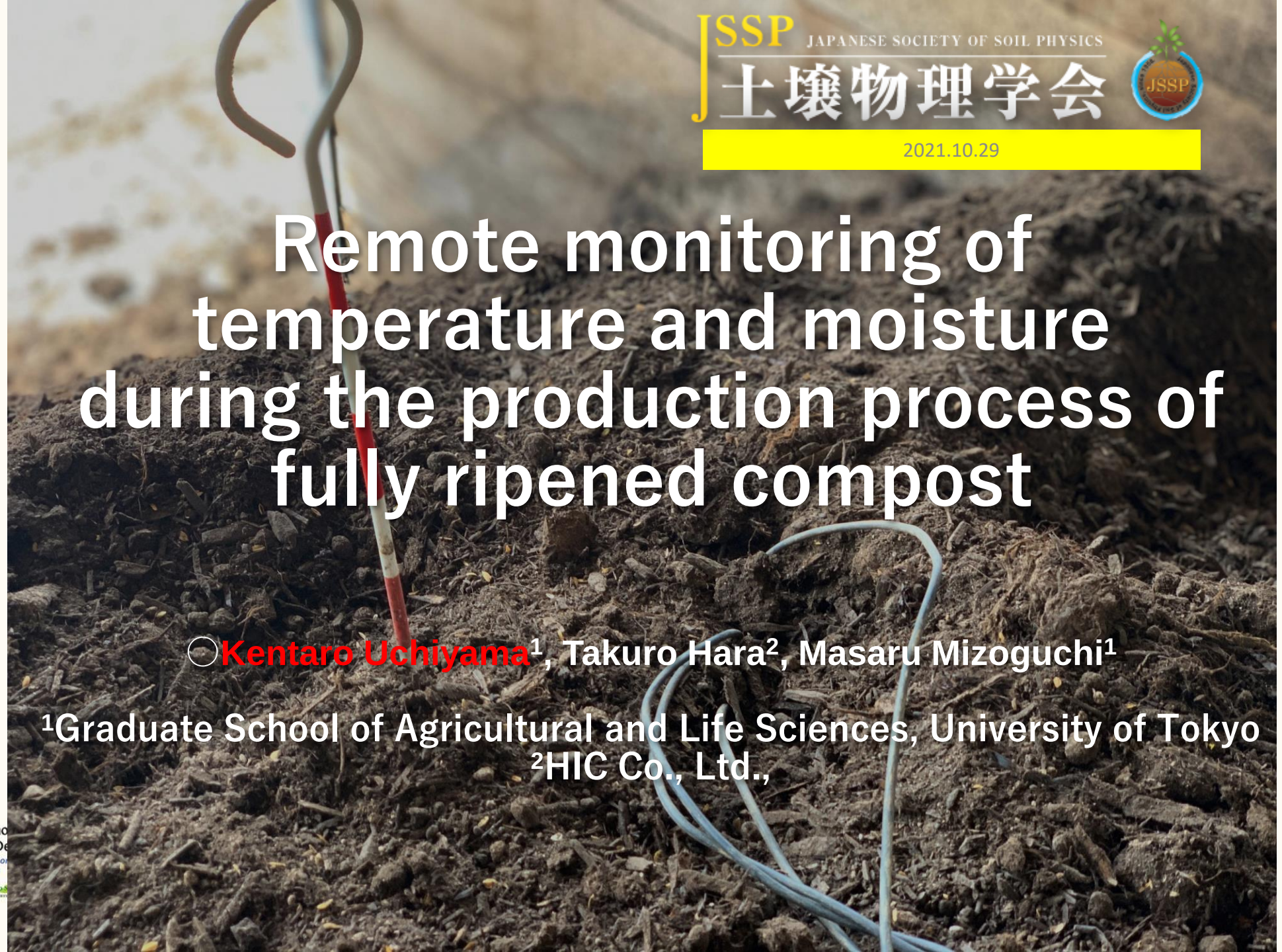
MY CHALLENGES OF RESILIENCE AGRICULTURAL SCIENCES IN FUKUSHIMA (TWO EXAMPLES)



- Composting using IoT sensors to combine the traditional composting method that has been around since the Edo era with the latest technology to restore the soil fertility lost due to decontamination
- Animal monitoring using LoRa communication technology to protect crops and fields from monkeys and wild boars



JSSP JAPANESE SOCIETY OF SOIL PHYSICS 土壌物理学会

2021.10.29

Remote monitoring of temperature and moisture during the production process of fully ripened compost

○Kentaro Uchiyama[1], Takuro Hara[2], Masaru Mizoguchi[1]

[1]Graduate School of Agricultural and Life Sciences, University of Tokyo
[2]HIC Co., Ltd.,

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Background

- The high-quality compost is needed for the soil lost fertility due to decontamination work in Fukushima
  - There are a lot of unripe composts in the market
- There is no standard for measuring the degree of maturity of "fully ripe compost“
  - Farmers produce compost by themselves based on their experience and intuition
- A method to measure and judge the degree of maturity at each production site is needed

Objectives

- To realize high-quality production of fully ripened compost without relying on experience and intuition by continuous remote monitoring using ICT/IoT

- To improve the efficiency of the production process of fully ripened compost and the quality of the final product

Experiment

- Site
  - Usushi Sugeta, Iitate Village,, Fukushima Prefecture
- Period:
  - November 2020 - August 2021
- Facilities: Compost cabin
  - 4m x 4m x 2m, approx. 30 m^3 x 4 units

Compost cabin

Air diffusers

Composting materials (27㎥)

① cow manure 3㎥

② poultry manure 4㎥

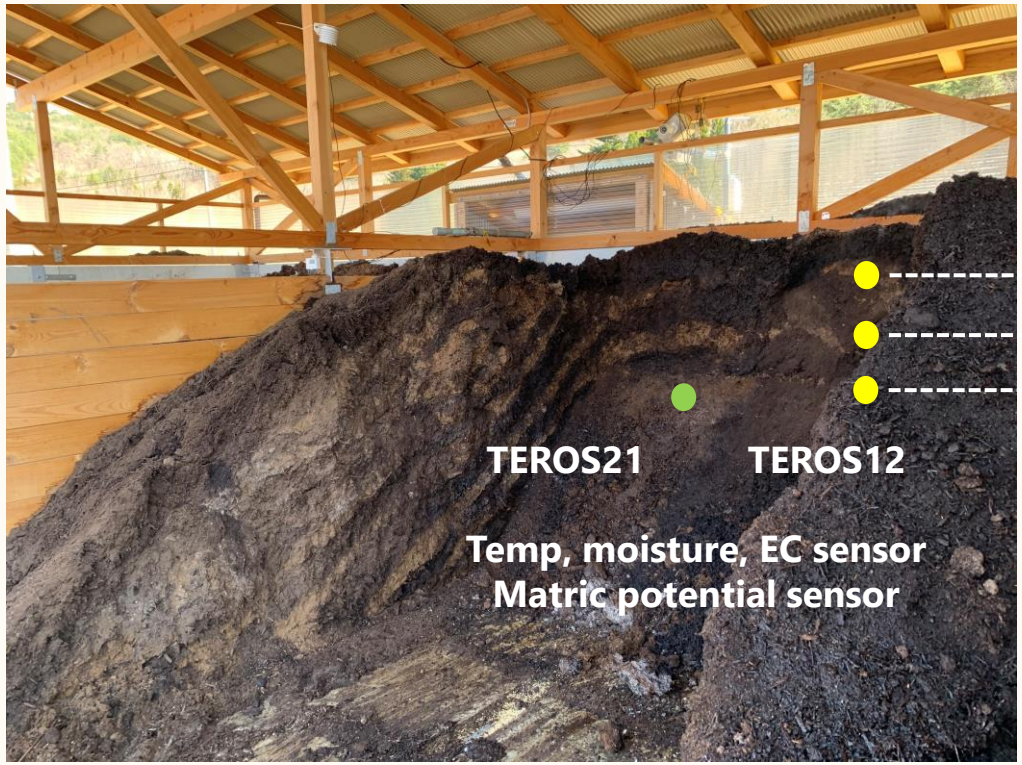
③ Mix compost 20㎥

cow 10%： poultry 15%： bark 65%： Microbiological materials 10%

Mixing of materials

Just after mixing

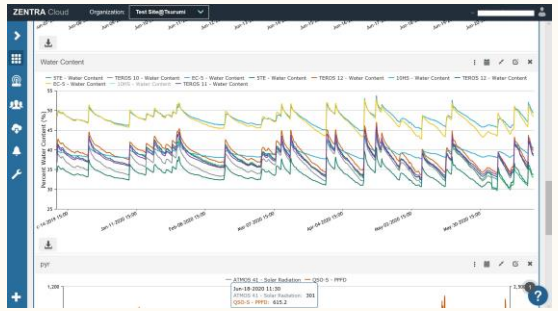
ICT/IoT monitoring Unit



Depth of sensors (20, 40, 60 cm from the top)

Data logger (METER)
ZL6/Em50

Interval=15 min



ZENTRA Cloud

TEROS21
(METER)

TEROS12
(METER)

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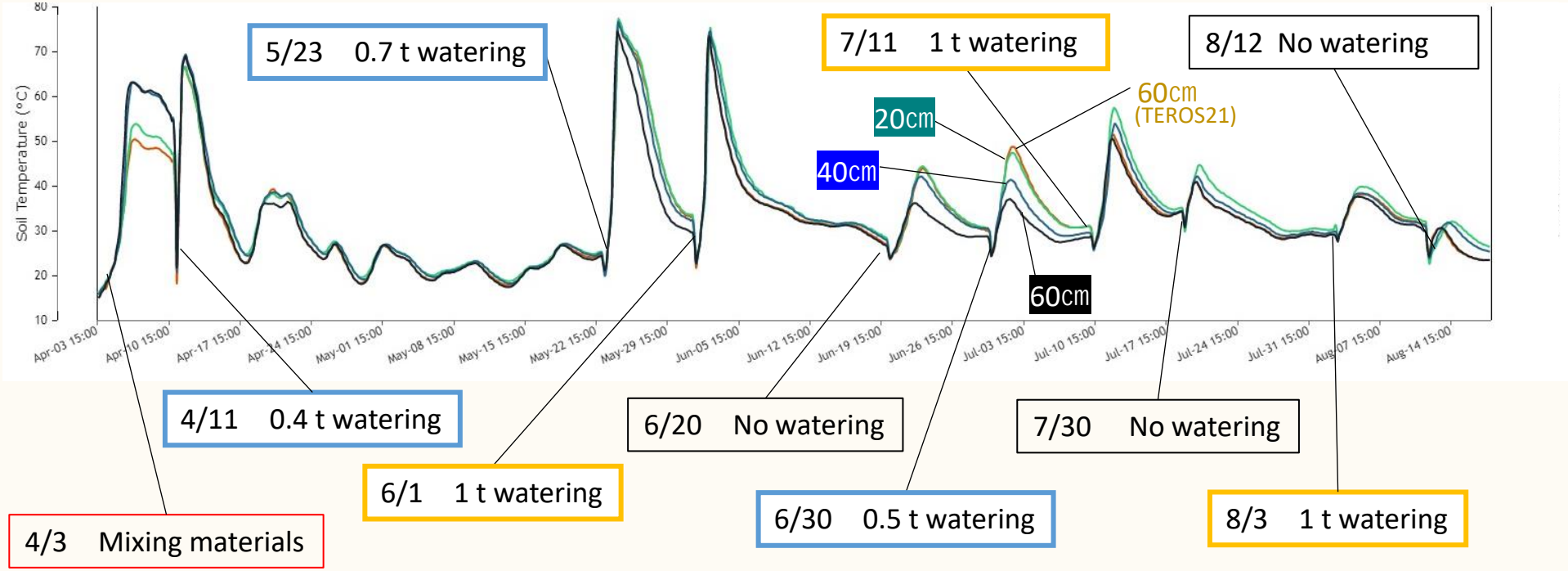
Result-1: Compost temperature

Total compost=30㎥



1. Watering at the time of turnover may be effective in the late stage of production

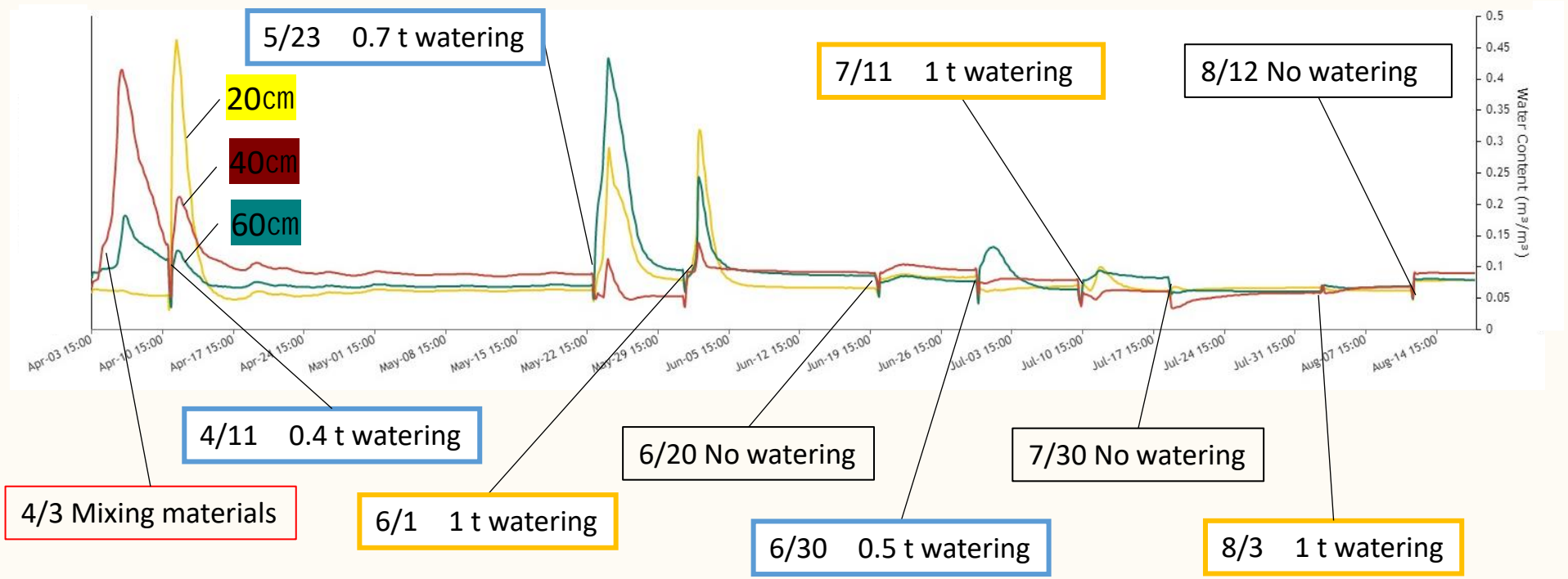
2. Watering at the time of temperature decrease may be effective

3. The temperature increase was highest at a depth of 20 cm

4. Temperature tended to increase at shallower depths after turnover

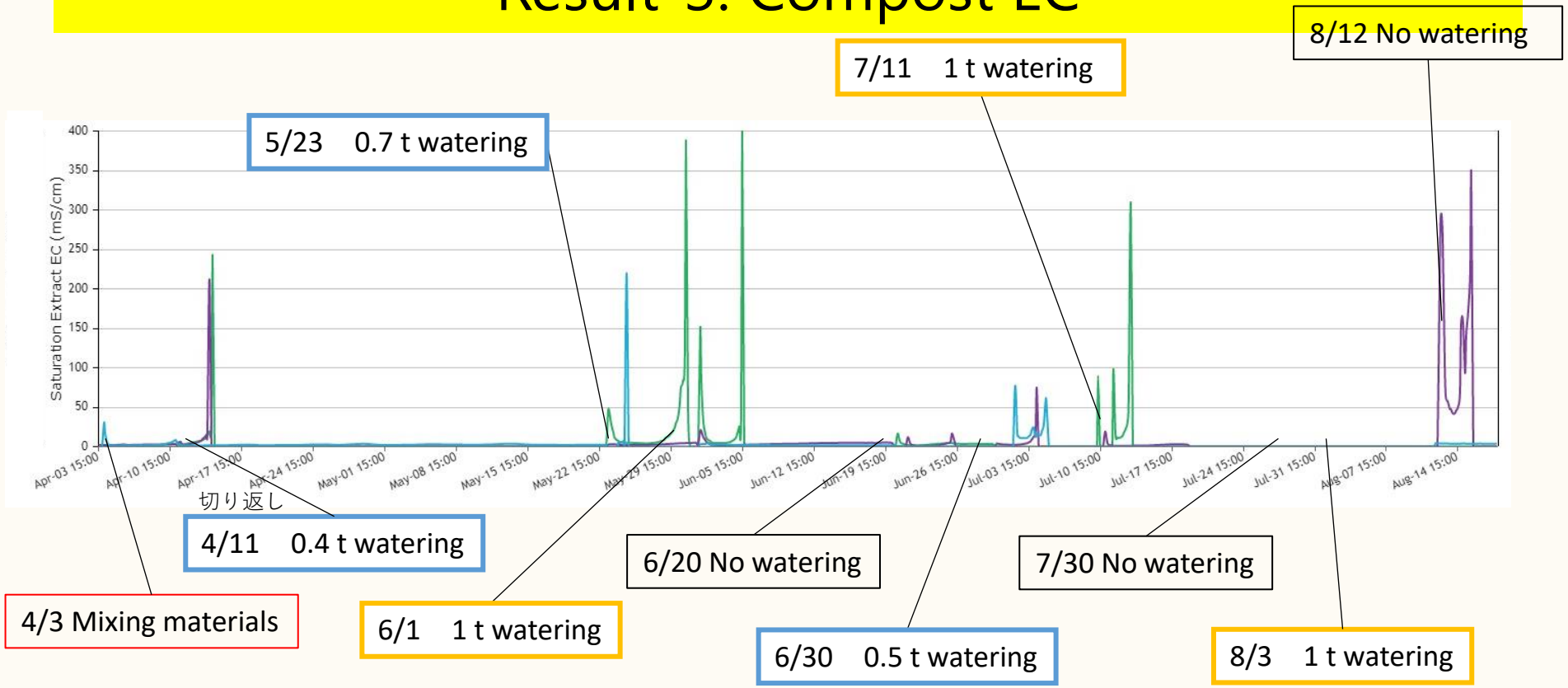
5. There were small differences among the depths (60cm, 40cm, and 20cm)

Result-2: Compost moisture content



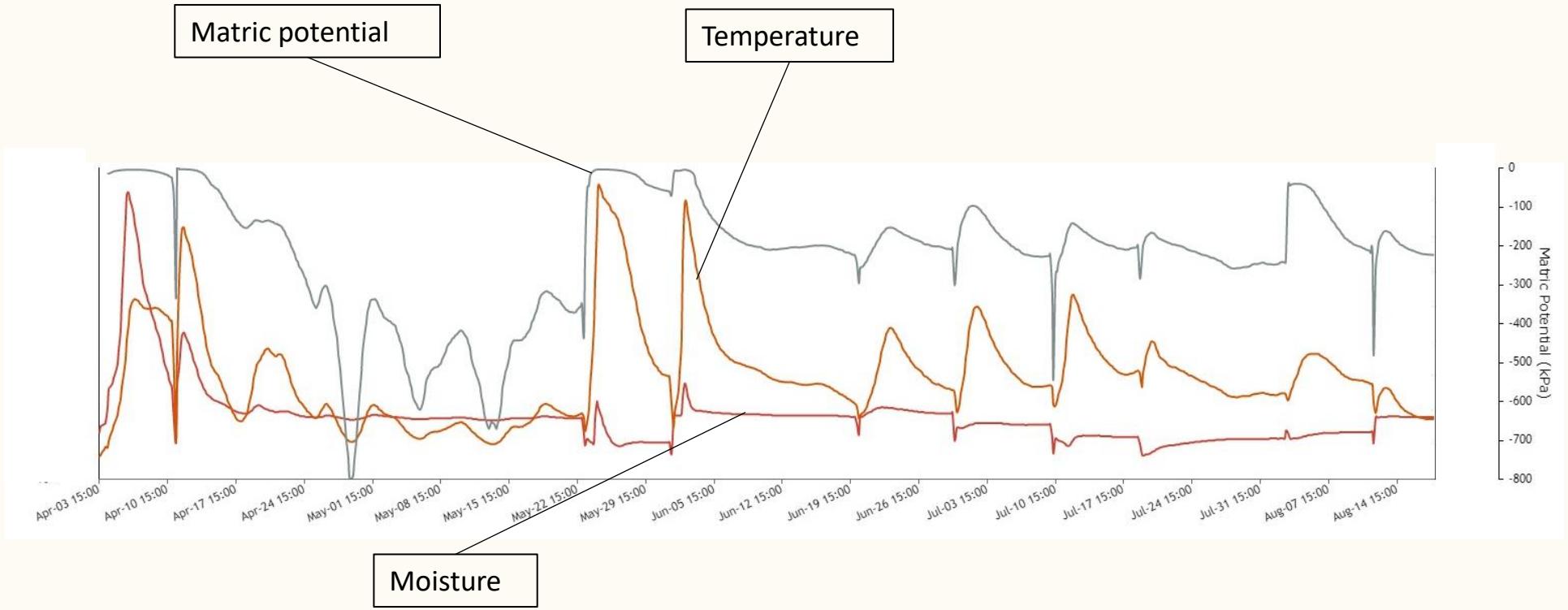
1. **After the turnover, the moisture content in the compost changed with/without watering**
2. **The moisture content in the compost varied greatly depending on the depth**
3. **There was no reproducibility in the change in moisture content with depth.**

Result-3: Compost EC



1. **No correlation was found between the change in EC and the timing of the turnaround (with or without sprinkling)**
2. **The cause of the sudden increase in EC was not found**
3. **There was no correlation between EC and water content in compost or temperature**
4. **EC monitoring might not be effective in compost production**

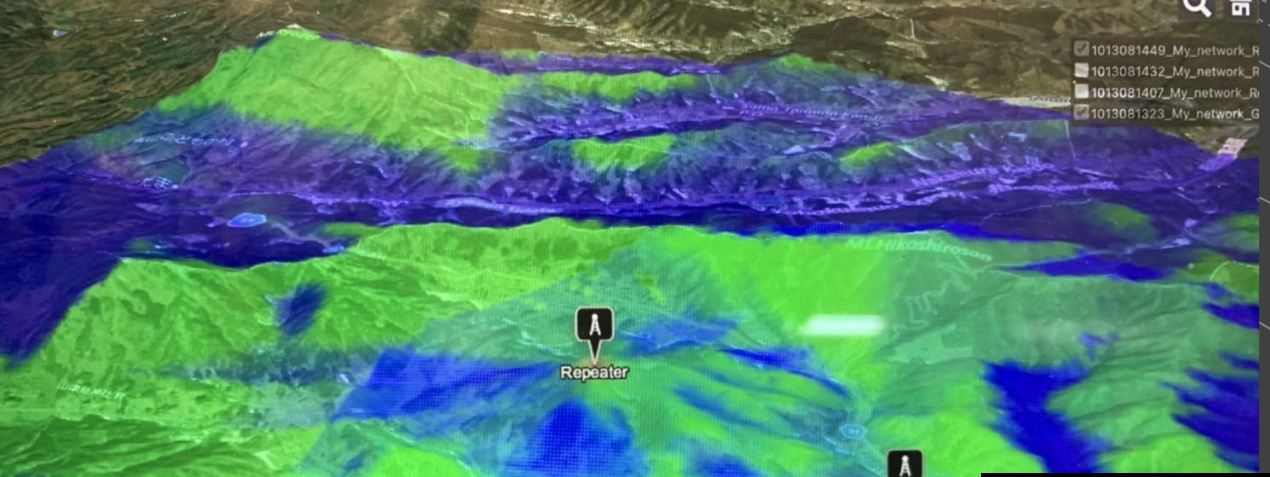
Result-4: Matric potential at the depth of 60 cm



1. **Matric potential is linked to temperature and moisture content in compost**
2. **It may be important to investigate the relationship between water movement in compost and the matric potential with depth**

Conclusion

- Temperature change of compost
  - There was a temperature change with depth
  - The temperature change due to fermentation heat is related to moisture content
- Changes in moisture content of compost
  - There was a relationship between the increase in water content and the increase in temperature by watering
- Effectiveness of ICT sensors
  - Mr. Hara of HIC Co., Ltd., an expert in this field, evaluated the effectiveness of remote monitoring using ICT sensors, suggesting the possibility of producing high-quality, fully ripened compost without relying on experience or intuition



https://www.youtube.com/watch?v=uv9StLAzcNM

MY CHALLENGES OF NEW AGRICULTURAL SCIENCES IN FUKUSHIMA

(2) I'm into Animal monitoring using LoRa communication technology to protect crops and fields from monkeys and wild boars

東京大学
THE UNIVERSITY OF TOKYO

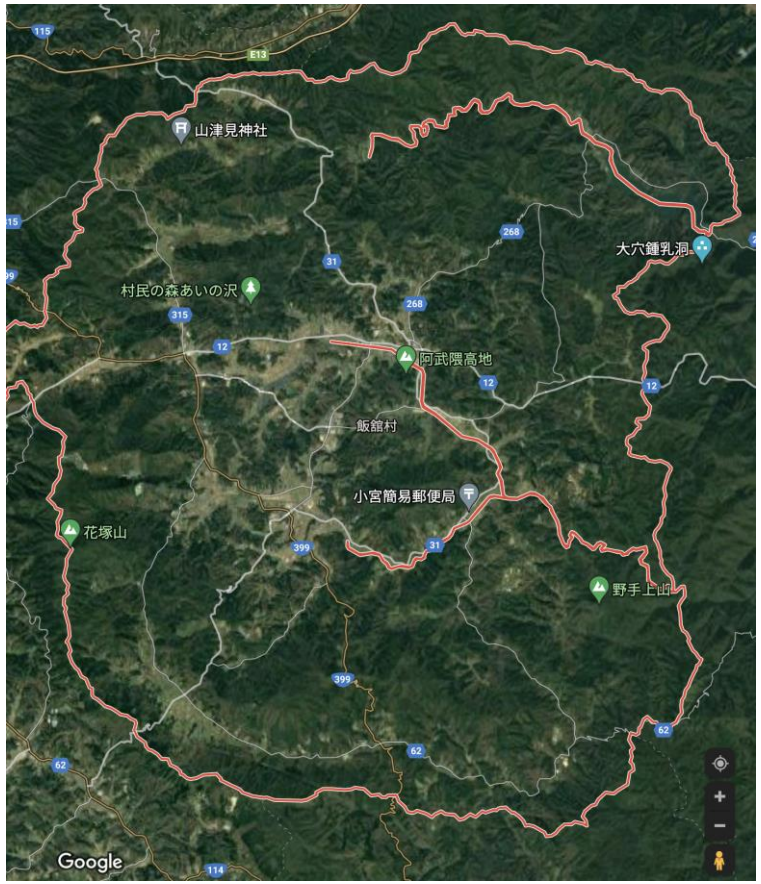
Evaluation of LoRa Radio Propagation and Optimization Method of LoRa Network Construction in Iitate Village, Fukushima

Maulana Riko Ahmad, Hiroaki Sugino, Masaru Mizoguchi

Graduate School of Agricultural and Life Sciences,

The University of Tokyo

Introduction



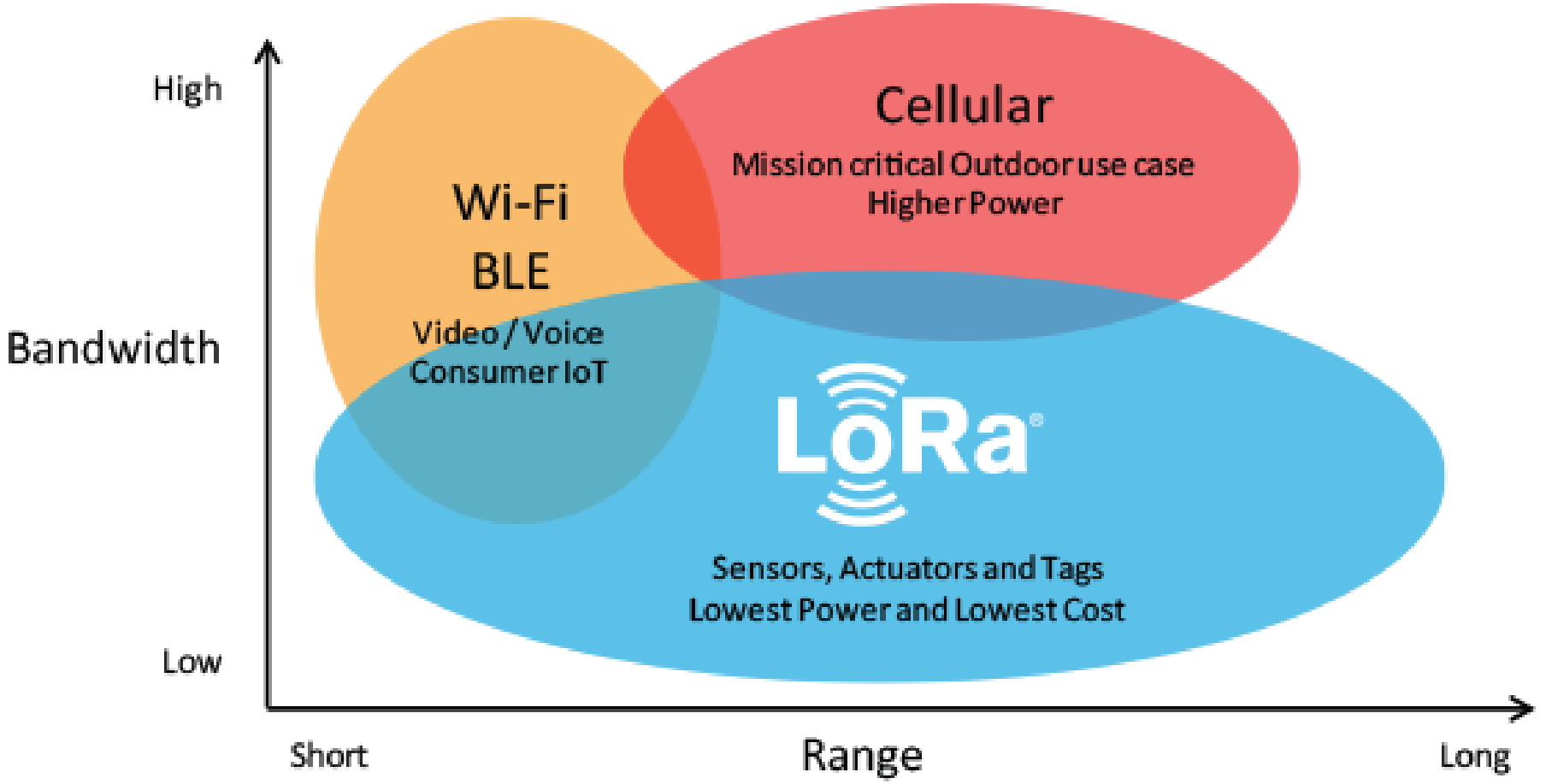
Iitate Village, Fukushima Prefecture is 75% mountain forest with villages.

The villagers, who returned to the village after the nuclear accident and are now farming here, protect their farmland with electric fences and other measures, but during the autumn harvest monkeys, wild boars and other animals are a constant threat.

In order to minimise the damage, it is necessary to track the behaviour of the animals in the forest, when and where they come from.

In this research, the temperature and humidity monitoring experiment by the IoT sensor installed in the mountain forest was done by using private LoRa among LPWA (Low Power Wide Area) which is recently paid attention as a low power consumption and wide area wireless communication system.

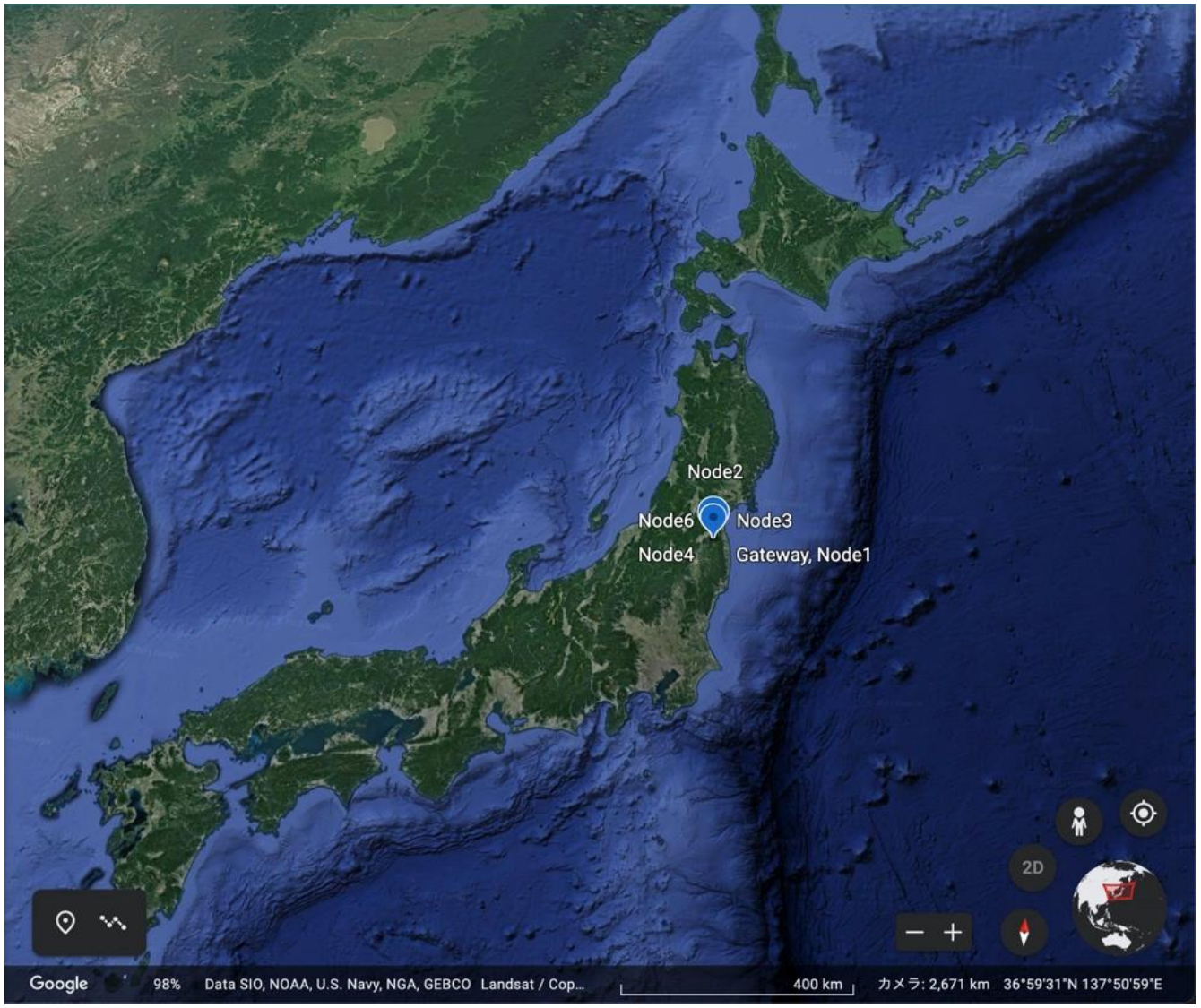
Introduction



https://www.semtech.com/lora/why-lora

Experiment Site

- Site : Sasu District,
  Iitate Village,
  Fukushima Prefecture
- Device : 12 nodes, included
  1 Gateway node
  11 Sensor nodes
- Altitude : 419m ~ 593m
- Height : 1.5m above ground
- Distance : 0~2km

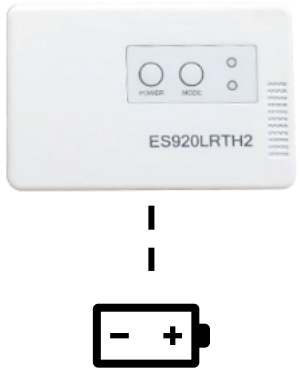


Experimental Setup

Sensor Node
(ES920LRTH2)

Gateway
(ES920GWX2)

Cloud Server
(AWS)



(Private LoRa)

Ethernet
(HTTP POST)

Monitor and download data

PC・Smartphone ・Tablet

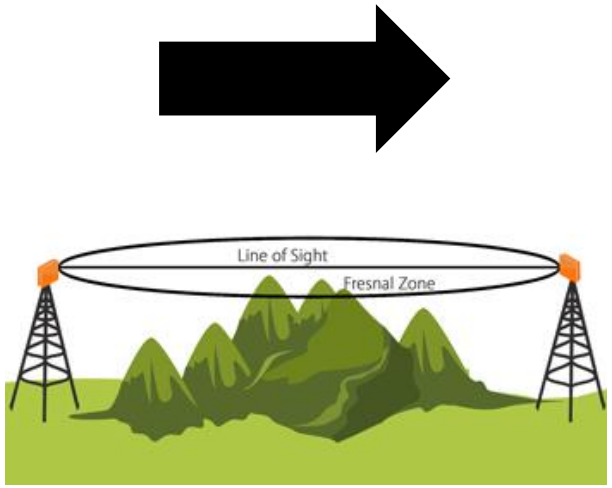
System Overview Diagram

together with EASEL, Inc

Implementation

Particularly for mountain forest area, pointing antenna upward is highly recommended (because of Fresnel zone phenomena)

Antenna pointing to mountain



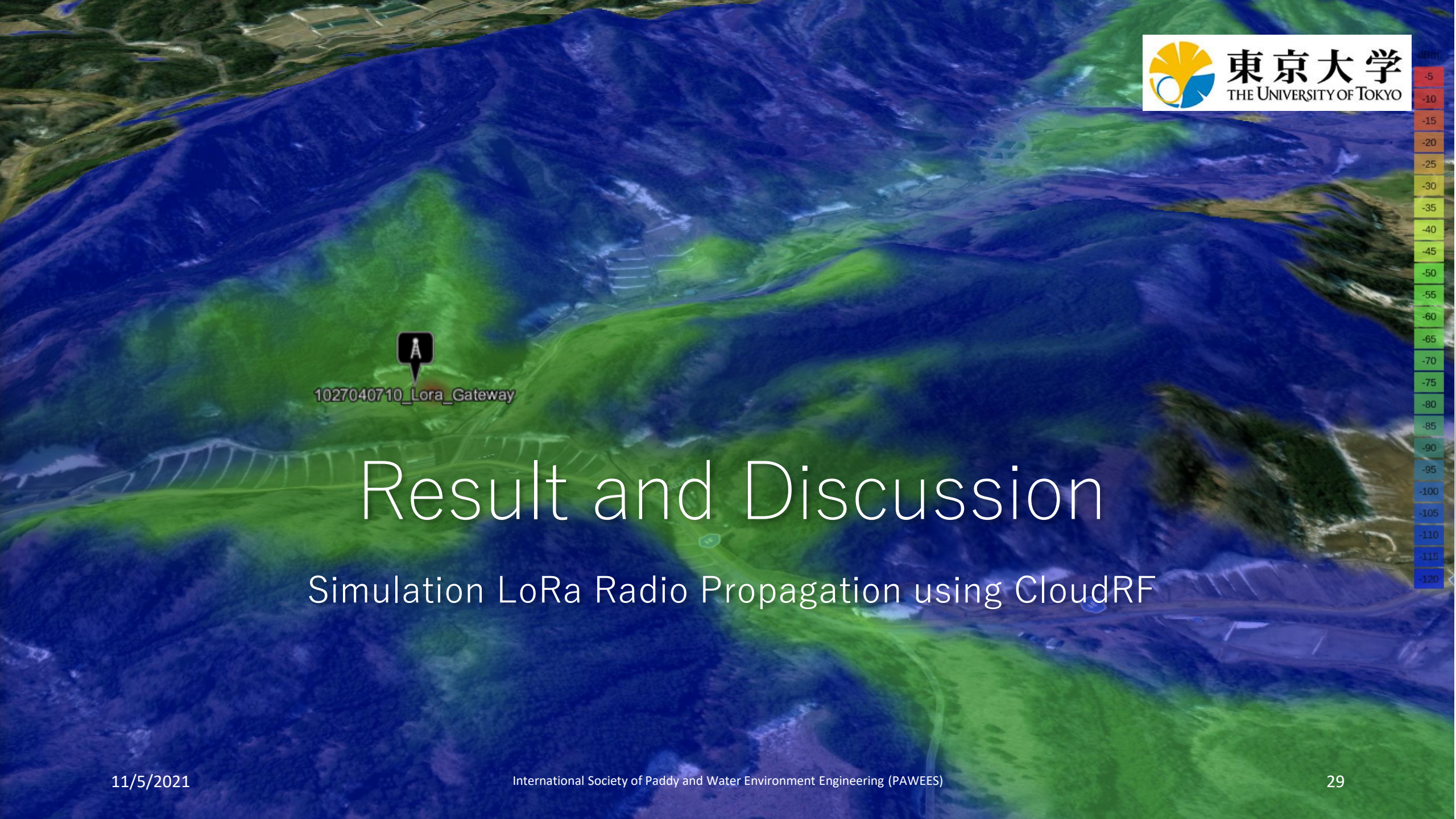
https://stage-blog.proxim.com/jp/products/knowledge-center/calculations/calculations-fresnel-clearance-zone

Antenna pointing upward

Implementation

Installment of the Gateway and Solar Panel

Installment of Sensor Node with net bag



Result and Discussion

Simulation LoRa Radio Propagation using CloudRF

Result: Data collection

- Date: 27th September ~ 27th October 2021
- Data (collected every 10 minutes): RSSI (signal strength), Humidity, Temperature, Battery condition, Date

マスタアラーム

温度

異常

湿度

異常

電池残量

正常

受信間隔

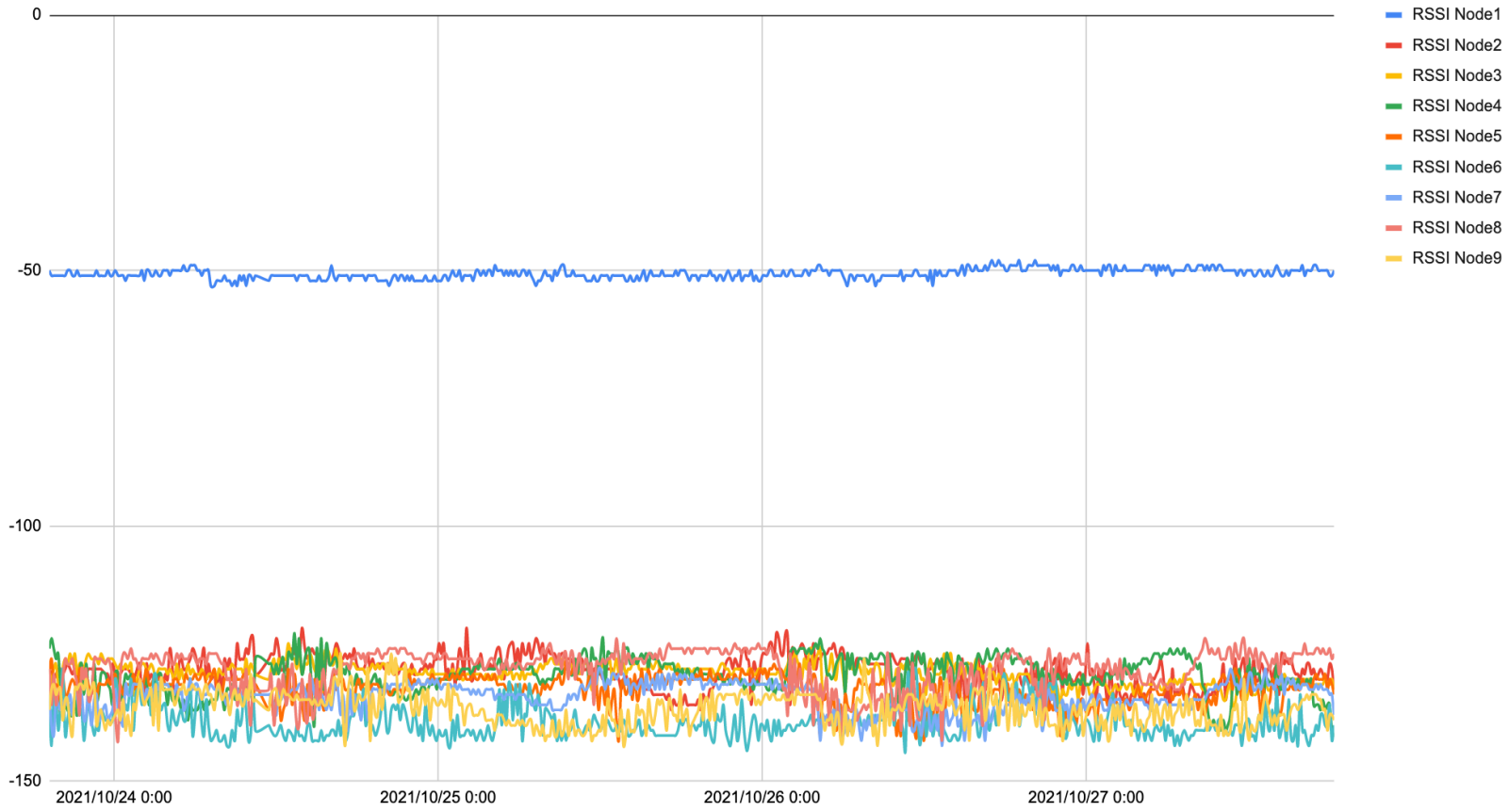
異常

モニター

名称	RSSI	温度	湿度	電池	受信時刻	しきい値	
						温度(°C)	湿度(%)
Node1	-51dBm	14.0°C	56%	2.6 V	2021-10-29 11:40:21	10.0～20.0	60～90
Node2	-127dBm	11.3°C	68%	2.7 V	2021-10-29 11:44:52	10.0～20.0	60～90
Node3	-131dBm	10.7°C	72%	2.7 V	2021-10-29 11:47:24	10.0～20.0	60～90
node4	-125dBm	11.3°C	65%	2.5 V	2021-10-29 11:42:41	10.0～20.0	60～90
Node5	-130dBm	11.8°C	67%	2.4 V	2021-10-29 11:46:45	10.0～20.0	60～90
Node6	-127dBm	10.6°C	73%	2.8 V	2021-10-29 11:40:54	10.0～20.0	60～90
Node7	-137dBm	11.2°C	68%	2.8 V	2021-10-29 11:38:53	10.0～20.0	60～90
Node8	-133dBm	10.4°C	75%	2.6 V	2021-10-29 11:37:36	10.0～20.0	60～90
Node9	-138dBm	11.2°C	62%	2.7 V	2021-10-29 11:35:46	10.0～20.0	60～90
Node10	-103dBm	20.5°C	50%	2.8 V	2021-10-24 16:23:45	10.0～20.0	60～90
Node11	-130dBm	10.8°C	75%	2.6 V	2021-10-24 16:01:14	10.0～20.0	60～90

Result: Signal strength

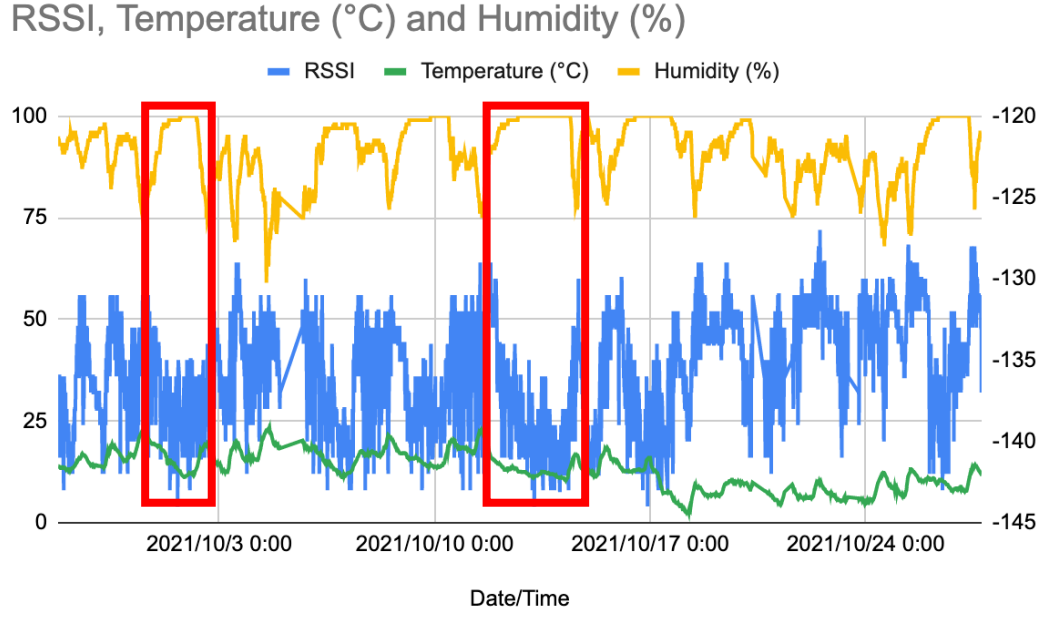
The strength of LoRa signal is not likely to be affected by distance for the mountain with a 2km radius



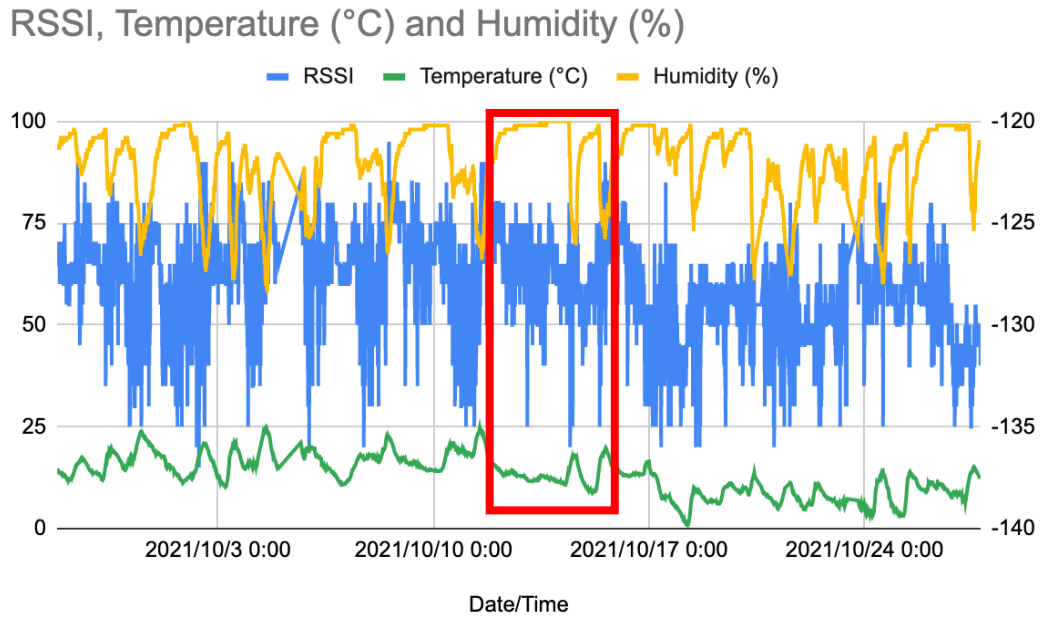
Result: Humidity vs. RSSI signal

- It was reported that humidity has no correlation with the RSSI signal in Urban area, but on this research shows that there is an effect of humidity for RSSI signal in the case of mountains.

Node2

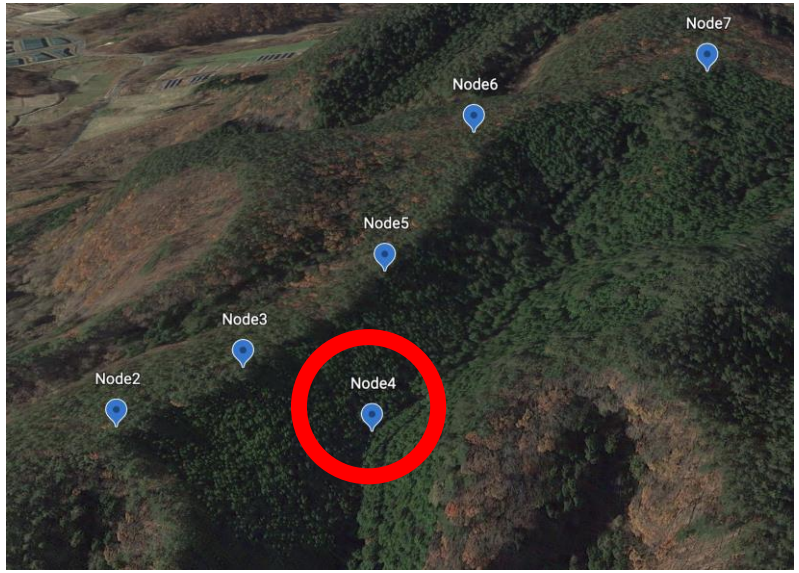


Node6

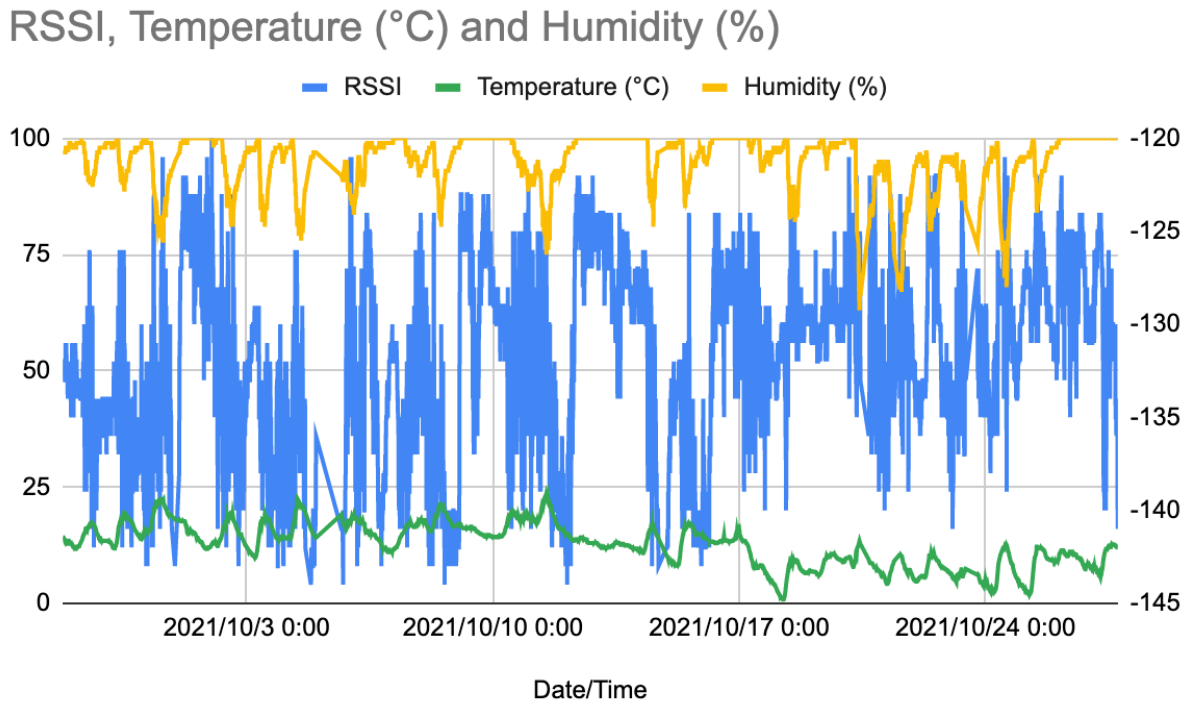


Result: River effect

- Unlike the rest, Node 4 is the most humid node and is located near a river
- The longer it stays in high humidity conditions, the signal strength become more unstable

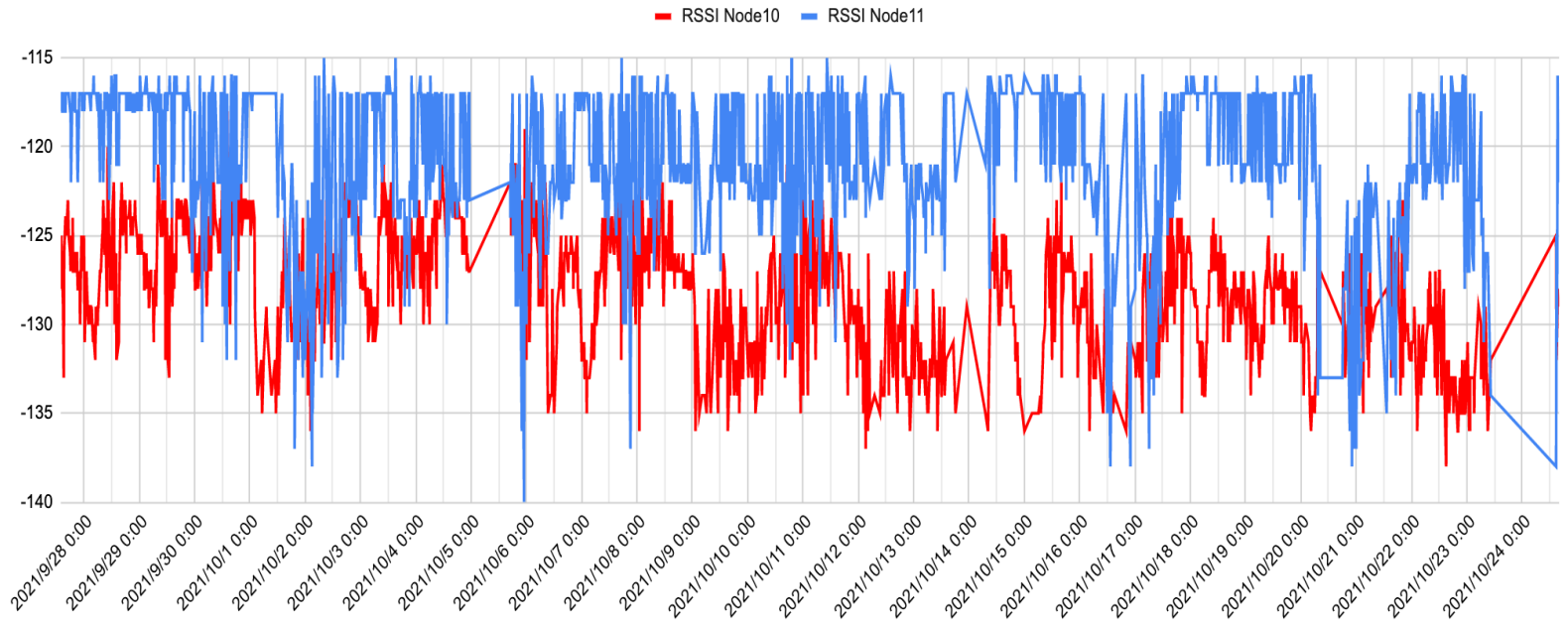


Node4



Result: Tree density vs. RSSI signal

- Assumed that Node10 and Node11 have same environment conditions beside tree density
- The lower the density of the trees, the more stable the signal strength.



Conclusion

- In this research, the experiment was conducted in the mountain forest of Sasu district, Iitate village, and it is expected that the know-how of LoRa communication in rural and mountainous areas in Japan or even **all over the world** can be provided by evaluating the radio propagation and optimizing the base station arrangement based on environmental condition such as temperature and humidity
- The strength of LoRa signal is not likely to be affected by distance for the mountain with a 2km radius
- The longer it stays in high humidity conditions, the signal strength become more unstable (sometimes data not sent completely)
- The lower the density of the trees, the more stable the signal strength

RESILIENCE AGRICULTURAL SCIENCE

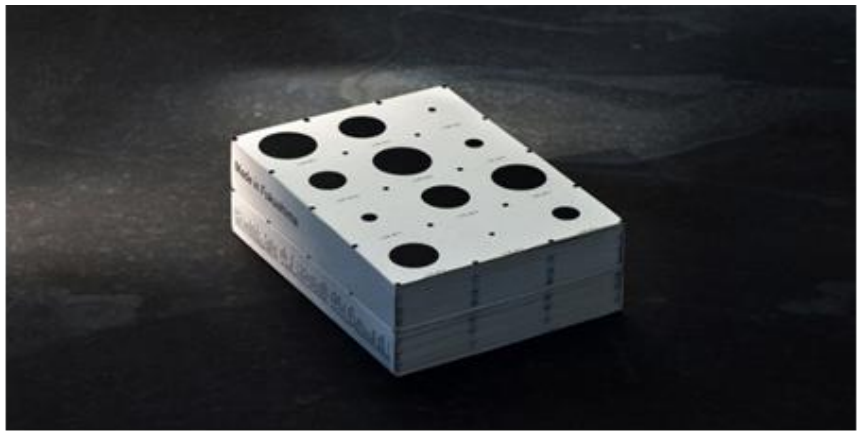
- IN RURAL AREAS
  - Are important for the places of food production and living environments.
  - There are many issues arising from various disasters including climate crisis.

- We have a CHANCE
  - to ask dedicated farmers who have a lot of traditional wisdom
  - to develop a new agricultural technology combining the wisdom and ICT/IoT.

- Let’s go to the real fields, and talk with the farmers!

CONCLUSION OF MY KEYNOTE SPEACH

- Agricultural science is the culmination of comprehensive science and technology.
- The agricultural science, which had been fragmented, is now trying to revive as a ***Resilience agricultural science*** like a phoenix from Fukushima, Japan and will expand in the world.



https://www.madeinfukushima.com/

THANK YOU!

https://www.youtube.com/watch?v=3R3jyauYGd4