SSC24-P4-24: Idea for Estimating Underground Water Levels at Peatlands in Sarobestsu, Hokkaido and Central Kalimantan, Indonesia by Using Multi-spectral Sensors for Development Small Satellite Observation System

Purpose:

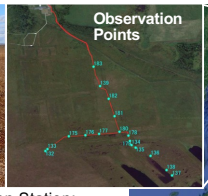
To Develop Estimation Model for Underground Water Level by Peatland Vegetation Spectral

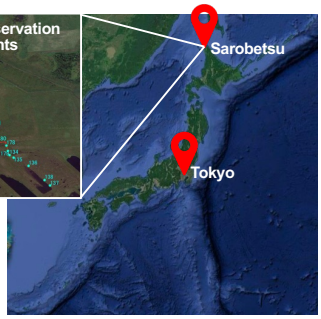
1. DEVELOPMENT: To Make Use Cases for New Multi-spectral Sensor for Drones & Small Satellites

2. GLOBAL ISSUE: CO_2 Emission by Decreasing Underground Water Levels at Peatland Due to Drainage System

3. STANDARDISATION: Peatland Can Be Maintained by Monitoring & Managing Underground Water Level Properly

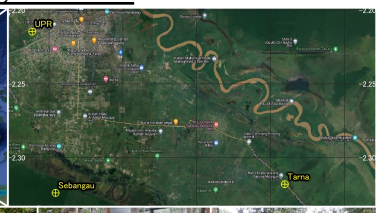
Study at Sarobetsu, Hokkaido:





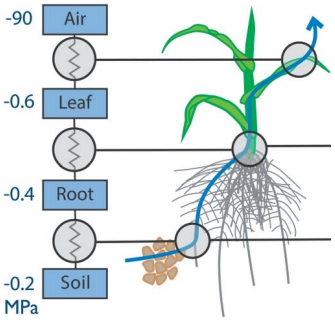
- Authors measure @ Observation Station:
  - Underground Water Level,
  - Soil Moisture,
  - Precipitation,
  - Air Temperature,
  - Humidity and
  - Photo Image of Ground every 10-minute, and Data transferred every 60-minute

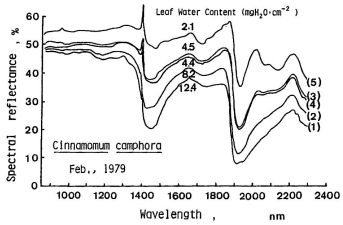
Study at Central Kalimantan, Indonesia:



Water Potentials:

- Driving Force: Differences of Water Potentials among atmosphere, leaves, roots and soil
- Water absorbed through water pressure difference: Air < Leaves < Root < Soil

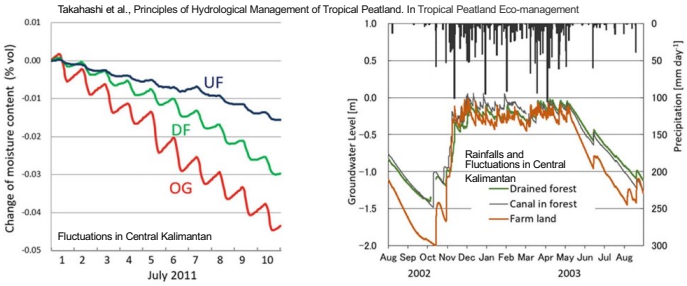




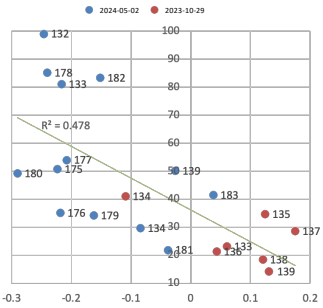
- Spectral features of leaves affected by water content.
- Reflections raised by dried conditions

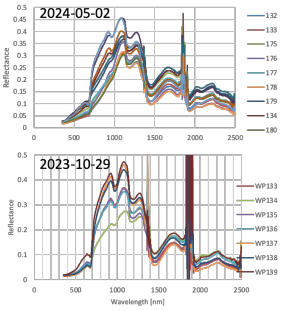
Fluctuation of Underground Water:

- Underground water levels decreased due to water cycles among transpirations and supplying water to rhizosphere
- Underground water levels recovered by rainfalls, and complicated process



Correlation between Spectral and Soil Moisture:





- Normalized Differential Water Index was applied.
- NDWI = (R885 – R1240) / (R885 + R1240)

Next Activities at Sarobetsu Summer 2024:

- Operate spectral sensor on a drone to observe Sarobetsu Area
- Procure a High-Resolution Satellite Image
- Make Vegetaion Maps

Additional Activities

- Apply interferometry and calculate ground movement
- Observe CO_2 retriever as well

Abstract: The authors' team has a five-year-project to develop multi-spectral sensors which can be loaded on small satellites and drones for the Earth observation since April 2023. Those sensors would be able to cover wavelengths between near infrared (around 1 μm) and middle wave infrared (around 5 μm). The authors main target in the project is to establish use cases. Peatland is a unique target for the multi-spectral sensors. Drainage systems have serious effects on decreasing underground water levels at the tropical peatland forests. The decreasing underground water levels leads encouraging microbial degradative activities and forest fires, and emissions of greenhouse gas (GHG) are huge impacts on climate change. Emissions of GHG could be controlled when appropriate monitoring and managing systems for underground water levels are established. Moreover, those systems could contribute Japanese companies to earn carbon credits. With those reasons, the authors work on development of estimation models for underground water levels through the observation of peatland vegetations by multi-spectral sensors. In 2023, the authors worked on 2 things: the first was researches on spectral features of vegetations on peatlands and relationships between water contents in soil and underground water levels; and the second was observation site selections. Water is raised by water potentials among atmosphere, leaves, roots and soil. Underground water levels are decreased because absorptions by vegetations and supplying water to rhizosphere soil. Also, underground water levels are recovered by rainfalls. Recovering systems by rainfalls have hysteresis, and the process is complicated although tank model was established for simulating the mechanisms of underground water level recovery. Site selections were also important activities to monitor seasonal changes of vegetations and underground water levels. The authors set 6 steps for the site selection: security at the sites; accessibility to the sites; vegetations which have correlations with underground water levels; stable weather conditions; cooperation with local institutions; and field survey. Sarobetsu and Central Kalimantan, Indonesia were selected. Sarobetsu is located at Hokkaido, and it is designated as the National Park. Unique sphagnum covers the peatland at Sarobetsu, and it is expected to be an indicator for estimation of underground water levels. Central Kalimantan is located at the tropical rainforest region, and deep peat layers are known to cover the lands. Authors installed the equipment and began to observe the underground water levels, water contents in soils, and vegetation layers at Sarobetsu in August 2023. Same equipment would be installed at three locations in Central Kalimantan in March 2024. The authors spent for the research on the peatland environment and the preparation for the observation in 2023. Those activities which could clarify the environment of the peatlands were necessary for developing the algorithms to estimate underground water levels by multi-spectral observation on peatland vegetations. The multi-spectral sensors are now under the developments, and the authors would use existing spaceborne and drone multi-spectral sensors for clarifying the correlations between vegetations and underground water levels as the next steps.

Reference: AOKI, M.; YABUKI, K.; TOTSUKA, T. Effective Spectral Characteristics of Leaf for the Remote Sensing of Leaf Water Content. J. Agr. Met. 44 (2): 111-117, 1988

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