ASEAN IVO Forum 2021
18 November 2021

ML-PEAT: Machine Learning for Data Analysis of Peat Swamp Forest Monitoring System

Research team:
Prof. Dr. Imas Sukaesih Sitanggang, Faculty Natural Science and Mathematics, IPB University
Prof. Dr. Ir. Lailan Syaufina, M.Sc, Faculty Forestry and Environment, IPB University
Prof. Ir. Dr. Aduwati Sali, Faculty of Engineering, Universiti Putra Malaysia
Asst Prof Dr. Wida Susanty Haji Suhaili, School of Computing and Informatics, Universiti Teknologi Brunei
Dr. Albert Sulaiman M.Si, Indonesian Institute of Sciences
and team

Background

Source : https://www.bbc.com/news/world-asia-34265922

Source : https://edition.cnn.com/2015/01/27/asia/asia-air-pollution-haze/index.html

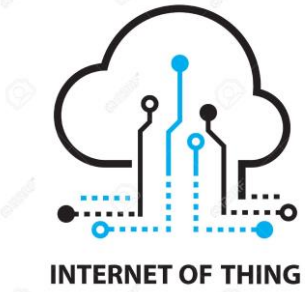
The total area of peatlands in Southeast Asia is estimated to be about 25 million ha, (60% of the world's tropical peatlands). Over 70% of total peatland area in Southeast Asia occurs in Indonesia (Source: ASEAN Peatland Management Strategy 2006-2020).

Forest and land fires are the annual environmental disaster as a regional issue among ASEAN member states

Smoke and haze produced by forest and land fires has raised the transboundary issue among ASEAN member states especially Indonesia, Malaysia, Singapore and Brunei

Forest and land fires prevention is the key in fire management to minimize the negative impacts of fires

Background



IoT Technology

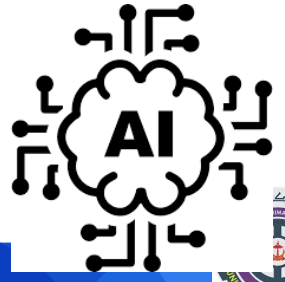
Mobile and web-based application

Reduce carbon emission and greenhouse effect

Real time monitoring of the environment in fire prone areas, especially in peatland

Early warning system of peatland fires

To minimize the negative impacts of peatland fires

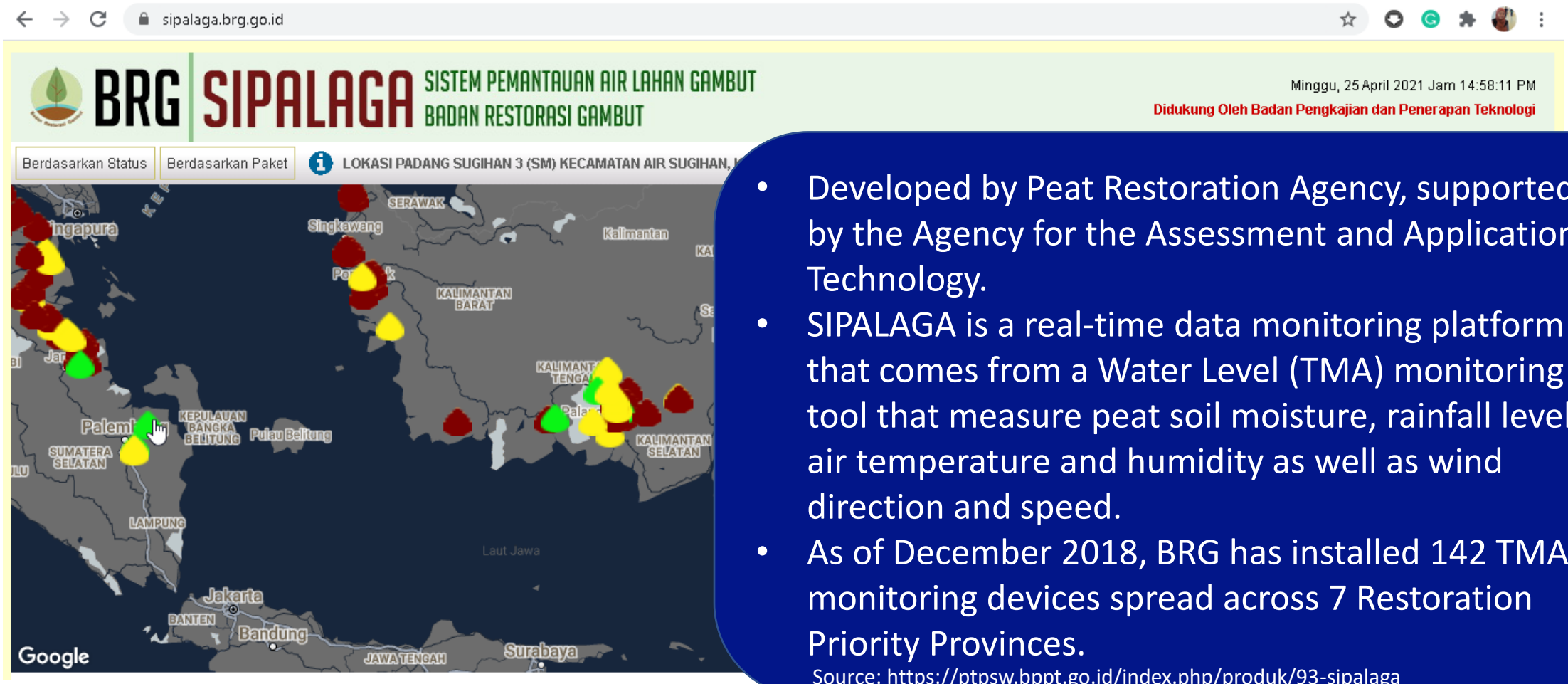


IPB University
Bogor Indonesia

IoT implementation in Indonesia, Malaysia dan Brunei Darussalam

- The previous collaboration research project entitled **NAPC: Networked ASEAN Peat Swamp Forest Communities** funded by ICT Virtual Organization of ASEAN Institutes and NICT (ASEAN IVO) has successfully implemented the ICT technology in monitoring peat swamp forest in **Indonesia**, **Malaysia** dan **Brunei Darussalam**.
- The Internet of Things (IoT)-based solution is proposed for real time monitoring peat swamp forest by recording some environment parameters such as **water level**, **temperature** and **humidity**.
- Those parameters have a high contribution to fuel conditions. For example, high water level of peat soil indicates low vulnerability to forest and land fires due to high moisture content of the ground fuels.

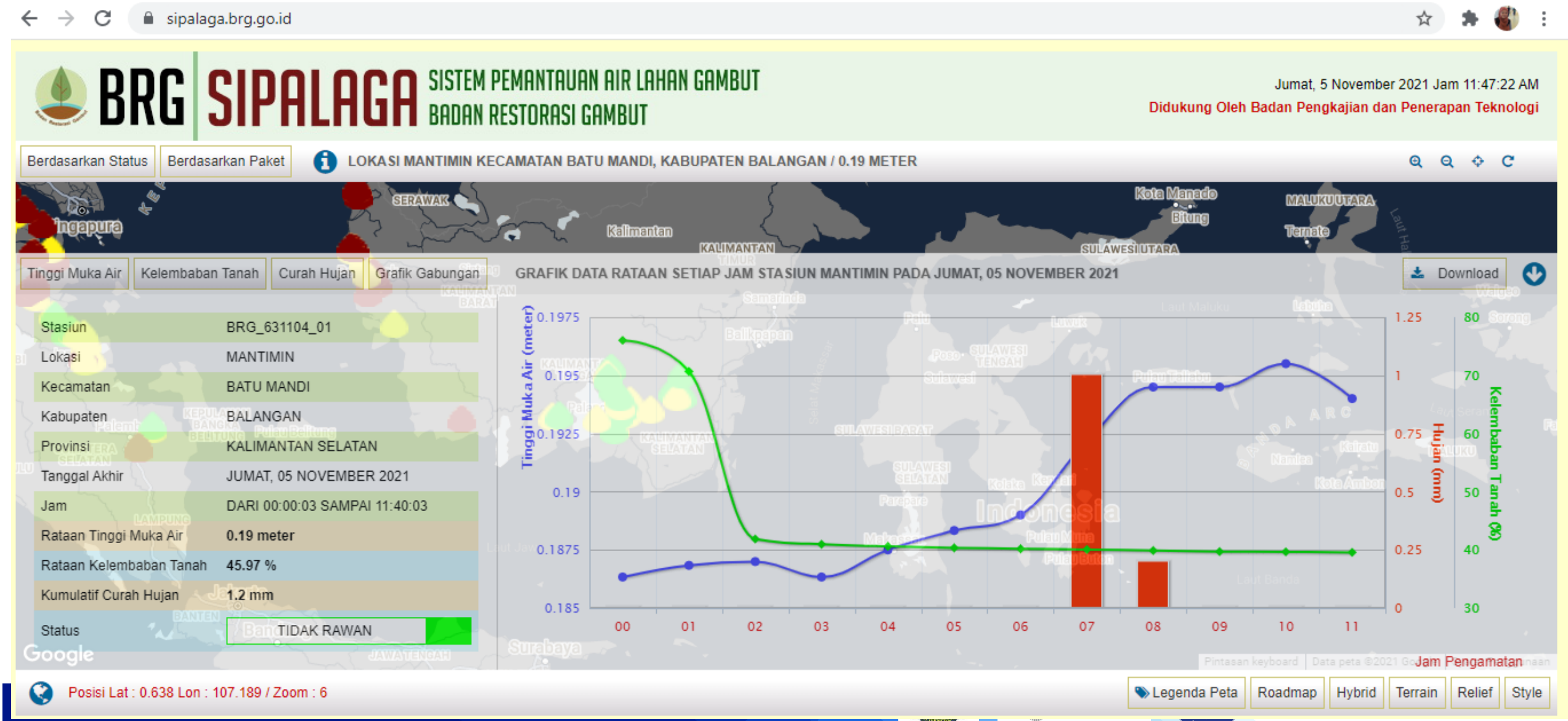
Peatland Realtime Monitoring System in Indonesia SIPALAGA- https://sipalaga.brg.go.id/



- Developed by Peat Restoration Agency, supported by the Agency for the Assessment and Application of Technology.
- SIPALAGA is a real-time data monitoring platform that comes from a Water Level (TMA) monitoring tool that measure peat soil moisture, rainfall levels, air temperature and humidity as well as wind direction and speed.
- As of December 2018, BRG has installed 142 TMA monitoring devices spread across 7 Restoration Priority Provinces.

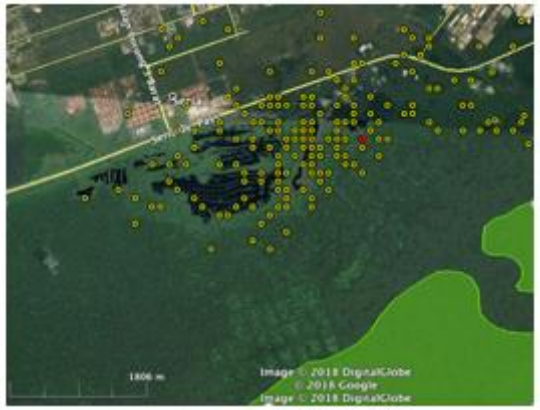
Source: https://ptpsw.bppt.go.id/index.php/produk/93-sipalaga

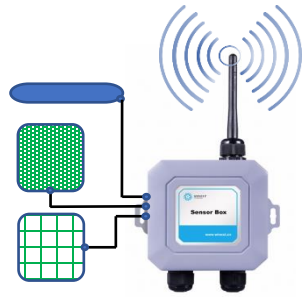
SIPALAGA- https://sipalaga.brg.go.id/



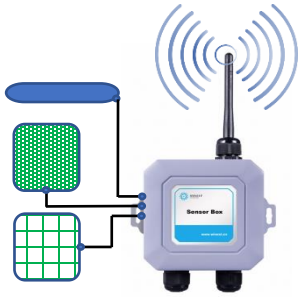
IoT implementation in Brunei

Study area: Badas Peatland

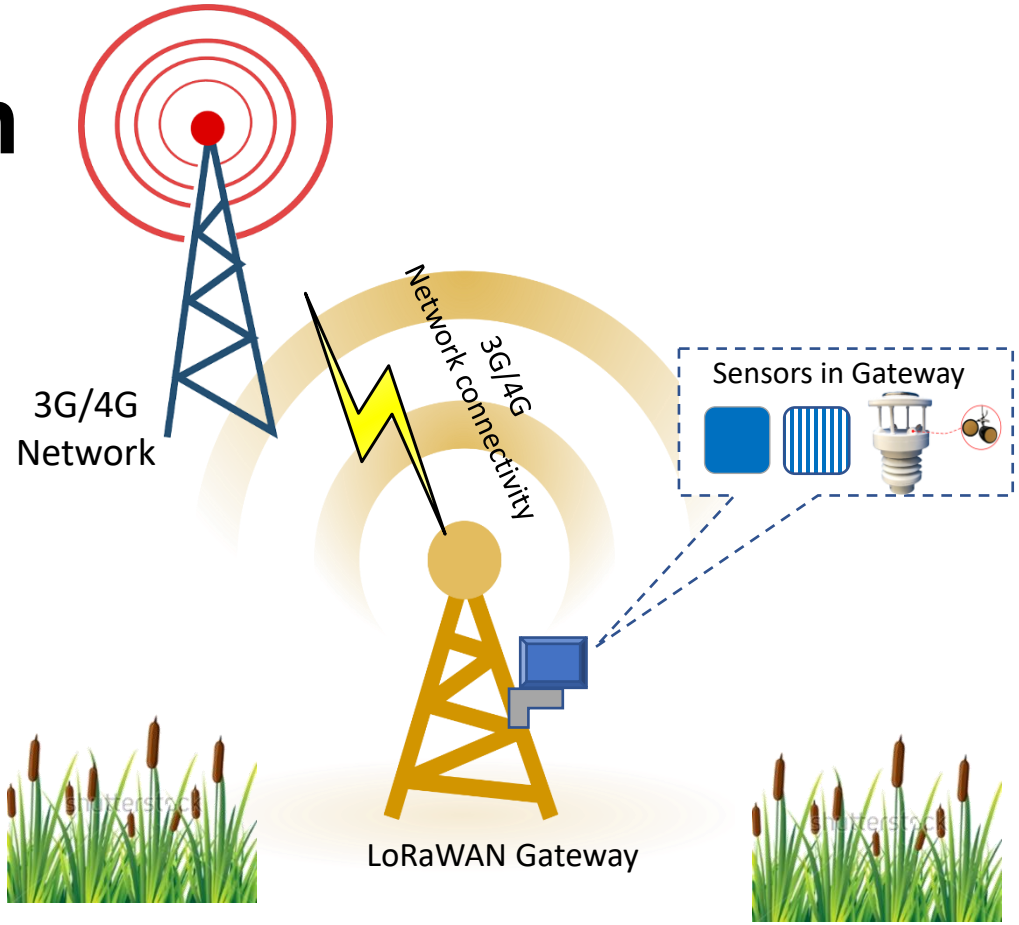


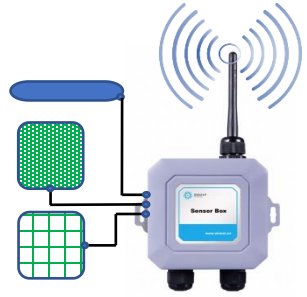


RSC 1

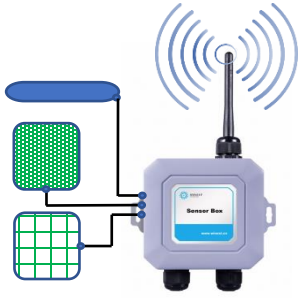


RSC 2





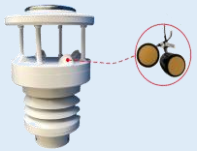
RSC 3



RSC 4

Sensors deployed in LoRaWAN Gateway

- 9370-P [Temperature, Humidity and Pressure Probe]
- 9325-P [Luminosity (luxes accuracy) Probe]



WS-3000 [(anemometer + wind vane + pluviometer) probe]

Deployment in Remote Sensing Clusters (RSCs)

Sensors and data logger

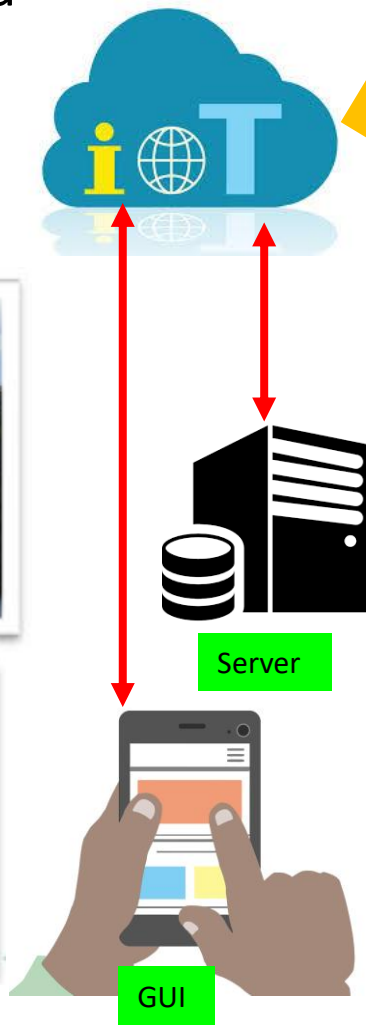
- 0091940 [In-Situ Rugged TROLL 200]
- 9255-P [Soil/Water temperature (Pt-1000) Probe]
- 9323-P [Soil moisture 8 m Probe 90,00 4 360,00]

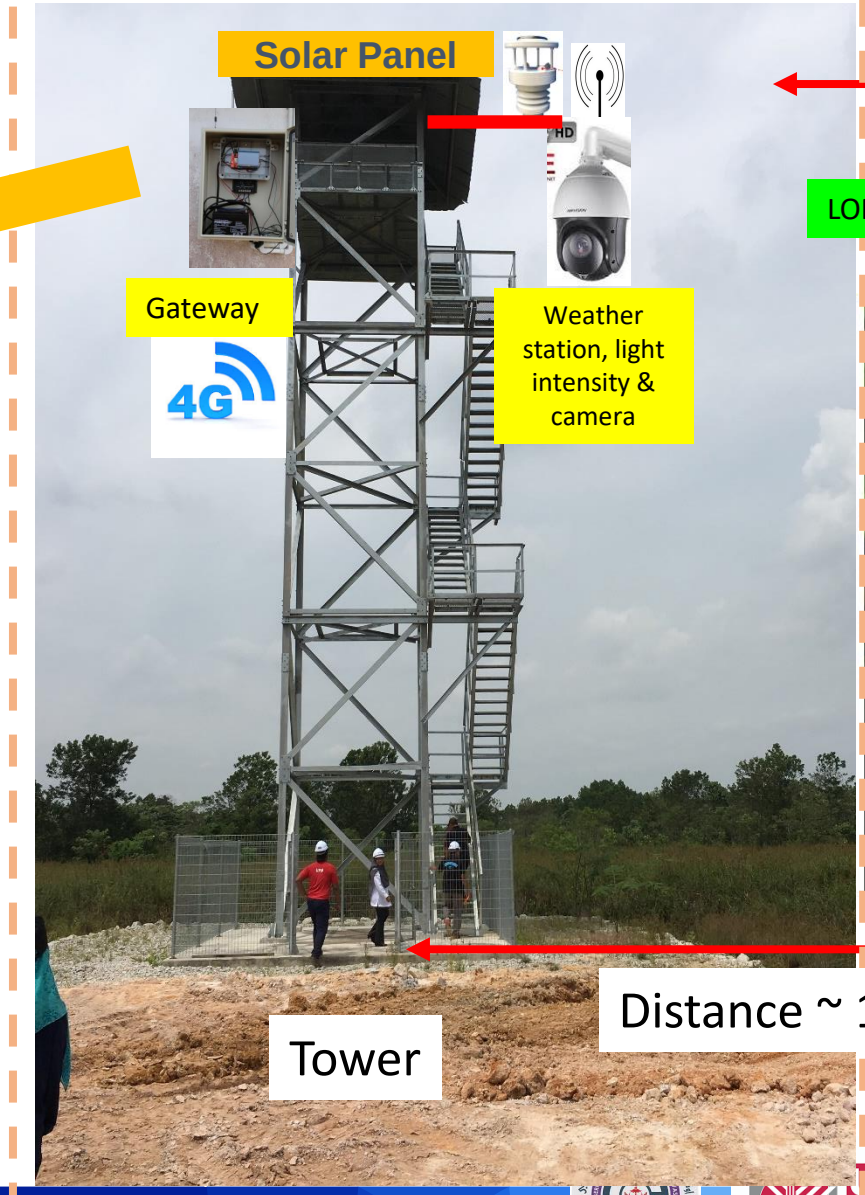
LoRaWAN components

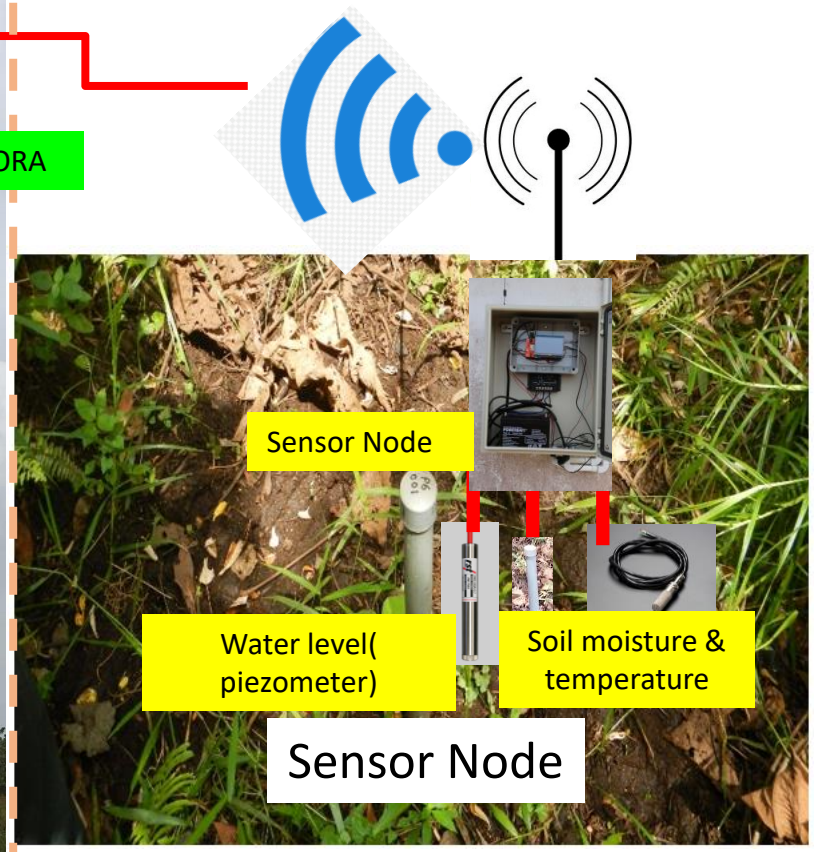
LoRaWAN Device

IoT implementation in Malaysia

Study area: Raja Musa Forest Reserve, Selangor







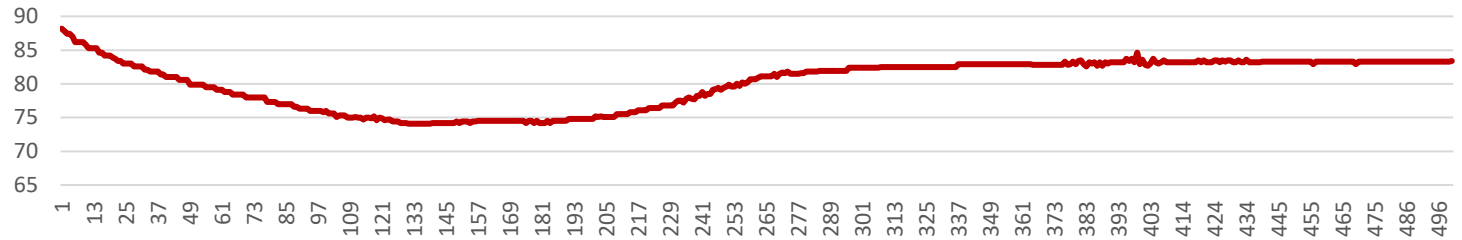
Distance ~ 150m to 1km

Plot of peatland data

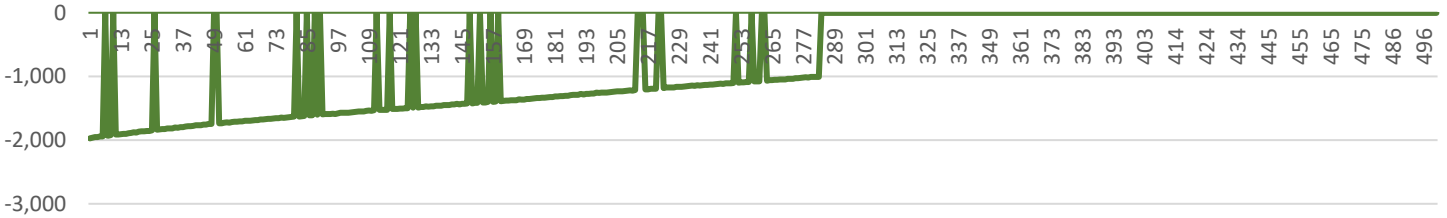
Data from SIPALAGA Indonesia

Precipitation

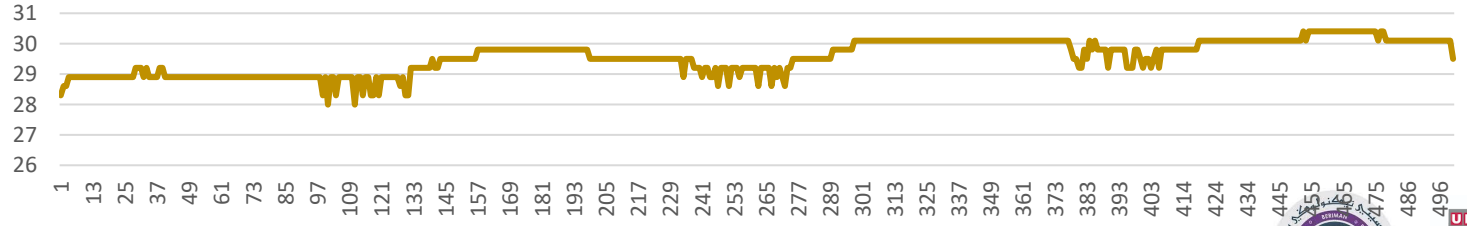
soil_moisture



gwl



temp



Data from IoT System Malaysia

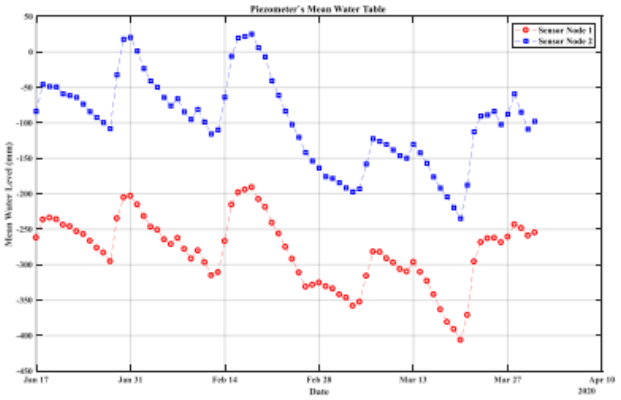
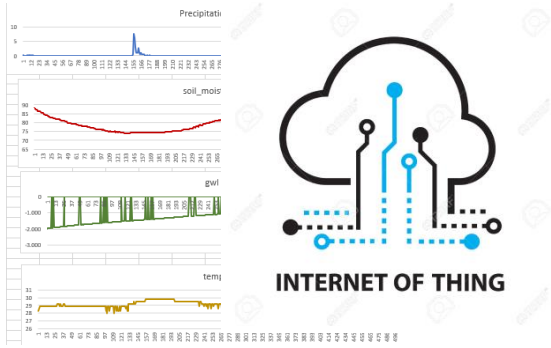


Fig. 4. Mean water table recorded from January to April 2020

Data quality?

Missing value, noise, outlier, inconsistent data?

Research agenda



Data analysis and data preprocessing

Machine Leaning

Natural and socio-economic factors

Real time data collected by IoT technology

Data management and data quality

Time series prediction model

Forest and land fires vulnerability

Peat swamp forest monitoring

Objectives

1. To analyze the quality of data recorded by the IoT system on peat swamp forest
2. To develop a pre-processing system to improve the quality of time series peat swamp forest data
3. To develop a time series prediction model of water level in peat swamp forest using the machine learning approach namely deep learning
4. To formulate forest and land fires vulnerability index as an early warning system based on the water level prediction in peat swamp forest

Expected Outputs

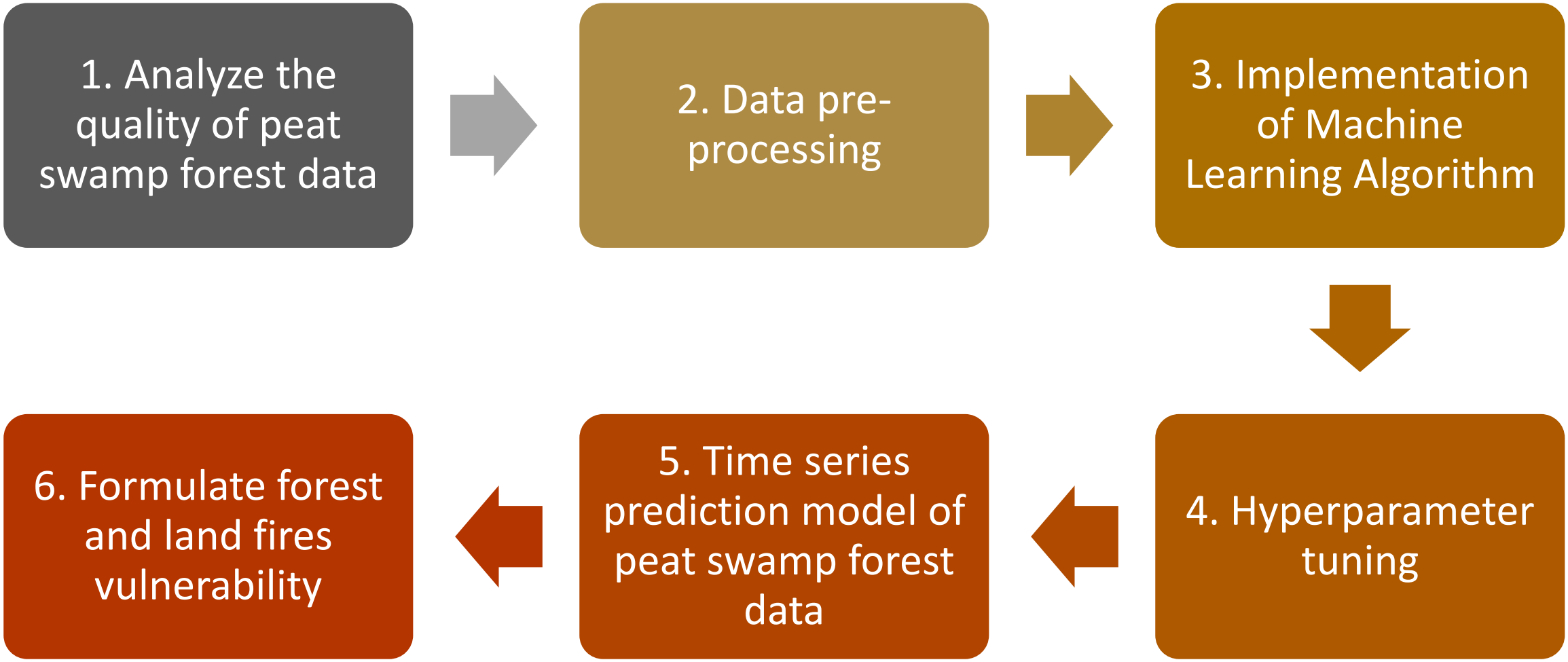
Main outputs:

1. A computer-based application for time series data pre-processing, case study: peat swamp forest data
2. A time series prediction model of water level in peat swamp forest
3. Spatial prediction of early warning system of peat swam forest fires
4. Forest and land fires vulnerability index based on water level in peat swamp forest

Additional outputs:

1. International publications in reputable journals and conferences
2. Student exchange among the collaborative research teams
3. Final project of postgraduate students
4. Workshops for respective stakeholders for awareness of the developed system

Method


1. Analyze the quality of peat swamp forest data
2. Data pre-processing
3. Implementation of Machine Learning Algorithm
4. Hyperparameter tuning
5. Time series prediction model of peat swamp forest data
6. Formulate forest and land fires vulnerability

Schedule (two years)

Phase	Month (year 1 and year 2)			
	1-6	7-12	13-18	19-24
ML-PEAT Workshop #1 ● Project interim meeting ● Project management ● Project plan presentation (by each country)	V			
Peat swamp forest data analysis	V			
Develop the data pre-processing system	V	V		
ML-PEAT Workshop #2 ● Project progress meeting ● Workshop with Stakeholders		V		
Develop time series prediction models of peat swamp forest data		V	V	
Research Exchange (student of staff)			V	
Publication #1			V	
ML-PEAT Workshop #3 ● Project progress meeting ● Workshop with Stakeholders			V	
Formulate the forest and land fires vulnerability based on the peat swamp forest data			V	V
ML-PEAT Workshop #4 ● Project final meeting ● Workshop with Stakeholders				V
Publication #2				V

Contributions

Innovation: introducing the innovative solutions in developing the time series prediction models of peat swamp forest data as an early warning of peat fires.

Capacity Building: enhancing expertise of students and staff by working together with local stakeholders such as the local communities and related governmental agencies to conduct the research project.

Collaboration and Partnership: establishing strategic cooperation among research team members from each country and related stakeholders to get feedback and improvement of the research projects.

Research team

1. Prof. Dr. Imas Sukaesih Sitanggang, Faculty Natural Science and Mathematics, IPB University
2. Prof. Dr. Ir. Lailan Syaufina, M.Sc, Faculty Forestry and Environment, IPB University
3. Dr. Albert Sulaiman M.Si, LIPI
4. Dr. Hari Agung Adrianto, Faculty Natural Science and Mathematics, IPB University
5. Muhammad Asyhar Agmalaro, M.Kom, Faculty Natural Science and Mathematics, IPB University

1. Prof. Ir. Dr. Aduwati Sali, Faculty of Engineering, UPM
2. Azizi Mohd Ali, WiPNET, UPM
3. Dr Sheriza Mohd Razali, INTROP, UPM
4. Ir Ts Dr Nordin Ramli, MIMOS
5. Prof Ir Dr Hafizal Mohamad, USIM
6. Assoc Prof Dr Sharifah Mumtazah Syed Ahmad, Faculty of Engineering, UPM

1. Asst Prof Dr. Wida Susanty Haji Suhaili, School of Computing and Informatics, Universiti Teknologi Brunei
2. Asst Prof Pg Dr Rafidah Pg Petra, Faculty of Engineering, Universiti Teknologi Brunei
3. Dr Hjh Nor Zainah Hj Siau, School of Computing and Informatics, Universiti Teknologi Brunei
4. Dr Arif Baramantoro, School of Computing and Informatics, Universiti Teknologi Brunei