Fire Detection and Alarm Systems of Peat-Forest Fires in JST-JICA Project

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**Project Purpose** Before Mid-term Evaluation

Peat-forest management model in Indonesia is established.

**Output 1**

Fire Detection and Fire Prediction System are established.

**Indicator:**

**Activity**

1. Improve the hotspot algorithms.
2. Estimate carbon emission by biomass burning among different ecotypes
3. Transfer in-situ fire information to each region
4. Construct prediction model of wild fire occurrence
5. Construct model of water regime
6. Make map of land cover/land use change
7. Establish spectral library (plant/soil) in investigation area

**[Project Purpose] After Mid-term Evaluation**

Peat-forest management method to reduce carbon emission is developed.

**Indicator:**

1) Carbon management method which can contribute to carbon reduction of 1/3 to 1/5 amount compared to current level in peatland is proposed.
2) Peat-forest management method is utilized in policy decision in developing international rules and bilateral offset mechanism.
3) Results of researches are published (Number and quality of research papers is good enough)

**Output 1**

Fire Detection and Fire Prediction System are established.

**Indicator:**

**Activity**

1-1 Improve the hotspot algorithms
1-2 Estimate carbon emission by biomass burning among different ecotypes
1-3 Transfer in-situ fire information to each region
1-4 Construct prediction model of wild fire occurrence
1-5 Construct model of water regime
1-6 Make map of land cover/land use change
1-7 Establish spectral library (plant/soil) in investigation area
1-8 Validate established system
8: Validate Established Systems

**FF1: Construct wild/peat fire control systems**
- **Step 1:** Detection of Fire Hot Spots by Satellites (resolution: 1km x 1km)
- **Step 2:** Validation of Hot Spots by UAV (Ground Truth)
- **Step 3:** Transmission of Fire Information by SMS

**FF2: Mapping and modeling the land cover**
- **Step 4:** Calculation of Burnt Area
- **Step 5:** Estimation of CO2 Emission by Biomass Burning among Different Type Ecosystems
- **Step 6:** Estimation of CO2 Emission from Burnt Area
Communication Networks of Fire Detection and Alarm Systems

STEP 1: Data Collection CPU
- Hotspots Distribution
- Data Analysis
- 4~5 hours

STEP 2: Satellite Data
- Peat Fires
- 6~8 hours

STEP 3: Local Government Palangkaraya
- UAV Ground Truth
- 2~3 hours

STEP 4-6: Data Base
- Fire History Data
- Land Use Data

STEP 7: Village People
- Village Fire Fighters
- Tumagsa Jabilan
- Taruna

STEP 4:
- Water Level Distribution
- Ground

STEP 5:
- Fire Information
- distance direction dangerous index

STEP 6:
- SMS LAPAN UNPAR

STEP 7:
- Vegetation Spectrum Data
Current progress on the achievement of FF1 outcomes

1. To verify the precision of hotspot data detected by the satellite, we have taken the hotspot aerial photography (1km x 1km) by Unmanned Air Vehicle (UAV) and then identified 20~30% current real fires area in the 1km square area. We suppose that hotspots are detected by the algorithm with the very high precision.
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<th>Spec. UAV Type</th>
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<th>F-3 (2012)</th>
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<td>2300mm</td>
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<tr>
<td>Length:</td>
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<tr>
<td>Weight:</td>
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<td>Power:</td>
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<td>6500 mAh x 2 units (30 min)</td>
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<tr>
<td>Stall Speed:</td>
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<td>Cruising Speed:</td>
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Ground Validation with UAV (Sep. 2011)

Mapping Source: JAXA, PALSAR 10m Mosaic Image, Central Kalimantan
3 September, 2012

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3 September, 2012

22km

20km
MODIS pixel Observed by UAV

Flight Distance A~B: 10km
Burnt Area: 15~20%
Flight Height: 200m

Plantation Area: Oil Palm
8. To validate established systems, from the viewpoint of the project goal, we have integrated the several processes such as satellite hotspot detection, hotspot data analysis, fire information delivery and verification. Then, we carried out the practical operation of fire detection and prediction based on the integrated systems. In addition, to evaluate the CO2 emission due to fires, we store the fire historical data, the land covered/use data and the biomass data of plat/soil as data base.
Specification of F-4 UAV : 2013.09

- Length/Wing Length/Height
  - 2.1m/2.76m/0.47m
- Weight: 5.5kg with Battery
- Power: Brushless Motors: 2 units

- Flight Speed: Max 100km/h
  - Cruising Speed: 50-80km/h
- Flight Time: Max 90 min.
- Payload: Max 1kg
- Data Link: 2.4GHz
  - (Specified Low Power Wireless)
- Communication Distance: 10km
Comparison of UAV Specification

Electric Motors

Electricity vs. Gasoline

- Wing Length
- Length
- Weight
- Flight Time

Electric Motors

Electricity vs. Gasoline

- F-2
- F-3
- F-4

- Gasolin Eng.
Specification of UAV with Engine

- Length / Wing Length / Height: 2.6m / 3.2m / 0.9m
- Weight: 35kg with Engine
- Engine: BT-86B7.5HP
  86cc 2 Cycle Gasoline Engine 2 Cylinders
- Flight Speed: Max 180km/h
  Cruising Speed: 120km/h
- Flight Time: Max 4 hours
- Flight Height: Max 4500m (14800ft)
- Payload: Max 6kg
- Data Link: 2.4GHz
  (Specified Low Power Wireless)
- Communication Distance: 10km
3. To transfer the fire information to stakeholders, we have developed the fire information transmission system based on the Short Message System (SMS) with both hardware and software in Indonesia, and we have carried out the practical operation to deliver peat-forest fire information such as the distance & direction of fire occurred points from the center of villages and the fire dangerous index.
MODIS Hotspot Database for JICA-JST SATREPS Project

(c) JICA-JST SATREPS project produced by JAXA/EORC, LAPAN and Hokkaido Univ.
Corresponding author: Koji Nakau Ph.D
nakau.koji@jaxa.jp
Wildfire location database (FF1-5)

- **Source data of fire alert system**

  Fire location arranged suitable for alert system
  - Time of fire detection
  - Latitude and longitude
  - Distance from village
  - Distance from road
  - Direction from village
  (Toward/Backward PKY)
SMS Messaging server

- Hard/Software to be purchased

  SMS will be sent through http access
  http://127.0.0.1:9333/ozeki?action=sendMessage&ozmsUserInfo=admin:abc123&recepient=06203105366&messageData=hello+world

NTT Indonesia will produce as a package.
4. To develop the peat-forest fire extension model based on 1km square hotspot data, we have examined the necessity and possibility of the peat-forest fire extension model, so that we found that it is difficult to develop the extension model inside the hotspot using 1km square hotspot data and it is seemed to be unnecessary for village people inside the distance 2km from the center of the village because the fire extension direction is determined by the wind direction and the soil moisture.
A result of MM5 simulation

Wind field around Palangka Raya
The local wind can be analyzed by this model.

At 13:00 local time in Palangka Raya, on September 4, 2006.

by Mr. Hatanaka
5. To notify the dangerous level of peat-forest fires, we defined the level of the peat fire index (PFI) by the correlation of the ground water level with the number of fire occurrence. Then, the 2-dimensional profile of the ground water level has been developed using both measurement data of ground water level at fixed points and 2-dimesional satellite moisture data. Instead of the fire extension model, the PFI was used as the fire alarm and delivered to the stakeholders as the fire information.
Ground water level in a peat swamp forest and the level of damages of peat/forest fire for 11 years
Fire Dangerous Index (FDI)

- Ground Water Table, CO2 Emission and Peat Fire Index

FDI-1: Ground Water Level -20cm～-50cm
  Ground Surface Fire
FDI-2: Ground Water Level -50cm～-100cm
  Surface Layer Peat Fire
FDI-3: Ground Water Level -100cm～
  Deep Layer Peat Fire
The system architecture monitoring peat forest fires
Thank you for your attention