DEVELOPMENT OF WILDFIRE ALERT SYSTEM FOR EFFICIENT FIRE FIGHTING

Topics

- Fire Alert System
  - Data Flow of This System
  - Wildfire Detection Algorithm
  - Data Integration for SMS Alert

- Fire Monitoring in Near Future

- Summary
Objects of FF-1 Subgroup

- **FF1-1** Fire detection algorithms for MODIS data
- **FF1-2** Local validation fire product
- **FF1-3** Simulation of fire propagation
- **FF1-4** Water regime for the fire prediction and water level of canals
- **FF1-5** Provide fire information to firefighting teams and other stakeholder agencies

Fire Alert System as a fruit of collaboration

- LAPAN’s NRT data
- Algorithm by HU, JMA
- Validation by HU, UNPAR
- Firefighter by UNPAR
- Fire Detection (FF-1-1)
- Servers At LAPAN
- Fire Simulation (FF-1-6)
- Model by UT
- Fire alert via SMS (FF-1-5)
- Hydrological info (FF-1-5)
Procedure of Fire Monitoring

Satellite observation
Currently, NASA’s satellite 10:30/1:30 (Day/Night)

IR radiation from fire

10:30/13:30
22:30/ 1:30
Everyday

Reception
Sulawesi

Transfer, Preprocess
Jakarta

Fire Detection Integration

Soil-moisture
Tokyo

Fire-fighter
Palangkaraya

In Several Minutes

SMS server
Jakarta

Wildfire Alert

Peatland fire database http://jica-jst.lapanrs.com/
**Peatland fire database**
http://jica-jst.lapanrs.com/

**Description of Wildfire location data:**

- **Observation Period:** Sep 2012
- **Province:** Kalimantan Tengah
- **Regency:** Pulang Pisau
- **District:** Jabirem Raya
- **Village:** Pilang
- **Satellite/Sensor:** Terra/MODIS and Aqua/MODIS

<table>
<thead>
<tr>
<th>Yr.</th>
<th>Mon.</th>
<th>SMS</th>
<th>Villages</th>
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<tbody>
<tr>
<td>2013</td>
<td>Dec</td>
<td>Tarunajaya</td>
<td>Tumbang Nusa</td>
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<tr>
<td>2012</td>
<td>Nov</td>
<td>Pilang</td>
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<td>2011</td>
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<td>2010</td>
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<td>Pilang</td>
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<tr>
<td>2009</td>
<td>Aug</td>
<td>Pilang</td>
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</table>

**Fire Detection by Satellite**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Lat</th>
<th>Long</th>
<th>Linear Distance</th>
<th>Direction</th>
<th>Road access</th>
<th>Algorithm</th>
<th>GWT</th>
<th>Map</th>
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<tbody>
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<td>2012-09-12</td>
<td>24 hotspots detected, 2 are accessible from the highway</td>
<td>2.477S 114 178E</td>
<td>1,960m 292 W</td>
<td>kn2</td>
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<td>79cm</td>
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<td>78cm</td>
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<td>2.459S 114 175E</td>
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<td>kn2 mod14</td>
<td>81cm</td>
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<td>Map</td>
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</table>
Wildfire detection: principle is simple.

Principally, fire pixel is detected as a high temperature area. It seems to be obvious as fire pixels.

Wildfire detection: principle is simple, but actually it doesn’t go strait.

Warmer than fire 13°C to 19°C

Fire: brightness temp: -18 to -1°C
Low temp by cirrus cloud.
Wildfire observation from space

- Hotspot pixel is “Mixcell” of fire and non-fire area
  - Depth of fire is 1 m - 10m
  - Resolution of IR sensors are >100m – 1km
  - Only 0.1 – 10% is filled by fire
- Apparent temperature rise are limited
  - Width:1km, Depth:10m, Temp: 800K
  - ΔT is 5-20K in TIR, 5-200K in 4µm

Actual wildfire detection

To detect weak signal from wildfire, we utilize contextual threshold.

To reduce false alarms, actual algorithm takes 6 steps in NASA’s algorithm.
Smoldering fires are omitted by MOD14.

Peat Fire in Indonesia

Yellow: MOD14 v4.3.2
Red: Proposed

R: 2.24 μm  G: 1.65 μm  B: 0.66 μm

Peat Fire in Indonesia

Yellow: MOD14 v4.3.2
Red: Proposed

R: 2.24 μm  G: 1.65 μm  B: 0.66 μm
Integration of fire information

Satellite observation
Currently, NASA’s satellite
10:30/1:30 (Day/Night)

IR radiation
from fire

Soil-moisture
Tokyo

IR radiation

Reception
Sulawesi

Transfer,
Preprocess
Jakarta

Real-time

Fire Detection Integration

Real-time

<1 hour

Fire-fighter
Palangkaraya

SMS server
Jakarta

Wildfire Alert

Once a day

FF1-4 Water Regime

Keetch-Byram Drought Index (KBDI)

KBDI is a soil/duff drought index that ranges from 0 (no drought) to 800 (extreme drought) and is based on soil capacity of 20 cm of water. Factors in the index are maximum daily temperature, daily precipitation, and annual precipitation. [Keetch et al, 1965]

Presently, this index is derived from satellite observation of land surface temperature (LST) from MTSAT received at IIS/U-Tokyo and precipitation derived from global satellite mapping (GSMaP) provided by JAXA EROC.

http://sharaku.eorc.jaxa.jp/GSMaP/

http://webgms.iis.u-tokyo.ac.jp/KBDI/
Fire Monitoring in Near Future

UNIFORM satellite fire monitoring

- Focused on wild fire monitoring
  - Thermal InfraRed sensor 11µm / 150m GSD
  - 100km swath ()
- Walking to Suppress
  - Resolution & Frequency
  - Accuracy for 1km is NOT enough for fire suppression
- Efficient fire suppression
  - International Cooperation
Advantage of mid-high res IR images

Satellites for Wildfire Monitoring

- Wildfire expands everyday $\rightarrow$ Once a day is important
- Suppression by human $\rightarrow$ Location accuracy important
Fire monitoring with multi satellites

- **UNIFORM-1**, **UNIFORM-2,3**
  - FY2013
  - Swath: 100km
  - Resol: 150m
- **SGLI on GCOM-C1**
  - FY2015
  - Swath: 1150km
  - Resol: 250m
- **CIRC on ALOS-2**
  - FY2013
  - Swath: 130km
  - Resol: 200m
- **CIRC/CALET on JEM/ISS**
  - FY2014
  - Width: 80km
  - Resol: 115m
- **ASTER on Terra**
  - Operation
  - Swath: 60km
  - Resol: 90m
- **OLI on LANDSAT8**
  - FY2012
  - Swath: 185km
  - Resol: 30m

New Japanese satellites for wildfire

<table>
<thead>
<tr>
<th>Launch year</th>
<th>Sensor</th>
<th>Satellite</th>
<th>4-1.6μ</th>
<th>11μ</th>
<th>Swath</th>
<th>Interval</th>
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<td><strong>Mid res.</strong></td>
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<tr>
<td>Operational (1998)</td>
<td>MODIS</td>
<td>Terra</td>
<td>1km</td>
<td>1km</td>
<td>2330km</td>
<td>0.5d</td>
</tr>
<tr>
<td>Operational (2002)</td>
<td>MODIS</td>
<td>Aqua</td>
<td>1km</td>
<td>1km</td>
<td>2330km</td>
<td>0.5d</td>
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<tr>
<td>Operational (2010)</td>
<td>VIIRS</td>
<td>NPP</td>
<td>750m</td>
<td>750m</td>
<td>3000km</td>
<td>0.5d</td>
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<tr>
<td>Operational (1999)</td>
<td>ETM+</td>
<td>LANDSAT 7</td>
<td>---</td>
<td>60m</td>
<td>185km</td>
<td>16d</td>
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<tr>
<td>Operational (1998)</td>
<td>ASTER</td>
<td>Terra</td>
<td>---</td>
<td>90m</td>
<td>60km</td>
<td>4.8d</td>
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<tr>
<td>Operational (2013)</td>
<td>OLI/TIRS</td>
<td>LANDSAT 8</td>
<td>30m</td>
<td>100m</td>
<td>185km</td>
<td>16d</td>
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<tr>
<td>2014</td>
<td>CIRC</td>
<td>ALOS 2</td>
<td>---</td>
<td>200m</td>
<td>130km</td>
<td>7d</td>
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<tr>
<td>2014</td>
<td>BOL</td>
<td>UNIFORM1</td>
<td>---</td>
<td>150m</td>
<td>100km</td>
<td>7d</td>
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<tr>
<td>2014</td>
<td>CIRC</td>
<td>JEM/CALET</td>
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<td>120m</td>
<td>70km</td>
<td>7d</td>
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<td>2016</td>
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<td>GCOM-C1</td>
<td>250m</td>
<td>250m</td>
<td>1150km</td>
<td>1.5d</td>
</tr>
<tr>
<td>2015</td>
<td>BOL</td>
<td>UNIFORM3</td>
<td>---</td>
<td>150m</td>
<td>100km</td>
<td>7d</td>
</tr>
</tbody>
</table>

- At least 5 satellites are available with high resolution sensors in 2014.
- Wildfire will be observed once a two to three days.
- Image available once a 3 days with determined launch schedule.
- Image available Everyday when all planned satellites launched.
- 3 high resolution IR sensors among 5 are Japanese.
Satellites for Wildfire Monitoring Near Future

- **MODIS**: 3-4 times a day, 1km resolution
- **New Satellites**: Almost once a day, 200m resolution
- **ASTER LANDSAT**: 1 time a two weeks, 30m/90m resolution

- Wildfire expands everyday → Once a day is important
- Suppression by human → Location accuracy important
- New satellites observes TIR with 100-250m resolution once a day

Summary

- Wildfire monitoring system developed
  - in operation
  - LAPAN’s Near Real-time Imagery
  - Daily wildfire / GWT maps on Web
- Development under the Collaboration
  - LAPAN: NRT images, Maintenance
  - UNPAR: Coordination with fire fighting team
  - HU, JMA, UT: Models and Algorithms
- New Japanese sensors will be available soon
  - Completely different information will be available