The Applications of Satellite Remote Sensing on Climate Change and Food Security in Indonesia

Dr. Erna Sri Adiningsih
Aerospace Analysis and Information Center
Outline

- The Importance of Climate Change and Food Security
- Climate Change Studies using Satellite Data
- Remote Sensing Satellites for Food Security
- Satellite Development for Remote Sensing and other Applications
- International Cooperation
- Concluding Remarks
Why climate change & food security issues are very important for Indonesia?

1. Climate change has been a fact (based on long term observation), not a presumable condition.
2. Climate change (& variability) has profound impacts on various sectors → agriculture, fishery, forestry, water management, health, water-related disasters (floods, droughts, landslides), coastal environment, etc.
3. Among those, agriculture is the most vulnerable sector → food supply will be affected under increasing demand due to population growth → threats food security.
Climate Hazards in Indonesia

INDONESIA: Natural Hazard Risks
Issued: 15 February 2007

Seismic, Volcanic and Tropical Storm Risk

All Natural Hazard Risks

The bar chart below shows the degree of exposure to natural hazards and the percentage of area affected. Tsunamis and storm surges are a threat to coastal regions, particularly gulfs, bays, and estuaries. Flood hazard results from river floods and torrential rain. Drought is caused by major deviations from the normal amounts of precipitation. Frost hazard depends on elevation and latitude.

Legend

Earthquake intensity

Tropical storm intensity

Modified Mercalli Scale
Saffir-Simpson Scale

Earthquake intensity zones indicate where there is a 20% probability that degrees of intensity shown on the map will be exceeded in 50 years.

Tropical storm intensity zones indicate where there is a 10% probability of a storm of this intensity striking in the next 10 years.
• We had big floods over Jakarta in early February, 2007. Then, continued in February, 2008 and 2009.
• In that time, 40-70% of Jakarta was under water, up to 4 meters deep in some areas.
• At least 100 people been killed.
• Almost 340,000 forced from their homes.
• How about recently?
Climate Change Impacts

- More Frequent Weather Extremes
- Prolonged Droughts
- Fires and GHG Emission
- Food Security
CLIMATE CHANGE AND IMPACTS
Time Series of Annual Air Temperature and Trend in Jakarta for 100 Years (1901-2002 PERIOD)

\[ y = 0.0151x - 2.5698 \]

Source: Lely/LAPAN
Climate Change Impact Studies

• Climate impacts on rainfall pattern, fire risks, food crop production, terrestrial ecosystems, coastal zone ecosystem, water level, water-related hazards.

• Remote sensing data from existing satellites are very essential for those studies.
Droughts, Fires and Haze Monitoring: Climate Extreme & GHG Emission

Fires in peat lands in Central Kalimantan
Climate Impact on Fire Risks

**GCPC Grid Rainfall Data**

**HOT SPOTS**

**Table of Fire Risks**

<table>
<thead>
<tr>
<th>Rainfall Category</th>
<th>Low (hotspots &lt;400)</th>
<th>Moderate (400 &lt; hotspots &lt;800)</th>
<th>High (800 &lt; hotspots &lt;2000)</th>
<th>Very high (hotspots &gt;2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Normal</td>
<td>0.423</td>
<td>0.231</td>
<td>0.154</td>
<td>0.192</td>
</tr>
<tr>
<td>Normal</td>
<td>0.935</td>
<td>0.016</td>
<td>0.032</td>
<td>0.016</td>
</tr>
<tr>
<td>Above Normal</td>
<td>0.943</td>
<td>0.057</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Indonesia’s Pledge for Emission Reduction –

Quotes from the President Speech

➤ “We are devising an energy mix policy ... that will reduce our emissions by 26 percent by 2020. With international support, we are confident we can reduce emissions by as much as 41 percent.”

➤ “We are also looking into the distinct possibility of committing a billion tons of CO2 reduction by 2050. We will change the status of our forests from that of a net emitter sector to a net [carbon] sink sector by 2030.”

President Yudhoyono first announced this pledge at the G20 summit in Pittsburgh, September 2009 then reiterated it at COP 15/CMP 5 in Copenhagen, December 2009

REMOTE SENSING SATELLITES COULD PROVIDE BETTER SPATIAL INFORMATION ON GHG & FOREST STATUS

CHALLENGES FOR SATELLITE DEVELOPMENT AND APPLICATIONS
CARBON ACCOUNTING AND CLIMATE CHANGE IMPACT ANALYSIS USING SATELLITE IMAGERIES
Indonesia’s National Carbon Accounting System (INCAS)

In cooperation with Australia

Vegetation cover change
as the basis of carbon-accounting
Indonesia’s National Carbon Accounting System (INCAS)

Sample results of Landsat ortho & terrain corrected as the basic maps for carbon accounting.
Detecting Climate Change Impacts

Snow Cover Change over Jayawijaya Mountain – Papua
1990 - 2003
CLIMATE AND CROP MONITORING TO SUPPORT FOOD SECURITY
RICE CROP GROWTH MONITORING IN JAVA ISLAND (MONTHLY USING MODIS DATA)

March 2009

LEGENDA:
- Tingkat Kehijauan Vegetasi:
  - Tinggi
  - Sedang
  - Rendah
- Informasi Pendukung:
  - Air
  - Bera
  - Akan
RICE CROP GREENNESS INDEX MONITORING USING MODIS DATA (MONTHLY)

AUGUST 2009

SEPTEMBER 2009

OCTOBER 2009
RICE FIELD INVENTORY USING SATELLITE IMAGERIES

Rice fields

INDONESIAN NATIONAL INSTITUTE OF AERONAUTICS AND SPACE
SPATIAL INFORMATION ON RICE FIELD STANDARD AREAS

RICE FIELDS AS THE BASIS FOR RICE FIELD MONITORING

INDONESIAN NATIONAL INSTITUTE OF AERONAUTICS AND SPACE
FLOOD MONITORING OF RICE FIELDS

FLOOD HAZARD OF RICE FIELDS IN JAVA&BALI ISLANDS (06-13 MARCH 2010)

INDONESIAN NATIONAL INSTITUTE OF AERONAUTICS AND SPACE
DROUGHT MONITORING OF RICE FIELDS

TINGKAT RAWAN KERING LAHAN SAWAH
PROVINSI BANTEN DAN JAWA BARAT
PERIODE 01 - 08 MEI 2010

TINGKAT RAWAN KERING LAHAN SAWAH
PROVINSI DIY DAN JAWA TENGAH
PERIODE 01 - 08 MEI 2010

TINGKAT RAWAN KERING LAHAN SAWAH
PROVINSI JAWA TIMUR
PERIODE 01 - 08 MEI 2010

TINGKAT RAWAN KERING LAHAN SAWAH
PROVINSI BALE
PERIODE 01 - 08 MEI 2010

INDONESIAN NATIONAL INSTITUTE OF AERONAUTICS AND SPACE
Drought index and rice production loss by district (Drawn from field data provided by Directorate of Plant Protection, Boer et al, 2002)
Optimization of Land Management for Determination of Crop Growing Season
Sample site: Lampung
Optimal Crop Growing Season for October-January: Maize, Rice, Cassava, Others
Optimal Crop Growing Season for October-January: Maize, Rice, Cassava, Others
Optimal Crop Growing Season for October-January: Maize, Rice, Cassava, Others
Zonation & Monitoring of Peanut Crop: In Lampung
Recommended Crop Development: Peanut
Land Suitability Assessment: Potential Development Area for Peanut
Problems & Challenges

• Climate in Indonesia is very dynamic seasonally.
• High cloud cover in Indonesia → few cloud free images from existing polar orbital satellites (optical & radar), due to low temporal resolution.
• Geostationary satellites → provide high temporal resolution, but low spatial resolution.
• Need adequate spatial resolution as well as temporal resolution (repetition) → Near Equator Orbital Satellites → most existing remote sensing satellites are polar
• Satellite development to fulfill the need
National Satellite Development Programme
LAPAN-TUBSAT Satellite

LAPAN Tubsat Orbit over Indonesia

LAPAN Tubsat Development & Operation

LAPAN Tubsat over Bromo Mountain
Satellite Utilization in Indonesia

Soekarno-Hatta Airport
Cengkareng, Banten
LAPAN-TUBSAT image

A video stitch image frame generated from video data recording. The resulting is an RGB composite color photo image of the location observed by the video streaming data. The image frame clearly show urban land use from spatial resolution and color separation. Some sea water attributes could also be observed.
LAPAN-TUBSAT data after application of unsupervised land use classification.
What are the needs?

More space-based observation, more repetitive times, cloud free.

Access to existing earth observation satellites which have special characteristics for better observations such as for climate parameters, GHG & biomass.

Data in near-real-time condition, such as GPM/GSMap satellite data observation.

Enhanced capacity building: educational program/training course for satellite meteorology/climatology, hyper-spectral data processing & analysis.

More international collaborations.
Concluding Remarks

• Climate change and food security are important issues in Indonesia to address.

• Space technology, remote sensing satellites in particular, are very beneficial for observations related to climate change parameters, impacts and mitigation actions, as well as adaptation to climate change.

• However, there are still limitations in the use of remote sensing satellite. Therefore, satellite development programs in Indonesia will be enhancing and challenging.

• International cooperation needs to be strengthened for better access to existing satellite data and enhanced capacity building.