MRV System Development for REDD+ in Indonesia: Pol-SAR Application *

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Acknowledgement
OUTLINE

• Introduction
• Demonstration Area
• Baseline Preparation
• Preliminary Study (Tier-1)
• Detail Study (Tier-3)
• Conclusions & Outlook
Introduction

• REDD+Indonesia: Bilateral (Norway-Indonesia), Voluntary (MOU, 2010)
• Readiness Phase (2011), Implementation Phase (2012), Performance Based (2014)
• MRV (Monitoring, Reporting & Verification) initiated prior 2014
• ESA/Envisat AOE-869 (2004) – SAR (C-Band)
• JAXA/ALOS RA2-402 (2007) – SAR (L-Band)
OUTLINE

• Introduction
• **Demonstration Area**
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• Conclusions & Outlook
Demonstration Area (NASA)
Decrease of forest cover in Indonesia 2000-2005: Forest cover change areas

Landscape classes:
- Natural forests
- Other areas
- No data (clouds) and inland water

MODES analysis – SDSU/SUNY-ESF
Landsat analysis – SDGU/MoF
MODES pre-processing – NASA/UMd/SDSU
Landsat data provision – USGS/GPW/UMd
Indonesia land cover – MoF
South Sumatera, Ogan Komering Ilir
The Super Site

585,000 Ha
(4 X Singapore)
The Super Site
OUTLINE

• Introduction
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• **Baseline Preparation**
  • Preliminary Study (Tier-1)
  • Detail Study (Tier-3)
• Conclusions & Outlook
Baseline Data

<table>
<thead>
<tr>
<th>Year</th>
<th>Year</th>
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<td>SAR</td>
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<tr>
<td>2012</td>
<td>2013</td>
<td>2014</td>
<td>....</td>
<td>....</td>
<td>2020</td>
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</table>
Forest cover loss and gain (Sumatera 2000-2009)

Further Readings:
- Kalimantan forest land cover change
- Sumatra forest land cover change
- Indonesian National Carbon Accounting System...
- Estimating above ground carbon stock...

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OUTLINE

• Introduction
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• **Preliminary Study (Tier-1)**
• Detail Study (Tier-3)
• Conclusions & Outlook
Preliminary Study (Tier-1)


  - Phase-1 (Tier-1):
    - Identification of Key Category: Forest Land remains Forest Land (FF),
    - Category Code: 3B1a (CO2),
    - Carbon Pool: Biomass, DOM, Soil (Peat) → Land Cover Change (LCC) = ΔBiomass

  - Phase-2:
    - Land Representation Analysis: 1995-2009 (15 Years)
    - Continuation for 2010-2014 (20 Years accumulative = AFOLU Default)

  - Phase-3 (Tier-3: started in 2012)
    - HTI Carbon Budget Analysis
    - Options: Loss-Gain or Stock Change
## Carbon Pool

<table>
<thead>
<tr>
<th>BIOMASS Forest/Non-Forest</th>
<th>DEAD ORGANIC MATTER (DOM)</th>
<th>SOIL Peat/Non-Peat</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGB</td>
<td>Natural</td>
<td>Degraded/Drained</td>
</tr>
<tr>
<td>BGB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIER-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIER-2</td>
<td></td>
<td></td>
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<tr>
<td>TIER-3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
HH-(2009©JAXA)
The Result: Radar (2-D)
HV-(2009©JAXA)
The Result:

Radar (2-D)

2009©AIPEX
## Preliminary Study: HTI Impact

<table>
<thead>
<tr>
<th>Tutupan Lahan</th>
<th>1995</th>
<th>%</th>
<th>2000</th>
<th>%</th>
<th>2004</th>
<th>%</th>
<th>2009</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hutan Sekunder</td>
<td>277,940</td>
<td>47.2</td>
<td>30,875</td>
<td>5.2</td>
<td>31,355</td>
<td>5.3</td>
<td>155,223</td>
<td>26.4</td>
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<tr>
<td>Kebun Campuran</td>
<td>13,191</td>
<td>2.2</td>
<td>13,191</td>
<td>2.2</td>
<td>7,624</td>
<td>1.3</td>
<td>12,908</td>
<td>2.2</td>
</tr>
<tr>
<td>Belukar</td>
<td>134,181</td>
<td>22.8</td>
<td>223,379</td>
<td>37.9</td>
<td>260,722</td>
<td>44.3</td>
<td>200,122</td>
<td>34.0</td>
</tr>
<tr>
<td>Belukar/Gelam</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100,682</td>
<td>17.1</td>
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<tr>
<td>Semak</td>
<td>68,907</td>
<td>11.7</td>
<td>231,459</td>
<td>39.3</td>
<td>234,674</td>
<td>39.9</td>
<td>64,202</td>
<td>10.9</td>
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<tr>
<td>Rawa</td>
<td>12,008</td>
<td>2.0</td>
<td>2,373</td>
<td>0.4</td>
<td>16,371</td>
<td>2.8</td>
<td>41,055</td>
<td>7.0</td>
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<tr>
<td>Lahan terbuka</td>
<td>48,860</td>
<td>8.3</td>
<td>53,129</td>
<td>9.0</td>
<td>13,562</td>
<td>2.3</td>
<td>14,643</td>
<td>2.5</td>
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<tr>
<td>Badan Air</td>
<td>6,854</td>
<td>1.2</td>
<td>1,097</td>
<td>0.2</td>
<td>2,552</td>
<td>0.4</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Bekas Terbakar</td>
<td>-</td>
<td>-</td>
<td>22,492</td>
<td>3.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Awan</td>
<td>26,894</td>
<td>4.6</td>
<td>10,840</td>
<td>1.8</td>
<td>21,974</td>
<td>3.7</td>
<td>-</td>
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<tr>
<td><strong>Total</strong></td>
<td>588,835</td>
<td>100</td>
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<td>100</td>
<td>588,835</td>
<td>100</td>
<td>588,835</td>
<td>100</td>
</tr>
</tbody>
</table>

Biomass: Plantation Forest > Secondary Forest > Bush > Shrub
Preliminary Study: HTI Impact

![Graph showing the impact of HTI over time across different land uses.](chart.png)
Preliminary Study: HTI Impact

- Hutan Sekunder
- Kebun Campuran
- Belukar
- Semak
- Rawa
- Lahan terbuka
- Badan Air
- Bekas Terbakar
- Awan
Preliminary Study: HTI Impact (Tier-1)

Serapan Karbon Biomasa

<table>
<thead>
<tr>
<th>Tahun</th>
<th>Total C-Gain</th>
<th>Peat C-Loss</th>
<th>Net C-Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>2,207,237</td>
<td>657,884</td>
<td>1,549,373</td>
</tr>
<tr>
<td>2000</td>
<td>1,870,797</td>
<td>406,067</td>
<td>1,264,730</td>
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<tr>
<td>2004</td>
<td>1,929,202</td>
<td>466,363</td>
<td>1,462,839</td>
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<tr>
<td>2009</td>
<td>2,645,602</td>
<td>729,643</td>
<td>1,915,959</td>
</tr>
</tbody>
</table>
Figure 2-4: Conceptual model changes in ecosystem carbon stocks following disturbance or degradation, and mitigation through reclamation: (A) stabilization at lower stocks than original, (B) stabilization at original stocks, and (C) stabilization at higher stocks (after Johnson, 1995).
OUTLINE

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The Result:

GDB 1:25,000
The Result:
GDB
GEO-CODING
MOSAICKING
Under Progress
OUTLINE

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Conclusions:
• Stripmap, medium resolution (mosaic)
• SAR data sustainability
• Forest/Non-Forest, Forest Change Detection, Biomass, Peat/Non-Peat

Outlook:
• C-SAR (X-Band), equatorial, UNFCCC Fast Funding Track, Astrium UK (2011) → no progress
• CP-SAR (L-Band), polar, LAPAN-Chibadai, micro-sat (2014-2016)
LAPAN-A5 SAR (2014-2016)

(Sumantyo and Triharyanto, 2012)
## Satellite system

<table>
<thead>
<tr>
<th>Satellite system</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>500 km</td>
</tr>
<tr>
<td>Bus weight</td>
<td>50 kg (LAPAN-A series)</td>
</tr>
<tr>
<td>Launch envelope</td>
<td>100 x 100 x 100 cm</td>
</tr>
<tr>
<td>Battery capacity</td>
<td>34 Ah @ 15 V</td>
</tr>
<tr>
<td>Solar panel capacity</td>
<td>120 W</td>
</tr>
<tr>
<td>Downlink</td>
<td>X-band : 200 Mbps</td>
</tr>
</tbody>
</table>

## Payload

<table>
<thead>
<tr>
<th>Payload</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic aperture radar</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>About 1.27 GHz</td>
</tr>
<tr>
<td>Polarimetry</td>
<td>HH, HV, VH, VV</td>
</tr>
<tr>
<td>Off-nadir angle</td>
<td>29 degree</td>
</tr>
<tr>
<td>Power consumption</td>
<td>350 Watts</td>
</tr>
<tr>
<td>Payload weight</td>
<td>About 60 kg</td>
</tr>
<tr>
<td>Antenna (deployed)</td>
<td>1 m x 4.5 m x 2 panels</td>
</tr>
<tr>
<td>Swath</td>
<td>100 km</td>
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<tr>
<td>Spatial resolution</td>
<td>30 m</td>
</tr>
<tr>
<td>PRF</td>
<td>2000 – 2500 Hz</td>
</tr>
</tbody>
</table>
THANK YOU
raimadoya@ipb.ac.id