Session 4 – Forest Canopy Disturbance Monitoring (FCDM)

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Challenges

Problems to detect forest disturbances/ degradation

- Small-scale signal (e.g. removal of single trees)
- Weak signal (low signal-to-noise ratio)
- Signal only detectable over short period due to fast vegetation regrowth in tropics
- Frequent cloud coverage in tropics
- Differentiation between natural phenological changes (e.g. seasonality) and actual disturbance events
Background

- Forest Cover Disturbance Monitoring (FCDM) allows detecting canopy disturbances
  - Monitoring based on a change detection approach

- FCDM includes two monitoring approaches
  - Optical-based (Delta-rNBR)
  - Radar-based (Delta-SPE)

- FCDM was developed under ReCaREDD project
  - ReCaREDD was EU project (2013-2018), launched by DG DEVCO and implemented by JRC
  - FCDM tool (optical) freely available
Basic Change Detection Principle

Accumulated canopy openings (reference period)

Accumulated canopy openings (analysis period)

Difference between accumulated canopy openings of reference and analysis period

<table>
<thead>
<tr>
<th>Canopy Opening</th>
<th>Reference period</th>
<th>Analysis period</th>
<th>FCDM result</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No change</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>Disturbance</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Regrowth</td>
<td></td>
</tr>
</tbody>
</table>
Capabilities

• **Monitoring of activity data:**
  - Changes (openings) in forest canopy
    • Large-scale changes = deforestation information
    • Small-scale changes = forest degradation information
  - Changes (closures) in forest canopy
    • Vegetation regrowth

• **Monitoring of ancillary data:**
  - Magnitude of signal refers to impact on ground
  - Information about date of disturbance
Input Data

• **Optical-based monitoring approach:**
  – Landsat imagery (Landsat 4, 5, 7 and 8) → 30m resolution
  – Sentinel-2 imagery (S-2A and S-2B) → 10m resolution

• **Radar-based monitoring approach:**
  – Sentinel-1 imagery (C-band) → 10m resolution

• **Forest mask (optional)**
  – Forest mask of TCD
  – Forest mask of JRC-TMF (Tropical Moist Forest Layer)
  – User defined forest mask
    (alternatively also no forest mask possible)
Output

Raster map showing:

- Indications of canopy disturbances within analysis period
  - Activity data of deforestation
  - Activity data of forest degradation

- Severity of canopy disturbances
  1-254: light to severe disturbance

- Indications of canopy closures
  - Vegetation regrowth
    0: non forest
    1: regrowth in forest
    2: no regrowth in forest

- Timing/ date of disturbance events

0: non forest
1: disturbance in forest
2: no disturbance in forest
Accuracy Assessment

- **FCDM-optical (Cambodia and Laos)**
  - Overall accuracy: 77.7%
  - Area-weighted user accuracy: 74.6%
  - Area-weighted producer accuracy: 52.2%

- **FCDM-radar (Cambodia)**
  - Overall accuracy: 96.3%
  - Area-weighted user accuracy: 94.0%
  - Area-weighted producer accuracy: 79.1%
Example Applications of FCDM

Study Site 1

Central African Republic
Republic of the Congo
High Sensitivity of Monitoring (Forest Disturbance in CAR)

Disturbance events before analysis period

Disturbance events during analysis period

VHR 06.2019
FCDM 2019
High Sensitivity of Monitoring (Forest Encroachment in CAR)

Disturbance events before analysis period

Disturbance events during analysis period

Omitted disturbance events during analysis period
High Sensitivity of Monitoring (Selective Logging in CAR)

Disturbance events before analysis period

Disturbance events during analysis period

Omitted disturbance event during analysis period
Example Applications of FCDM

Study Site 2

Cameroon
Republic of the Congo
Temporal Information (Forest Concession in Congo)
Temporal Information (Forest Concession in Congo)

Single tree extraction sites
Temporal Information (Forest Concession in Congo)
Temporal Information
(Forest Concession in Congo)

Logging in 2019
(maybe not managed
during 2018 period)
High Sensitivity of Monitoring (Forest Disturbance in Congo)

Difficulty to detect disturbances visually

Disturbance event before analysis period

Omitted disturbance events during analysis period

Disturbance events during analysis period
High Sensitivity of Monitoring (Forest Disturbance in Congo)

Difficulty to detect disturbances visually

Omitted disturbance events during analysis period

Disturbance events during analysis period
High Sensitivity of Monitoring (Forest Concession in Congo)

Higher sensitivity compared to other systems (GLAD)

Logging infrastructure already established in 2018 → No signal in 2019 result
Added Value of FCDM Products

- Monitoring of disturbances in different forest types (evergreen, seasonal, mangrove, …)
- Detection of both large-scale (deforestation) and small-scale (degradation) tree canopy changes
- Detection of short-term (visible) tree canopy changes
- Flexibility in selecting the monitoring period
- Flexibility in selecting a threshold value (binary mask)
- Capacity to monitor disturbances in areas of frequent/permanent cloud cover
- Capacity to monitor disturbances in mountainous areas
Conclusion

Capacity to detect forest disturbances/ degradation

• Change detection approach is sensitive to small-scale and/or weak signal (e.g. removal of single trees)

• Change detection approach analyses every available image over analysis period, thus allowing to detect even short-term disturbances

• Radar-based approach allows monitoring independent of cloud coverage

• Radar-based approach allows differentiation between seasonal changes and actual disturbance events
Acknowledgements and References

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Thank you for your attention

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