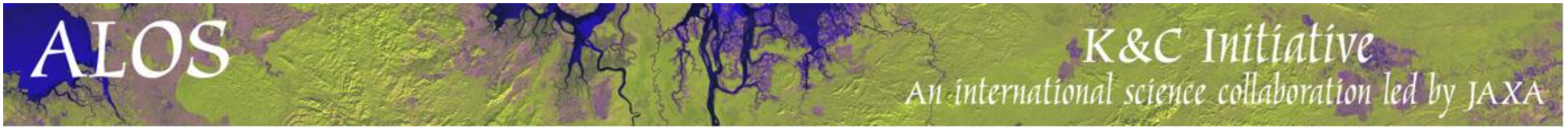


Post-K&C – First Report

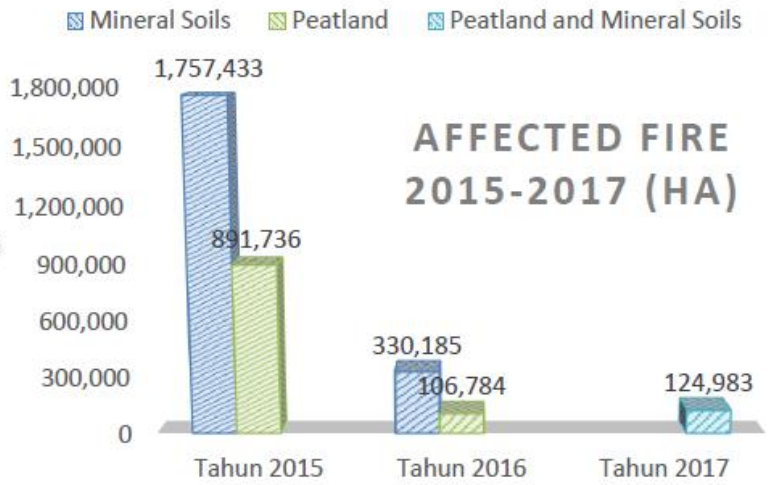
Development of Digital Services for Peatland Monitoring

Rahmat Arief[1], Orbita Roswintiarti[1], Dede Dirgahayu[1], Ita Carolita[1], M Taufik[2], Dirk Hoekman[3]

[1]Indonesian National Institute for Aeronautics and Space (LAPAN), [2]IPB University, [3]Wageningen University

Post-KC Science Team meeting #1
Tokyo, Japan, January 20-24, 2020

Peatland in Indonesia : An Overview



INDONESIA — **15 million ha**

7 Provinces — **13 million ha**

BRG Restoration MANDATE
2 Million ha in 7 province

Riau,
Jambi,
South Sumatera,
West Kalimantan,
Central Kalimantan,
South Kalimantan,
Papua

BRG Restoration TARGET (7Province)

2,5 million ha
104 PHU

Non Concession Area:
1.1 Million Ha
Funded by State Budget

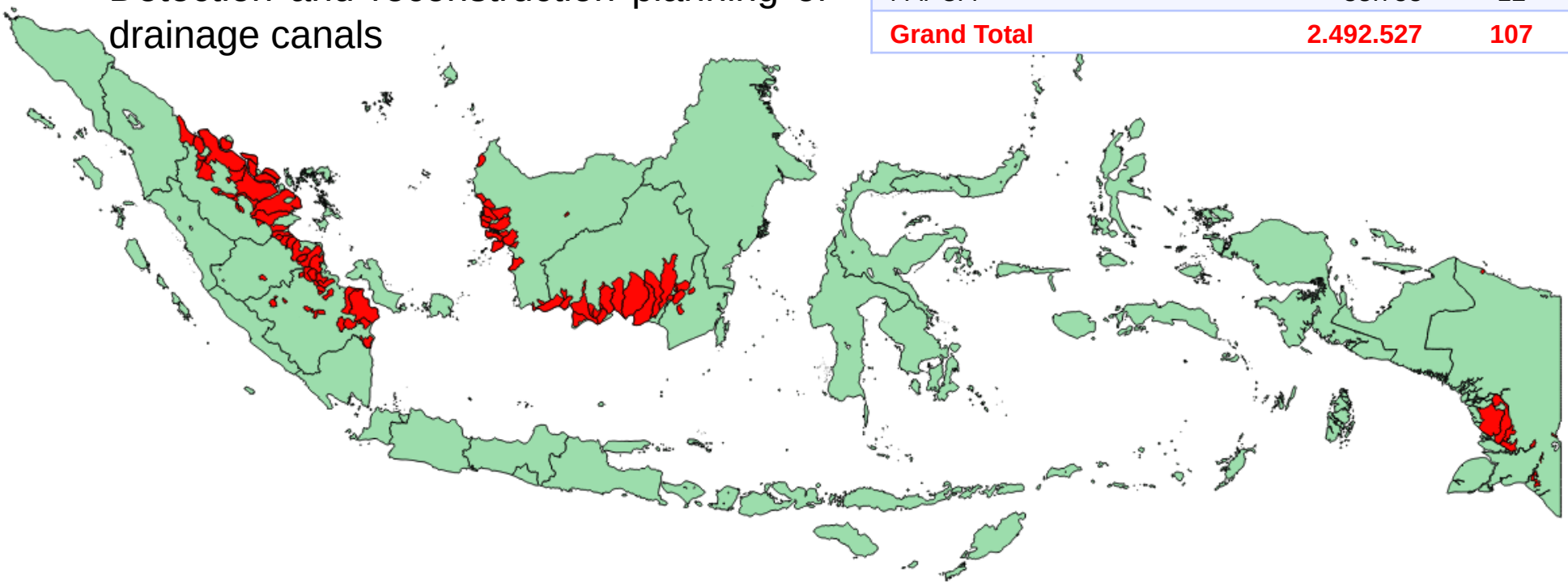
Concession Area:
1,4 Million Ha
Concession responsibility under MoEF coordination

Source : BRG

Priority areas in 7 provinces

- Mapping of Peatland
- Mapping of Forest cover change
- Mapping of soil moisture
- Monitoring of hydrology
- Detection of Peat forest fire and burn scar
- Detection and reconstruction planning of drainage canals

Province	Area [Ha]	PHU
RIAU	814.732	24
JAMBI	151.663	10
SOUTH SUMATERA	615.907	25
WEST KALIMANTAN	119.634	17
SOUTH KALIMANTAN	38.761	4
CENTRAL KALIMANTAN	713.076	19
PAPUA	38.753	12
Grand Total	**2.492.527**	**107**



Project outline and objectives

The objectives of the proposed development are

(1) to demonstrate the innovative applications for peatlands monitoring and rehabilitation focused on 3 main thematic information products:

- **a) Monitoring of forest fire**
- **b) Monitoring of soil moisture**
- c) Detection of new drainage canals

(2) to demonstrate the satellite data digital services for multi sensor satellite data such as Landsat7/8, SPOT6/7, Sentinel-1, Sentinel-2, ALOS2 PALSAR2 ARD, and MODIS.

User Requirement : Role of Remote Sensing for supporting Peatlands monitoring (LAPAN – BRG Meeting)

- Hotspot from MODIS/ VIIRS from Terra/Aqua/SNPP/NOAA
- Rainfall rate from Himawari-8
- Landcover change (re-vegetation dan de-vegetation)
- Fire Danger Rating System (FDRS):
  - FFMC (Fine Fuel Moisture Code)
  - DC (Drought Code)
  - FWI (Fire Weather Index)
- *Soil Moisture (Proxies indices with in situ measurement)*
- *Ground Water Level (Proxies indices with in situ measurement)*
- *Burn Area*
- *Drainage Canal network in Peatlands (Wageningen University)*

(Goal 1a) Forest Fire Monitoring

Early Warning

- FDRS
- Rainfall

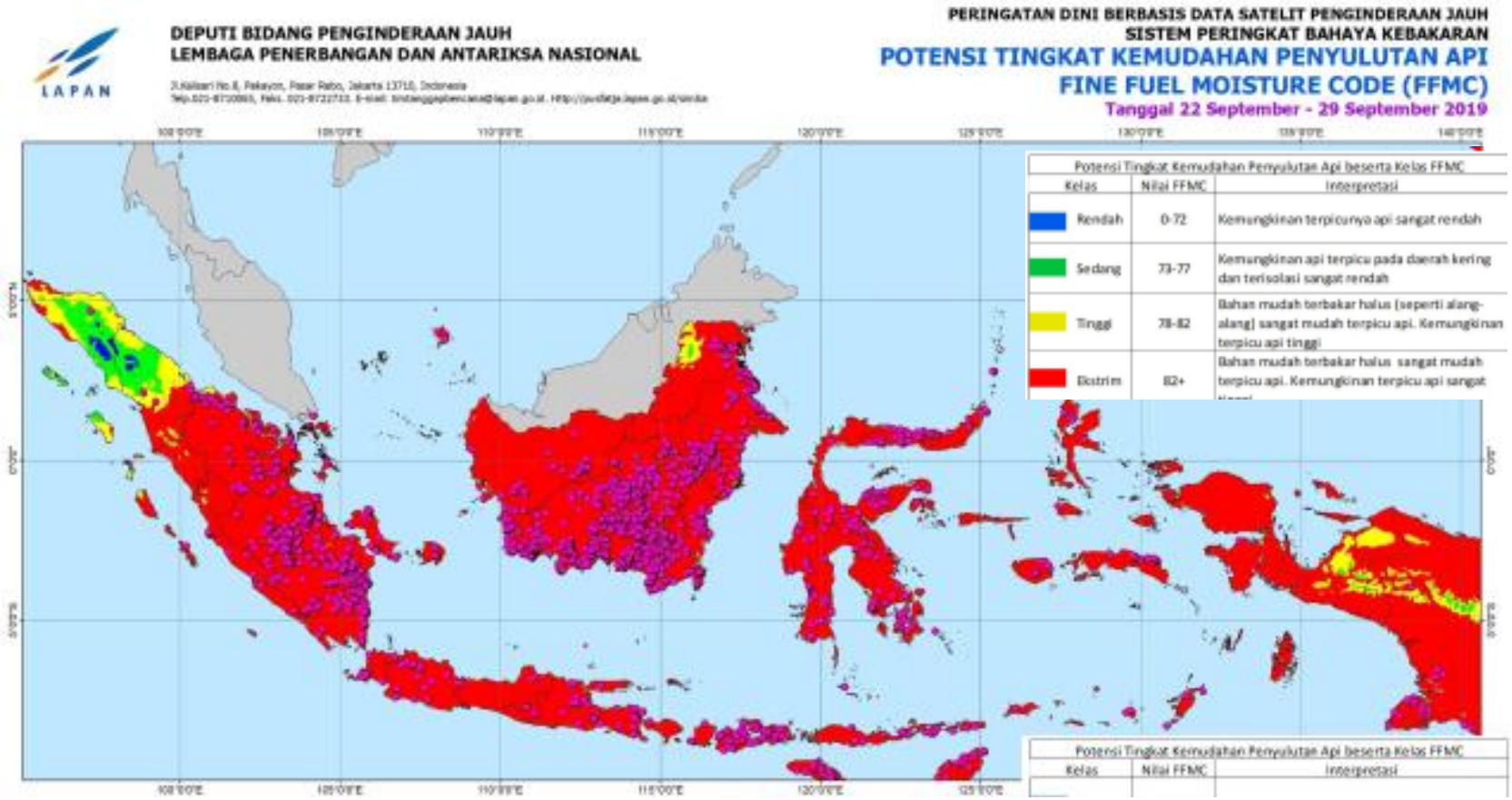
Emergency Response

- Hotspot/active fire
- Smoke

Affected Area

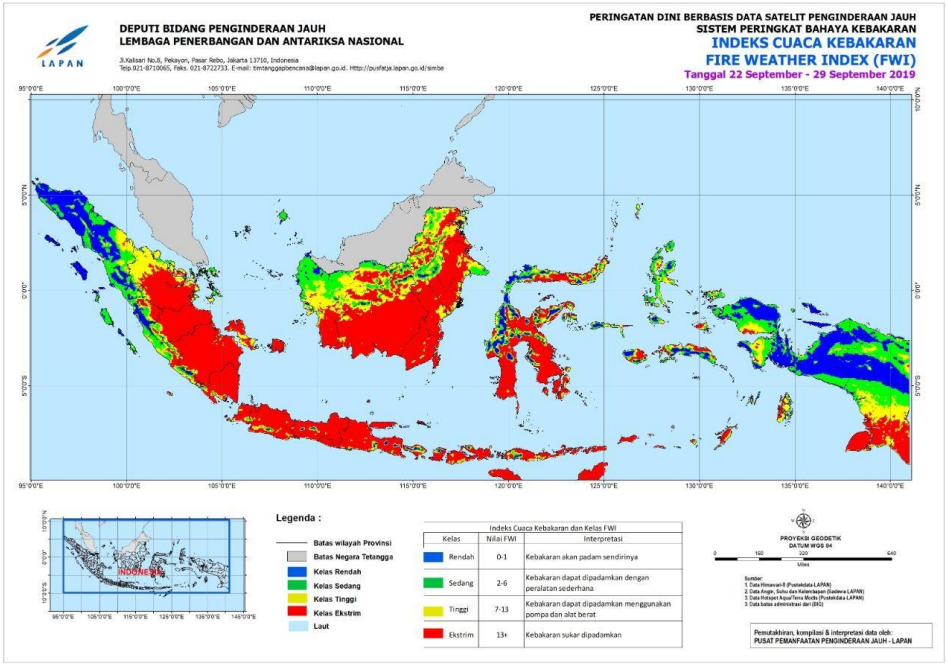
- Burnt area

Fire danger rating system (FDRS)

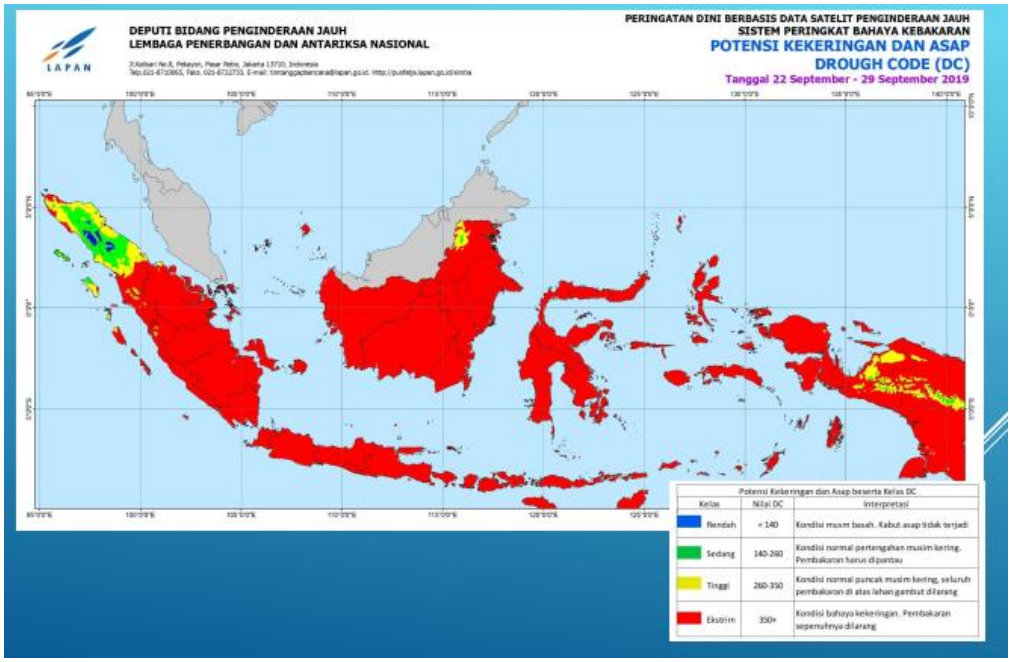


Fire danger rating system (FDRS) using remote sensing data i.e. drought code (DC) and fine fuel moisture code (FFMC) as an early warning program for forest/land fire. Hotspot from MODIS/VIIRS (Purple dots)

FIRE WEATHER INDEX



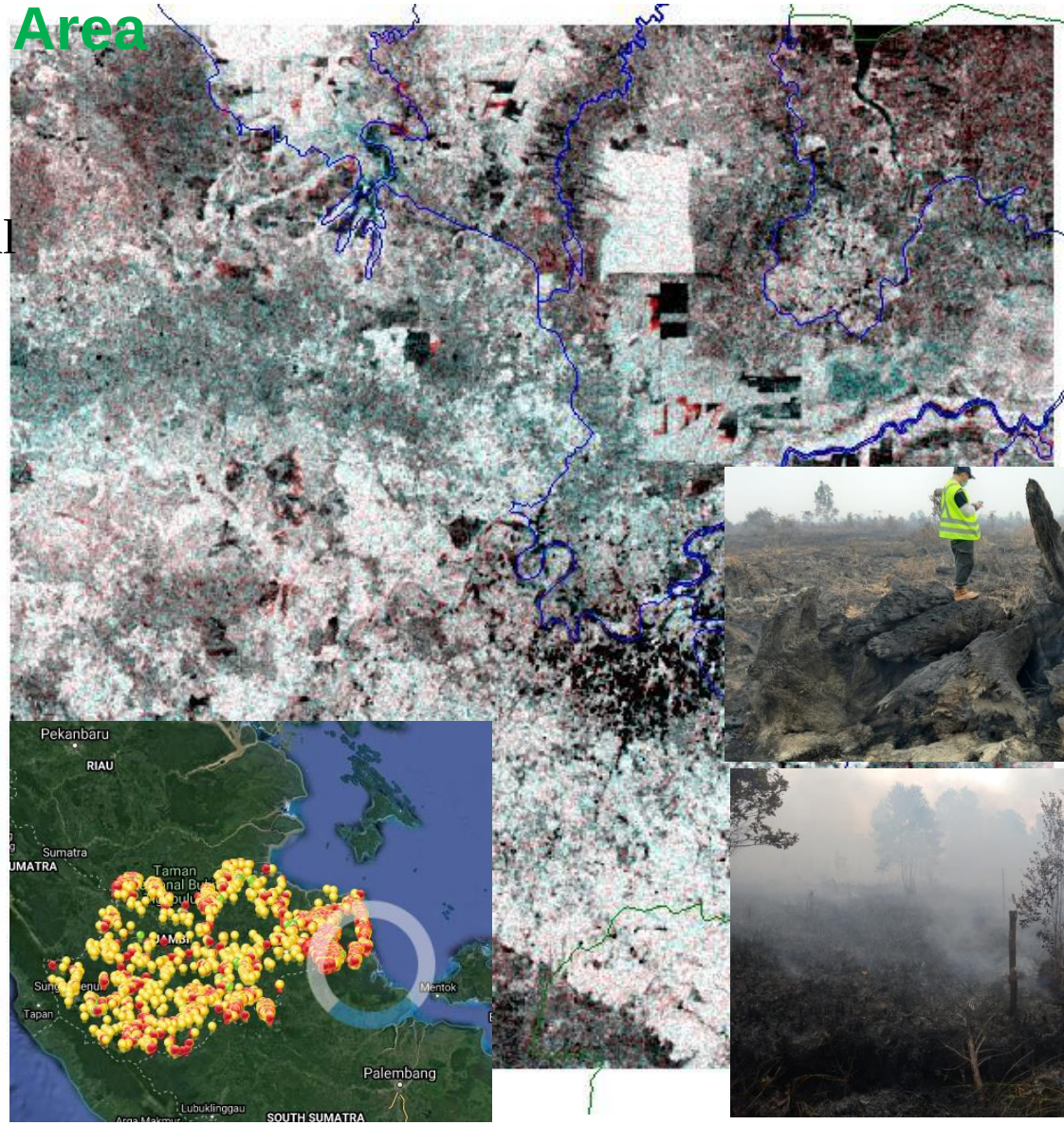
Drought and smoke Potential



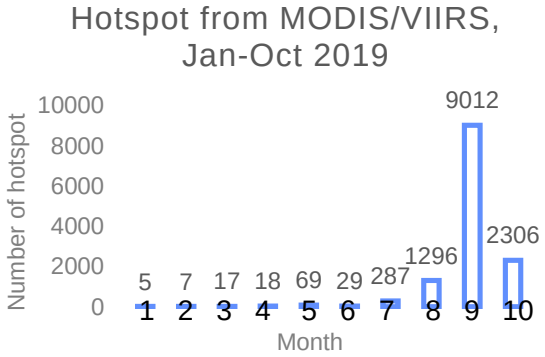
Estimation of Burnt Area

ALOS2-PALSAR2
JJFAST Scansar 50m
RGB Composite – Temporal
R: **20190628**
G/B : **20190728**
Pre-Processing:
- Calibration
- Speckle Filtering (Frost 5x5)

Blue Line : Peatlands



Location : Jambi Province Tile S03E113



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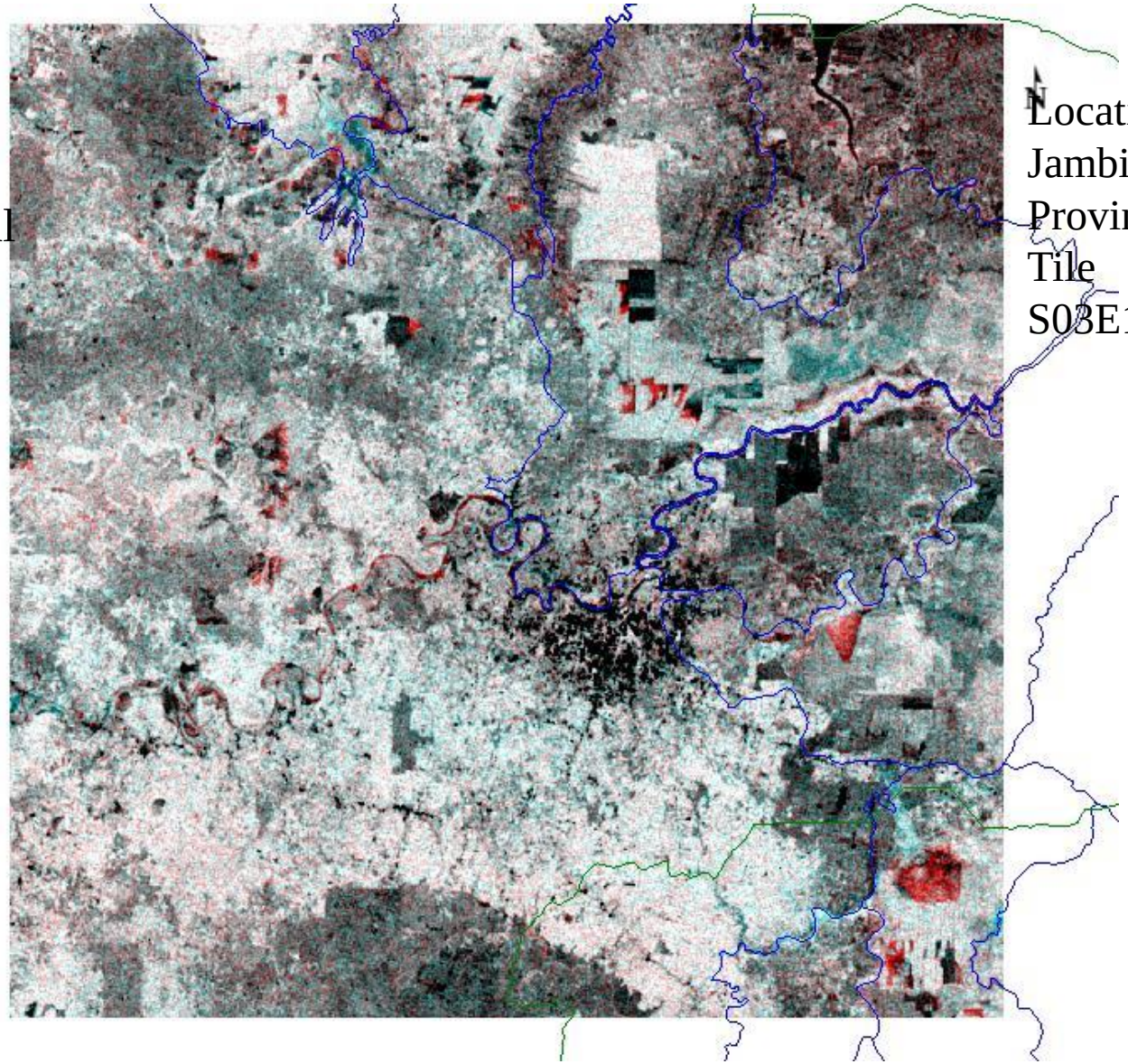
ALOS2-PALSAR2
JJFAST Scansar 50m
RGB Composite – Temporal
R: **20190628**
G/B : **20190823**



Location :
Jambi
Province
Tile
S03E113

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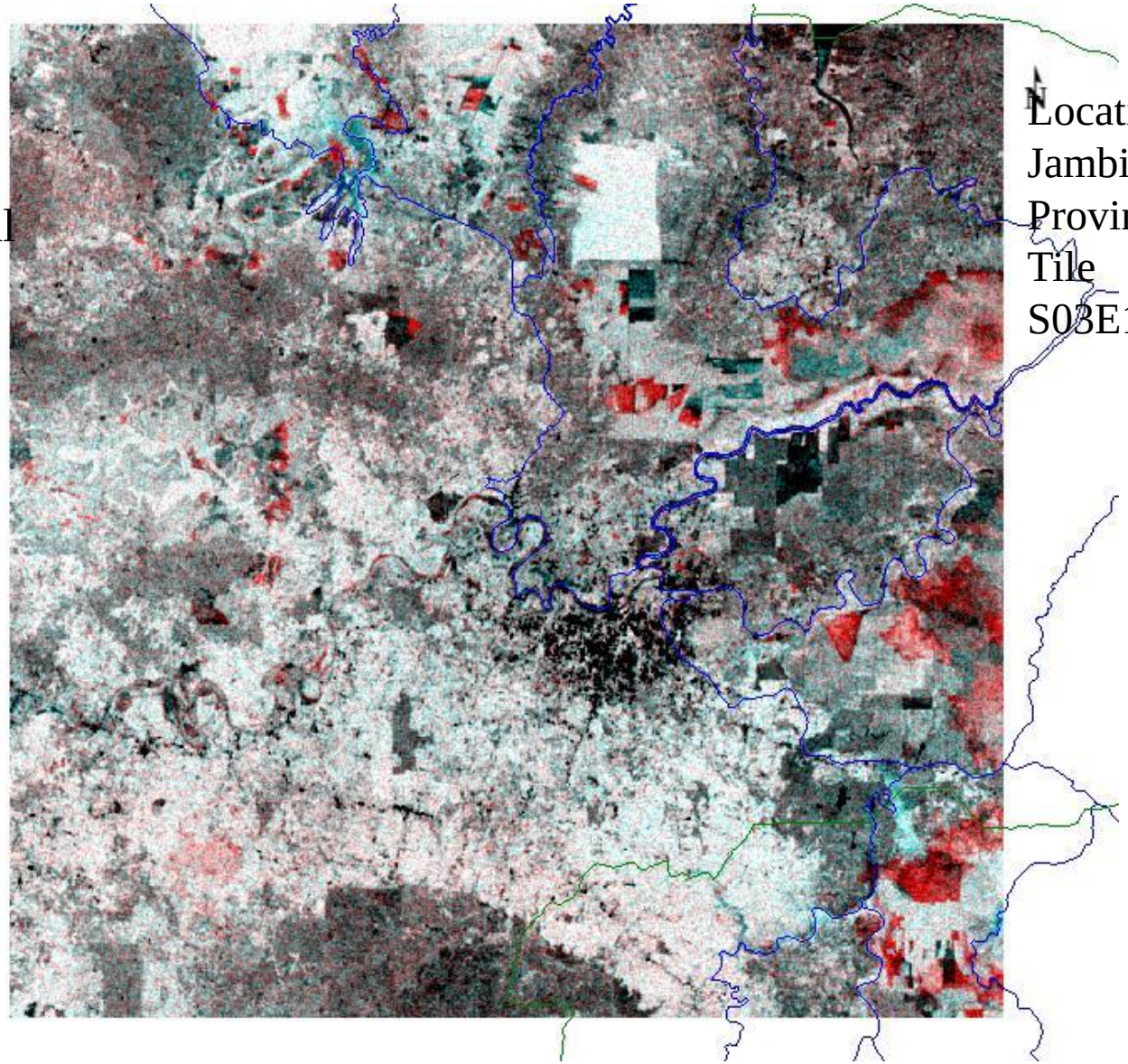
ALOS2-PALSAR2
JJFAST Scansar 50m
RGB Composite – Temporal
R: **20190628**
G/B : **20191004**



Location :
Jambi
Province
Tile
S03E113

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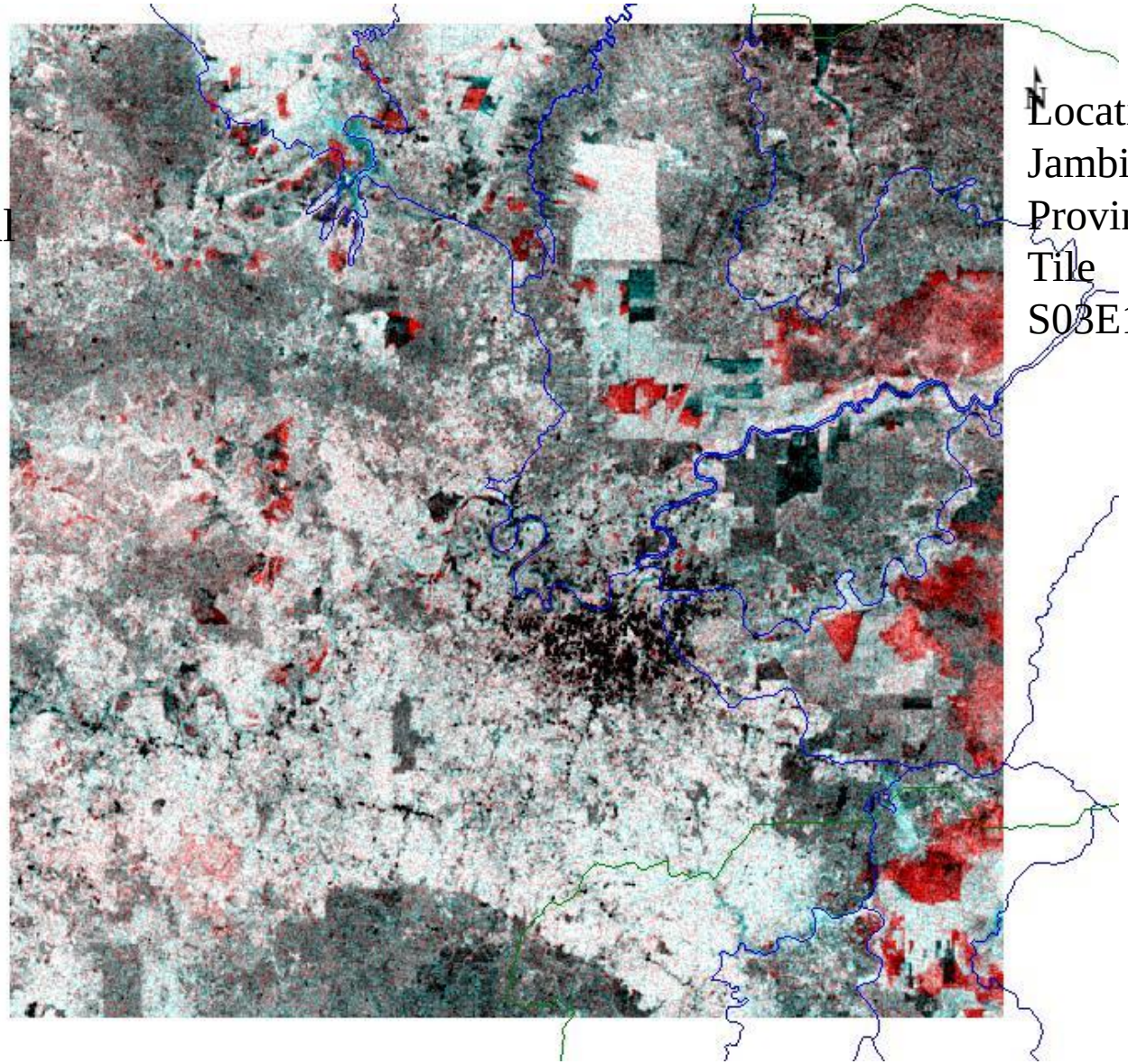
ALOS2-PALSAR2
JJFAST Scansar 50m
RGB Composite – Temporal
R: **20190628**
G/B : **20191018**



Location :
Jambi
Province
Tile
S03E113

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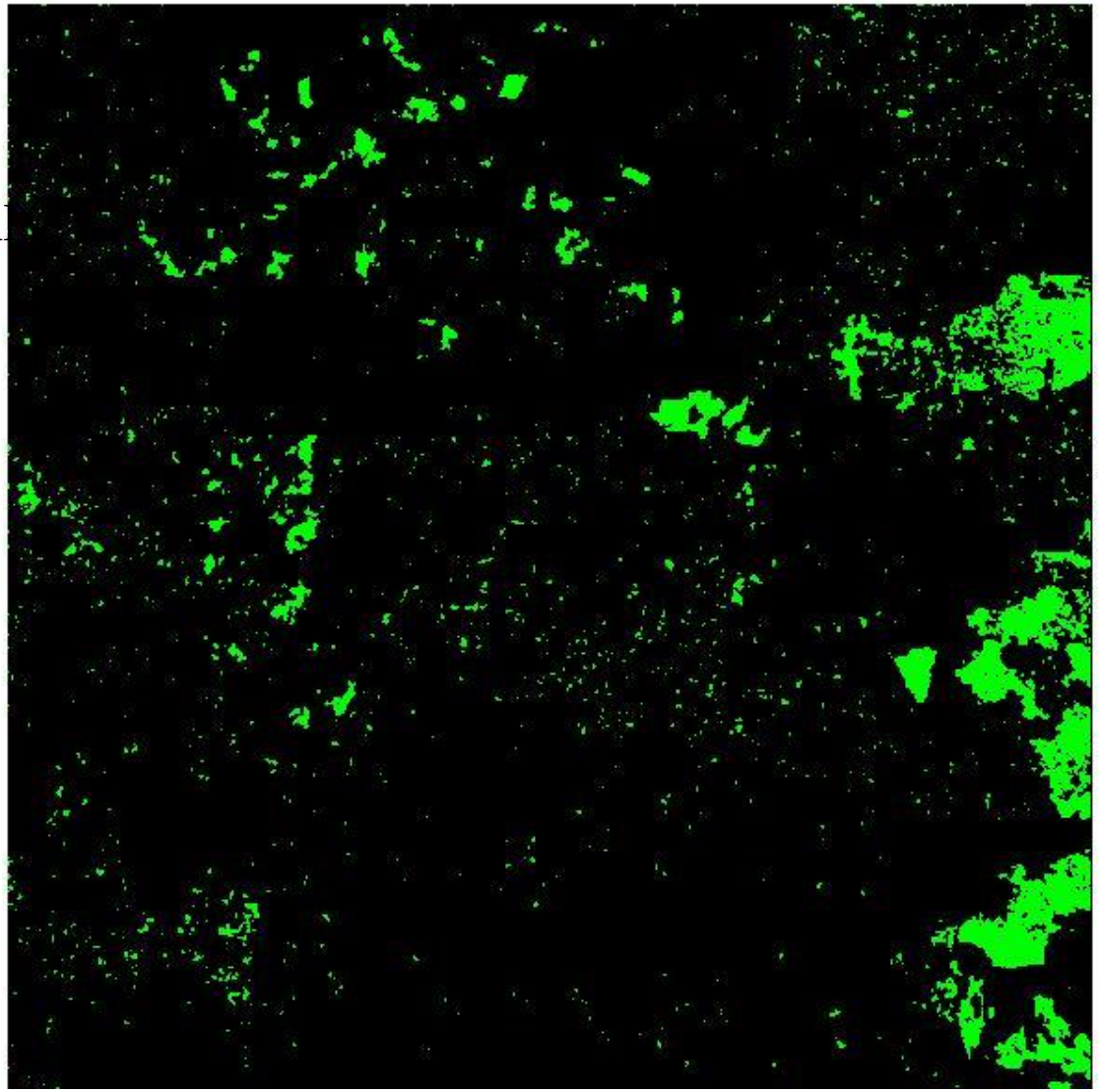
ALOS2-PALSAR2
JJFAST Scansar 50m
RGB Composite – Temporal
Pre : **20190628**
Post : 20191018

Change Detection using
threshold
and Segmentation



N

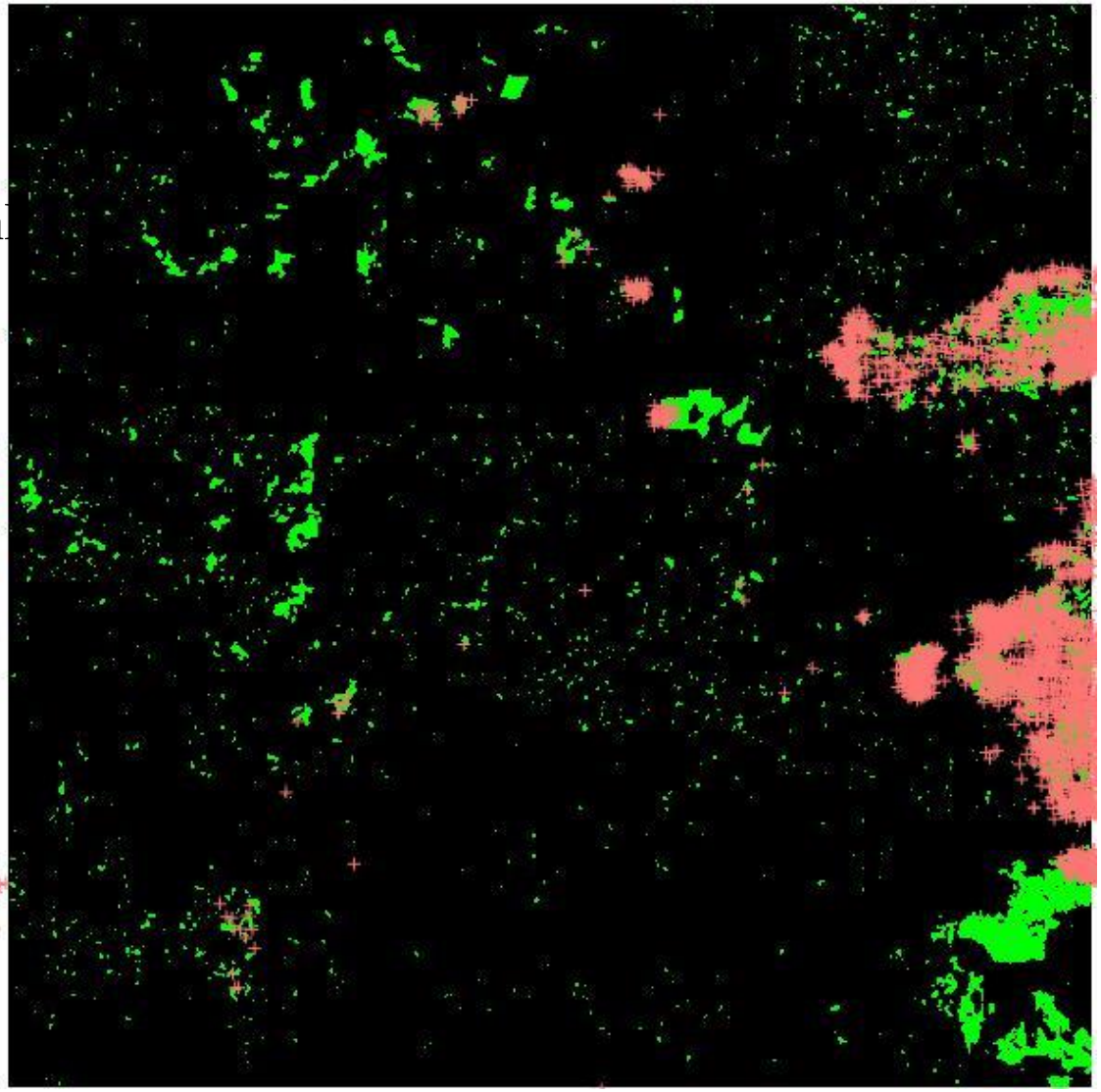
Location :
Jambi
Province
Tile
S03E113

ALOS2-PALSAR2
JJFAST Scansar 50m
RGB Composite – Temporal
Period:
20190628 - 20191018

Green polygon :
Change Detection of
using threshold
and Segmentation

Red dots :
hotspot (MODIS/VIIRS)
from 20190628-20191018

How to distinguish burn
area and change?



Location :
Jambi
Province
Tile
S03E113

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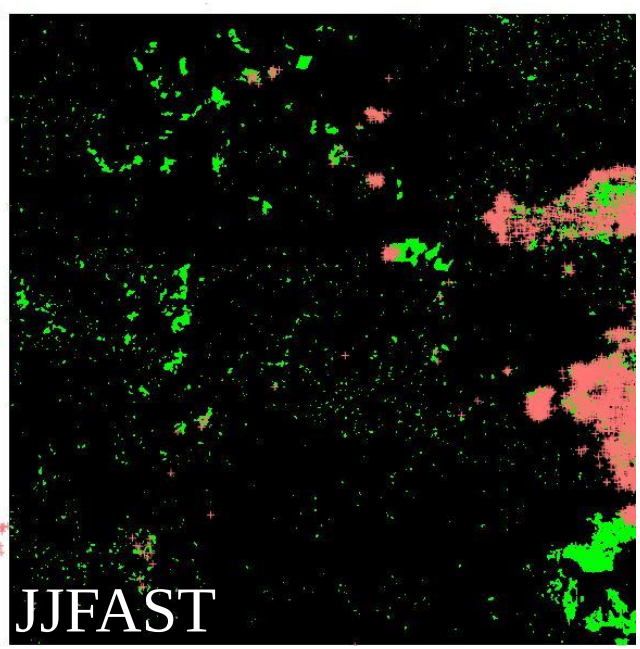
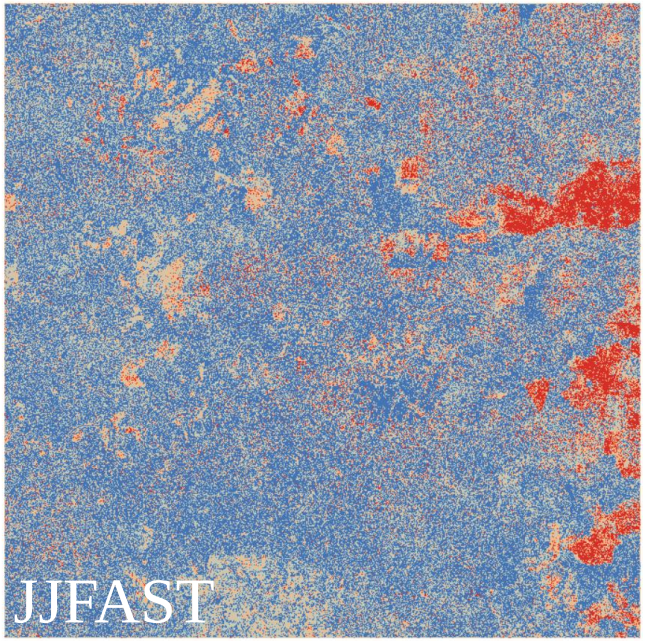


Green polygon :
Change Detection of using threshold and smoothing

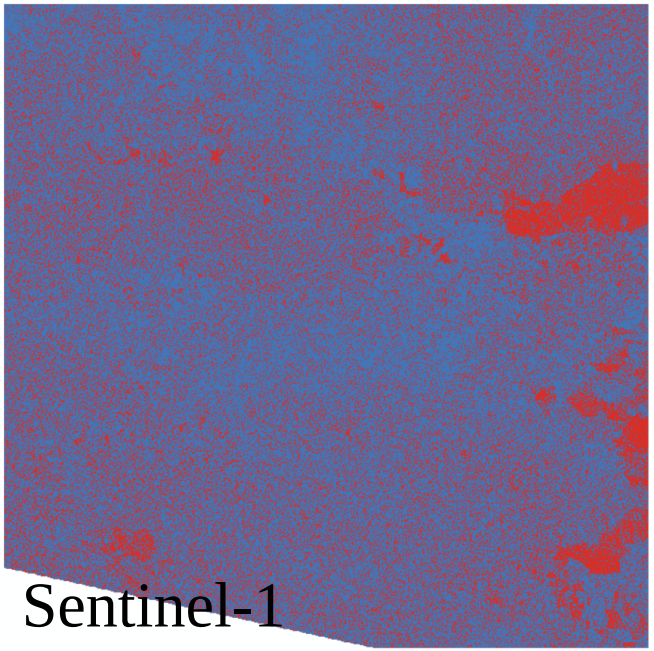
Pink dots :
hotspot (MODIS/VIIRS) from 20190628-20191018

Train data: Burn and noburn (total 1334 samples), Number of trees: 500



Random Forest classification of JJFAST
Input : Pre HH, Pre HV, Post HH, Post HV, NDiff HH, Ndiff HV
Probability :

- 0 - 0.168627451
- 0.168627451 - 0.356862745
- 0.356862745 - 0.631372549
- 0.631372549 - 1

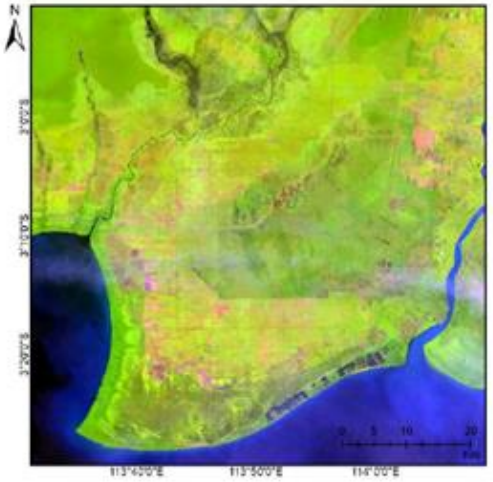


Random Forest classification of Sentinel 1
Input : Pre VV, Pre VH, Post VV, Post VH, NDiffVV, NDiffVH
Probability :

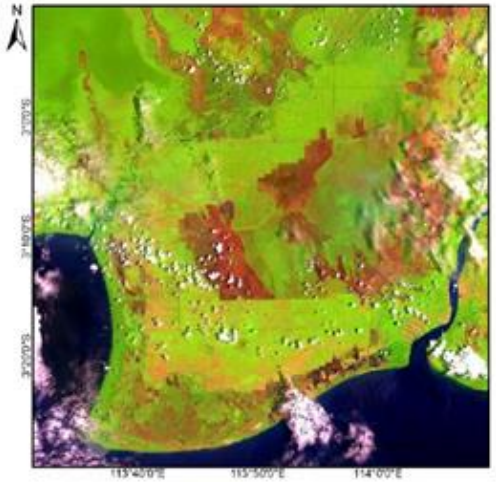
- 0 - 0.419607843
- 0.419607843 - 1

Confusion Matrix	BURN	NOBURN
JJFAST	0.252	0.1696
Sentinel-1	0.35	0.292

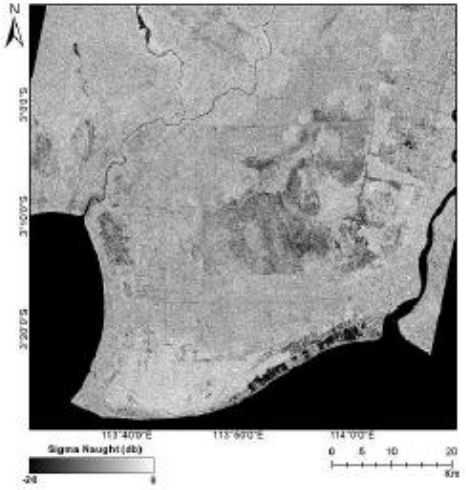
Combination Difference NBR (L8) and Sentinel-1



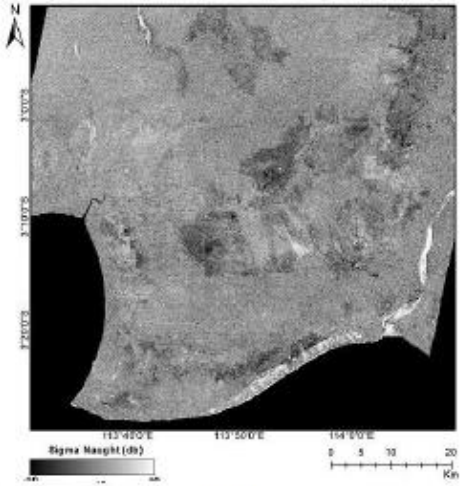
Landsat-8 RGB 654, 23 March 2019



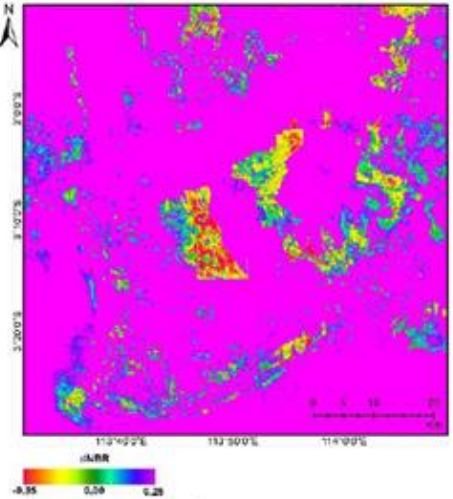
Landsat-8 RGB 654, 17 October 2019



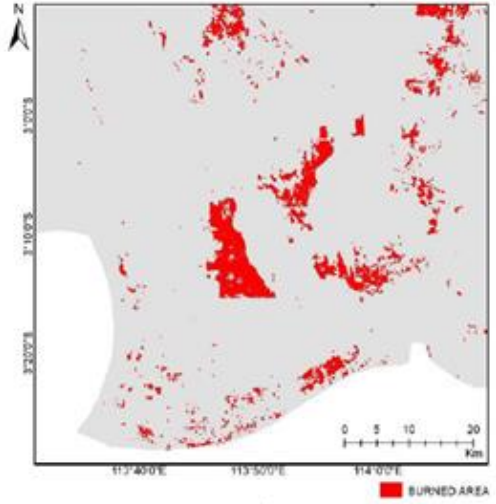
VH



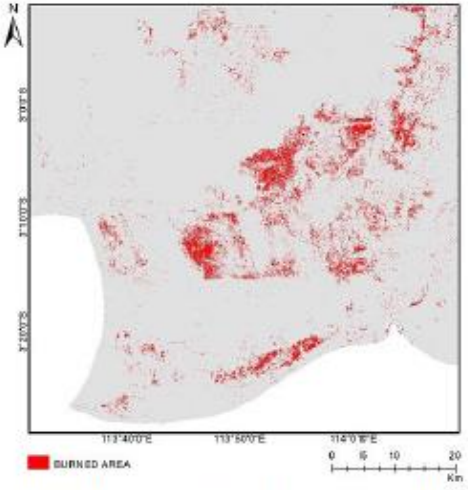
VV



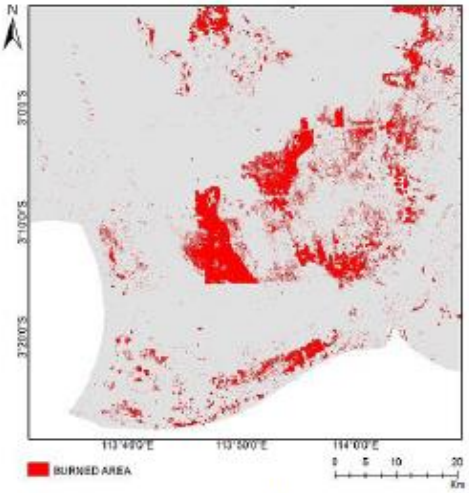
dNBR
(23 March 2019 - 17 October 2019)



Burned area
(period 23 March 2019 - 17 October 2019)



Burned area extracted from Sentinel-1



Burned area extracted from Sentinel-1 combined with burned area extracted

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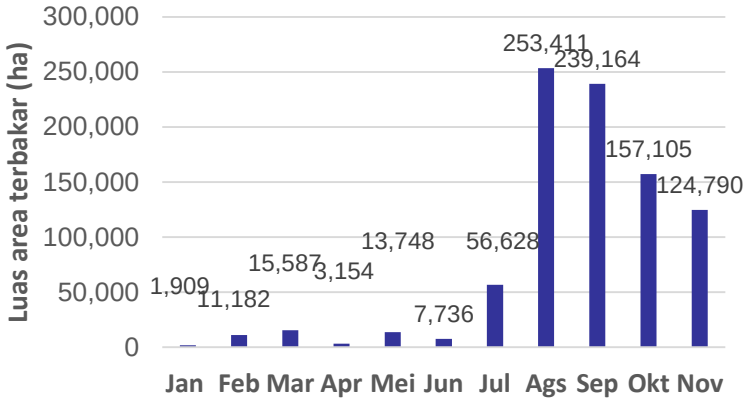
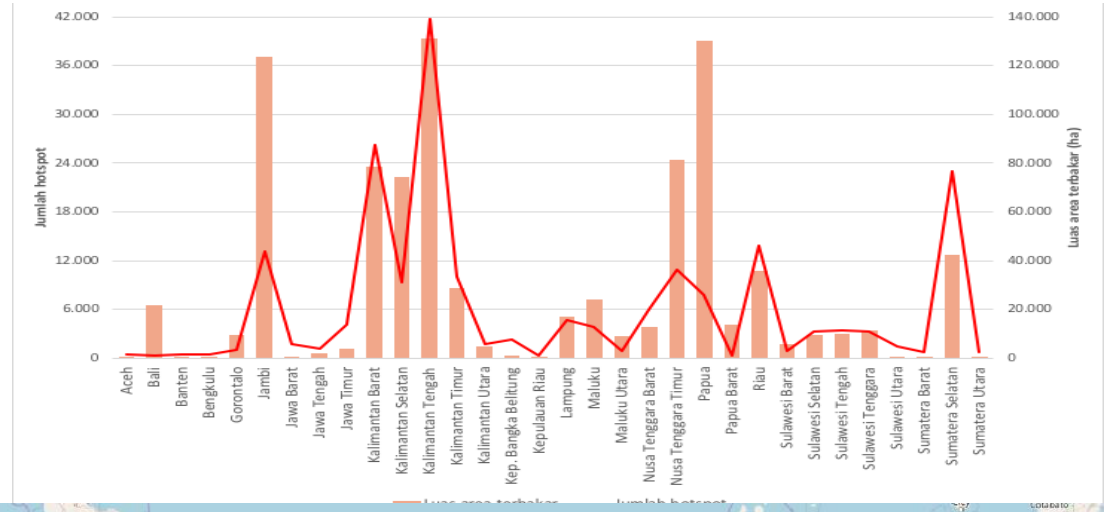
Estimation of Burnt Area (January - November 2019) in Indonesia



Estimation of Burnt Area per province (January - November 2019)

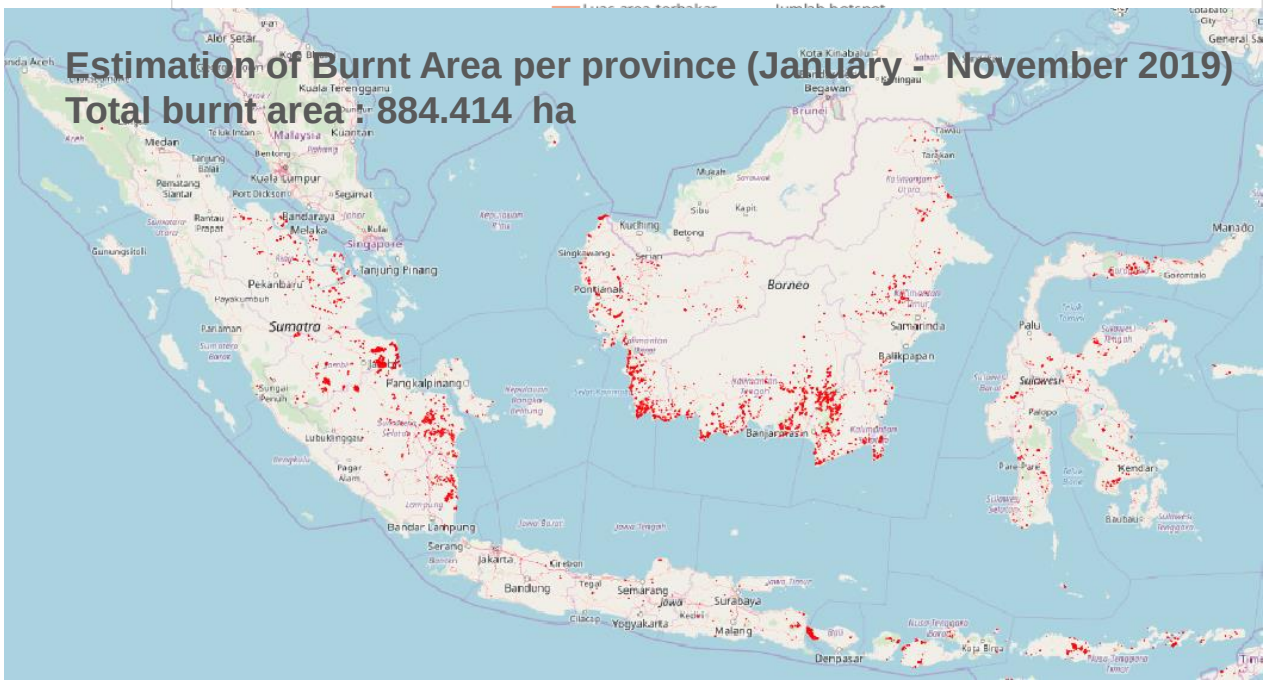


Next Steps

- Still need to be validated

Estimation of Burnt Area per province (January - November 2019)

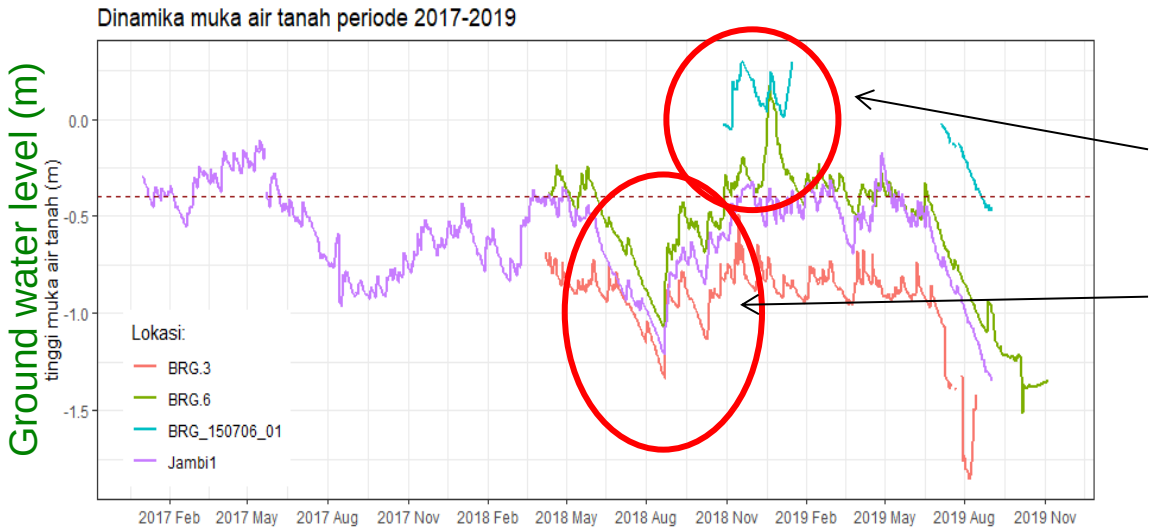
Total burnt area : 884.414 ha

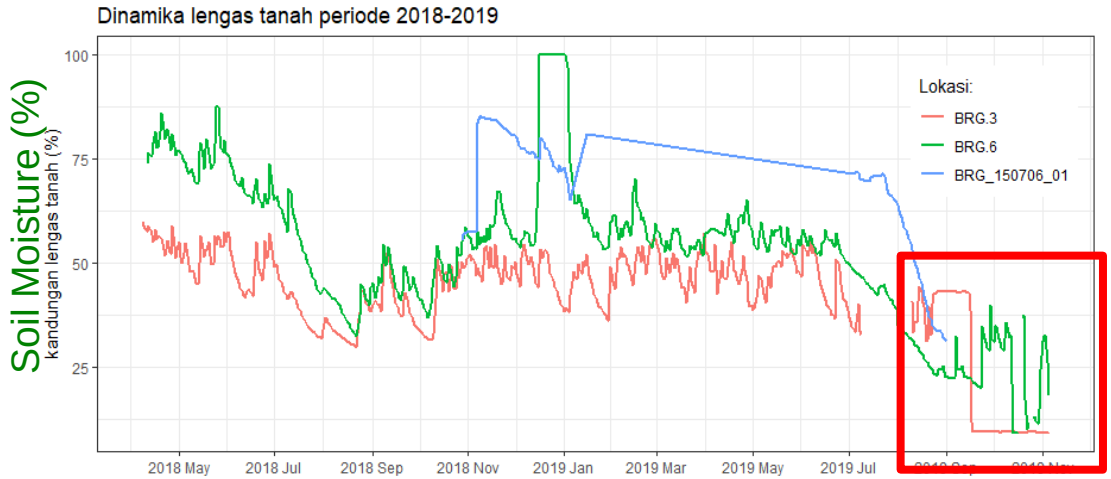


(Goal 1b) Soil moisture Estimation in Peatland

- Observation data of soil moisture and ground water level from 42 BRG sesame stations are used to build a model of spatial peat soil moisture estimation
- The soil moisture estimation model is built from the relationship between observation soil moisture and the Normalize Difference Polarization Index (NDPI) parameter from backscatter VV/VH of Sentinel-1
- The combined conditions of wetness and roughness of plant canopies on peatlands affect the humility of the underlying land (dielectric changes in objects). Therefore the use of the NDPI Index is used directly to estimate soil moisture

GWL and soil moisture time series at the same observation station of Jambi Province visited on 26-28 August 2019.

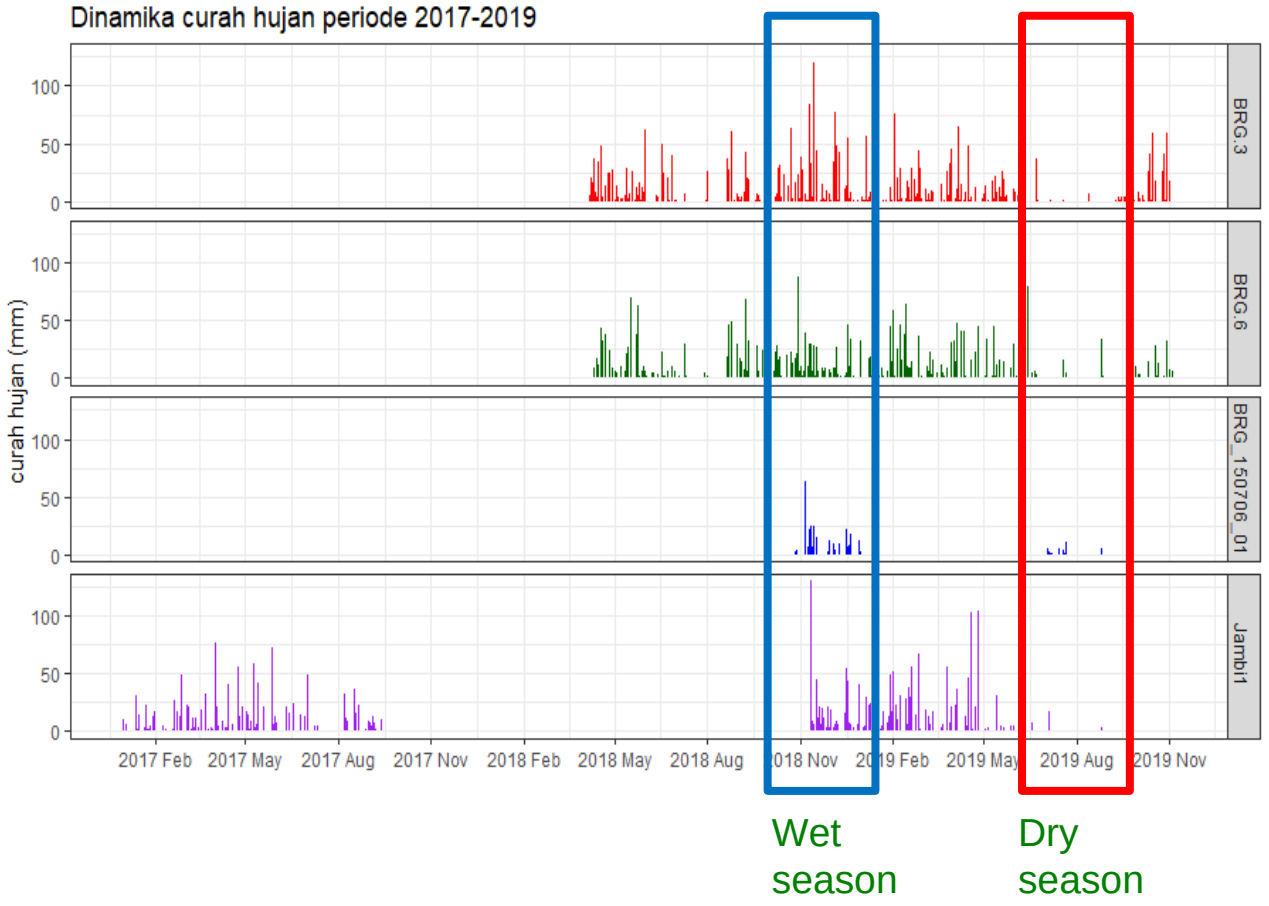




- GWL variations are below -0.1 m even in the rainy season, except BRG.6 and BRG_150607_01 Station
- BRG.6 Station was flooded during the period 18-27 December 2018 with a maximum TMA reaching 0.25m
- In the dry month period (July-August), the TMA value at the five stations experienced a massive decline and reached its lowest point each year at the end of August

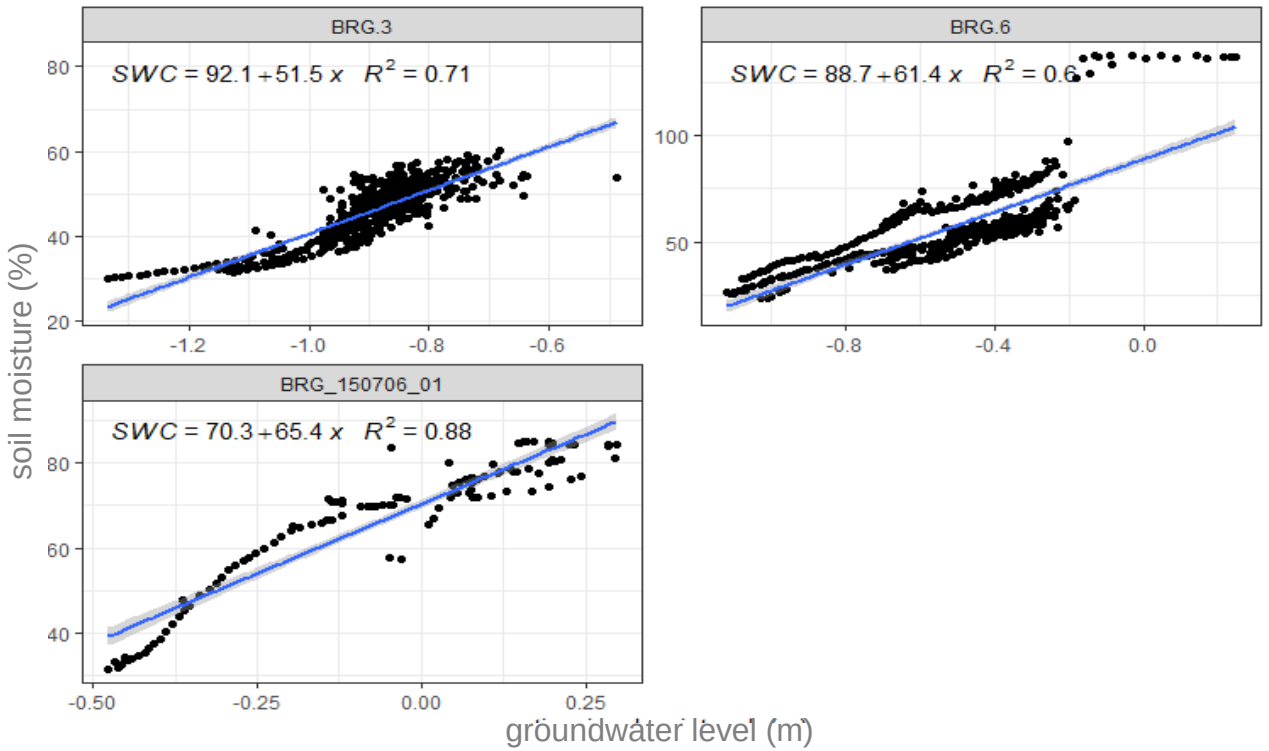
- Sesame tool measures SM at depths of 0-10 cm. The five stations show similar patterns of SM variation
- In general, the upper layers of peat are in wet conditions during the rainy season, and the humidity decreases during the dry season period.
- The soil moisture value has a correlation with the dynamics of the ground water level. High ground water level tends to produce high soil moisture value

Rainfall time series at the same observation station of Jambi Province visited on 26-28 August 2019.



- The study locations has two peaks in the rainy season, February-April and October-December.
- During the month the rainfall was very high to reach 100mm / day as happened at BRG station.3 (120mm, 11 November 2018), and Jambi.1 (130 mm, 12 November 2018; 104 mm, 19 & 26 April 2019).
- The lowest rainfall occurs around July-August

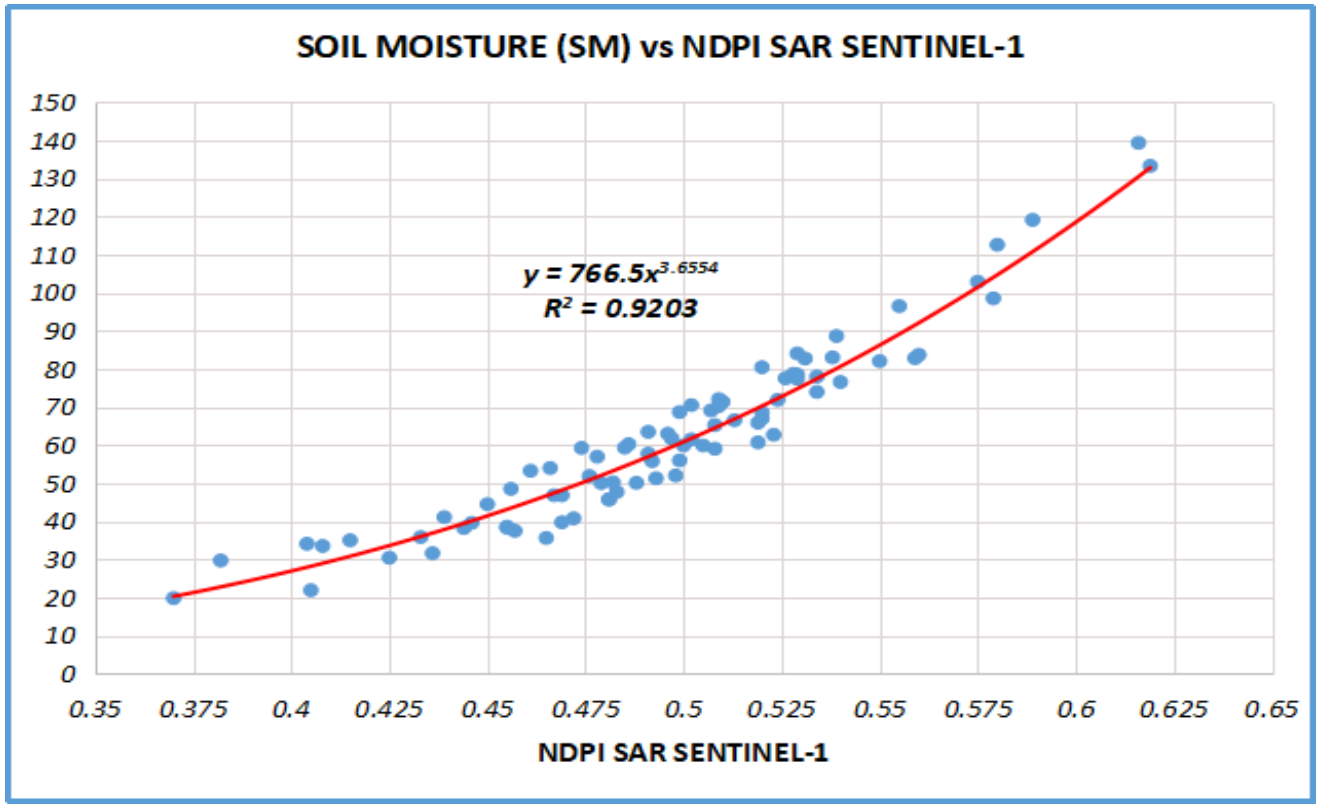
Hydrometeorological data correlation



- In general there is a positive and linear correlation between soil moisture and ground water level with a correlation coefficient > 0.7.
- With this fact, soil moisture parameters can be used to estimate water levels

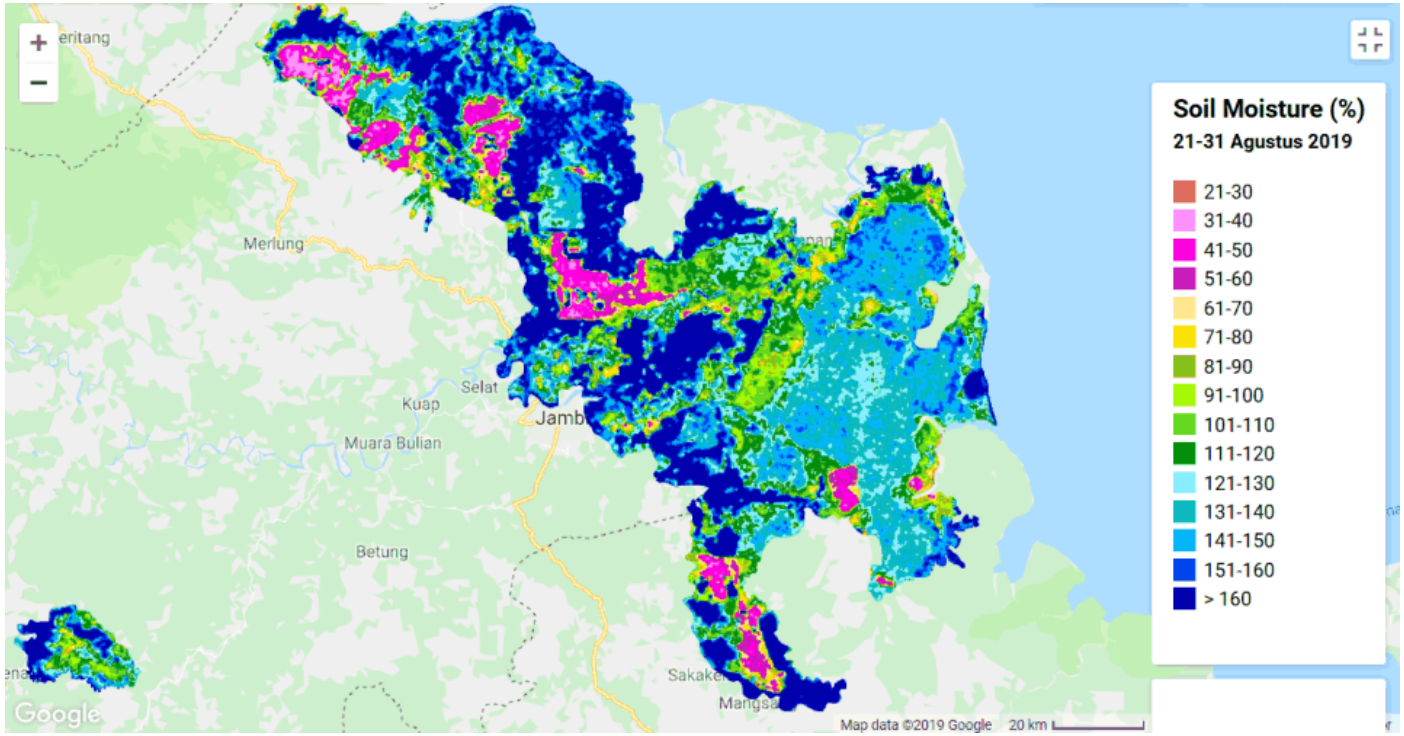
Correlation between soil moisture (% in y axis) and groundwater level (m in x axis) for stations BRG.3, BRG.6 and BRG_150706_01 (near the burnt location)

Correlation between soil moisture (SM in %) with NDPI SAR parameters from Sentinel-1 images



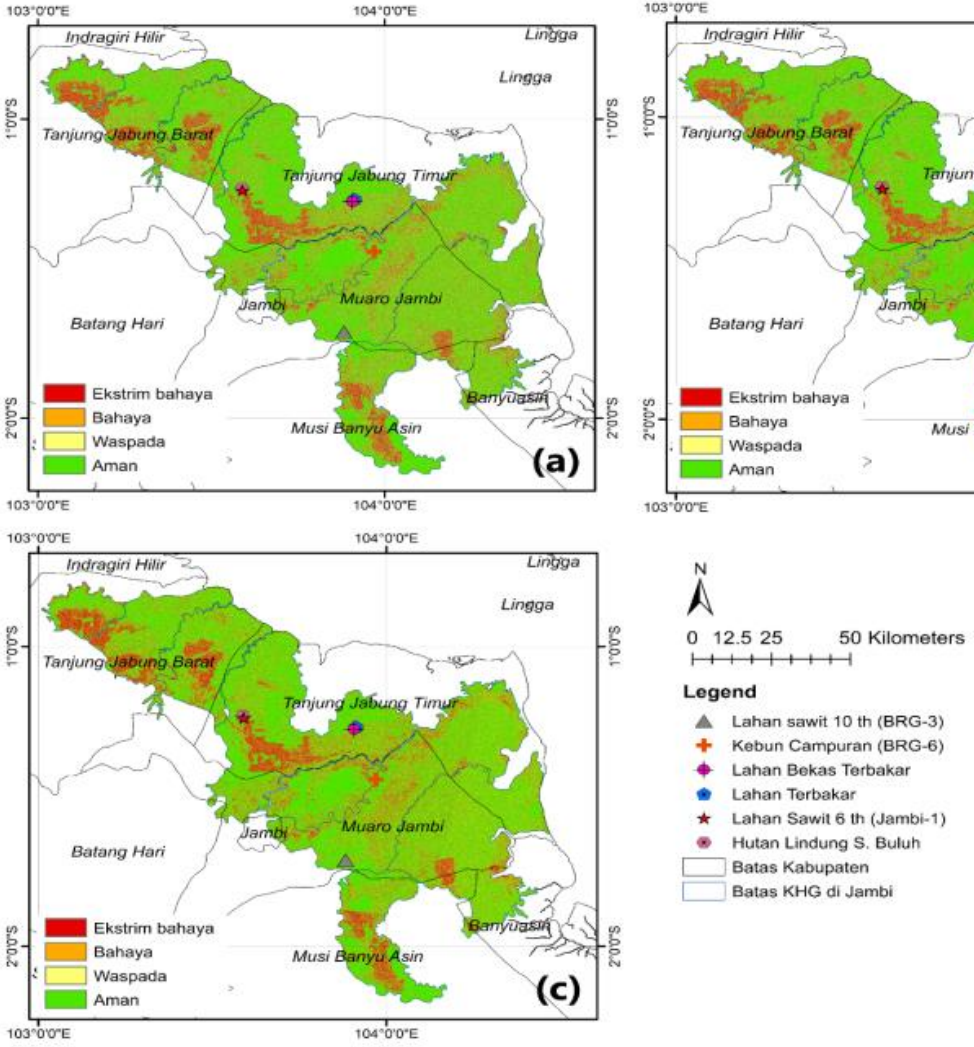
- The increase SM causes a significant increase in NDPI.
- NDPI threshold value of around 0.4 indicates a slightly dry SM condition (<30%)
- NDPI threshold values around 0.575 indicate high SM (> 100%)

Estimation of soil moisture in KHG Jambi on August 2019



- The soil moisture condition in the Peatlands of Jambi region is mostly in the wet category (> 91%)
- Sungai Buluh has soil moisture values ranging from 121-130%.
- Low soil moisture (<40%) with red magenta is detected in some areas

Peat Fire Vulnerability Mapping



the vulnerability of Jambi peatland fires from on (a) ten days 1, (b) ten days 2, and (c) ten days 3 in August 2019 periods did not change much. Several spots in the same area were identified as dangers to forest fires, namely in the Districts of East and West Tanjung Jabung

Index mKBDI	Ground water level (cm)	Soil Moisture(%)	Status
1 – 100	< 40	> 60	Safe
100 – 200	40 – 60	50-60	Alert
200 – 250	60 – 70	40-49	Danger
250 – 300	> 70	< 40	Very danger

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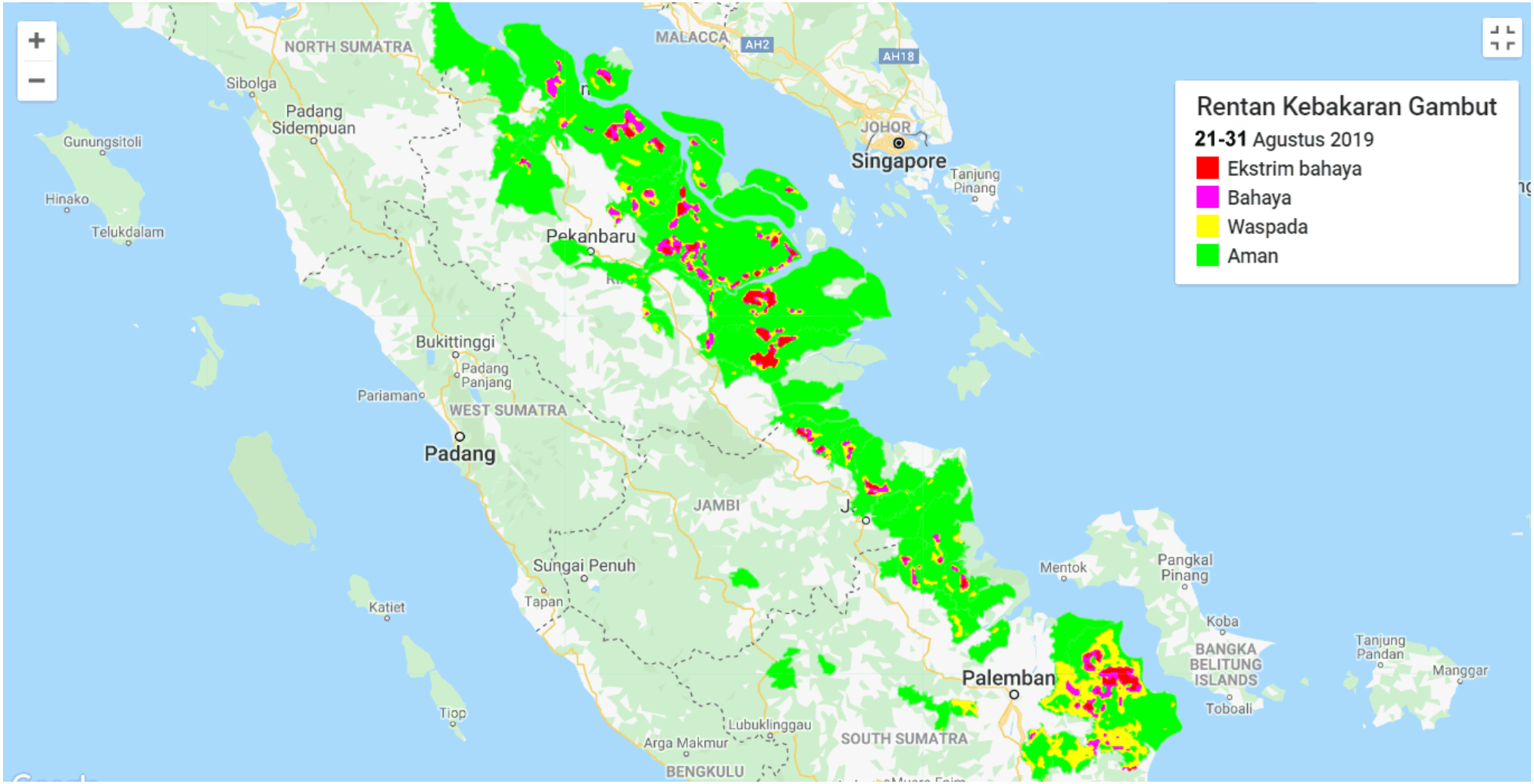
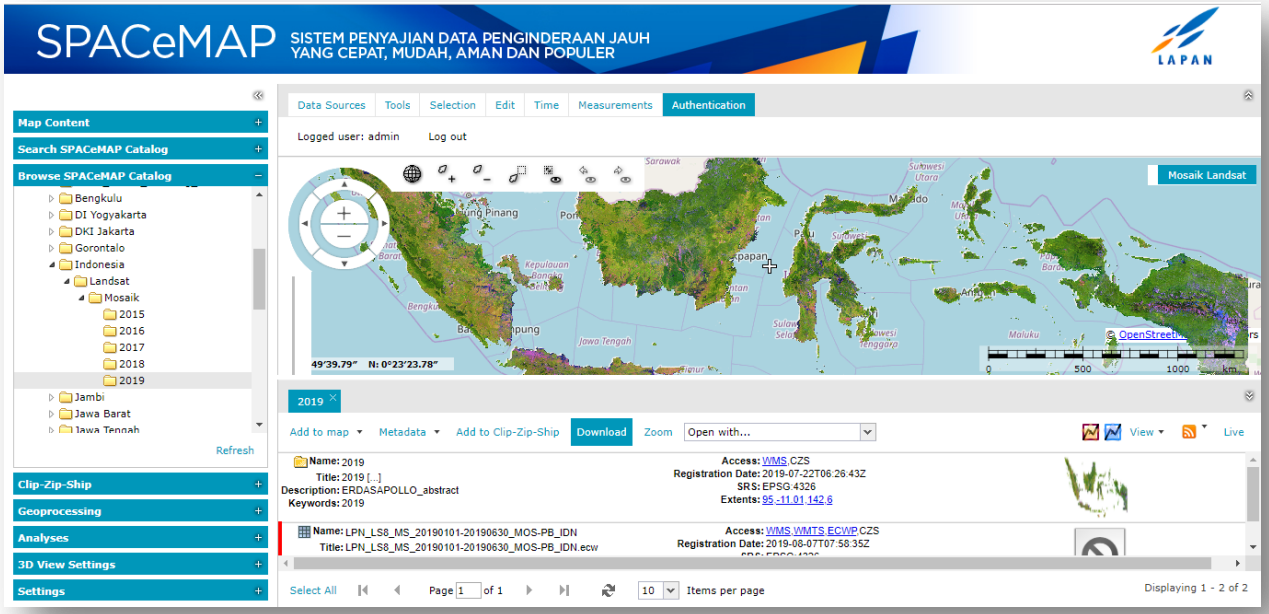
Peat Fire Vulnerability Mapping



(Goal 2) Platform digital services for multi sensor satellite (optical and SAR)



- Acqusition to Product :
  - Data Access ➔ Reflectance/Backscatter ➔ Information extraction ➔ Access ➔ Information Product
- Landsat-8,SPOT6/7, Pleiades, TerraSAR-X, Sentinel-1/2, ALOS2-PALSAR2 Mosaic JJFAST (planned)
- Production of Analysis Ready Data
- Based on Satellite Data Cube Design
- Providing information products via webservices

Deliverables and other output

Describe planned output of your project.

- Project deliverables
  - Distribution of Burnt Areas for the Period of January - November 2019
- Non-peer-reviewed publications (conference papers, reports etc.)
  - The 4th International Seminar on Sensors, Instrumentation, Measurement and Metrology (ISSIMM 2019), Detecting the Burned Area in Southern Kalimantan by Using the Sentinel-1 Polarimetric SAR and Landsat-8 OLI Optic

Summary and Future Plan

- Need to validate the burn area
- Estimation of burnt area (January - November 2019) 884.414 ha. But recapitulation of burn area in Jan-Dec 2019 displayed on the SIPONGI website, total 1,592,010 ha ➔ Sinergy with Ministry of Forestry and Environment to compare the method how to calculate the burn area
- Integration with classification for burn area using JJFAST
- Soil moisture map based on ALOS2 PALSAR2

THANK YOU

Rahmat Arief
rahmat.arief@lapan.go.id