THE ROLE OF REMOTE SENSING TO SUPPORT FOOD SECURITY IN INDDONESIA

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REMOTE SENSING APPLICATION CENTER
NATIONAL INSTITUTE OF AERONAUTICS AND SPACE (LAPAN)

2017

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PRESENTATION OUTLINE

- BACKGROUND : MAIN TASKS AND FUNCTIONS LAPAN BASED ON LAW NO 21 TH 2013 ABOUT SPACE

  - VISI & MISI LAPAN
- SATELLITE DATA RECEIVED FROM LAPAN GROUND STATION
- LOGICAL FRAMEWORK : ROLE OF RS FOR FOOD SECURITY
- BIOGEOPHYSICAL PARAMETERS EXTRACTION OF FOOD VULNERABILITY USING RS DATA
- INTEGRATION OF RS & GIS FOR MAPPING THE SPATIAL DISTRIBUTION OF FOOD VULNERABILITY
- CONCLUSION

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Background

- Application of Remote Sensing (RS) activities for monitoring the growth conditions of rice paddy fields in Java – Bali have undertaken since 2005 by RS Application Center,LAPAN. Java contribute ±70% of Indonesian rice production.
- This activity is part of research focus in the field of food security in Indonesia. Factors that affect food security in a region associated with spatial aspects such as: Food Availability and Vulnerability. Spatial information that shows the actual condition of the indicators of Food Availability and Vulnerability can be derived from RS data which has high spectral and temporal resolution, like as Landsat 8, MODIS data.
- Spatial information include : the greeness rice crop, rice growth stage, early growing season, rice crop growth stage, harvest failures caused by drought, flood, pets and diseases in the paddy field, harvest area, & productivity. Those informatios are needed to predict the rice production

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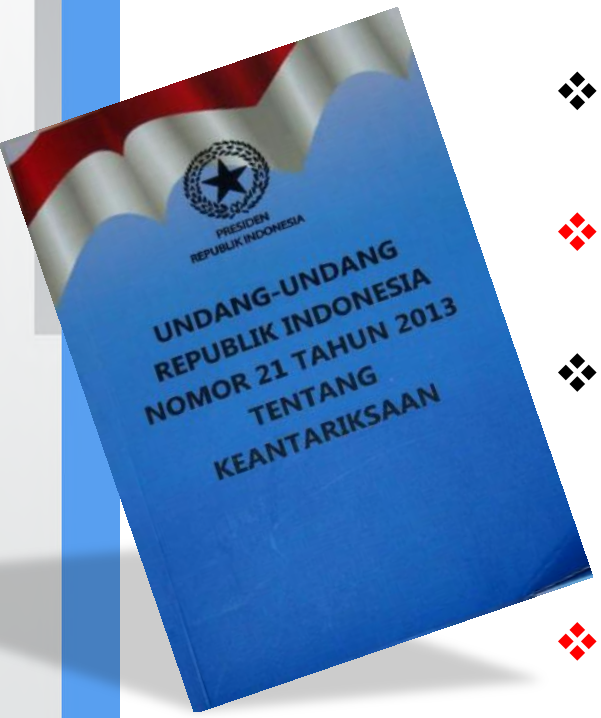
LAW No 21 2013 ABOUT SPACE

Matters related to remote sensing activities, among others:



- Planning, developing and operating satellites and ground stations of remote sensing (articles 16 and 17).
- Providing the high-resolution of remote sensing data (article 18).
- Building of Standard methods and quality of data processing (Article 19).
- Organizing the storage and distribution of data through the National Remote Sensing Data Bank, data network node in the system of the National Spatial Data Network (Article 20).
- Making guidelines on the application and dissemination of remote sensing information (article 22).
- Data Processing mean :

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DATA PROCESSING BASED ON LAW No 21, 2013

Article 19

(1) Remote sensing data processing as referred to in Article 15, verse(1b) may include: geometric correction; radiometric correction; classification; and detection of bio-geo-physical parameters.

(2) Processing of remote sensing data must be done with reference to the methods and quality of remote sensing data processing decided by the Institute.

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http://www.inderaja.lapan.go.id/index.php/subblog/pages/2016/5/Visi-dan-Misi-Deputi-Bidang-Penginderaan-Jauh

www.inderaja.lapan.go.id/index.php/home

Search with Google Search

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DEPUTI BIDANG PENGINDERAAN JAUH

Deputy of Remote Sensing Affairs

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Monday , 18-09-2017

Field of Competence

Remote Sensing Technology and Data Center

Remote Sensing Application Centre

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Pusat Pemanfaatan Penginderaan Jauh

Remote Sensing Applications Center

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ions Center

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Sistem Informasi Sumber Daya Alam dan Lingkungan (SIPANDA)

Focused Services

Tugas Pusat Pemanfaatan Penginderaan Jauh adalah melaksanakan penelitian, pengembangan dan perekayasaan serta penyelenggaraan keantariksaan dibidang pemanfaatan penginderaan jauh (Pasal 126 Perka No.8 Tahun 2015 Tentang Organisasi dan Tata Kerja LAPAN)

usfatja.lapan.go.id/sipanda

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Ground Station Locations and Coverages

Ground Station Facilities - Jakarta

MODIS – Pare-Pare

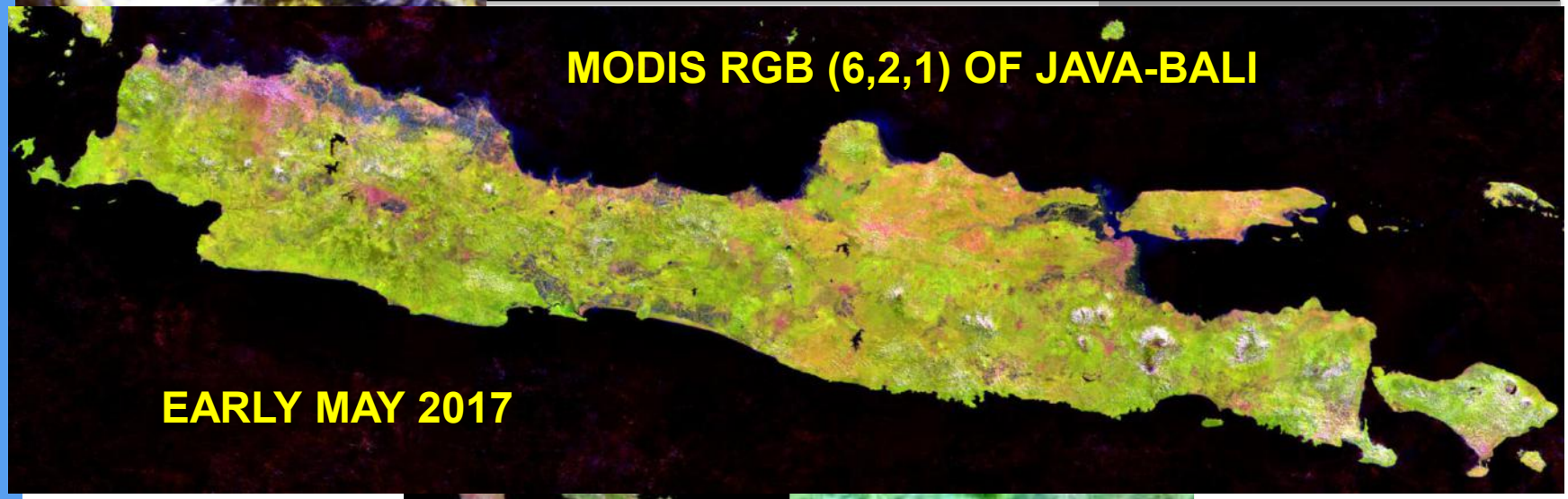
GMS - Jakarta

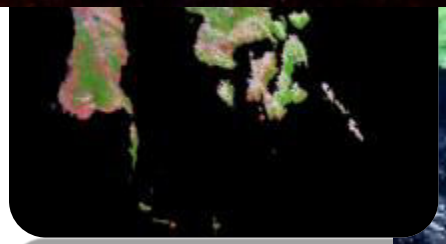
Feng Yun - J

NOAA - Jakarta

- **Data:**
  - MTSAT-1R
  - NOAA/AVHRR
  - Terra/Aqua MODIS
  - Feng Yun-1D
  - Landsat-7/ETM+
  - SPOT-4
  - ENVISAT (Cooperatewith ESA)
  - SAR Imagery
  - etc

Data Availability





MODIS

LANDSAT

SPOT

Data Availability

SPOT-5,6,7

EROS-1A

Ikonos

Quickbird

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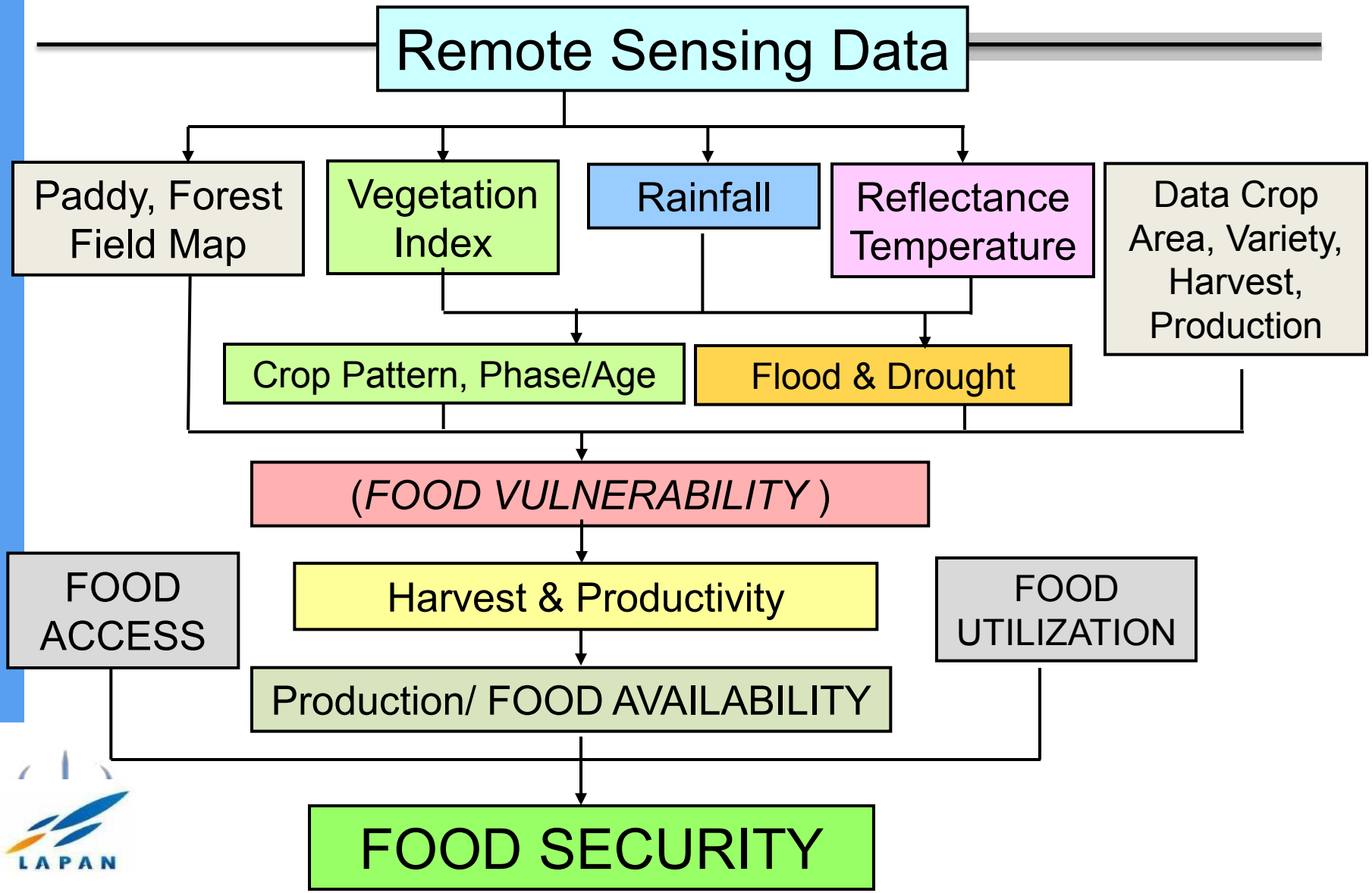
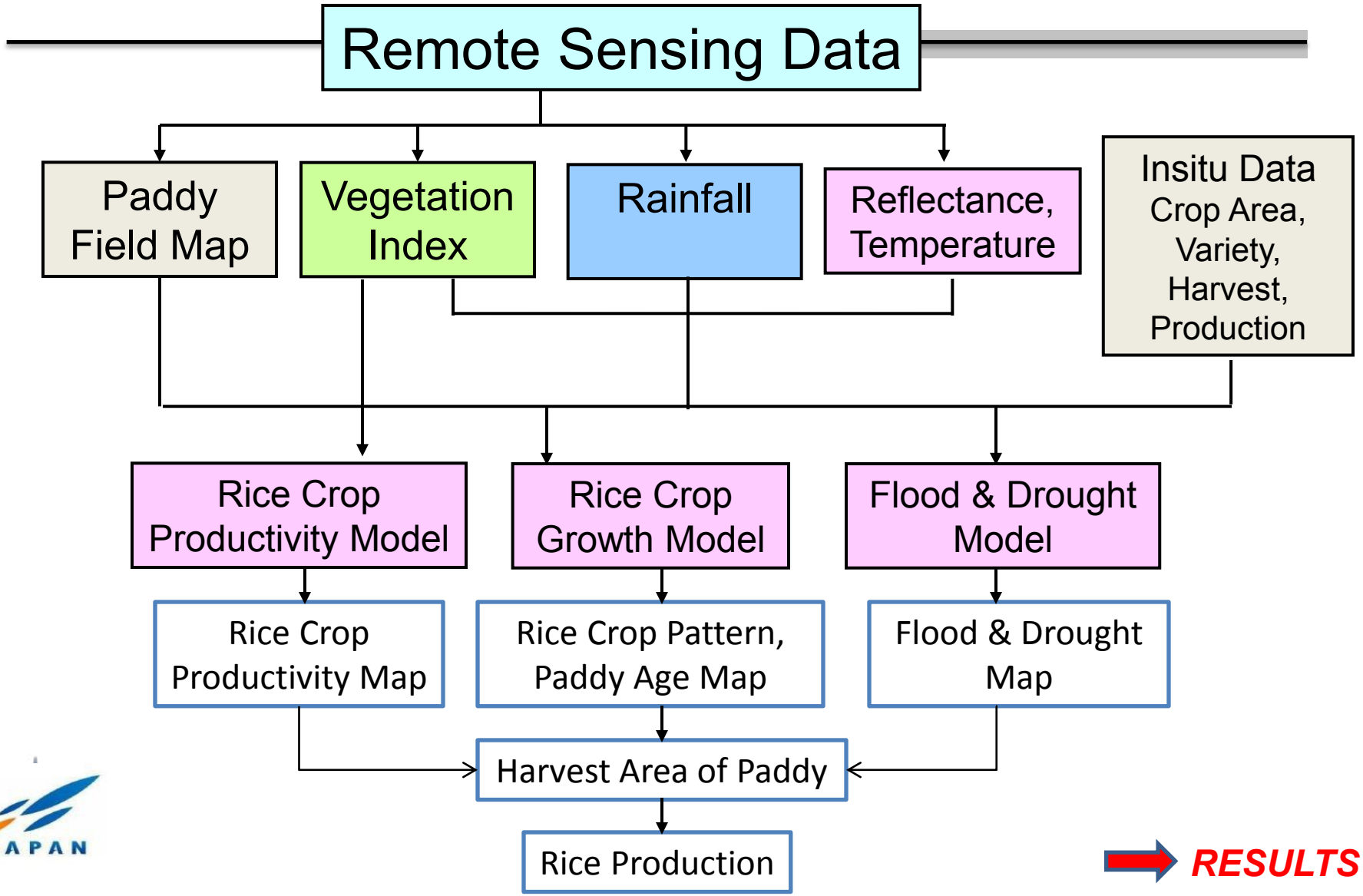
LOGICAL FRAMEWORK

THE ROLE OF RS FOR FOOD SECURITY



LOGICAL FRAMEWORK : ROLE OF RS FOR FOOD SECURITY



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RESULTS

BIOGEOPHYSICAL PARAMETERS EXTRACTION OF FOOD VULNERABILITY USING RS DATA

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Objectives

- Main goal of research is to predict the rice/paddy production:
  - ✓ Greenness rice crop & growing season (rice crop area) monitoring
  - ✓ Rice crop growth stage (paddy age) monitoring for predicting the potential harvest area
  - ✓ Flood & drought vulnerability monitoring at paddy field
  - ✓ Crop yield (productivity) estimation of rice crop

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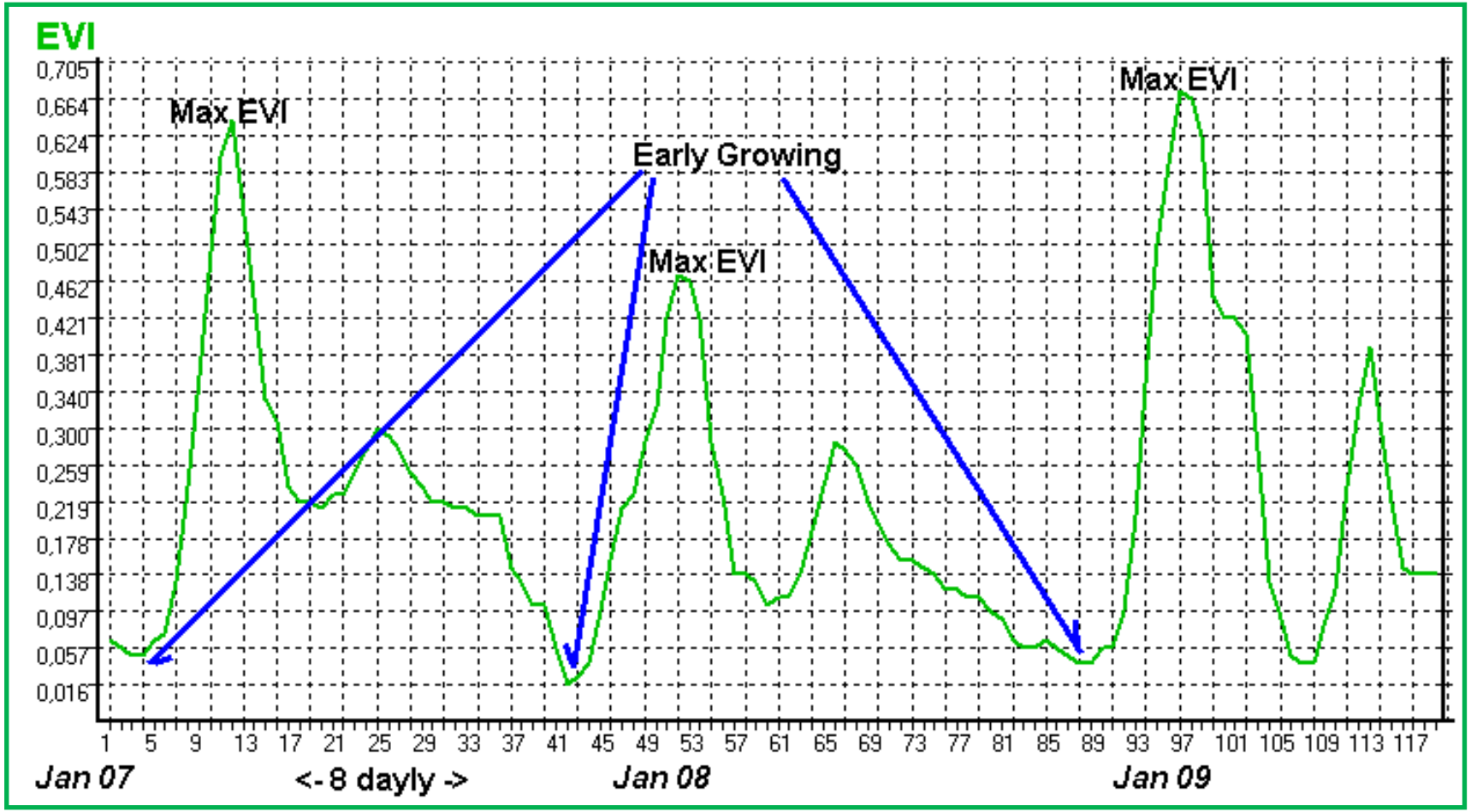
Rice Crop Growth Model



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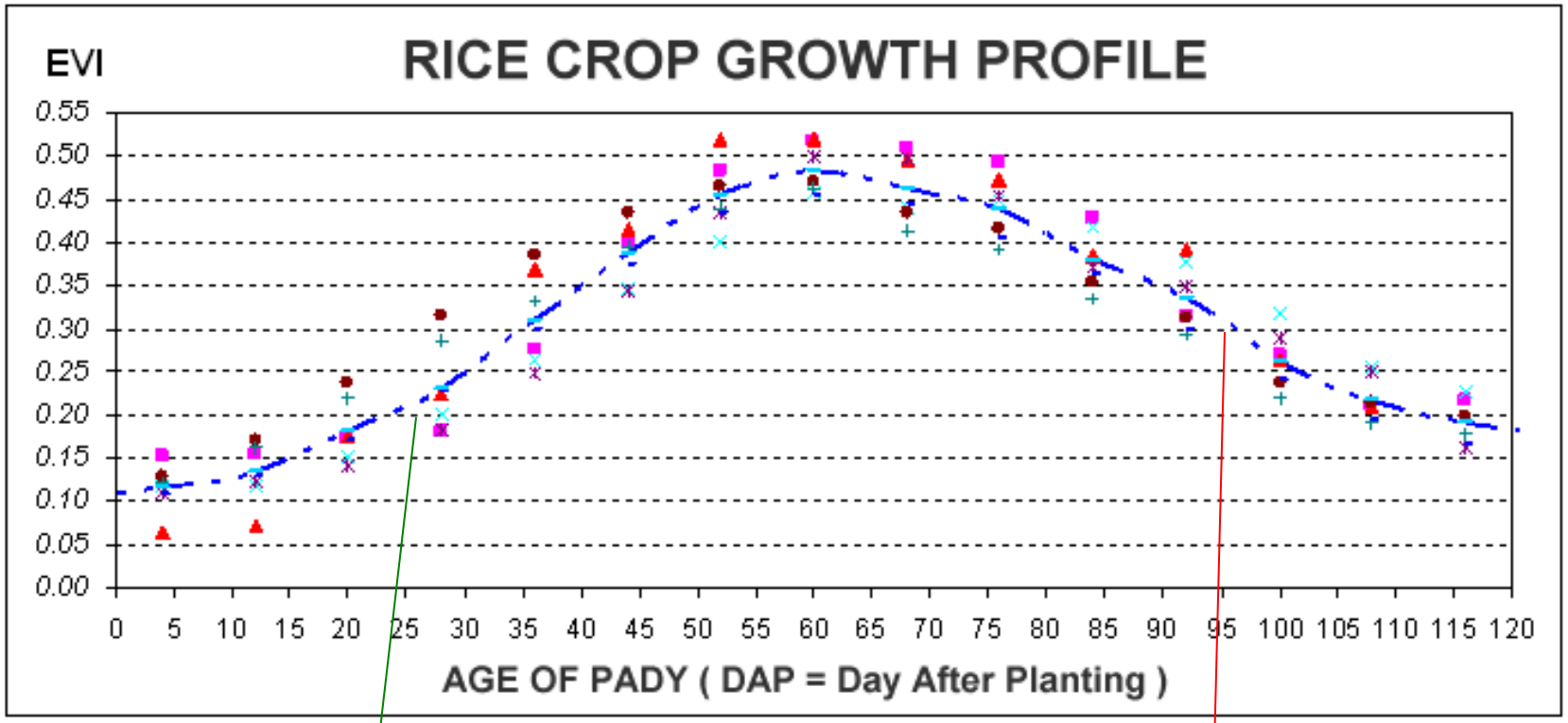
Rice Crop Growth Model



$$Y_{Veg} = 140.632 + 0.1323\,X + 0.0199\,X^2 - 0.0001\,X^3$$

$$Y_{Gen} = 13.39 + 6.95\,X - 0.0862\,X^2 + 0.0003\,X^3$$

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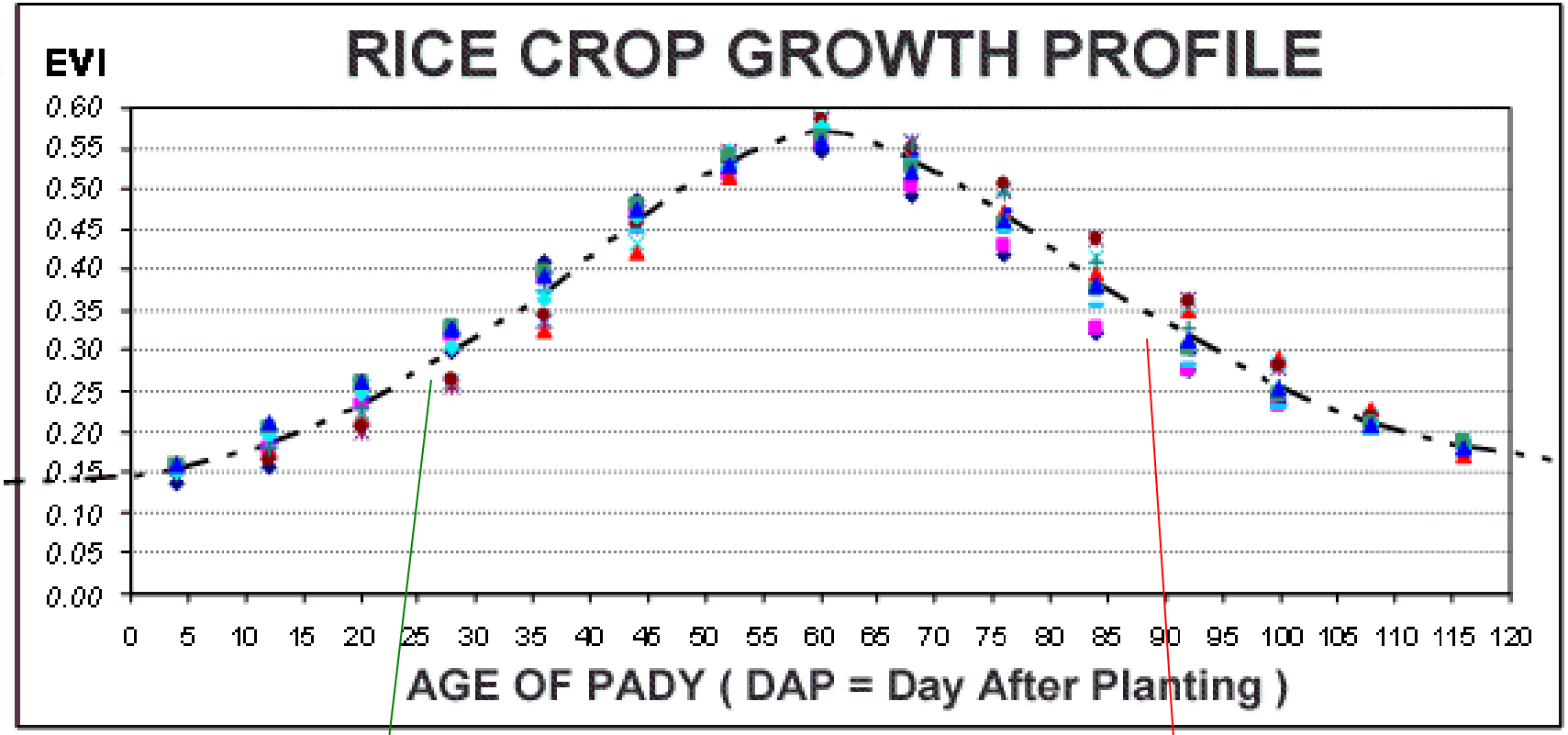
Rice Crop Growth Model



$$Y_{Veg} = 145.151 + 0.2712\,X + 0.0249\,X^2 - 0.0002\,X^3$$

$$Y_{Gen} = 86.63 + 5.3578\,X - 0.0754\,X^2 + 0.0003\,X^3$$

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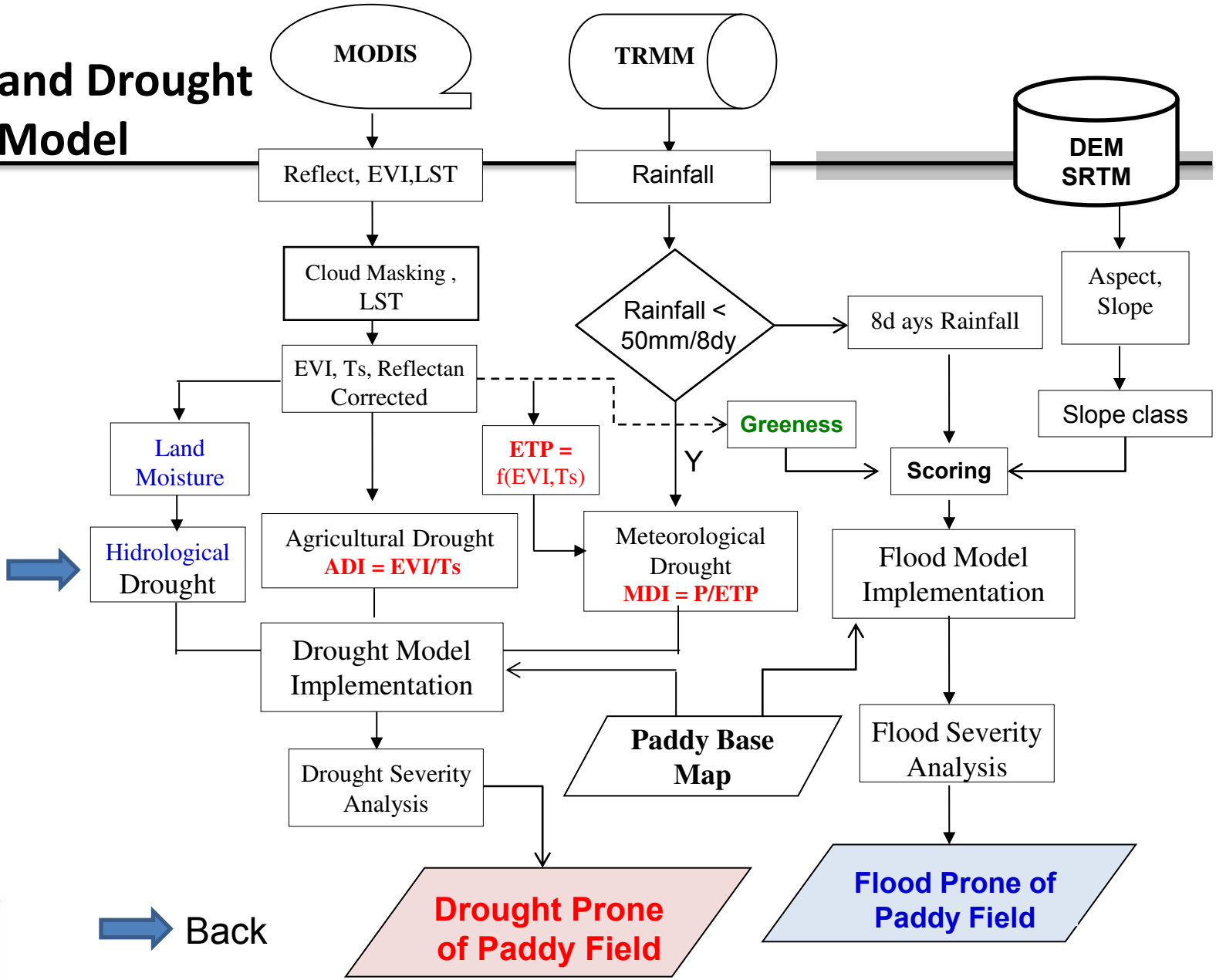
Back

Flood and Drought Model



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Drought Indices

❖ **Meteorological** ***: MDI = P/ETP (FAO, 1978)***

❖ **Agricultural** : ***VDI (Vegetation Drought Index) = IV/Ts***
Dirgahayu (2006), Mieyer (2009)
IV = 128 + 125*EVI ; Ts = surface temperature (celcius)

- **EVI (*Enhanced Vegetation Index*), Huete et al (1999) :**

$$\mathrm{EVI} = G\frac{\rho_{\mathrm{NIR}} - \rho_{\mathrm{red}}}{\rho_{\mathrm{NIR}} + C_1 \times \rho_{\mathrm{red}} - C_2 \times \rho_{\mathrm{blue}} + L}$$

p NIR	: NIR reflectance (8 dayly)
p red	: red reflectance (8 dayly)
p blue	: blue reflectance (8 dayly)
G	: Gain = 2.5
C1, C2	: coefficients = 6 (red) ; 7.5 (blue)

❖ **Hidrological :** ***LM (Land Moisture) = - 16.8 - 0.934 R2 + 15.9 VDI (%)***
R2: NIR MODIS Reflectance (%)
(Dirgahayu, 2012)

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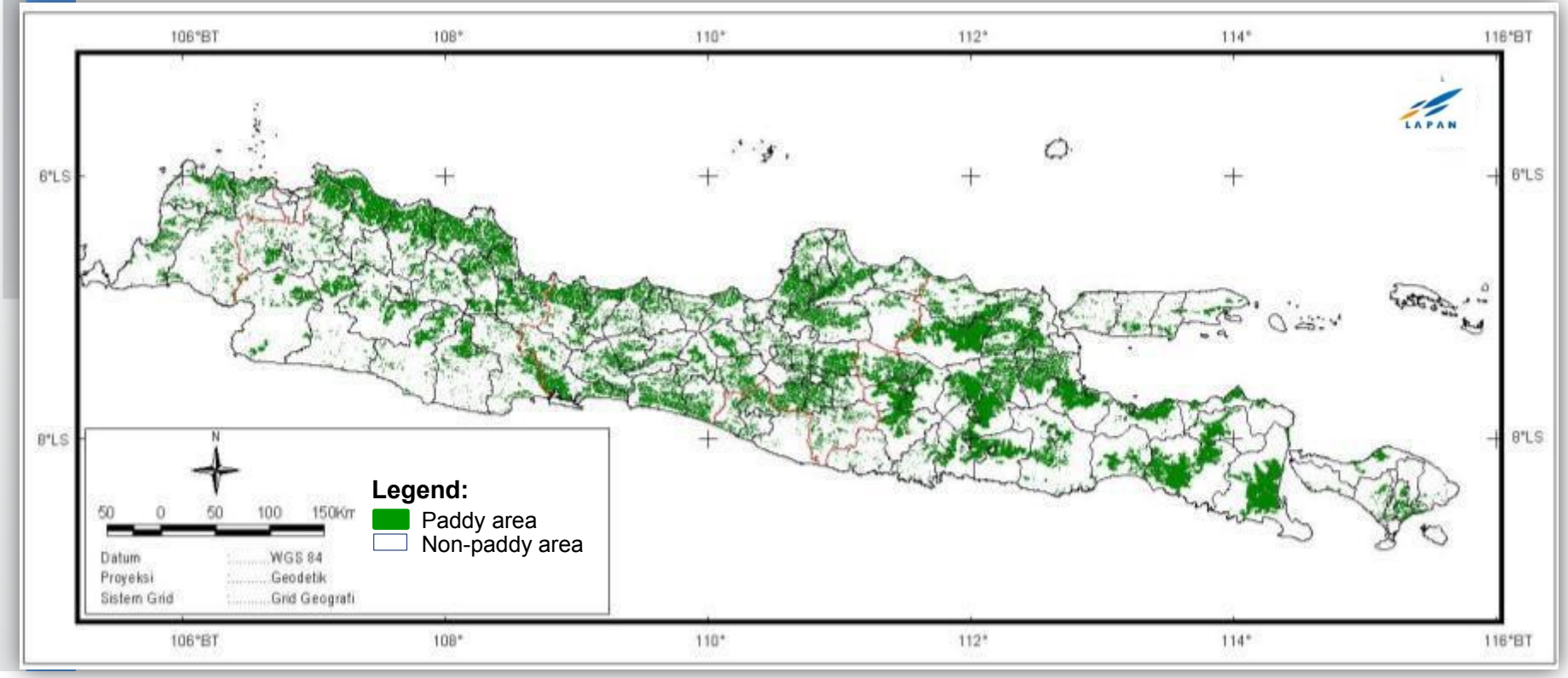
➡ Drought Method

Paddy Field Map, based on Landsat 8



Source: Landsat-8/EM+ data (2013-2015)

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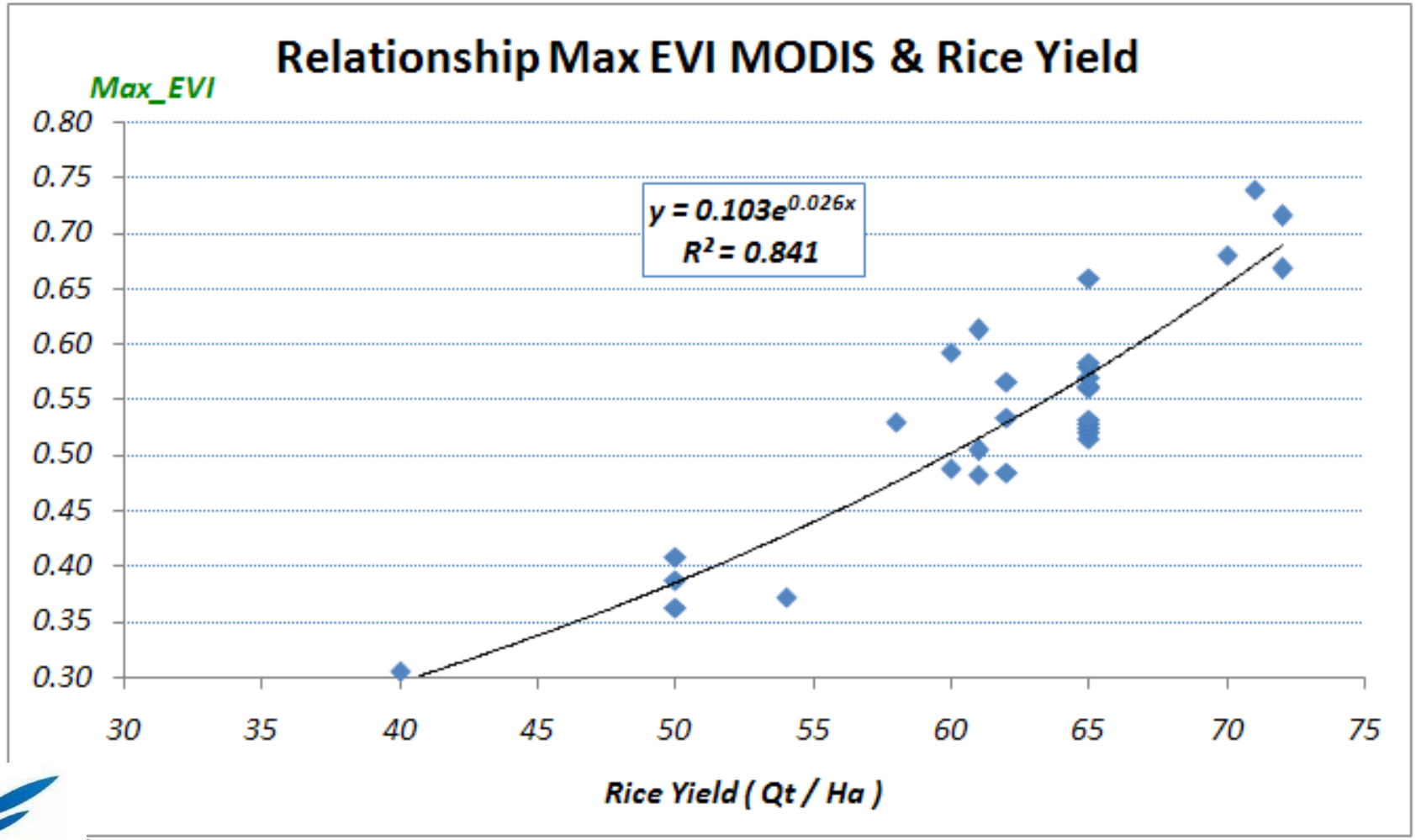
Rice Crop Yield Estimation Model



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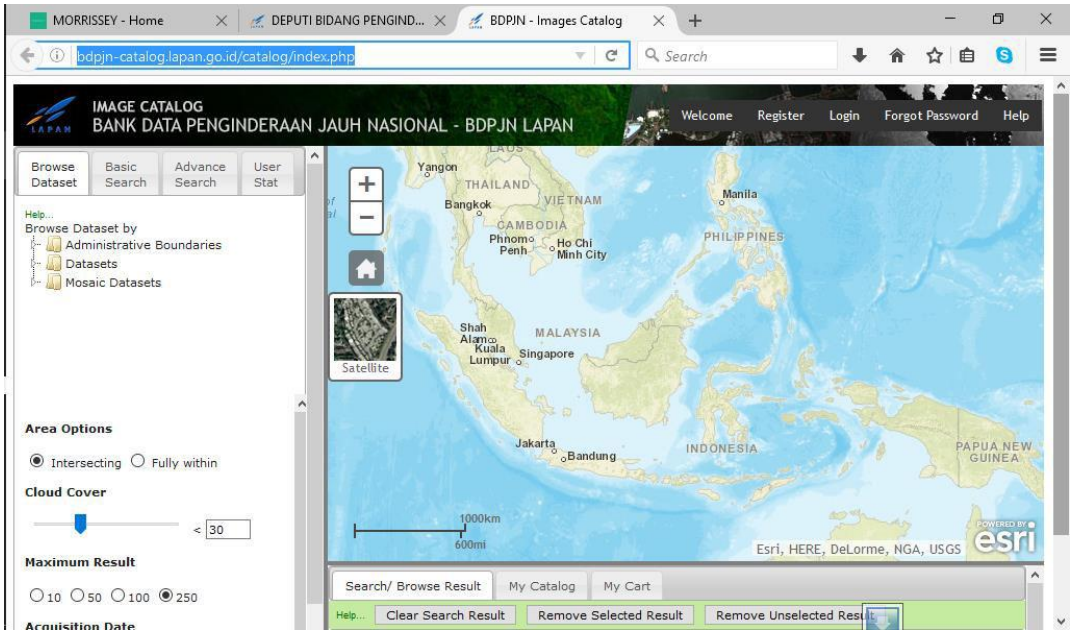
http://bdpjn-catalog.lapan.go.id/catalog/index.php



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http://pusfatja.lapan.go.id/incas.php
http://www.pertanian.go.id/

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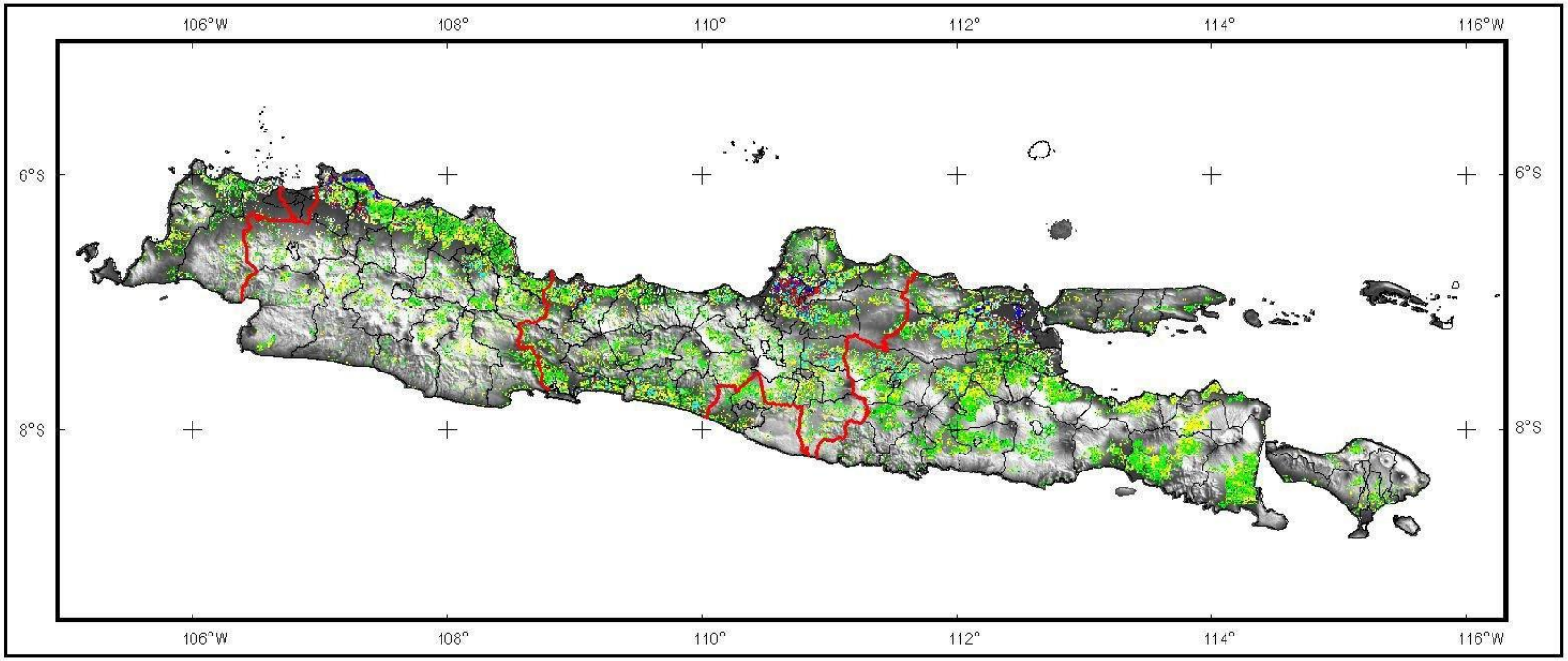
Monitoring Result

GREENNESS VEGETATION OF PADDY FIELD IN JAVA AND BALI ISLAND

MARCH 2012



N

50 0 50 100 150Km

Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geographic

LEGEND:

Greenness Vegetation Level:

- Water body
- Bare Land
- Very Low
- Low
- Moderate
- High

Data Source:
1. Terra-MODIS Data
2. Administrative Boundary of East Java and Bali Province
3. DEM SRTM 90 m

Produced By :

REMOTE SENSING APPLICATION CENTER
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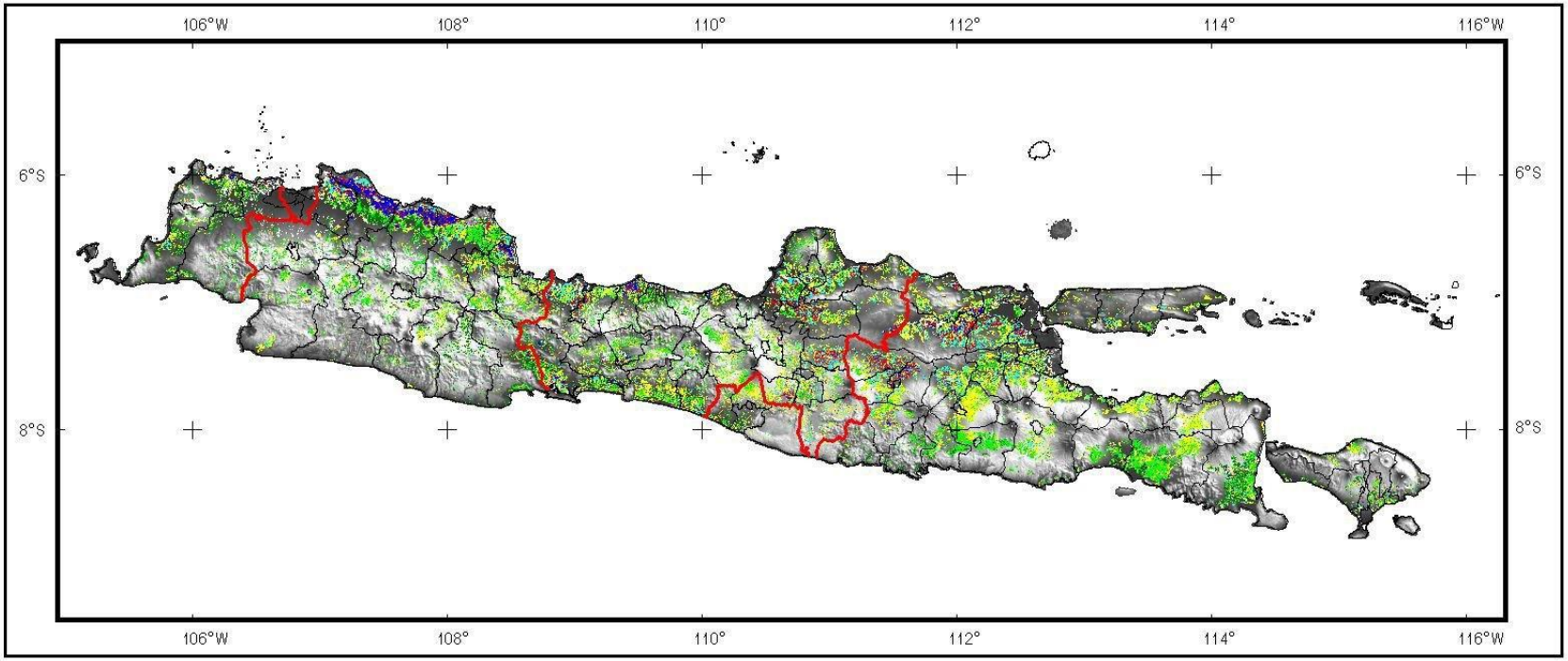
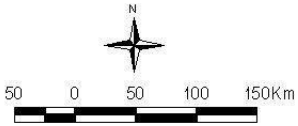
email: simba@lapan.go.id
http://www.lapanrs.com

Greenness Paddy Monitoring

GREENNESS VEGETATION OF PADDY FIELD IN JAVA AND BALI ISLAND

JULY 2012





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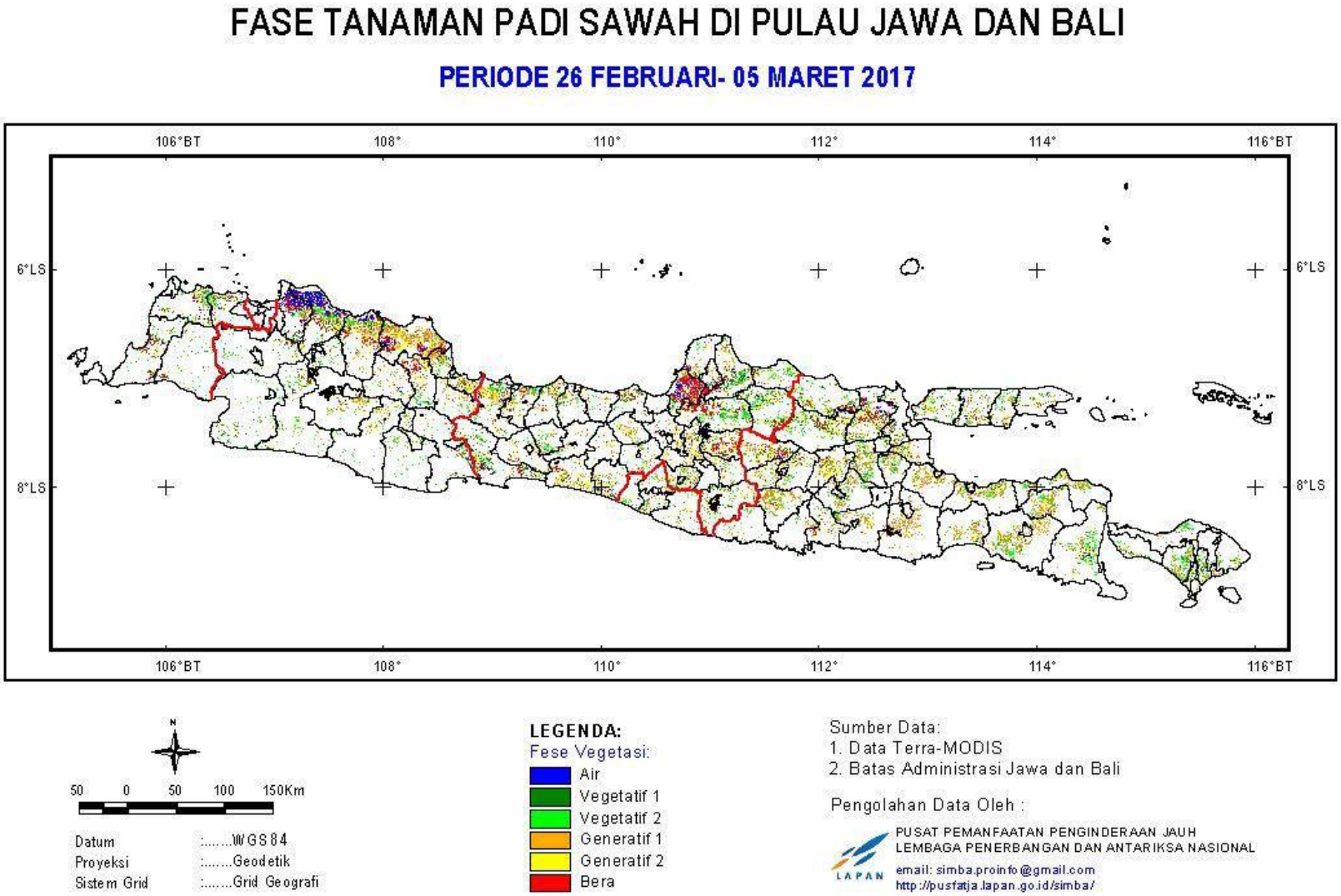
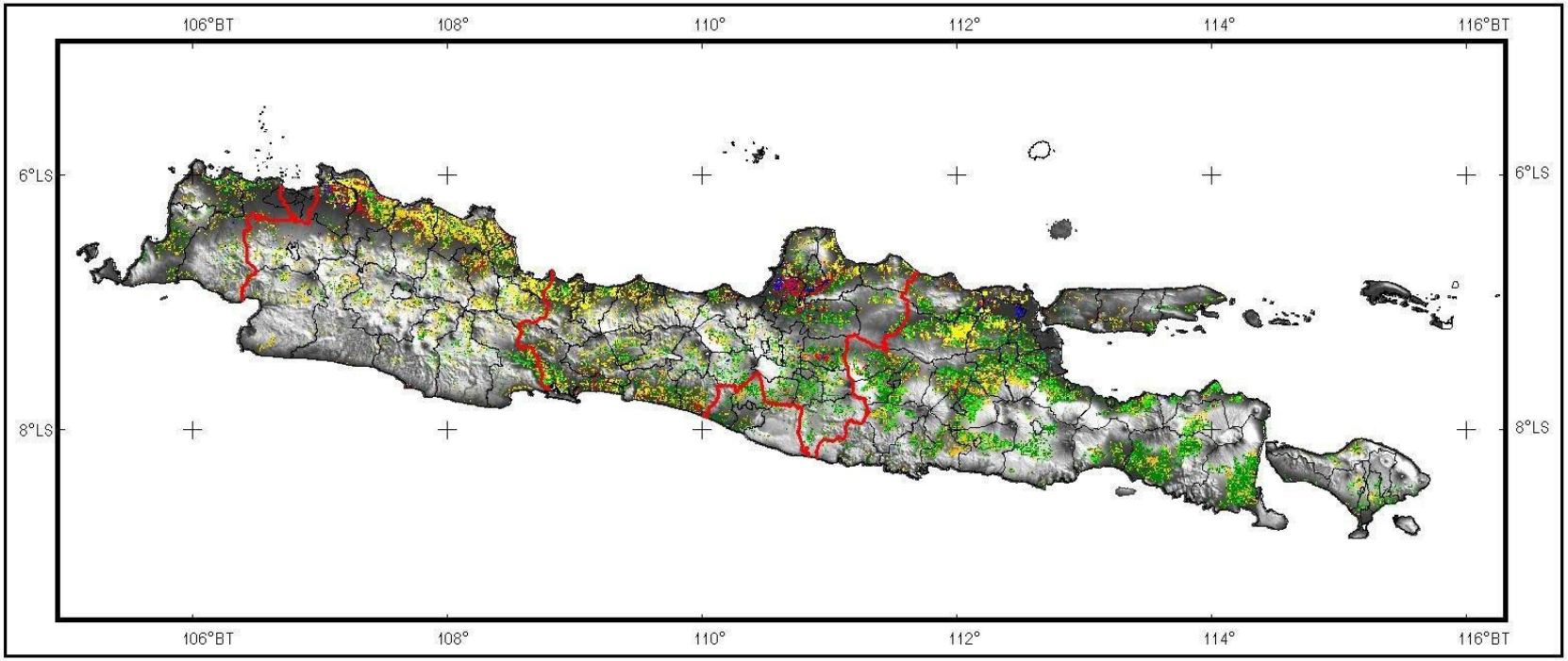
Phase Growth of Paddy Monitoring



Phase Growth of Paddy Monitoring

GROWTH PHASE OF PADDY FIELD IN JAVA AND BALI ISLAND

13th - 20th MARCH 2012



N

50 0 50 100 150Km

Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geographic

LEGEND:
Growth Phase :
- Water
- Bare Land
- Vegetative 1
- Vegetative 2
- Generative 1
- Generative 2

Data Source:
1. Terra-MODIS
2. Administrative Boundary of Java and Bali Island
3. DEM SRTM 90 m

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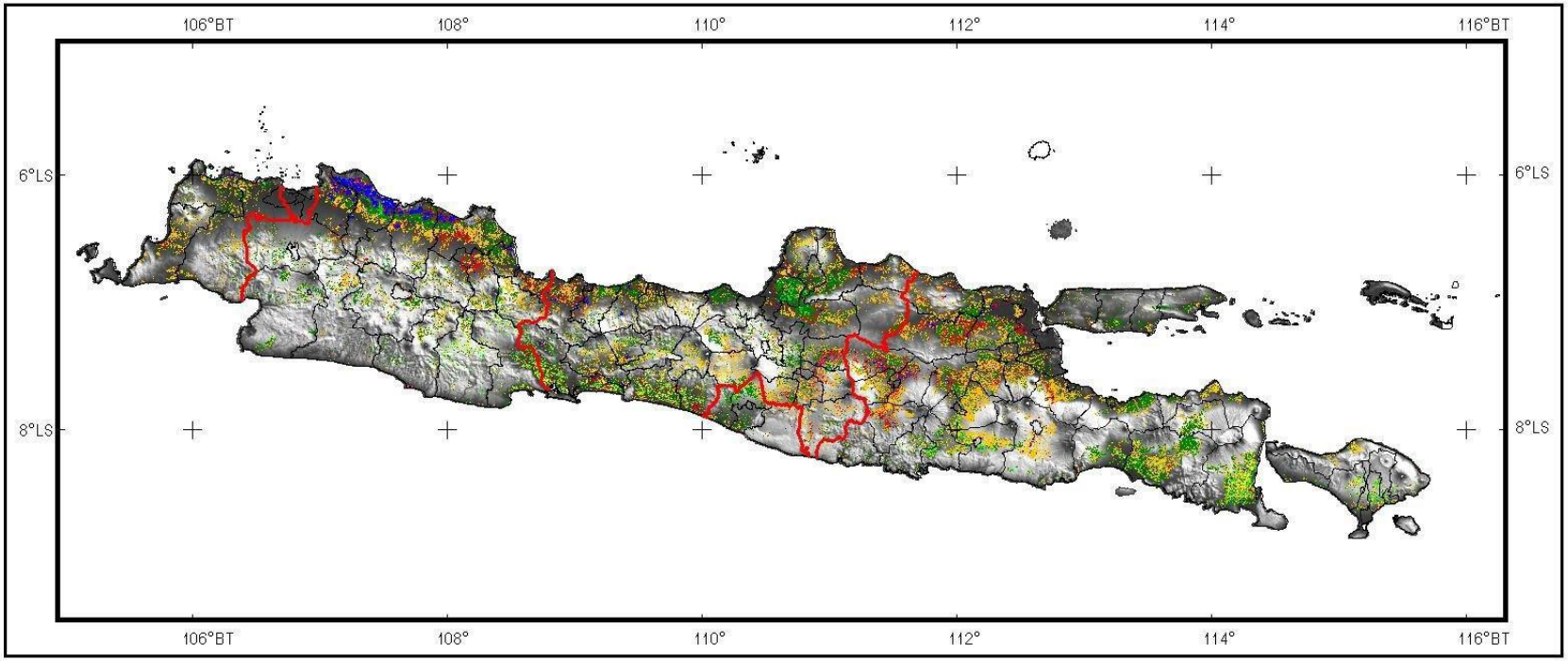
Phase Growth of Paddy Monitoring

GROWTH PHASE OF PADDY FIELD IN JAVA AND BALI ISLAND

19th - 26th JULY 2012



N

50 0 50 100 150Km

Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geographic

LEGEND:
Growth Phase :
- Water
- Bare Land
- Vegetative 1
- Vegetative 2
- Generative 1
- Generative 2

Data Source:
1. Terra-MODIS
2. Administrative Boundary of Java and Bali Island
3. DEM SRTM 90 m

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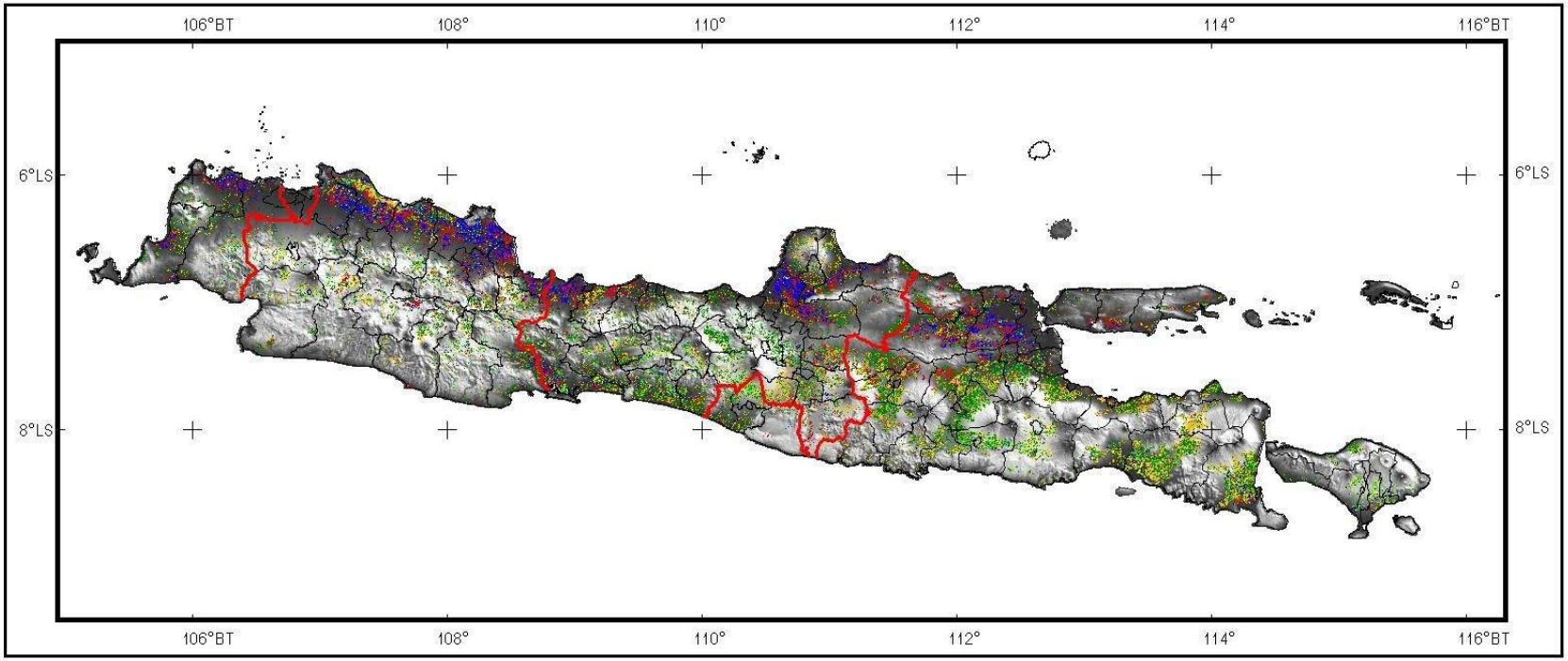
Phase Growth of Paddy Monitoring

GROWTH PHASE OF PADDY FIELD IN JAVA AND BALI ISLAND

31th October - 7th November 2012



N

50 0 50 100 150Km

Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geographic

LEGEND:
Growth Phase :
- Water
- Bare Land
- Vegetative 1
- Vegetative 2
- Generative 1
- Generative 2

Data Source:
1. Terra-MODIS
2. Administrative Boundary of Java and Bali Island
3. DEM SRTM 90 m

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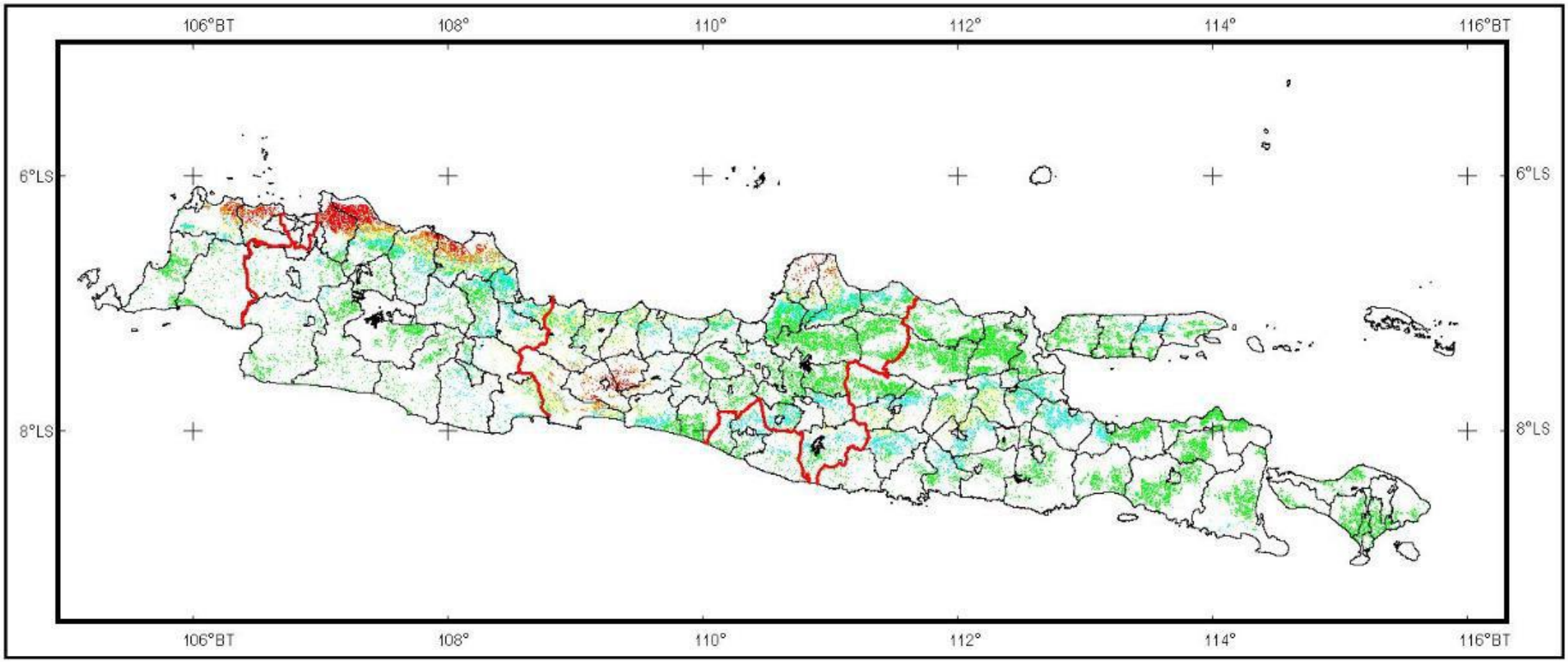
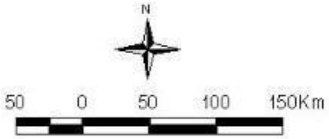
TINGKAT RAWAN BANJIR LAHAN SAWAH DI PULAU JAWA DAN BALI

PERIODE 10 - 17 FEBRUARI 2017





Datum :.....WGS 84
Proyeksi :.....Geodetik
Sistem Grid :.....Grid Geografi

LEGENDA:

Rawan Banjir:

- Tidak Banjir
- Ringan
- Sedang
- Berat
- Sangat Berat

Sumber Data :

1. Data Terra-MODIS
2. Data TRMM
3. Batas Administrasi Provinsi Jawa dan Bali
4. Data DEM SRTM 90 m

Pengolahan Data Oleh :

PUSAT PEMANFAATAN PENGINDERAAN JAUH
LEMBAGA PENERBANGAN DAN ANTARIKSA NASIONAL
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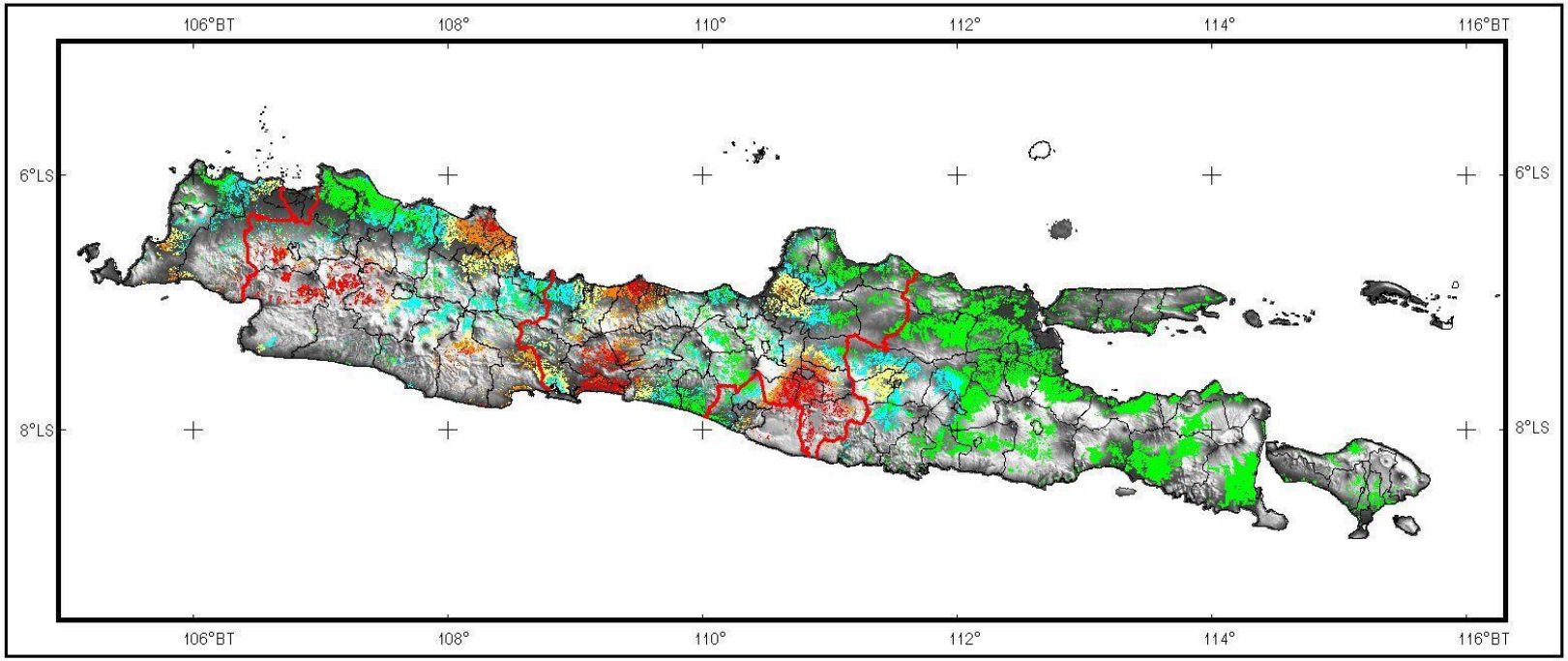
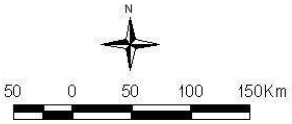
email: simba.proinfo@gmail.com
http://pustfatja.lapan.go.id/simba/

Flood Monitoring

FLOOD VULNERABILITY OF PADDY FIELD IN JAVA AND BALI ISLAND

31th October - 7th November 2012





Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geographic

LEGEND :

Flood Vulnerability :

- Non-flood
- Low
- Moderate
- High
- Very high

Data Source :

1. Terra-MODIS
2. TRMM
3. Administrative Boundary of Java and Bali Island
4. DEM SRTM 90 m

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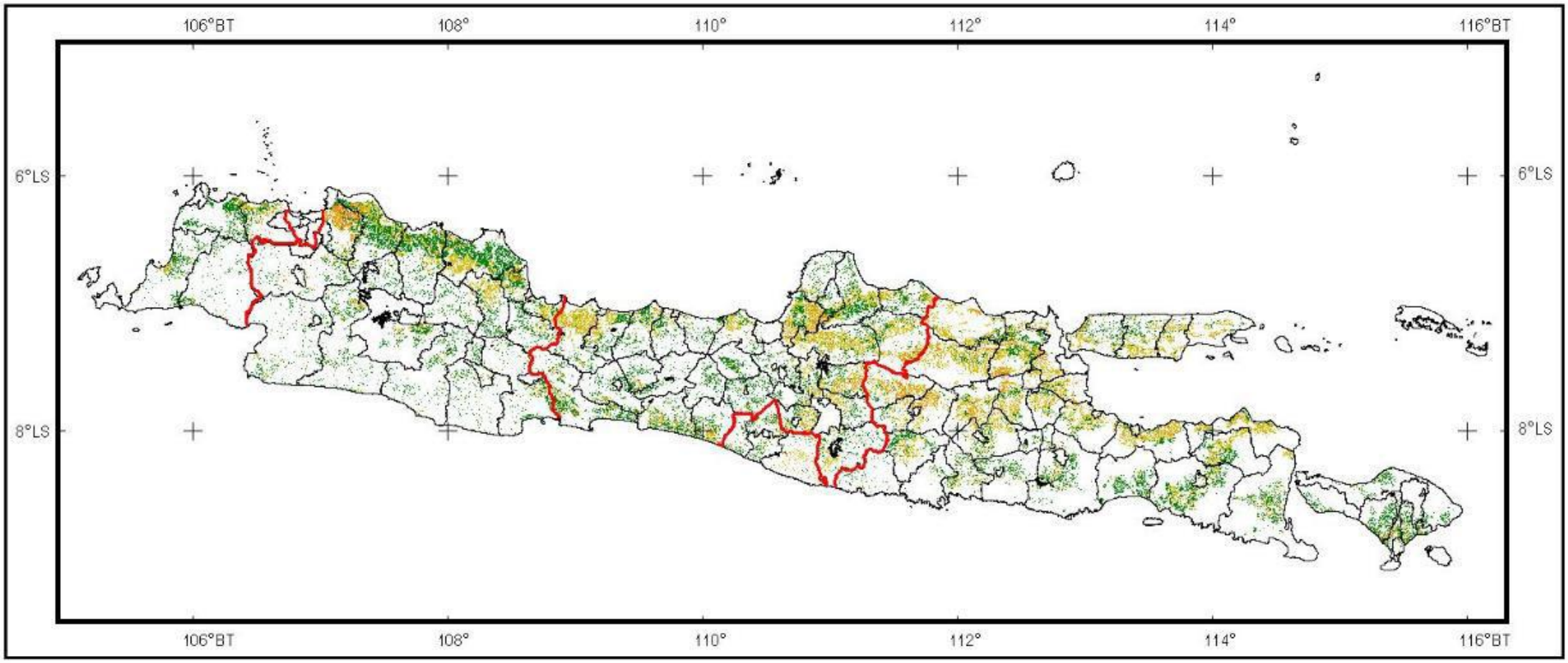
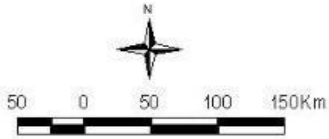
TINGKAT RAWAN KEKERINGAN LAHAN SAWAH DI PULAU JAWA DAN BALI

PERIODE 12 - 19 JULI 2017





Datum :.....WGS 84
Proyeksi :.....Geodetik
Sistem Grid :.....Grid Geografi

LEGENDA:

Rawan Kering:

- Non Kering
- Kering Ringan
- Kering Sedang
- Kering Berat
- Puso

Sumber Data :

1. Data Terra-MODIS
2. Data TRMM
3. Batas Administrasi Provinsi Jawa dan Bali

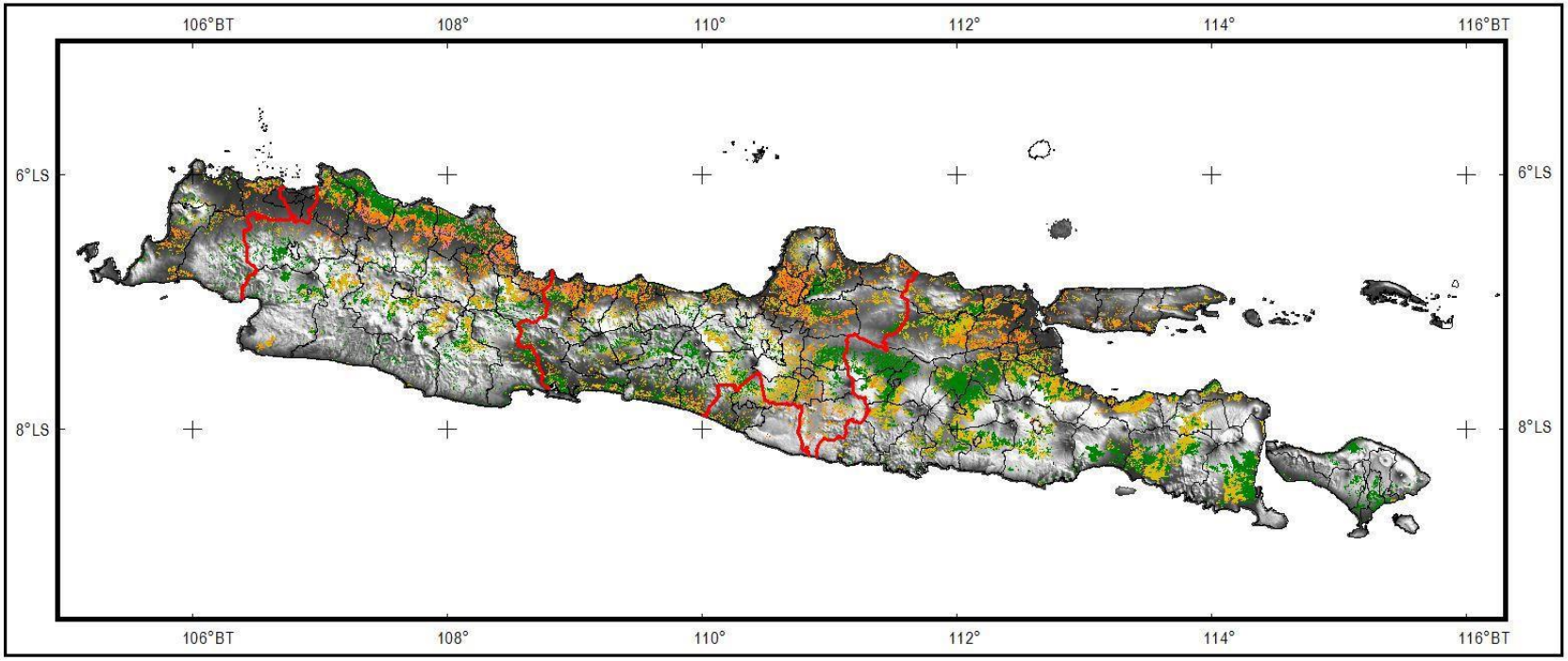
Pengolahan Data Oleh :

PUSAT PEMANFAATAN PENGINDERAAN JAUH
LEMBAGA PENERBANGAN DAN ANTARIKSA NASIONAL
email: simba.proinfo@gmail.com
http://pusfatja.lapan.go.id/simba/

Drought Monitoring

DROUGHT VULNERABILITY OF PADDY FIELD IN JAVA AND BALI ISLAND

PERIOD 13 - 20 SEPTEMBER 2012



N

50 0 50 100 150Km

Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geography

LEGEND :

Drought vulnerability:

- Non-drought
- Low
- Moderate
- High
- Extreme

Data Source:

1. Terra-MODIS
2. TRMM
3. Administrative Boundary of Java and Bali Island
4. DEM SRTM 90 m

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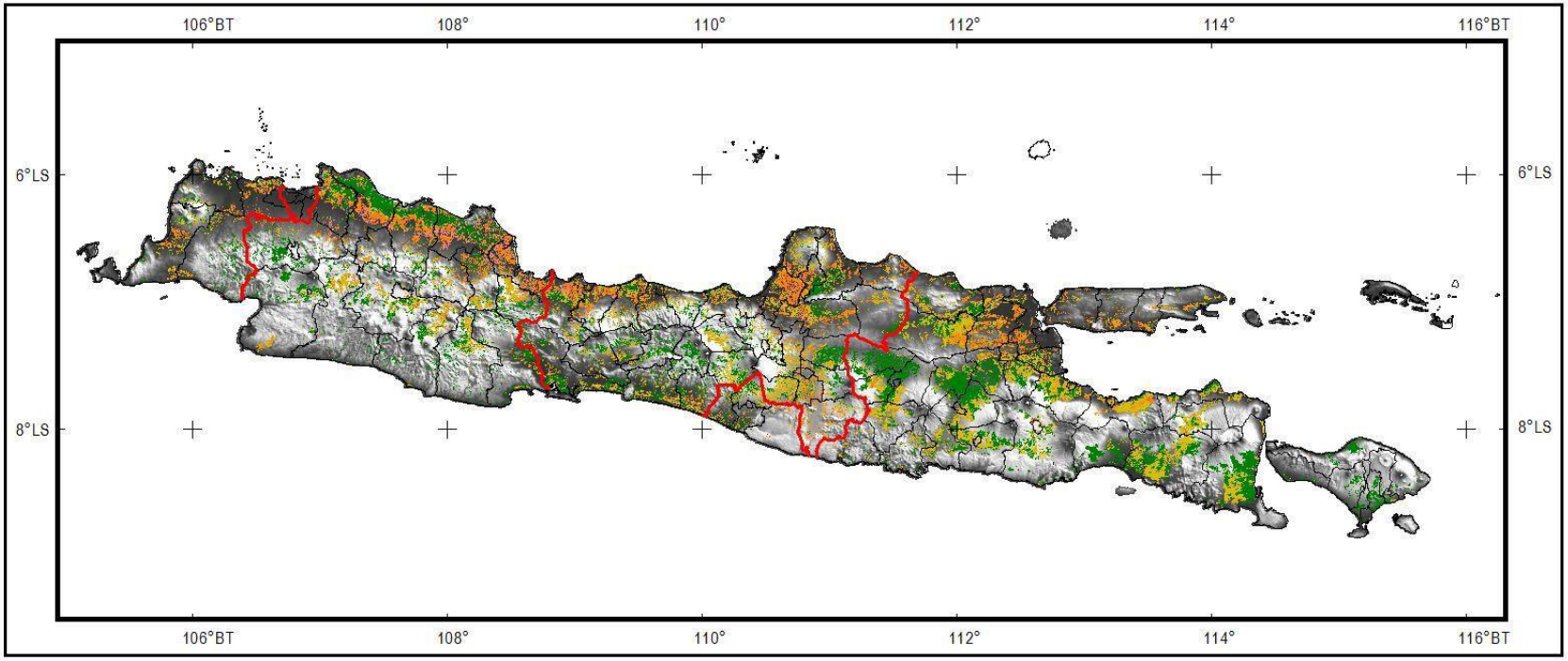
Drought Monitoring

DROUGHT VULNERABILITY OF PADDY FIELD IN JAVA AND BALI ISLAND

PERIOD 13 - 20 SEPTEMBER 2012



N

50 0 50 100 150Km

Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geography

LEGEND :

Drought vulnerability:

- Non-drought
- Low
- Moderate
- High
- Extreme

Data Source:

1. Terra-MODIS
2. TRMM
3. Administrative Boundary of Java and Bali Island
4. DEM SRTM 90 m

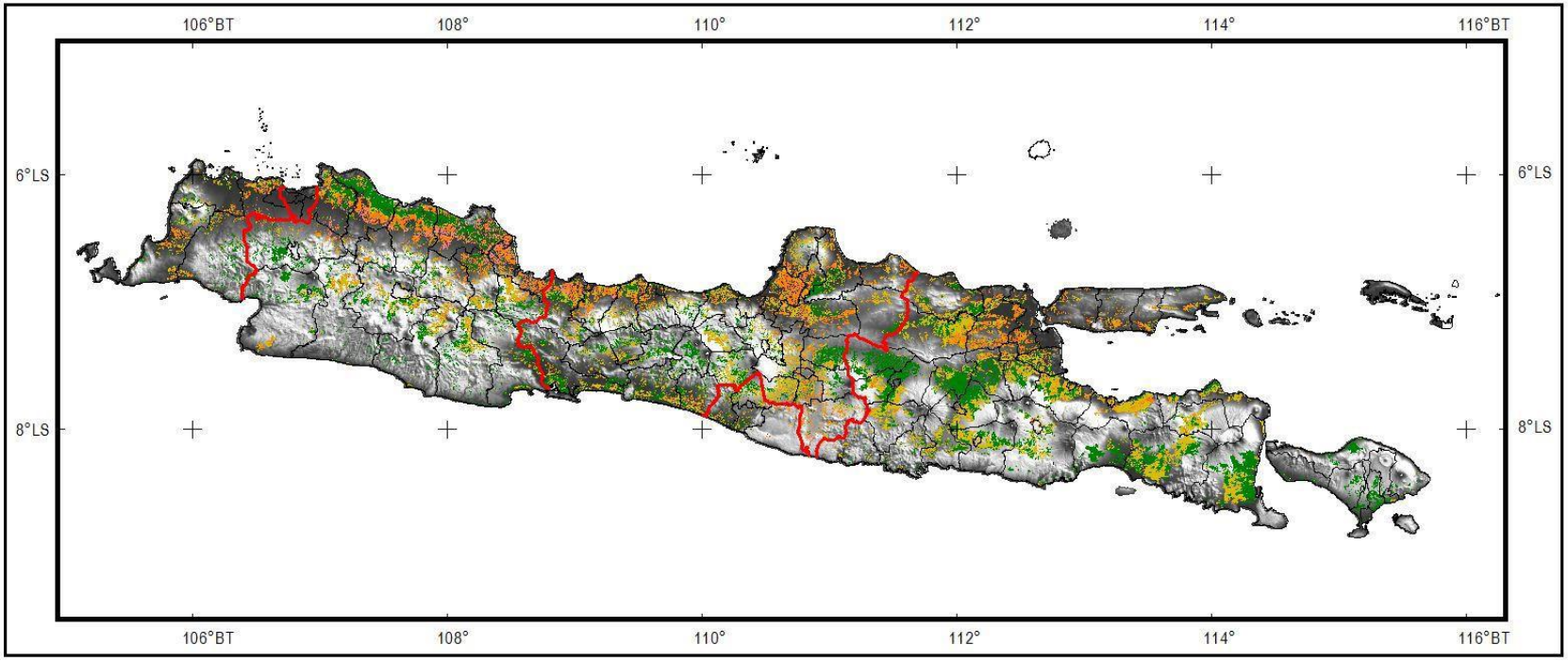
Produced By :

REMOTE SENSING APPLICATION CENTER
INDONESIAN NATIONAL INSTITUTE OF AERONAUTICS AND SPACE
email: simba@lapan.go.id
http://www.lapanrs.com/SIMBA

Drought Monitoring

DROUGHT VULNERABILITY OF PADDY FIELD IN JAVA AND BALI ISLAND

PERIOD 13 - 20 SEPTEMBER 2012



N

50 0 50 100 150Km

Datum :.....WGS 84
Projection :.....Geodetic
Grid System :.....Geography

LEGEND :

Drought vulnerability:

- Non-drought
- Low
- Moderate
- High
- Extreme

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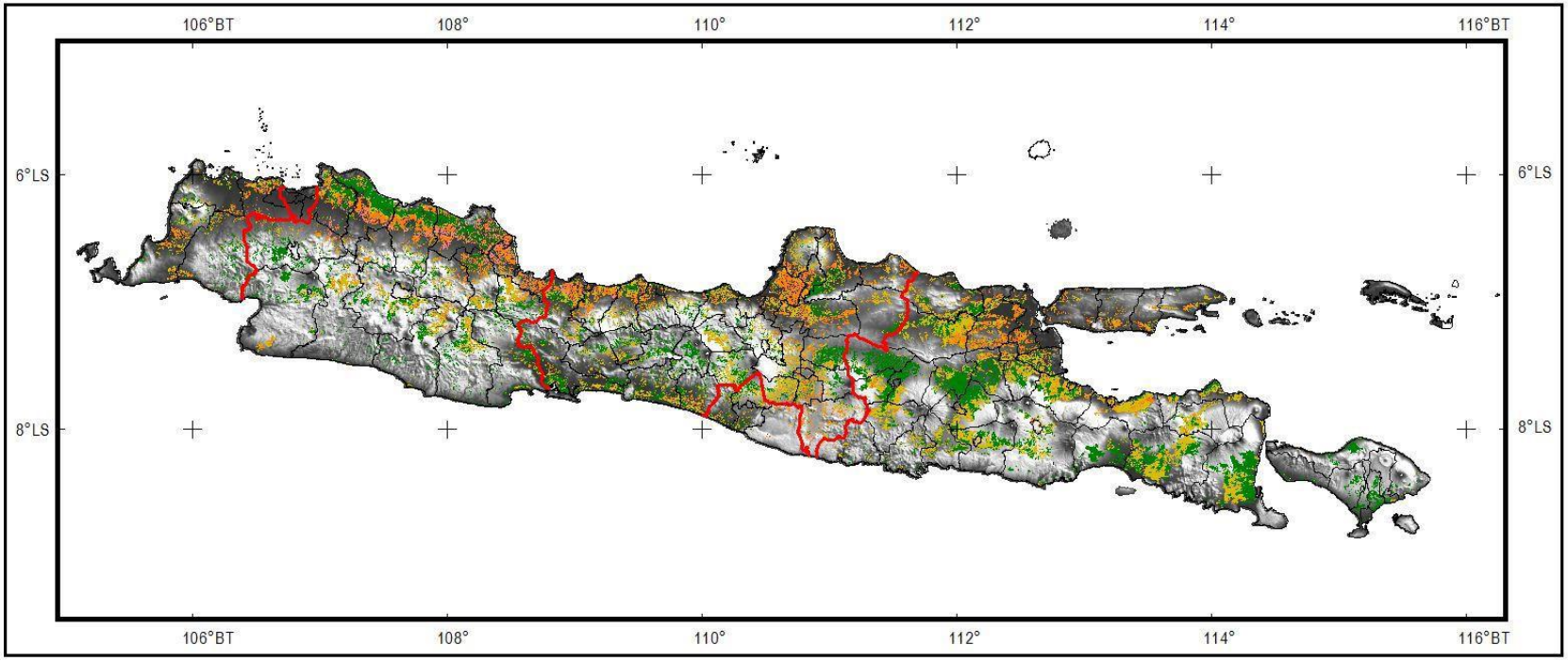

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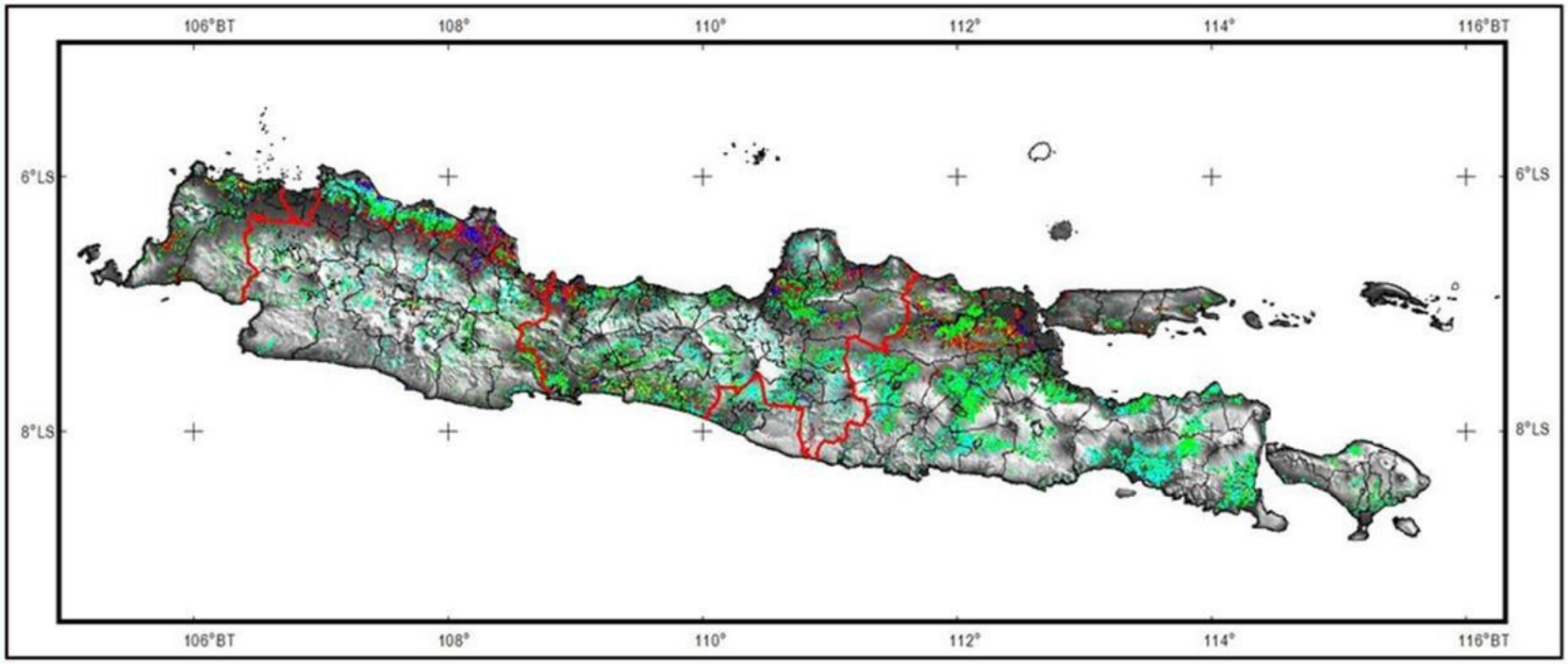
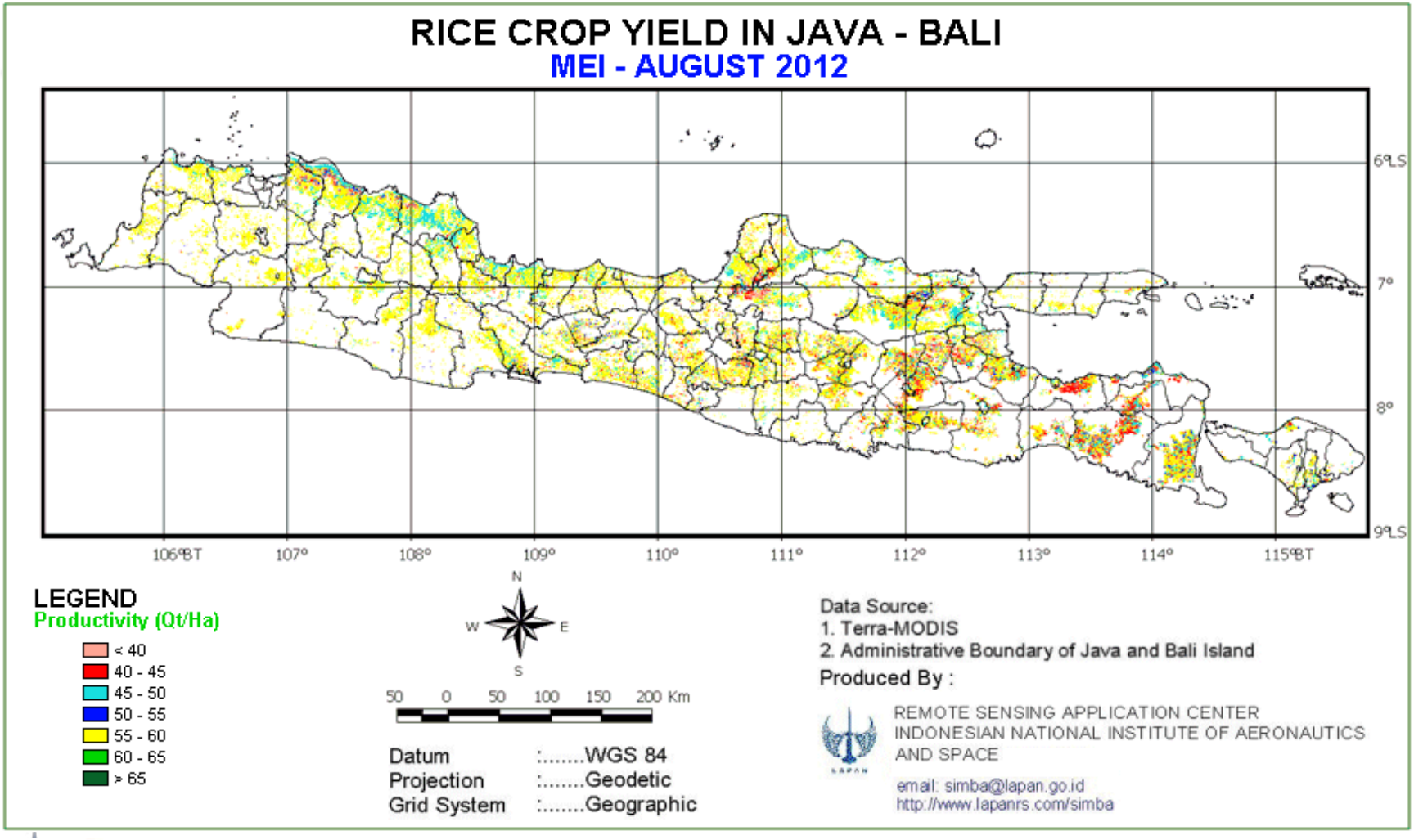
Harvest Time Monitoring



LAPAN

Rice Yield Estimation

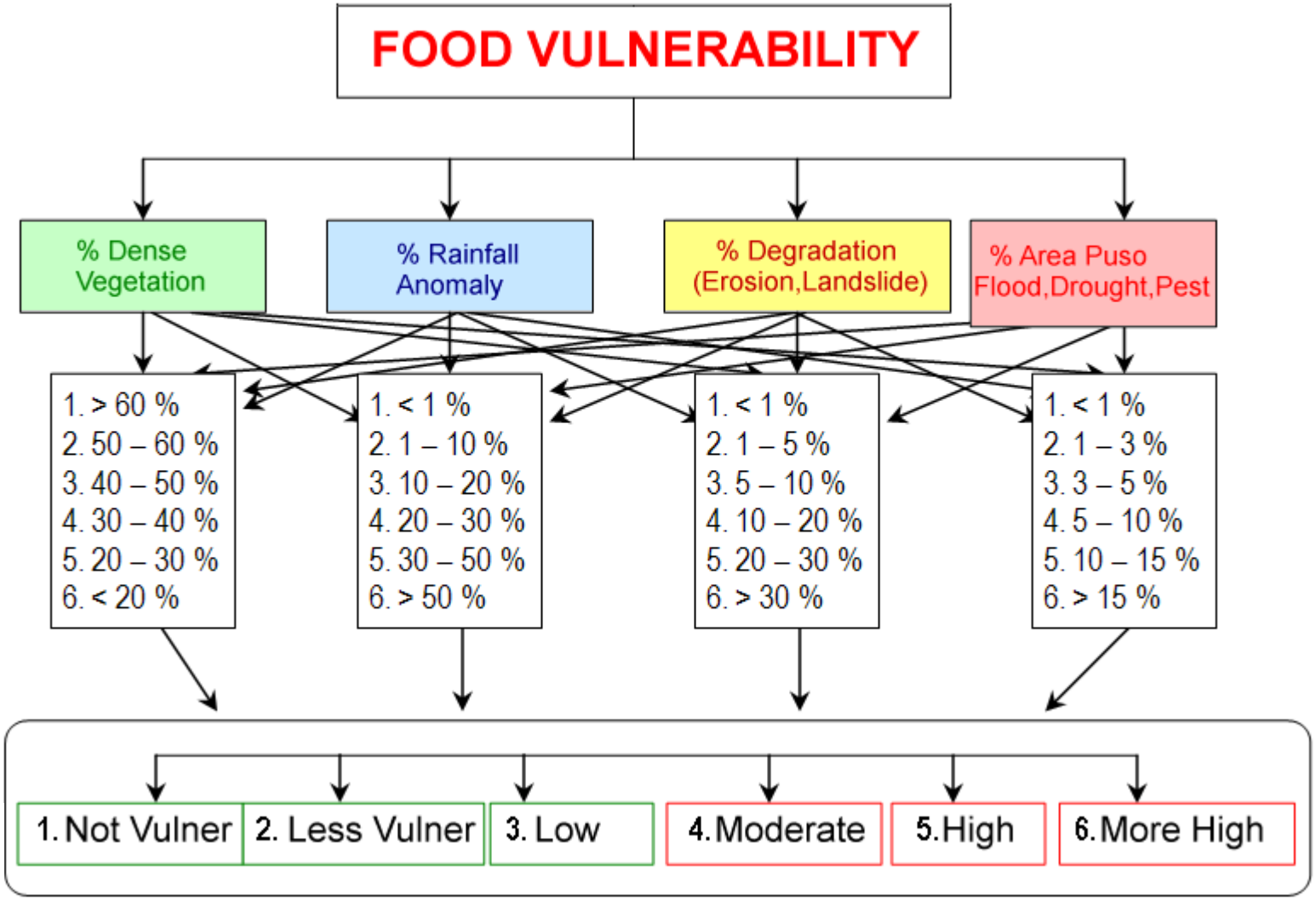


LAPAN

INTEGRATION OF RS & GIS FOR MAPPING THE SPATIAL DISTRIBUTION OF FOOD VULNERABILITY

LAPAN

METHOD: VULNERABILITY CRITERIA



LAPAN

METHOD

1. % Vegetation : PV = (100*IVh) / A

IVh : sum pixels area which have EVI >= EVI_t.

EVI_t : *treshold* , min value EVI of EVI max in certain region (derived based on statistical EVI (Enhanced Vegetation Index) multemporal during 3 years).

A : sum pixels in Filter box (3x3) pixel

$$EVI = 2.5*(R2 - R1)/(1+R2 + 6*R1 - 7.5*R3)$$

R1,R2,R3 : NIR, Red, & blue channel Reflectances of RS Data

2. Rainfall Anomaly :

$$ACH = 100*(CHp - CHr)/CHr = 100*(CHp/CHr - 1)$$

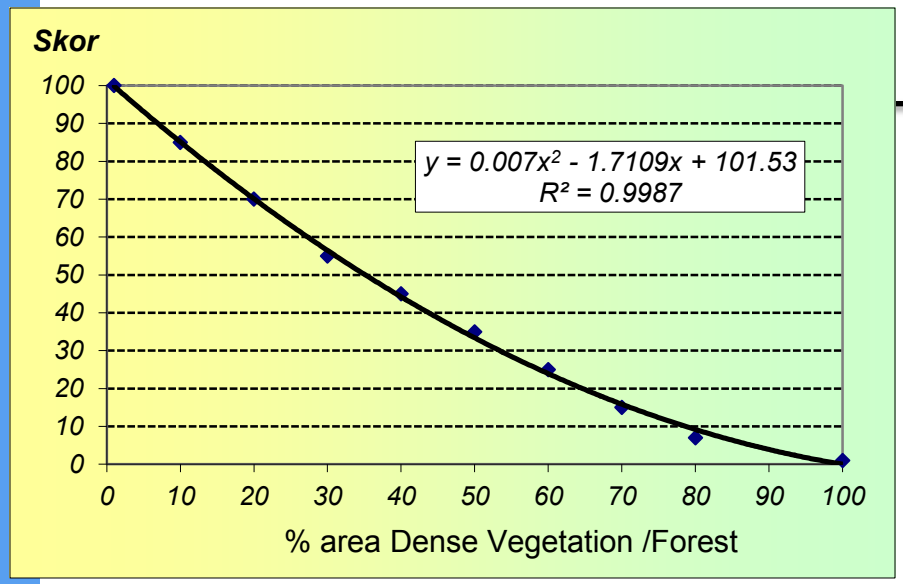
CHp : Cumulative Rainfall during 4 months (Sub Round)

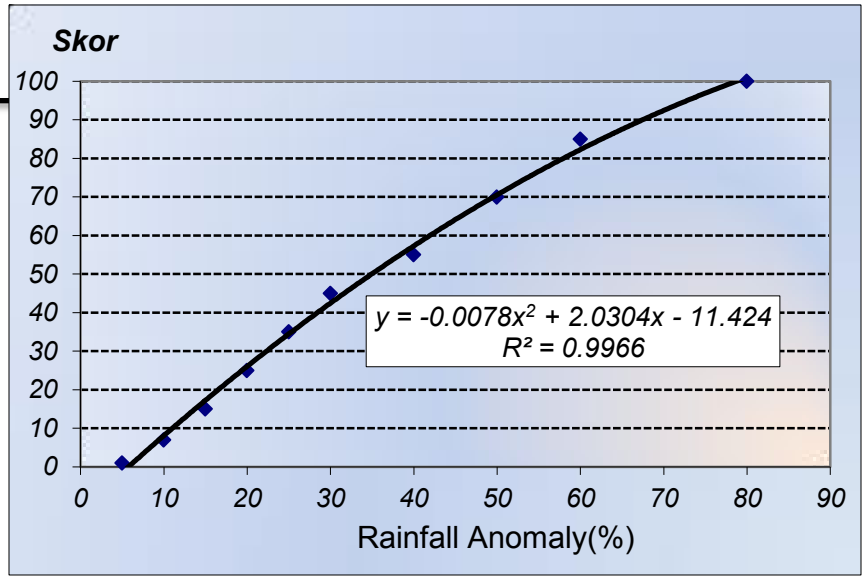
CHr : Average Rainfall of each sub round during 10-30 years

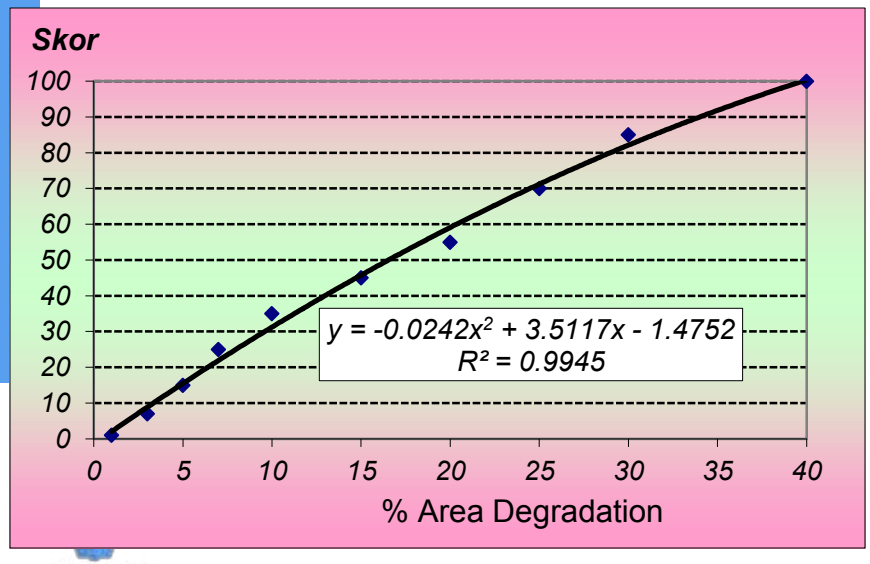
Rainfall Status (Normal) : 0.85 > Chp/Chr < 1.15 or -15 > ACH < 15

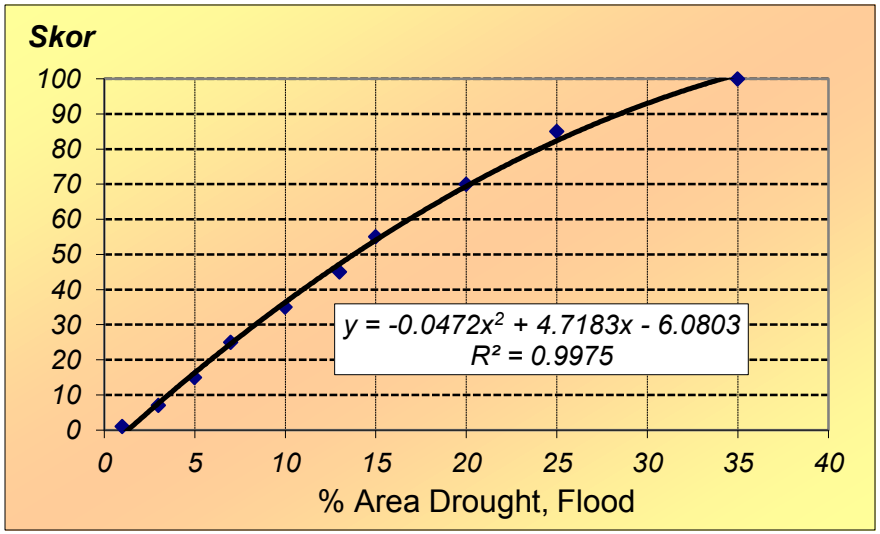
LAPAN

SCORING FOR SUB FACTORS



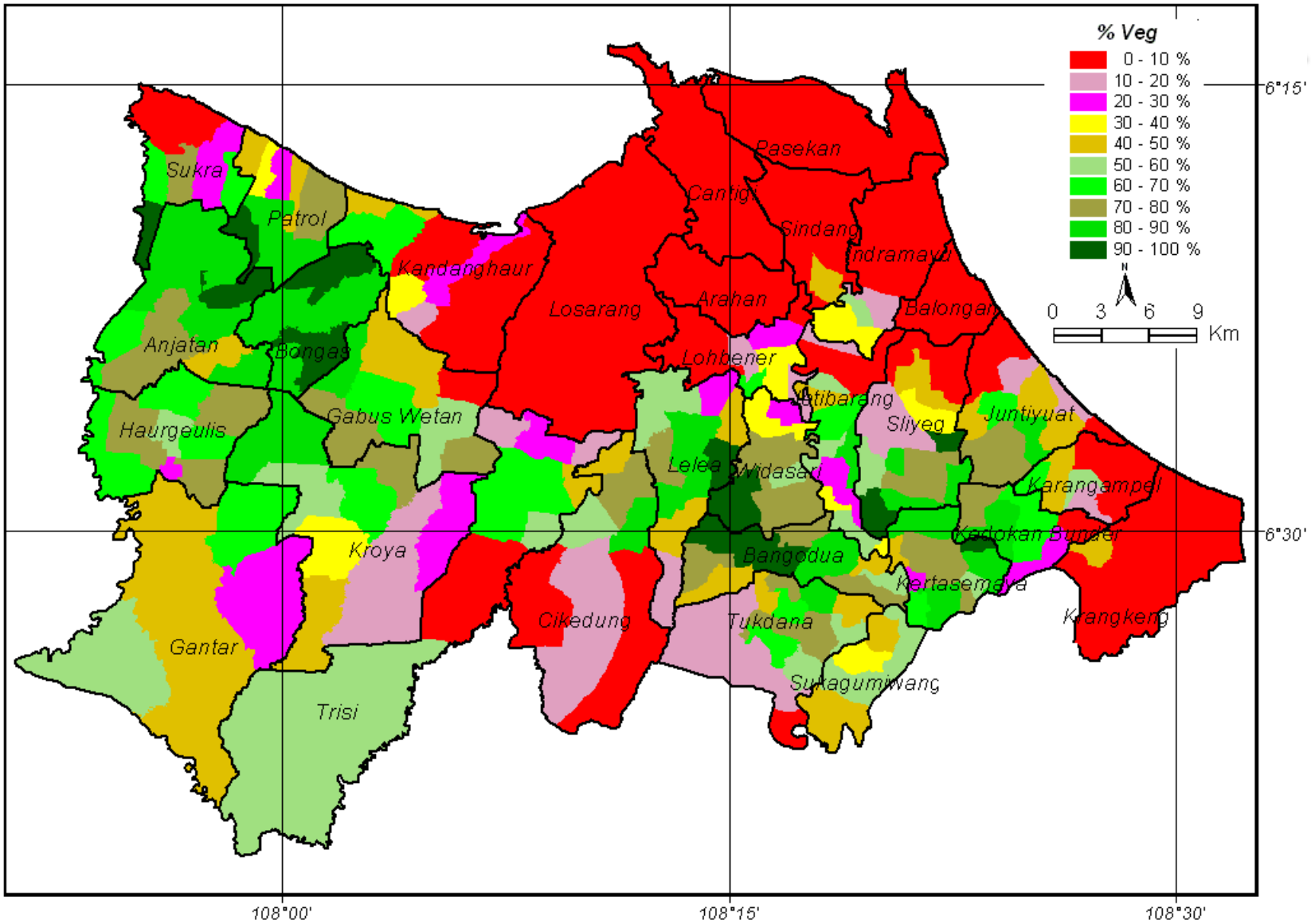




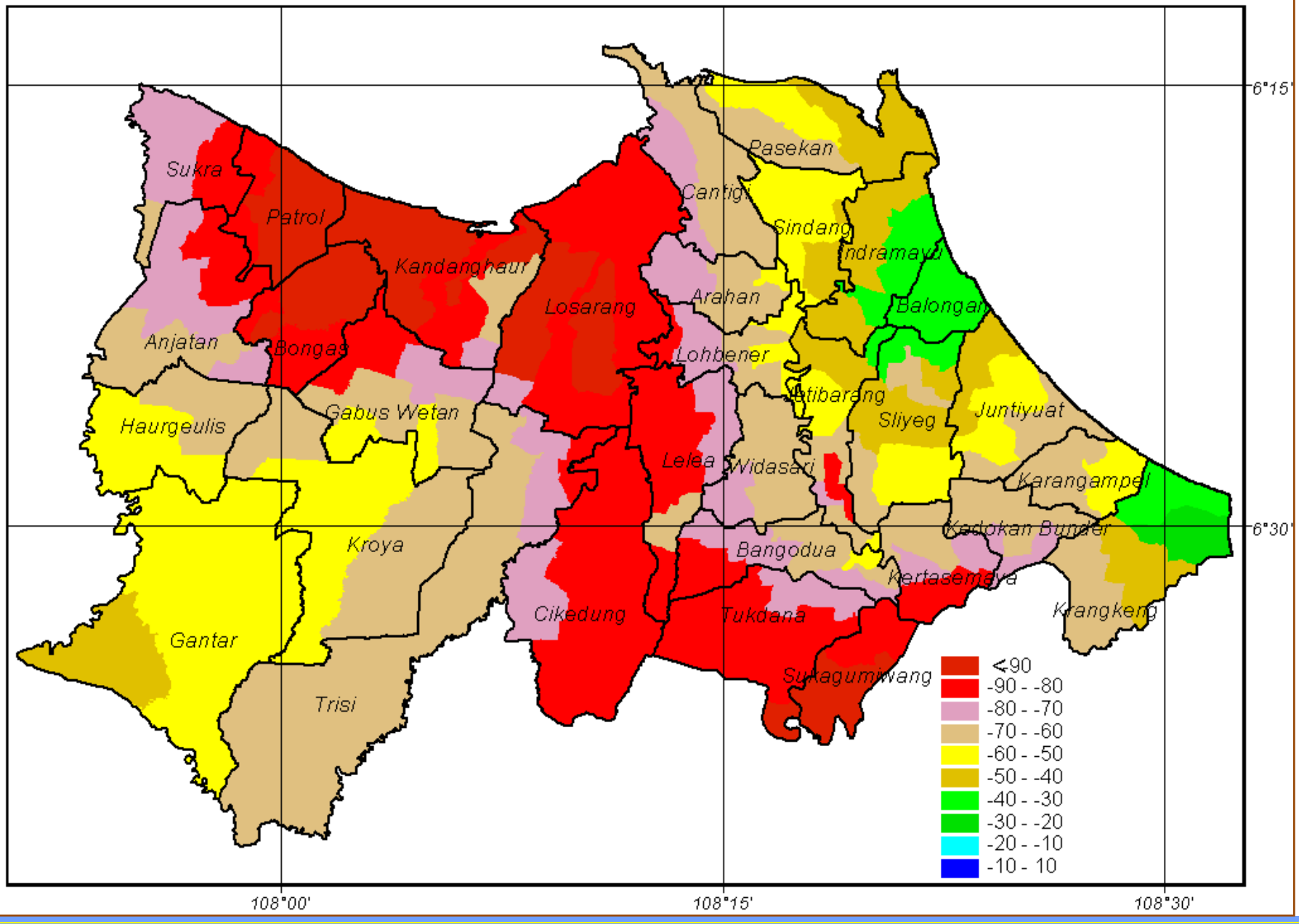


LAPAN

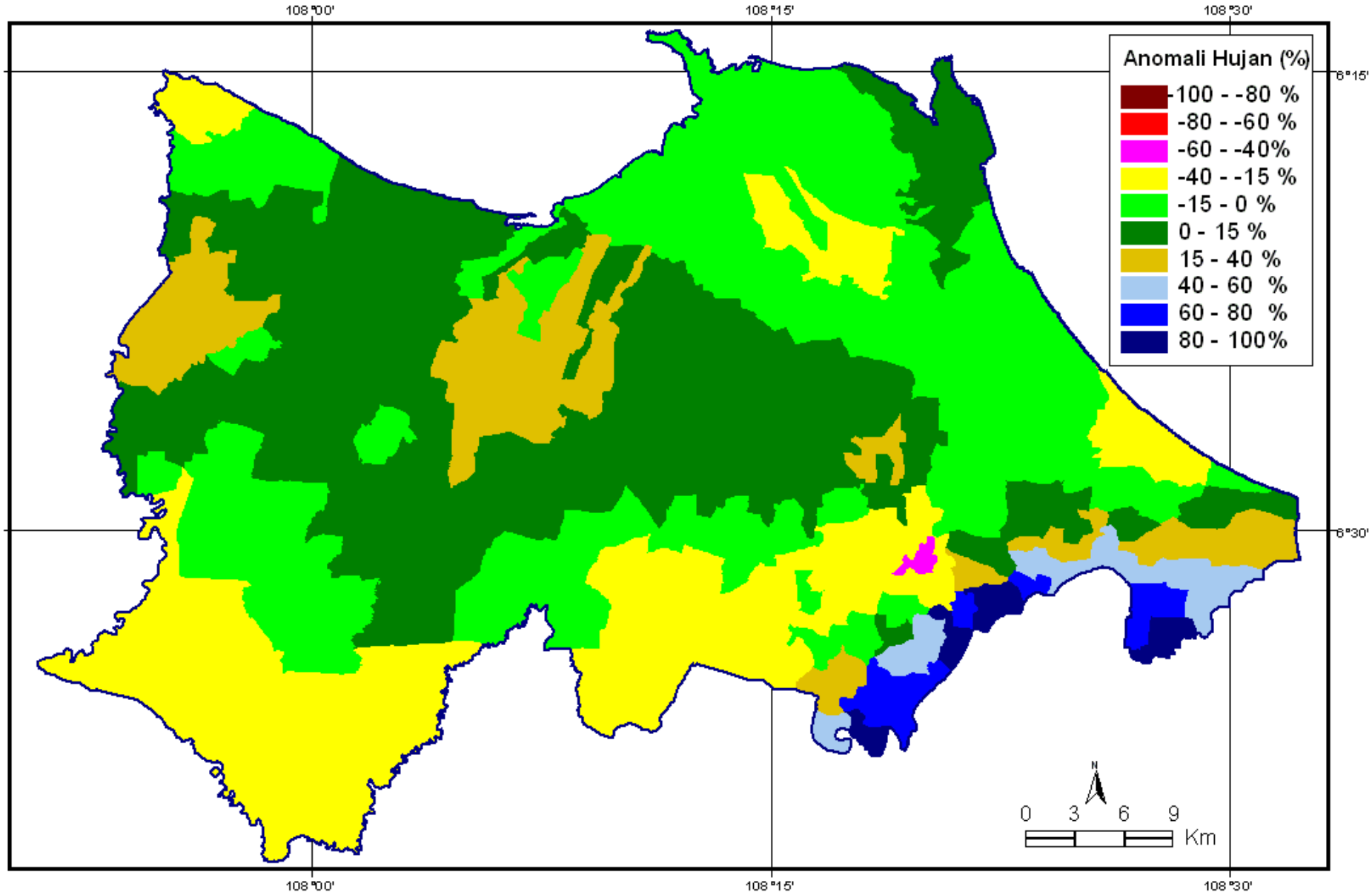
% DENSE VEGETATION MAY-AUGUST 2008



RAINFALL ANOMALY MAY-AUGUST 2008

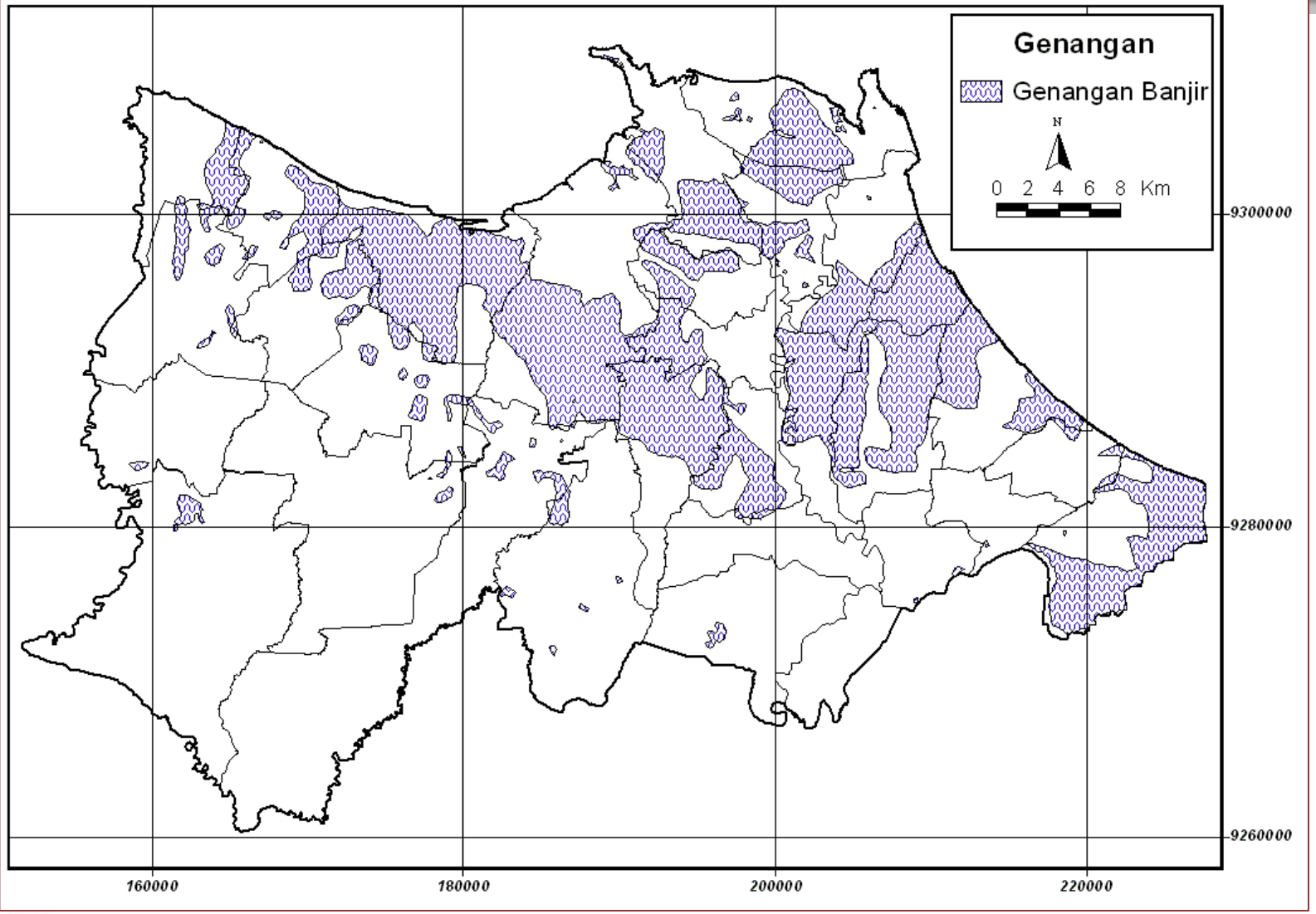


ANOMALI CURAH HUJAN JANUARI-APRIL 2006

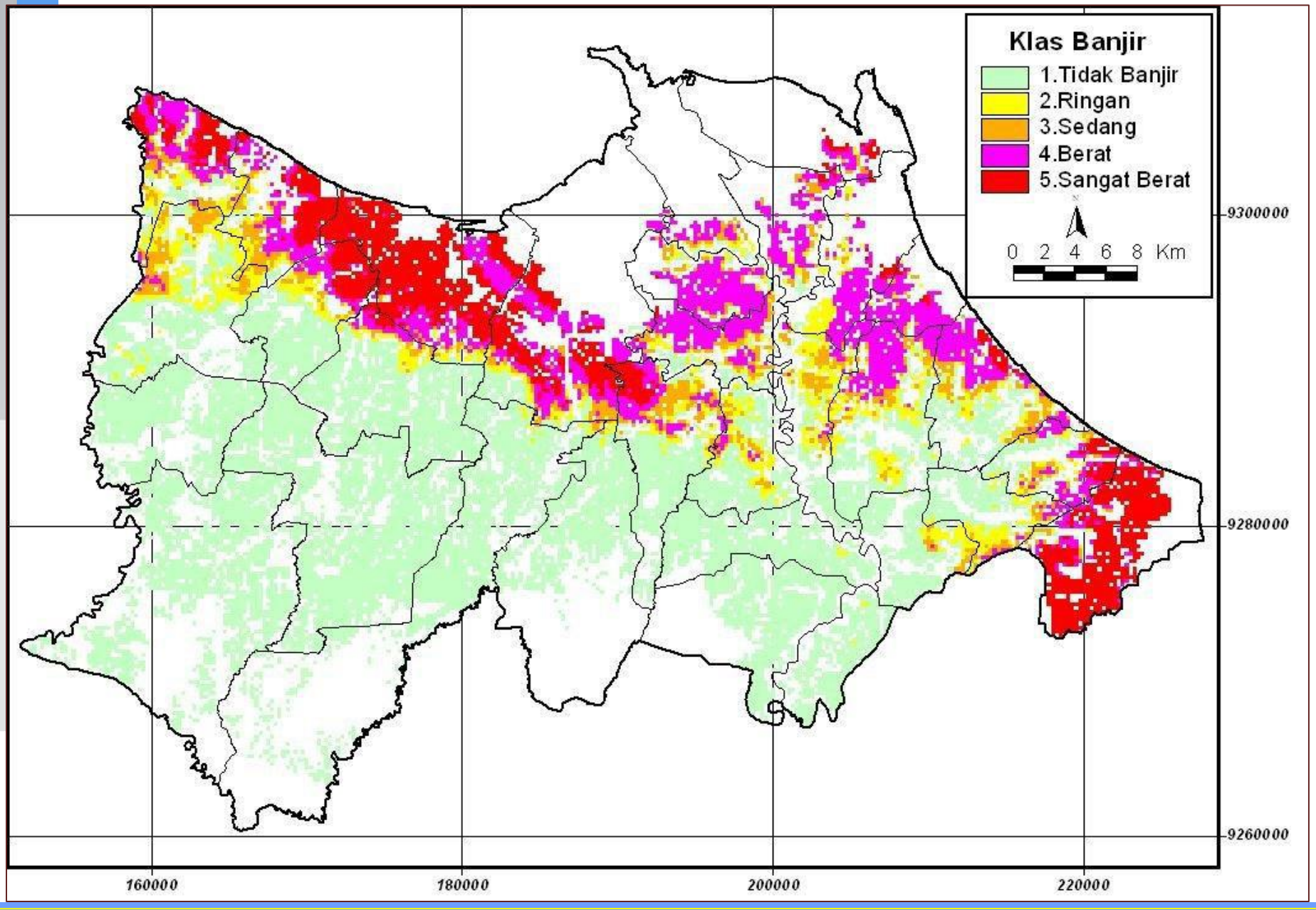


INNUDATION MAP OF INDRAMAYU 2006

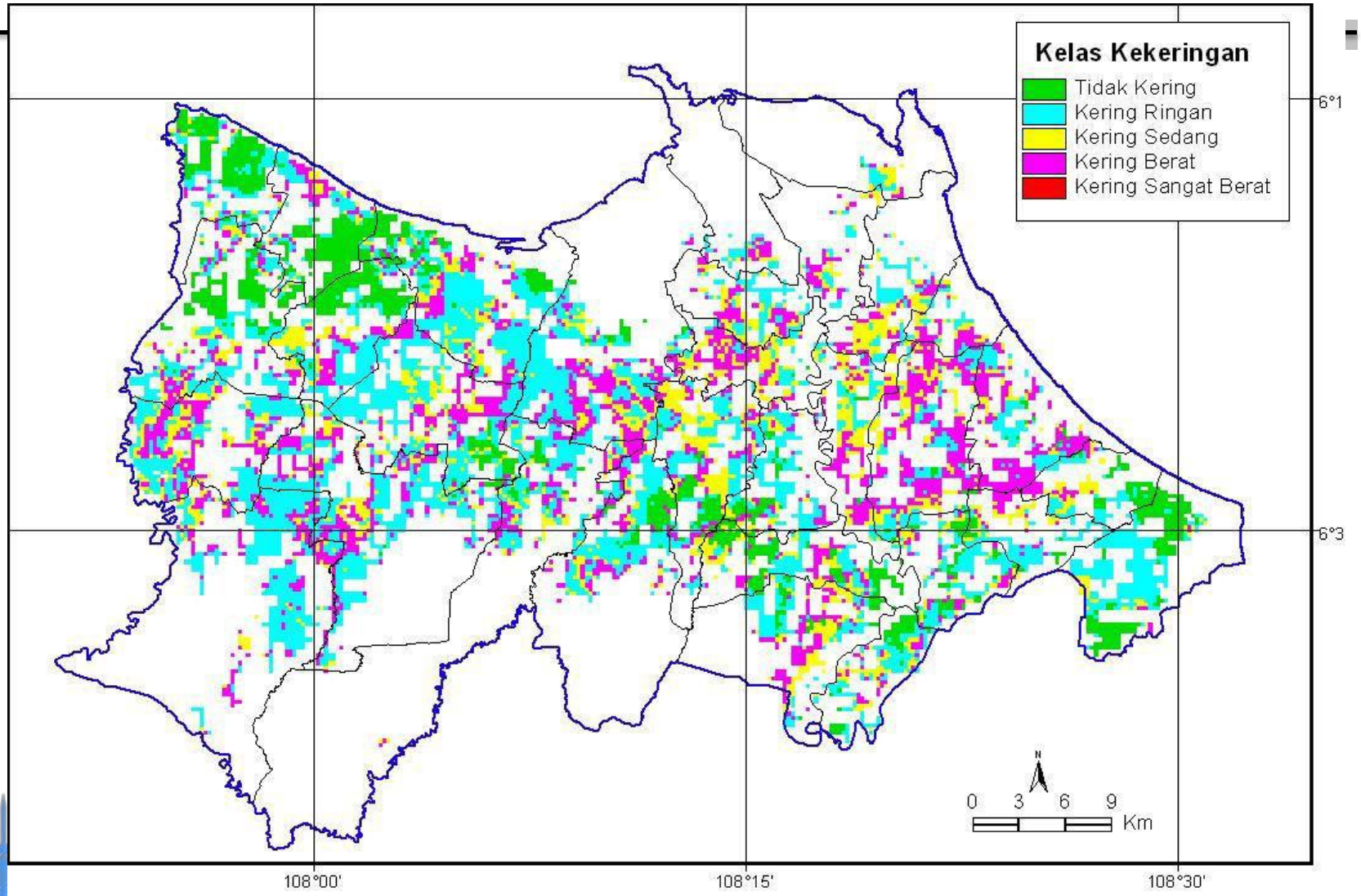
Used for computing factors weight to create a model of Flood Vulnerability in paddy field using CMA Method



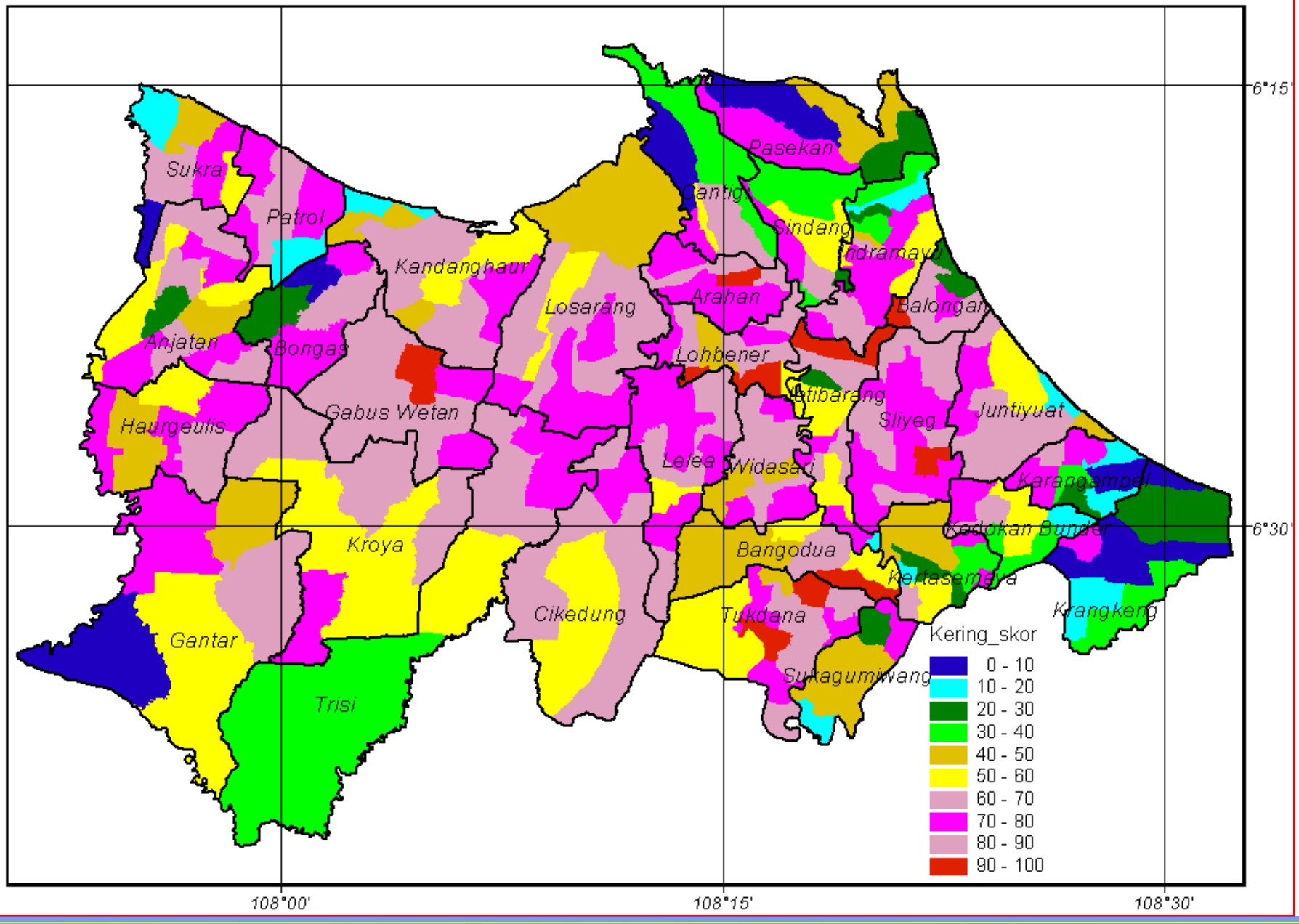
FLOOD HAZARD IN PADDY FIELD ON JANUARY 2006



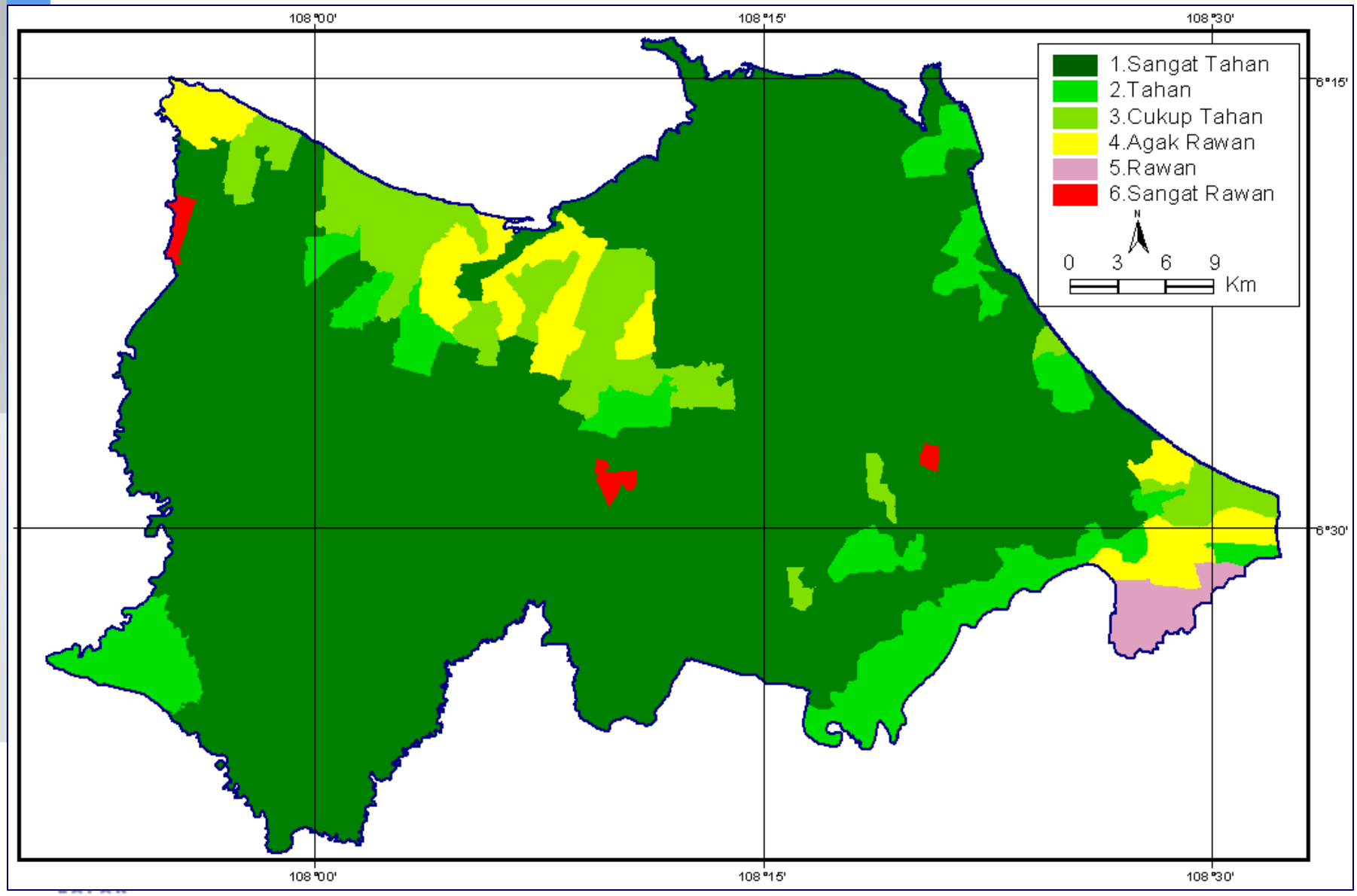
DROUGHT IN PADDY FIELD MAY-AUGUST 2008



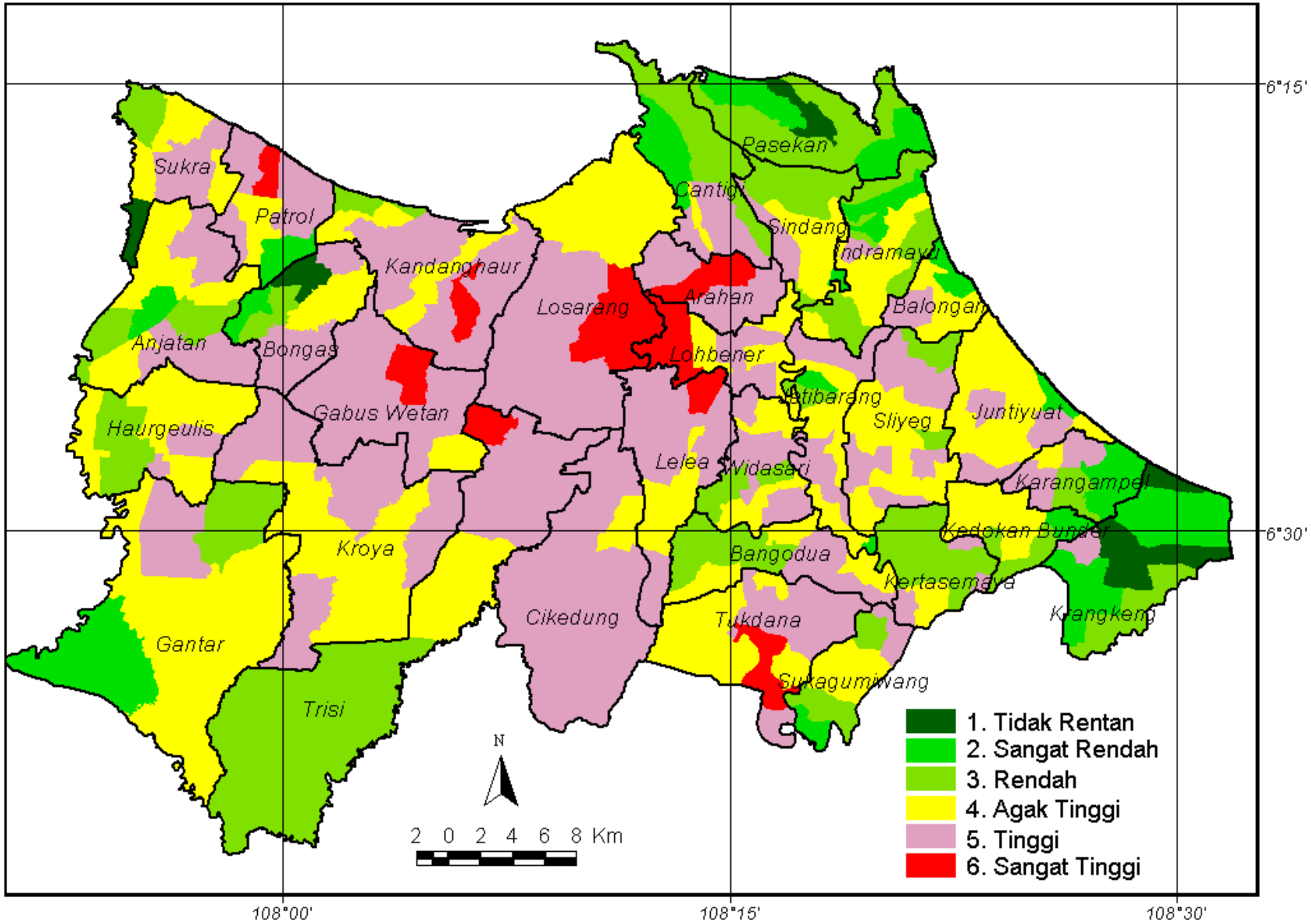
% HEAVY DROUGHT OF INDRAMAYU, MAY-AUGUST 2008



FOOD VULNERABILITY OF INDRAMAYU JANUARY-APRIL 2006



FOOD VULNERABILITY OF INDRAMAYU MAY-AUGUST 2008

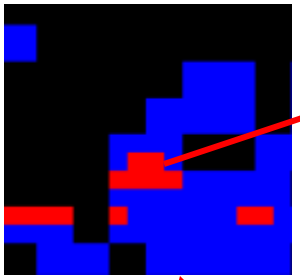


Dissemination (User Agency: MoA = Agriculture) - Discussion

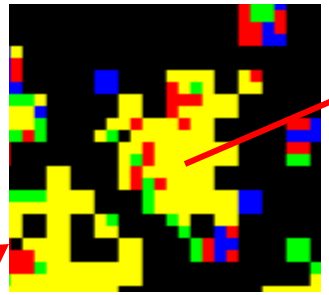
Requirement of MoA:
-Drought/flood prediction in paddy field
- Paddy Growth Phase/stages (from LAPAN)

LAPAN

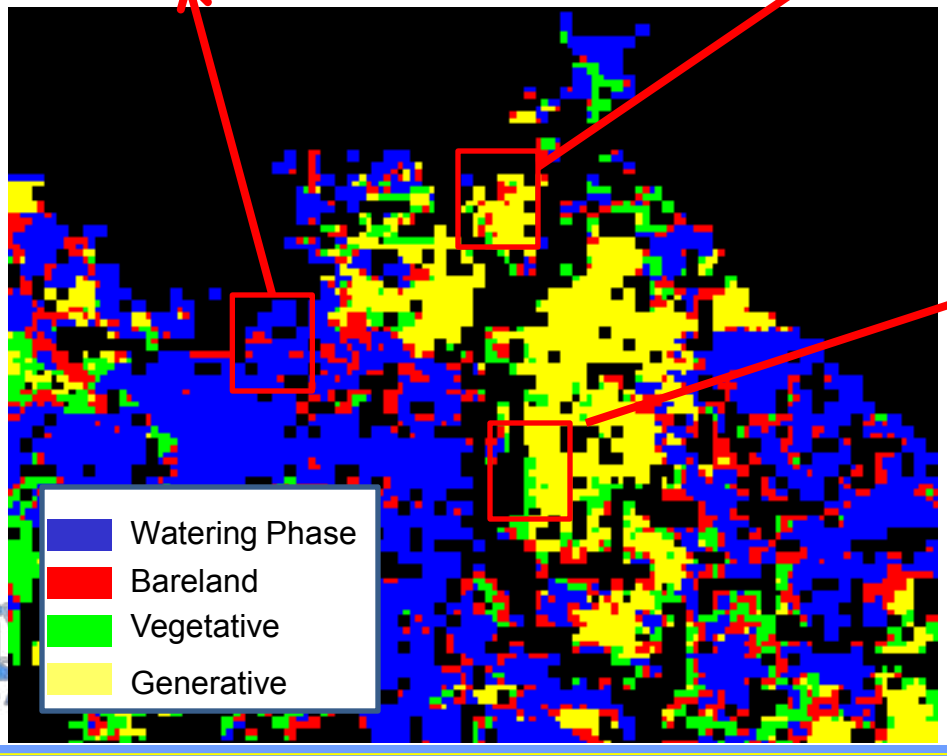
Validation in the Study Area

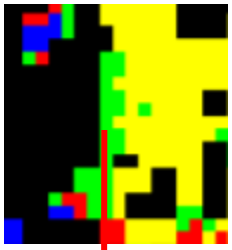


Bare land



Generative





Vegetative

Dissemination (User Agency: MoA)
- Training

LAPAN

Closing Remark

- LAPAN has been doing research on Rice Crop Growth Monitoring to Support Food Security in Indonesia since 2005
- The results of research have been delivered to user agencies (MoA and Statistical Bureau)
- LAPAN will continue support Rice Crop Monitoring for all Indonesian Area

LAPAN