THE CLIMATE FORECASTING FOR DICTRICT LEVEL IN INDONESIA
(Case Study in East Java)

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OUTLINE

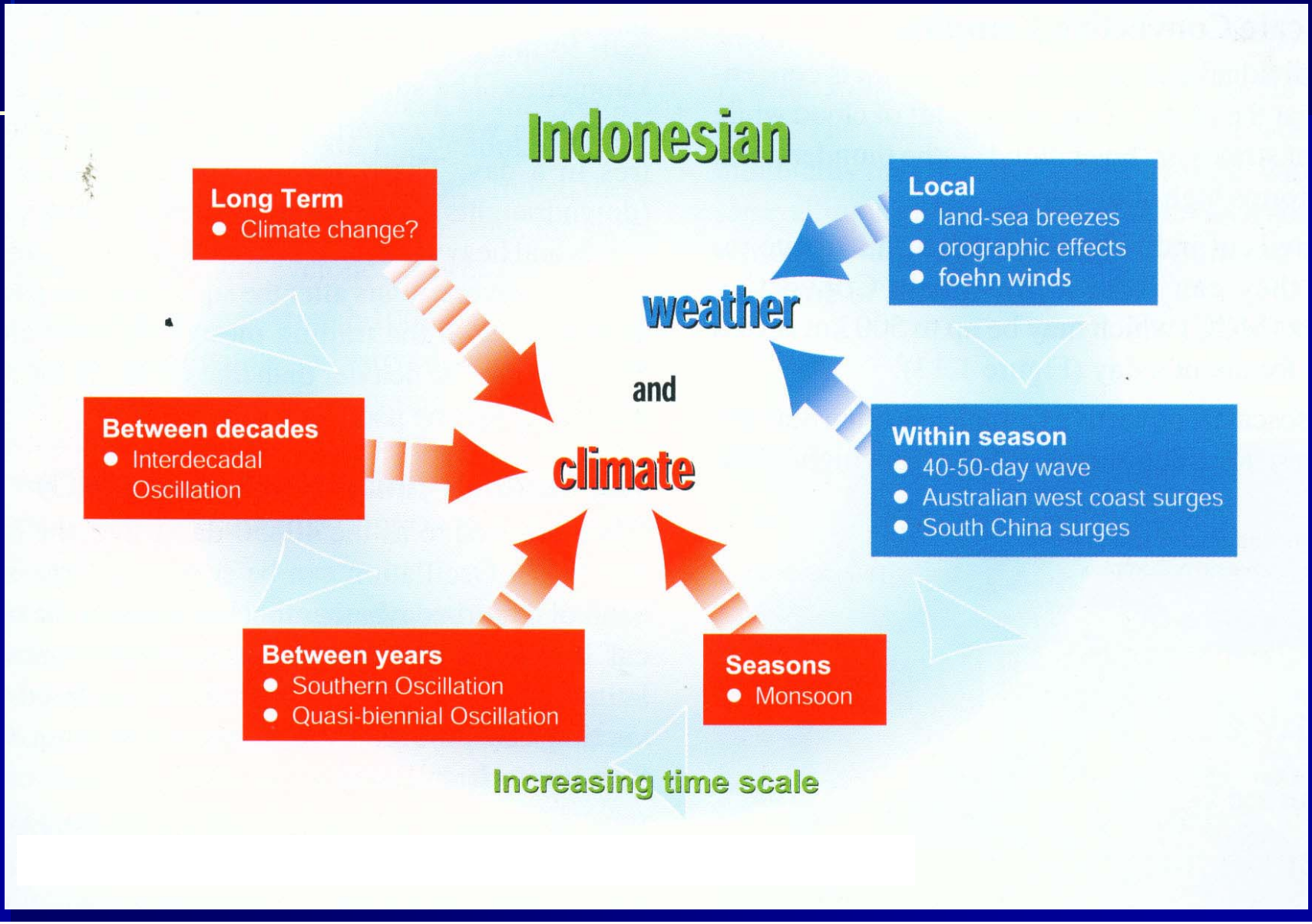
- Introduction
  - ✓ Abstract
  - ✓ Background
  - ✓ Scope of Activities
  - ✓ Goals
- Data and Method
- Climate Forecast program for Sub province (District Scale)
- Result (Rainfall Type Zonation, District Level)

INTRODUCTION

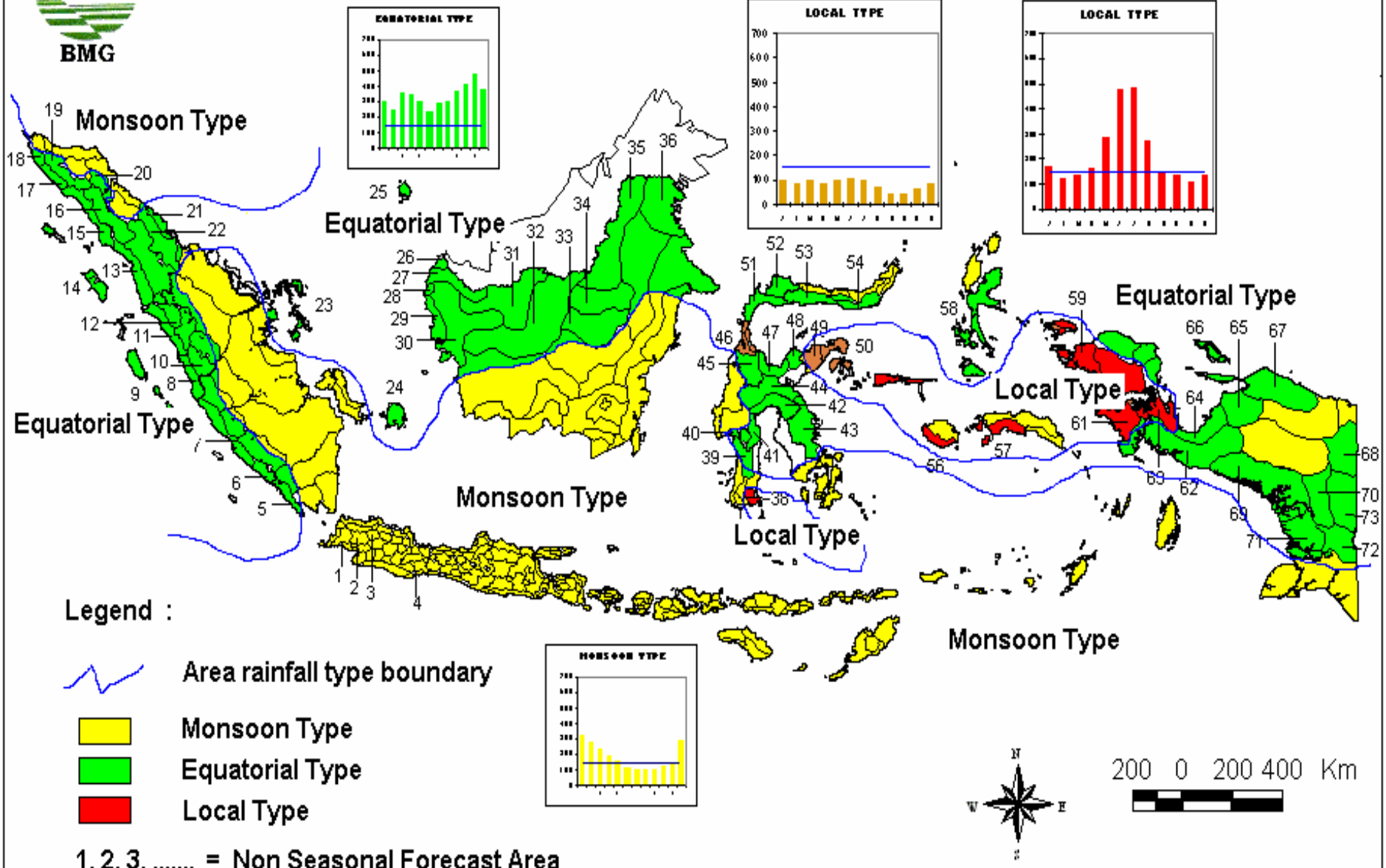
ABSTRACT

1. Rainfall in Indonesia is mainly affected by geographical condition as an archipelago between two continents, Asia-Australia and a very wide ocean-Indian Ocean.
2. Most rainfall patterns in Indonesia are dominated specially by two types, “monsoon” and “equatorial”. The monsoon type they are has wet (rainy) and dry season in a year. But equatorial there is no dry season, almost wet and rainy a year.
3. For rainfall prediction in Java especially East Java on several District, it need specific method by create group for rainfall type more detail namely “clustering” methode.
4. In each istrict there will consist of several types of rainfall pattern that have different on onset and length of season.
5. This technique is very helpfull to determine the prediction of the onset for rainy and dry season with combine the ARIMA, ANFIS, KALMAN, and WAVELET models.
6. The climate forecasting information can be deployed for agriculture and irrigation (i.e. seeding plan) and also for anticipating of ENSO phenomena. This will help to reduce the risk of climate extreem or climate anomaly.

THE FACTORS THAT INFLUENCE VARIABILITY IN INDONESIAN RAINFALL



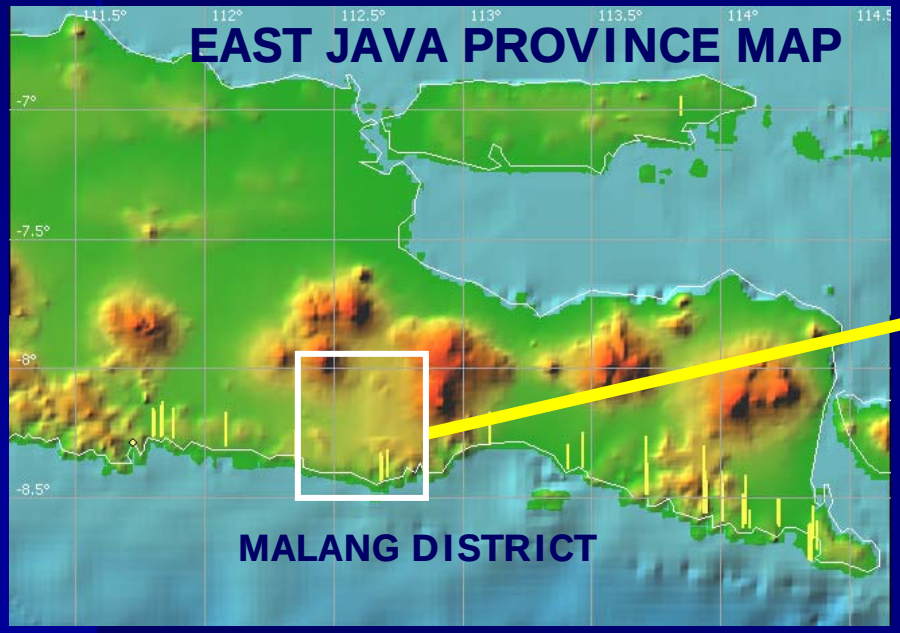
The General Rainfall Types in Indonesia

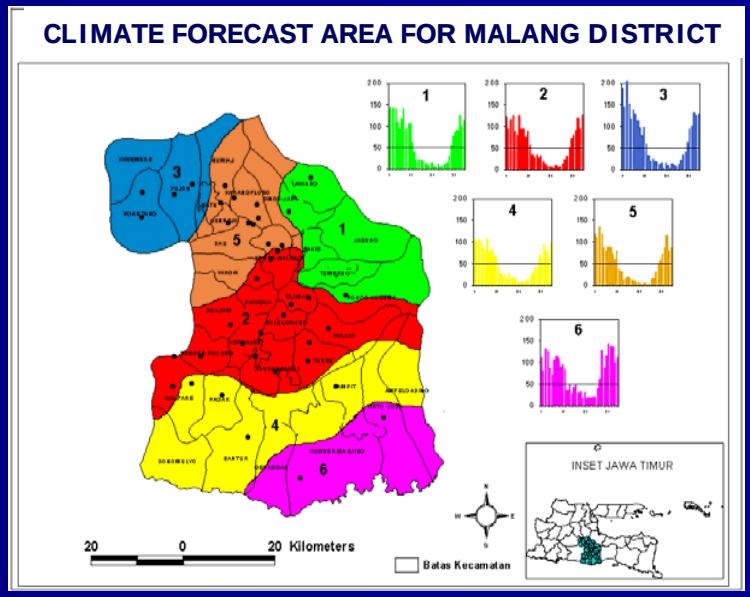


INTRODUCTION

BACKGROUND

1. Existing Method of Climate Forecast Area-*ZPI*, (Global Scale)
2. Low Accuracy of Climate Forecast (The onset of rainy and dry season)
3. Difficulty of Rainfall Data Collecting and Distribution (Communication problem)
4. Climate Forecast Information (Optimizing The Onset of Rainy and Dry Season Information)





SCOPE OF ACTIVITIES

1. Divide of Climate Forecast Area into Sub Province (District level), until sub district regionalization.
2. Increasing Accuracy/precision of Climate Forecast using Dynamical and Statistical Method.
3. Climate Information Collaboration between local institution (District level), and BMG Jakarta.

Goals:

Strengthening of Climate Forecast Dissemination, specially for Climate forecast in District level to support Local Institution (i.e. Agriculture Division)

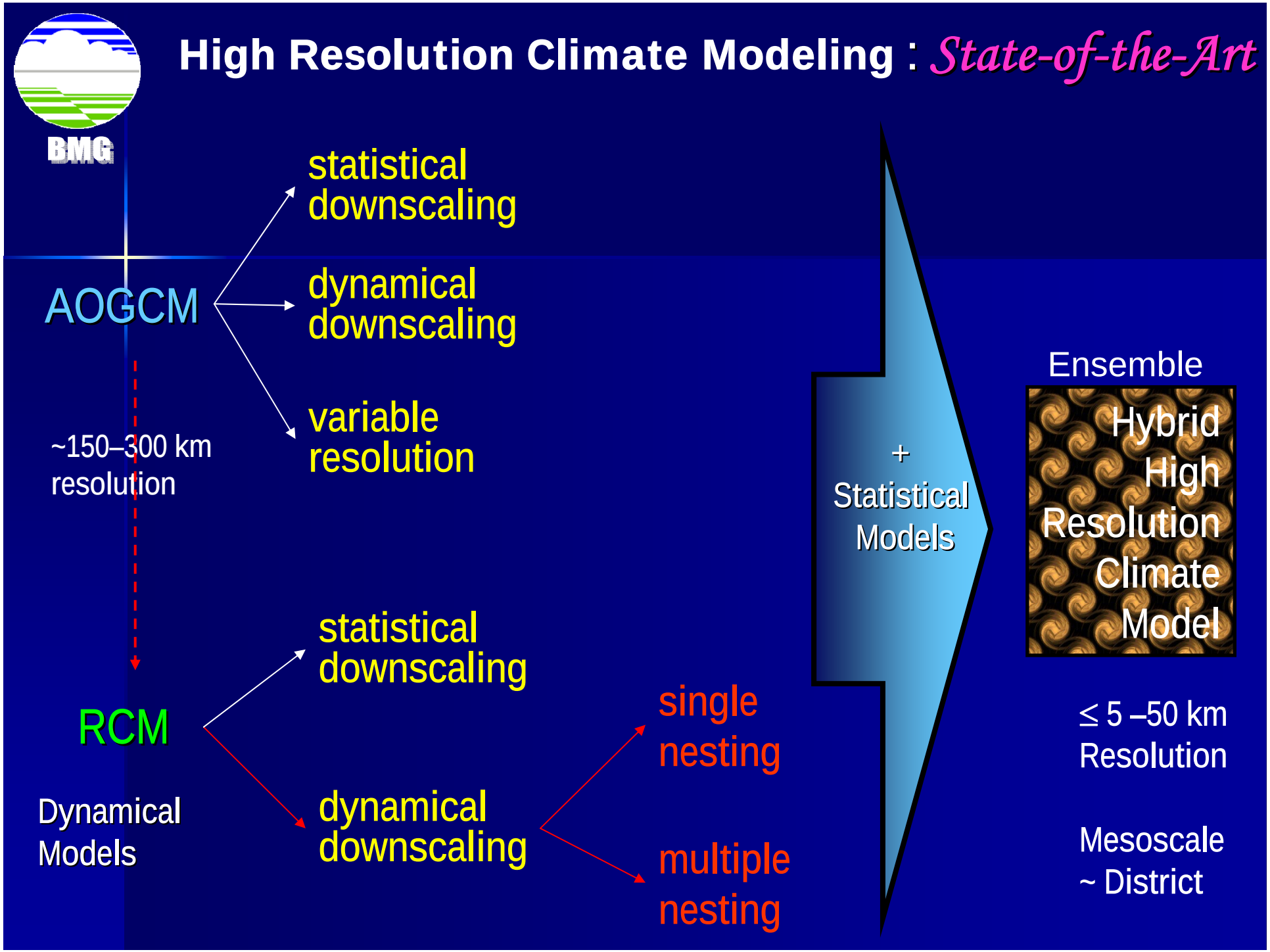
DATA AND METHOD

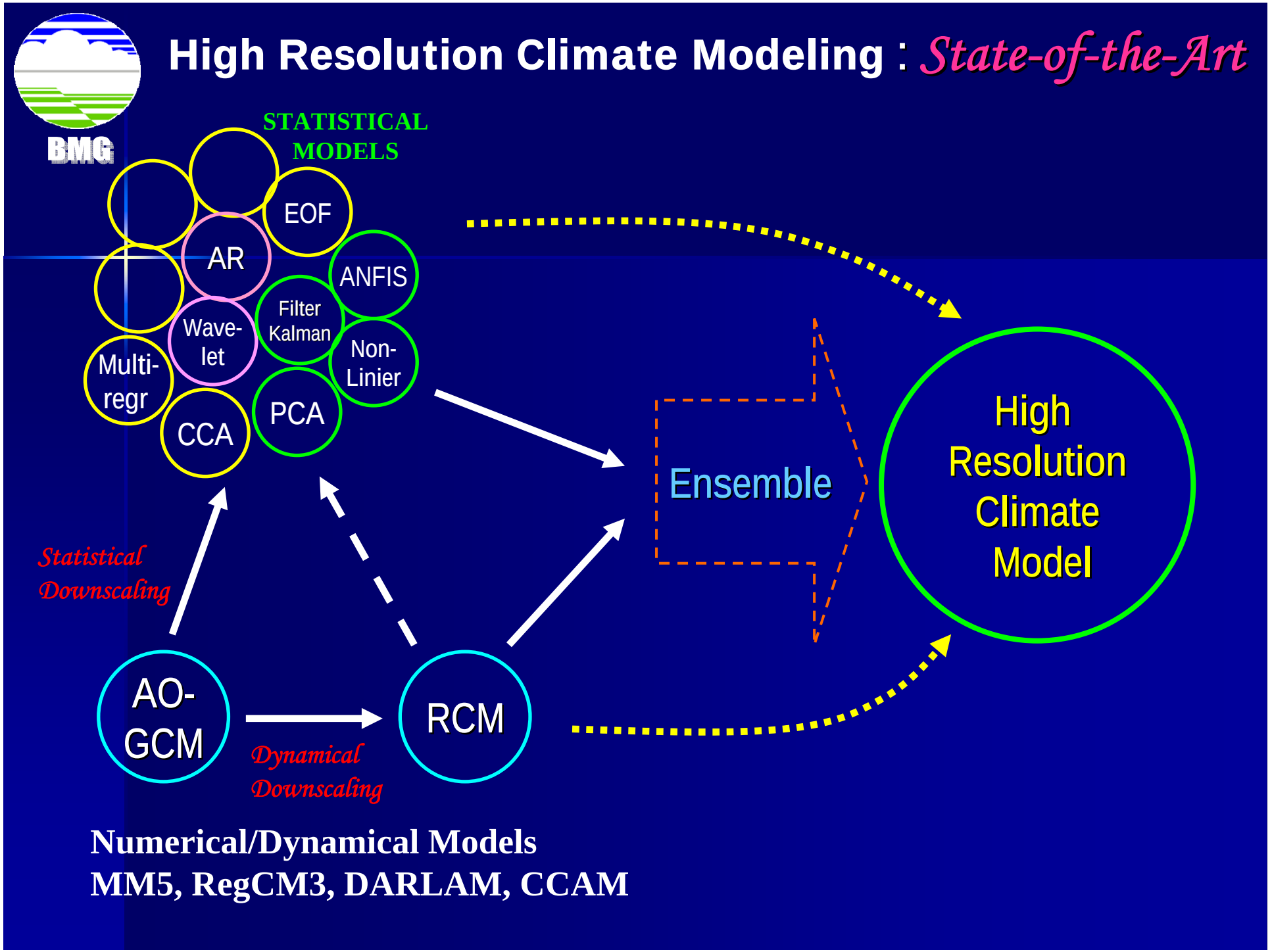
DATA :

- Rainfall data (Historical rainfall data, 1971 – 2000)
- Coordinate/Position of Rainfall Stations
- Topography and Regional Geography Condition

METHOD :

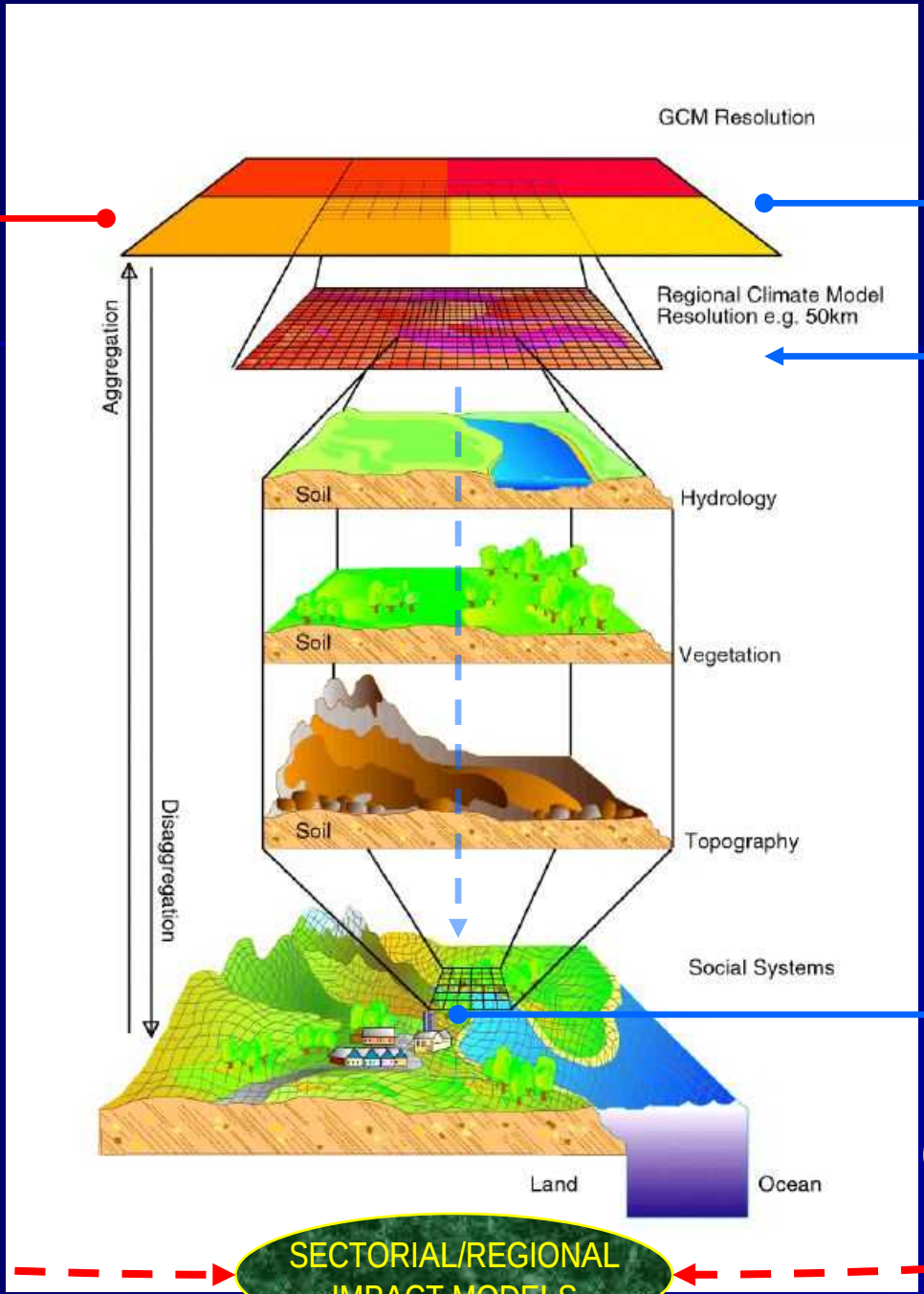
- Analysis of Rainfall Type Classification (*Clustering*)
- Thiessen Polygon Method (Smoothing with Visual Analysis, Consider to topography and geography condition)
- Determine of Normal Season Period every Climate Forecast Area
- Forecasting → Hybrid : ARIMA, NonLin, PCA, Wavelet, ANFIS, Kalman, CPT (Recent develop)


BMG
High Resolution Climate Modeling : State-of-the-Art
AOGCM
statistical downscaling
dynamical downscaling
variable resolution
~150–300 km resolution
RCM
Dynamical Models
statistical downscaling
dynamical downscaling
single nesting
multiple nesting
+ Statistical Models
Ensemble
Hybrid High Resolution Climate Model
≤ 5 –50 km Resolution
Mesoscale ~ District


BMG
High Resolution Climate Modeling : State-of-the-Art
STATISTICAL MODELS
EOF
AR
ANFIS
Filter Kalman
Wave-let
Non-Linier
Multi-regr
PCA
CCA
Ensemble
High Resolution Climate Model
Statistical Downscaling
AO-GCM
RCM
Dynamical Downscaling
Numerical/Dynamical Models
MM5, RegCM3, DARLAM, CCAM

BMG

Statistical Downscaling



Dynamical Downscaling

High Resolution Climate Model

High Resolution Climate Model

SECTORIAL/REGIONAL IMPACT MODELS

Why Hybrid & Ensemble ?

- **Every Method Has a variance of Forecasting Scale (time, location)**
- **Weather and Climate are non linear phenomenon and c*haotic* → Need Ensemble for prediction activities→ *probability density function***

CLIMATE FORECAST PROGRAM FOR SUBPROVINCE (DISTRICT LEVEL)

BMG

Y 2004

10 districts

ARIMA, Kalman

Indramayu
Bandung
Cirebon
Sragen
Malang
Lahat
Banjar
Minahasa
Maros
Jembrana

S/H for Statistical Model Including MR1234

Y 2005

10 districts

ANFIS,Wavelet, NonLin.,PCA

+

20 districts

ARIMA, Wavelet, ANFIS, Kalman, NonLin.,PCA

Socialize new forecast Tool (New Models) to districts (<-> 30 districts)

PC Cluster for Numerical Model

Y 2006 and 2007

Validation of 10 districts

Developing of 40 New Districts

ARIMA, Wavelet, ANFIS, Kalman, NonLin.,PCA

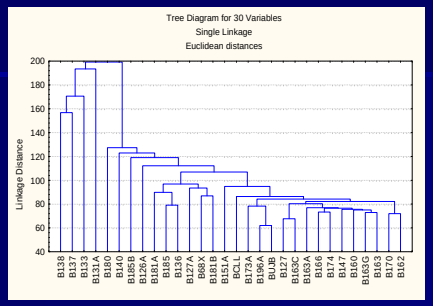
Numerical Model of 10 districts

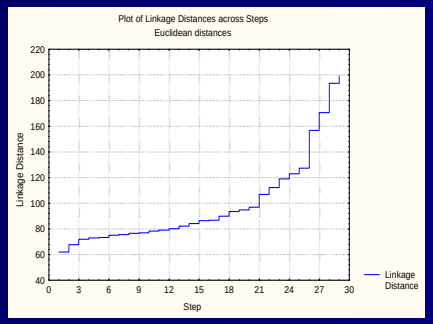
Expand PC Cluster

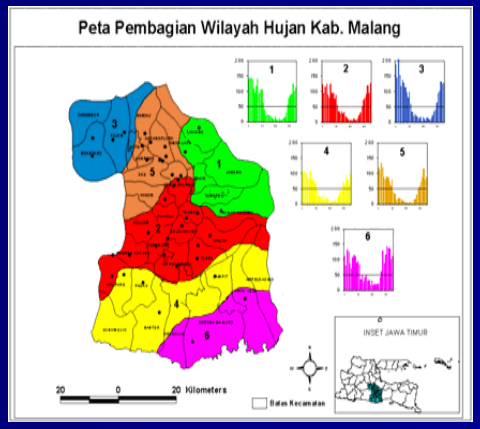
SCOPE OF ACTIVITIES

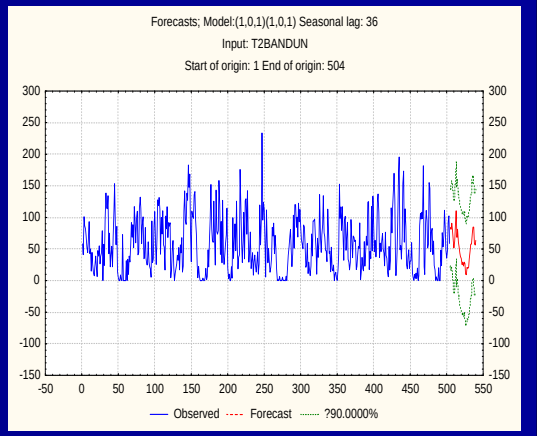
1. Mapping of Rainfall data condition (Daily and Monthly)
2. Positioning of Rainfall Station (Using GPS)
3. Cluster Analysis (Rainfall Type Zonation = ZPI)
4. ZPI Mapping in district (priority of Food sentra district)
5. Determine Normal Climate Value (30 years data period)
6. Re arrange rainfall data average (ten days period) every ZPI, Time series analysis (Seasonal Forecasting).
7. Provide Climate forecast (district scale = resolution 5-10 km)
8. Climate forecast Update (Wet and Dry period)
9. Climate forecast dissemination (Local government and institutions linkages)
10. Climate forecast maintain (Update, Implement, Validate and Monitor)

SCOPE OF ACTIVITIES









Positioning & Data Collecting → Clustering → Zoning → Multi-Model Develop-ment → Forecasting

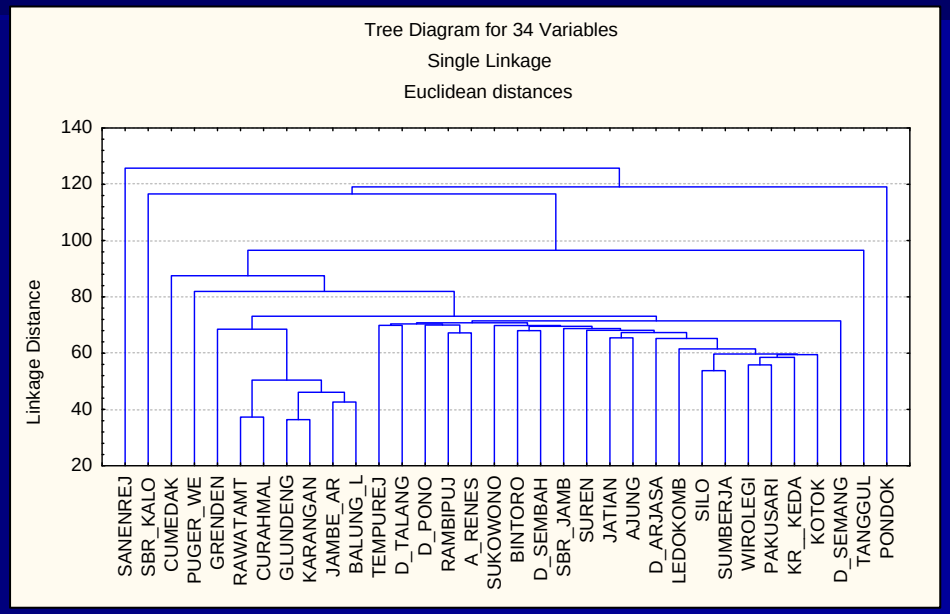
Validation

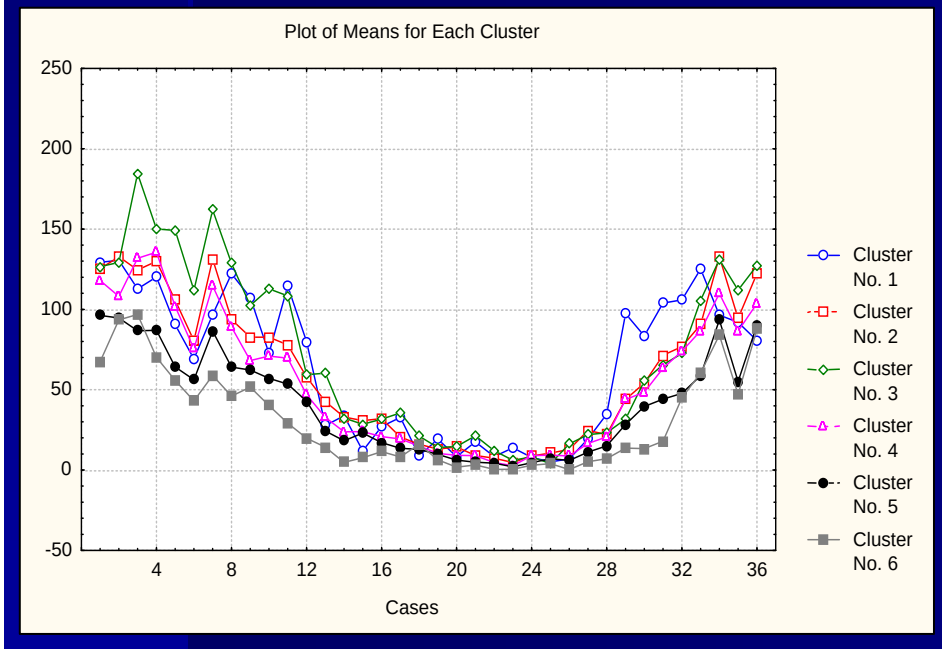
PROCESSING AND RESULT

(Statistica 5.5, modul *cluster analysis* sub modul *Joining (tree clustering)*.)

A. Clustering (Jember district)

Cluster Diagram Rainfall data (10 days) from 36 rainfall station



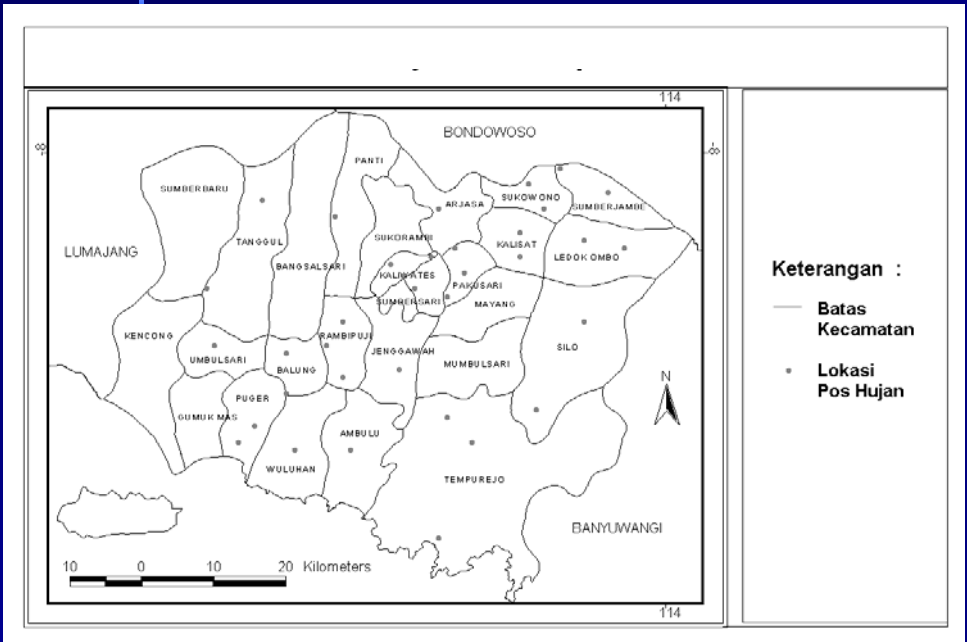


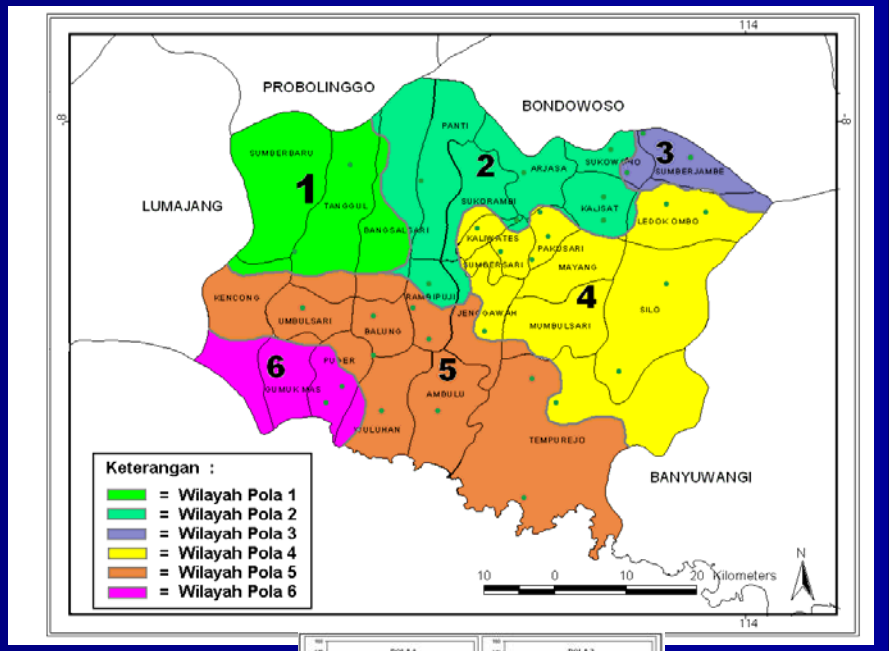
Plot of Means for Each Cluster

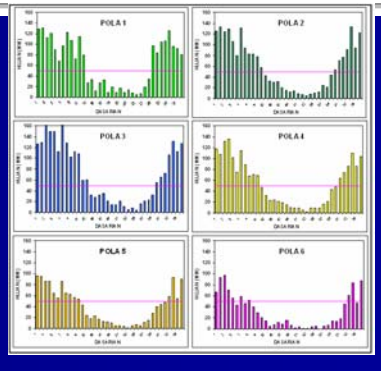
BMG

B. Mapping (Jember District)

Rainfall type zonation and Rainfall pattern graph (10 days period)





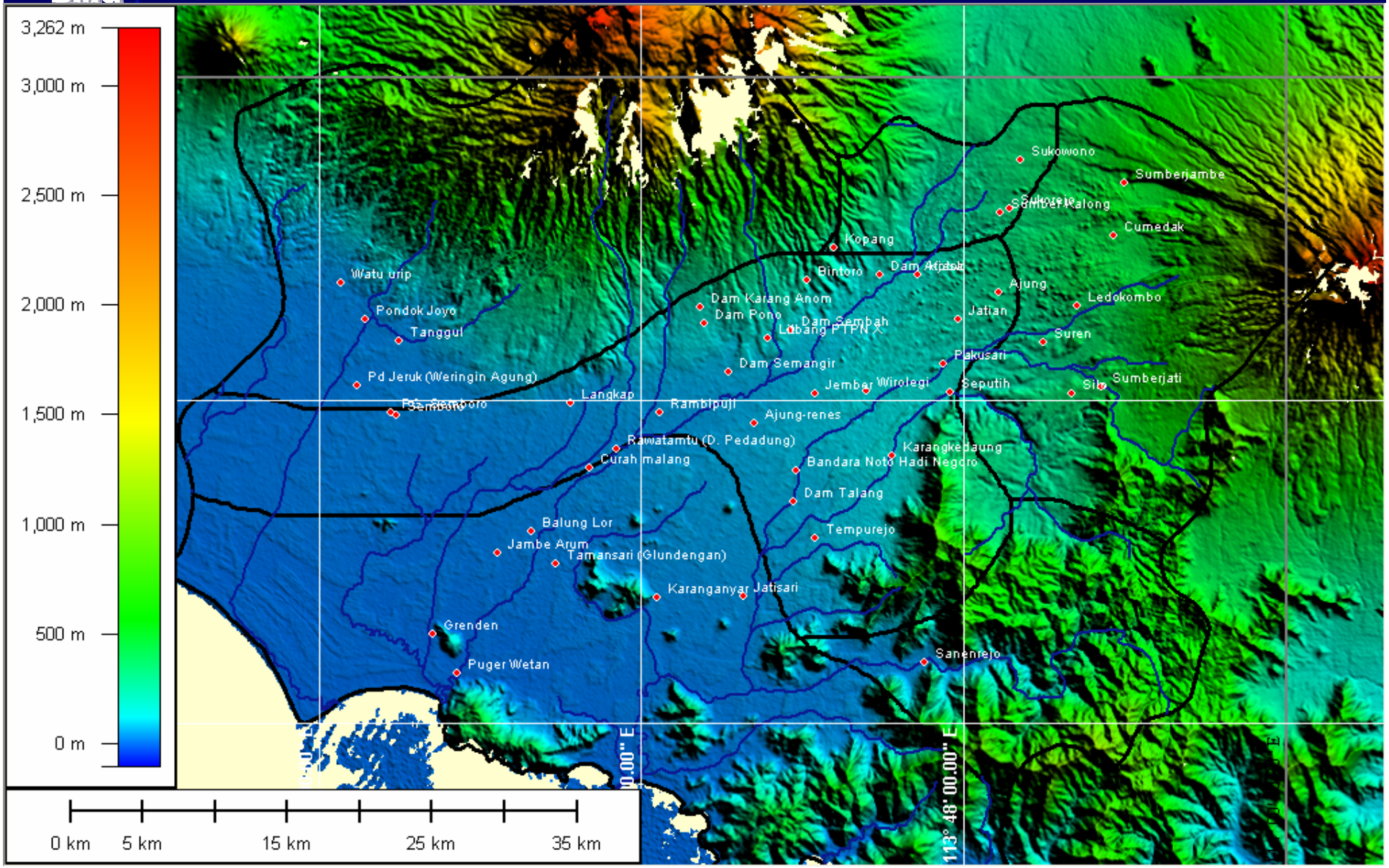


Rainfall stations mapping

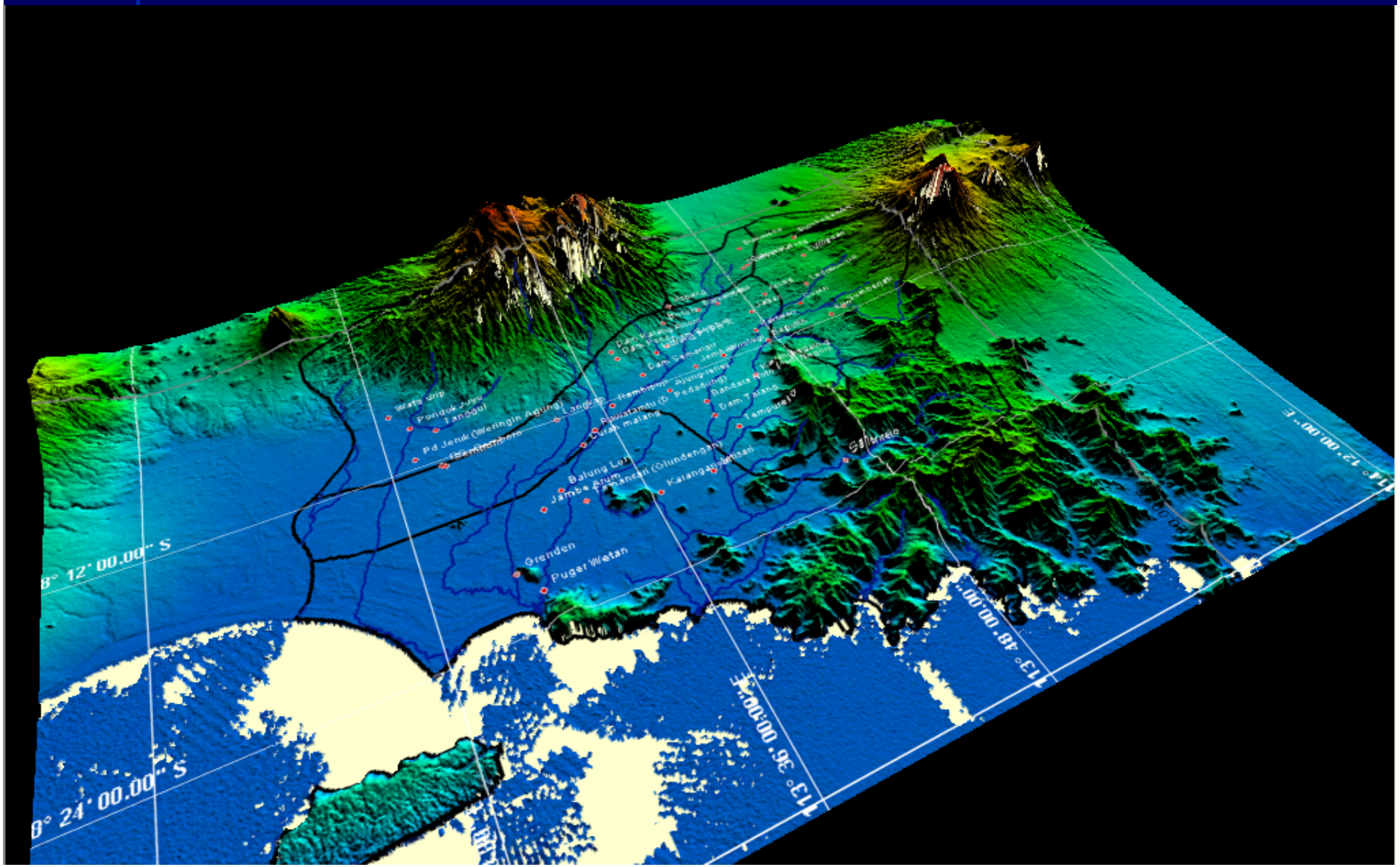
PROCESSING AND RESULT
(Historical Data Characteristics for Jember District)

SEASONAL	CRITERIA	NUMBER OF RAINFALL TYPES					
		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Dry Season	The Onset	May I	Mei I	May II	Apr III	Apr III	Apr I
	The End	Oct I	Oct II	Oct II	Oct III	Nov II	Nov II
	Num. Duration (decade)	16	17	16	19	21	23
	Total Rainfall (mm)	284	347	323	375	383	274
Wet/Rainy Season	The Onset	Oct II	Oct III	Oct III	Nov I	Nov III	Nov III
	The End	Apr III	Apr III	May I	Apr II	Apr II	Mar III
	Num. Duration (decade)	20	19	20	17	15	13
	Total Rainfall (mm)	2031	1867	2255	1607	1106	803

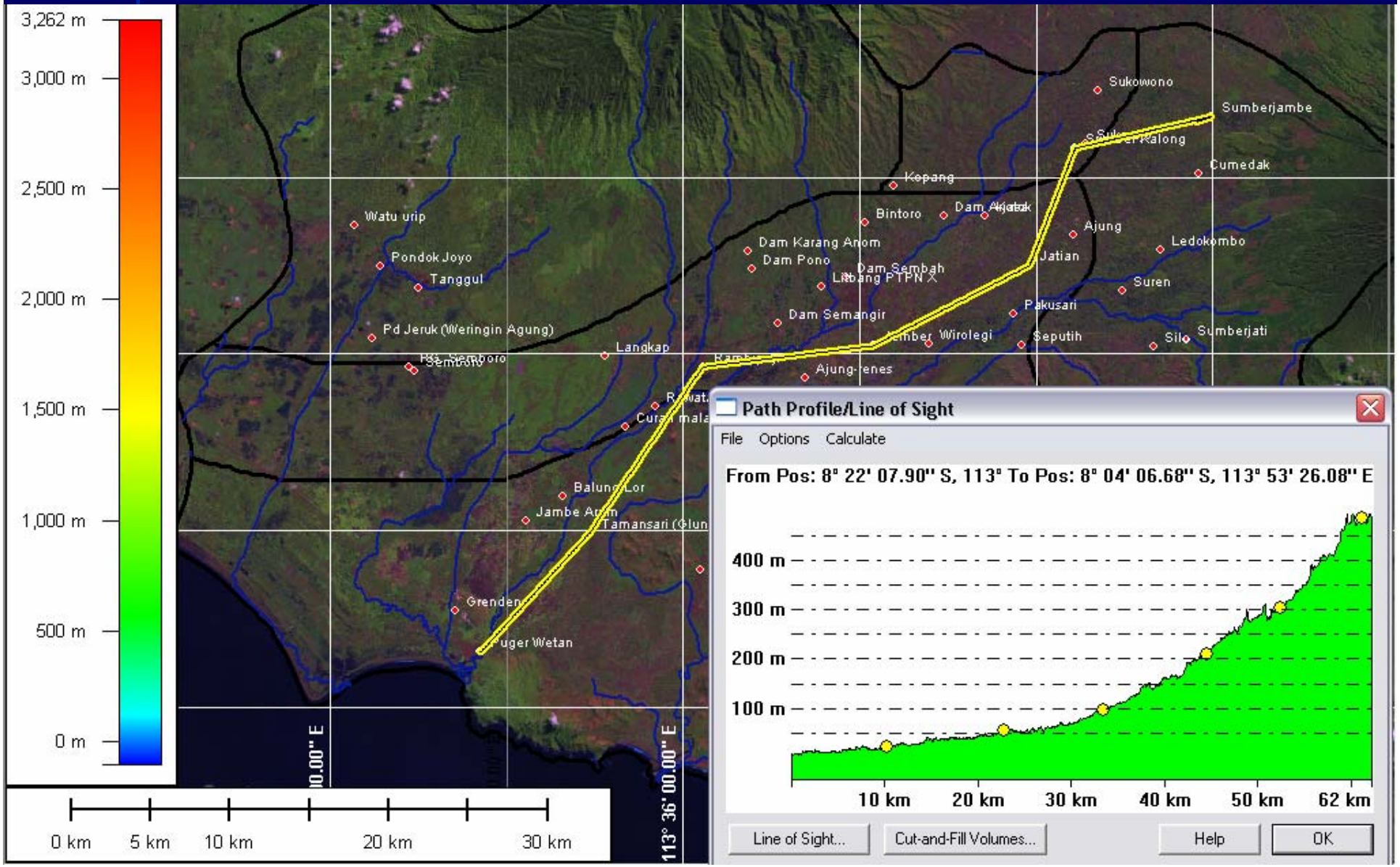
TOPOGRAPHY AND GEOGRAPHY CONDITION ON JEMBER DISTRICT, EAST JAVA



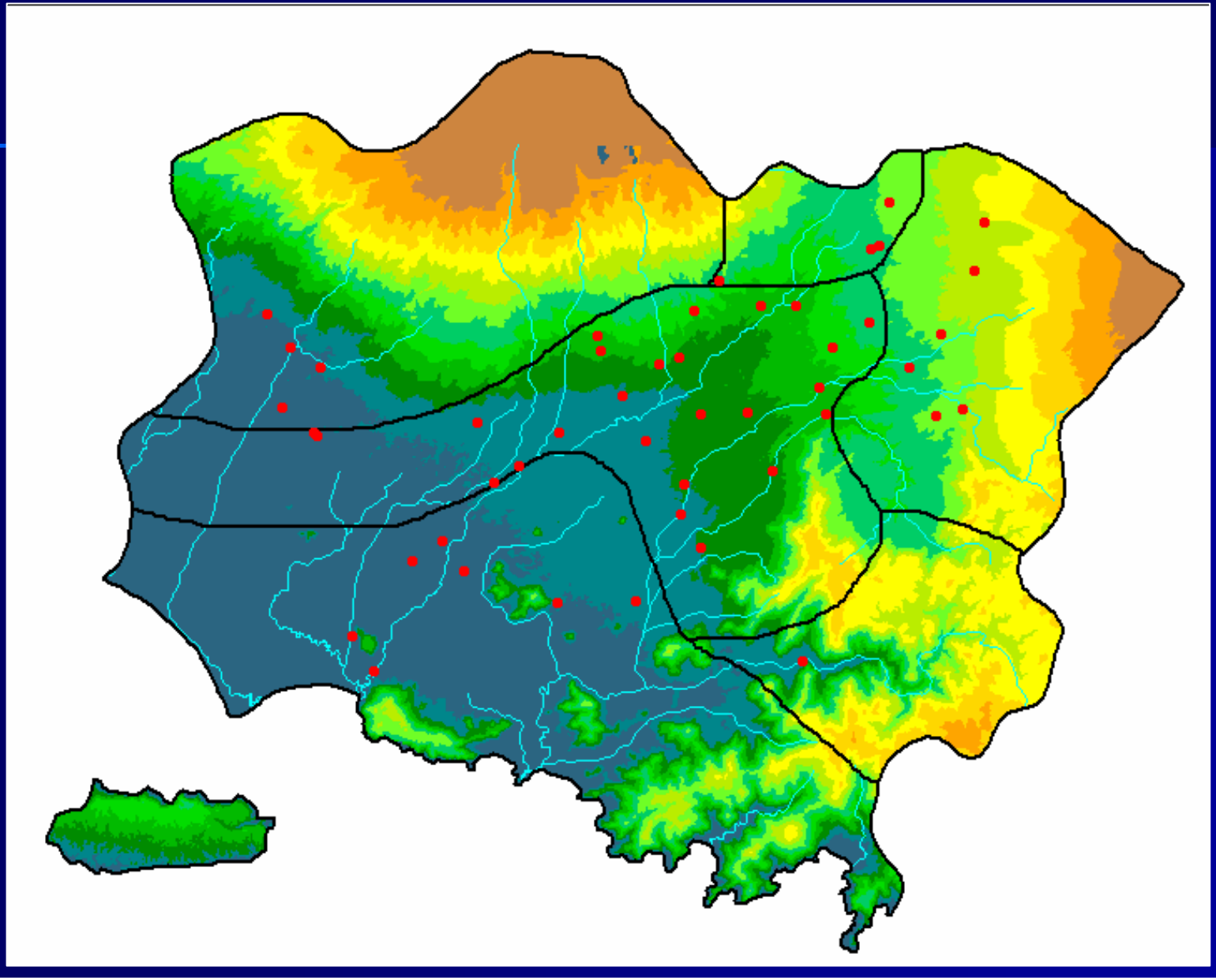
TOPOGRAPHY AND GEOGRAPHY CONDITION ON JEMBER DISTRICT, EAST JAVA



TOPOGRAPHY AND GEOGRAPHY CONDITION ON JEMBER DISTRICT, EAST JAVA



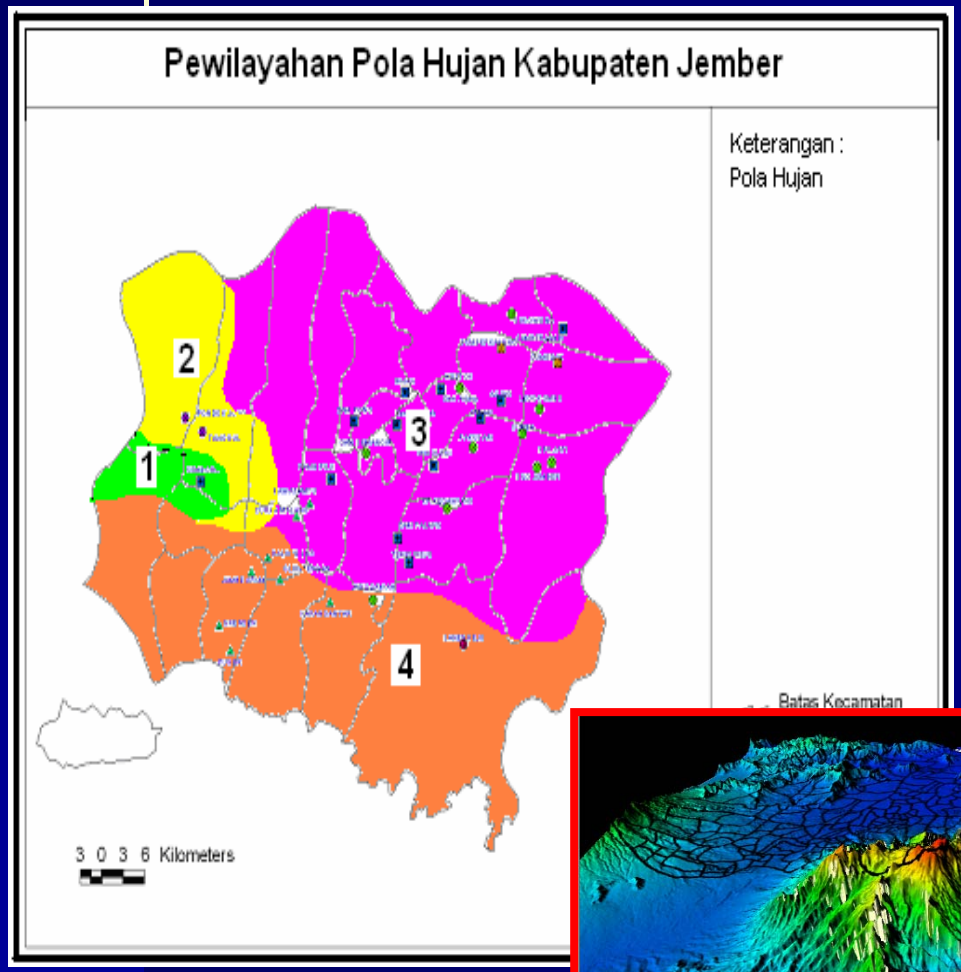
RAINFALL STATIONS & CONTOUR CONDITION ON JEMBER DISTRICT, EAST JAVA



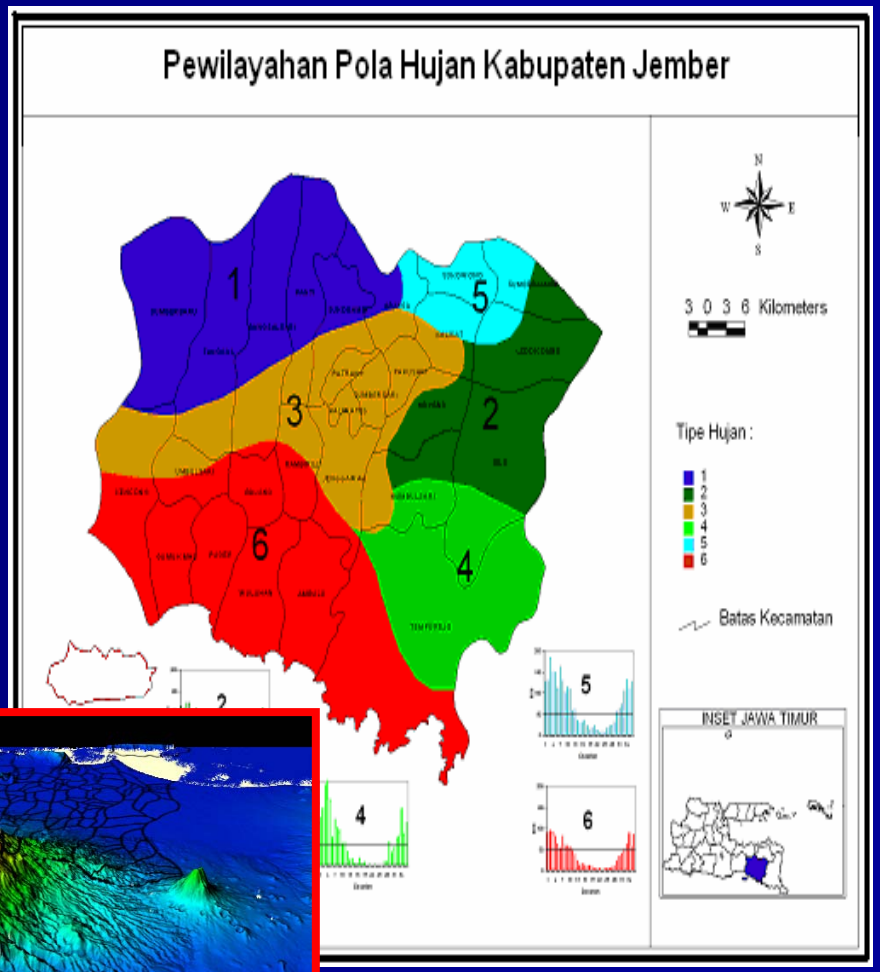
MAPPING OF RAINFALL AREAS FOR EACH DISTRICT ON EAST JAVA BY CLUSTERING TECHNIQUE

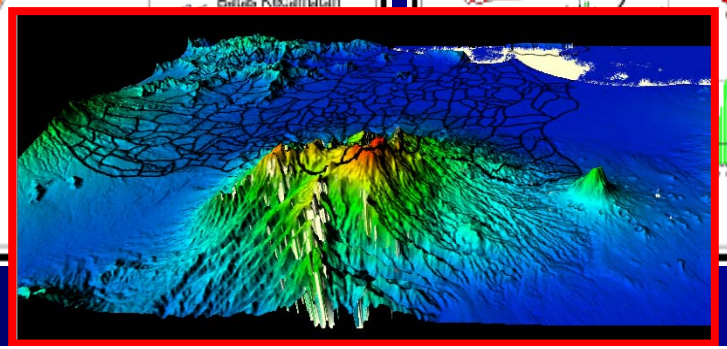
Map of Area Rainfall Type for Jember District

OLD, before Clustering process



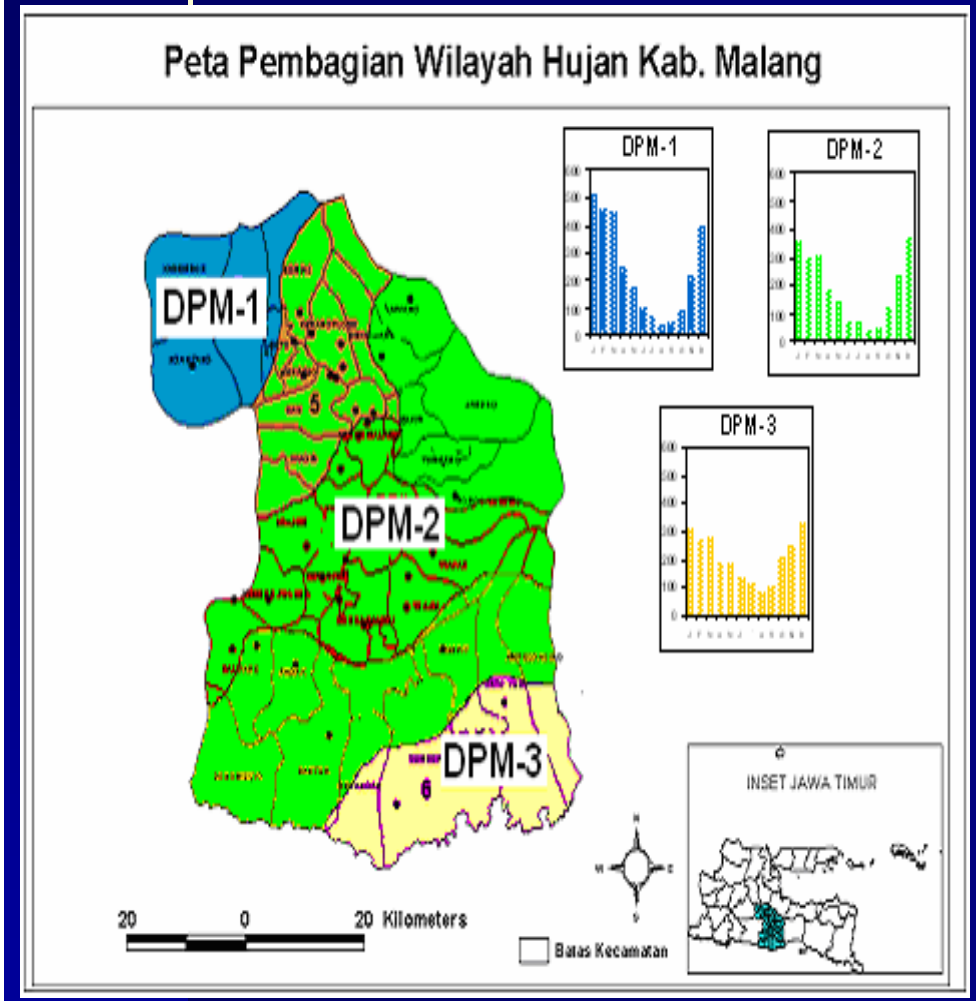
NEW, after Clustering process



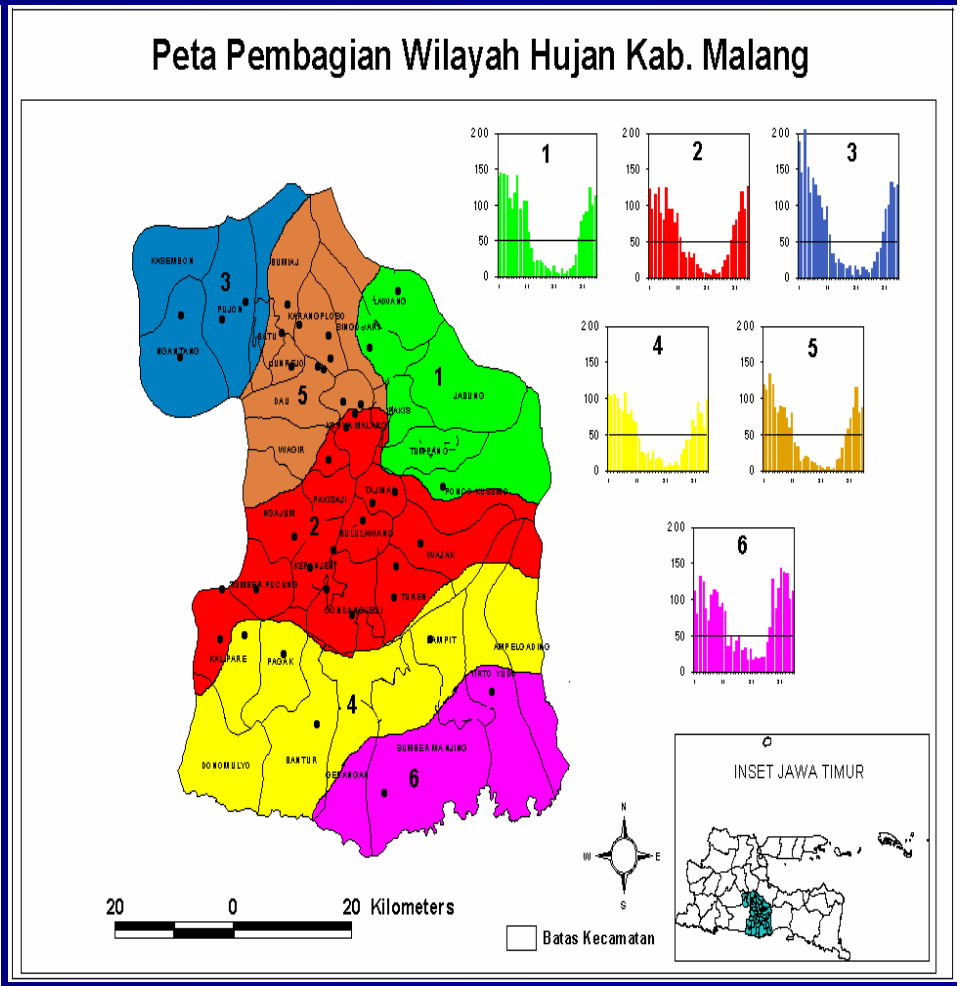


Map of Area Rainfall Type for Malang District

OLD, before Clustering process

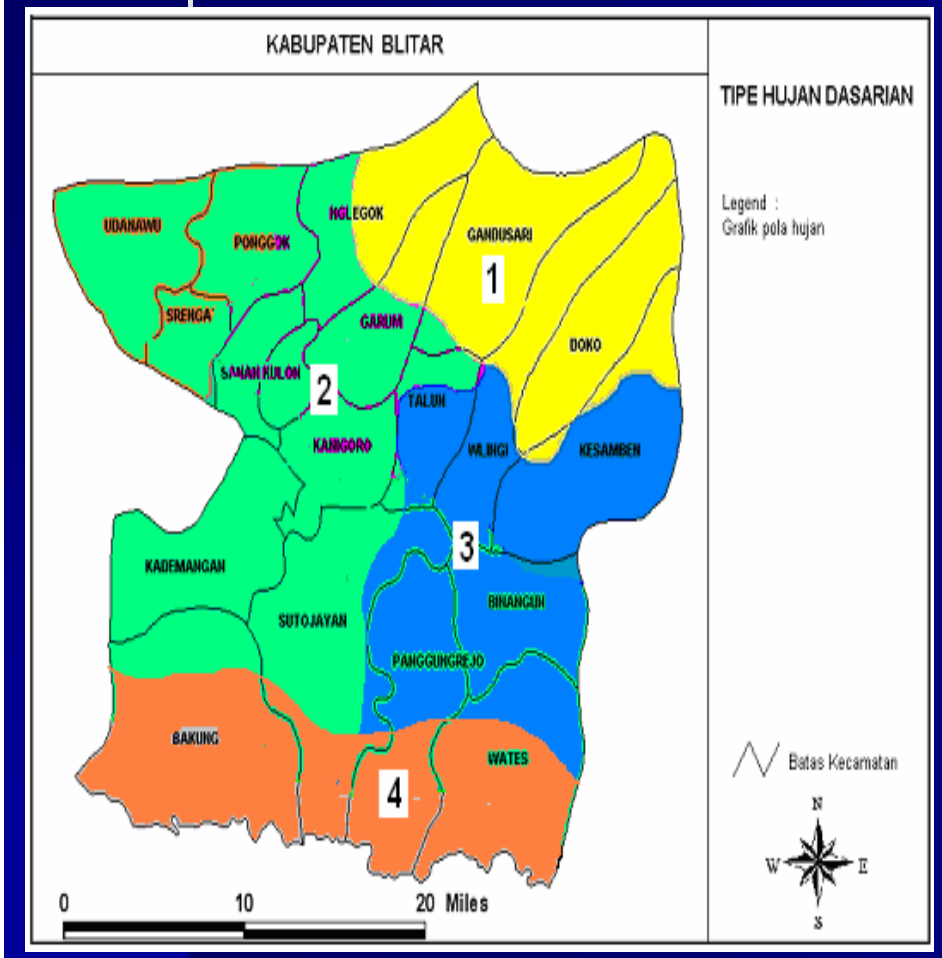


NEW, after Clustering process

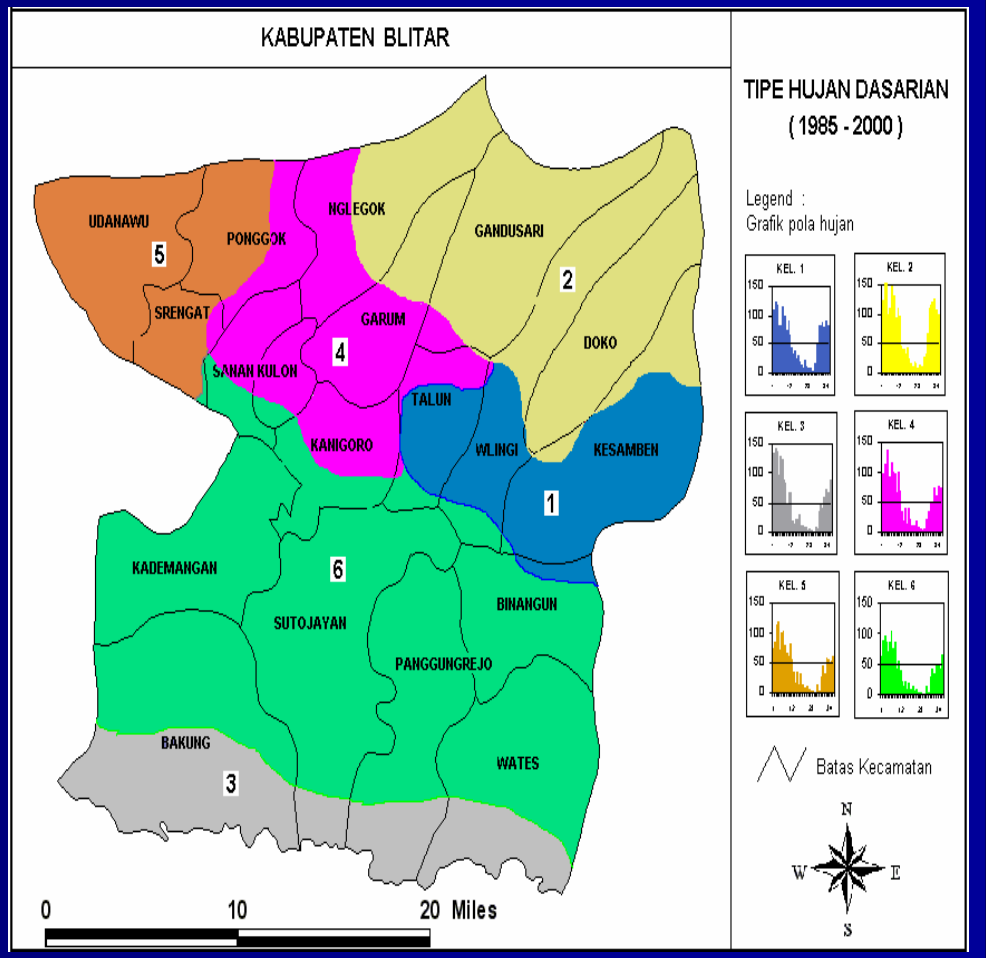


Map of Area Rainfall Type for Blitar District

OLD, before Clustering process



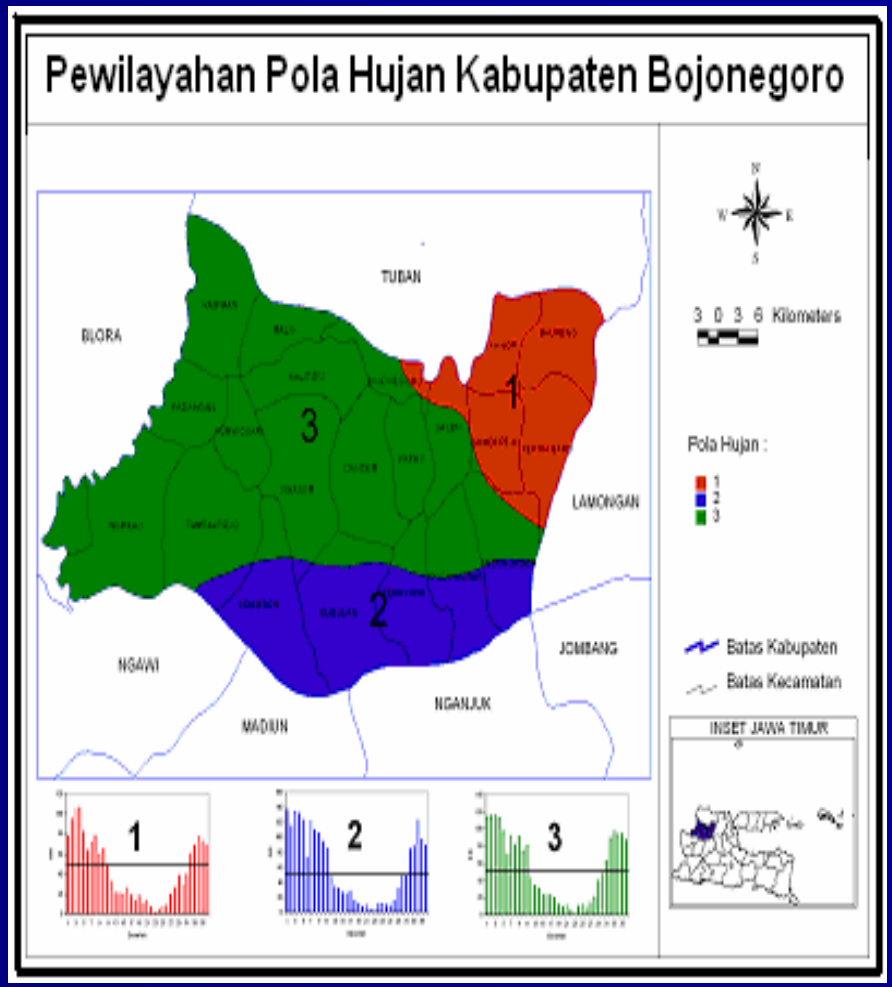
NEW, after Clustering process



Map of Area Rainfall Type for Bojonegoro District

OLD, before Clustering process

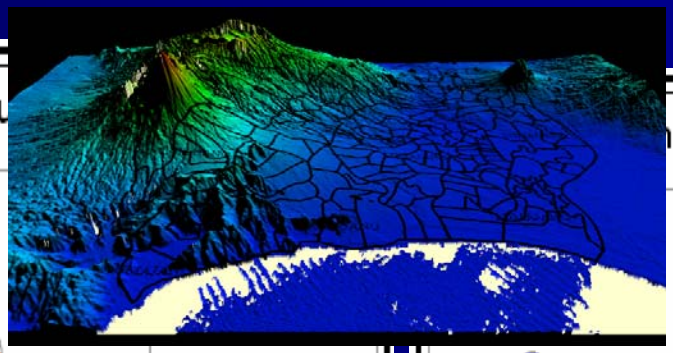
NEW, after Clustering process

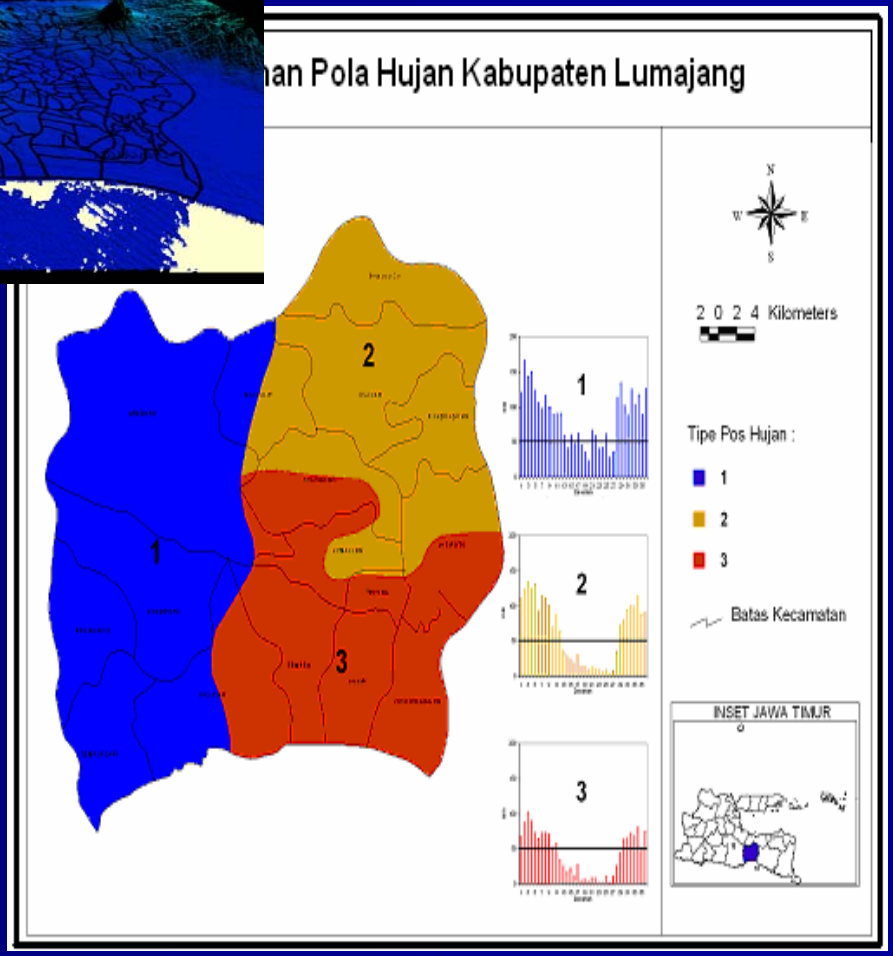


Map of Area Rainfall Type for Lumajang District

OLD, before Clustering process

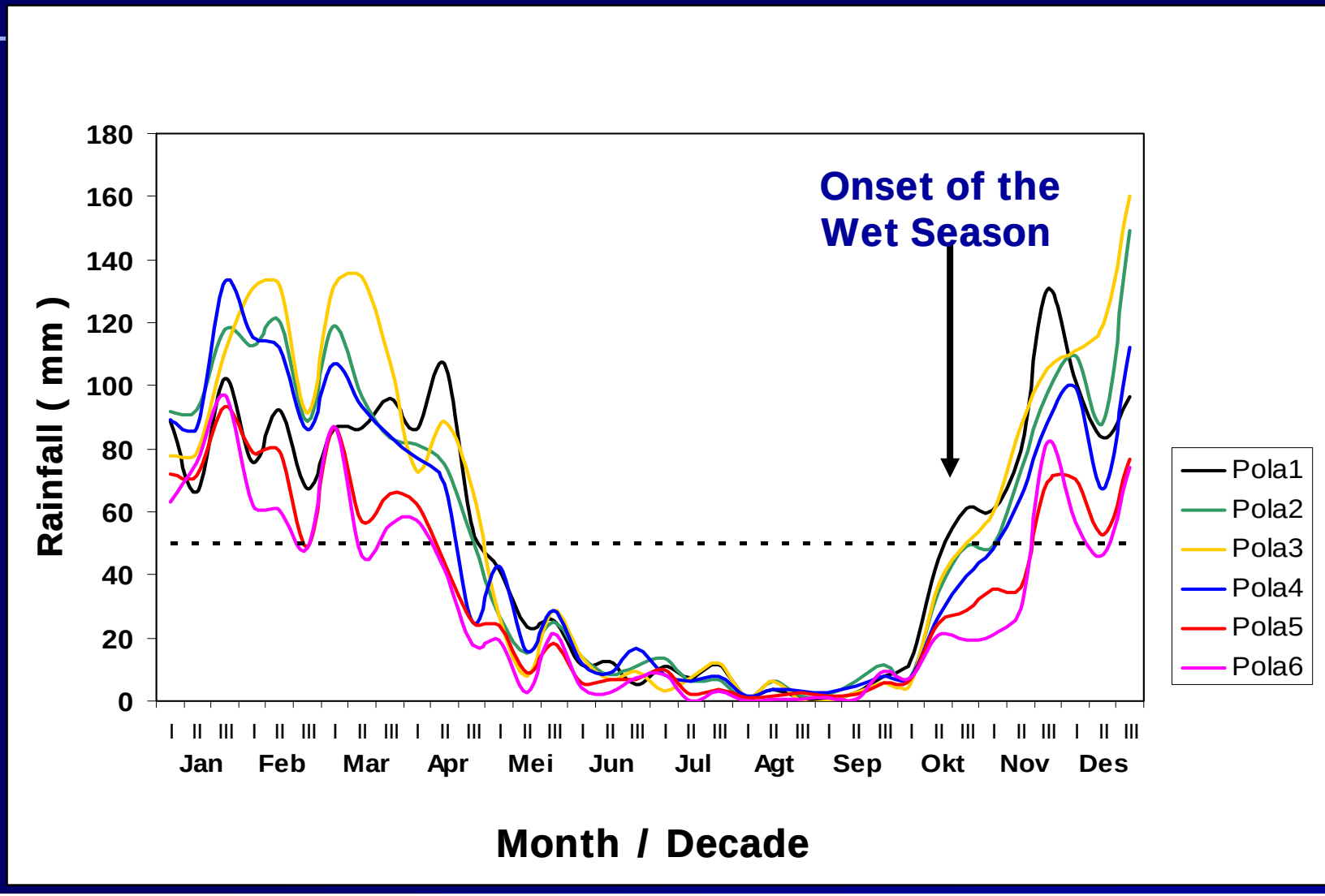
NEW, after Clustering process





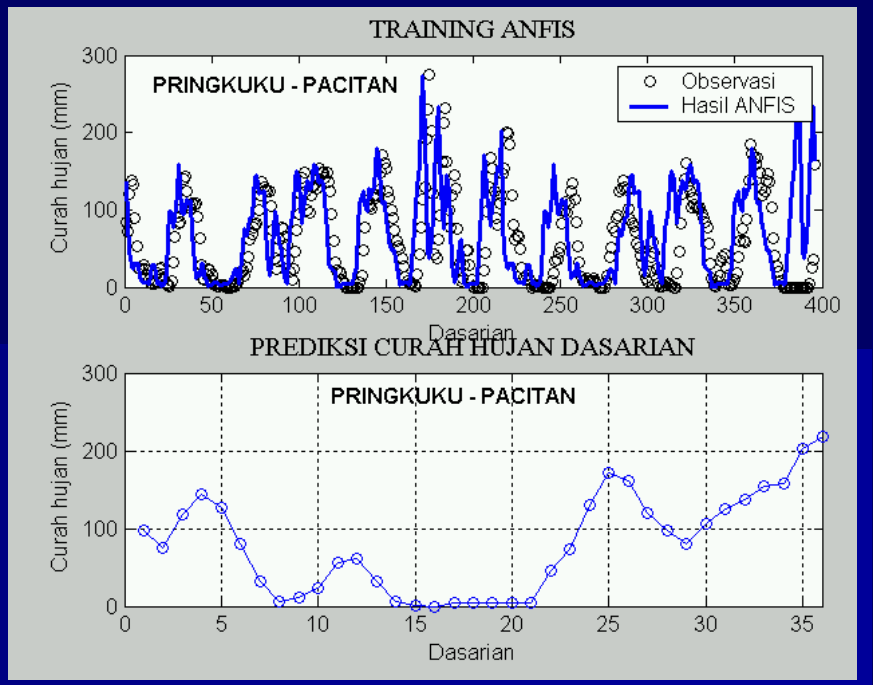
Decade Rainfall Forecast for Each Types in 2007 on Jember District, East Java

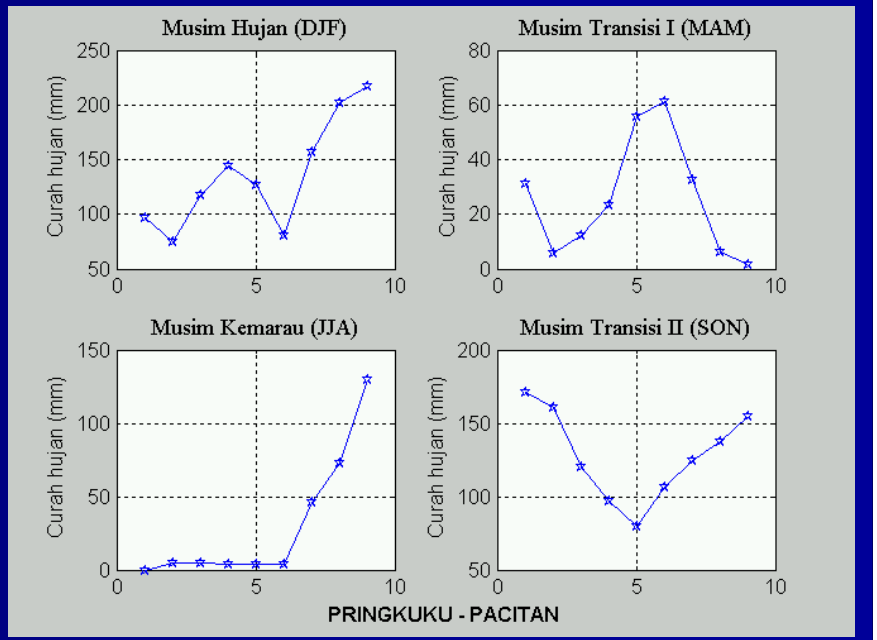
(ARIMA STATISTICAL MODEL)



ANFIS MODEL RESULT FOR RAINFALL PREDICTION 2007 ON PACITAN – EAST JAVA

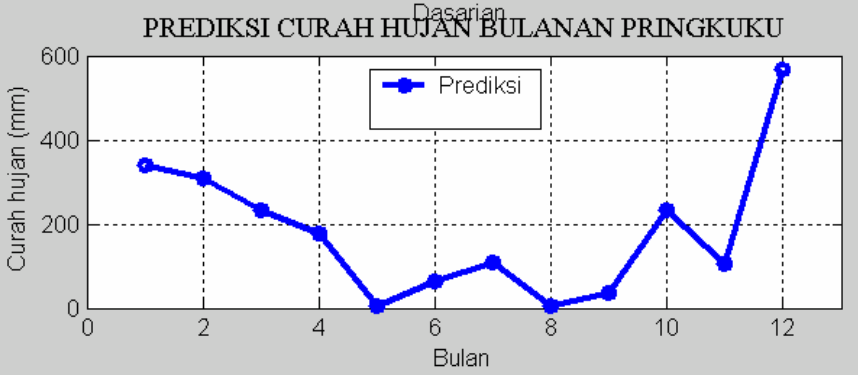
(BASED DATA : 1980-2006)

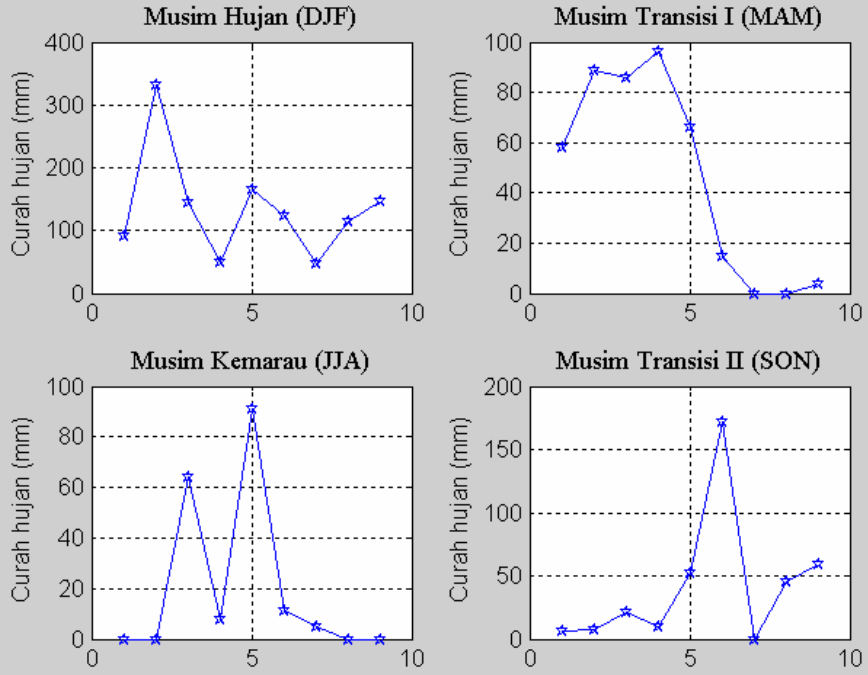


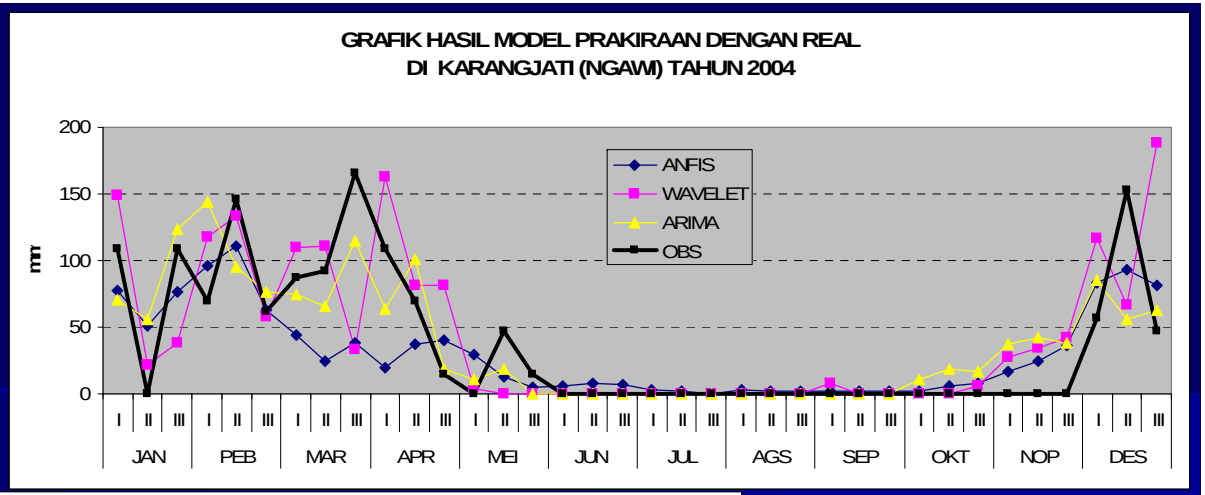


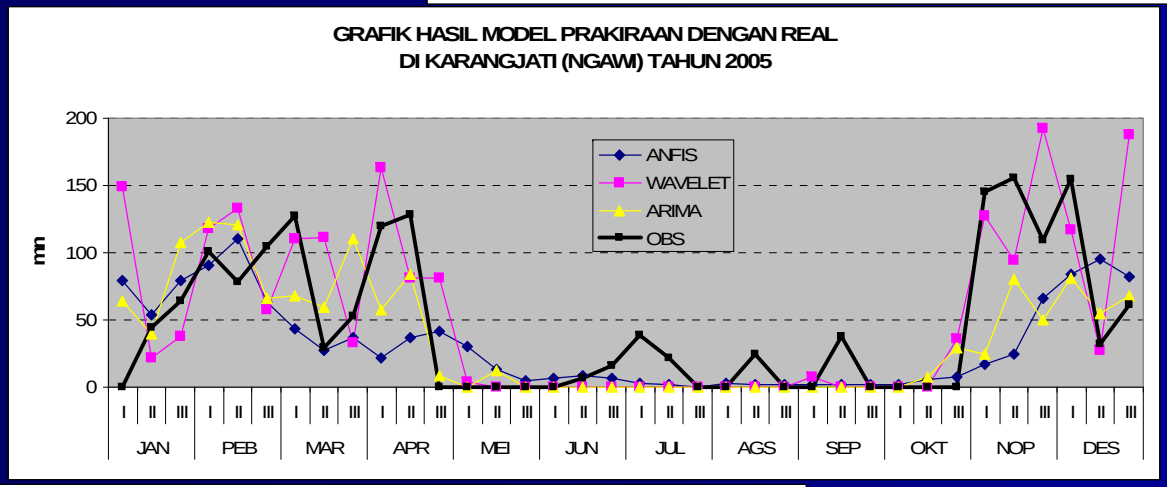
WAVELET MODEL RESULT FOR RAINFALL PREDICTION 2007 ON PACITAN – EAST JAVA

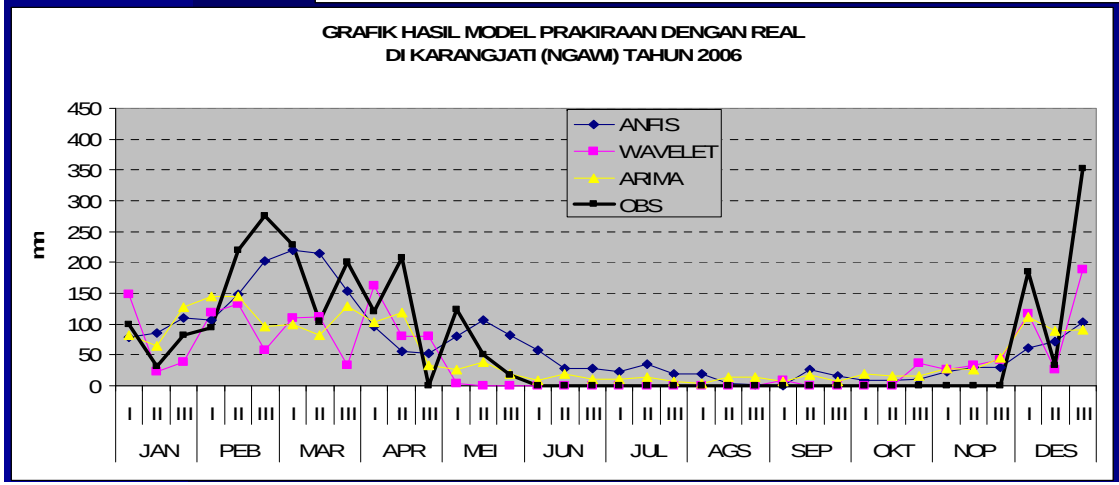
(BASED DATA : 1980-2006)





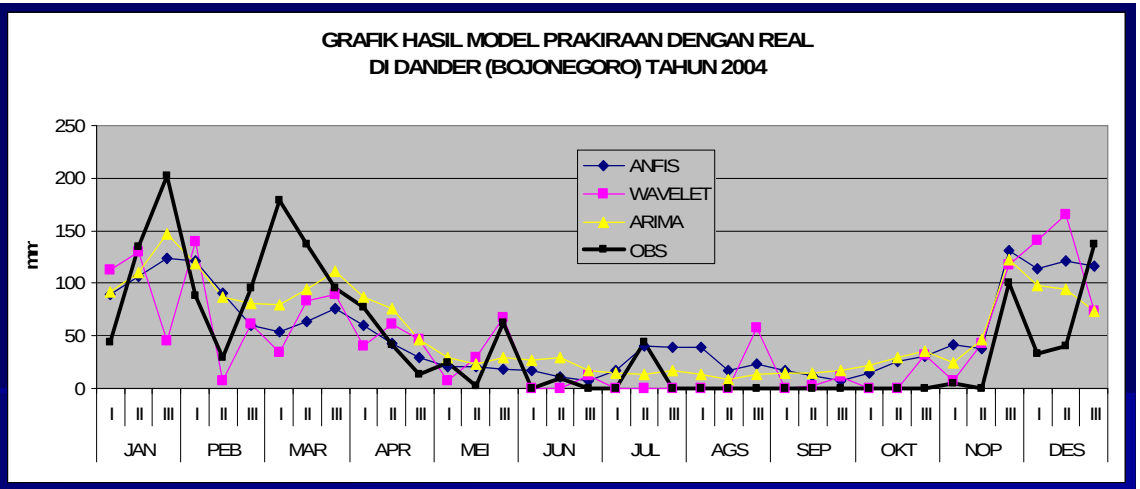


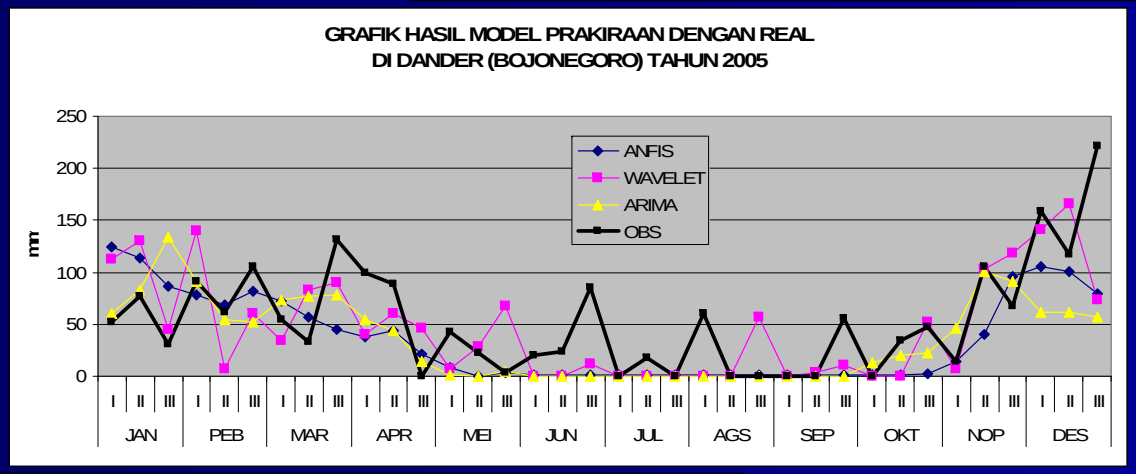


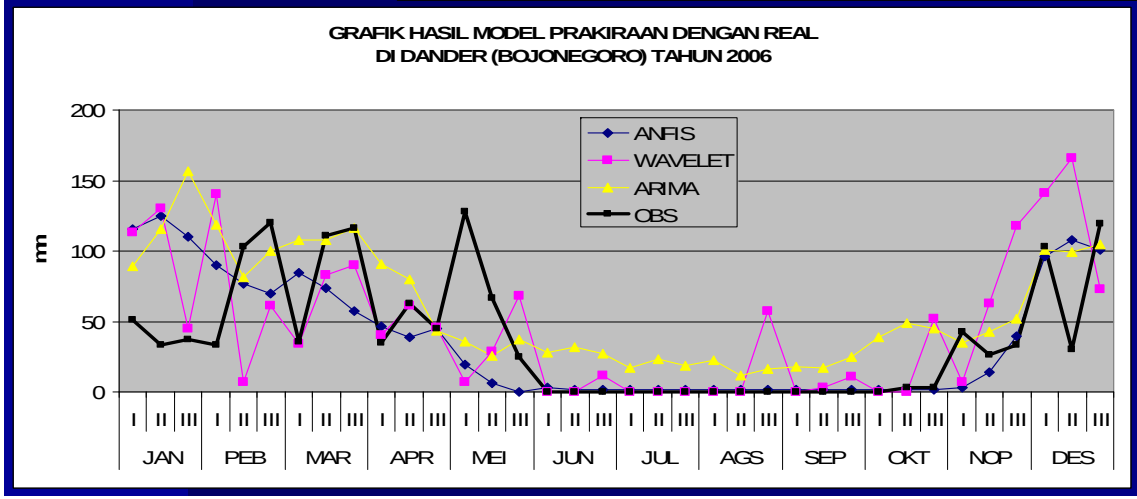


DECADAL RAINFALL FORECAST AND OBS FOR 2004-2006 ON NGAWI DISTRICT - EAST JAVA

(USED 3 MODELS)



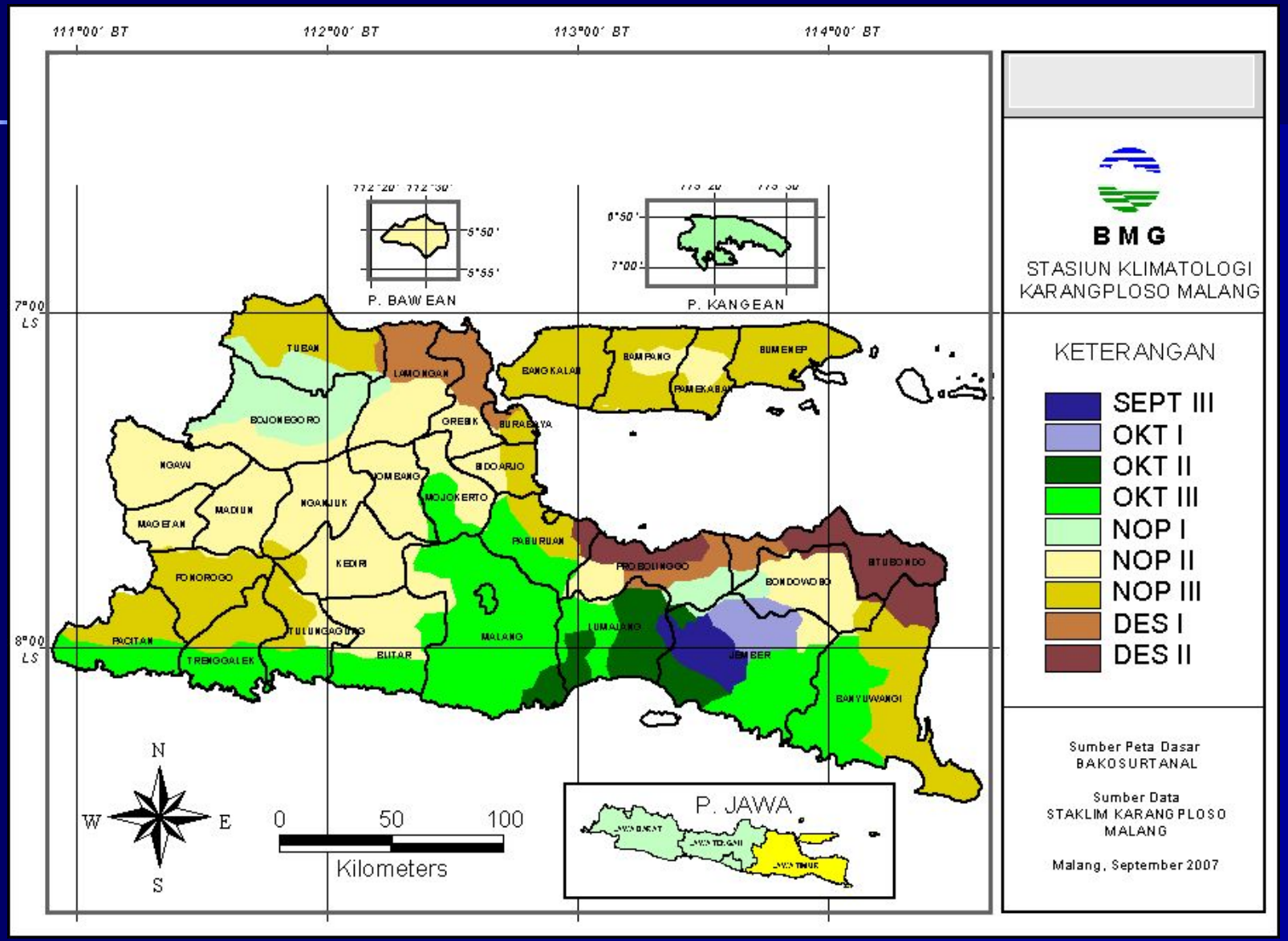




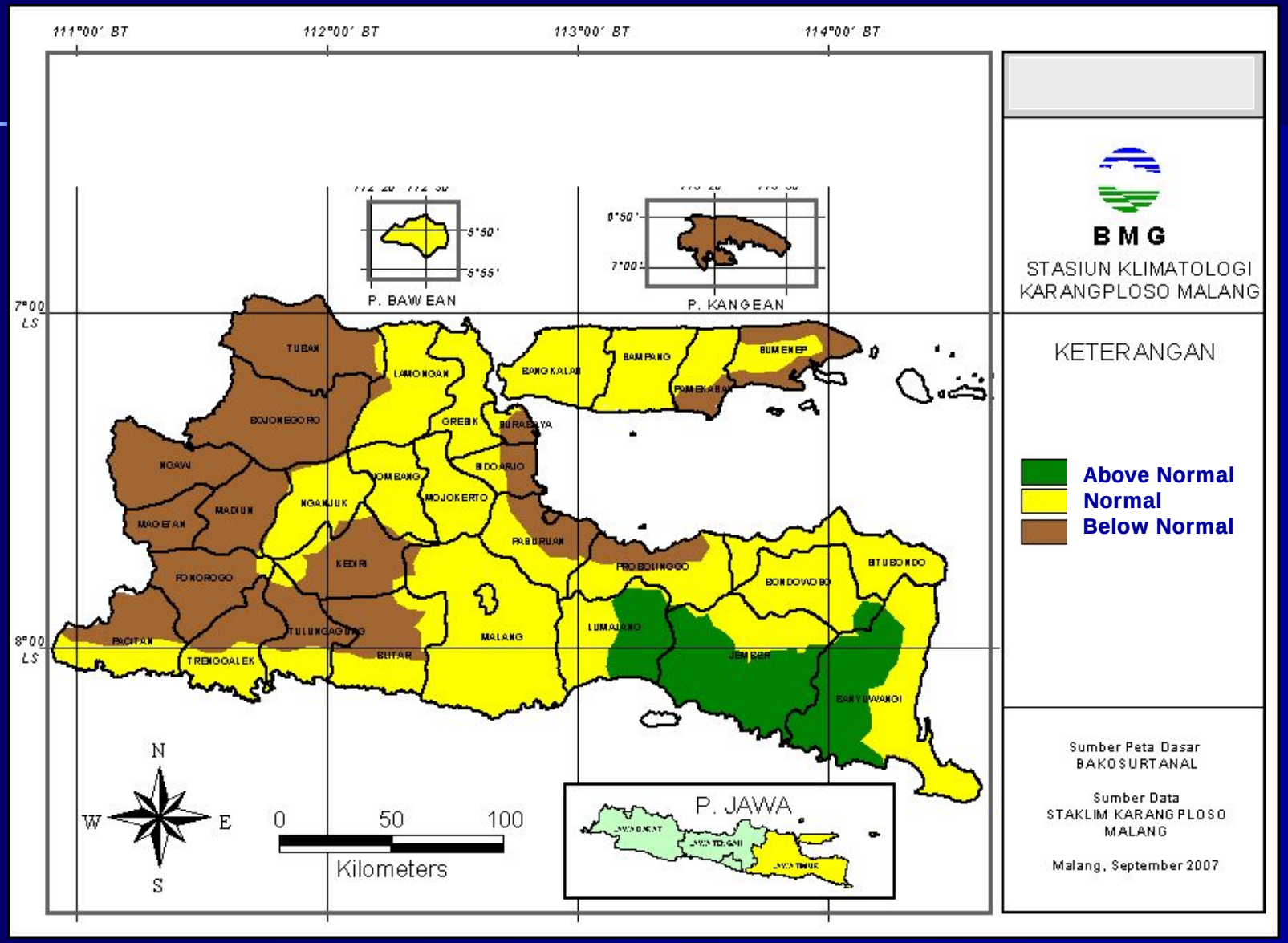
DECADAL RAINFALL FORECAST AND OBS FOR 2004-2006 ON BOJONEGORO DISTRICT - EAST JAVA

(USED 3 MODELS)

Prediction for The Onset of Wet Season 2007/2008 on East Java :

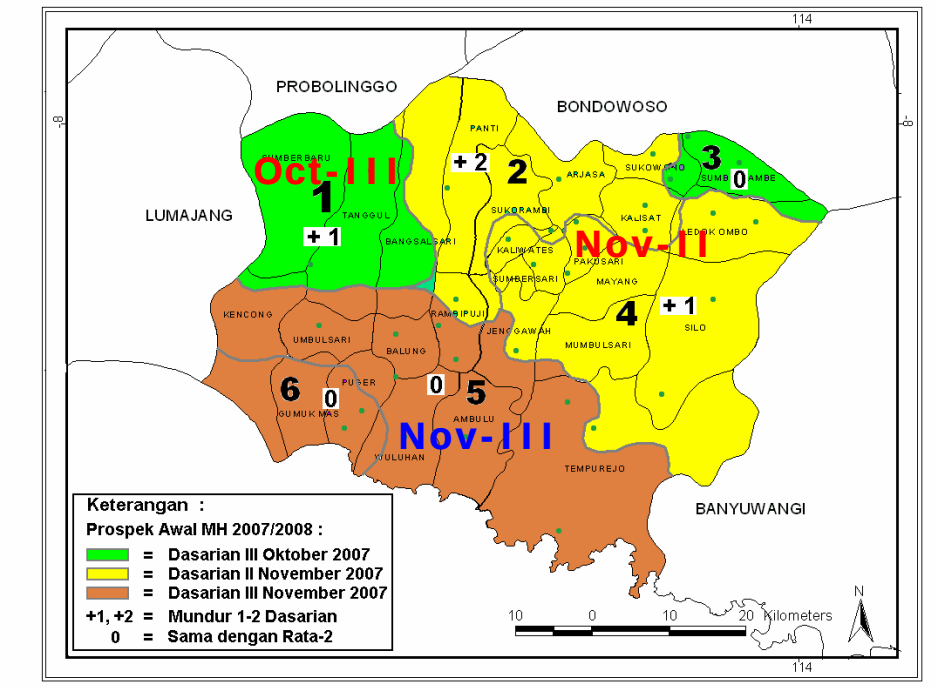


Prediction for The Characteristic of Wet Season 2007/2008 on East Java :

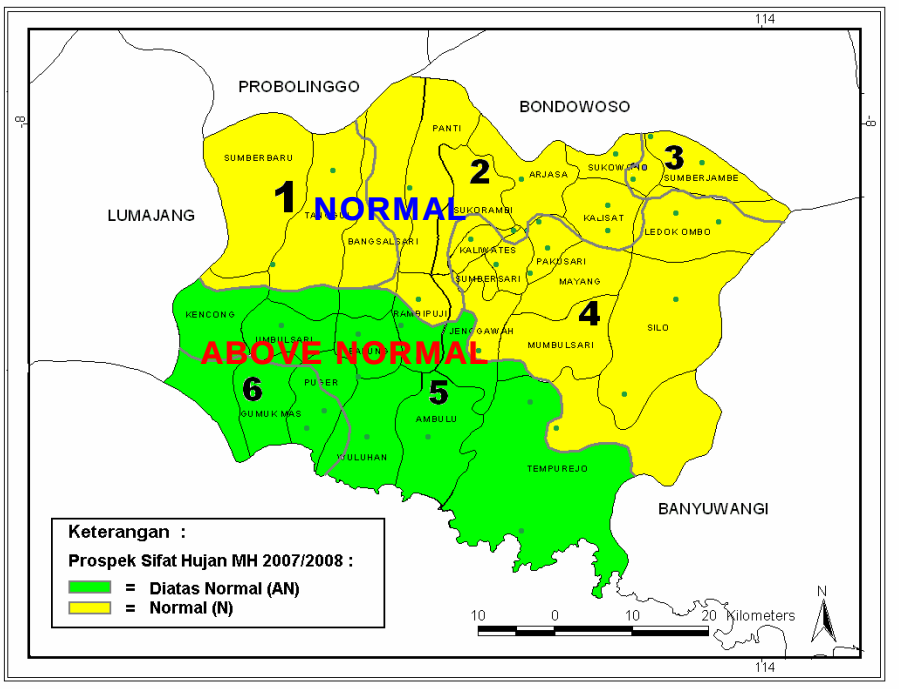


Climate Prediction for The Onset of Wet Season 2007/2008 on Jember District, East Java :

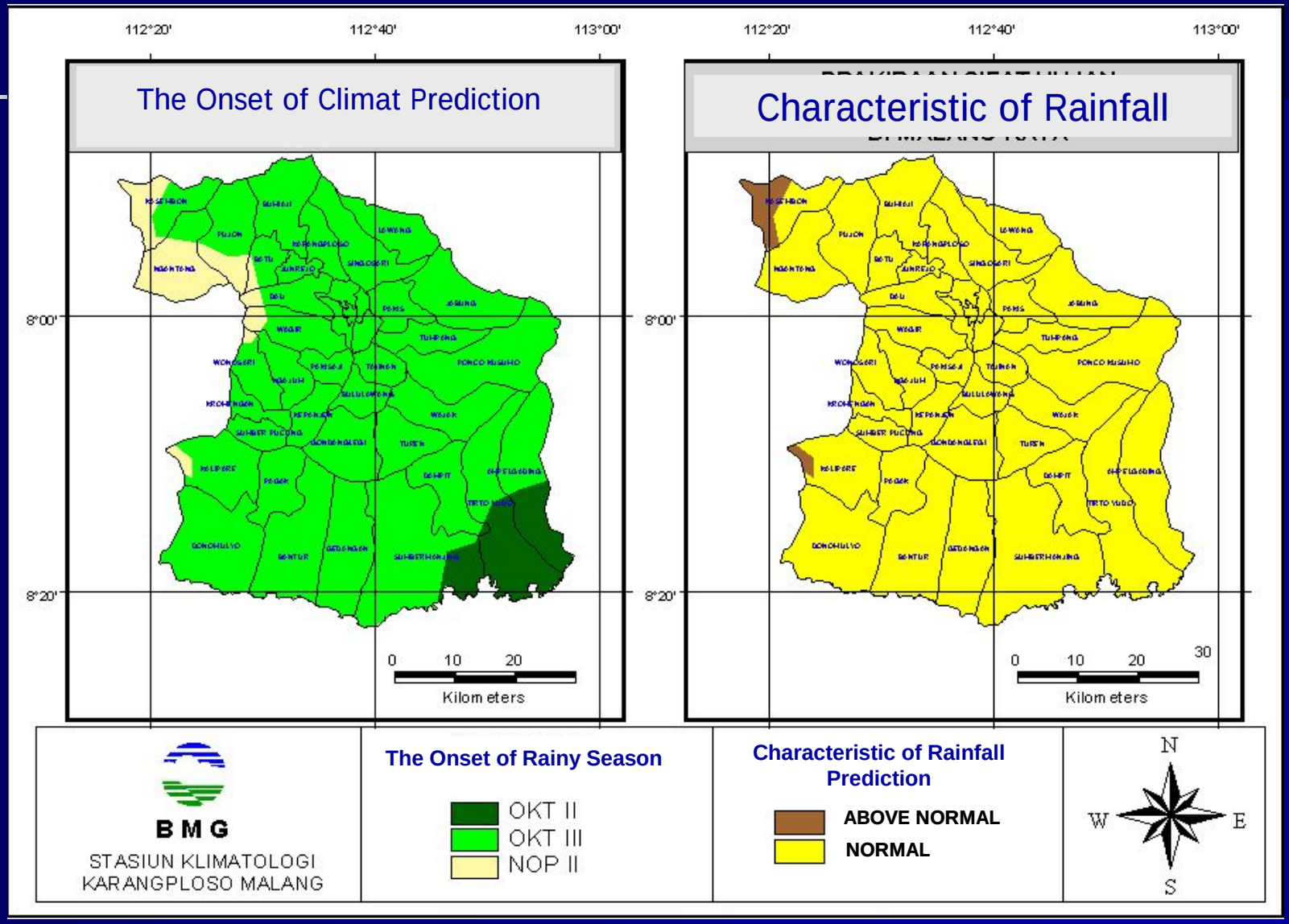
The Onset of Rainy Season



The Charateristic of Rainy Season



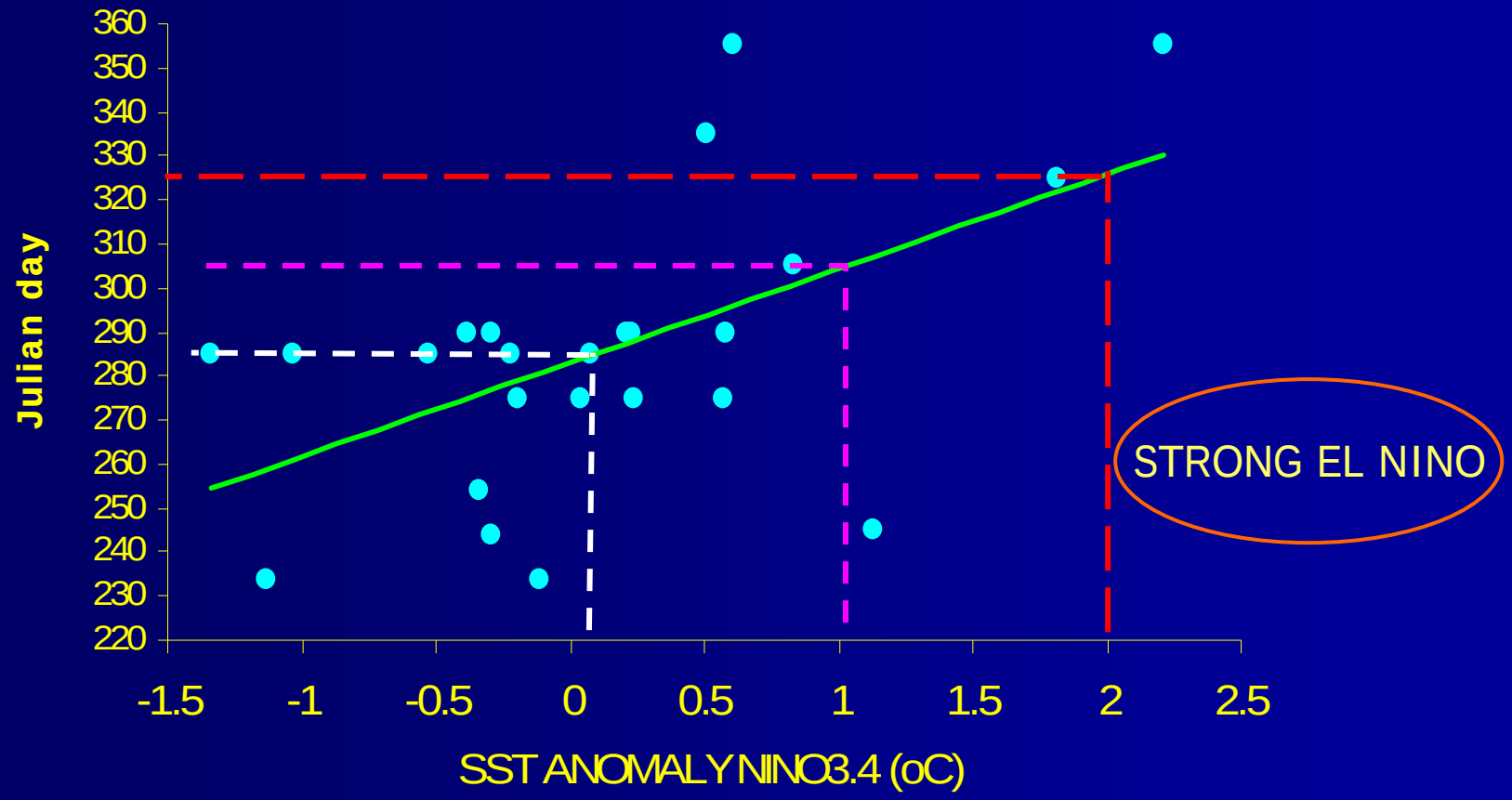
Climate Prediction for The Onset of Wet Season 2007/2008 on Malang District, East Java :



BMG

RELATIONSHIP OF SST ANOMALY NINO3.4 (AUGUST) BETWEEN THE ONSET OF WET SEASON (JULIAN DAY) ON PACITAN DISTRICT, EAST JAVA

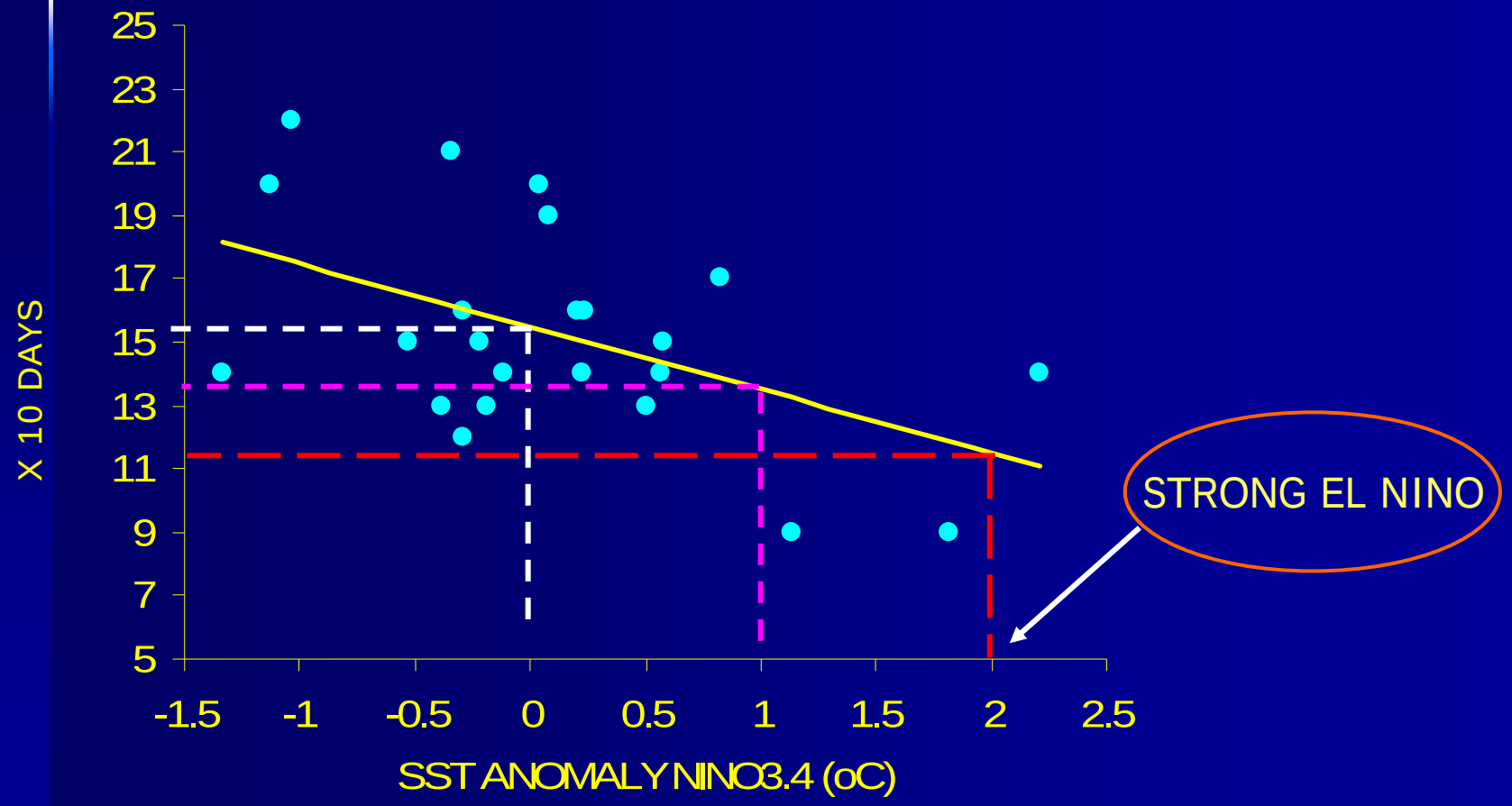
(BASED DATA 1983-2006)



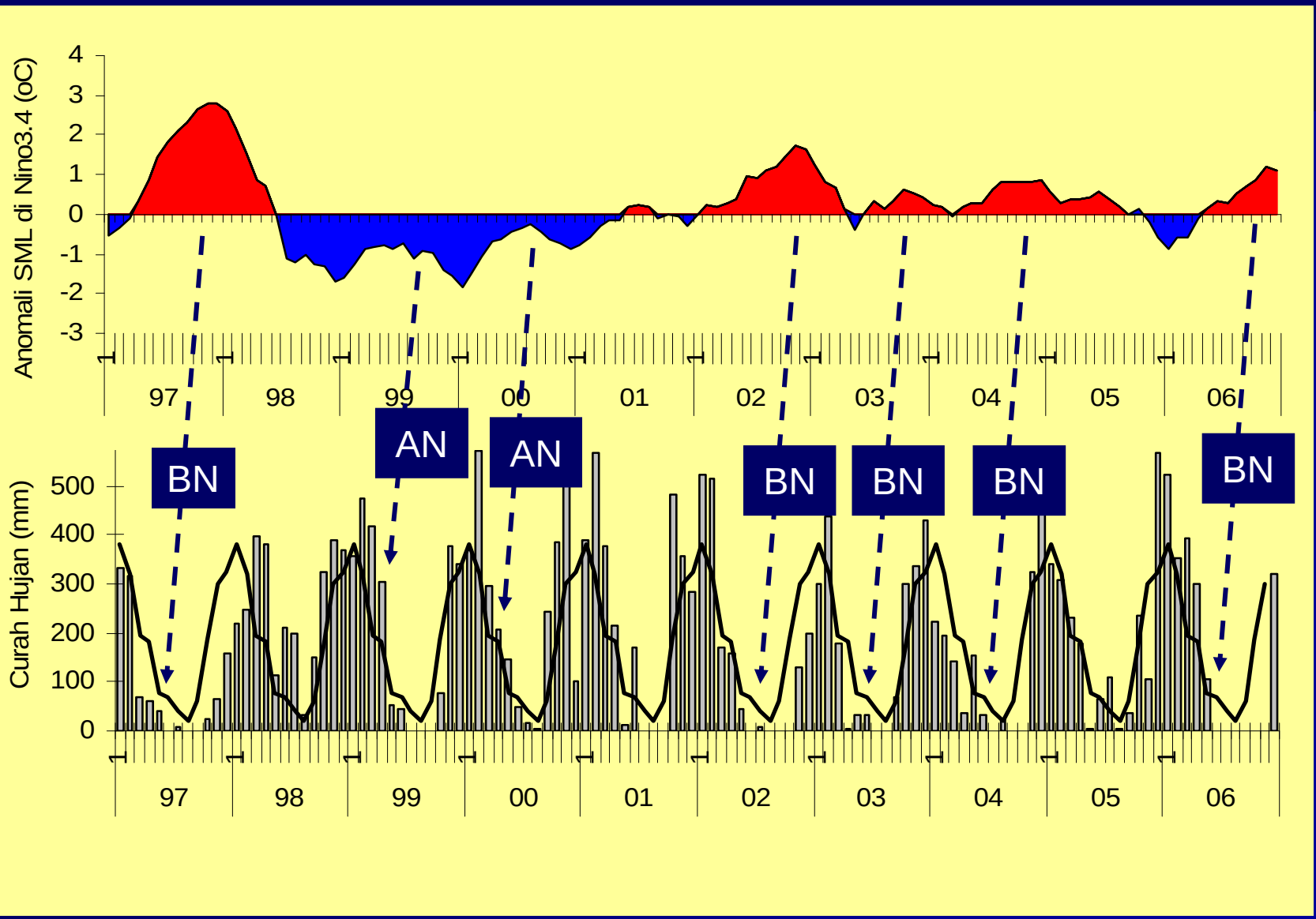
BMG

RELATIONSHIP OF SST ANOMALY NINO3.4 ON AUGUST BETWEEN THE LONG OF WET SEASON ON PACITAN DISTRICT, EAST JAVA

(BASED DATA : 1983 – 2006)



SSTA Nino 3.4 and its impact for Rainfall on Pacitan District, East Java



FLOWCHART OF MULTIPLE REGRESSION – SST / SSTA

INPUT : 85°E - 155 ° E ; 15 ° N - 15 ° S SST / SSTA GRID 1° LAT-LONG

AVERAGE

21 SST / SSTA GRID INDONESIA

RAINFALL DATA

- EXPONENTIAL SMOOTHING
- RESIDUAL ANALYSES

STEPWISE FUNCTION

FORECAST OF :
SST / SSTA GRID INDONESIA

MULTIPLE REGR. EQUATION

BMG

OUTPUT

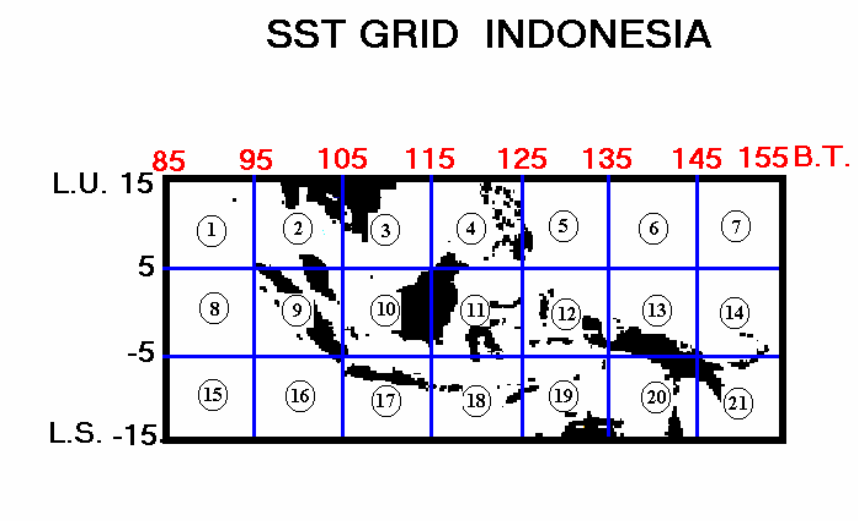
RAINFALL FORECAST (POINT LAT-LONG)

A. MONTHLY FORECAST

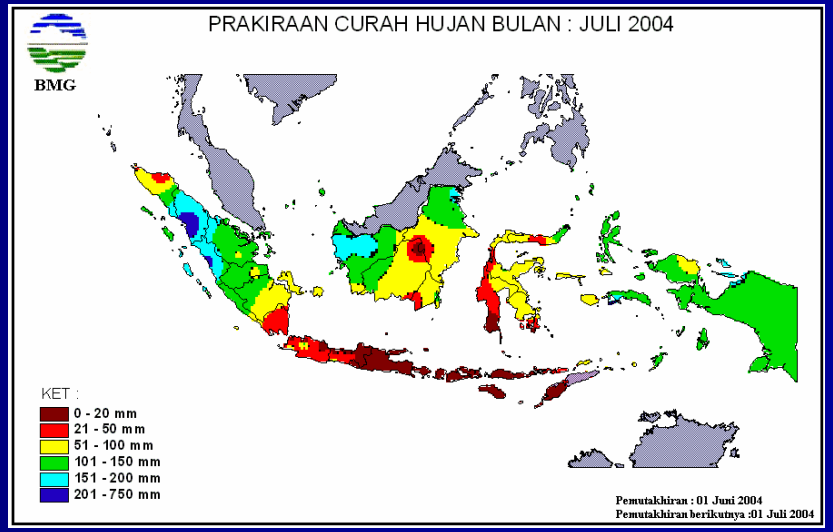
I. 1. MULTIPLE REGRESSION - SST / SSTA INDONESIA

DOMAIN

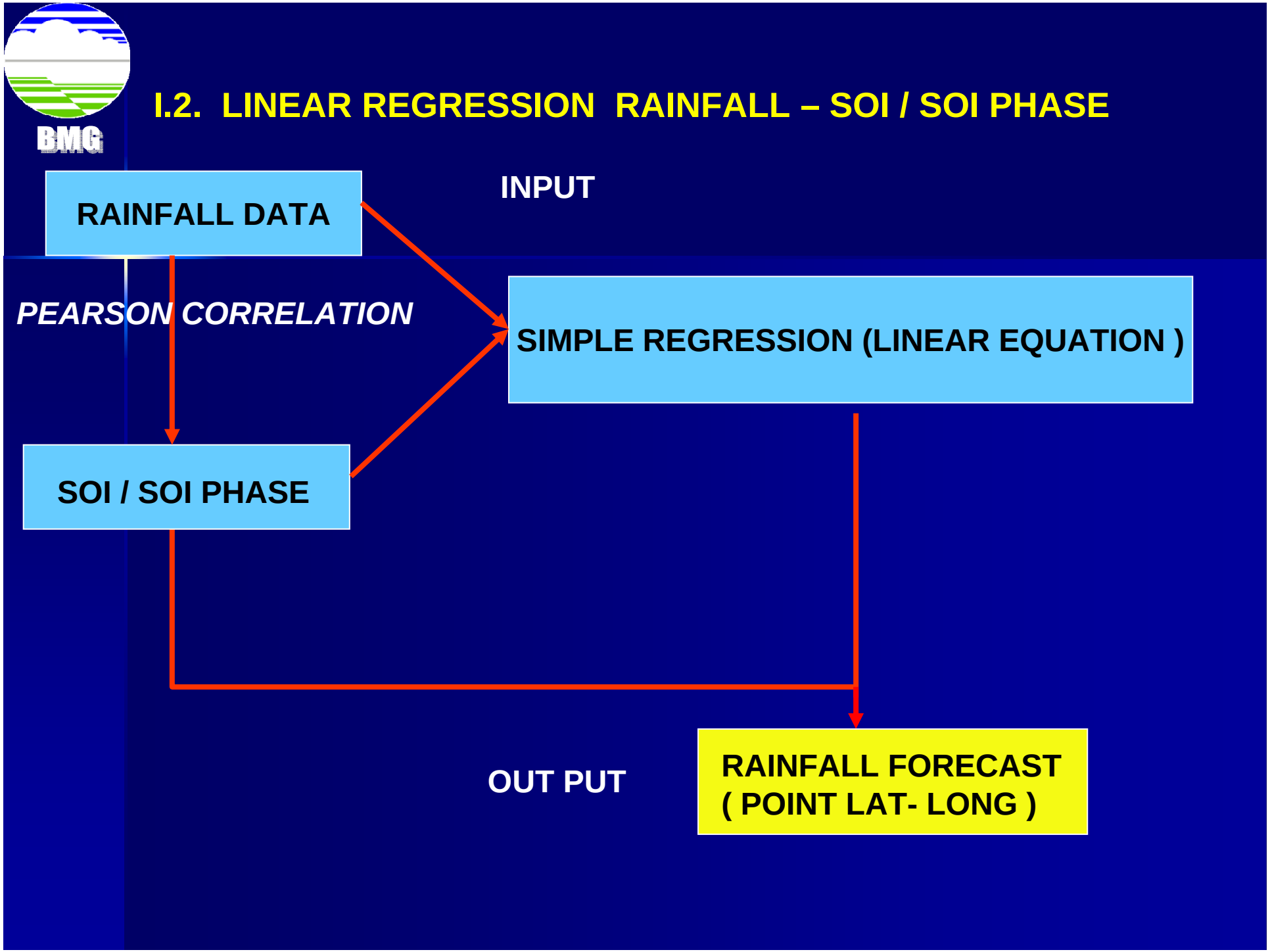
1. SST / SSTA

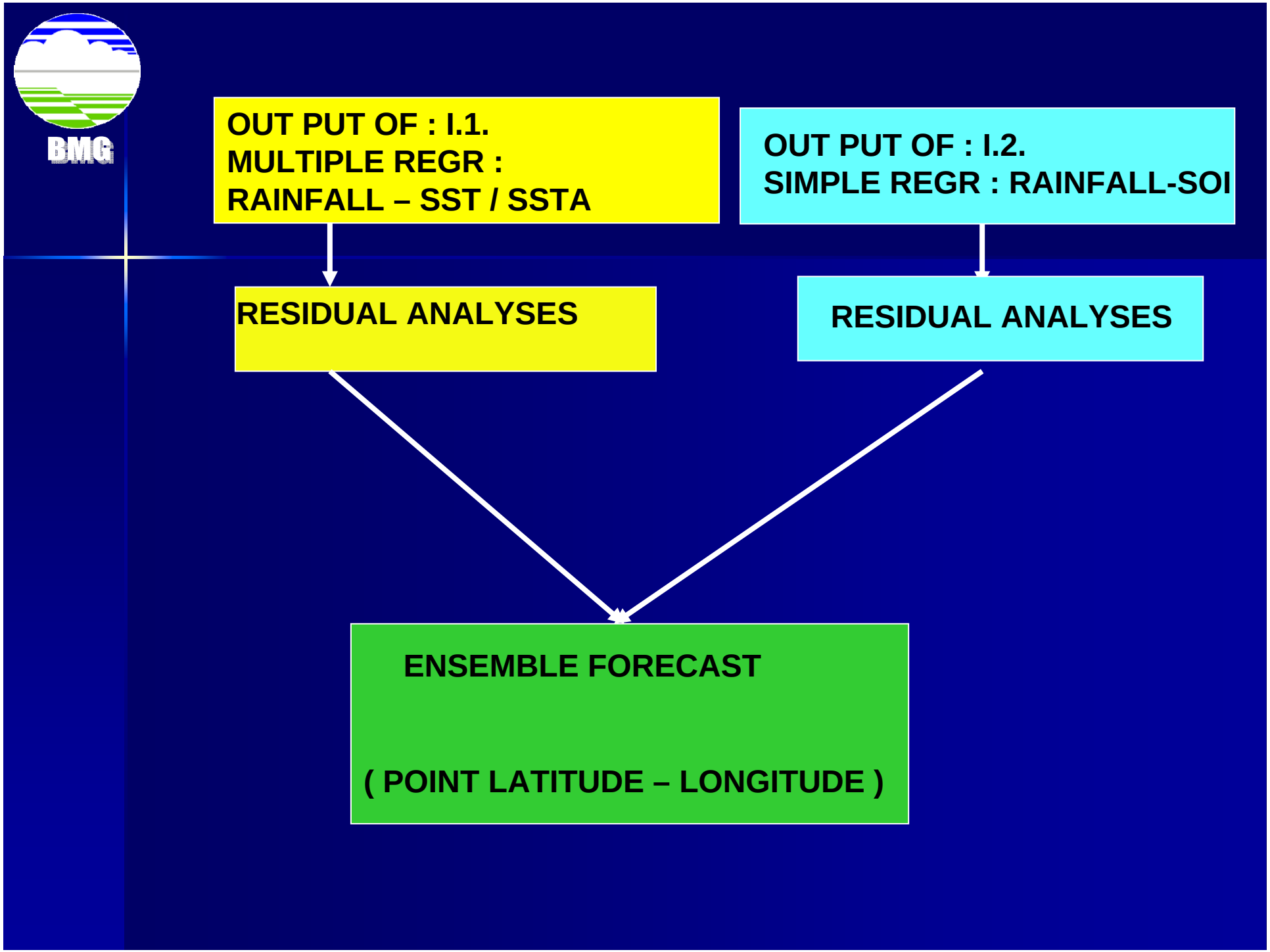


2. FORECAST AREA



I.2. LINEAR REGRESSION RAINFALL – SOI / SOI PHASE




BMG
OUT PUT OF : I.1.
MULTIPLE REGR :
RAINFALL – SST / SSTA
OUT PUT OF : I.2.
SIMPLE REGR : RAINFALL-SOI
RESIDUAL ANALYSES
RESIDUAL ANALYSES
ENSEMBLE FORECAST
(POINT LATITUDE – LONGITUDE)

II. ANALYSIS

II. 1. ANALOGUE ANALYSIS.

SERIES OF:
1. **SST / SSTA**
2. **SOI / SOI PHASE**

CURRENT YEAR OF :
1. **SST / SSTA**
2. **SOI / SOI PHASE**

PICK UP AT LEAST 5 YEARS SIMILAR SERIES DATA WITH CURRENT YEAR

ANALYSIS MONTHLY RAINFALL DISTRIBUTION THE SIMILAR YEARS

II. ANALYSIS (Cont)

II.2. DINAMICAL ANALYSIS

- ANALYSIS PROBABILITY OF : EL NINO ; LA NINA ; NORMAL
- ANALYSIS OF : DIPOLE MODE INDEX
- ANALYSIS OF : ASIA –AUSTRALIA MONSOON CIRCULATION

↓

REVIEW THE RAINFALL DISTRIBUTION FOR THE SIMILAR CONDITION

II.2. DINAMICAL ANALYSIS (Cont)

ENSEMBLE FORECAST FROM :
I.1. MULTIPLE REGR
I.2 SIMPLE REGR

ANALOGUE ANALYSIS

DYNAMICAL ANALYSIS

FINAL FORECAST (POINT LAT – LONG)

INTERPOLATE SURFACE

B. 1 SEASONAL FORECAST

A. EXP SMOOTHING AND ARIMA METHODE

INPUT :

1. SERIES OF ONSET DRY / WET SEASON
2. SERIES OF TOTAL RAINFALL DURING THE SEASON

EXPONENTIAL SMOOTHING

ARIMA

1. FORECAST OF ONSET DRY / WET
2. FORECAST OF TOTAL RAINFALL DURING THE SEASON

1. FORECAST OF ONSET DRY / WET
2. FORECAST OF TOTAL RAINFALL DURING THE SESAON

RESIDUAL ANAYSES

RESIDUAL ANALYSES

OUTPUT :

FORECAST FOR DRY / WET SEASON

B. NEURAL NETWORK METHODE

INPUT : **1. SERIES OF ONSET DRY / WET SEASON**

PEARSON CORRELATION

ANALYSIS OF CORRELATION AMONG THEM

DEFINE THE STRONG CORRELATION AS PREDICTORS

NEURAL NETWORK

OUTPUT : **FORECAST ONSET OF WET/ DRY SEASON**

OUTPUT OF :
EXP SMOOTHING AND ARIMA

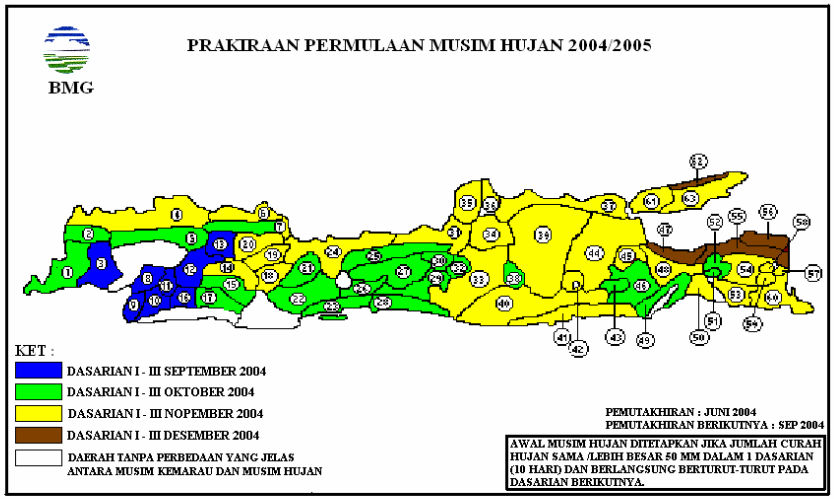
OUTPUT OF NEURAL

ANALOGUE ANALYSES

DYNAMICAL ANALYSES

FINAL SEASONAL FORECAST

SPASIAL PLOTTING



VERYFICATION FOR CHARACTERISTIC OF DRY AND WET SEASON

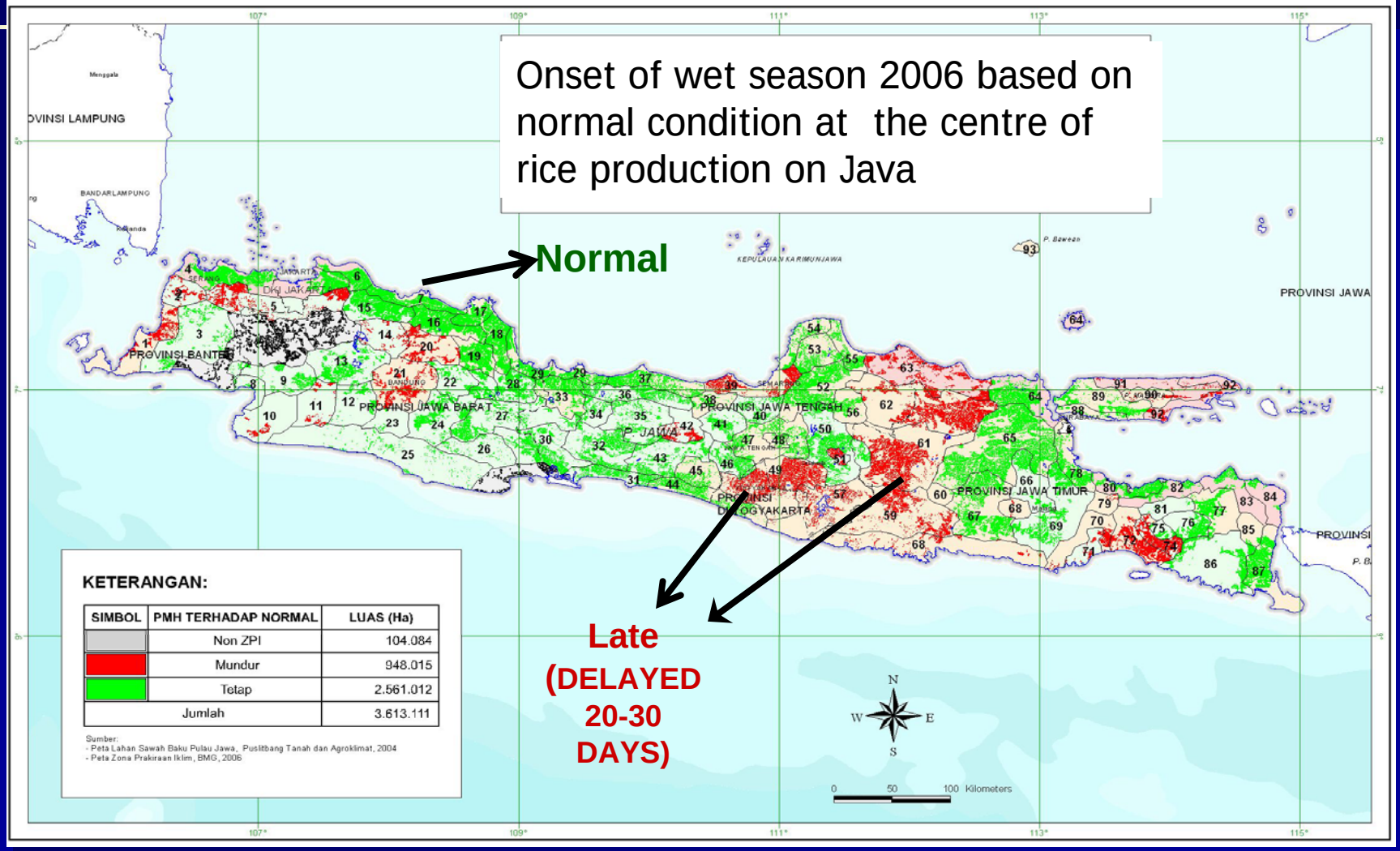
AT 220 ZONE FORECAST SEASON IN INDONESIA

(%)

NOTE :
*) = FORECAST FOR 2007

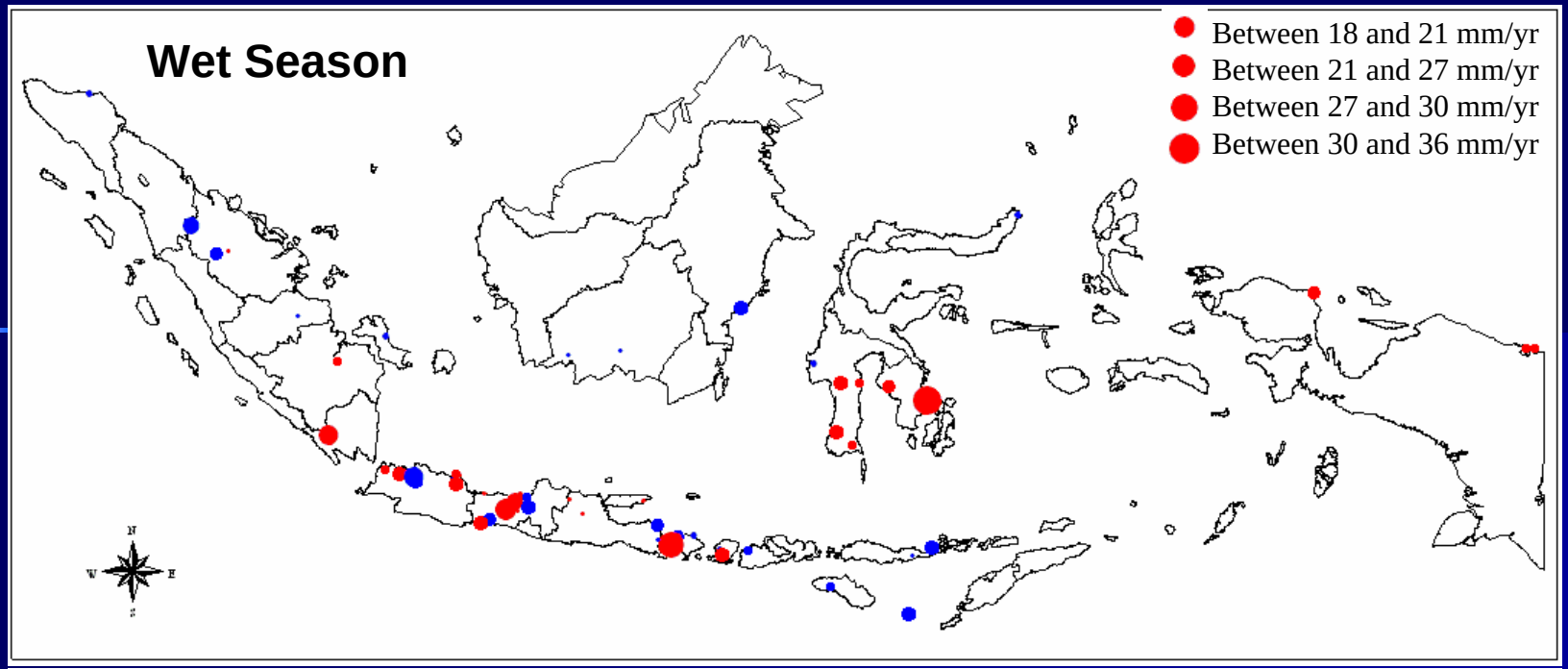
YEAR	DRY SEASON			WET SEASON		
	AN	N	BN	AN	N	BN
1981	60	30	10	21	62	17
1982	2	14	84	5	43	52
1983	33	35	32	37	54	10
1984	60	30	10	10	66	24
1985	29	46	25	22	69	9
1986	39	43	18	14	65	22
1987	5	21	74	21	57	22
1988	42	37	21	28	56	16
1989	40	48	12	16	64	21
1990	23	40	38	19	56	26
1991	6	18	75	15	33	52
1992	40	32	28	20	56	24
1993	14	27	59	25	56	18
1994	4	20	76	22	56	22
1995	38	34	27	20	60	20
1996	35	29	35	17	51	33
1997	4	10	86	12	37	51
1998	81	12	7	39	45	16
1999	34	36	29	36	46	18
2000	31	45	24	21	45	34
2001	31	42	28	19	55	26
2002	1	15	83	16	37	47
2003	8	26	66	17	40	43
2004	5	25	70	7	49	44
2005	14	45	41	22	41	37
2006	15	36	49	11	57	32
2007 *)	10	60	30	12	66	22

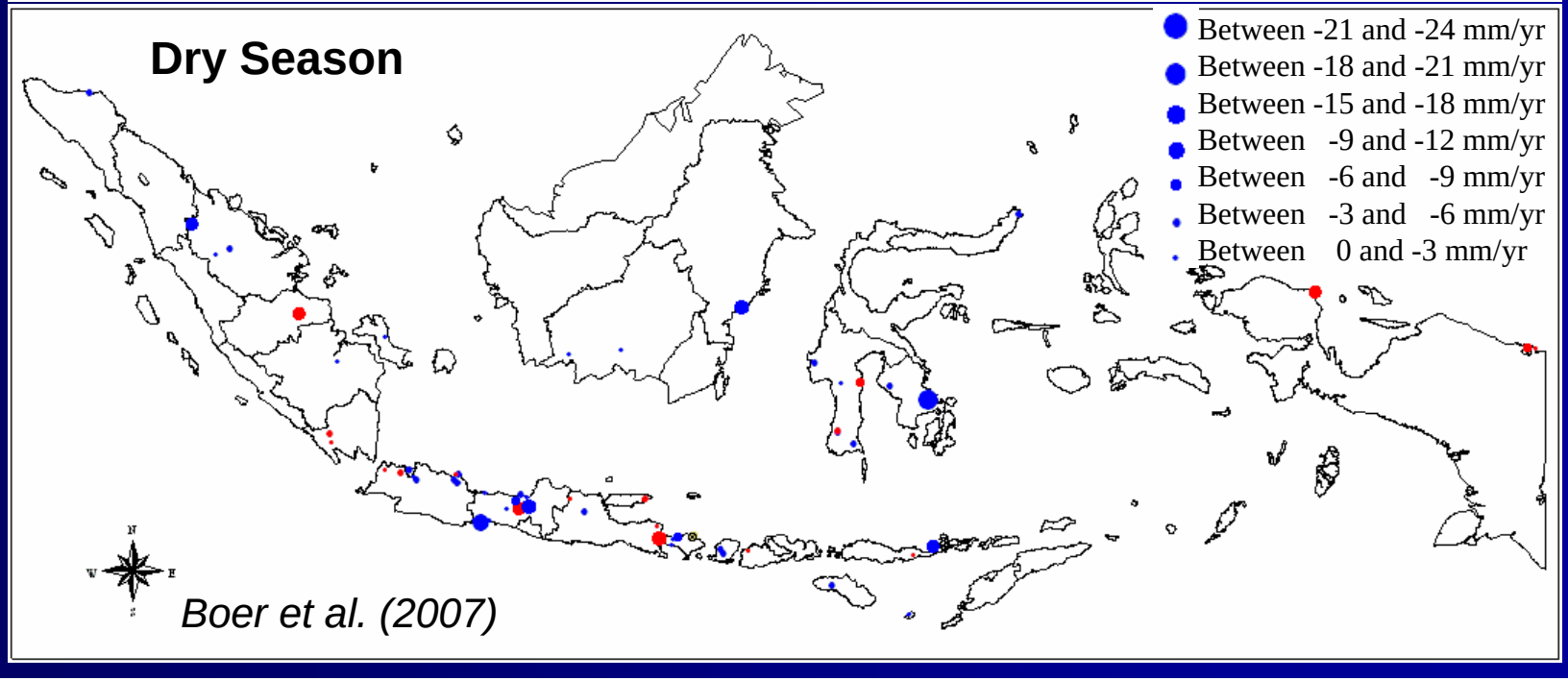
El Nino 2006, caused late the onset of wet season at several places of rice production on Java



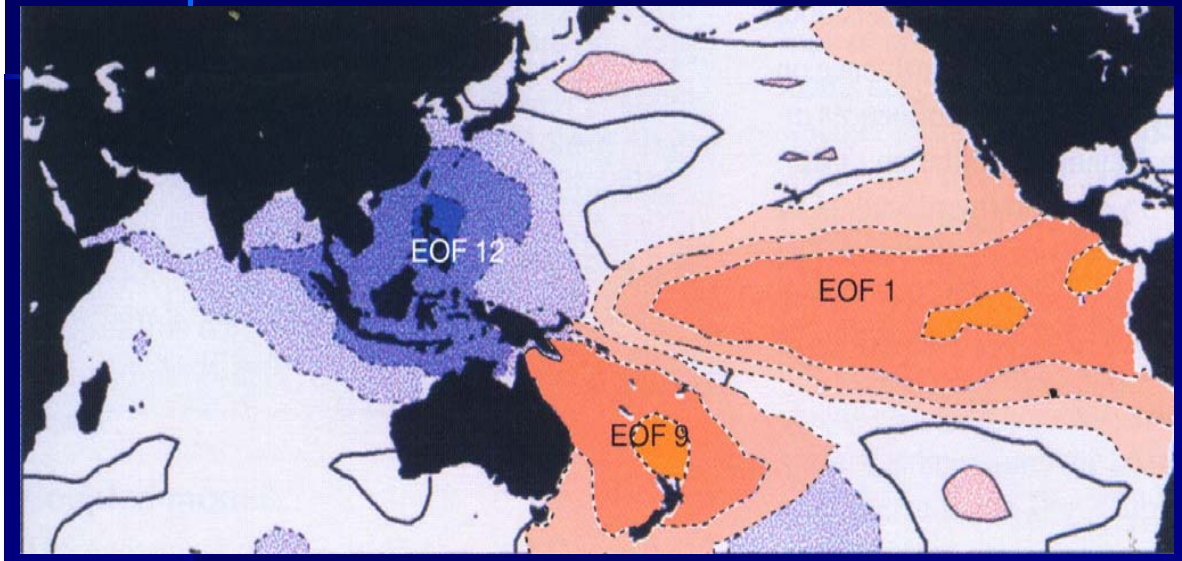
TREND OF SEASONAL CHANGE IN INDONESIA

BMG



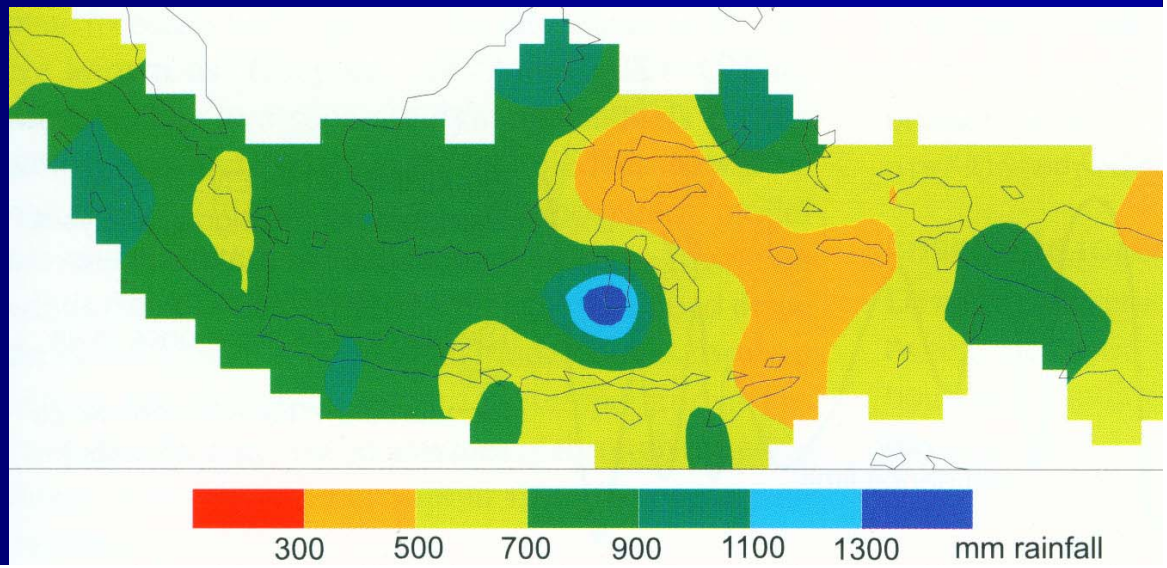


BMG and Australian BoM are developing a statistical forecasting model using “Empirical Orthogonal Function” (EOFs) of sea surface temperature (SST) analyses for the Indian and Pacific Oceans as predictors.



The current version uses EOFs of SST in the central-eastern Pasicic (Nin0-3 and Nino-4), the western Pacific and around Indonesia; these are described as the ENSO Pattern, the ‘Western Pacific Pattern’ and the ‘Indonesian pattern’.

Map showing the location of the three SST regions used in the developmental forecast system for Indonesia.



An example of a forecast map generated under the developmental model.

Seasonal climate forecasting can never be an exact science; there are too many world-wide, regional and local disturbances to broad patterns

Terimakasih

THANK YOU

BADAN METEOROLOGI & GEOFISIKA

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