The Republic of Indonesia
Badan Meteorologi, Klimatologi, dan Geofisika

The Republic of Indonesia Project of Capacity Development for the Implementation of Agricultural Insurance - Capacity Development on Meteorological and Climate Data Analysis for the Agricultural Insurance

Completion Report

October 2020

Japan International Cooperation Agency

Japan Meteorological Business Support Center

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The Republic of Indonesia Project of Capacity Development for the Implementation of Agricultural Insurance - Capacity Development on Meteorological and Climate Data Analysis for the Agricultural Insurance

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Ver. 1.2

As of 9 October 2020

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Abbreviation

Abbreviation	Terms
BAPPENAS	Kementerian Perencanaan Pembangunan Nasional (*National Development Planning Ministry*)
BMKG	Badan Meteorologi, Klimatologi, dan Geofisika (*Agency for Meteorology Climatology and Geophysics*)
C/P	Counter Personnel
ENSO	El Niño Southern Oscillation
GCM	Global Climate Model
	General Circulation Model
GrADS	Grid Analysis and Display System
IPCC	Intergovernmental Panel on Climate Change
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JAXA	Japan Aerospace Exploration Agency
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
JMBSC	Japan Meteorological Business Support Center
MRI	Japan Meteorological Agency, Meteorological Research Institute
NCAR	National Center for Atmospheric Research (US)
NCEP	National Centers for Environmental Prediction (US)
NOAA	National Oceanic and Atmospheric Administration (US)
PIKAM	Pusat Iklim, Agroklimat dan Iklim Maritim (*Center for Climate, Agroclimate and Maritime Climate*)
PIKU	Pusat Perubahan Iklim dan Kualitas Udara (*Center for Climate Change and Air Quality*)
WMO	World Meteorological Organization
WRF	Weather Research & Forecasting

[UN Caritography Section], Referred in January 2019

Administrative Unit	
1st layer:	Provinsi
2nd layer:	Kabupaten
	Kota
3rd layer:	Kecamatan
	Kelurahan
	Desa

Activity Photo

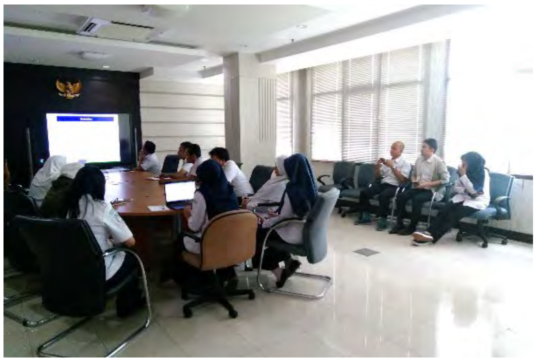
Meeting with Key Activity 1 Member

Meeting with Key Activity 2 Member

Rain Post Inspection (East Java)

Rain Post Inspection (South Sulawesi)

Key Activity 1 and Key Activity 2 Joint Meeting



Midterm Reporting

Dry Season Forecast National Meeting in 2020

Final Reporting (Online Meeting)

1. Outline of the Project

1. Outline of the Project

This project was implemented as a part of the "Agricultural insurance is continuously implemented in Indonesia" mainly with BMKG for enhancing capacity development for agricultural insurance. The overall goal, project purpose, outputs and activities of the umbrella project are as follows.

Goal	Agricultural insurance is continuously implemented in Indonesia
Project Purpose	Capacity of the key ministries/institutions, the concerned local governments, and other relevant organizations to enhance the implementation of agricultural insurance is strengthened.
Outputs	1. Capacity to implement the current scheme of agricultural insurance for paddy is strengthened. 2. Capacity to analyze and improve agricultural insurance scheme is strengthened.
Sites	Jakarta DKI; East Java Province; South Sulawesi Province
Activities	1-1. Promote the implementation of the current scheme of agricultural insurance at the pilot sites. 1-2. Conduct objective reviews at the pilot sites, and communicate their results and recommendations. 1-3. Coordinate and promote the implementation of the current scheme at the national level. 1-4. Conduct information dissemination and training at the national level. 1-5. Organize study visit(s). 1-6. Conduct objective reviews at the national level, and communicate their results and recommendations. 2-1. Conduct assessment of meteorological observation and climate/disaster risk data, communicate the results and recommendations for capacity development, as well as relevant training for capacity building in order for such data to be utilized for insurance implementation/development incl. weather-index based insurance. 2-2. Prioritize and conduct desk-top/field studies concerning yield-based insurance, other commodities to be insured, use of remote sensing, etc., and relevant training as necessary. 2-3. Prioritize and conduct policy studies concerning financial and fiscal issues relating to agricultural insurance. 2-4. Develop and communicate recommendations, based on the results of the activities 2-1, 2-2 and 2-3.
Period	October 2017 – September 2022 (5 years)

The output related to this project in the above is "output 2: Capacity to analyze and improve agricultural insurance scheme is strengthened.", and activity is "2-1. Conduct assessment of meteorological observation and data for climate/disaster risk and capacity development training, and make a recommendation based on the results of the assessment in order for such data to be utilized for implementation/development of insurance including weather-index based insurance."

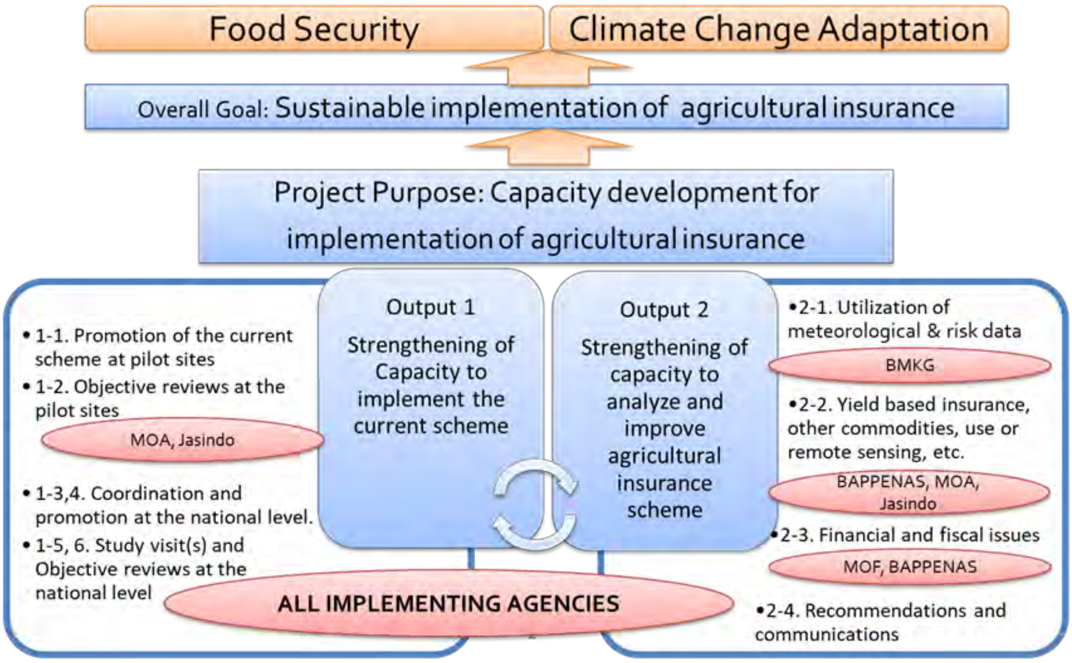


Fig. 1-1 Frame of Project Implementation

1.1 Project Purpose

Based on the R/D (Record of Discussions) of the "Project of Capacity Development for the Implementation of Agricultural Insurance in the Republic of Indonesia", the project targets for implementing activities for "Activity 2-1: Conduct field surveys concerning weather-index based insurance and the relevant training".

In particularly, "Conduct assessment of meteorological observation and climate/disaster risk data, communicate results and recommendations for capacity development as well as relevant training, in order for such data to be utilized for insurance implementation/development including weather-index based insurance.".

For enhancing ability of BMKG for agricultural insurance, the project supports the following 3 key activities.

1: Provide/prepare reliable meteorological data for agricultural insurance.

2: Develop weather information and strengthen abilities for producing products for agriculture.

3: Enhance analysis abilities of risk analysis for climate change dataset.

2. Work Plan

2. Work Plan

Work Plan (version 0) (Fig. 2-1) for the project was explained during the 1st assignment of JICA expert in December 2018 and activities of this project was discussed through meetings with BMKG. In December 2018, baseline survey was conducted to research (i) BMKG observation data for agricultural insurance, (ii) BMKG mid-long-range forecast and products, (iii) observation data and rain gauge at Malang observatory in East Java and interview (iv) data users, the Ministry of Agriculture and Jashido.

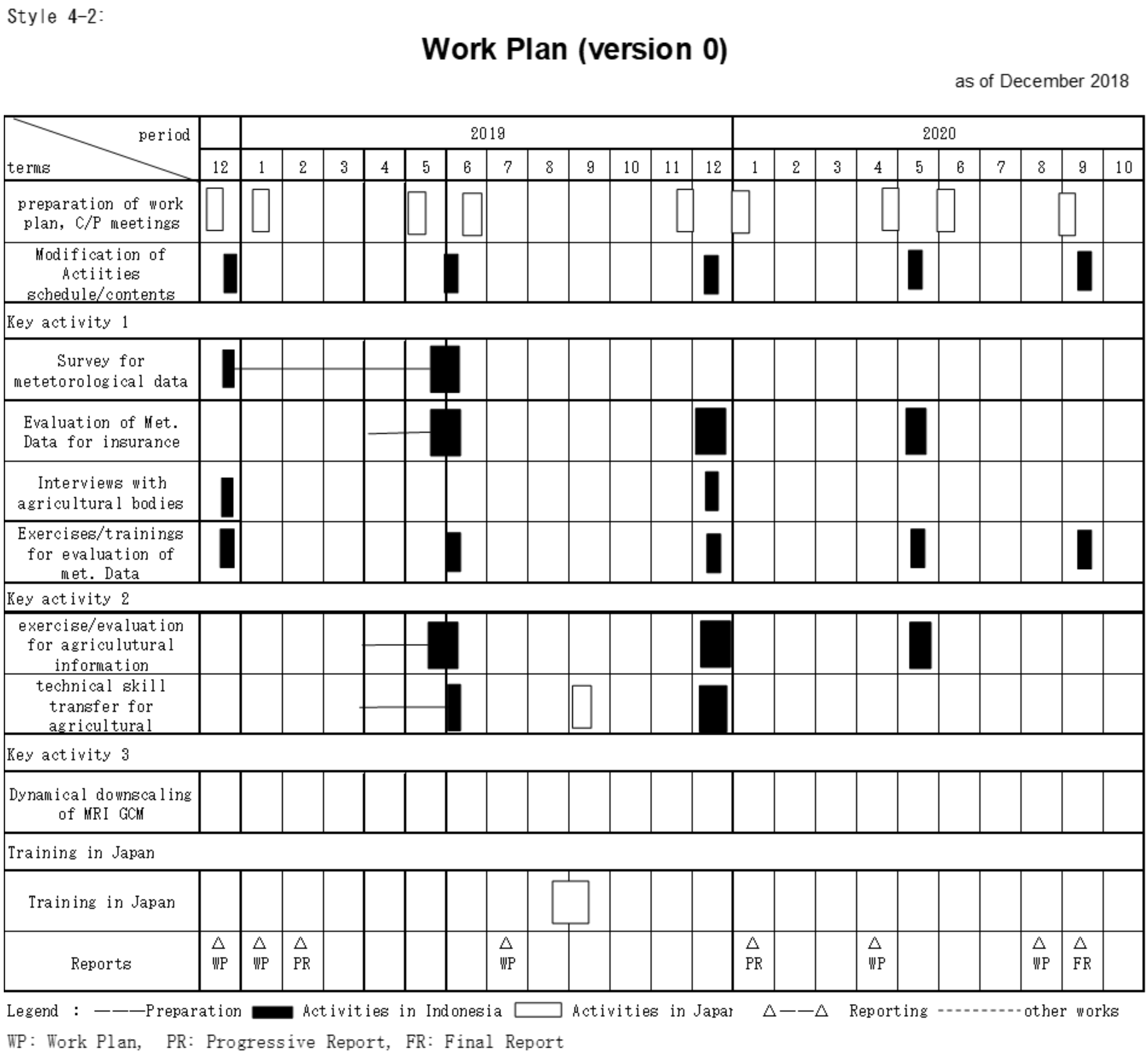


Fig. 2-1 Work Plan (Ver.0)

Work Plan had been updated according to the project implementation and the updated. Key Policies of the project are as follows

2.1 Key Activities of the Project

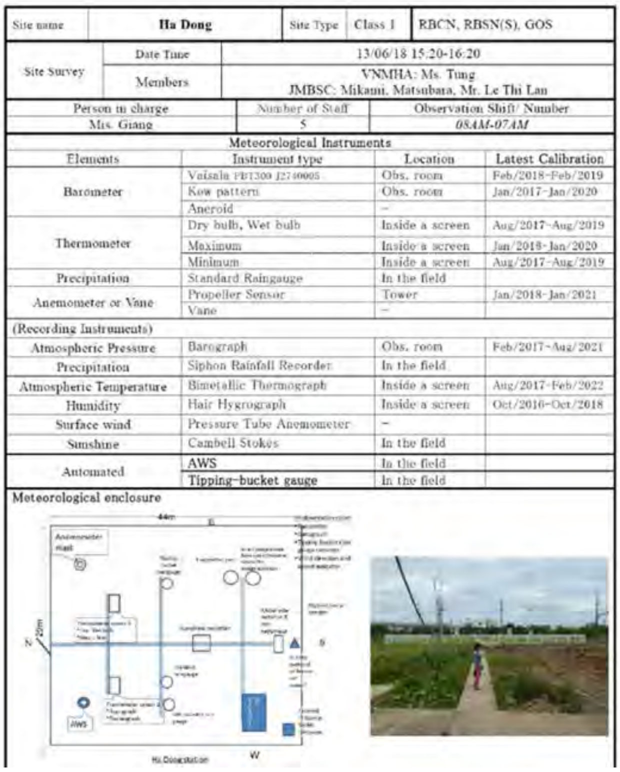
Key Activity 1	Evaluation of reliability of the data and enhancement of required skills

In Japan, insurance companies use meteorological data observed and shared by the Japan Meteorological Agency (JMA) and pricing methods of insurance are different from each company and shorter period dataset, for example 10-year data, are also commonly used for pricing and designing of insurances.

Insurance companies require data guaranteed by BMKG. Ideally, BMKG should prepare reliable dataset for BMKG manual observation data (daily precipitation for at least 10 years hopefully for 30 years). The contents of the data should be:

1. raw and cleaned (missing data are substituted or estimated) data
2. average, standard deviation for decal, monthly data at each station
3. meta data (latitude, longitude, elevation, equipment and so on)

However, Indonesia is a large country and the number of manual observation stations managed by BMKG is not enough for insurance company's requirements in provincial/city levels. For preparing the requirements, the project additionally checked reliability of BMKG AWS (Automatic Weather Station) data with manual station data, re-analysis data and other source (GSMaP, etc.) for secondary reliable dataset.



Site name	Ha Dong	Site Type	Class I	RBCN, RBSN(S), GOS
Site Survey	Date Time	13/06/18 15:20-16:20		
	Members	VNMHA: Ms. Tung JMBSC: Mikami, Matsubara, Mr. Le Thi Lan		
Person in charge	Number of Staff	Observation Shift/ Number		
Mrs. Giang	5	*08AM-07AM*		

Meteorological Instruments			
Elements	**Instrument type**	**Location**	**Latest Calibration**
Barometer	Vaisala PB1300 J2740005	Obs. room	Feb/2018-Feb/2019
	Kew pattern	Obs. room	Jan/2017-Jan/2020
	Aneroid	–	
Thermometer	Dry bulb, Wet bulb	Inside a screen	Aug/2017-Aug/2019
	Maximum	Inside a screen	Jan/2018-Jan/2020
	Minimum	Inside a screen	Aug/2017-Aug/2019
Precipitation	Standard Raingauge	In the field	
Anemometer or Vane	Propeller Sensor	Tower	Jan/2018-Jan/2021
	Vane	–	
(Recording Instruments)			
Atmospheric Pressure	Barograph	Obs. room	Feb/2017-Aug/2021
Precipitation	Siphon Rainfall Recorder	In the field	
Atmospheric Temperature	Bimetallic Thermograph	Inside a screen	Aug/2017-Feb/2022
Humidity	Hair Hygrograph	Inside a screen	Oct/2016-Oct/2018
Surface wind	Pressure Tube Anemometer	–	
Sunshine	Cambell Stokes	In the field	
Automated	AWS	In the field	
	Tipping-bucket gauge	In the field	

Fig. 2-2 An Example of Meta-data Sheet of Stations

Quality check of the precipitation data used in Japan is:

(a) Cross-check between radar echo and surface rain gauge observation data

(b) Numerical analyzed wet area (for example, the area where the humidity is higher than 80%) check

(c) Comparison with GSMaP (Global Satellite Mapping of Precipitation) data provided by JAXA

(d) Double sum check with near stations

The data evaluation methods were discussed through data collection and the project implement data quality check of AWS, rain post data and GSMaP data for preparing to agricultural insurance requirements.

Regarding GSMaP, BMKG climate section has already been producing the precipitation distribution map from GSMaP to monitor drought and BMKG is already familiar with its usage. While, there are some kinds of GSMaP data, for example real time data, near real time data and re-analysis data, the project collected re-analyzed GSMaP data from 2000 to the latest and evaluated its accuracy and usage.

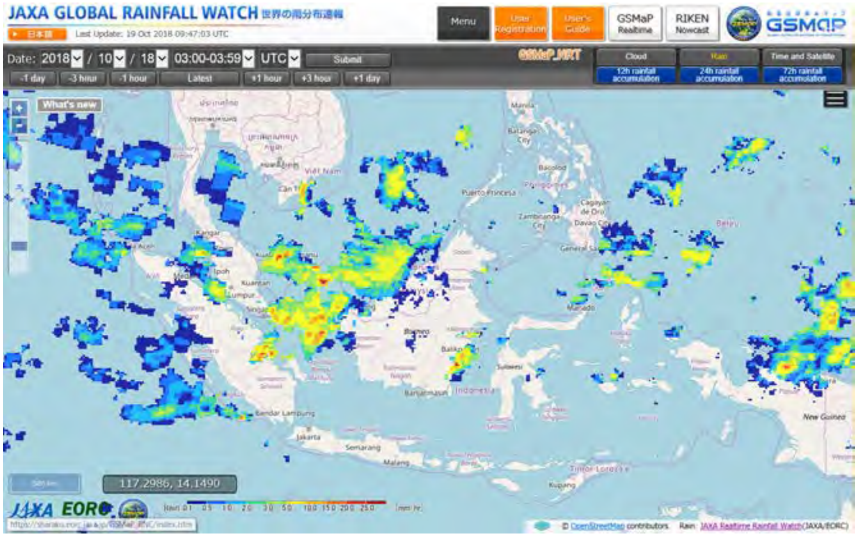


Fig. 2-3 An Example of GSMaP (https://sharaku.eorc.jaxa.jp/GSMaP/index.htm)

Key Activity 2 | Enhance middle-long-range forecasting skill

BMKG has already developed meteorological data products for agriculture for example, the normal of monthly and dasarian (10-day) precipitation, onset and offset of monsoon, CDD (Consecutive Dry Day), CWD (Consecutive Wet Day). Additionally, BMKG have conducted “Field Climate School” for dekades.

At the beginning of the project, the project team (i) implemented survey for BMKG products for agriculture, (ii) compared there products with products of Japanese organizations/agencies for agriculture, (iii) implemented interviews to users (farmers and insurance companies) and grasped their requirements and required data. Based on these surveys, the project evaluated the reliability of actual BMKG forecasts and collected/evaluated other data sources for observation and forecasting of JMA and other prediction centers.

As above mentioned, lots of products are already produced inside BMKG. Based on the surveys, the forecast expert discussed with BMKG and JMA experts regarding:

(i) Which products to be developed in the project,

(ii) What kind of supports BMKG expects to JMA,

And they identified that:

(iii) Improvement of forecasts for transitions seasons between the dry season and the wet season is especially required.

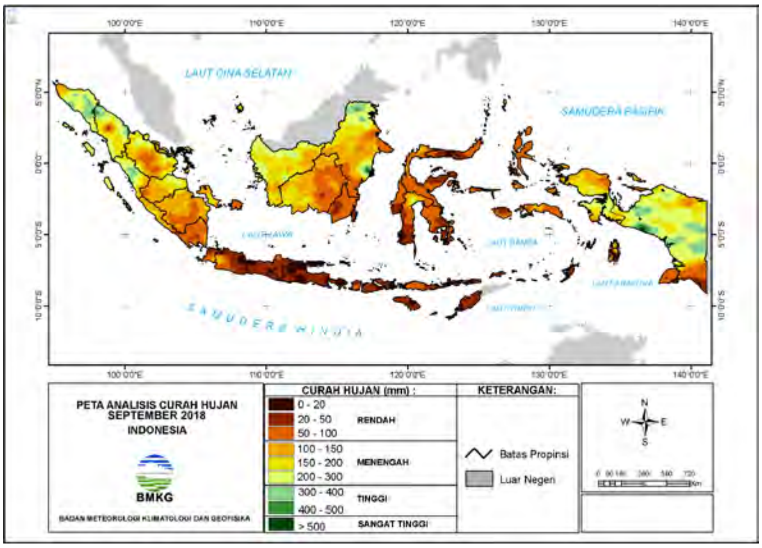


Fig. 2-4 Monthly Precipitation Map (BMKG)

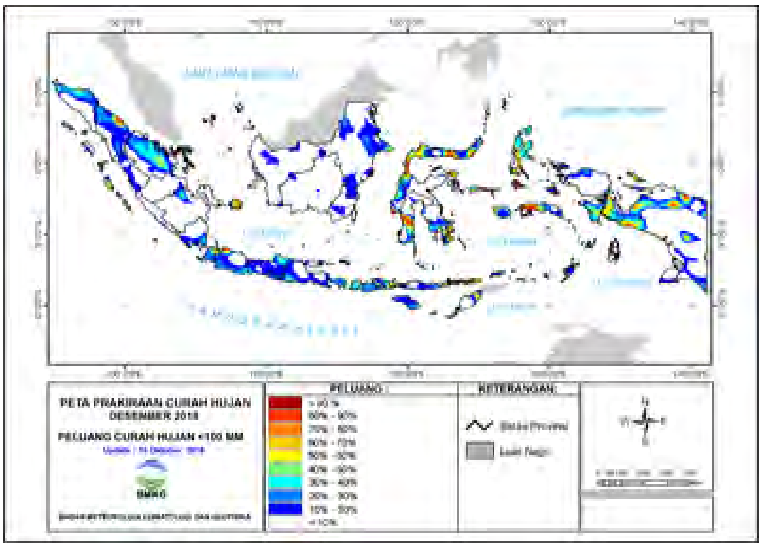


Fig. 2-5 Probabilistic Product of Precipitation (BMKG)

Key Activity 3	Develop climate change data

In order to continue and manage agricultural insurance, the project must evaluate long-term climate change. The long-term climate change data were developed through the former project implemented by JICA from 2010 to 2015 and 20km resolution climate prediction data were shared to regional climate offices of BMKG.

In order to develop climate prediction dataset, the project implemented the following 2 activities.

(A) AGCM data analysis/visualization software

Through the ‘Program for Risk Information on Climate Change’ developed 20km resolution AGCM (Atmospheric Global Climate Model) global data, and the ‘Social Implementation Program on Climate Change Adaptation Technology’ supported training courses for usage of software to cutout, visualize and evaluate data from AGCM at stations, visualize data, evaluate data.

(B) MRI AGCM downscaling

JMBSC research center implemented 'Theme C: Integrated Climate Change Model' of 'Integrated Research Program for Advancing Climate Models (TOUGOU), and supported downscaling to 5km resolution from AGCM data.

For (A), the project implemented training in Japan (1 week in MRI), including follow-up seminars at BMKG by the trainees.

For (B), BMKG and JICA experts agreed that 2 researchers would implement the downscaling using MRI-HPC for 2.5 months when MRI or JMBSC could invite BMKG researchers in 2019.

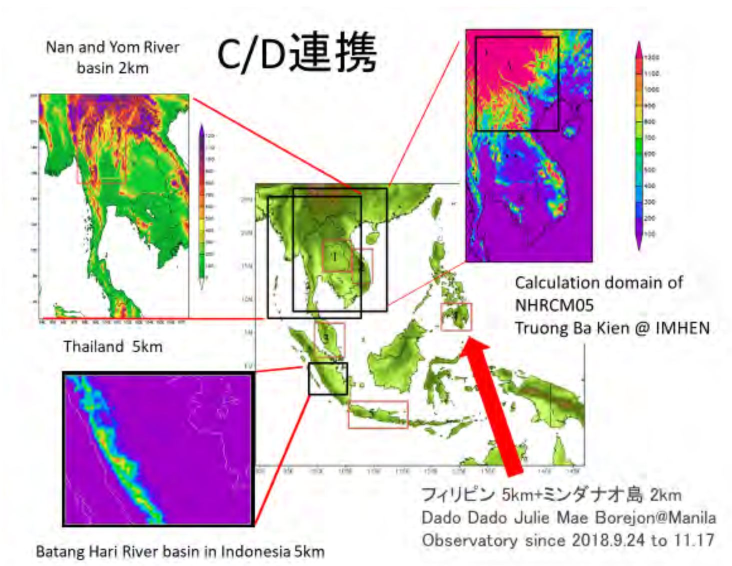


Fig. 2-6 TOUGOU Program Cooperation in South-East Asia

3. Result of the Activity

3. Result of the Activity

Outputs, Objectively Verifiable Indicators, Means of Verification and Activities related to the project are as follows.

Output	2. Capacity to analyze, develop and improve agricultural insurance scheme strengthened.
Indicator	2-1 BMKG staff trained. 2-2 meteorological and climate database's quality improved.
Means of Verification	2-1 Trained report. 2-2 Metrological and climate database
Activities	2-1 Conduct training on meteorological and climate data analysis suitable for the development of the agricultural insurance

Activities in Indonesia were implemented along "Work Plan". "Work plan" was revised from version 0 to version 5 and each version of work plan is attached in Appendix A. In chapter 3, activities of each key activity are described along Work Plan (version 5) shown in Fig. 3-1.

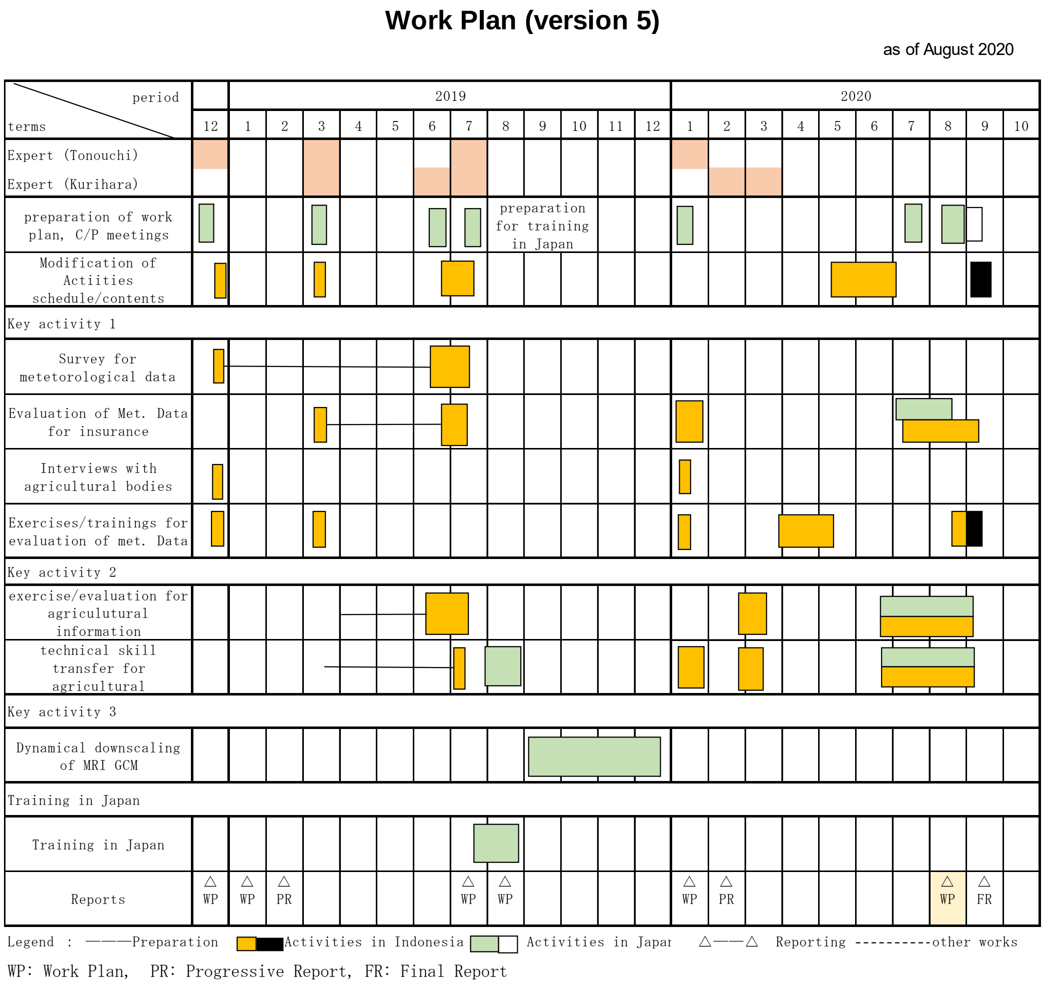


Fig. 3-1 Work Plan (version 5, as of August 2020)

JICA experts explained the work plan version 0 and proposed 3 Key Activities requested BMKG to organize a Working Group (WG) for each key activity in December 2018. Key activities are,

1. Provide/prepare reliable meteorological data for agricultural insurance.
2. Develop weather information and strengthen abilities for producing products for agriculture.
3. Enhance analysis abilities of risk analysis for climate change dataset.

and members of each key activity are organized shown in Table 3-1.

Table 3-1 Member of Working Group for Each Key Activity

Key Activity/ WG	BMKG Members	JICA Expert
1	Agus Sabana Hadi (Mr.) Noveta Chandra Isti Puspita (Ms.) ** Leni Nazarudin (Ms.) Ganesha Tri Chandrasa (Mr.) Muhammad Sudirman (Mr.) Dyni Frina Meisda (Ms.) Linda Natalia So'langi (Ms.)	Michihiko Tonouchi (Mr.)
2	Novi Fitrianti (Ms.) Rosi Hanif Damayanti (Ms.) Ridha Rahmat (Mr.) Damiana Fitria K. (Ms.) Adi Ripaldi (Mr.) ** Dr. Amsari Muzakir Setiawan (Mr.)	Koichi Kurihara (Dr.)
3	Ganesha Tri Chandrasa (Mr.) ** Ari Kurniadi (Mr.) Apriliana Rizqi Fauziyah (Ms.)	Michihiko Tonouchi (Mr.)

** Team Leader

[WG 1 Activity]

Regarding "Dataset for agricultural insurance", the following 3 types of BMKG data available: (i) SYNOP stations (179), (ii) AWS (Automatic Weather Station)/ARG (Automatic Rain Gauge) (944), (iii) rain post (5426). WG1 discussed and agreed to collect information on (a) metadata, (b) missing data ratio and c) maintenance methods and (d) substituted or estimated data for missing data. Additionally, WG1 agreed to collect metadata and rain post data in 2 pilot areas (Central Java and Southern Sulawesi) and strengthen abilities to treat/evaluate meteorological data for agricultural insurance scheme.

[WG 2 Activity]

In December 2018, "Baseline Survey" was implemented with WG2 for weather products BMKG issuing for agricultural sectors, compared them with JMA weather products and interviews to weather information users were made on requirement for weather information for insurance and agricultural management. According to results of the survey, most of products expected were already produced by BMKG, then WG2 discussed,

(i) which products WG would develop,

(ii) what kinds of supports BMKG expects to JMA,

And on the meeting held on 12th December 2018, the WG fixed targets of key activity 2 as:

(iii) improvement of forecasts for transitions of seasons between the dry season and the wet season

(iv) higher resolution forecasts for pilot areas.

Based on the discussion JICA expert agreed to collect JMA seasonal forecast (1-month, 3-month, 6-month forecasts), to prepare software to decode JMA forecast data and share the software with BMKG prior to activities scheduled in July 2019.

[WG 3 Activity]

JMBSC research center implemented “Theme C: Integrated Climate Change Model Program” of “Integrated Research Program for Advancing Climate Models Program (TOUGOU)”, and supported dynamical downscaling in 5km resolution of AGCM data in cooperation with the Meteorological Research Institute (MRI). WG also agreed to second BMKG researchers, if MRI or JMBSC is authorized to invite 2 researchers to implement dynamical downscaling that covers whole Indonesia for Present (1981 to 2000) and for Future (2081-2100) using HPC (High Performance Computer) for 2.5 months as a joint research in MRI.

[Preparation for Activities in Japan]

Through the “Program for Risk Information on Climate Change Project” (“Phase 1 project” from 2010 to 2015), 20km resolution AGCM (Atmospheric Global Climate Model) whish was dynamically downscaled data were developed. For enhancing data utilities, training courses for usage of AGCM data, which includes to cutout, visualize and evaluate data from AGCM at stations, were proposed as a part of training in Japan in 2019. WG agreed to learn these packages during the training and share them to other BMKG members.

3.1 Key Activity 1

“Output 2” of the PDM is “Capacity to analyze, develop and improve agricultural insurance scheme strengthened” and to develop and improve agricultural insurance scheme of BMKG, WG1 tried to collect rain post data in pilot areas and improved analysis skills for agricultural insurance through evaluation of these data.

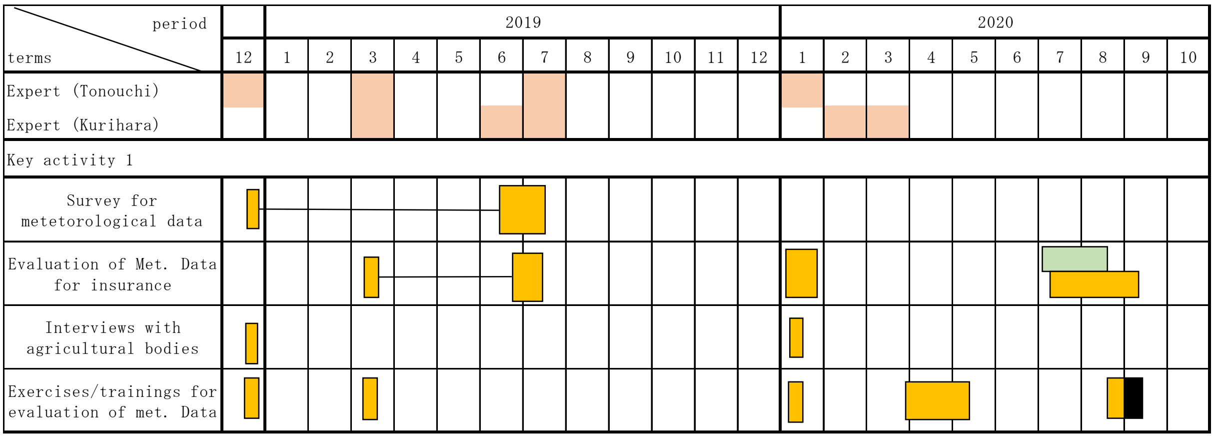


Fig. 3-1-1 Work Plan for Key Activity 1

3.1.1 Outline of Key Activity 1

Insurance companies require "data guaranteed by BMKG" (daily precipitation for at least for 10 years, hopefully for 30 years). The most reliable dataset in Indonesia is the BMKG manual observation data (SYNOP data) where quality is checked on a monthly basis in BMKG Database Center. Required dataset is,

a) Raw and cleaned (missing data substituted or estimated) data
b) Their average, standard deviation for decal, monthly data at the station
c) Meta data (latitude, longitude, elevation, equipment, etc.)

SYNOP data is reliable, however, the number of SYNOP station is only 169 and it's too coarse to use for agricultural insurance as values for design and evaluation. And in Indonesian area, convective and localized precipitation frequently bring more isolated rain than that in extratropical countries, and higher resolution horizontal observations are required for agricultural insurance. In order to increase available meteorological data, it is necessary to check reliability of AWS/ARG and rain post data with SYNOP station data and also to evaluate GSMaP data as alternative data. GSMaP re-analyzed data was already developed in "Climate Variability Center" as drought monitoring database and it could have been an alternative data in case that there was no observation in some areas.

As mentioned above, BMKG has 3 types of rain data, i.e. (i) SYNOP stations (179), (ii) AWS (Automatic Weather Station)/ARG (Automatic Rain Gauge) (944), (iii) rain post (5426) exist in BMKG. WG has also developed precipitation map data shown in the left panel of Fig. 2-4.

3.1.2 Issues to be Addressed in Key Activity 1

For design and implementation of agricultural insurances, reliable data guaranteed by BMKG are indispensable and the most reliable SYNOP stations are officially managed only at 179 locations. In Indonesian area, when convective and localized precipitation frequently bring isolated rain, it's impossible to implement agricultural insurance only using SYNOP data.

JICA expert implemented on-site comparison for SYNOP and AWS data experimentally in December 2018. However, SYNOP data were sparse and AWS data did not have a long history of observation (just for several years). WG1 decided to collect rain post data from 2 pilot sites and evaluate them with SYNOP data. And in case that reliability of rain post data is not enough, WG1 needed to evaluate GSMaP data too.

For the purpose, WG1 agreed the following homework until activities scheduled in June 2019.

[Preparation by BMKG]

- Identify what kinds of data, how many stations exist in east Java and south Sulawesi.
- List up SYNOP and rain post stations, <name, latitude, longitude and elevation>
- Collect daily precipitation data for SYNOP station at least for 10 years, hopefully 30 years.
- Collect also AWS data and if both AYNOP and AWS data are available at a station, collect hourly precipitation and compare with SYNOP data (3/6 hourly precipitation and daily precipitation).

[Preparation by JICA Expert]

- Download GSMaP data, JRA55 (re-analysis data) and develop software to pick up hourly data from GSMaP data based on the station list (coded by C language)
- Collect JMA 1month-3month forecasts data and develop software to pick up daily precipitation data.

[Evaluation Process]

1st step

- Make 10-year daily precipitation database for agricultural insurance in east Java and southeast of Sulawesi for SYNOP data.
- Compare rain post data with SYNOP in daily precipitation and 3/6 hourly precipitation.

2nd step

- GSMaP daily/dasarian data comparison in these areas.
- Evaluate their effectivity of GSMaP data for agricultural insurance.

3.1.3 Activities Carried Out in Key Activity 1

(1) Quality Control of Key Activity 1

A seminar by insurance experts was held in BMKG, and data analysis process for agricultural insurance was discussed in July 2019 (Fig. 3-1-2).

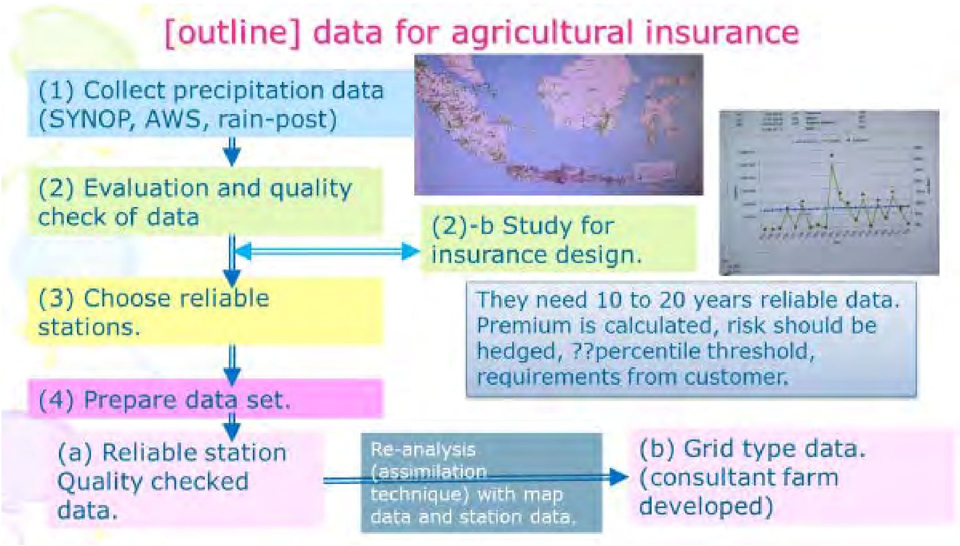


Fig. 3-1-2 Outline of Data Analysis Process for Agricultural Insurance

During the homework from January to June in 2019,

BMKG collected “rain post data”

- Malang: ~47 stations (2000~2018)
- Sulawesi: ~24 stations (2000~2018)

JICA expert collected.

- GSMaP: 2005~2019/2 (1km-resolution)
- JMA 1/3/6 forecasts: 2012/8 ~ 2019/3 (1.25 degree-resolution)

GAMaP data consisted from,

- GSMaP RNL: 2005.1 to 2014.2
- GSMaP gauge: 2014.3 to 2019.2
- Format: 4-byte float data, Area: (0.05E, 59.95N) ~ (0.05W, 59.95S), 0.1 degree resolution, (3,600 * 1,200 data)

データ名	プロダクト	名称	アルゴリズム バージョン	フォルダ名	提供期間	備考
世界の雨分布 リアルタイム	GSMaP_NOW	リアルタイム版	v6	now/latest	最新24時間	24時間過ぎたデータは随時削除されます。
				now/half_hour	2017/03/29～2018/10/31	観測範囲は、静止気象衛星「ひまわり」の観測範囲内のみです。
					2018/11/1～2019/06/26	観測範囲は、静止気象衛星「ひまわり」および「Meteosat」の観測範囲内のみです。
					2019/06/27～現在	
	GSMaP_Gauge_NOW	リアルタイム 雨量計補正版	v6	now/latest	最新24時間	
				now/half_hour_G	2019/06/27～現在	
世界の雨分布 速報	GSMaP_NRT	準リアルタイム版	v5	realtime_ver/v5/hourly realtime_ver/v5/daily	2008/10/10～2014/9/2	
				realtime_ver/v5/daily0.1	2014/1/1～2014/9/2	
			v6	realtime/latest realtime_ver/v6/latest	最新24時間	"realtime" と "realtime_ver/v6" は同一のデータです。
				realtime_ver/v6/archive realtime_ver/v6/hourly realtime_ver/v6/daily realtime_ver/v6/daily0.1 realtime_ver/v6/monthly	2000/3/1～現在	"realtime_ver/v6/archive" と "realtime_ver/v6/hourly" は同一のデータです。
			v7	realtime_ver/v7/latest	最新24時間	
				realtime_ver/v7/archive realtime_ver/v7/hourly realtime_ver/v7/daily realtime_ver/v7/daily0.1 realtime_ver/v7/monthly	2017/4/1～現在	"realtime_ver/v7/archive" と "realtime_ver/v7/hourly" は同一のデータです。
	GSMaP_MVK	標準版	v5	standard/v5/hourly standard/v5/daily	2000/3/1～2010/11/30	
			v6	standard/v6/hourly standard/v6/daily standard/v6/monthly	2014/3/1～現在	
			v7	standard/v7/hourly standard/v7/daily standard/v7/monthly	2014/3/1～現在	
	GSMaP_RNL	再解析版	v6	standard/v6/hourly standard/v6/daily standard/v6/monthly	2000/3/1～2014/2/28	GSMaP_MVK v6と同一アルゴリズムにて再解析
	GSMaP_Gauge_NRT	準リアルタイム 雨量計補正版	v6	realtime_ver/v6/latest	最新24時間	
				realtime_ver/v6/hourly_G realtime_ver/v6/daily_G realtime_ver/v6/daily0.1_G realtime_ver/v6/monthly_G	2000/4/1～現在	
			v7	realtime_ver/v7/latest	最新24時間	
				realtime_ver/v7/hourly_G realtime_ver/v7/daily_G realtime_ver/v7/daily0.1_G realtime_ver/v7/monthly_G	2017/4/1～現在	
	GSMaP_Gauge	標準 雨量計補正版	v5	standard/v5/hourly_G	2000/3/2～2010/11/29	
			v6	standard/v6/hourly_G standard/v6/daily_G standard/v6/monthly_G	2014/3/1～現在	
			v6（改訂版）	standard/v6/hourly_Grev standard/v6/daily_Grev standard/v6/monthly_Grev	2014/3/1～現在	
			v7	standard/v7/hourly_G standard/v7/daily_G standard/v7/monthly_G	2014/3/1～現在	
	GSMaP_Gauge_RNL	再解析 雨量計補正版	v6	standard/v6/hourly_G standard/v6/daily_G standard/v6/monthly_G	2000/3/1～2014/2/28	GSMaP_MVK v6と同一アルゴリズムにて再解析
			v6（改訂版）	standard/v6/hourly_Grev standard/v6/daily_Grev standard/v6/monthly_Grev	2000/3/1～2014/2/28	GSMaP_MVK v6と同一アルゴリズムにて再解析
世界の雨分布 統計	GSMaP_CLM	準リアルタイム 雨量計補正 統計データ	v6	climate/gnrt6/daily climate/gnrt6/pentad climate/gnrt6/weekly climate/gnrt6/10 days climate/gnrt6/monthly	2000/4/1～現在	
				climate/gnrt6/climo/daily climate/gnrt6/climo/pentad climate/gnrt6/climo/weekly climate/gnrt6/climo/10 days climate/gnrt6/climo/monthly	2000/4～2020/3	
				climate/gnrt6/SPI	(*1)	
GSMaP 理研ナウキャスト	GSMaP_RNC	理研AICSによる 予報データ	v6	riken_nowcast/masked	最新2日	
				riken_nowcast/raw	最新16日	

(*1) April 2000 - March 2020 (Before March 2020)

April 2000 - target month (After April 2020)

Fig. 3-1-3 Lists of GSMaP data
(https://sharaku.eorc.jaxa.jp/GSMaP/faq/GSMaP_faq01_j.html)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	cccc	name	lon	lat	he	fl	yyyy	mm	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
2933	96935	JUANDASU	###	-738	3	1	2016	11	0	0	0	0	2	1	0	7	3	0	0	32	0	0	6	9	5	1	0	0	2
2934	96973	KALIANGE	###	-705	3	1	2016	11	0	0	0	0	0	0	0	0	0	0	7	0	1	9	1	0	6	0	0	0	0
2935	96745	JAKARTA/	###	-618	8	1	2016	12	0	5	0	13	94	0	0	15	0	0	0	3	0	1	0	0	997	0	1	0	0
2936	96749	JAKARTA/	###	-612	8	1	2016	12	0	4	24	32	3	0	0	23	1	0	1	0	2	1	0	0	0	0	7	0	0
2937	96805	CILACAP	###	-773	6	1	2016	12	13	39	18	9	15	159	159	1	7	3	1	0	19	6	4	0	93	0	0	0	0
2938	96839	SEMARANG	###	-698	3	1	2016	12	1	0	0	0	0	2	103	1	6	1	6	1	6	8	1	0	1	9	2	0	0
2939	96925	SANGKAPU	###	-585	3	1	2016	12	44	28	1	1	37	30	21	20	98	43	132	2	66	10	9	4	0	12	9	20	0
2940	96935	JUANDASU	###	-738	3	1	2016	12	2	45	1	5	6	25	0	0	1	0	0	0	5	0	4	2	0	0	22	0	0
2941	96973	KALIANGE	###	-705	3	1	2016	12	0	1	3	1	2	5	0	5	4	3	0	12	1	35	22	0	7	2	43	0	0
2942	96745	JAKARTA/	###	-618	8	1	2017	1	0	0	31	16	42	4	3	0	13	3	20	0	0	3	2	2	28	0	0	0	0
2943	96749	JAKARTA/	###	-612	8	1	2017	1	2	0	0	6	34	3	0	1	12	64	11	1	0	3	0	2	0	3	0	0	0
2944	96805	CILACAP	###	-773	6	1	2017	1	7	15	61	0	58	9	6	0	66	23	0	0	1	13	1	7	17	3	18	9	3
2945	96839	SEMARANG	###	-698	3	1	2017	1	10	70	15	0	1	2	10	0	14	0	0	1	0	19	36	94	5	0	3	4	0
2946	96925	SANGKAPU	###	-585	3	1	2017	1	0	5	0	1	10	28	0	0	0	0	0	21	77	12	1	36	113	0	990	7	0
2947	96935	JUANDASU	###	-738	3	1	2017	1	0	27	0	6	1	0	0	0	0	0	0	55	0	51	28	9	11	0	132	28	67
2948	96973	KALIANGE	###	-705	3	1	2017	1	36	59	34	0	12	1	3	0	0	26	13	14	1	31	1	11	2	12	0	0	13

Fig. 3-1-4 Simple Check Sheet for Precipitation (Find Strange/Abnormal Data)

Firstly, WG1 made matrix tables [station] vs [daily precipitation] and colored boxes, for example 10<=[green], 30<=[yellow], 100<=[orange], 500<=[red]. WG1 evaluated missing data or abnormal data by comparing them with data at nearby stations and judged its reliability. Some of them were corrected or some were excluded from database.

For example, in Fig. 3-1-4, figures of 990 or 997 appear in the table. They are codes in SYNOP reports as they are: 0.0mm is coded as ‘990’ and 0.7mm is coded as ‘997’, respectively.

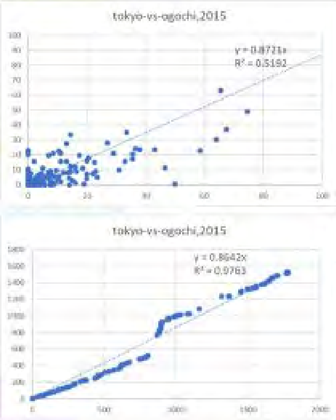
(2) Evaluation of Rain Post Data

Next, WG tried to evaluate accuracy of rain post data with SYNOP observation data.

At first (July 2019), WG tried evaluation by Excel sheet and its functions. WG evaluated [SYNOP and rain post], [SYNOP and GSMaP], [rain post and GSMaP] with basic statistical values and double sum curves (sum of accumulated precipitation forms at the beginning of each year at both stations).

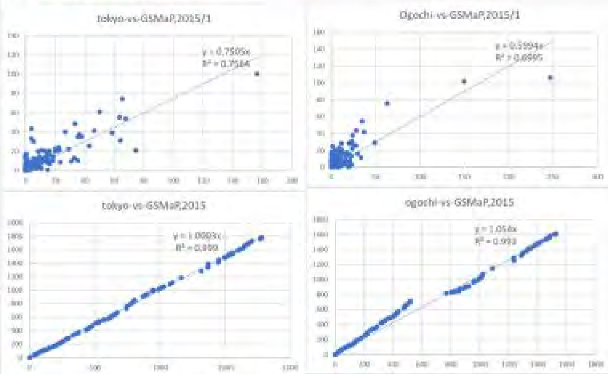
Evaluation indexes and thresholds were temporary fixed as shown in “summarize table” in Fig. 3-1-5(b), and evaluation by Excel basis was implemented in July to August 2019.

2(c). Evaluation 1

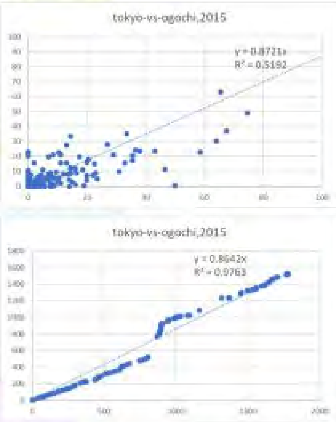


R^2 and proportion

Make scatter-map and sum line and plot regression line (set interest equal to '0') for 1 year data.
Make same charts for GSMaP and observation data at both stations.



2(d). Evaluation 2



smoothness

(Idea)
If rain post data has lots of strange data, sum line winds greatly and the line seems not smooth.

I have no confidence, but propose 1 parameter.
Smoothness = average of (ΣRbi-prop*ΣRai)/(prop*σa)
Here,
ΣRbi is sum of R from day-1 to day-x at station b
ΣRai is sum of R from day-1 to day-x at station a
σa is standard deviation of daily precipitation of station a
And
Prop is proportion of both data.
It is deviation around regression line.
If sum line is smooth, the number would be small, and if not smooth, it would be bigger.
It has relation with correlation factor R, because it is calculated from variance and covariance.

Please refer row-G,H,R,S of excel sheet.

2 (e). Evaluation 3

precipitation >= 20 mm/day

		yes	no	Ogochi
Tokyo	yes	14	13	
	no	7	330	

Tokyo vs Ogochi
precipitation >= 50 mm/dasariany

		yes	no	Ogochi
Tokyo	yes	7	7	
	no	2	20	

Tokyo vs GSMaP(Tokyo)
precipitation >= 50 mm/dasariany

		yes	no	Ogochi
Tokyo	yes	12	2	
	no	3	19	

Ogochi vs GSMaP(Ogochi)
precipitation >= 50 mm/dasariany

		yes	no	Ogochi
Tokyo	yes	8	1	
	no	2	25	

(Idea)
Index type insurance uses an index, for example number of precipitation days or total precipitation during certain period.
I set 2 threshold,
20mm/day and 50mm/dasarian.
The former, I suppose, effective rain for crop should be more than 20mm/h. The later is BMKG rainy season onset/offset threshold.

Please refer row-D,K,V,W and Y46-AC69 of excel sheet.

In row-D, description is as follows,
=(B64>=$D$4)*10+(C64>=$D$4)
Here $D$4 is threshold (=20/day).
If daily precipitation A (B64) is >= 20, plus 10,
If daily precipitation B(C64) is >= 20, plus 1
And at contingency table, count '0', '1' (A=no, B=yes), '10'(A=yes, B=no) and '11' (A,B=yes).

Contingency table

	yes	no
Yes	a (11)	b (10)
no	c (01)	d (00)

Fig. 3-1-5(a) Evaluation of Rain Post Data

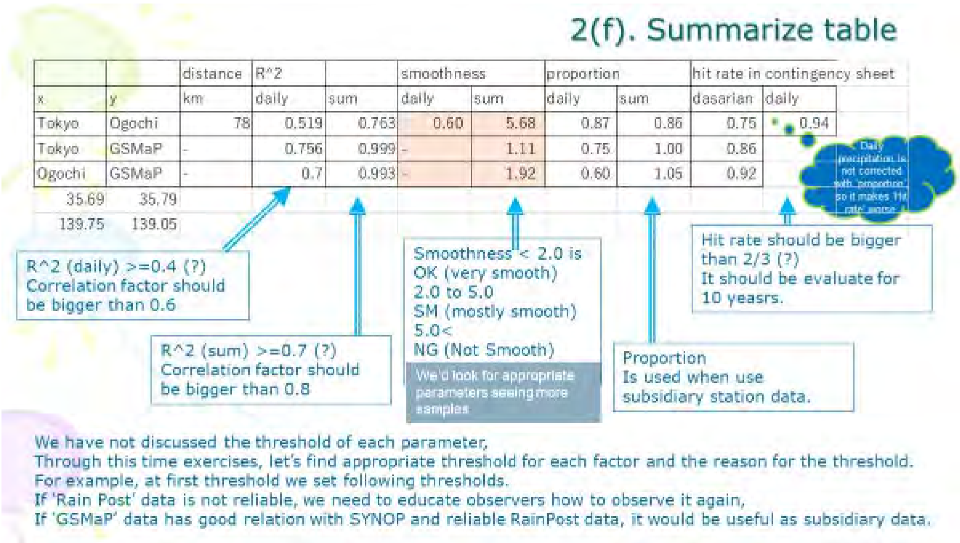
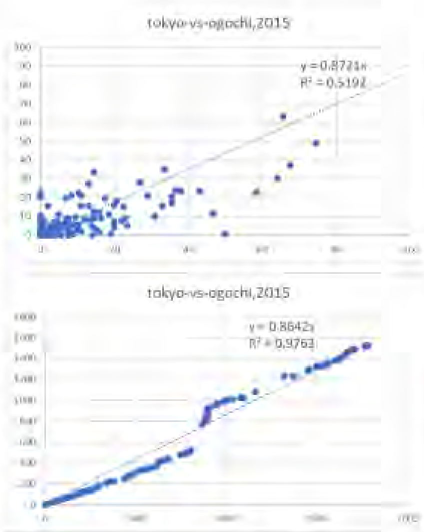


Fig. 3-1-5(b) Evaluation of Rain Post Data

WG roughly fixed thresholds for evaluation of rain post data, however, the method using excel file needed time and efforts to put data and evaluate each by each. In 2nd half of 2019, BMKG expanded its evaluation to 10 years for sample stations and JICA expert developed software coded by Python to shorten evaluation time and make it easier in August 2019.

In January 2020, for evaluation of rain post data with SYNOP and GSMaP were continued. The parameter of smoothness was changed as shown in Fig. 3-1-6. And program code for data evaluation was improved in Python and shared to BMKG. Data evaluation has been continued in BMKG as homework.



smoothness

Evaluation 2

(Idea)
If rain post data has lots of strange data, sum line winds greatly and the line seems not smooth.

I have no confidence, but propose 1 parameter.
Smoothness = average of (ΣRbi-prop*ΣRai)/(prop*Σai)
Here,
ΣRbi is sum of R from day-1 to day-x at station b
ΣRai is sum of R from day-1 to day-x at station a
Σai is sum of R at station.
And
Prop is proportion of both data.
It is deviation around regression line.
If sum line is smooth, the number would be small, and if not smooth, it would be bigger.
It has relation with correlation factor R, because it is calculated from variance and covariance.

Please refer row-G,H,R,S of excel sheet.

Summarize table

We'd better analyze more stations and more years, to analyze easily, we developed statistic analysis software coded by Python.

2010		distance	R^2		smoothness		proportion		hit rate in contingency sheet	
x	y	km	daily	sum	daily	sum	daily	sum	dasarian	daily
Stamet Banyuwangi	Kaliklatak	6	0.0136	0.9866	0.23	2.43%	0.61	1.51	0.78	0.85
Stamet Banyuwangi	GSMaP	-	-0.189	0.9955	-	1.56%	1.09	0.88	0.89	53
Kaliklatak	GSMaP	-	-0.054	0.9937		1.79%	0.32	0.59	0.75	13
-8.22	-8.19									
114.38	114.34									

R^2 (daily) >=0.01 (?)
Correlation factor should be bigger than 0.6

R^2 (sum) >=0.8
Correlation factor should be bigger than 0.8

Smoothness < 2.0 is OK (very smooth)
2.0 to 5.0 SM (mostly smooth)
5.0< NG (Not Smooth)

within 2% "smooth"
within 5% "relatively smooth"
more than 5% "not smooth"

We'd look for appropriate parameters seeing more samples

Proportion
Is used when use subsidiary station data.

Daily precipitation is not corrected with 'proportion', so it makes 'Hit rate' worse

Hit rate should be bigger than 2/3 (?)
It should be evaluate for 10 yeasrs.

At now, we suppose,
- (a) R(ΣSYNOP, Σrain-post)>0.9
- (b) Smoothness is smaller than 5%
- © Double-sum line does not have significant gap

[rain post] station is 'reliable'

If the rain-post is not reliable and SYNOP and GSMaP comparison is reliable,
GSMaP would be better than rain-post at the area

Fig. 3-1-6 Change of Evaluation Parameters (January 2020)

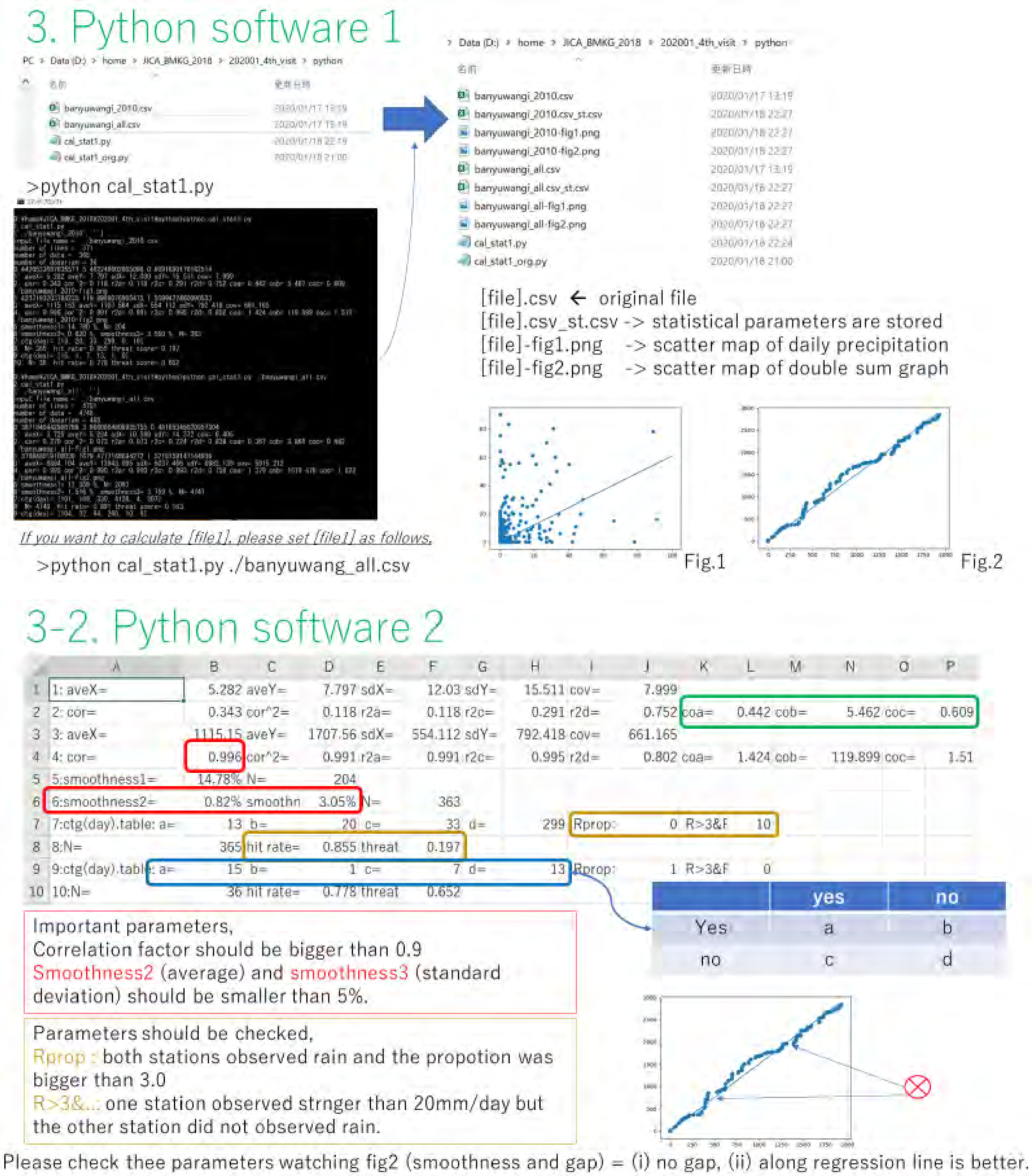


Fig. 3-1-7 Development of Software (Python)

(3) Reliability Evaluation 1 (Trial in Japan)

Due to COVID19 pandemic, travels and on-site activities were suspended since April 2020.

In Japanese side, JICA experts expanded evaluation methods with 5-year data in Japan and shared following strategy to select alternative station for the original target station for agricultural insurance.

[Summarize Table and Determination of Alternative Station]

Factors shown in Table 3-1-1 to evaluate similarity of precipitation patters are calculated by Excel and Python software, and results are summarized.

Table 3-1-1 Summarize Table

2019	0	distance	R^2	0	smoothne	0	proportion	0	hit rate in	0
x	y	km	daily	sum	daily	sum	daily	sum	dasarian	daily
Hachioji	Fuchu	18	0.886	0.998	0.02	1.16%	0.79	0.98	0.89	0.97
0	0	0	>=0.6	>=0.8	0.00	<=2%	0.00	<=20%	4	12
0	0	0	0	0	0.00	jump	event	0	shower	1
35.67	139.32	1mm<=	109	10mm<=	41	45	2*sigma	0%	3*sigma	25%
35.68	139.48	0	112	0	84%	53	7	0%	4	2%

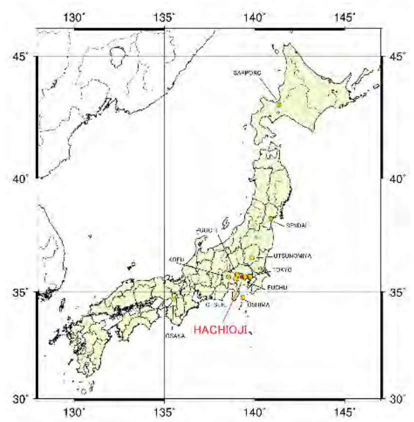
JICA expert tried to find the most appropriate alternative station in Hachioji comparing Fuchu, Ogouchi, Otsuki, Kofu, Tokyo, Oshima, Utsunomiya, Sendai, Sapporo and Osaka for 5 years (2015 to 2019). Based on the result, the following factors were found there are useful for judging an alternative station to the original station. JICA expert proposed:

1. Correlation factor of daily precipitation between 2 stations
2. Hit rate in “Contingency Table for dasarian”
3. Number of step shape gaps between both stations

The expert calculated scores for 10 stations to the original station “Hachioji” and shows the result in Table 3-1-2.

Table 3-1-2 Score Table for Choosing Alternative Station

Station	Distance from Hachioji	R^2	Hit Rate	Gap
Fuchu	18	14	10	0
Ogouchi	33	10	8	-1
Otsuki	42	6	8	-1
Kofu	85	6	6	0
Tokyo	47	4	8	0
Oshima	101	1	0	-4
Utsunomiya	114	1	0	-2
Sendai	334	4	5	-3
Sapporo	842	0	0	-5
Osaka	432	0	0	-5



Score	4	2	1
R^2	>=0.9	>=0.8	>=0.6
Hit Rate		>=0.9	>=0.8

Score Table

(4) Reliability Evaluation 2 (Rain Post Data in Indonesia)

a) Climatology

In general, both East Java and South Sulawesi regions have several types of rainfall patterns (Fig. 3-1-10). BMKG categorizes the difference in rainfall patterns between these regions into climate zones (ZOM) and non-climate zones (NON-ZOM).These areas are categorized into climate zones possess a distinct period of the wet and dry season, usually associated with the monsoonal-type rainfall, while the non-climate zones do not have any clear difference between the wet and dry seasons (associated with other types of rainfall patterns such as equatorial, anti-monsoonal, or specific type of local wet/dry pattern). In East Java, all ground observations (BMKG stations and rain posts) are located within the areas that are categorized as ZOM, while South Sulawesi has a more diverse classification in which some ground observations are located in the NON-ZOM area. The location of the ground observations that are used in this activity is shown in Fig. 3-1-8 and Fig. 3-1-9.

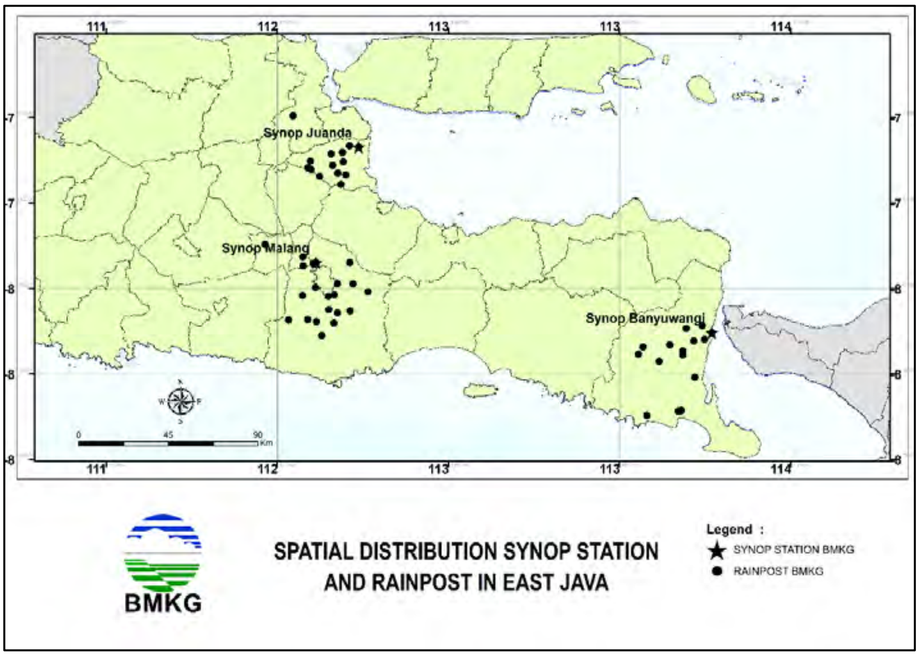


Fig. 3-1-8 Location of Ground-Based Observations (BMKG's Main Station and Rain Posts) in East Java in which Data were Retrieved for the Analysis

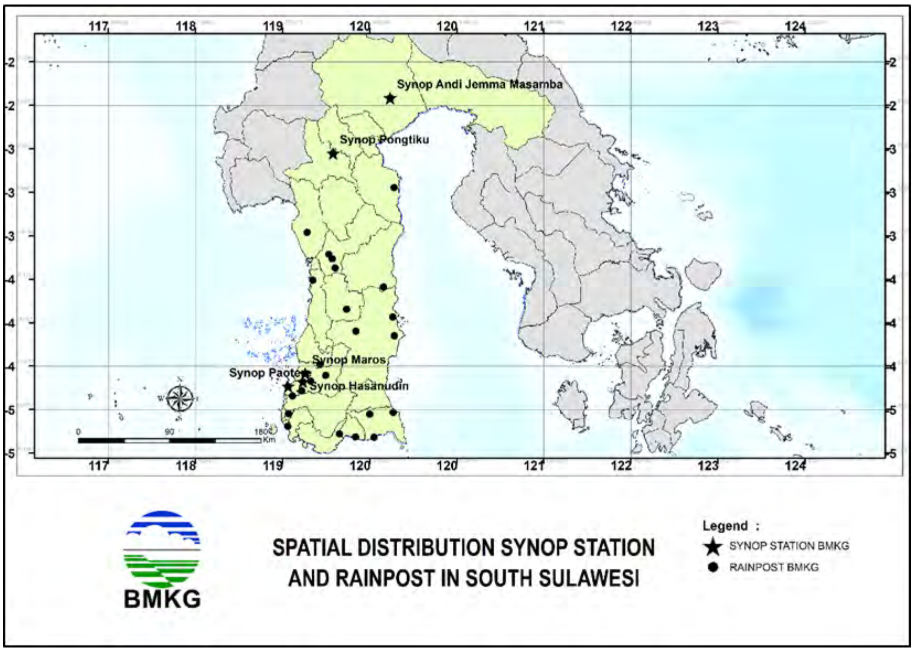


Fig. 3-1-9 Location of Ground-Based Observations (BMKG's Main Station and Rain Posts) in South Sulawesi in which Data were Retrieved for the Analysis

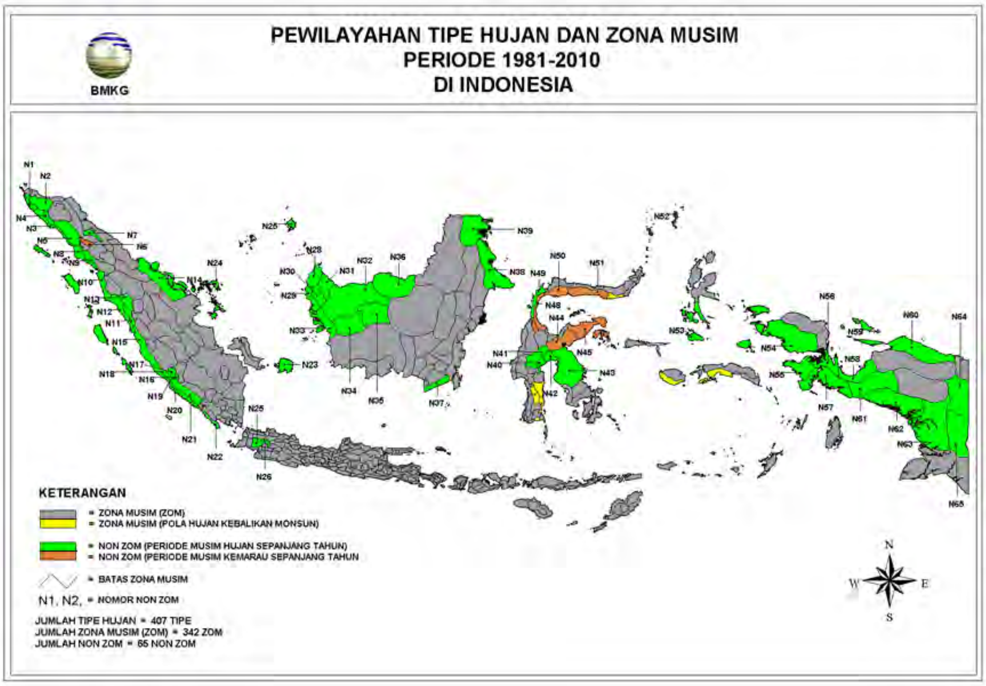


Fig. 3-1-10 Classification of Regions Based on its Rainfall Pattern Type by BMKG

b) Data Collection

The working group in BMKG's side identified and collected several required data for the purpose of analysis over the area of East Java and South Sulawesi, which were considered as the pilot area of this project. Initially, the necessary climate data for this project are the rainfall data from BMKG's primary observation station registered in WMO database (hereupon referred as "SYNOP station data"), additional rain post data (independent observation in cooperation with BMKG, hereupon referred as "rain post data"), and rainfall data from automatic observation system (ARG/AWS/AAWS). Automatic observations have not been relevant yet due to short temporal coverage of the historical data. At now, only two data (SYNOP data and rain post data) which have longer observation period meet agricultural insurance requirements.

The first step was to apply quality control to data from rain posts in East Java and South Sulawesi. The quality controls are (i) at least 5-year continuous data exists without any missing periods, and (ii) for comparative analysis 10-year of daily rainfall data exists. After performing quality check above, reference SYNOP stations and rain posts were selected as follows.

[East Java]

3 SYNOP stations are used for the analysis in the East Java area as a reference.

a) Juanda SYNOP station, Surabaya, acting as a reference for 13 surrounding selected pilot rain posts
b) Karangploso SYNOP station, Malang, acting as a reference for 20 surrounding selected pilot rain posts
c) Banyuwangi SYNOP station, Banyuwangi, acting as a reference for 14 surrounding selected

pilot rain posts

[Sulawesi Selatan]

5 SYNOP stations are used for the analysis within the South Sulawesi area as a reference.

a) Hasanuddin SYNOP station, Makassar, acting as a reference for 5 surrounding selected pilot rain posts
b) Maros SYNOP station, Makassar, acting as a reference for 8 surrounding selected pilot rain posts
c) Paotere SYNOP station, Makassar, acting as a reference for 9 surrounding selected pilot rain posts
d) Pongtiku SYNOP station, Tana Toraja, acting as a reference for 13 surrounding selected pilot rain posts
e) Andi Jemma Masamba SYNOP station, North Luwu, acting as a reference for 1 surrounding selected pilot rain post

There are 3 rain posts with 2 SYNOP stations as a reference, considering distances to reference stations.

[GSMaP data]

In addition to the comparative analysis between SYNOP stations and rain posts, WG had done comparative analyses between both ground observation data (SYNOP and rain post) and the GSMaP satellite data. This assessment was conducted in order to identify the performance of GSMaP over the two provinces to check its reliability as alternative data.

The usage of GSMaP data is important considering the lack of homogenous spatial coverage in Indonesia. The application of climate index insurance would require alternative data in the case that there is no reliable ground observation in a certain area. There're few types of GSMaP data (difference of data used and timing of production), WG used the GSMaP MVK data, an hourly dataset which use whole satellite data and re-analyzed with SYNOP data.

c) Indexes for Comparison

The assessment of reliability was done by adopting the step-by-step instructions methodology as explained by the experts from JICA. Selected indexes for data evaluation on this project were as follows.

[Correlation Coefficient]

Correlation is one of the statistical tests to judge relationship between variables. The correlation coefficient is calculated by following equation.

$$correlation\ coefficient = \frac{S_{xy}}{(\sqrt{S_{xx}} \times \sqrt{S_{yy}})}$$

Here, *x* is target data, *y* is reference data, S_{xy} is covariance (*x*,*y*), S_{xx} is variance (*x*) and S_{yy} is variance (*y*).

The larger correlation coefficient means the higher reliability of rain post data to the reference SYNOP data. In the analysis, the correlation coefficient is calculated based on daily and cumulative rainfall (sum of total precipitation from the 1st day of the year to the day). The cumulative rainfall correlation coefficient is the 1st parameter to evaluate reliability of rainfall data and the threshold for reliability is bigger than 0.9.

[Smoothness]

Smoothness is the deviation from a regression line. Smaller smoothness means that precipitation pattern are similar and there exist smaller number of gaps between 2 stations. Smoothness is closely connected with the correlation coefficient, as it is calculated using variance and covariance. The calculation of smoothness is also based on cumulative rainfall data, and the 2nd threshold of reliability is smoothness is smaller than 5%.

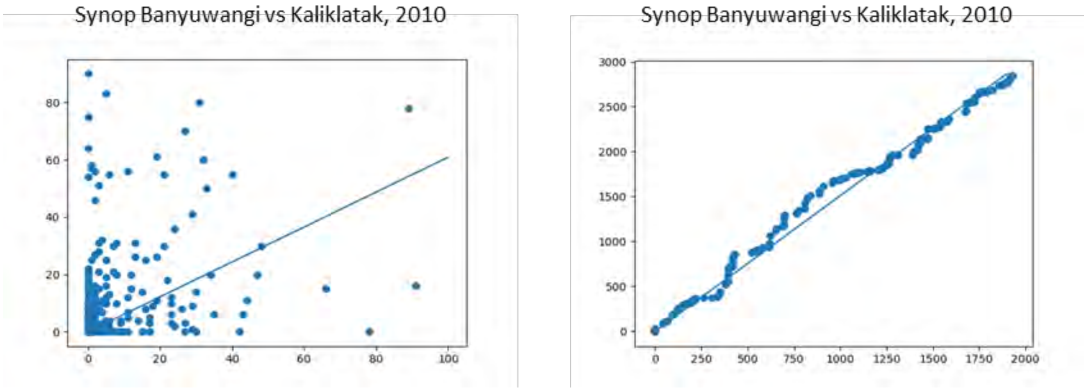


Fig. 3-1-11 Scatter Chart (Left) and Double-Sum Curve (Right)

[Contingency Table]

The reliability of data is also evaluated by hit rate of contingency table. The hit-rate procedure was done for daily and dekadal (10-day cumulative) rainfall. The threshold is 20 mm/day for daily rainfall and 50 mm/day for dekadal rainfall. The 20 mm/day is the BMKG's standard for light rain, and the 50mm/dasarian is one of the BMKG's criteria for determining the season on-set. The 3rd threshold for reliability class based on the hit-rate is greater than 0.67.

contingency table				
Synop Banyuwangi vs Kaliklatak				
precipitation >=		20	mm/day	
		yes	no	Kaliklatak
Synop Banyuwangi	yes	13	20	
	no	33	299	
Synop Banyuwangi vs Kaliklatak				
precipitation >=		50	mm/dasariany	
		yes	no	Kaliklatak
Synop Banyuwangi	yes	15	1	
	no	7	13	

Fig. 3-1-12 Contingency Table

[Number of Gaps]

The number of gaps (jumps) is determined based on the double sum curve, in which a gap in the comparison graph between two datasets occurred. These gaps are brought by localized rain by convective clouds, missing data or troubles in rain gauges. If heavy rainfall is only detected in one of the data, then a shape gap in the double sum curve is displayed. This index is not considered for the reliability class calculation.

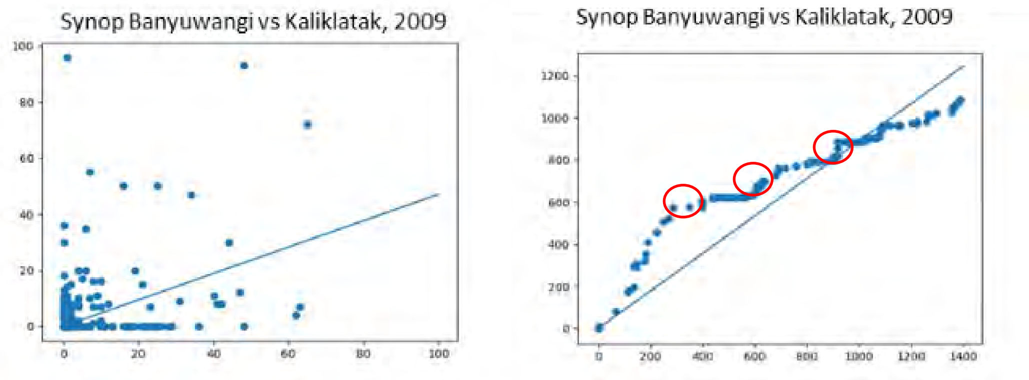


Fig. 3-1-13 Gaps (Circle) in Double-Sum Curve with a Shape Gap

[Scores of Reliability]

Previously mentioned factors/indexes are calculated with both Microsoft Excel and Python software, and a sample of results is shown in Table 3-1-3.

Table 3-1-3 An Example of the Summary of Calculation and Reliability Class between Kaliklatak Rain Post and Banyuwangi SYNOP Station

							>=0.9	<=5%	<=5%			>=0.67	>=0.67			
No	Rain Post	Lat	Lon	Year	Distance	Correlation		smoothness		Proportion		Hit rate in contingency sheet		Reliable	TRUE	FALSE
					(km)	daily	sum	smoothness 2 (average)	smoothness 3 (SD)	daily	sum	daily	dasarian	Dasarian		
	Stamet Banyuwangi	-8.2167	114.383													
1	Kaliklatak	-8.1853	114.34	2009	6	0.403	0.967	6.42%	5.37%	0.471	0.891	0.75	0.918	FALSE		
	Kaliklatak	-8.1853	114.34	2010	6	0.343	0.996	2.42%	2.03%	0.609	1.51	0.855	0.778	TRUE		
	Kaliklatak	-8.1853	114.34	2011	6	0.262	0.982	4.49%	3.27%	0.461	1.186	0.923	0.722	TRUE		
	Kaliklatak	-8.1853	114.34	2012	6	0.385	0.983	5.63%	3.26%	0.792	1.443	0.902	0.806	FALSE		
	Kaliklatak	-8.1853	114.34	2013	6	0.063	0.988	2.89%	3.10%	0.234	1.589	0.841	0.833	TRUE		
	Kaliklatak	-8.1853	114.34	2014	6	0.173	0.991	3.24%	2.31%	0.251	1.227	0.923	0.806	TRUE		
	Kaliklatak	-8.1853	114.34	2015	6	0.246	0.99	2.75%	2.85%	0.305	1.015	0.91	0.917	TRUE		
	Kaliklatak	-8.1853	114.34	2016	6	0.133	0.99	2.95%	2.41%	0.287	1.099	0.877	0.806	TRUE		
	Kaliklatak	-8.1853	114.34	2017	6	0.202	0.977	4.76%	3.93%	0.315	0.924	0.874	0.75	TRUE		
	Kaliklatak	-8.1853	114.34	2018	6	0.227	0.98	3.40%	3.12%	0.335	1.003	0.901	0.806	TRUE	8	2
	Kaliklatak														80	20

The summary indicates that the score of Kaliklatak rain post relative to Banyuwangi SYNOP station is 80%. As mentioned above, the thresholds are used for comparisons.

1. Correlation coefficient of cumulative rainfall between two data
2. Smoothness
3. Hit rate of contingency table for dasarian rainfall

The determination of the reliability of a rain post stations in East Java and South Sulawesi, the BMKG WG used a slightly different approach from reliability evaluation in Japan (mentioned in 3.1.4). In the evaluation, reliability was judged year by year with 3 thresholds for 10 years, and finally evaluated as the score, a percentage of reliable data for 10 years shown in Table 3-1-4.

Table 3-1-4 Reliability Evaluation Criteria

Percentage Reliable Data	Evaluation Criteria
91 – 100%	Reliable
81 – 90%	Reliable
71 – 80%	Reliable
61 – 70%	Reliable
<= 60%	Unreliable

The result of evaluation for rain posts data is shown in Fig. 3-1-14. In general, the result varies with indexes and their criteria.

d) Evaluation Results of Reliability

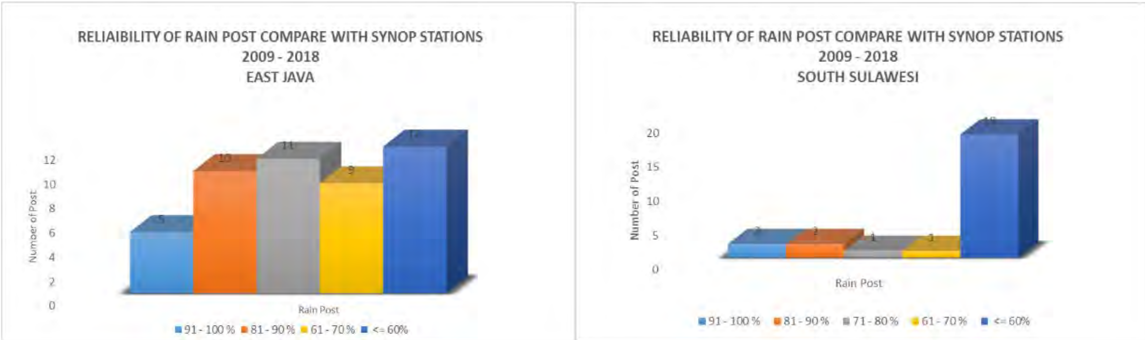


Fig. 3-1-14 Distribution of Reliability Scores of Rain Posts
(Reference to SYNOP Stations)

Fig. 3-1-15 shows that in East Java, there are 35 rain posts (out of 71) with reliability score exceeding to 60%. In case a rain post station data has missing data or rain gauge failures, it can be replaced/estimated by the data from the reference SYNOP station. In Fig. 3-1-14, it shows that reliability scores in East Java are relatively better than those in South Sulawesi. The low reliability in South Sulawesi is considered to be the result of the difference in the rainfall pattern between the rain posts and the reference SYNOP station. As explained before, all regions in East Java are categorized as a ZOM-type (having a monsoonal-type rainfall pattern). Meanwhile, South Sulawesi consists of several regions which have few different rainfall patterns.

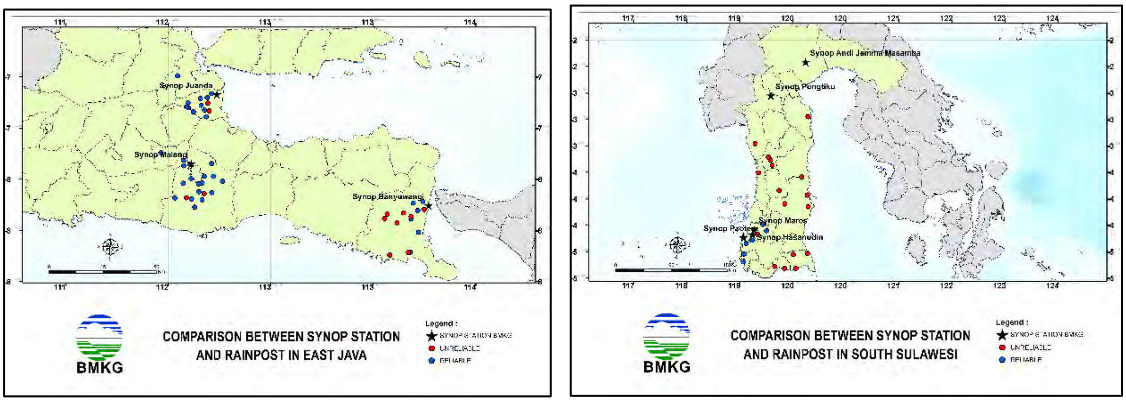


Fig. 3-1-15 Comparation between SYNOP Stations and Rain Posts

And then, in order to evaluate GSMaP effectivity as alternative data, WG evaluated GSMaP, satellite-based precipitation estimated data, with SYNOP and rain post data as shown in Fig. 3-1-16.

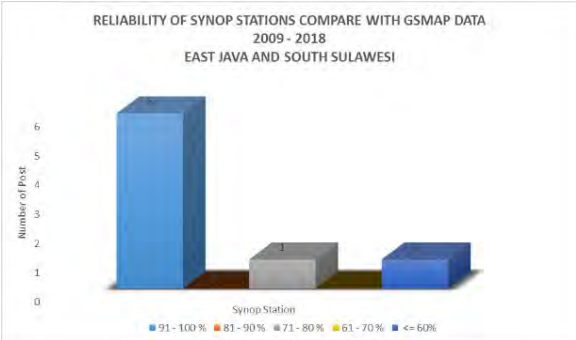


Fig. 3-1-16 Reliability Scores of GSMaP Data (As Composed with SYNOP Station, N=10)

Eight of GSMaP data (the nearest grid data to a station) of reference SYNOP station, seven of them shows the score greater than 70%, with the other one shows a score smaller than 60%. 2 SYNOP stations that have sores smaller than 80% located in higher elevation area. The evaluation results for ground observations are shown in Fig. 3-1-17.

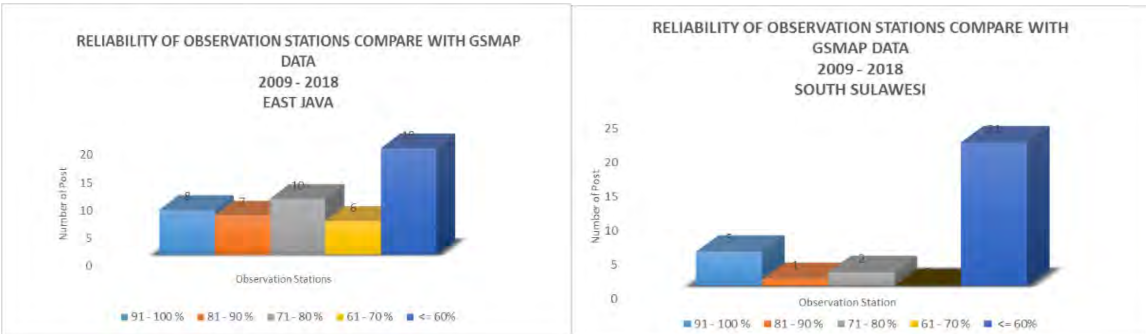


Fig. 3-1-17 Reliability of GSMaP Data Composed to the Ground Observations

Fig. 3-1-18 shows that in general, the reliability of GSMaP data at the rain post locations is relatively low. While the reliability of GSMaP data is good at the location of SYNOP station, the comparison between the GSMaP and the rain post destination suggests an opposite result.

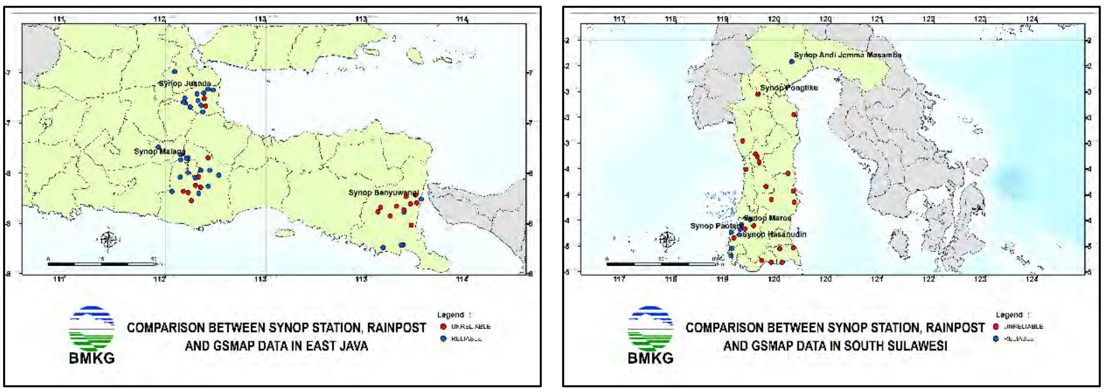
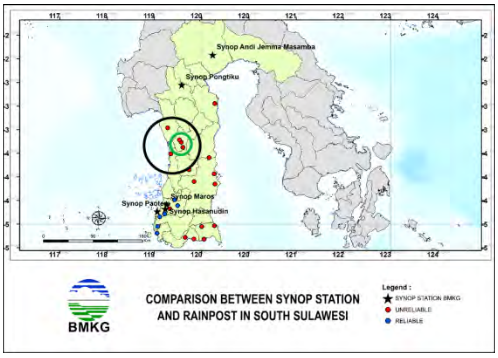


Fig. 3-1-18 Comparation SYNOP Station and Rain Post with GSMaP Data

GSMaP MVK is calibrated with precipitation map (NOAA CPC Global Daily Gauge) calibrated with SYNOP data (surface observation data) exchanged through Global Telecommunication System

(GTS) managed by WMO, and then GSMaP shows higher reliability with SYNOP data around SYNOP stations. And areas nearby SYNOP station have higher reliability with GSMaP data, rain posts also have higher reliability.



Rain post	Amparita	Bilokka	Sereang	Mallawa	Cempa
Amparita		80	70	30	20
Bilokka	80		70	30	20
Sereang	70	70		40	30
Mallawa	30	30	40		20
Cempa	20	20	30	20	

Fig. 3-1-19 Cross evaluation of Rain Posts

Additionally, WG tried cross evaluation between each rain post in central area of southeast Sulawesi where there is no SYNOP station. The scores between mutual rain posts are shown in Fig. 3-1-19, and according to the scores, 3 (out of 5) rain posts showed greater than 60% scores for 10-years and rain posts data is supposed to be reliable. Another 2 stations showed lower scores in 20 to 40% locates farther area compared to 3 concentrated rain posts (located closer less than 20km). WG guessed that in Southeast Sulawesi, localized rain by convective clouds is more significant compared to the other areas. The results indicate that we have to consider higher resolution/density of rain gauge stations less than 20km in the area where convective rains are frequent.

e) Summary of Analysis

Through activities of key activity 1, WG collected rain post data in pilot areas and developed reliability evaluation methods for collected data. Findings are:

- ✓ Most of rain post data has reliability.
- ✓ Even in convective precipitation area, nearby rain post in 20km, shows reliability.
- ✓ Map of precipitation data, for example GSMaP, is useful if it is calibrated with reliable surface observation data.

Summary of analysis and future plans for analysis are as follows.

[Summary]

a) The reliability of rain posts data is determined based on the percentage of reliable years during the 10-year period, with a minimum threshold more than 60% or 0.6.

b) The justification of the reliable years is based on the three criteria, which are: correlation coefficient greater than 0.9, smoothness less than 5%, and hit rate exceeding 0.67.

c) The reliability of rain posts data in East Java is better than those in South Sulawesi. In East Java, 35 out of 47 rain posts are reliable, while only 6 out of 24 in South Sulawesi. Some possible causes are, (a) The proximity of rain posts concerning the reference station and, (b) Variation of rainfall pattern over the regions.

d) The performance of the GSMaP data in East Java is better than in South Sulawesi, both in reconstructing SYNOP station ground observations and rain post ground observations.

[Conclusions]

a) A further evaluation needs to be done in other regions. The results of the evaluation should be compared to the East Java and South Sulawesi results.
b) Considering the frequent event of convective rainfall over Indonesia, it might be good to add more criteria into the reliability justification (among them might be the number of jumps from the double sum curve).
c) Comparison of data between rain posts in close distance and altitude could provide an alternative in the further effort of assessing reliability.
d) For the purpose of agricultural insurance, the top priority reference data should be the SYNOP ground observation data. In the case that the location is significantly far from SYNOP stations, the rain posts data can be used after the previously explained quality control method is applied. Another option is to use satellite-based observations like GSMaP data.
e) In addition to the agricultural insurance project, collection, analysis, and evaluation that are performed might be very important for other BMKG activities as well, hence, this activity should be continued in the future.

f) Summary of Key Activity 1

Through communication with insurance companies (Sompo Japan Co. and Jashindo) and users (MOF and agricultural researchers), they expected reliable precipitation data secured by BMKG and hopefully in high resolution, for example 1km. Farmers expected that data becomes threshold for payment and should be objective and hopefully BMKG data is used for insurance design and for insurance.

During the baseline survey in December 2018, BMKG proposed to study various indexes for agricultural insurance and for indexes to crop diseases or crop yields. However, most of index type of weather insurance (mainly agricultural insurance) has been managed by meteorological factors, for example number of rainy days or precipitation during crop seasons. BMKG has already established reliable SYNOP data of which quality checked, and then the project set targets to collect, evaluate and add additional precipitation data for agricultural insurance.

Through activities, it was found that (i) quality checked and reliable rain post data are mostly useful and (ii) these data can improve quality of re-analyzed precipitation distribution data using GSMaP and BMKG observation data. The project suggests that if BMKG collects and improve quality of precipitation data, the data would contribute to agricultural insurance as well as BMKG precipitation products and database. Continuous activities for collecting rain post and AWS/ARG data and evaluate them will strengthen BMKG's capacity to analyze, develop and improve agricultural insurance scheme.

Regarding agricultural indexes to diseases or yields, agricultural laboratories or researchers have knowledge on the meteorological factors that affect them. "The Project of Capacity Development for

Implementation of Climate Change Strategies Phase 2" (Phase 2 project) started in July 2020 and through the project of risks of climate change will be evaluated with Japanese meteorological and agricultural researchers. As a part of risk analysis activities, capacity development for agricultural indexes should be scheduled in the Phase 2 project.

Though the project, meetings for activities, lectures, exercises for evaluation, meetings held and so on are listed in Appendix C.

3.1.4 Achievement of Key Activity 1

Through activities of key activity 1, WG collected rain post data in pilot areas and developed reliability evaluation methods for collected data. Findings are,

- ✓ Most of rain post data are reliable.
- ✓ Even in the convective precipitation area, nearby rain post within 20km from a SYNOP station shows reliability.
- ✓ Map precipitation data, for example GSMaP, is also useful if it is calibrated with reliable surface observation data.

WG achieved to analyze, develop and improve meteorological data usage/scheme for agricultural insurance mentioned in output2 of the umbrella project "Indonesia Project of Capacity Development for the Implementation of Agricultural Insurance". In order to strengthen these scheme, continuous activities in future are expected.

- ✓ Collect additional rain post data, evaluate them and add to database.
- ✓ Collect AWS/ARG for dataset for agricultural insurance in future.
- ✓ Develop reanalysis of precipitation map data using GSMaP with AWS/ARG and rain posts.

In recent several years, AWS (Automatic Weather Station) and ARG (Automatic Rain Gauge) network have been developed and the 'Days Without Rain' (Fig. 3-1-20) map is operationally provided on BMKG web site. AWS and ARG observation data are also used for precipitation re-analysis by calibrating GSMaP data with AWS/ARG data.

As mentioned in the previous analysis, if BMKG collects, evaluates reliable data from rain posts and adds the data into a database, these data would make re-analysis precipitation data (map) more reliable and improve indexes for agricultural insurance.

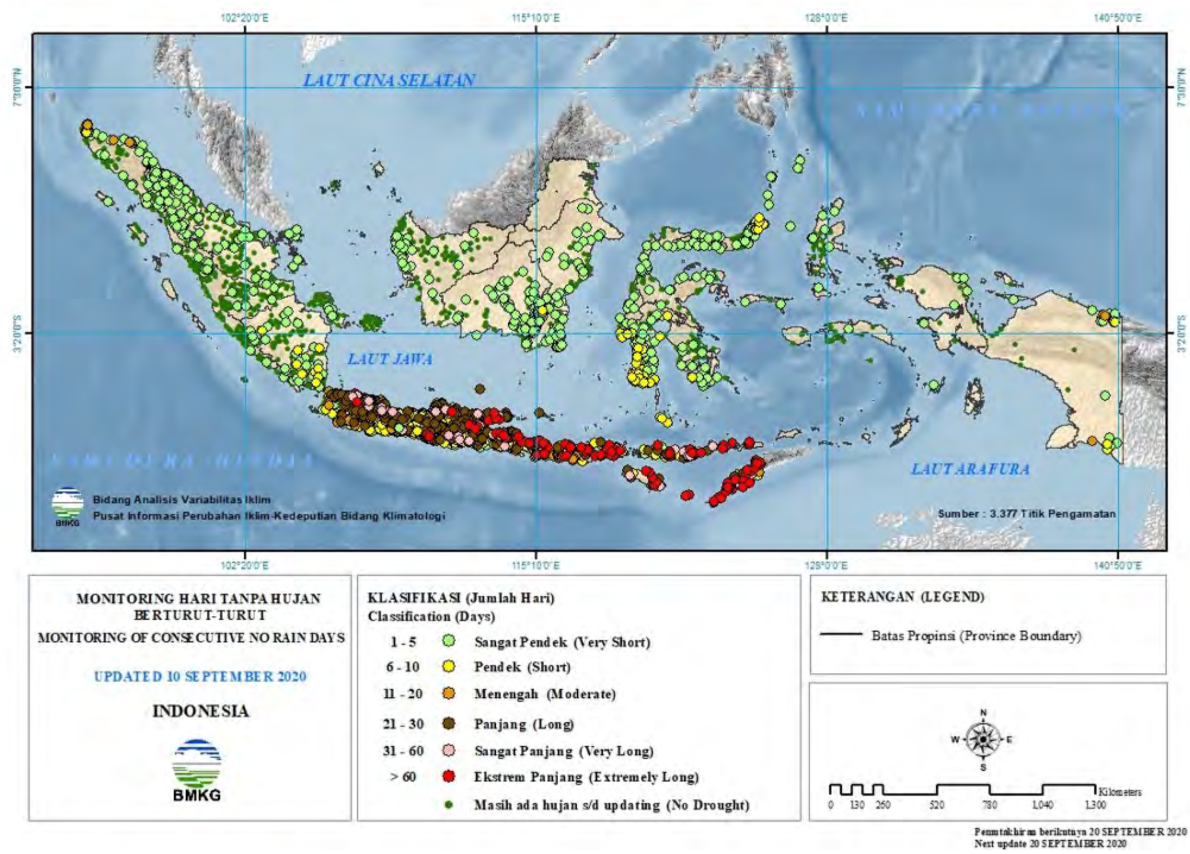


Fig. 3-1-20 Map “Days without Rain” (from BMKG Website)

3.1.5 Contribution to Output 2 and Activity 2-1.

[Output 2: Capacity to analyze, develop and improve agricultural insurance scheme strengthened] for this purpose, rain post data, observatory data were collected and analyzed, and the result was shared between headquarters and East Java and South Sulawesi observatories. In order to evaluate the effectiveness of rain post data for the use of agricultural insurance. Achievements of verifiable indicators are listed in Table 3-1-5.

Table 3-1-5 Achievements of Key Activity 1

Verifiable Indicator		Achievement
2-1	BMKG staff trained.	8 in Climate change section 4 in Climate Variability section At least 4 each in Malang and South Sulawesi observatory
2-2	Meteorological and climate database’s quality improved.	47 rain post data in East Java and 24 rain post data in South Sulawesi were collected and evaluated from 2009 to 2018. GSMaP MVK data was collected from 2005 to 2019/2.

		Data evaluation process for agricultural insurance was developed.

The requirement from insurance companies to BMKG is to share reliable weather information guaranteed by BMKG as the National Meteorological Service. BMKG already established a quality-check system and steadily provided authorized SYNOP observation on a monthly basis.

3.2 Key Activity 2

3.2.1 Outline of Key Activity 2

(1) Climatic Features in Indonesia

Indonesia, which consists of five major islands and more than 13,000 islands, is characterized by variety of climatic features including significant Dry and Wet seasons. Generally, Dry Season is from July/August to October and Wet Season is from October to January/February. However, yearly and regional variations are significant.

Factors affecting weather/climate variability: El Niño Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), SST around the Indonesian regions, Asian-Australian monsoon, and Madden-Julian Oscillation (MJO) which is one of tropical-atmospheric variations are shown below. It is noted that global warming may be elevated to one of crucial factors in Indonesian climate change and variability.

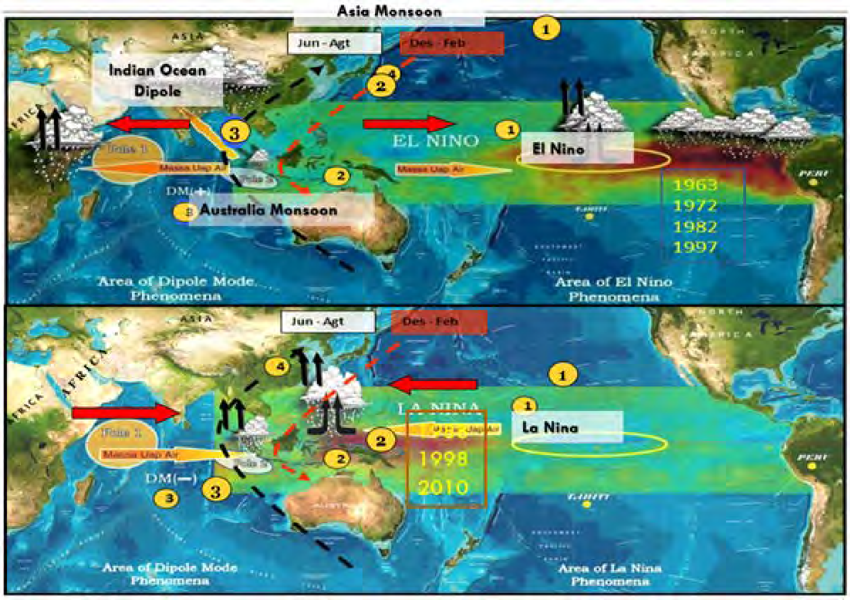


Fig. 3-2-1 Major Climatic Drivers in Indonesia (from BMKG)

As mentioned above, weather/climate features in Indonesia are characterized by many different weather/climates conditions, BMKG therefore settles 342 seasonal zones (ZOM) and 65 non-seasonal zones (Non ZOM) for their seasonal weather forecast. Three major rainfall types and seasonal forecast regions are shown below.

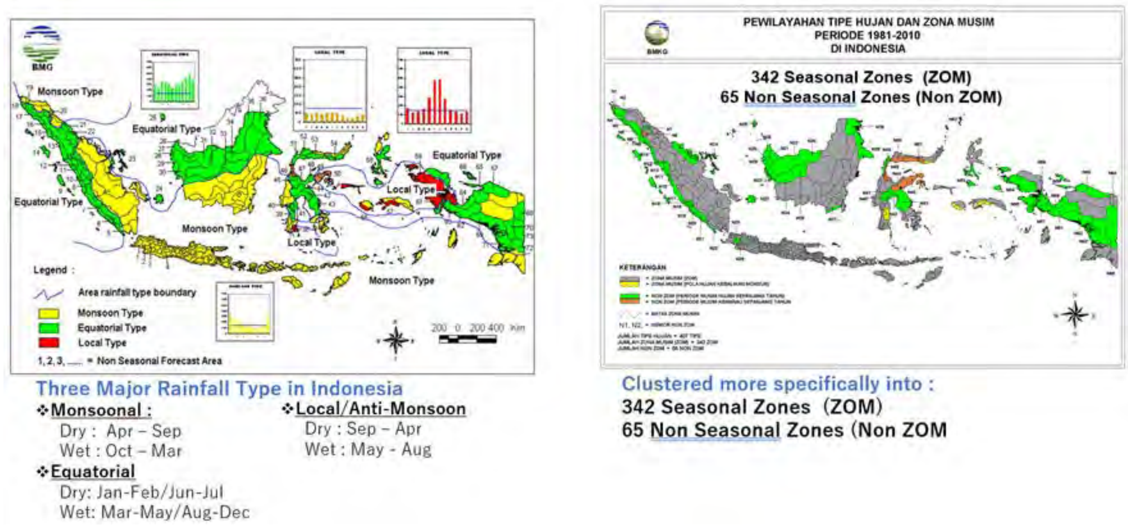


Fig. 3-2-2 Major Rainfall Types and Seasonal Forecast Regions (from BMKG)

(2) Operational Seasonal Forecasts by BMKG

BMKG issues seasonal weather forecasts in 10-day, Monthly and 3-month and Wet season/ Dry season forecast which are based on dynamical ensemble model provided from ECMWF, weather guidance prepared by BMKG and monitoring/diagnosis results of ENSO, IOD, Asian-Australian monsoons, MJO, etc. BMKG also refers to outputs (e.g., ENSO forecasts) of other national weather centers such as CPC/NOAA and TCC/CPD/JMA and applies empirical/statistical approach. Moreover, BMKG has engaged in developing multi model ensemble (MME) methods for seasonal forecast to be introduced for operational forecasting for a couple of years in cooperation with Institute Technology Bandung (ITB).

Meanwhile, regarding producing seasonal forecasts for Dry season/Wet season, several meetings were held to consider and discuss present climate/weather conditions and driving factors affecting weather/climate conditions over Indonesia. An example of time flow for preparing seasonal forecast 2020 is shown below:

Table 3-2-1 Time flow of the Preparation of Dry Season Forecast in the Year 2020

	Preparation of Dry Season Forecast
1	In January, preparation starts within Climate Change Information Center. Each section participates in the preparation.
2	After a draft forecast is prepared by the Climate Center. Preparation within BMKG HQ follows. Explanation/coordination is made among BMKG HQ.
3	In February 25-28 Dry Season Forecast Meeting is held and forecasters from HQ as well as from local centers all over the country attend the meeting to prepare for the dry season forecast in Indonesia. Contents of the dry season forecast are agreed among participants.
4	On March 9 NCOF (National Climate Outlook Forum) is held to explain BMKG draft dry season forecast to receive comments. Amendments are made as appropriate to fix official

	BMKG forecast.
5	In late March, press conference is held to announce the dry season forecast. Deputy director general for climatology oversees the press conference.

One of main users of seasonal weather forecast is planning and managing operations in agricultural sector since weather conditions are one of the important factors in crop productions. Main crops in Indonesia are rice, soybeans and corn. Therefore, BMKG has earnestly provided weather information timely to the government related to agricultural sectors and advice to farmers in 'Climate Field School' directly and constantly.

3.2.2 Issues to be Addressed in Key Activity 2

As mentioned in section 3.2.1, BMKG issues seasonal forecast such as monthly/ 3-month/ half-month/ Dry and Wet season forecast, however users strongly request accurate forecast especially for wet season onset forecast. Forecasts of wet season onset and/or retreat are significantly important for farmers to manage planting crops. On the other hand, in order to improve accuracy of seasonal forecasts, it is quite necessary for BMKG to clearly understand the factors that affect rainfall variability in Dry/Wet season. Moreover, heavy rainfall hazards have been increasing in recent years, therefore demands of weather information for disaster prevention measures become stronger.

Considering these issues, JICA expert decided to tackle tasks below in Key Activity 2:

- Evaluation of seasonal forecast in the pilot regions
- Analysis of features in wet season rainfall and wet season onset
- Study of predictability of heavy rainfall for 1-month ahead
- Evaluation of ENSO forecast which is one of the most important factors for improving seasonal forecast

(1) Main Tasks and Working Group

Working group (WG) for Key Activity 2 was established and BMKG staff were assigned for each task as shown below. Japanese side (JICA experts) worked with them and provided necessary data, information and support to BMKG side.

Table 3-2-2 Main Tasks and Working Group Members

Tasks	Staff
(1) Evaluation of Dry/Wet Season Onset Forecast (2) Case Study on Monsoon Onset/Retreat Variability (3) Case Study on Predictability of Heavy Rainfall up to One Month ahead	Adi* Novi Rosi Damiana
(4) Evaluation of ENSO Forecast for Seasonal Forecast	Supari Amsari Ridha
(5) Exchange of Information with Users	-

* PIC of Key activity 2

(2) Work Plan and Actual Activities

For key activity 2, 4 visits of the JICA expert to Indonesia were planned (March 2019, June-July 2019, February-March 2020, and June-July 2021) during project period from March 2019 to July 2020 as shown below. However, due to COVID-19 problem, the 4th visit was canceled and replaced to the online meetings from April 2020 and emails to continue to exchange information.

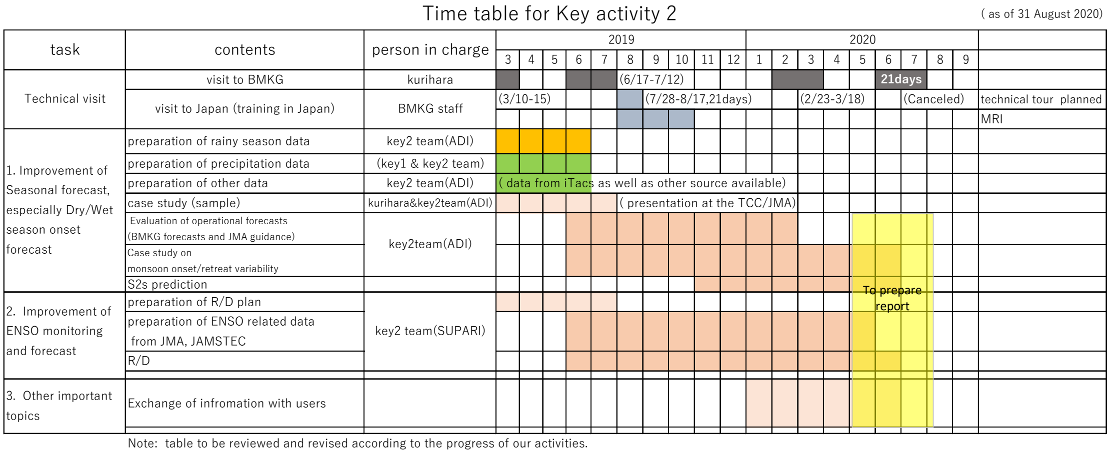


Fig. 3-2-3 Timetable for Key Activity 2

3.2.3 Activities Carried Out in Key Activity 2

As the first step, verification of operational seasonal forecasts was conducted. Then case studies of monsoon variability in the pilot regions (East Java and South Sulawesi) were conducted to understand climatic features of onset/retreat of Dry/Wet season. Thirdly, a study of forecasting of severe weather conditions based on numerical model outputs, Subseasonal to seasonal (S2S) predictions, in Java Island was carried out. Finally, skill of ENSO predictions by JMA and NCEP was evaluated.

(1) Evaluation of Dry/Wet Season Onset Forecast

a) Purpose

BMKG seasonal forecasts (seasonal onset and monthly rainfall probability) were evaluated in pilot regions and main islands in Indonesia. Hit rate of forecasts and climatological forecasts are calculated and compared to evaluate forecast skills. Skill comparison was conducted for 6 BMKG forecasts as shown below (Table 3-2-3). Definition of seasonal onset and retreat by BMKG is shown in Fig. 3-2-4.

Evaluation of JMA 1-month forecast which BMKG uses as one of the forecast guidance materials was also conducted.

Table 3-2-3 Contents of Forecast Evaluation

1	Hit Rate Comparison between Dry Season Onset Forecast issued by BMKG and Climatological Forecast in Indonesia
2	Hit Rate Comparison of Issued Dry Season Onset among 5 Major Islands in Indonesia
3	Hit Rate Comparison between Wet Season Onset Forecast issued by BMKG and Climatological Forecast in Indonesia

4	Hit Rate Comparison of Issued Wet Season Onset among 5 Major Islands in Indonesia
5	Comparison of Hit Rate Estimates for Early Dry and Wet Seasons in ZOM 152 and ZOM 299
6	Hit Rate Probabilistic Forecast for Monthly Rainfall in 2018
7	Evaluation of JMA One-month forecast for 2018

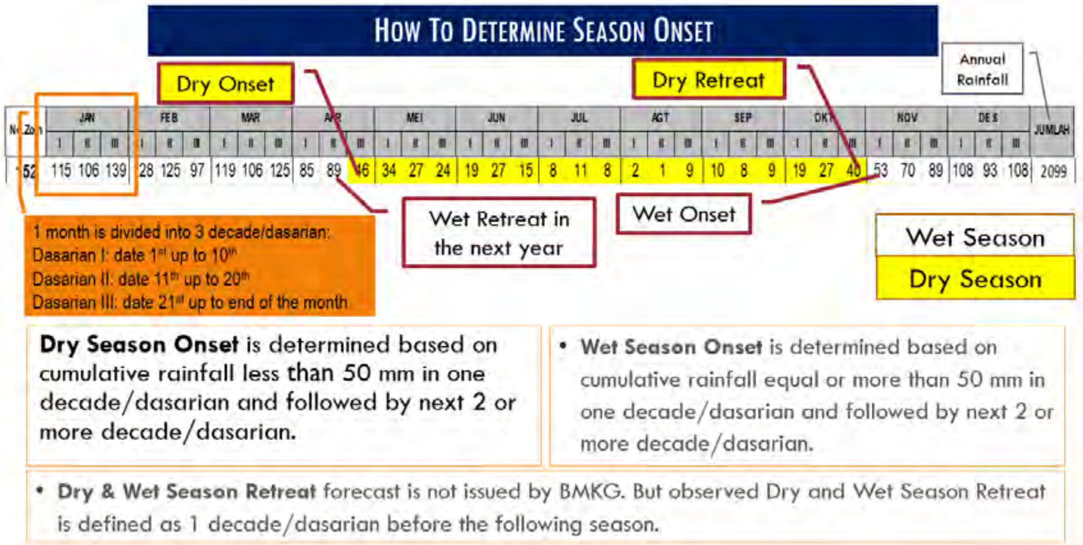


Fig. 3-2-4 Definition of Dry/Wet Season by BMKG

b) Results

① Hit rate of dry season onset (Fig. 3-2-5)

- Hit Rate of Dry Season Onset forecasts in Indonesia are around 30-60%, and the hit rate are irregular between major islands.
- Overall, Dry Season Onset forecasts during 2012-2018 are better than climatological forecast, except 2018.

Fig. 3-2-5 Hit Rate for Dry Season Onset Forecast

② Hit rate of wet season onset (Fig. 3-2-6)

- Hit Rate of Wet Season Onset forecasts in Indonesia are around 20-80%, and the hit rate are irregular between major islands. This variation is larger than the dry season onset.
- Overall, Wet Season Onset forecasts during 2012-2018 are better than climatological forecast, except 2013/2014.

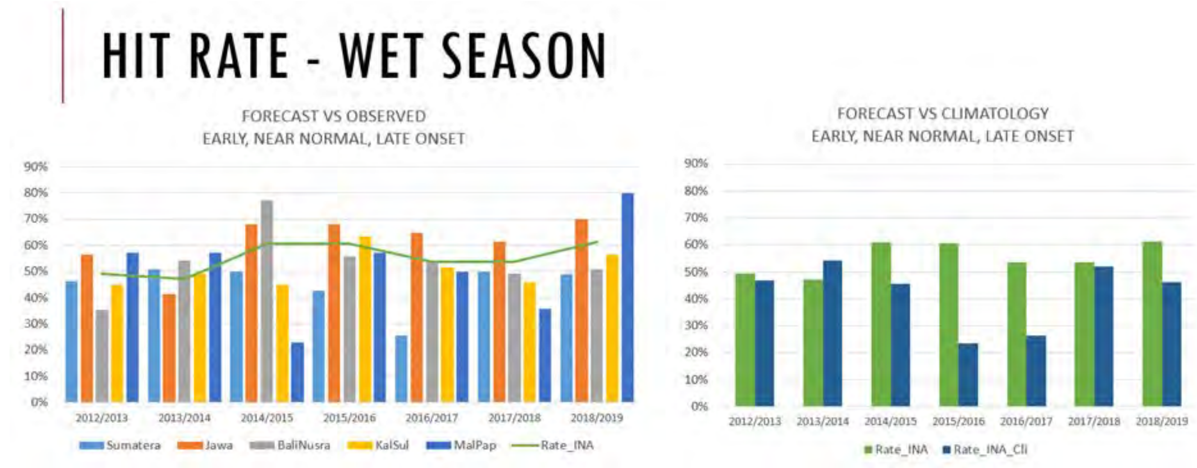


Fig. 3-2-6 Hit Rate for Wet Season Onset

③ Re-forecast for Seasonal Onset in ZOM 152 and ZOM 299 by using 4 statistical forecast methods (Fig. 3-2-7)

- Overall, for both Dry and Wet Season Onset forecasts in ZOM 152 and 299 using ARIMA and WAV_ARIMA are higher hit rate than the forecasts using ANFIS and WAV_ANFIS.
- ARIMA shows the highest Hit Rate of both Dry and Wet Season Onset forecast in ZOM 152.
- WAV_ARIMA shows the highest Hit Rate of both Dry and Wet Season Onset forecast in ZOM 299.

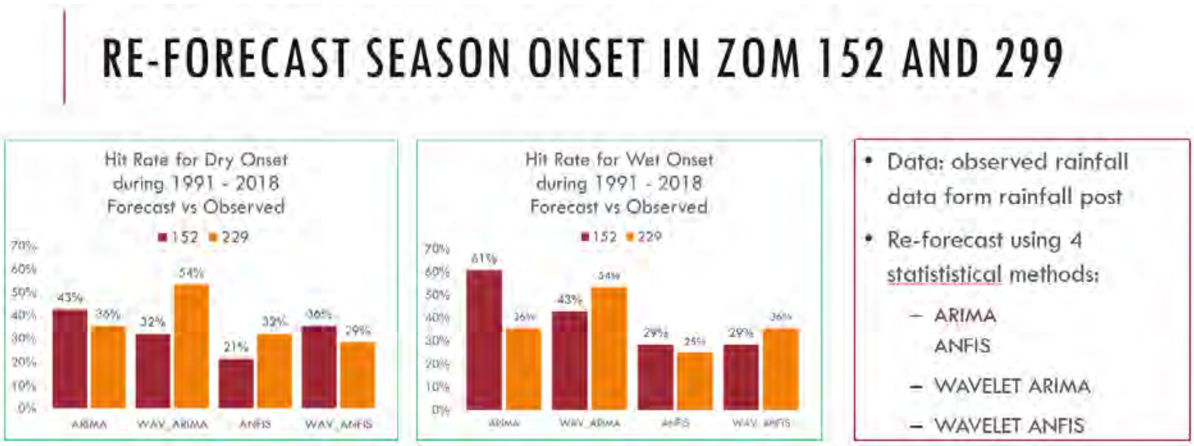


Fig. 3-2-7 Hit Rate for Dry/Wet Season Onset by Statistical Methods

④ Verification on JMA 1-month Forecasts (Fig. 3-2-8)

JMA one-month forecast data is used as one of forecast guidance in BMKG. JMA forecasts for the period from February 2018 to January 2019 was verified.

- Spatially, forecasts in parts of Sumatra well match observation during March - April 2018 and December 2018 - January 2019.
- For the Java during February 2018 and April 2018, forecast in whole Java regions harmonize with observation in these months.
- Most of Kalimantan well match during April - May 2018, October 2018, and January 2019, and for Bali and West Nusa Tenggara match only in January 2019.

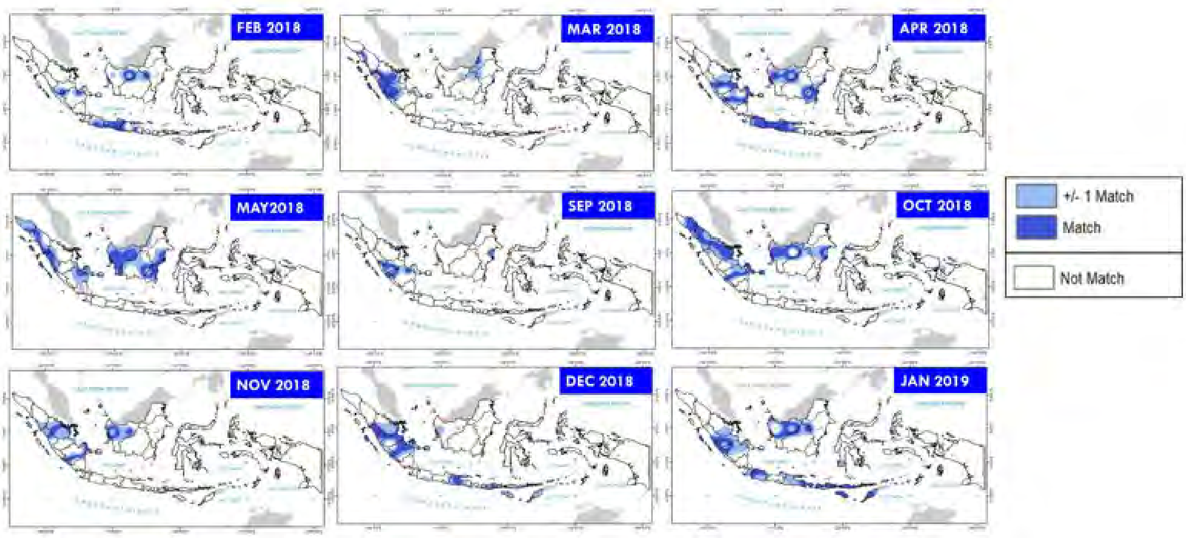


Fig. 3-2-8 Verification JMA One Month Forecast in 2018

*Areas where forecast matches observed category are indicated by blue and light blue.

Summary of the evaluations is as follows:

- Generally, dry and wet season onset forecasts in 342 Seasonal Zones in Indonesia that has been issued by BMKG since 2012 was better than the climatological forecast, except dry season in 2018 and wet season in 2013/2014. Generally, wet season onset forecast had higher hit rate and skill than dry season onset forecast. This means wet season onset forecast is better than dry season onset forecast.
- Among 4 statistical methods (ARIMA, WAVELET ARIMA, ANFIS, and WAVELET ANFIS) dry and wet season onset forecast in ZOM 152 was the best with ARIMA, while ZOM 299 was the best with WAVELET ARIMA.
- Verification of probabilistic forecast for monthly rainfall in 2018 showed no significant difference between the lag-6 and the lag-0 forecasts. Probabilistic forecasts for categories: less than 100mm/month, less than 150 mm/month, and more than 200 mm/month tended to be relatively good in hit rate. Hit rate of the probabilistic forecasts in 2018 for less than 100 mm/month and less than 150 mm/month tended to drop around June – August 2018, while the rate for more than 200 mm/month was peaked in the same season.

- Overall, JMA 1-month forecasts in western part Indonesia matching rate was less than 60%. The highest of matching with forecasts was in December 2018, while the lowest was in September 2018. During forecast from Feb 2018 until Jan 2019 generally matched forecast in middle part of Sumatra and west part of Kalimantan. Meanwhile the matching in other regions were limited in specific months.

c) Achievement

- Present skills for seasonal forecasting, especially that for Dry and Wet season forecast were obtained.
- It was found that generally wet season onset forecast had higher hit rate and skill than dry season onset forecast. This means wet season onset forecast was more reliable than dry season onset forecast.
- It was found that ARIMA and WAVELET ARIMA showed the best skills among 4 statistical models for dry and wet season onset forecasts for ZOM152 and ZOM299, respectively.

d) Future Task

- To enhance seasonal forecast ability and continue improving seasonal forecasts, it is important to monitor forecast skills continuously. Thus, it is necessary to continue evaluation of operational forecasts, which will provide useful information for improving operational forecasts.
- From this study, it was found that season onset forecast skill is better than the climatology but still needed farther improvement.

(2) Case Study on Monsoon Onset/Retreat (Offset) Variability

a) Purpose

To understand monsoon onset/retreat variability, statistical analysis of monsoon variability was conducted in two pilot areas: ZOM152 in East Java and ZOM299 in South Sulawesi. The historical 10-day (dasarian) rainfall data for the period from 1981 to the present for these ZOMs were collected to identify onset/retreat of Dry/Wet season for each year. This identification is based on a definition of monsoon onset/offset by BMKG (Fig. 3-2-4).

Basic statistics calculated for studying climatic features in the ZOMs are:

- Climate normal (average of 30 years;1981 to 2010) for 10day/Monthly/Dry season/Wet season rainfall (Fig. 3-2-9 for monthly rainfall).
- Climate normal for onset/offset of Dry/Wet season as well as period of Dry/West season.
- Years involving certain features were selected, such as:
  - ✓ Years that have significantly early/late onset/offset of Dry/Wet season
  - ✓ Years that have significantly small/large precipitation during Dry/Wet season

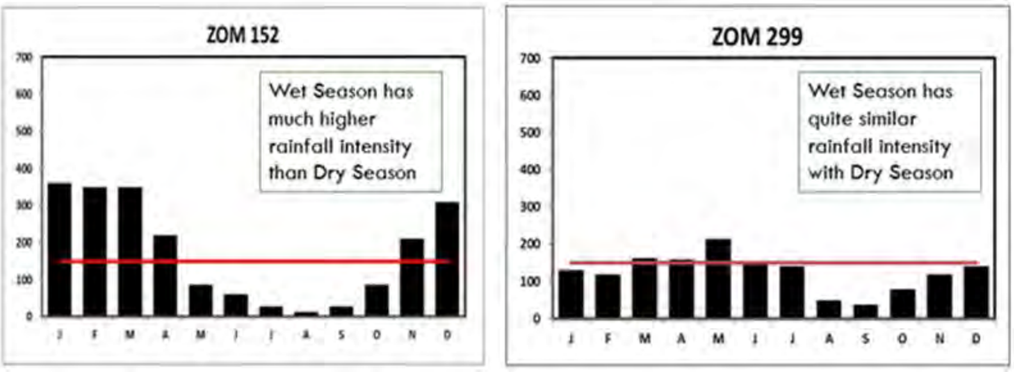


Fig. 3-2-9 Average Monthly Rainfall Amount and Period of Dry/Wet Season for ZOM152 and ZOM299

b) Results

① ZONE 152 (East Java)

- Onset Variation during 1981-2019 for both dry and wet season is not too large (around -/+ 1 month from its normal)
- Mode of Dry Season Onset during 1981-2019 is same as Normal (Apr III)
- Mode of Wet Season Onset during 1981-2019 is 1 dasarian later (Nov II) than the Normal (Nov I)
- Large rainfall fluctuation makes identification of the onset easy
- It is not statistically meaningful that cumulative rainfall trends decreasing in both season
- ENSO clearly affects seasonal cumulative rainfall rather than Indonesian SST and IOD. La Niña leads small rainfall in dry season, and La Niña and warm Indonesian SST simultaneously lead large rainfall in wet season. Meanwhile, warm Niño 3.4 SST leads small rainfall in wet season.

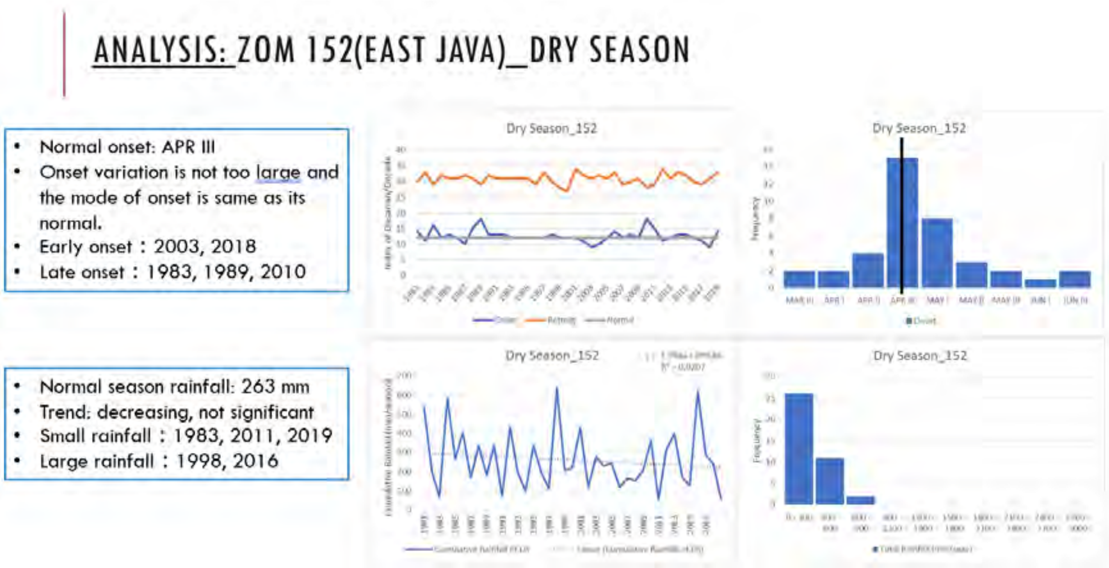


Fig. 3-2-10 Analysis of Dry Season Onset/Retreat Variability for ZOM152

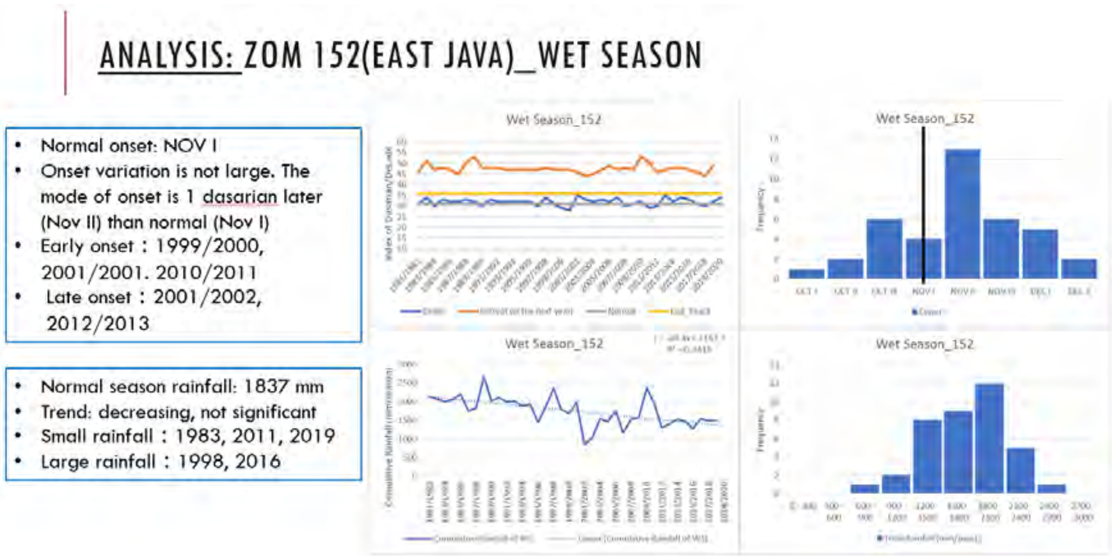


Fig. 3-2-11 Analysis of Wet Season Onset/Retreat Variability for ZOM152

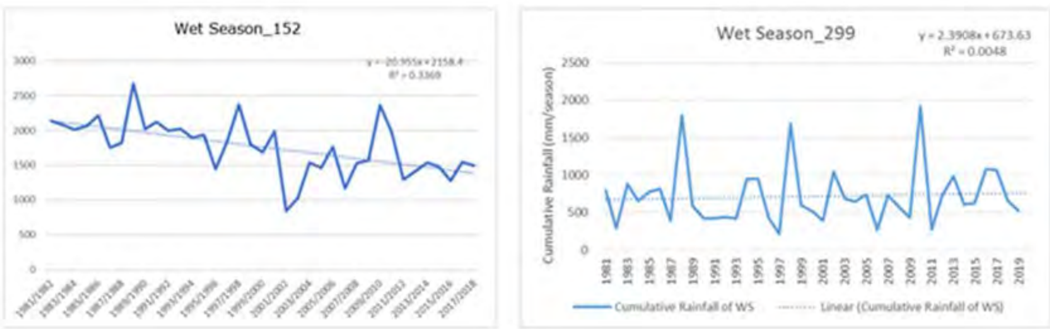


Fig. 3-2-12 Time Series of Wet Season Total Rainfall Amount and Trend
(Left: ZOM152, Right: ZOM299)

② ZONE 299 (SOUTH SULAWESI)

- Onset Variation during 1981-2019 for both dry and wet season is exceptionally large (up to -/+3 month from the normal).
- Mode of Dry Season Onset during 1981-2019 (Jul II) is 1 month later than the Normal (Jun III)
- Mode of Wet Season Onset during 1981-2019 (Mar II) is same as the Normal (Mar II)
- Small gaps of the rainfall fluctuation against the threshold makes it difficult to determine the onset
- Insignificant decreasing trend in dry season cumulative rainfall and increasing trend in wet season cumulative rainfall are identified, these however are not statistically meaningful.
- ENSO has more clear influence on seasonal cumulative rainfall than Indonesian SST and IOD. El Niño leads small rainfall in both dry and wet season, while La Niña leads large rainfall in wet season.

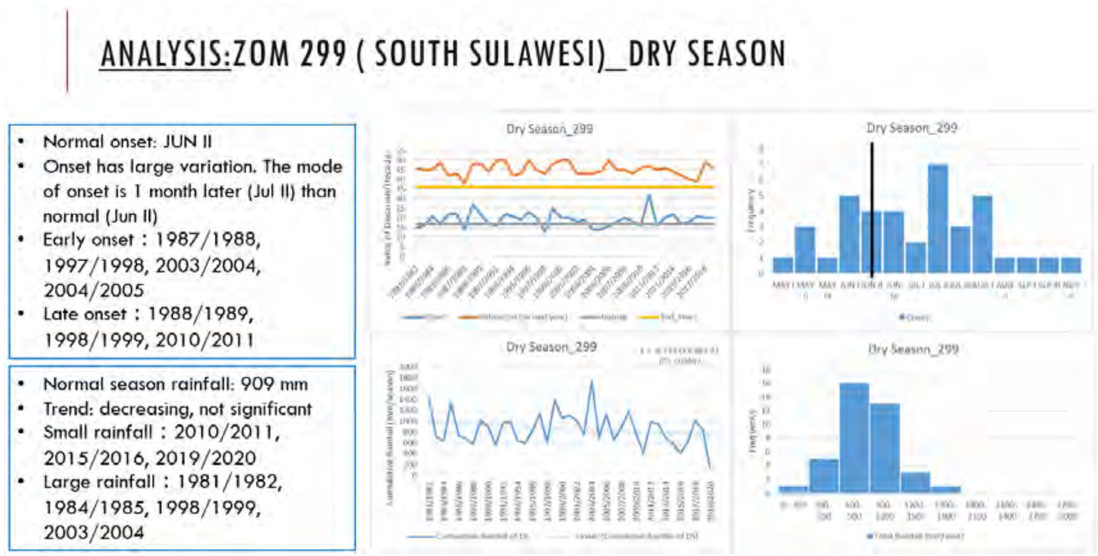


Fig. 3-2-13 Analysis of <u>Dry Season</u> Onset/Retreat Variability for ZOM299

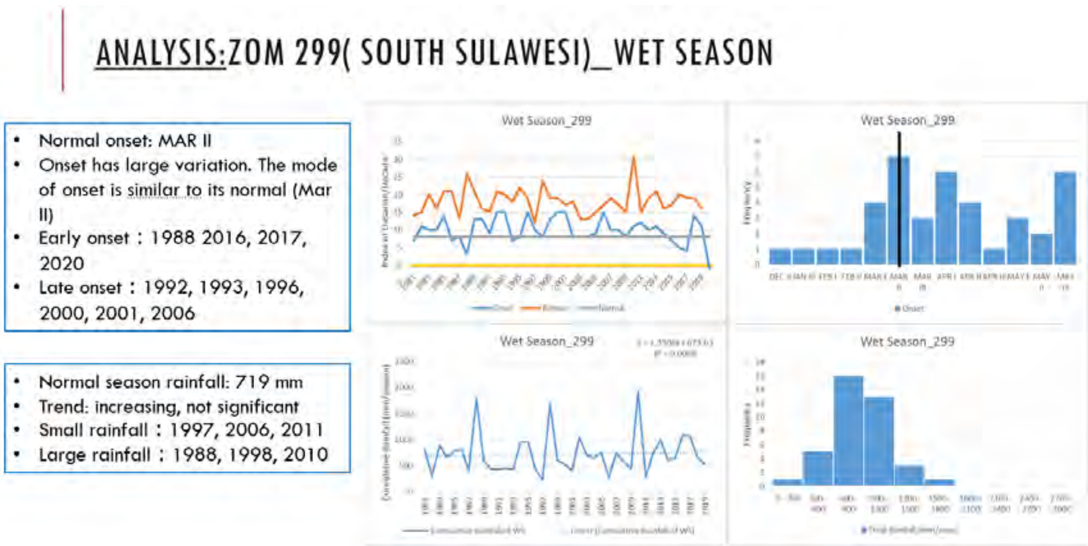


Fig. 3-2-14 Analysis of <u>Wet Season</u> Onset/Retreat Variability for ZOM299

c) Achievement

- The study clarified features of seasonal onset/retreat variability in the pilot regions. These results were highly appreciated within BMKG climate centers, since BMKG is developing new normal (30-year average from 1991 to 2020) that is to be officially used from the year 2021 for 10 years, therefore, features of onset/retreat variability are thought as one of the important information. A member of Key activity 2 WG was invited and could give a presentation on this topic at the National forecast meeting for 2020/21 rainy season, where officials representing regional BMKG centers attended. These studies are encouraged to be conducted in other regions.
- It was re-confirmed that ENSO and other factors were strongly associated with monsoon variability in the pilot regions. Moreover, it became evident that ENSO clearly affects more than other factors.

d) Future Task

- Regarding case studies of monsoon variability, conducted study had been limited to 2 pilot areas. However, other areas and islands are still remaining to be studied. It is expected that the same kind of studies should be conducted in other major islands or regions in the future project.
- Moreover, it is also necessary that factors affecting the monsoon variability should be studied further, especially, impacts of ENSO, IOD and other factors to atmospheric circulation and climate variability around Indonesian region.
- In the study conducted in the project, considered parameters in atmosphere-ocean were SST deviation, ENSO and IOD. There are other various parameters that should be studied further in the season where those three parameters do not have clear influence on seasonal variability. Therefore, role of other parameters should also be studied.

(3) Case Study on Predictability of Heavy Rainfall up to One Month Ahead

a) Purpose

BMKG uses ECMWF S2S(Subseasonal to seasonal) product in their operation for dekad (10day) forecasts and for Climate Early Warning against drought and severe rainfall potential, while medium range forecasts still lack research/development. In this project, predictability of heavy rainfall up to one month ahead was studied by using S2S products. Java Island was chosen for this study because natural disasters such as flood, drought or landslides are quite common and many people fall victim to the disasters. Satellite blending rainfall data (GSMaP) and rain post data were used to produce dekad rainfall data (10days) in this study. S2S ECMWF reforecast data model output with a resolution of 1.50*1.50 and containing 11 members were also used.

b) Results

- ECMWF S2S model can estimate the potential for high rainfall in LT1 or 1 dekad before the target dekad and show the potential for high rainfall in LT2, especially in Central Java. However, LT3 will not indicate the potential for high rainfall in Java region.
- By using the average of grid points in Java region at extreme events, it was found that fluctuation of rainfall by LT1 forecast shows a similar fluctuation pattern to the observation pattern.
- It is found that the longer the leadtime of prediction, the smaller the correlation. This shows that the closer to the initial condition of predictions with the target dekad, the better the prediction ECMWF model and vice versa.

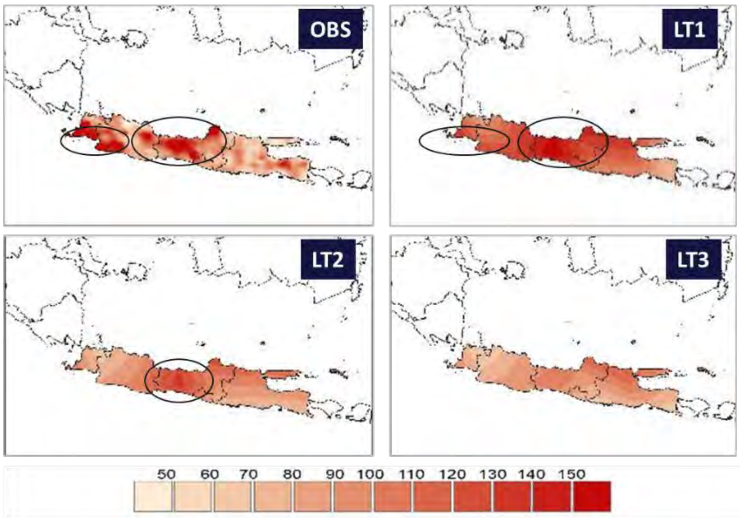


Fig. 3-2-15 Comparison of Rainfall Observation (OBS)
and Forecasted Rainfall with Different Leadtime (LT1, LT2, and LT3)

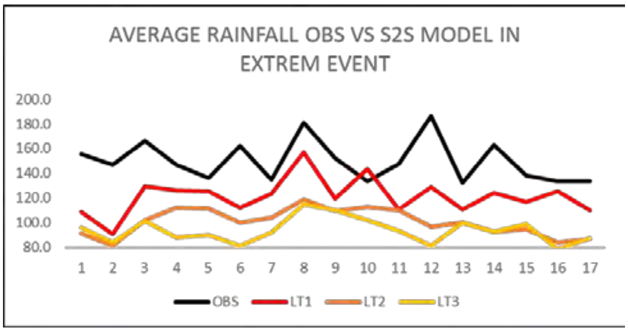


Fig. 3-2-16 Average Rainfall Observation and S2S Model in Extreme Event

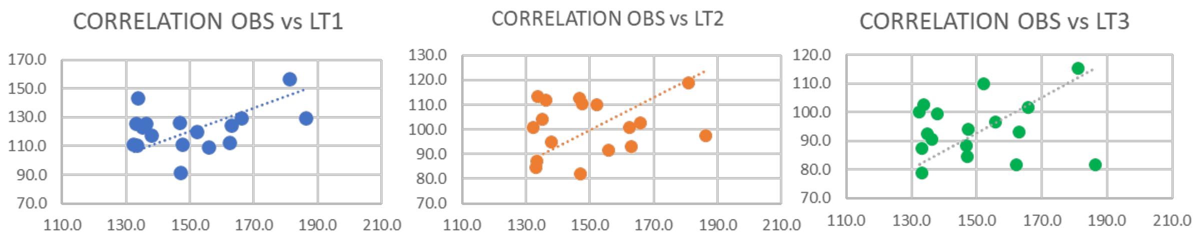


Fig. 3-2-17 Correlation between Observed Rainfall (OBS)
and Forecasted Rainfall with Different Leadtime (LT1, LT2, and LT3)

c) Achievement

- This study suggested that S2S prediction information is useful to make forecasts of possible occurrence of severe weather better.

d) Future Task

- Better forecast severe weather conditions is presently highly demanded for disaster prevention due to recurrence of severe weather-related hazard in Indonesia and all over the world under the changing global climate conditions. Studies of S2S prediction based on advanced numerical prediction systems should be continued providing better weather and climate information for disaster prevention.

- This study is expected to examine conditions of interaction between atmosphere and the ocean and physical processes driving MJO. Understanding the process, especially the processes involved in the propagation of MJO on the maritime continent, the key to improving the prediction system can be provided. Therefore, it is necessary to study reliability of predictions on the S2S time scale at the time of extreme events associated with MJO.

(4) Evaluation of ENSO Forecasts for Seasonal Forecasts

a) Purpose

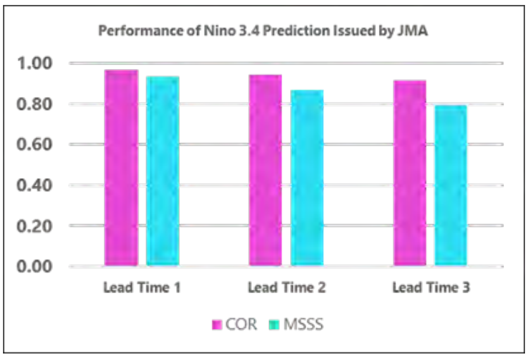
Since Indonesian climate is strongly affected by ENSO, information of the ENSO is especially important. BMKG developed an ENSO forecast statistical model using Singular Spectrum Analysis (SSA), this model however still needs to be improved. Therefore, whenever BMKG releases the ENSO prediction, BMKG has combined it with other ENSO predictions issued by some international climate centers, such as JMA, JAMSTEC, NOAA, etc. However, verification of ENSO predictions from these institutions has not been carried out due to limitation to access forecast archive.

Objective of this study is to examine the skill of ENSO predictions issued by JMA and NCEP since those products are used regularly in BMKG as a reference to monitor/forecast ENSO events.

As recommended by WMO, the technique of Standardized Verification System (SVS) for Long-Range Forecast was applied for this study.

b) Results

- ENSO Prediction issued by JMA and NCEP CFSV2 have good skills on forecasting 1 to 3 months ahead indicated by high correlation coefficient and positive value of MSSS score.
- However, the skill of both JMA and NCEP CFSV2 products are reduced for May- August period. This suggests that careful interpretation is needed for ENSO forecasts issued on the period.



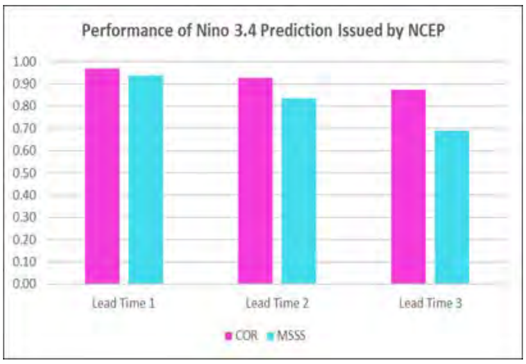


Fig. 3-2-18 Performance of ENSO Prediction Method by JMA(Left) and NCEP(Right)

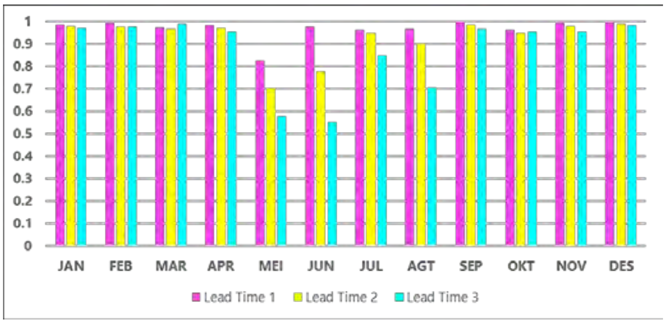


Fig. 3-2-19 Performance of Nino 3.4 Prediction Issued by JMA using Correlation Method

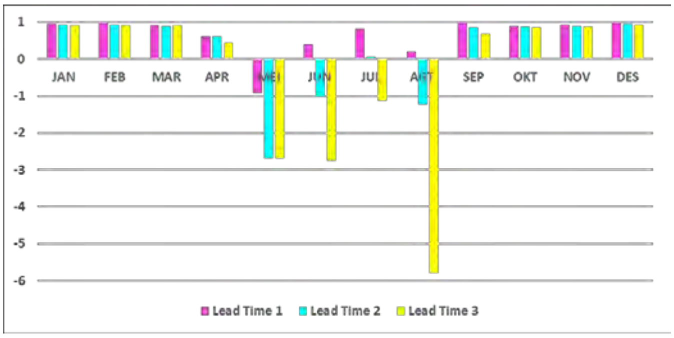


Fig. 3-2-20 Performance of Nino 3.4 Prediction Issued by JMA using MSSS Method

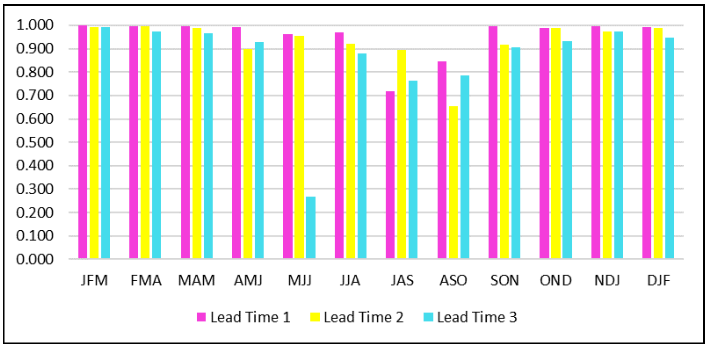


Fig. 3-2-21 Performance of Nino 3.4 Prediction Issued by NCEP using Correlation Method

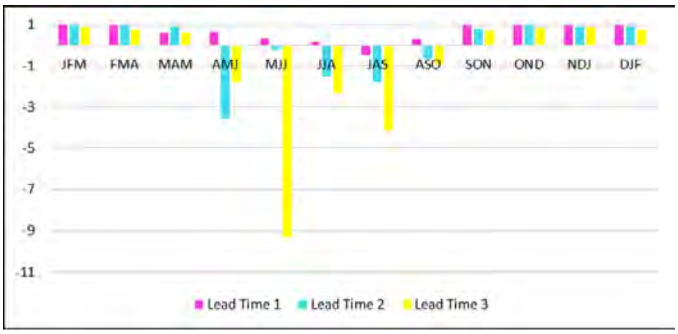


Fig. 3-2-22 Performance of Nino 3.4 Prediction Issued by NCEP using MSSS Method

c) Achievement

- Evaluation of the ENSO forecast by JMA and NCEP was newly carried out. It was found both

ENSO Prediction issued by JMA and NCEP had good skills on forecasting 1 to 3 months ahead.

- On the other hand, as the skills of both JMA and NCEP products decreased for May- August period, careful interpretation is needed for ENSO forecasts for the period mentioned above.

d) Future Task

- Forecasts and information of ENSO, which is known to be one of the main driving forces on the weather and climate in Indonesian regions, are presently effectively used for agricultural management in Indonesia, therefore the better forecasts are highly demanded. Further studies are needed for better information of ENSO monitoring/forecast.
- Indonesian climate is also strongly driven by IOD (Indian Ocean Dipole). Information on the IOD status during the upcoming months is crucial for the government sectors and the public to design their activity plans, moreover, the precise information on the IOD status will enable them to design a suitable policy and plans. In this context, knowledge on the skill of IOD forecasts is essentially required. In the next project, it is hoped that the skill of IOD predictions issued by JMA is examined since this product is used regularly by BMKG as a reference on monitoring IOD event.

(5) Exchange of Information with Users

a) Activities and Results

A meeting with JICA expert for key activity 2 and one of the government agricultural sectors (Agro-climate and Hydrology Research Institute (Balitklimat)) was held in Bogor for information exchange. The purpose of the meeting was to learn what kind of information and how to receive, and how to provide agricultural operation/guidance to farmers and to hear their requests for the information. Since there were no special requests for weather information from agriculture side, JICA expert felt that present cooperation between BMKG and agricultural sector was remarkably close and effective.

Regarding seasonal forecasts such as Dry/Wet season forecasts, BMKG’s information has been provided timely to agricultural side since the information is particularly important and useful for rice farming and other crops cultivation management. One of the examples of good collaboration is that a draft of seasonal forecasts is shared among the agriculture sector for preparing agricultural guidance for farmers. This indicates agriculture side is able to use plenty of time for preparing their guidance information to farmers.

An example of the importance of BMKG’s information is, when BMKG informed onset of an ENSO event, the agriculture sectors would change their agriculture guidance to farmers according to updated weather forecast information.

One of the goals forecast producers pursue is to produce ‘User-oriented forecasts’, namely, to provide users useful information in a timely manner. For this purpose, BMKG, producer of the information, needs to learn what kind of information is required for agriculture. Moreover, BMKG must provide users with information of the forecast quality to be used properly. It is emphasized that as weather information has certain errors, appropriate use is highly recommended. Users are also encouraged to appropriately understand contents of weather forecast information including its quality.

Therefore, exchange of views on the weather forecasts and information between BMKG and agricultural sectors was planned during the latter period of the project, however, due to COVID-19 issues, meeting with users could not be held.

b) Achievement

- Hearing session with one of the government agriculture sectors was conducted and it was found that weather information such as seasonal forecasts was well utilized and cooperation between BMKG and users had been maintained properly.
- Meetings with some other users could not be held during the project period.

c) Future Task

- It is much desirable to provide timely weather information according to various agricultural user's needs and requests. BMKG should continuously make efforts to grasp user-needs and improve the weather information through exchange of information with users.

3.2.4 Achievement of Key Activity 2

Evaluation of seasonal forecasts and ENSO forecasts and studies of dry/wet season variability and heavy rainfall productivity were conducted through Key Activity 2 activities. Achievements of these activities are summarized as follows:

- Seasonal forecasts have higher skills than climate forecasts. This indicates that the forecasts are useful for farmers who use agricultural insurance.
- Features of wet season onset and wet season rainfall amount variability in the pilot regions were clarified. These results are expected to lead to improve weather information for farmers.
- It was suggested that 1-month forecasts are applicable to predict heavy rainfall in a certain area. Further studies/developments are expected to produce weather information used for agricultural disaster prevention.
- It was found that ENSO forecasts issued by JMA and NCEP had good skills for 3 months ahead. This result is expected to lead to improve weather information for farmers.

Meetings and seminars, and documents concerning Key Activity 2 are listed in Appendix-C.

3.2.5 Contribution to Output 2 and Activity 2-1.

[Output 2: Capacity to analyze, develop and improve agricultural insurance scheme strengthened], [2-1. Conduct assessment of meteorological observation and climate/disaster risk data, communicate the results and recommendations for capacity development, as well as relevant training for capacity building in order for such data to be utilized for insurance implementation/development incl. weather-index based insurance.] was strengthened through evaluation of seasonal forecasts and ENSO forecasts and studies of dry/wet season variability and heavy rainfall predictability that were conducted in Key Activity 2 activities. Achievements of verifiable indicators are listed in Table 3-2-4.

Table 3-2-4 Achievements of Key Activity 2

Verifiable Indicator		Achievement
2-1	BMKG staff trained.	8 staff in Climate change section 4 staff in Climate Variability section
2-2	Meteorological and climate database's quality improved.	Synoptic rain dataset for ZOM152 and ZOM299 produced Seasonal forecast skill found better than climatological forecast Monsoon variability clarified ENSO forecast skill found good for certain period

Key Activity 2 working group was engaged in 'Developing weather information and enhancing abilities' and had certain achievements as mentioned in sections 3.2.3. and 3.2.4. To Produce/provide better weather information based on the achievements, following activities are needed to be conducted/continued:

- Present study showed that seasonal forecasts such as wet season onset forecast has a better skill than climatological forecasts. For improving forecast skills, evaluation of seasonal forecasts and study on wet season rainfall variability are needed to be continued. The present study was conducted in 2 pilot regions, however, it is recommended that these studies should also be expanded into whole Indonesia.
- Study of predicting heavy rainfall up to 1 month ahead suggested that it is applicable in certain areas. Request for the information for significant events such as heavy rainfall for several weeks ahead becomes high in recent years. The study therefore should be continued to obtain a lot of case results toward operational production of these information.
- It was found that ENSO forecasts contribute for 3-month ahead forecasts. On the other hand, forecasts of IOD is also important for seasonal forecasts for the climate in Indonesia. Therefore, it is much expected to conduct evaluation of IOD forecasts.
- Finally, it should be emphasized that timely provision of weather information according to demands/requests from users such as agricultural sectors should be continued. It is advised that BMKG should continue to exchange information with users in order to continue improving, producing, and providing 'user-oriented weather information'.

3.3 Key Activity 3

3.3.1 Outline of Key Activity 3

In order to continue and manage agricultural insurance automatically, it is necessary to evaluate long-term meteorological risks. The long-term climate change data were developed during a project implemented by JICA from 2010 to 2015 and 20km resolution climate prediction data were shared among regional climate offices of BMKG.

3.3.2 Issues to be addressed in Key Activity 3

BMKG implemented dynamical downscaling of GCM data in JICA Phase 1 or in CORDEX project and the downscaled data are listed in Table 3-3-1. The resolution of these downscaled data is 20 to 25km and higher resolution data (for example 5km) that cover whole Indonesia was required by other agencies for future planning.

Table 3-3-1 Dynamical Downscaling BMKG Implemented

Area	Resolution	Model (GCM, Downscaling, Senario)	Period	Factor
Java	4km	GCM MIROC5, RCM WRF, RCP 4.5	2032-2040 and 2006-2014	Precipitation and temperature
Sulawesi	4km	GCM MIROC5, RCM WRF, RCP 4.5	2032-2040 and 2006-2014	Precipitation and temperature
Whole Indonesia	20km	GCM MIROC5, RCM WRF, RCP 4.5	2006-2040	Precipitation, temperature, relative humidity, wind
CORDEC-SEA	25km	6 GCM(s), RCM, RegCM (NCAR ver.4), RCP 4.5 & 8.5		Maximum, minimum and average temperature

JMBSC research center implemented 'Theme C: Integrated Climate Change Model' of 'Integrated Research Program for Advancing Climate Models (TOUGOU) and supported downscaling to 5km resolution from AGCM data. BMKG and JICA expert agreed that 2 researchers would implement the downscaling using MRI-HPC for 2.5 months on the condition that MRI or JMBSC could invite BMKG researchers in 2019.

For utilization of downscaled data, WG3 agreed that the project would exercise courses, including comparison of GCM prediction data between present and future, visualization and evaluation of GCM data in Japan (MRI) and after the training, BMKG trainees would bring these materials and knowledge back to BMKG and share them through seminars to BMKG.

3.3.3 Activities carried out in Key Activity 3

MRI invited 2 BMKG staff members to implement dynamical downscaling of MRI-AGCM (Atmospheric Global Climate Model) for present (1981 to 2000) and future (2081 to 2100). BMKG nominated the following 2 staff members,

- Ari Kurniadi (Mr.)
- Apriana Rizqi Fauziyah (Ms.)

The implemented dynamical downscaling in 5 km resolution covers whole Indonesia from end of

August to November.

[Historical Periods]

- Run completed (in ES-Earth Simulator): 1981 - 1992
- Transferred (in MRI system): 1981-1990
- Copied (in our HDD): 1981-1989

[Future]

- Run completed (in ES): 2079-2089,
- Transferred (in MRI): 2079-2089
- Copied (in our HDD): 2079-2087
- Run failed: 2086

And they brought back 3 HDD (@12TB) and 2 HDD (@5TB) to Indonesia with results of calculation in December 2019 and remaining HDDs (7 HDDs) are kept in MRI for next year's downscaling activities.

For activities in 2020, Dr. Sasaki of MRI planned to invite 3 more researchers from BMKG, 2 staffs will conduct the rest 10-year period historical runs and 10-year future runs in 5 km resolution and 1 more researcher to downscale at a finer resolution of 2 km for certain regions, not whole Indonesia.

However, due to COVID19 pandemic, the project could not invite BMKG researchers to Japan. Therefore, WG3 discussed for the alternative plan for dynamical downscaling and agreed the JICA experts for dynamical downscaling would implement the remaining downscaling on behalf of BMKG researchers while exchanging information and result on the internet. The downscaled data for the remaining years will be shared with BMKG by the end of FY2020.

A list of meetings and data regarding Key Activity 3 is attached as Appendix C.

[Results of Dynamical Downscaling]

WG3 member compared average temperature and precipitation for the present (1981 to 2000) and the future (2081 to 2100) at the nearest grid point to Jakarta. The monthly temperature increased 2 to 3 degree Celsius mainly in the dry season (June to October) and monthly precipitation decreased mainly in the rainy season. 30% decrease of precipitation for a few months in the rainy season was analyzed and the result is same as the future projection in Phase 1 project (2010 to 2015).

The activity report in MRI is attached in Appendix D.

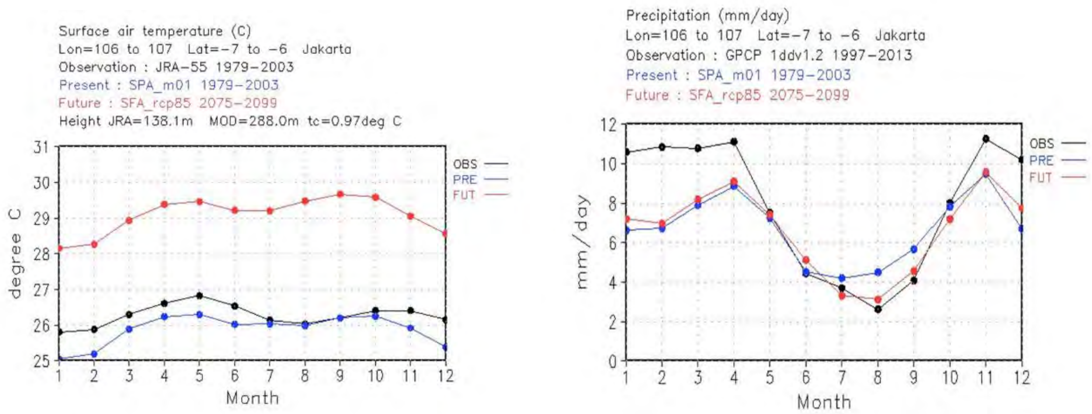


Fig. 3-3-1 Comparison of Temperature and Precipitation (Present and Future, Jakarta)

[Comparison of Downscaled Data]

As part of 'Training in Japan', 6 trainees studied in MRI software packages and their usage for dynamically downscaled data, which were developed for use in local governmental organizations or laboratories in Japan. The trainees analyzed difference (trend) of temperature and precipitation between the present and the future for main Indonesian islands using 20km resolution GCM data. The results of analysis in the pilot areas (Java and Sulawesi islands) are attached in Appendix D.

3.3.4 Achievement of Key Activity 3

In the original plan for dynamical downscaling for Indonesia in 5km resolution, 20-year downscaling for Present (1981-2000) and another 20-year downscaling for Future (2081-2100) had been calculated in 2019. However, as Indonesia covers a vast area and it took longer computing time than that had been previously planned and only half of downscaling had finished. MRI wants to continue co-researching with BMKG for dynamical downscaling that covers Indonesia and remaining 10-year periods for Present and for Future. Downscaling would be prepared in 2020 as co-operative research by 3 BMKG researchers and MRI.

However, due to COVID19 pandemic, the project could not invite BMKG researchers to Japan. WG3 discussed for the alternative plan for dynamical downscaling and agreed the JICA expert for dynamical downscaling would implement remaining downscaling on behalf of BMKG researchers while exchanging information and results on the internet. The downscaled data for remaining years would be shared with BMKG by the end of FY2020.

3.3.5 Contribution to Output 2 and Activity 2-1.

[Output 2: Capacity to analyze, develop and improve agricultural insurance scheme strengthened] was strengthen through knowledge for impacts by climate change projection downscaling and evaluation and these knowledge encourages i) understanding trend of precipitation, duration of rainy season and its onset and ii) strengthening analysis ability for climate projection and long-range forecasting. Achievement of verifiable indicators are listed in Table 3-3-2.

Table 3-3-2 Achievement of Key Activity 3

Verifiable Indicator		Achievement
2-1	BMKG staff trained.	2 BMKG researchers learned dynamical downscaling and results/knowledge were shared.
2-2	Meteorological and climate database's quality improved.	5km resolution dynamically downscaled data for 20 years (10 years for [Present] and 10 years for [future]) were added.

3.4 Training in Japan (August 2019)

Training in Japan that targets agricultural insurance, JMA analysis/forecast data usage, downscaled AGCM data usage, discussion for GSMaP data, JAMSTEC long-range SST forecast and so on were implemented in August 2019. The report of the training was implemented in 19 of December 2019 and reports were attached as Appendix B.

[Title of the Training]

PROJECT OF CAPACITY DEVELOPMENT FOR THE IMPLEMENTATION OF AGRICULTURAL INSURANCE IN THE REPUBLIC OF INDONESIA

[TRAININIG IN JAPAN FOR ENHANCING ABILITIES FOR METEOROLOGICAL/CLIMATOROLOGICAL DATA USAGA]

[Outline of the Training]

a) Period: 28th of July (Sun.) to 17th of August (Sat.), 2019
b) Number of trainees: 6
c) Counterpart organization of the Japanese side: Japan Meteorological Business Support Center
d) Language: English

Table 3-4-1 Training Schedule

No.	Date			training schedule BMKG trainees (6 persons)	institute	trainig site	lector	accommodation
1	28-Jul	sun		travel [Jakarta to Narita]				
2	29-Jul	mon		Arrive at Narita, JICA breefing	JICA	JICA		JICA Tokyo
			PM	Orientation	JMBSC	JICA	Tonouchi	
3	30-Jul	tue	AM	Courtesy call to JBNSC DG, review for homework.	JMA	JMA	Komatsu	
			PM	coutesy call, TCC (activityies of BMKG, el nino forecast, Climate system monitoring)			Mochizuki	JICA Tokyo
4	31-Jul	wed	AM	TCC (seasonal forecast, 1/3 months forecas)	JMA	JMA	Mochizuki	
			PM	TCC (Climate change information, products to users)			Mochizuki	JICA Tokyo
5	1-Aug	thu		Sonpo Japan and Nosai	Sonpo Japan Nippon Kowa (tokyo)	Sonpo Japan		
				Nosai Japan	Nosai			JICA Tokyo
6	2-Aug	fri		JAMSTEC	JAMSTEC	Yokohama		JICA Tokyo
7	3-Aug	sat		documentation				JICA Tokyo
8	4-Aug	sun		documantation				JICA Tokyo
9	5-Aug	mon		exercises: Climate Prediction Utilities 1	MRI	MRI	Kusunoki	JICA Tsukuba
10	6-Aug	tue		exercises: Climate Prediction Utilities 2	MRI	MRI	Kusunoki	JICA Tsukuba
11	7-Aug	wed		exercises: Climate Prediction Utilities 3	MRI	MRI	Kusunoki	JICA Tsukuba
12	8-Aug	thu		Weather index and adaptation for climate change	NIAES	NIAES	Nishimori	JICA Tsukuba
13	9-Aug	fri	AM	GSMaP, satellite based information	JAXA	JAXA Tsukuba	Ms Yamaji	
			PM	Climate prediction	Tsukuba Univ.	Tsukuba Univ.	Kusaka	JICA Tokyo
14	10-Aug	sat		documentation				JICA Tokyo
15	11-Aug	sun		documantation				JICA Tokyo
16	12-Aug	mon		travel [Tsukuba to Morioka]				Morioka
17	13-Aug	tue		travel [Morioka to Kuriyagawa]				
			PM	Weather information and agriculture	Tohoku noushi	Morioka		Morioka
18	14-Aug	wed	AM	Travel [Sendai to Tokyo]				
			PM	JMA DRR operation	JMBSC	JICA Tokyo	Kurihara	JICA Tokyo
19	15-Aug	thu		Adaptation for Climate Change or documentation		JICA Tokyo	not fixed	JICA Tokyo
20	16-Aug	fri	PM	final presentation and work plan	JICA	JICA Tokyo	Tonouchi	JICA Tokyo
21	17-Aug	sat		travel [Narita to Jakarta]				

(1) Targets of the Training

a) Purpose and Preparation for Training

The training was designed to enhance BMKG abilities for agricultural insurance and climate change activities by learning data and software package obtained though the training. Trainees study agricultural insurance designing and required data, weather data/forecast for agriculture, improving methods/ideas of long-range forecasting, climate change data usage in Japan. The knowledge obtained through the training should be shared to whole BMKG staff members after the training. Following terms are considered in order to make training effectively,

- In June, trainees and JICA expert team would prepare installation software (ex. GrADS, Linux) used in Japanese training and study outline of JMA-TCC web page contents.
- After return to BMKG, trainees would hold a seminar (reporting trainings and share their knowledge obtained) and share materials/data.

b) Target Trainees

Trainees are 6 BMKG staff members in charge of climate change and agricultural information. (officers treat Atmospheric Global Climate Model (AGCM) data and in charge for long term forecasting).

c) Matters and Targets of Achievement for the Training

[Agricultural Insurance Analysis Ability]

BMKG implements research and analysis for agricultural insurance especially index type insurance and preparing weather data, however, operational data provision has not been started. For the operation, trainees need to learn design of agricultural insurance, required data, its accuracy and authorization process by governmental agencies from insurance companies. Additionally, trainees need to learn weather information and indexes required from farmers through lectures/exercise in agricultural research institutes and prepare for future research.

[Climate Change]

BMKG studied and obtained dynamical downscaling technique and data of AGCM by WRF model (meteorological dynamical model provided by NCAR) through training in Tsukuba university and share the downscaled data with a software package to draw charts, to compare future climate changes using GrADS to local branch offices of BMKG. And through various projects, BMKG continues activities for climate change of Indonesia. However, Indonesia has a large area and computing power they can us is not enough for downscaling GSM data covers whole Indonesian region. On the context, BMKG needs to obtain 20km resolution dynamically downscaled data and study software packages to draw charts and compare future climate change developed by Japanese research institutes and universities.

[Long-Range Forecast]

BMKG implements long-range forecast mainly based on European Centre for Medium-Range Weather Forecasts (ECMWF) models and through Japan Meteorological Agency Tokyo Climate Center (JMA-TCC) training, BMKG studied JMA-TCC data service usage and use for climate outlook analysis. In Indonesia, preparing for climate change, especially delay of rainy season onset and decrease of precipitation in El Niño event, BMKG needs to enhance abilities for climate outlook watch in the tropical zone, needs to improve long-range forecast accuracy, to study latest research results and to keep continuous cooperation with JMA.

d) Targets of Training

Targets of the training for each theme are as follows.

[Agricultural Insurance]

- Understand outline of index type insurance, designing procedure and usage of weather data for insurances.
- Understand weather information and weather indexes for agriculture.

[Climate Change]

- Obtain 20 km resolution Pseudo-Global Warming data and study software package for drawing charts and implementing basic comparison of future projection data.
- Study dynamical and statistical downscaling of AGCM, remarks and limitation of the data.

[Long-Range Forecast]

- Understand JMA-TCC data base usage and data source for climate outlook watch in tropical zones and study outline and accuracy of long-range forecasting of JMA.
- Understand JMA-TCC activities and exchange mutual experiences for continuous cooperation between BMKG and JMA.

(2) Implemented Trainings

Table 3-4-2 Implemented Trainings (2019)

Terms	Contents	Venue	Data and time
Outline of JMA activities	Through lectures and a tour, understand missions, activities of JMA. Study operation of AWS center (AMeDAS center), forecasting center, seismology/volcano center (2 hours)	JMA headquarter	7/30(Tue) AM
JMA seasonal forecast and ensemble forecast	Lectures on seasonal forecast and ensemble forecast JMA operating. Discussion of mutual experiences and researches for long-range forecast/watch for continuous cooperation between BMKG and JMA. (3.5 hours)	JMA Tokyo Climate Center (JMA-TCC)	7/30(Tue) PM
iTacs and long-range forecast in tropical area	Exercise on climate watch system (iTacs) usage. Lectures on middle and long-term range forecast in the tropical area. (1day + 1 hour)	JMA- TCC	7/30(Tue) PM 7/31(Wed)
Index type insurance	Lectures on the design of index type agricultural insurance, required data and its accuracy. Study examples of agricultural insurances in Asian countries and introduction for insurance for natural disasters (weather/climate risk insurance). (2 hours)	Sompo-Japan insurance	8/1(Thu) AM
NOSAI insurance	Lecture on NOSAI structure/outline of compensation insurance for agriculture and for risks for agriculture brought by climate change (2 hours)	NOSAI	8/1(Thu) PM
Marine forecast and long-range forecast in the tropical area	Lectures on marine forecast and long-range forecast JAMSTEC implementing. The outline of products and accuracy of these models. Latest researches in	JAMSTSEC	8/2(Fri) <not fixed yet>

	tropical marine area. (4 hours)		
Usage of AGCM data	Lectures on downscaling technique of AGCM data and remarks of them (dynamical downscaling and statistical downscaling). Exercises for analysis package of 20km resolution Pseudo-Global Warming data (until 2100) and trial for analysis of future climate change in Indonesia area. (3 days)	Meteorological Research Institute (MRI) of JMA	8/5(Mon), 6(Tue), 7(Wed)
Weather information for agriculture	Lectures on researches/analysis of yield and weather parameters <rice, soybean, corn and cassava>, on usage of climate change data, on agricultural impact of climate change and on agricultural indexes in Japan. (1 day)	National Institute for Agro-Environmental Sciences, the National Agriculture and Food Research Organization)	8/8(Thu)
GSMaP data and JAXA	Lectures on GSMaP data (various products and their accuracy), and short tour in JAXA facility. (1 day)	JAXA	8/9(Fri)
Examples of weather information usage for agriculture	Introduction of weather information usage for rice and adaptation examples for climate change in agriculture. A short tout of local agricultural laboratory. (1 day)	Tohoku National Agricultural Experiment Station	8/13(Tue)
Reporting of work plan	Reporting of training in Japan, preparation for a forum to share knowledge to BMKG and work plan of future activities. (1.5 days)	JMBSC or JICA	8/14(Wed) PM 8/15(Thu)
Evaluation meeting	Presentation of work plan and evaluation meeting of the training. (1 day)	JICA	8/16(Fri) PM

4. Recommendation to Achieve Overall Goal of the Project

4. Recommendation to Achieve Overall Goal of the Project

This project contributes to the "Project of Capacity Development for the Implementation of Agricultural Insurance" Activity "2-1. Conduct assessment of meteorological observation and data for climate/disaster risk and capacity development training, and make a recommendation based on the results of the assessment in order for such data to be utilized for implementation/development of insurance including weather-index based insurance." It also supports the project output "2. Capacity to analyze and improve agricultural insurance scheme is strengthened."

The Climatology Division of BMKG, is responsible for the mid-long-range forecast (dekadal to seasonal forecast) as the governmental agency responsible for observation, forecast and warning for meteorological, geo-hazardous and marine phenomena and climate change information, and they provide important weather-related information to agricultural stakeholders in Indonesia, where agriculture is one of its major industries.

The outputs of this project are 1) to develop meteorological observation data and enhance required ability to improve agricultural insurance and 2) to develop climate/disaster risk data. For the former output, WG implemented data collection and evaluation of rain post data in pilot areas as key activity 1, such steady data collection and quality control activities are often neglected by some south eastern Asian meteorological offices, which tend to seek for state-of-the-art-technologies and quick results, but as a result of continuous collection and quality check of the data, WG found that (i) the spatial density of observatories is an important factor in the Indonesian region where local and convective rain events are dominant, (ii) the horizontal distance of about 20km between each station is necessary to obtain reliable precipitation data representing the area, and (iii) in order to estimate the reliable precipitation distribution by using satellite or numerical model data, it is necessary to calibrate them with reliable surface observations.

For the latter output, to develop climate/disaster risk data, WG coped with evaluation of mid-long-range forecast and their improvement as key activity 2 and the WG found that (i) the reliability of forecasts of onset and offset of the rainy season in pilot areas are higher than that of climatological forecasts, (ii) in East Java, there is a trend that precipitation is decreasing, (iii) the evaluation of subseasonal to seasonal (S2S) forecasts suggests that heavy rain is predictable within a leadtime of 2 dasarians and (iv) the reliability evaluation of ENSO forecasts revealed that it is necessary to continuously evaluate the accuracy of forecasts of MJO, ENSO, IOD and the Australian monsoon that have considerable impacts on precipitation events in Indonesia.

In addition, as key activity 3, WG implemented dynamical downscaling of the Atmospheric Global Climate Model (JMA-MRI-AGCM) into 5km resolution for present (1981-1992) and future (2079-2089) and added 10-year climate prediction data to each decade. Moreover, through training in Japan, WG members learned basic evaluation technique and software usage to analyze future trends of temperature and precipitation in Indonesia.

The overall goal and purpose of the "Project of Capacity Development for the Implementation of Agricultural Insurance" are as follows:

Overall Goal:

Agricultural insurance is continuously implemented in Indonesia.

Project Purpose:

Capacity of the key ministries/institutions, the concerned local governments, and other relevant organizations to enhance the implementation of agricultural insurance is strengthened.

Therefore, the agricultural insurance business and the ability of relevant authorities should be further developed in the whole of Indonesia.

The Indonesian ministries/institutions and the public have strong expectation for and confidence in BMKG. To meet their expectations, it is important that BMKG, as the National Weather Service of Indonesia, should "1. construct reliable database and provide reliable data" and "2. share/issue user-oriented information based on user needs". The three key activities performed in the project as mentioned below should be continued and further strengthened considering the two viewpoints mentioned above.

For Key Activity 1, it is necessary to continue direct contribution to the agricultural insurance through:

- Collection and evaluation of reliable data as much as possible, and development of reliable observation database
- Developing reliable precipitation maps in high resolution based on the reanalysis of satellite data, for example GSMaP and numerical predictions that are calibrated with reliable SYNOP, AWS/ARG, rain post

For Key Activity 2, following BMKG activities to strengthen its ability of seasonal forecast could contribute to smoother introduction of agricultural insurance, i.e. ,

- Improvements of monsoon onset/offset forecast accuracy, development of S2S heavy rain potential forecasts, would contribute to prioritizing the schedule of promotion and popularization activities for agricultural insurances as well as farmers' risk management and would contribute indirectly to averting moral hazards of farmers and keeping stable management of agricultural insurance
- Climate zones and improving the accuracy would contribute to premium pricing of the reginal agricultural insurance depending on the risk that farmers face in each region (as mentioned in the report of AgroInsurance)

For Key Activity 3, continuous activities for higher resolution dynamical downscaling covering the whole Indonesia would contribute to agricultural insurance, i.e.

- Higher resolution dynamical downscaled product (5km resolution, the present product is 20km resolution) would express more detailed geographical phenomenon, their trend in the past and future projection of meteorological elements such as temperature and precipitation and contribute to more precise risk evaluation in the future and appropriate re-design and proper frequency of insurance scheme, e.g. insurance instruments and systems that meet specific local needs

In order to achieve the overall goals, BMKGS should i) continue to add, improve and develop meteorological data and their reliability along BMKG’s strategic plan and ii) focus on information dissemination for users of the agricultural insurance.

5. Summary of the Project

5. Summary of the Project

BMKG has high ability to analyze and has improved dataset for agricultural insurance to enhance it through collecting basic observation data and data evaluation. BMKG has also been trying to improve analysis of long-range forecast validation for onset/offset period in pilot areas, S2S forecasts and ENSO forecasts as an activity for evaluation of weather risks. Additionally, BMKG started higher resolution dynamical downscaling of the Atmospheric Global Climate Model. BMKG abilities have been enhanced steadily through these activities.

For enhancing ability for analysis and improvement of agricultural insurance, BMKG is expected to continue the following activities, (i) collecting reliable data as much as possible, (ii) evaluating their quality and (iii) sharing/providing these reliable data to users.

BMKG already started to produce re-analysis precipitation map into high resolution using data of satellite, SYNOP and AWS/ARG. An outcome of these activities including 'Non-precipitation map with AWS/ARG data' is already provided on BMKG's website (Fig. 3-1-20). This product is expected to be added user-oriented weather information based on communication with data users. The high-resolution precipitation map is also expected to contribute to statistical downscaling as a reference data for the "Project of Capacity Development for Implementation of Climate Change Strategies in Indonesia Phase2 - Capacity Development for Climate Change Projection" (Phase 2 project).

Regarding the improvement of long-range forecast, there are various phenomena which should be considered in the tropical zone such as IOD and BMKG is expected to continue to communicate with data users which this project had not tackled enough due to COVID19 pandemic.

BMKG has been developing and improving their products. Meanwhile, closer coordination with other organizations and local offices would also enable BMKG to use more data for their products. Furthermore, improvements in the communication with other organizations is required too.

Finally, in the "Phase 2 project" by JICA, 5km resolution dynamical downscaling for present, future and near future already launched in cooperation with JMA Meteorological Research Institute and other research institutes/universities, and the results will be shared in 2020. For climate projection data usage, communication and viewpoint from users are required to analyze and disseminate the products. Continuous cooperation and supports for Indonesian ministries/institutions linking to Japanese ministries/institutions are indispensable not only for enhancement of ability for analysis and development of agricultural insurance but also for comprehensive risk hedges in a wide range of sectors who conduct an adaptation plans against climate change.

Appendix A. Work Plan

Style 4-2:

Work Plan (version 5)

as of August 2020

period / terms	12	2019 1	2	3	4	5	6	7	8	9	10	11	12	2020 1	2	3	4	5	6	7	8	9	10
Expert (Tonouchi)																							
Expert (Kurihara)																							
preparation of work plan, C/P meetings										preparation for training in Japan													
Modification of Actiities schedule/contents																							
Key activity 1																							
Survey for metetorological data																							
Evaluation of Met. Data for insurance																							
Interviews with agricultural bodies																							
Exercises/trainings for evaluation of met. Data																							
Key activity 2																							
exercise/evaluation for agriculutural information																							
technical skill transfer for agricultural information																							
Key activity 3																							
Dynamical downscaling of MRI GCM																							
Training in Japan																							
Training in Japan																							
Reports	△ WP	△ WP	△ PR					△ WP	△ WP					△ WP	△ PR						△ WP	△ FR	

Legend : ――――Preparation ▭▬Activities in Indonesia ▭▭ Activities in Japan △――△ Reporting ----------other works

WP: Work Plan, PR: Progressive Report, FR: Final Report

Appendix B. Member Schedule for the Project: Expert Assignment Plan/Result

The Republic of IndonesiaProject of Capacity Development for the Implementation of Agricultural Insurance

Activities in Indonesia

No.	Name	Specialty		Trip	2018		2019												2020										Day	Man Month
					11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10		
1	Michihiko TONOUCHI	Forecasting, Radar usage	Plan	10		(14)						(21)						(14)				(10) −(10)					(10) −(9)		30	0.99
			Result	1	12/9〜15	12/19〜22 (11)			3/9 3/14				7/2 7/13 (12)						1/12 1/22 (11)										34	1.13
2	Koichi KURIHARA	Data Precision Evaluation	Plan	11								(28)						(28)											56	1.87
			Result	0					3/10 3/15			6/16 7/13 (28)								2/23	3/17 (24)								52	1.73
																													86	2.86
																													86	2.86

Activities in Japan

No.	Name	Specialty		Trip	2018		2019												2020										Day	Man Month
					11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10		
1	Michihiko TONOUCHI	Forecasting, Radar usage	Plan			(5)	(5)				(3)								(5)		(2)				(12)	(2)	(5)		39	1.95
			Result			12/3〜7 (5)	1/7-8 (2)		3/19-20、22 (3)														5/27-29 (3)	6/2-4 (3)	7/28 (1)	8/24-27 (4)	9/3, 17, 23 (3)		24	1.20
2	Koichi KURIHARA	Data Precision Evaluation	Plan								(8)		(2)	Training in Japan (10)			(8)		(2)						(12)		(2)		44	2.21
			Result						3/19 3/20 (2)				7/25, 26 (2)	8/5 8/16 (11)							3/25 3/27 (3)	4/24 (1)	5/18-19, 25-26 (4)	(8.5)	6/3-4, 14-17, 23-25 (13)	(9)	(5.7)		59	2.96
																													83	4.16
																													83.2	4.16

↑7/8, 11, 13-17, 20-22, 27-29

↑8/3-6, 11, 17, 18, 21, 24, 26, 27

↑9/2, 16, 21, 23-25, 28

Day	Man Month
169	7.02
169.2	7.02

Legend:	
Plan (Gray)	
Result (Black)	
Expense (Shaded)	

	2018-11	2018-12	2019-1	2019-2	2019-3	2019-4	2019-5	2019-6	2019-7	2019-8	2019-9	2019-10	2019-11	2019-12	2020-1	2020-2	2020-3	2020-4	2020-5	2020-6	2020-7	2020-8	2020-9	2020-10
Reporting		△ WP1	△ PR1	△ WP2					△ WP3					△ PR2/WP4				△ WP5				△ WP6	△ FR	

Appendix C. Seminar, Lecture, Collected Materials

Appendix-C

Key Activity 1: Meeting, Lecture and Documents

Meeting, lecture/seminar, collected data/documents (e.g., operation manual) related to Key Activity 1 are shown in the following tables.

Table 1 Major Meeting Records

Date	Counterparts	Items
2018/12/11	Pak Dodo and Climate division	Kickoff meeting for Work Plan
2018/12/12	Ministry of Agriculture	Crop yield data and requests for weather information for agriculture
2018/12/19-20	Malang observatory	Activities for agriculture in Malang and rain post data includes metadata
2019/3/11	Climate change section	GSMaP data usage and possibility
2019/7/3,11	Climate change section	Rain post and GSMaP data evaluation for agricultural insurance
2019/7/9	Climate Variability section	JMA 1,3 months forecast evaluation
2020/1/16	Climate Variability section	JMA 6 months ensemble forecast usage
2020/1/20	Climate change section	Rain post and GSMaP data evaluation by Python
2020/5/25	Climate change section	Activity plan meeting under COVID-19
2020/7/10	Climate change section	Meeting for summarize rain post evaluation
2020/8/27,9/3,18,21	Climate change section	Discussion for results of research for rain post evaluation

Table 2 Lecture, Seminar and Training (Key Activity 1)

No.	Date	Terms	Lecturer	Participants
1	2018/12/11	Required data for agriculture and weather information for Work Plan discussion	Michihiko Tonouchi	10
2	2019/7/4-5	Rain post evaluation with Excel	Michihiko Tonouchi	8
3	2019/7/8-9	Rain post evaluation with Excel	Michihiko Tonouchi	8
4	2019/7/9	Joint meeting with agricultural insurance consultants (Index-type insurance pricing)	Michihiko Tonouchi	20
5	2020/1/13-15	Rain post evaluation with python	Michihiko	8

			Tonouchi	
6	2020/1/16-17	JMA 6months ensemble forecast usage	Michihiko Tonouchi	4
7	2020/4-5,2020/8-9	Rain post data evaluation	homework	4
8	2020/8/24-9/23	Rain post analysis and summarize results	Michihiko Tonouchi	8

Table 3 Collected Data/Documents (Key Activity 1)

Title	Contents	Place
Rain post data	Rain post data 47 rain post data in East Java and 24 rain post data in South Sulawesi from 2009 to 2018	East Java South Sulawesi
GSMaP MVK, rain-gauge reanalysis data	2009 to 2018, 1 hourly GSMaP MVK data	Global
JMA 1,3 months data	JMA 1,3 months forecast data	Global
JMA 6 months forecast	JMA 6 months forecast data (from December 2019, 5-day interval)	Global
Rain post data evaluation	Excel version and Python version	
GSMaP software	Pick up grid data from GSMaP	
Long range forecast software	Pick up 1,3,6 months JMA forecasts data and scripts for viewing them by Grads	

Key Activity 2: Meeting, Lecture and Documents

(1) Lecture on the Latest Information of Techniques for Monitoring/Analysis/Forecasts

Meeting, lecture/seminar were held with WG members. Lectures on the latest analysis methods and usage of internet analysis related to current tasks were conducted. Summary of the lectures are shown in the following tables.

Table 4 Lectures on the Seasonal Forecast Technics and Analysis Methods

Lectures on the seasonal forecast tecnics and analysis methods					
No.	Date	Place	Participant	Title	Contents
1	2019.06.18	BMKG HQ	WG mebers	JMA Seasonal Forecasts_ Evaluation of the probability forecast	Introduction of JMA seasonal forecast and lecture on how to evaluate probability forecast
2	2019.07.05	BMKG HQ	WG mebers	How to use iTacs	Explanation of Atomophere/Ocean data analysis tool provided by JMA through internet. ID for this tool provided by JMA to each WG members.
3	2020.02.27	Yello Hotel (Dry Season Forecast Meeting 2020)	BMKG staff from HQ as well as from local offices	Improving Seasonal Forecast for Climate and Agriculture Insurance	Introduction to the current JICA-BMKG project, JMA seasonal forecast, and feature of climate variations in Japan.
4	2020.08.05	BMKG,ZOOM meeting (Wet Season Forecast Meeting 2020/21)	BMKG staff from HQ as well as from local offices through internet	Evaluation on Normal Season Onset By Koichi Kurihara (JICA) and Rosi Hanif Damayanti, S.Tr(BMKG)	Features of monsoon onset variavity are explained based on the current project study results, and future study plans introduced.

iTacs, one of climate analysis tools provided by TCC/CPD of JMA, is useful for the current study/development. ID and password of iTacs were provided to each WG member by courtesy of TCC/CPD/JMA.

(2) BMKG Operational Meeting

A JICA expert was invited to the following meetings and made speeches.

1) Dry season forecast national meeting for 2020
2) Wet season forecast national meeting for 2020/2021
3) NCOF (National Climate Outlook Forum) meetings for Dry season forecast 2020 and Wet season forecast 2020/2021

Other meetings are also held for Key Activity 2. Major meetings are listed in the following table.

Table 5 Major Meeting Records

Date	Place	Participant	Contents
2019.03.11	BMKG HQ	Key1 and Key2 team	General discussion on the JICA-BMKG project
2019.03.12	BMKG HQ	Key2 team	Kick off meeting for Key2: Work plan and

			WG (Working group)
2019.03.14	BMKG HQ	Key2 team	Work plan including homework for Key2 team and JICA expert for the next 2 months
2019.06.17	BMKG HQ	Key1 and Key2 team JICA secretariat	Introduction of JICA-BMKG project and role of BMKG within the project. Workplan during JICA expert's stay at BMKG
2019.06.18	BMKG HQ	Key2 team	Introduction of JMA seasonal forecast and how to evaluate probability forecast. Introduction of BMKG seasonal forecast evaluation.
2019.06.18	BMKG HQ	Key2 team	Introduction of JMA seasonal forecast guidance data provided by JMBSC
2019.06.18	BMKG HQ	Dr. Dodo, Director	Courtesy call. Explanation of the workplan for the project
2019.06.21	BMKG HQ	Key2 team staff	Consultation with each of Key2 team staff for their work activities
2019.06.24	BMKG HQ	Key2 team	Explanation of study method and data for monsoon variability
2019.06.25	BMKG HQ	Key2 team	Discussion for BMKG seasonal forecast including evaluation of probability forecast
2019.07.01	BMKG HQ	Key2 team	Report and review of Key activity 2
2019.07. 04	BMKG HQ	Dr. Dodo, Director	Courtesy call. Explanation of the current situation of the project
2019.07.05	BMKG HQ	Trainees in Japan	Advice for training in Japan
2019.07.08	BMKG HQ	Key2 team	Review and planning for Key activity 2
2019.07.09	BMKG HQ	BMKG staff, local staff from East Japan and South Sulawesi JICA secretariat	BMKG workshop for meteorological data utilization for agriculture Lecture by Agro-insurance experts for the JICA-BMKG project
2019.07.09	BMKG HQ	BMKG staff for seasonal forecast	Inspection of the seasonal forecast operation
2019.07.10	BMKG HQ	BMKG staff for seasonal forecast and local staff	Inspection of the online meeting for the seasonal forecast operation
2019.07.11	BMKG HQ	Key1 and Key2 team	Plan and coordination meeting
2019.07.12	BMKG HQ	BMKG staff for seasonal forecast	Inspection of the seasonal forecast operation including discussion and advice

		Experts for seasonal forecast	from Experts from universities and institutes
2020.02.25	BMKG HQ	Key2 team	Plan and coordination meeting
2020.02.26 to 27	Yellow hotel in Jakarta	BMKG staff from HQ and local offices	Dry Season Forecast Meeting 2020
2020.03.09	BMKG HQ	BMKG staff for seasonal forecast service and experts from universities and institutions	Climate Forum for Dry season 2020
2020.03.10	BMKG HQ	Key2 team	Plan and coordination meeting
2020.03.12	Bogor Agro-climate and Hydrology Research Institute (Balitklimat)	JICA secretariat Staff (Balitklimat)	Exchange of information on seasonal forecast and its utilization
2020.06.16	Online meeting	Key2 team	Report and coordination for the progress after the March meeting and work plan until August 2020
2020.07.14	Online meeting	Key2 team	Report and coordination for the progress, report format and work plan until August 2020
2020.07.21	Online meeting	Key2 team	Report and coordination for the progress of the studies and work plan until August 2020
2020.08.05	Online meeting	BMKG staff for seasonal forecast service	The National Meeting on the 2020/2021 Rainy Season Forecast
2020.08.11	Online meeting	BMKG staff for seasonal forecast service and experts from universities and institutions	National Climate Outlook Forum for Rainy Season Forecast 2020/2021
2020.08.24	Online meeting	BMKG, JICA and Indonesian government agencies	Technical Meeting via Zoom: Project of Capacity Development for the Implementation of Agriculture Insurance
2020.09.16	Online meeting	Key2 team	Preparation of the complete report Key2 and the project final report meeting
2020.09.21	Online meeting	Key2 team	Preparation of the complete report Key2 and the project final report meeting

2020.09.23	Online meeting	BMKG and JICA staff Invitees from agricultural sectors etc.	The JICA-BMKG project final report meeting

(3) Training in Japan for Seasonal Forecasts

Topics on seasonal forecast and related matters such as climate monitoring, ENSO forecasts, and disaster prevention activities including agricultural weather information were provided as a training by experts from JMA and other institutions in Japan as shown below:

- Seasonal forecast activity in JMA
- ENSO monitoring and outlook activity in JMA and JAMSTEC
- JMA agrometeorological information by JICA expert
- Agriculture under Changing Climate at Tohoku Agricultural Research Center, NARO
- Disaster Management in Japan and effective usage of meteorological information by JICA expert

Other lectures conducted by JICA expert were listed in the following table.

Table 6 Lecture, Seminar and Training (Key Activity 2)

No.	Date	Terms	Lecturer	Participants
1	2019/6/18	JMA seasonal forecasts, evaluation of the probability forecast	Koichi Kurihara	10
2	2019/7/5	How to use iTacs	Koichi Kurihara	10
3	2020/2/27	Improving seasonal forecast for climate and agriculture insurance	Koichi Kurihara	100 (National forecast meeting)
4	2020/8/5	Evaluation on normal season onset	Koichi Kurihara Rosi Hanif Damayanti S. Tr	100 (National forecast meeting via zoom)

For evaluation of seasonal forecast by BMKG, it is particularly important to compare the evaluation result to the others. Moreover, for study/development topics such as case study on monsoon variability, S2S analysis and ENSO forecast evaluation data and information for seasonal forecasts and ENSO forecast from other international centers are necessary. Thus, forecast data and information in the following table were provided.

Table 7 Collected Data/Documents

1	Seasonal forecast by JMA (Japan Meteorological Agency) for forecast result evaluation and S2S (Sub-seasonal to Seasonal) analysis
2	JMA ENSO forecast data for the last 30 years for evaluation of ENSO forecast

Key Activity 3: Meeting, Lecture and Documents

Meeting, lecture/seminar, collected data/documents (e.g., operation manual) related to Key Activity 3 are shown in the following tables.

Table 8 Major Meeting Record

Date	Counterparts	Items
2019/12/11	1st JCC	Reporting of dynamical downscaling in MRI

Table 9 Lecture, Seminar and Training (Key Activity 3)

No.	Date	Terms	Lecturer	Participants
1	September to December 2019	Dynamical downscaling of MRI-AGCM data	Dr. Sasaki (MRI)	Indonesia

Table 10 Collected Data/Documents

Title	Contents	Area
Downscaled data (MRI, RCP8.5)	5km resolution dynamical downscaled data with 3 HDD (@12TB) and 2 HDD (@5TB)	Indonesia

Syllabi for training in Japan which were conducted in 2019 are as the followings.

研修科目	東京気候センター（TCC）の活動概要	
Title	Introduction of the Tokyo Climate Center (TCC)	
研修日	7 月 30 日（火）午後	（0.5 時間）
形式（講義/実習）	講義	
講師	望月　泰（気象庁　異常気象情報センター）	
Lecturer	Yasushi Mochizuki (JMA TCC)	
研修内容	TCC は WMO（世界気象機関）指定の RAII（アジア地域）「地域気候センター」として、RAII 各国への気候データ・情報・解析ツールの提供を行い、また技術力向上の支援を行っていることを紹介する。	
Content	Introduction to TCC’s role as one of the RAII regional climate centers designated by WMO, including provision of climate data, information and tools, together with supporting capacity development	
研修のねらい（講師が期待する研修到達度）	TCC の WMO 地域気候センターとしての機能・役割を理解する。	

研修科目	気象庁アンサンブル季節予報の仕組みとプロダクト	
Title	JMA Ensemble Prediction System for Seasonal Prediction and its Products on TCC website	
研修日	7 月 30 日（火）午後	（0.75 時間）
形式（講義/実習）	講義	
講師	山田　崇（気象庁　異常気象情報センター）	
Lecturer	Takashi Yamada (JMA TCC)	
研修内容	気象庁のアンサンブル季節予報の仕組みと作成する気象情報について講義を行い、これら情報が TCC ウェブサイトから入手できることを紹介する。	
Content	Introduction to JMA Ensemble Prediction System for Seasonal Prediction and its Products on TCC website.	
研修のねらい（講師が期待する研修到達度）	アンサンブル季節予報の仕組みを理解するとともに、作成された情報を TCC ウェブサイトから入手して、BMKG 季節予報の参考資料として活用できることを学ぶ。	

研修科目	気象庁の季節予報業務	
Title	Introduction to JMA Seasonal Forecasts	
研修日	7 月 30 日（火）午後	（0.75 時間）
形式（講義/実習）	講義	
講師	伊藤　明（気象庁　気候情報課）	
Lecturer	Akira Ito (JMA Climate Prediction Division (CPD))	
研修内容	気象庁の季節予報はアンサンブル数値予報とガイダンスにより作成していることや、農業・水産業やアパレルなど季節予報ユーザーと協力して季節予報の利用法を開発して、季節予報を利活用している実例を紹介する。	
Content	Introduction to JMA seasonal forecast, which is based on dynamical ensemble forecast method and guidance materials, and how to use forecast information by the users such as agriculture, fisheries and apparel sale industries.	
研修のねらい（講師が期待する研修到達度）	気象庁の季節予報はアンサンブル予報とガイダンス資料に基づいて作成されることや、情報の利活用のためにユーザーと協力して利用法を開発することが有効であることを学ぶ。	

研修科目	エルニーニョ・ラニーニャの監視と予測	
Title	Monitoring and prediction of El Niño and La Nina	
研修日	7 月 30 日（火）午後	（1.0 時間）

形式（講義/実習）	講義
講師	吉川　郁夫（気象庁　気候情報課）
Lecturer	Ikuo Yoshikawa (JMA Climate Prediction Division (CPD))
研修内容	エルニーニョ・南方振動（ENSO）の監視・予測が気候変動の予測にとり重要であること、気象庁の ENSO 監視・予測システム、さらに現在の熱帯太平洋の状況と今後の見通しについて紹介する。
Content	Introduction to monitoring and prediction of El Niño/southern oscillation (ENSO), its impact on global climate, JMA’s ENSO monitoring and prediction system, and explanation of current tropical ocean/atmosphere conditions and their outlook.
研修のねらい（講師が期待する研修到達度）	エルニーニョ・南方振動の監視と予測が季節予報などの気候予測にとって重要であることを学ぶ。

研修科目	気候解析ツール iTacs(Interactive Tool for Analysis of the Climate System)の解説と利用	
Title	Introduction and operation of iTacs	
研修日	7 月 30 日（火）午後 7 月 31 日（水）午前・午後	（1.0 時間） （4.5 時間）
形式（講義/実習）	実習	
講師	若松　俊哉（気象庁　異常気象情報センター）	
Lecturer	Shunya Wakamatsu (JMA TCC)	
研修内容	TCC が開発して WEB 上で運用する気候解析ツール iTacs を利用して気候変動の解析を行う方法を、ENSO や IOD、MJO の解析など様々な具体例の実習を通して講義する。	
Content	Introduction to iTacs and to learn how to use iTacs for analyzing atmospheric and tropical ocean conditions such as El Niño /southern oscillation, Indian ocean dipole, and so on.	
研修のねらい（講師が期待する研修到達度）	気候変動の実例の解析実習を通して、iTacs を活用することにより大気・海洋の様々な現象について解析できることを学ぶ。	

研修科目	BMKG の最近の気候情報業務の紹介	
Title	Latest status on BMKG climate services (an open session to JMA staff members)	
研修日	7 月 31 日（水）午前	（1.0 時間）
形式（講義/実習）	講義	
講師	望月　泰（気象庁　異常気象情報センター）	

Lecturer	Yasushi　Mochizuki (JMA TCC)
研修内容	研修員が BMKG 気候情報業務を紹介し、気象庁スタッフからの質疑やアドバイスを受ける。
Content	Introduction to BMKG climate-related activities by trainees, followed by discussions, comments and advices by the JMA session participants for enhancing its activities.
研修のねらい（講師が期待する研修到達度）	BMKG の気候関連の活動について、コメントやアドバイスを受け、今後の活動推進に資する。

研修科目	気象庁本庁見学（観測現業室及び予報現業室）	
Title	Inspection tour to the JMA operational observation and forecast room	
研修日	7 月 31 日（水）午後	（0.5 時間）
形式（講義/実習）	見学	
講師	大塩　健志　（気象庁　企画課国際室）	
Lecturer	Kenji Ohshio (JMA International office)	
研修内容	レーダー、アメダス、高層観測等の気象観測ネットワークの運用を一元的に管理している観測システム運用室の観測現業室を見学する。また、天気予報の全国予報中枢の現業作業室を見学する。	
Content	Through an inspection tour to the JMA operational observation room and forecast room, trainees learn observation networks and remote-control systems for radar, AWS, wind profiler and so on, and JMA forecast and warning system.	
研修のねらい（講師が期待する研修到達度）	気象庁の観測及び予報の現業室を見学して、観測情報の一元管理や先進的な予報センターのシステムを学ぶ。	

研修科目	インデックス型農業保険	
Title	An Introduction to Sompo’s Agricultural Insurance Activities	
研修日	8 月 1 日（木）午前	（2.5 時間）
形式（講義/実習）	講義	
講師	福渡　潔（SOMPO リスクマネジメント株式会社）	
Lecturer	Kiyoshi Fukuwatari (SOMPO Risk Management)	
研修内容	日本及び東南アジアにおける災害保険の現状、保険を活用することによる経済発展への寄与に関する講義、損保ジャパンが実施したタイにおける降水量をインデックスとした農業保険の取り組み、フィリピン及びミャンマーで実施した（実施予定）台風・サ	

	イクロンをインデックスとした農業保険の取り組みについての実例紹介。	
Content	Through a lecture for index type agricultural insurances, study insurance structure and effectiveness, and a lecture for examples of index type agricultural insurances in south-east Asian countries, study agricultural insurance and required weather data. (2 hours)	
研修のねらい（講師が期待する研修到達度）	インデックス型農業保険の概要について学習し、農業保険の概要・実情を使いする、また、インデックス型農業実例について講義を頂き、保険の設計、必要となるデータ、それらの効果について理解する。	

研修科目	季節予報に関わる大気海洋変動とその予測	
Title	Atmospheric and Oceanic variability related to seasonal forecasting and its prediction	
研修日	8 月 1 日（月）午後	（2.0 時間）
形式（講義/実習）	講義	
講師	前田　修平（気象庁　気象研究所）	
Lecturer	Syuhei Maeda (JMA MRI)	
研修内容	季節予報を行う上で必要となる、熱帯域における大気及び海洋の長期変動についての講義。MJO、ロスビー波、ケルビン波の変動と発生理由、ENSO、エルニーニョモドキ、IOD とその指数、10 年単位で変動する PDO、ENSO-モンスーンの変動についての講義。	
Content	Through a lecture for variability in tropical zones, study oscillation in tropical zones, MJO, Kelvin wave, Rossby wave, ENSO, El Niño modoki, IOD and learn these indexes.	
研修のねらい（講師が期待する研修到達度）	熱帯域で季節予報を行う上で必要となる、MJO、ENSO、エルニーニョモドキ、IOD などについて現象及びその発生過程の講義により、季節予報モデルを理解するための基礎的な変動を理解する。また、それらを把握するためのインデックスを理解する。	

研修科目	JAMSTEC 長期予報プロダクトとその利用	
Title	JMA long range forecast product and its usage	
研修日	8 月 2 日（金）午前	（2.0 時間＋2.0 時間）
形式（講義/実習）	講義、見学	
講師	土井　威志（国立研究法人　海洋研究開発機構）	
Lecturer	Takeshi Doi (JAMSTEC)	

研修内容	JAMSTEC の ENSO を中心とした長期予報の概要、プロダクト、情報提供サイトに係る講義、ENSO 予報の精度評価、熱帯における海面水温の変動と日本を含むアジア域な気候への気候のインパクト JAMSTEC の気候モデル、海洋探査、都市域モデルに関する研究の紹介、大型コンピューター「地球シミュレーター」の見学。	
Content	Lecture for JAMSTEC long range forecast, especially ENSO forecast and evaluation of forecasts and for impact on climate in Asian countries. Introduction of JAMTEC climate modeling, urban modelling and these research results. A short tour to 'Earth simulator' HPC system.	
研修のねらい（講師が期待する研修到達度）	BMKG で利用している、JAMSTEC の ENSO 予報についてその概要と精度を学習するとともに BMKG での利用内容を紹介し、今後の相互交流のための人的ネットワークの構築。BMKG での利用を進めるための過去データ、精度評価データの共有を受ける。	

研修科目	気象研究所の最近の活動	
Title	Introduction to current activities of MRI (Meteorological Research Institute)	
研修日	8 月 5 日（月）午後	（2.0 時間）
形式（講義/実習）	講義と見学	
講師	楠　昌司（気象庁　気象研究所　客員研究員）	
Lecturer	Shoji Kusunoki　(JMA MRI Visiting researcher)	
研修内容	気象研究所の地球科学全般の研究活動、特に国際協力による温暖化予測ダウンスケール研究の紹介と研究の基盤となるスーパーコンピューターの見学を行い、地球温暖化予測と地域気候への影響に関する最新の研究活動について講義する。	
Content	Through introduction to MRI activities, especially global warming down scale research activities based on international cooperation framework, and inspection tour to MRI supercomputer system, trainees learn the latest research activities associated with global warning and its impacts on regional climates	
研修のねらい（講師が期待する研修到達度）	温暖化予測研究の最新の取り組みとその基盤となるスーパーコンピューターシステムについて学び、BMKG における今後の研究開発の参考に資する。	

研修科目	地球温暖化について	
Title	What is global warming?	
研修日	8 月 6 日（火）午前	（2.0 時間）

形式（講義/実習）	講義	
講師	楠　昌司（気象庁　気象研究所　客員研究員）	
Lecturer	Shoji Kusunoki　(JMA MRI Visiting researcher)	
研修内容	地球温暖化のメカニズムと過去から現在の全球の気候変動、GHC 排出シナリオごとの地球温暖化予測、温暖化の影響評価について、IPCC 第 5 次評価報告書等に基づいて講義する。	
Content	Mechanism of global warming, global climate change and variability from past to present, global climate warming projection for different GHC emission scenario and warming impact studies are lectured based on IPCC report V.	
研修のねらい（講師が期待する研修到達度）	地球温暖化の仕組みや温暖化の実況と予測、さらにその影響について、最新の知見を学び理解する。	

研修科目	GrADS（Grid Analysis and Display System）を用いた地球温暖化予測資料の解析	
Title	Analysis of global warming using GrADS and global warming projection data around Indonesian region.	
研修日	8 月 6 日（火）午後	（2.0 時間）
形式（講義/実習）	実習	
講師	楠　昌司（気象庁　気象研究所　客員研究員）	
Lecturer	Shoji Kusunoki　(JMA MRI Visiting researcher)	
研修内容	あらかじめ PC にインストールされた温暖化予測情報と解析ツール（GrADS）を用いて、主にインドネシア周辺の温暖化予測資料を解析・描画して、解析ツールの利用法を実習するとともにインドネシア地域の温暖化の状況を明らかにする。	
Content	Through analyzing and drawing global warming projection data　using GrADS, trainees learn how to use GrADS as well as understand future climate change and variability around Indonesian region associated with global warming.	
研修のねらい（講師が期待する研修到達度）	汎用性の高い気候解析ツールである GrADS の利用法を習得するとともに、インドネシア周辺における温暖化予測について理解する。	

研修科目	インドネシアの 5 地域における温暖化予測の解析	
Title	Analysis of the global warming projection in the Indonesian 5 regions	
研修日	8 月 7 日（水）午前 午後	（2.5 時間） （1.0 時間）

形式（講義/実習）	実習
講師	楠　昌司（気象庁　気象研究所　客員研究員）
Lecturer	Shoji Kusunoki　(JMA MRI Visiting researcher)
研修内容	講義・実習で習得した地球温暖化の知見と GrADS を用いた解析手法を活用して、各研修員に割り当てられたインドネシアの 5 地域における温暖化予測資料（気温と降水量）を解析し、分布図や時系列図を作成して、その特徴を取りまとめる。
Content	By using knowledge of global warning and GrADS analysis technics learned, trainees analyze temperature and precipitation features of global warning projections in the 5 Indonesian regions, and prepare short reports, individually.
研修のねらい（講師が期待する研修到達度）	取得した知見と解析手法を用いることにより、自国の温暖化予測の特徴を解析できることを学ぶ.

研修科目	インドネシア 5 地域における温暖化予測解析の報告	
Title	Evaluation of analysis on global warming projection in the Indonesian 5 regions	
研修日	8 月 7 日（水）午後	（1.0 時間）
形式（講義/実習）	実習	
講師	楠　昌司（気象庁　気象研究所　客員研究員　）	
Lecturer	Shoji Kusunoki　(JMA MRI Visiting researcher)	
研修内容	インドネシア各地域における温暖化予測（気温と降水量）の解析結果を各研修員が発表し、温暖化の地域特性や共通する特徴について検討する。	
Content	Trainees report results of analysis on global warming projection in the Indonesian regions and consider regional characteristics and common features.	
研修のねらい（講師が期待する研修到達度）	インドネシアにおける温暖化の一般的な特徴と温暖化の地域特性について、研修員各自の報告と検討を通して学ぶ。	

研修科目	農業気象インデックスと農業における気候変動適応策	
Title	Index type agricultural insurance and relation between crop production and weather.	
研修日	8 月 8 日（木）	（2.0 時間＋2.0 時間）
形式（講義/実習）	講義	
講師	西森　基貴（農研機構　農業環境変動研究センター　気候変動対	

	応研究領域ユニット長）
Lecturer	Mototaka Nishimori (NARO)
研修内容	Bojonegoro における BMKG・損保ジャパン・RESTEC によるインデックス型農業保険について収集した気象データ、保険の対象期間・インデックスの設定、保険支払いのためのインデックスの設定についての講義。 インドネシアにおける主要作物を気象要素との研究結果の紹介、太平洋地域における研究から IPO インデックスがこの地域の気候インデックスとして有効であること、2014 年の同プロジェクトで解析された極端気象がインドネシアの穀物生産に与える影響についての講義。
Content	Collaboration Research on Climate Index Insurances for farmers in Indonesia with SOMPO, RESTEC and BMKG funded by JICA-BOP (Bojonegoro, East java). Relationships between the crop productivity in Indonesia and information of Interdecadal Pacific Oscillation (IPO) and Pacific region climate Hydrological and Extreme Effects on Serial Production Variabilities in Indonesia (referred to Dr. Lizumi's collaborated with T.Sakai (NIES) and JICA-BMKG Training Program 2014).
研修のねらい（講師が期待する研修到達度）	前回の JICA プロジェクトにおけるインデックス型保険の設計の概要を理解する。インドネシア及び太平洋地域における「気象と作物生産量」の研究の紹介を通して、生産に影響を与える気象要素とその期間を理解する。

研修科目	衛星観測降水量データ GSMaP の利用	
Title	GSMaP products and an example for GSMaP data and agricultural insurance	
研修日	8 月 9 日（金）AM	（2.0 時間）
形式（講義/実習）	講義、討議	
講師	山地　萌果（宇宙航空研究開発機構（JAXA）筑波宇宙センター）	
Lecturer	Moeka Yamaji (JAXA)	
研修内容	JAXA が運用・提供を行っている、衛星観測降水量データ GSMaP のプロダクトの種類、その精度、アジアにおける利用者についての紹介。BMKG による GSMaP データと SYNOP/AWS 観測値の精度評価結果の発表、精度評価結果（異常値の原因検討を含む）にかかる討議。ミャンマーにおけるローガンへのインデクス型農業保険の紹介。	

Content	Lectures on GSMaP data JAXA manages and opens (products and these accuracy usage in Asian countries). A report of GSMaP data and SYNOP/AWS data comparison by BMKG and discussion for these results and cause of abnormal data). Lecture on an experiment of index type insurance for Longan in Myanmar.
研修のねらい（講師が期待する研修到達度）	降雨量観測データがない地域のインデックス型保険での利用可能性を検討している GSMaP データについて、その概要と精度を理解する。BMKG による解析結果を発表し、GSMaP データ提供者とその精度・課題について討議する。

研修科目	東南アジアの大都市における都市化が気候変動に与える影響	
Title	Past and Future Urbanization of the Southeast Asian Mega-Cities and Its Impacts on the Local Climate	
研修日	8 月 9 日（金）PM	（2.0 時間）
形式（講義/実習）	講義、討議	
講師	日下　博幸（筑波大学　計算科学研究センター　地球環境研究部門　教授）	
Lecturer	Hiroyuki Kusaka (Tsukuba university)	
研修内容	東南アジアの大都市において、都市化が将来の気候変動に与える影響、都市化による降雨メカニズムの変化に関する講義。気候変動による寄与と都市化の寄与の分析	
Content	Lectures on climate change projection results considering future urbanization of each city. Climate change effect and urbanization effect are separately evaluated. Another lecture on urbanization effect to the precipitation mechanism.	
研修のねらい（講師が期待する研修到達度）	最新の気候変動モデルによる解析結果についての講義を通して、インドネンシアにおける気候変動の影響を理解する、特に都市化によりる人口が集中する大都市における影響を学習し、BMKG が行う気候変動影響評価のための知識を学習する。	

研修科目	気象庁の農業気象情報	
Title	Agro-meteorological information prepared by JMA	
研修日	8 月 13 日（火）午前	（1.0 時間）
形式（講義/実習）	講義	
講師	栗原　弘一（一般財団法人　気象業務支援センター）	
Lecturer	Koichi Kurihara (JMBSC)	

研修内容	水稲の冷害をもたらす大気循環の特徴を示し、日本では農業とりわけ稲作にどのような気象情報が必要とされ、気象庁が農業機関と協力して農業気象情報を提供しているか、講義する。
Content	Showing features of atmospheric circulation around Japan which tend to cause cold damages on agricultural products, agro-meteorological information, especially that for paddy crop cultivation, prepared by JMA in cooperation with agriculture organizations are lectured.
研修のねらい（講師が期待する研修到達度）	日本では農業関係者にさまざまな気象情報を提供し、水稲の冷害回避等に活用されていることを理解する。

研修科目	気候変動と農業	
Title	Agriculture under Changing Climate	
研修日	8 月 13 日（火）午後	（2.0 時間）
形式（講義/実習）	講義と見学	
講師	長谷川　利拡（東北農業研究センター、農研機構）	
Lecturer	Toshihiro Hasegawa (Tohoku Agricultural Research Center, NARO)	
研修内容	地球温暖化の進行する中、水稲への影響評価の国際的な取り組みと東北地方における水稲栽培への気候変動の影響緩和のための早期警戒情報提供の取り組みについて講義する。さらに、農作物への気候変動影響評価のための実験施設を見学して、最新の実験研究について学ぶ。	
Content	International efforts to project the impacts on rice under global warming and early warning systems for current climate variability to reduce impacts on rice in Tohoku Region are lectured. In addition, through inspection tour to a laboratory, trainees learn how to evaluate impacts on agricultural products under changing climate.	
研修のねらい（講師が期待する研修到達度）	地球温暖化により農作物にどのような影響が予想されるか,及び農業のための早期警戒情報の仕組みを理解する。	

研修科目	日本における災害管理と気象情報の効果的な利用法	
Title	Disaster Management in Japan and Effective usage of meteorological information	
研修日	8 月 14 日（水）午後	（2.0 時間）
形式（講義/実習）	講義	
講師	栗原　弘一（一般財団法人　気象業務支援センター）	

Lecturer	Koichi Kurihara (JMBSC)
研修内容	日本では国及び地方の防災機関、さらに報道機関等が密接に連携して防災対応していること、また、気象防災情報を効果的に市民に伝え、適確な判断と行動をとるために必要な情報内容や提供の仕方について講義する。
Content	Introduction to disaster management including roles of central, prefectural, and municipal governments, and effective use of disaster prevention information, which is to be timely provided to end-users for their quick decisions and actions for protecting themselves.
研修のねらい（講師が期待する研修到達度）	日本における防災対応の仕組みを理解するとともに、気象情報の効果的な作成・提供の方法を学ぶ。

Appendix D. Final Activity Report

BADAN METEOROLOGI, KLIMATOLOGI, DAN GEOFISIKA
Jl. Angkasa I No. 2, Kemayoran, Jakarta 10610, Telp. : (021) 4246321 Fax. : (021) 4246703
P.O. Box 3540 Jkt, Website : http://www.bmkg.go.id
BMKG

Jakarta, 18 September 2020

Nomor : KL.02.01/003/KPP/IX/2020
Lampiran : 2 (dua) halaman
Perihal : *Launching* Laporan Akhir Kegiatan BMKG-JICA

Yth. Bapak/Ibu (Mohon Periksa Lampiran)
di
Tempat

Dalam rangka peluncuran laporan akhir kegiatan BMKG-JICA, dengan ini kami mohon kehadiran Bapak/Ibu dalam rapat yang akan diselenggarakan pada :

Hari/Tanggal : Rabu, 23 September 2020
Waktu : 8.30 s.d 12.15
Tempat : Offline : CEWS Room BMKG Building B 2nd Floor
Online : video conference via Zoom Meeting
- Meeting ID : 856 6525 8628
- Password : 836702

Acara : Presentasi dan Diskusi Aktivitas 1, Aktivitas 2, dan Aktivitas 3
BMKG-JICA (JMBSC)

Demikian disampaikan. Atas kehadirannya kami ucapkan terima kasih.

Kepala Pusat Informasi
Perubahan Iklim

Dodo Gunawan

Tembusan Yth.:
1. Kepala BMKG
2. Sekretaris Utama
3. Deputi Bidang Klimatologi

Lampiran I Undangan
Nomor : KL.02.01/003/KPP/IX/2020
Tanggal : September 2020

DAFTAR UNDANGAN

1. **Kementerian PPN/BAPPENAS**
   Direktur Pangan dan Pertanian

2. **Kementerian Pertanian**
   Direktur Pembiayaan Pertanian

3. **Balai Penelitian Agroklimat dan Hidrologi**
   Kepala Seksi Jasa Penelitian

4. **Kementerian Keuangan**
   Direktur Pengelolaan Risiko Keuangan Negara

5. **Jasindo**
   Direktur Pengembangan Bisnis

6. **Yayasan Agri Sustineri Indonesia (YASI Foundation)**

7. **Japan International Cooperation Agency (JICA)**
   1. *Economic Development Department*
   2. JICA *Indonesia Office*
   3. JICA *Project of Capacity Development for the Implementation of Agricultural Insurance*
   4. JICA *Project of Capacity Development for the Implementation of Climate Change Strategies Phase 2*

8. **Badan Meteorologi, Klimatologi dan Geofisika**
   1. Kepala Pusat Meteorologi Publik
   2. Kepala Pusat Layanan Informasi Iklim Terapan
   3. Kepala Pusat Meteorologi Maritim
   4. Kepala Pusat Penelitian dan Pengembangan
   5. Kepala Bidang Analisis Variabilitas Iklim
   6. Kepala Bidang Analisis Perubahan Iklim
   7. Kepala Bidang Manajemen Operasi Iklim dan Kualitas Udara
   8. Kepala Bidang Informasi Iklim Terapan
   9. Kepala Bidang Diseminasi Informasi Iklim dan Kualitas Udara
   10. Kepala Bidang Penelitian dan Pengembangan Klimatologi
   11. Kepala Bidang Penelitian dan Pengembangan Meteorologi
   12. Kepala Bidang Layanan Informasi Cuaca
   13. Kepala Bidang Prediksi dan Peringatan Dini Cuaca
   14. Kepala Bagian Hubungan Masyarakat

Tentative Agenda

Launching Final Report BMKG-JICA

September 23, 2020

08.30 - 08.45	Keynote and Instructional Speech from Deputy of Climatology	Drs. Herizal, M.Si
08.45 - 09.00	Keynote Speech from JICA	Ms. Mizoe
09.00 - 09.15	Session I: *Assessment of Precipitation Data and Recommendation Towards Further Utilization by Other Institutions* **Collecting Rainpost Data from East Java and South Sulawesi for the Implementation of Agricultural Insurance** *By : M. Sudirman, Climate Change Projection and Analysis Sub Division BMKG*	**Moderator :** Dodo Gunawan
09.15 - 09.30	**Evaluation of Rain Post Data in Indonesia for Agricultural Insurance** *By : Noveta C, Climate Change Projection and Analysis Sub Division BMKG*	
09.30 - 09.45	**BMKG Observation Data for Agricultural Insurance** *By : Tonouchi, JMBSC*	
09.45 - 10.00	Discussions	
10.00 - 10.30	Session II: *Status of Seasonal Forecasting and Recommendation Towards Further Utilization in Agriculture Sector* **Seasonal Forecast Evaluation and Monsoon Onset/Retreat Variability** *By : Rosi, Climate Analysis and Information Sub-Division BMKG*	
10.30 - 10.45	**Subseasonal-to-Seasonal Prediction for Extreme Events** *By : Novi, Climate Analysis and Information Sub-Division BMKG*	
10.45 - 11.00	**ENSO Forecast Evaluation** *By : Ridha, Climate Analysis and Information Sub-Division BMKG*	
11.00 - 11.15	**Future Plan for Key Activity 2** *By : Adi, Climate Analysis and Information Sub-Division BMKG*	
11.15 - 11.30	**For Enhancing Long-range Forecasting Ability** *By : Dr. Kurihara, JMBSC*	
11.30 - 11.45	Discussions	
11.45 – 12.15	Wrap-up and Closing Remarks	1. Dodo Gunawan 2. JICA

Key Activity 1 :

3. Evaluation for Rain Post data in Indonesia

3.1 Climatology

In general, both the region of East Java and South Sulawesi have several types of rainfall patterns. BMKG categorizes the difference in rainfall patterns between regions into climate zones (ZOM) and non-climate zones (NON-ZOM) areas. Areas categorized into climate zones possess a distinct period of the wet and dry season, usually associated with the monsoonal-type of rainfall, while the non-climate zones areas have an unclear difference between wet and dry seasons (associated with other types of rainfall patterns such as equatorial, anti-monsoonal, or specific type of local wet/dry pattern). In East Java, all the ground observations are located within the areas that are categorized as ZOM, while South Sulawesi has a more diverse classification in which some ground observations are located in the NON-ZOM area. The location of the ground observations that are used in this activity is illustrated below:

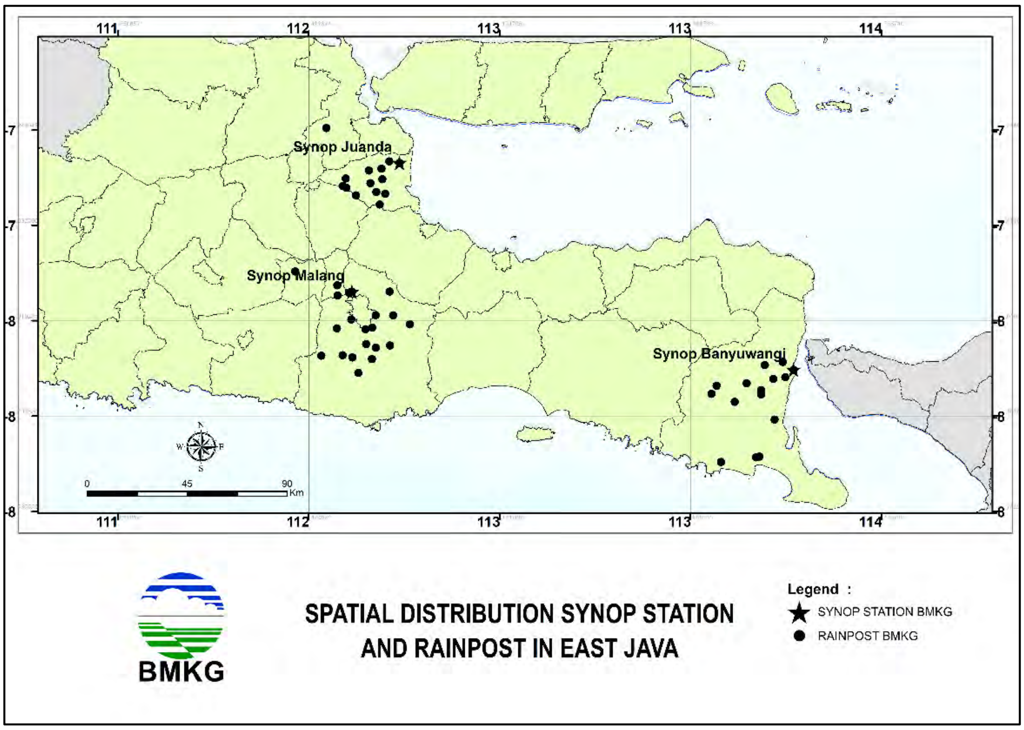


Figure XX. Location of ground-based observations (BMKG's main station and rain-posts) in East Java in which data were retrieved for the analysis

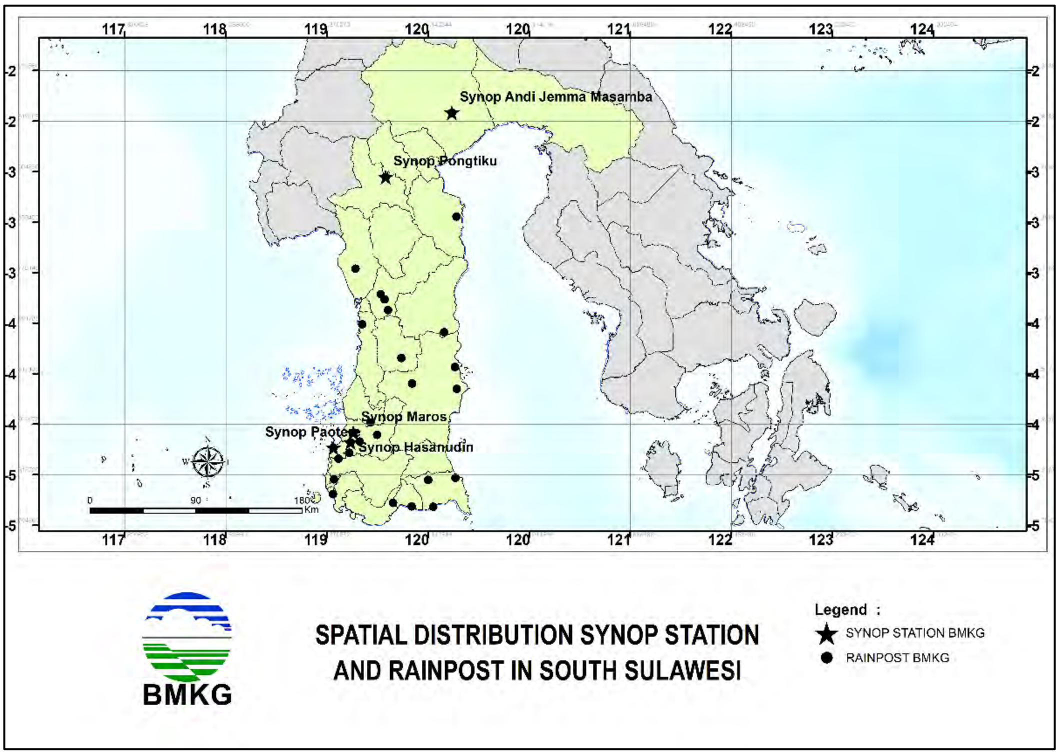


Figure XX. Location of ground-based observations (BMKG's main station and rain-posts) in South Sulawesi in which data were retrieved for the analysis

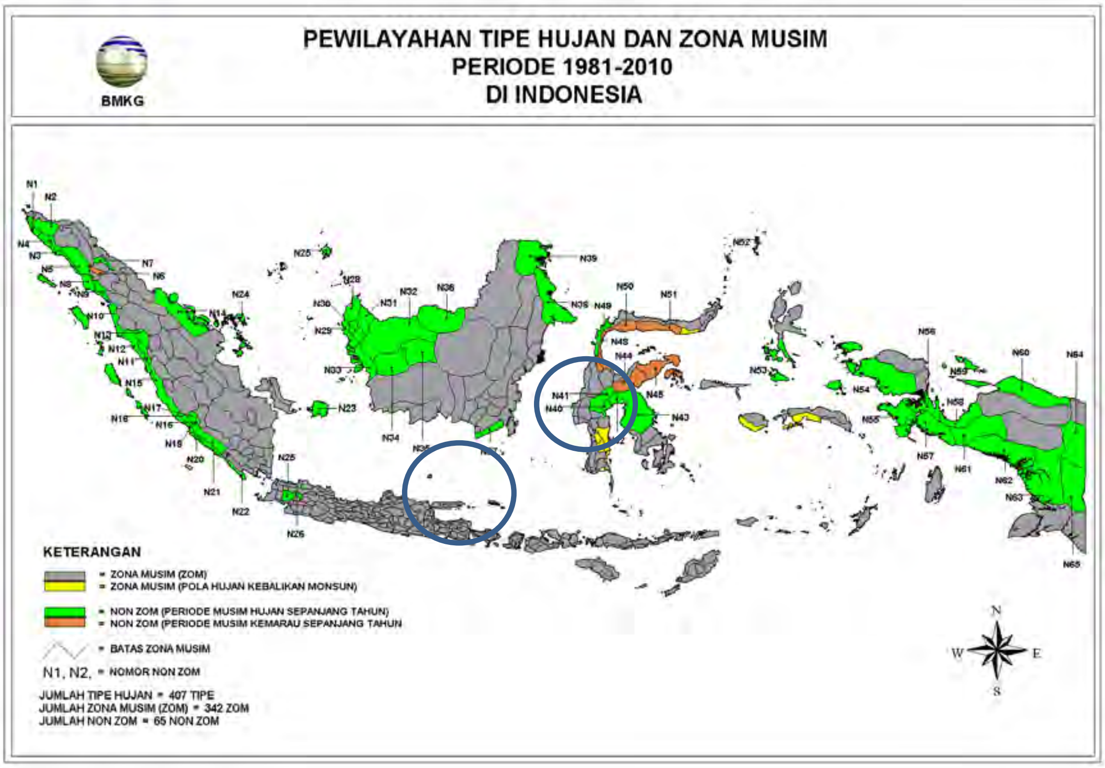


Figure XX. Classification of regions based on its rainfall pattern type as categorized by BMKG

3.2 Indexes for comparison of cumulative precipitation

The working group in BMKG's side has identified and collect several required data for the purpose of analysis over the area of East Java and South Sulawesi, which are considered as the pilot area of this project. Initially, the necessary climate data for this project are the rainfall data from BMKG's primary observation station registered in WMO database (hereupon referred as "SYNOP station data"), additional rain post data (independent observation in cooperation with BMKG, hereupon referred as "rain post data"), and rainfall data from automatic observation system (ARG/AWS/AAWS). Due to several factors, only two data (SYNOP data and rain post data) will be used. Automatic observation is not yet relevant due to short temporal coverage of the historical data.

The first step was to do some quality control of data over the stations and rain posts data in East Java and South Sulawesi. The quality control includes the checking of a minimum of 5-year continuous data, without any blank values. The required length for the following comparative analysis is the 10-year of daily rainfall data. After performing the quality control and selection and division of the relevant station relative to certain rain posts, the regions of analysis are divided based on the reference SYNOP stations:

1. East Java

   3 SYNOP stations are used for the analysis within the East Java area as a reference. The rain post data would then later be classified into several reliability classes based on the comparison with these following reference SYNOP stations. Those three stations are:

   a. Juanda SYNOP station, Surabaya, acting as a reference for 13 surrounding selected pilot rain posts
   b. Karangploso SYNOP station, Malang, acting as a reference for 20 surrounding selected pilot rain posts
   c. Banyuwangi SYNOP station, Banyuwangi, acting as a reference for 14 surrounding selected pilot rain posts

2. Sulawesi Selatan

   5 SYNOP stations are used for the analysis within the South Sulawesi area as a reference. The rain post data would then later be classified into several reliability classes based on the comparison with these following reference SYNOP stations. Those five stations are:

   a. Hasanuddin SYNOP station, Makassar, acting as a reference for 5 surrounding selected pilot rain posts

b. Maros SYNOP station, Makassar, acting as a reference for 8 surrounding selected pilot rain posts
c. Paotere SYNOP station, Makassar, acting as a reference for 9 surrounding selected pilot rain posts
d. Pongtiku SYNOP station, Tana Toraja, acting as a reference for 13 surrounding selected pilot rain posts
e. Andi Jemma Masamba SYNOP station, North Luwu, acting as a reference for 1 surrounding selected pilot rain post

There are three rain posts with two SYNOP stations as a reference, considering the close proximity of the locations.

In addition to the comparative analysis between SYNOP stations and rain posts, the BMKG working group has done the comparative analysis between both ground observation data (SYNOP and rain post) and the GSMaP satellite data. This assessment is done in order to identify the performance of GSMaP over the two provinces as the domain of analysis. The usage of GSMaP data is important considering the lack of homogenous spatial coverage in Indonesia. The application of climate index insurance would require alternative data in the case that there is no reliable ground observation in a certain area. The GSMaP data that is used is the GSMaP MVK, an hourly dataset which later processed to daily data for the purpose of the analysis.

The assessment of reliability was done by adopting the step-by-step instructions methodology as explained by the experts from JICA. Those methods including:

1. Correlation coefficient

   Correlation is one of the statistical tests to determine whether or not a relationship exists between variables. The correlation coefficient itself indicates the magnitude or intensity of the relationship.

$$correlation\ coefficient = \frac{Sxy}{(\sqrt{Sxx} \times \sqrt{Syy})}$$

Notes:

x = reliable (reference) data

y = to be tested data

Sxy = *covariance* (x,y)

Sxx = *variance* (x)

Syy = *variance* (y)

A bigger the coefficient correlation value shows higher reliability to the reference data. In this project, the correlation coefficient is calculated based on daily and cumulative rainfall. The cumulative rainfall correlation coefficient acted as the main parameter in the reliability test of rainfall data. The threshold for reliability class based on the correlation coefficient is less than 0.9.

2. Smoothness

Smoothness is the deviation relative to the regression line. Small smoothness value shows the data has low deviation, displayed by a relatively smooth comparison line. Smoothness is closely connected with the correlation coefficient, s it is calculated using variance dan covariance. Smaller smoothness values indicate a higher reliability of the tested data. The calculation of smoothness is also based on cumulative rainfall data, with the threshold of reliability class of less than 5%.

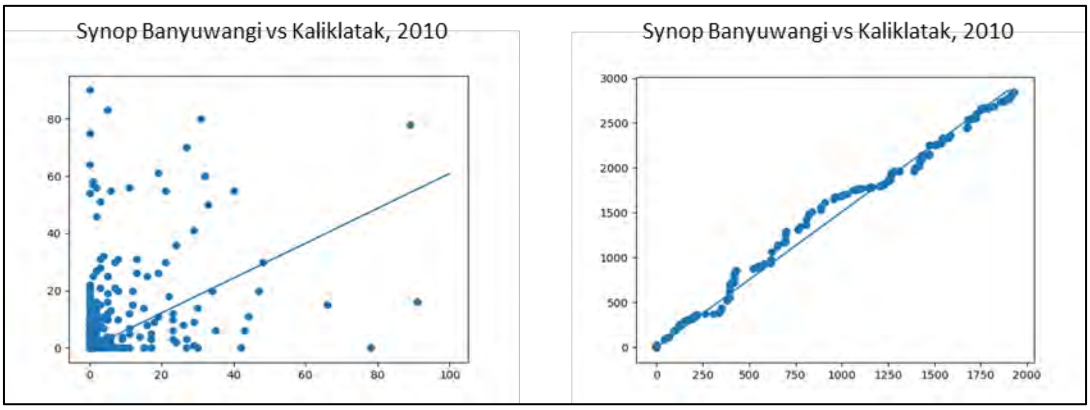


Figure xx. Scatter chart and double sum curve

3. Contingency table

The reliability of data in this method is determined by the higher hit-rate values. The hit-rate procedure was done for daily and dekadal (10-day cumulative) rainfall. The threshold is 20 mm/day for daily rainfall and 50 mm/day for decadal rainfall. The 20 mm/day threshold is the BMKG's standard for light rain while the 50mm/day threshold is one of the BMKG's criteria for determining the season onset. The threshold for reliability class based on the hit-rate is greater than 0.67.

contingency table				
Synop Banyuwangi vs Kaliklatak				
precipitation >=		20	mm/day	
		yes	no	Kaliklatak
Synop Banyuwangi	yes	13	20	
	no	33	299	
Synop Banyuwangi vs Kaliklatak				
precipitation >=		50	mm/dasariany	
		yes	no	Kaliklatak
Synop Banyuwangi	yes	15	1	
	no	7	13	

Figure xx Contingency Table

4. Number of jumps

   The number of jumps is determined based on the double sum curve, in which a jump in the comparison graph between two datasets occurred. This is usually present in the case of heavy rainfall. If heavy rainfall is only detected in one of the data, then a shape gap in the double sum curve is displayed. This index is not considered for the reliability class calculation.

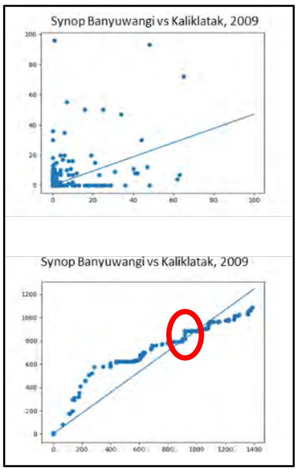


Figure xx scatter chart and double sum curve with a shape gap

3.3 Summary and determination of alternative station

Previously mentioned factors/indexes are calculated with both Microsoft Excel and Python software, and the result is displayed in the following.

Table 1. An example of the summary of calculation and reliability class between Kaliklatak rain post and Banyuwangi SYNOP station

							>=0.9	<=5%	<=5%			>=0.67	>=0.67			
No	Rain Post	Lat	Lon	Year	Distance (km)	Correlation daily	Correlation sum	smoothness: smoothness 2 (average)	smoothness: smoothness 3 (SD)	Proportion daily	Proportion sum	Hit rate in contingency sheet: daily	Hit rate in contingency sheet: dasarian	Reliable Dasarian	TRUE	FALSE
	Stamet Banyuwangi	-8.2167	114.383													
1	Kaliklatak	-8.1853	114.34	2009	6	0.403	0.967	6.42%	5.37%	0.471	0.891	0.75	0.918	FALSE		
	Kaliklatak	-8.1853	114.34	2010	6	0.343	0.996	2.42%	2.03%	0.609	1.51	0.855	0.778	TRUE		
	Kaliklatak	-8.1853	114.34	2011	6	0.262	0.982	4.49%	3.27%	0.461	1.186	0.923	0.722	TRUE		
	Kaliklatak	-8.1853	114.34	2012	6	0.385	0.983	5.63%	3.26%	0.792	1.443	0.902	0.806	FALSE		
	Kaliklatak	-8.1853	114.34	2013	6	0.063	0.988	2.89%	3.10%	0.234	1.589	0.841	0.833	TRUE		
	Kaliklatak	-8.1853	114.34	2014	6	0.173	0.991	3.24%	2.31%	0.251	1.227	0.923	0.806	TRUE		
	Kaliklatak	-8.1853	114.34	2015	6	0.246	0.99	2.75%	2.85%	0.305	1.015	0.91	0.917	TRUE		
	Kaliklatak	-8.1853	114.34	2016	6	0.133	0.99	2.95%	2.41%	0.287	1.099	0.877	0.806	TRUE		
	Kaliklatak	-8.1853	114.34	2017	6	0.202	0.977	4.76%	3.93%	0.315	0.924	0.874	0.75	TRUE		
	Kaliklatak	-8.1853	114.34	2018	6	0.227	0.98	3.40%	3.12%	0.335	1.003	0.901	0.806	TRUE	8	2
	Kaliklatak														80	20

Table 1 shows the result of the calculation for each year within the recent 10 years. The summary indicates that the reliability criteria of Kaliklatak rain post relative to Banyuwangi SYNOP station produce a value of 80%. This means that within the 10-years period, there are 8 reliable years and 2 unreliable years based on the employed threshold. As mentioned above, the threshold used is based on these following indexes:

1. Correlation coefficient of cumulative rainfall between two data
2. Smoothness
3. Hit rate contingency table of dasarian rainfall

The determination of the reliability class of a rain post in East Java and South Sulawesi, the BMKG working group use a slightly different approach with what has been done by the JICA experts. In this case, the year-by-year justification is used, which later summarized into the number of the analyzed year (10 years period). Only then, the reliability of the rain post relative to the reference station can be assessed.

Table 2. Reliability Criteria

Percentage Reliable	Criteria
91 - 100 %	Reliable
81 - 90 %	Reliable
71 - 80 %	Reliable
61 - 70 %	Reliable
<= 60%	Unreliable

The result of all the processed rain-posts data is presented in Figure XX. In general, the result shows a varying result of reliability criteria.

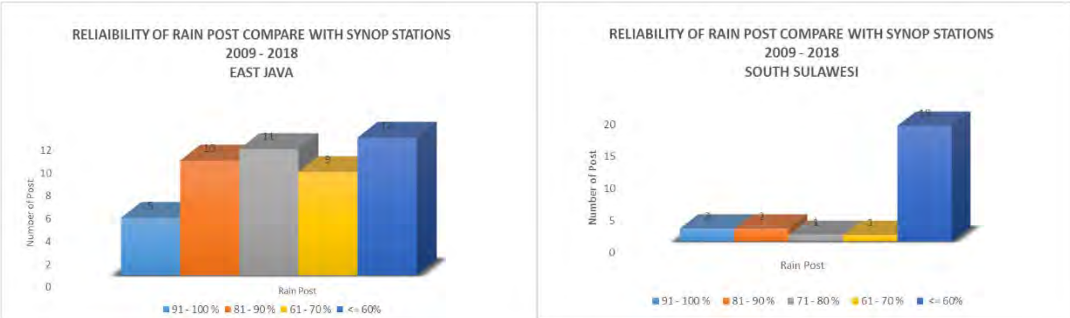


Figure XX. Diagram of reliability class of rain-posts

(as compared with SYNOP station)

Figure XX shows that in East Java, there are 35 rain-posts with reliability values exceeding 60%. This means that, if the data from those 35 posts are decided to be used for further analysis purposes, the missing data can be replaced by the data from the reference SYNOP station. It can be inferred from the result that the reliability values in East Java are relatively better than those in South Sulawesi. The low reliability in South Sulawesi is suspected to be the result of the difference in the rainfall pattern among the rain-posts and the SYNOP station that is used as a reference. As explained earlier, all regions in East Java are categorized as a ZOM-type (having a monsoonal-type rainfall pattern). Meanwhile, South Sulawesi itself is a region with more than one type of rainfall pattern. This limitation offers another opportunity to use a different dataset as a supporting tool, in which one of them is the satellite-based data. The GSMaP is one of the satellite-based data that is used in this analysis.

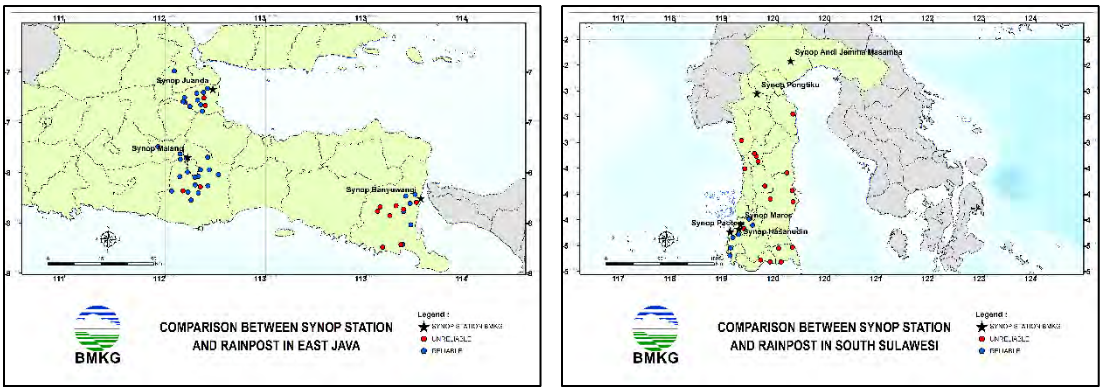


Figure XX. Comparation Between Synop Station and Rainpost

As with the rain-posts and SYNOP data, the reliability of GSMaP data (compared to the reference SYNOP data) is required to be assessed in the beginning. The reliability class of the comparison between GSMAP data and SYNOP data is displayed in Figure XX.

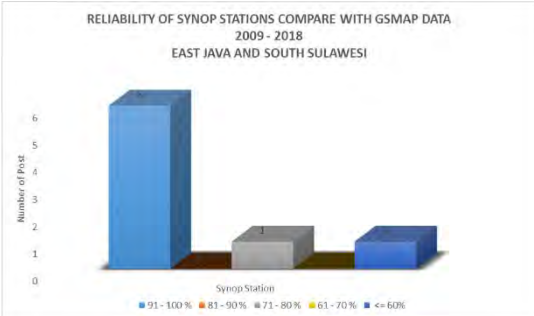


Figure XX. Diagram of reliability class of GSMaP data (as compared with SYNOP station)

Among 8 of the analyzed GSMaP data with the same location as the reference SYNOP station, 7 of them suggesting a high-reliability class greater than 70%, with the other one having a lower reliability class (less than 60 %). Two Synop station that have reliabity less than 80% are the locations in high elevation. This implies that the GSMaP data has a higher performance in reconstructing the ground observation located in low elevation. The calculation result for the reliability of ground observations and the GSMaP data is shown in Figure XX.

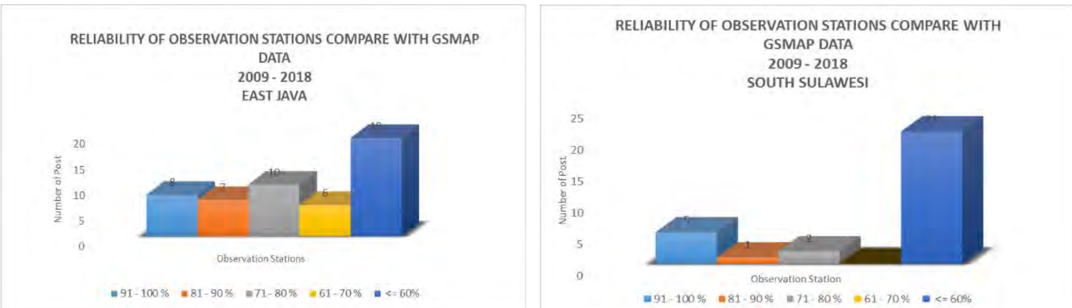


Figure XX. Reliability of GSMaP data compared to the ground observations

Figure XX shows that mostly, the reliability of GSMaP data over the rain-posts location is relatively low. While the reliability of GSMaP data is good in the location of SYNOP station, the comparison between the GSMaP over the rain-posts location suggests an opposite result.

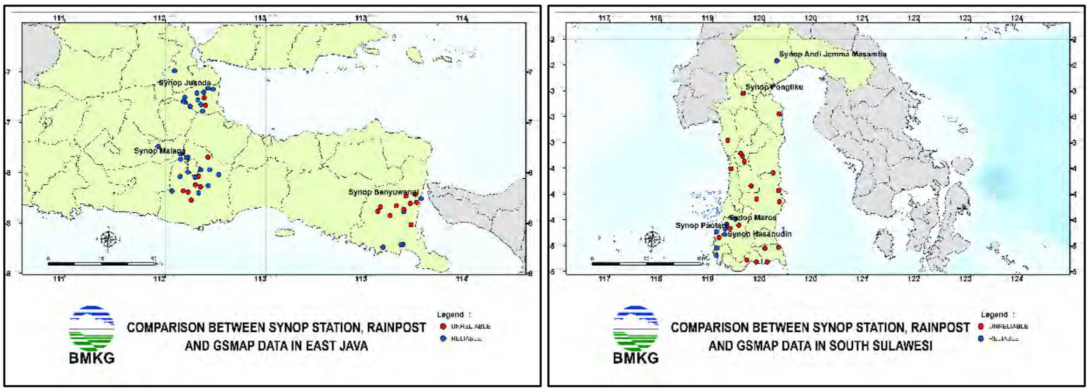


Figure XX Comparation Synop Station and Rainpost with GSMaP Data

Based on those reliability calculation results, the BMKG working group recommends the following suggestions:

a. If a rain-post has a reliability class greater than 60%, the rain-post data is reliable to the reference station. If the data is to be used for an analysis purpose (particularly for climate-index insurance decision), then the missing data could be substituted with the data from the reference station. The substituted data must be calculated first with the equation retrieved from the reliability calculation.

b. If a rain-post has low reliability both towards the reference SYNOP station and GSMaP data in the area, while the GSMaP has high reliability in the SYNOP station area, then there are two possibilities. The first is to use another reference station and recalculate the reliability class, while the second is to use the GSMaP data as the substitute.

Summary:

a. The reliability of rain-posts data is determined based on the percentage of reliable years during the 10-year period, with a minimum threshold more than 60% or 0.6.

b. The justification of the reliable years is based on the three criteria, which are: correlation coefficient greater than 0.9, smoothness less than 5%, and hit-rate exceeding 0.67.

c. The reliability of rain-posts data in East Java is better than in South Sulawesi. In East Java, 35 out of 47 rain-posts is reliable, while only 6 out of 24 in South Sulawesi. Some suspected causes are, (a) The proximity of rain-posts concerning the reference station and, (b) Variation of rainfall pattern over the regions.

d. The performance of the GSMaP data in East Java is better (than in South Sulawesi), both in reconstructing SYNOP station ground observations and rain-post ground observations.

4. Conclusions

a. A further evaluation needs to be done in other regions. The results of the evaluation should be compared to the East Java and South Sulawesi results.
b. Considering the frequent event of convective rainfall over Indonesia, it might be good to add more criteria into the reliability justification (among them might be the number of jumps from the double sum curve).
c. Comparison between rain posts data with lower difference in distance and altitude could provide an alternative in the further effort of assessing reliability.
d. For the purpose of agricultural insurance, the top priority be the SYNOP ground observation data. In the case of the location is significantly far from the SYNOP data, the rain posts data can be used after applying the previously explained quality control method. Other options is to use satellite-based observations like GSMaP data.
e. *Not only for agricultural insurance also for BMKG various activities, collection of rain post data and these evaluation is important. We should continue such activities.*
f. *BMKG now starting AWS/ARG network and these data is used for BMKG drought index, GSMaP precipitation re-calibrated with observation (AWS/ARG) data. For future usage of the product not only for drought index but for mesh precipitation data to watch heavy rain, BMKG needs to develop quality check for AWS/ARG data and the methods what we have done is applicable for AWS/ARG quality check.*

FINAL REPORT OF JICA PROJECT

Project of Capacity Development for The Implementation of Agricultural Insurance for Republic Indonesia

Key Activity 2: Develop Weather Information and Strengthen Abilities for Producing Products for Agriculture.

Adi Ripaldi, Supari, Rosi Hanif D, Novi Fitrianti, Ridha Rahmat and Damiana Kurihara,

Centre For Climate Change Information, BMKG – Indonesia

JICA

1 Improvement of Seasonal Forecast

1-1 Evaluation of Operational Forecast (BMKG Forecast and JMA guidance)

(1) Introduction

- **Background**

The climate in Indonesia is influenced by several factors such as Monsoon wind, ENSO, IOD, MJO and Sea Surface Temperature in Indonesia. These factors are driving factors of climate variability in Indonesia on a daily, weekly, monthly to annual scale. Climate in the territory of Indonesia varies among regions. There are 3 main patterns of rainfall in Indonesia, namely the unimodal monsoon rainfall pattern, the equatorial rainfall pattern which has bimodal monthly rainfall distribution (two peaks of wet season) and the local rain pattern which has a monthly rainfall distribution in contrast to the monsoon rain pattern. Local patterns have unimodal but in opposite pattern with monsoon rainfall pattern.

To simplify the forecast of the season's onset in an area, BMKG classifies regions based on the types and characteristics of climate. At present, there are 342 Seasonal Zones (ZOM) in Indonesia and 65 Non Seasonal Zones (Non ZOM). The seasonal zone is a region that has a clear distinction between wet season and dry season. Whereas the non-seasonal zone has unclear distinction between wet season and dry season. Forecast of season's onset has been carried out since 2000 where at that time there were only 21 climate forecast areas. The mapping of the seasonal zone region is used by BMKG to predict the season's onset in each district which has a similar pattern of climate. This study aims to evaluate climate forecasts in Indonesia. The evaluation covers verification of the season's onset forecast that issued by BMKG, verification of season's onset forecast using 4 statistical methods ARIMA, ARIMA WAVELET, ANFIS and ANFIS WAVELET at 2 seasonal zones in East Java represented by ZOM 152 and South Sulawesi by ZOM 299, and verification of the probabilistic forecast for monthly rainfall in 2018 using ECMWF data. Those verifications are carried out as part of key activity 2 of the JICA project namely "Develop Weather Information and Strengths Abilities for Producing Products for Agriculture". It is hoped that through this activity we can obtain information about quality of the data and methods that have been used so far in seasonal forecast so that in the future we can improve the forecast products by BMKG. Accurate forecasts can support even improve BMKG services to public, especially in agriculture sector.

- **Data and Method**

In this activity, we compare wet season and dry season forecast data that have been officially issued by BMKG with observed data. The observation data were collected from the regional offices of BMKG throughout Indonesia who are in charge of climatology in their respective regions. Seasonal forecast conducted by BMKG Headquarter uses two main methods, they are statistical method and the dynamic method. The dynamic method uses the daily data of the global ECMWF and CSFv2 models while the statistical method uses 4 methods namely ARIMA, ARIMA WAVELET, ANFIS and ANFIS WAVELET. These statistical methods are very commonly used by forecasters in headquarter and regional offices of BMKG. But until now there is still lack of verification measurements related to those methods in each seasonal zone in Indonesia, so it is necessary to verify the methods. This activity carries out verification in two seasonal zones in East Java and South Sulawesi as case studies. Both regions were chosen based on the objective of JICA's activities to develop implementation of climate information for agricultural insurance using climate index that is planned to be carried out in both regions. Therefore, to carry out the statistical methods, we need series of data which have at least 30 years observation data from rainfall posts in both regions. The territory of Indonesia consists of 342 Seasonal Zones (ZOM) and 65 Non Seasonal Zones (Non ZOM). East Java and South Sulawesi are representative of center for rice in Indonesia. This pilot tries to assess the existing Seasonal Zones (ZOM) in both areas. The assessment for both provinces, takes 1 seasonal zone representative by selecting the ZOM based on the best data availability, more complete series or more than 30 years, then ZOM 152 (Monsoonal type) was chosen to represent the East Java and ZOM 299 (Local Type) representative South Sulawesi. ZOM 152, located at south of Bojonegoro, has 4 main rainfall posts while ZOM 299, located in southern Soppeng and Central Bone, has 6 main rainfall posts where two of them have complete data since 1981.

In carrying out the verification, several stages are done as following stages:

1. Season’s onset forecast data that has been issued by BMKG and observed season’s onset data for both wet and dry season are changed into categorical data where there are 3 categories, namely **Near Normal (NN)** where season’s onset of forecast and observation only has +/- 1 dasarian/dekad (10 day period) near normal, **Earlier than Normal (E)** where season’s onset of forecast and observation has 2 or more dasarian (dekad) earlier than normal, and **Later than Normal (L)** where season’s onset of forecast and observation has 2 or more dasarian (dekad) later than normal.

Table 1-1-1. 3 x 3 Contingency Table for Verification of Season's Onset Forecast

SCORE	Observed E	Observed NN	Observed L
Forecast E	1	0	0
Forecast NN	0	1	0
Forecast L	0	0	1

2. From those data that have become categorical data, we calculate the score and hit rate using the 3x3 contingency table. This method is performed for each large island in the Indonesia (Sumatra, Java, Bali-Nusa Tenggara, Kalimantan-Sulawesi and Maluku-Papua).
3. For verification of seasonal zone (ZOM) in East Java and South Sulawesi using 4 statistical methods, several steps were carried out. The basic data that used in this verification is started from 1981. We perform reforecast of each method for data series since 10 years before the reforecast year. If the reforecast year is called **n** then the series that we used for the prediction is **(n-10) until (n-1),** and we repeat the same steps until **n + 19.** In this case, in order to reforecast 1991, we use data during 1981 - 1990, for 1992 we use data during 1982-1991, and so on for the next 20 years.
4. From this process, 20 years of reforecast rainfall data were obtained from each method in dasarian or dekad scale. These values are then used to determine the season's onset and the season's retreat for wet season and dry season. The determination of season's onset is determined based on the criteria set by BMKG. It is said that the wet season's onset is defined when the rainfall is more or equal to 50 mm/dasarian and followed by the following two dasarians while the dry season's onset is defined when the rainfall is below 50 mm/dasarian and followed by the following two dasarians. This can be explained by Figure 1-1-1 below.

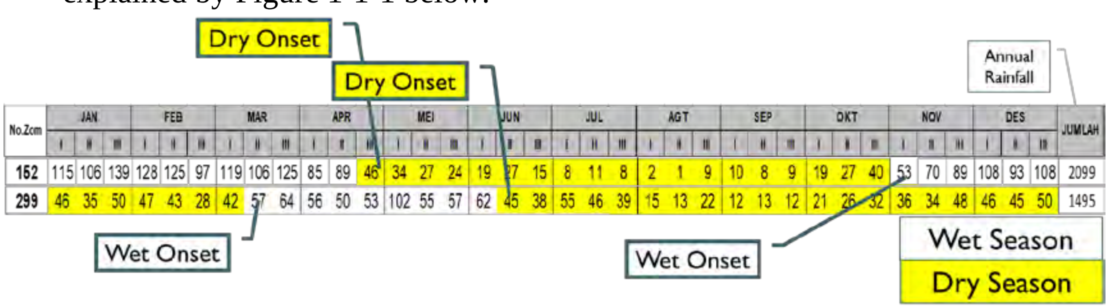


Figure 1-1-1. Determination of the start of the season based on BMKG criteria

5. After determining the onset of dry season and wet season, the data is converted into categorical data like the verification of issued season's onset forecast from BMKG

(point 1) where the data is converted into data 3 categories then calculate the score and the hit rate for each statistical method.

6. The probabilistic forecast of monthly rainfall during 2018 is verified using a contingency table with observed data that is blended between observation stations and GSMaP satellite data. Probabilistic forecast data in each category (less than 20 mm / month, less than 50 mm / month, less than 100 mm / month, less than 150 mm / month, more than 50 mm / month, more than 100 mm / month, more than from 150 mm / month, more than 200 mm / month, more than 300 mm / month, more than 400 mm / month, more than 500 mm / month, and more than 600 mm / month) is converted into categorical data namely, **Yes** and **No Event** where the score is 1 (one) if the probability of rainfall forecast in category **a** is greater than 50% and the observed rainfall is also in category **a** too, or the probability of rainfall in category **a** is less than 50% and the observed rainfall is not in category **a**. The following is an example of a contingency table for verifying rainfall probabilistic forecast of August for category of *less than 20 mm / month*.

Table 1-1-2. 2 x 2 Contingency Table for Verification of Probabilistic Forecast

SCORE **August** **Below 20 mm/month**	Observation below 20 mm/month **(Yes)**	Observation above 20 mm/month **(No)**
Forecast Probability >50% **(Yes)**	1	0
Forecast Probability ≤50% **(No)**	0	1

(2) Result and Discussion

As it is known that Indonesia has 342 ZOM regions. This verification of season’s onset forecast was divided into 5 large islands in Indonesia including Sumatra, Java, Bali-Nusa Tenggara, Kalimantan-Sulawesi, and Maluku-Papua.

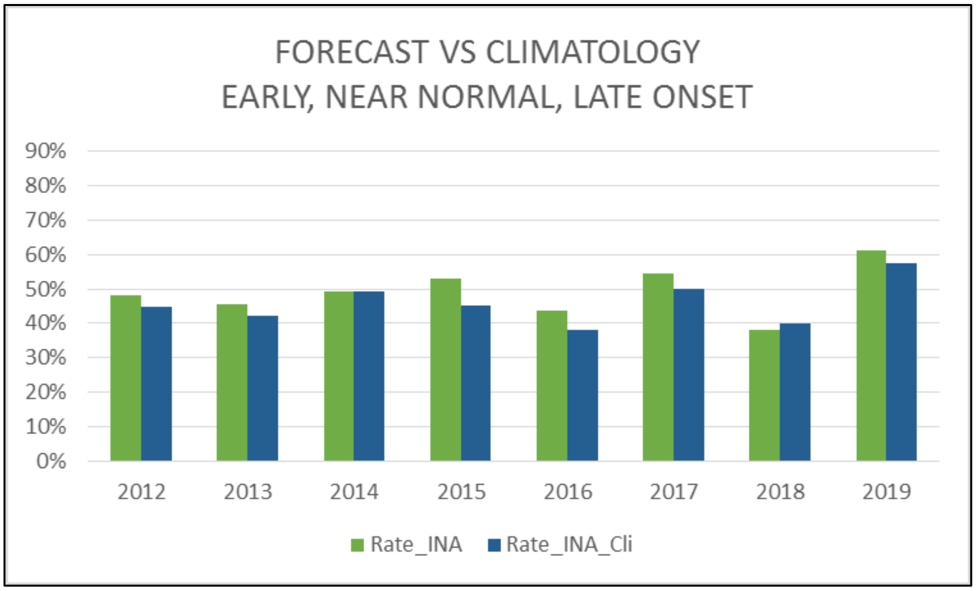


Figure1-1-2. Hit Rate Comparison between Dry Season's Onset Forecast issued by BMKG and Climatological Forecast in Indonesia

Figure 1-1-2 explains the hit rate of the dry season's onset forecast issued by BMKG to the observed dry season's onset compared with hit rate of dry season's onset forecast using climatological forecast to observed dry season's onset over 342 ZOMs in Indonesia during 2012 until 2019. As seen in the Figure above, it is found that the forecast hit rate of the issued dry season's onset in Indonesia ranges around 40 - 60%. This shows that the issued forecast of the dry season's onset in Indonesia has an accuracy level that is around 40% up to 60% compared to its observed dry season's onset. As for climatological forecast of dry season's onset, the hit rate is not much different from the issued forecast hit rate (+/- less than 10% difference) but still lower than the issued dry season's onset forecast. This also explains that dry season's onset in Indonesia tends not to be much different from its normal.

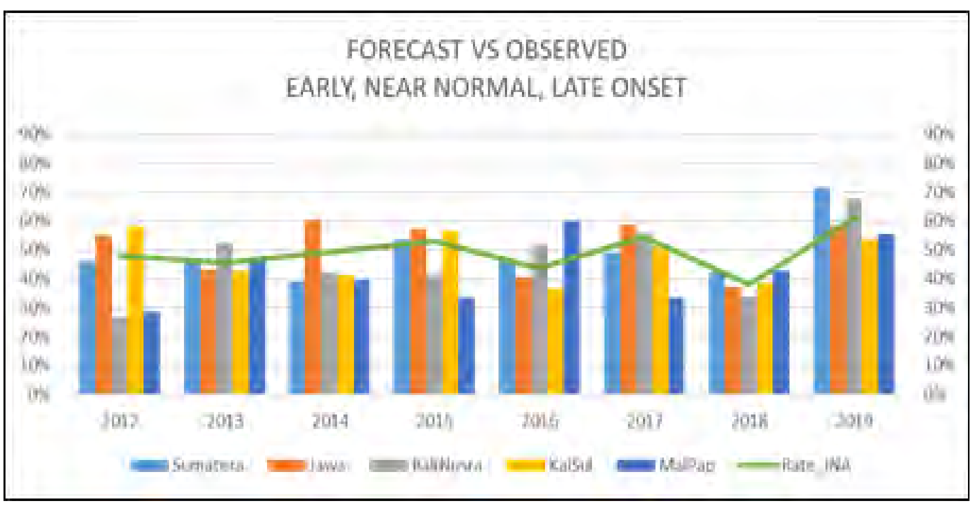


Figure 1-1-3. Hit Rate Comparison of Issued Dry Season's Onset among 5 Major Islands in Indonesia

Figure 1-1-3 explains the hit rate of dry season's onset forecast issued by BMKG for 5 major islands in Indonesia. It shows that the hit rate in Java generally has the highest hit rate among 5 major islands. Bali - Nusa Tenggara and Maluku Papua generally has lower hit rate than other islands. The hit rate in 5 major islands fluctuates each year. We can say that 2019 has best forecast since the hit rate for all 5 major islands is more than 50% where in previous years they have relatively lower hit rate especially Maluku-Papua was less than 40%.

Table1-1- 3. Skill Score of Issued Dry Season's Onset Forecast Over Indonesia

Skill	2012	2013	2014	2015	2016	2017	2018	2019
Skill_INA	0.07	0.08	0.00	0.17	0.15	0.09	-0.05	0.95
Sumatera	0.32	-0.04	0.05	0.32	0.00	0.09	0.10	0.36
Jawa	0.03	-0.11	0.03	0.06	0.72	0.12	-0.15	0.00
BaliNusra	-0.45	0.29	-0.07	0.29	-0.19	0.00	0.11	0.03
KalSul	0.64	0.69	-0.13	0.30	0.05	0.15	-0.04	0.16
MalPap	1.00	0.40	0.50	0.25	0.13	-0.20	0.00	0.00

Table 1-1-3 explains the skill of dry season's onset forecast issued by BMKG on 5 major islands in Indonesia where the score is obtained from the difference between the score of the issued forecast with its climatological forecast score compared to the climatological forecast score. It is seen that generally issued forecast for dry season's onset in Indonesia is better than the climatological forecast. Several years for some major islands and 2018 for Indonesia have negative score which indicates that the issued forecast for the dry season's onset is worse than its climatological forecast. While 0.00 indicates that the issued forecast is as good as its climatological forecast. The skill score for Indonesia in 2019 reaches 0.95 as its highest score. When we looked in details on each major island, it generally varies where the Java region has the highest score in 2016 (0.72) and Bali-Nusa Tenggara has least score in 2012 (-0.45).

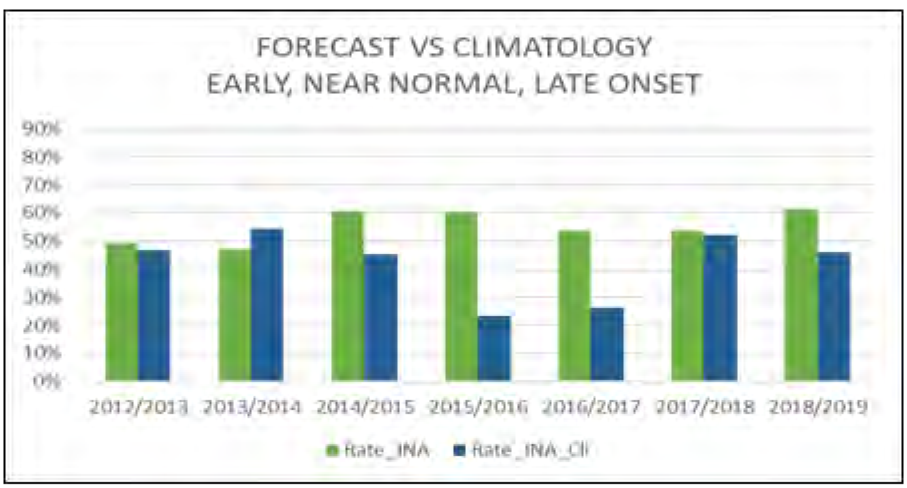


Figure 1-1-4. Hit Rate Comparison between Wet Season's Onset Forecast issued by BMKG and Climatological Forecast in Indonesia

Figure 1-1-4 explains the hit rate of the wet season's onset forecast issued by BMKG to the observed wet season's onset compared with hit rate of wet season's onset forecast using climatological forecast to observed wet season's onset over 342 ZOMs in Indonesia during 2012 until 2019. As seen in the Figure above, it is found that the forecast hit rate of the issued dry season's onset in Indonesia ranges around 50 - 60%. This shows that the issued forecast of the wet season's onset in Indonesia has an accuracy level that is around 50% up to 60% compared to its observed wet season's onset. As for climatological forecast of wet season's onset, the hit rate has relatively large gap (generally more than 10% gap) and lower than the issued wet season's onset forecast. This also explains wet season's onset in Indonesia tends to vary from its normal.

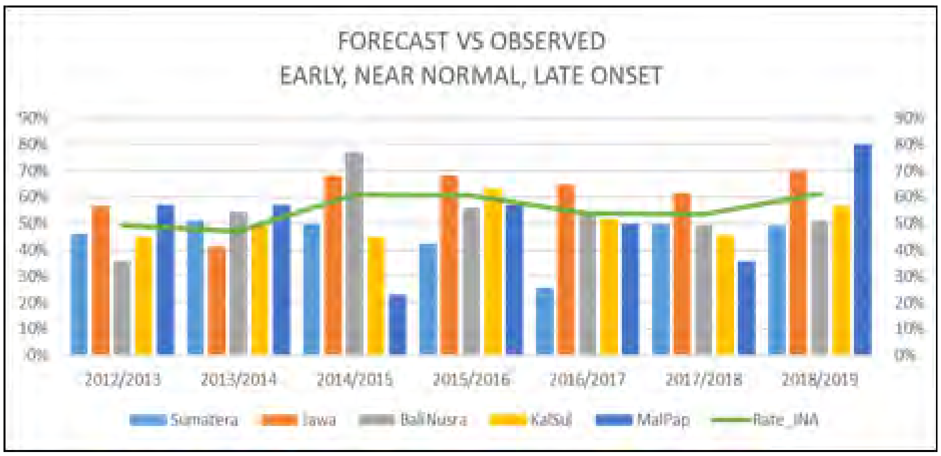


Figure 1-1-5 Hit Rate Comparison of Issued Wet Season's Onset among 5 Major Islands in Indonesia

Figure 1-1-5 explains the hit rate of wet season's onset forecast issued by BMKG for 5 major islands in Indonesia. It shows that the hit rate in Java generally has the highest hit rate among 5 major islands. The hit rate in 5 major islands fluctuates each year. We can say that 2015/2016 has best forecast since the hit rate for all almost 5 major islands are more than 50% (except Sumatra with 43%) while in other years they have relatively lower hit rate.

Table 1-1-. Skill Score of Issued Wet Season's Onset Forecast Over Indonesia

Skill	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Skill_INA	**0.05**	**-0.13**	**0.34**	**1.58**	**1.02**	**0.03**	**1.03**
Sumatera	0.00	0.08	0.13	1.09	0.30	0.09	0.00
Jawa	0.02	-0.27	0.40	1.62	5.13	0.06	0.46
BaliNusra	0.00	-0.14	0.22	0.94	0.03	-0.15	0.20
KalSul	0.12	-0.03	0.93	3.22	0.33	0.12	0.40
MalPap	0.60	0.60	-0.40	1.67	0.00	0.00	0.33

Table 1-1-4 explains the skill of wet season's onset forecast issued by BMKG on 5 major islands in Indonesia where the score is obtained from the difference between the score of the issued forecast with its climatological forecast score compared to the climatological forecast score. It is seen that generally issued forecast for wet season's onset in Indonesia is better than the climatological forecast. Several years for some major islands and 2013/2014 for Indonesia have negative score which indicates that the issued forecast for the wet season's onset is worse than its climatological forecast. While 0.00 indicates that the issued forecast is as good as its climatological forecast. The skill score for Indonesia in 2015/2016 reaches 1.58 as its highest score. When we looked in details on each major island, it generally varies where Java region has the highest score in 2016/2017 (5.13) and Maluku-Papua has least score in 2014/2015 (-0.40).

In addition to verification of dry and wet season's onset forecast in 342 Indonesian Seasonal Zones (ZOMs), verification is also carried out on two Seasonal Zones in East Java (ZOM 152) and South Sulawesi (ZOM 299).

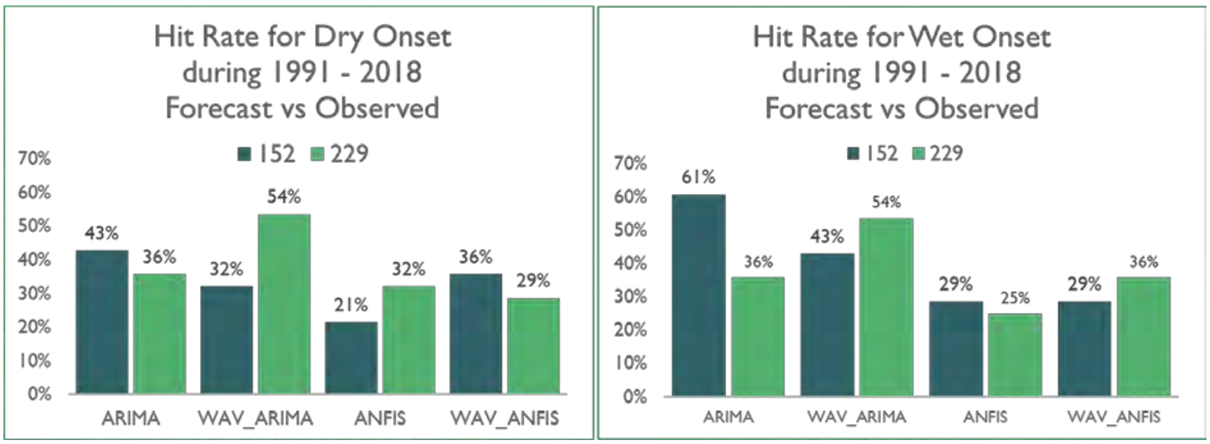


Figure 1-1-6. Comparison of Hit Rate Estimates for Early Dry and Wet Season in ZOM 152 and ZOM 299

Figure 1-1-6 explains the results of verification for dry and wet season's onset forecast using four statistical reforecast methods (ARIMA, WAVELET ARIMA, ANFIS, and WAVELET ANFIS) during the 1991-2018 period. It shows that ARIMA and WAVELET ARIMA methods have better verification results than other methods to predict the dry and wet season's onset in both Seasonal Zones (ZOM 152 and ZOM 299). The season's onset forecast in ZOM 152 is best using ARIMA method with 43% of hit rate for dry season's onset forecast and 61% for the wet season's onset forecast. Whereas the season's onset forecast in ZOM 299 is best to use the WAVELET ARIMA method with 54% of hit rate for both dry and wet season's onset forecast.

Aside from season's onset forecast, we also conduct verification for probabilistic forecast of monthly rainfall during 2018.

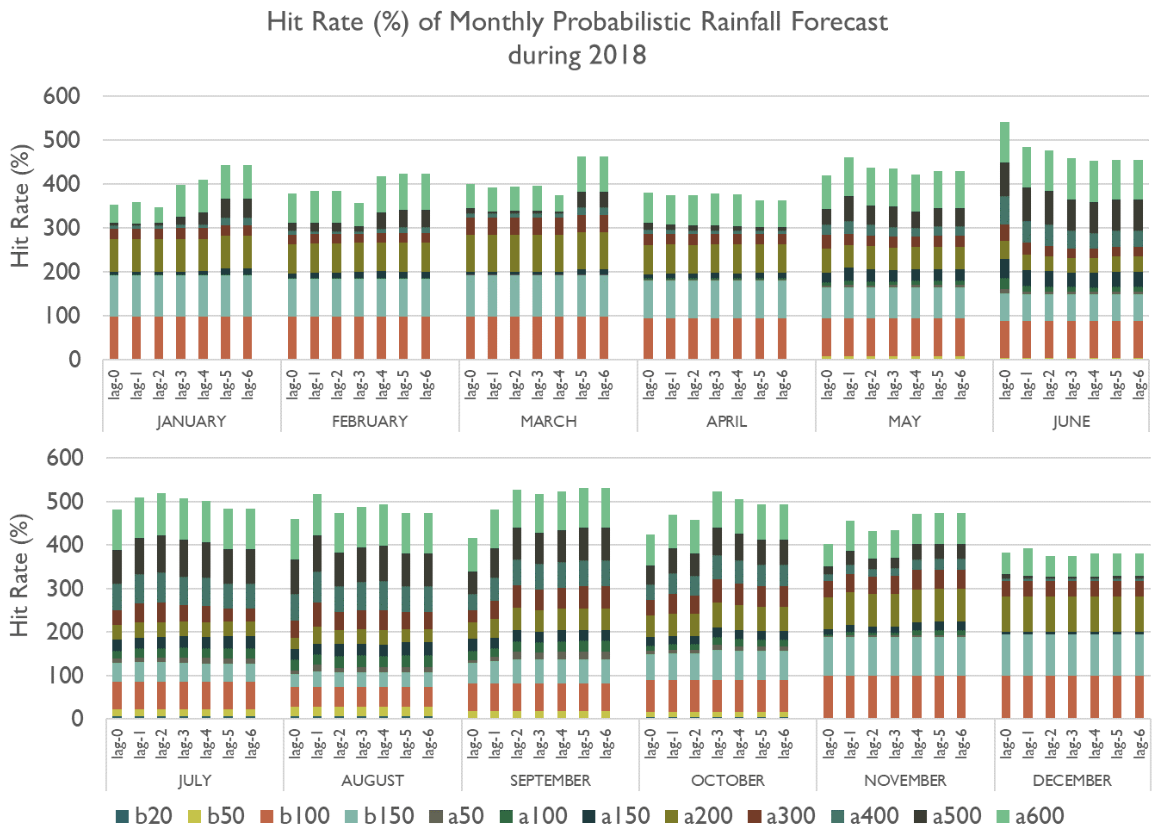


Figure 1-1-7. Hit Rate Probabilistic Forecast for Monthly Rainfall in 2018

Figure 1-1-7 shows that in general, monthly rainfall probabilistic forecasts during 2018 for categories less than 100 mm/month, less than 150 mm/month, and more than 200 mm/month tend to be good throughout the year with hit rate generally greater than 50%. The hit rate for the category less than 100 mm/month and less than 150 mm/month tends to decrease in June-August 2018 as the target month while the category of more than 200 mm / month has the best hit rate for June - August 2018 as the target month. The hit rate for the category 600 mm/month tends to be relatively good especially for May - October 2018 as the target month. Generally, there is no significant difference among the lag-6 until lag-0 forecasts.

(3) Results and Future Tasks

- **Results**

From the result and discussion above, there are some points that can be taken as conclusion as follows:

- Generally dry and wet season's onset forecast for 342 Seasonal Zones in Indonesia issued by BMKG since 2012 is better than the climatological forecast, except 2018 for dry season and 2013/2014 for wet season. Generally wet season's onset forecast has higher hit rate and skill than dry season's onset forecast so we can say that wet season's onset forecast is better than dry season's onset forecast.

- Among 4 statistical methods (ARIMA, WAVELET ARIMA, ANFIS, and WAVELET ANFIS) that is used to forecast dry and wet season's onset durig 1991-2018 in ZOM 152 (East Java) and ZOM 299 (South Sulawesi) shows that dry and wet season's onset forecast in ZOM 152 is best using ARIMA while ZOM 299 is best using WAVELET ARIMA.
- Verification on probabilistic forecast for monthly rainfall during 2018 shows that generally there is no significant difference among the lag-6 until lag-0 forecasts. Probabilistic for categories less than 100mm/month, less than 150 mm/month, and more than 200 mm/month tend to be relatively good. Hit rate of the probabilistic forecast during 2018 for less than 100 mm/month and less than 150 mm/month tend to decrease a lot around June – August 2018 (the target month) while more than 200 mm/month is at its peak.

- **Future Task**

From this study, we found that our season onset forecast's skill is better than the climatology but still need some improvement. So, in the future we are interested in studying the variability of season onset in East Java and South Sulawesi.

1-2 Case Study on Dry and Wet Season's Variability

(1) Introduction

- **Background**

Indonesia has a strategic location which is located between two continents (Asia and Australia) and between two oceans (Indian Ocean and Pacific Ocean). The interaction between the atmosphere-ocean as well as the exchange of air masses between both continents and both oceans across Indonesia are very essential in determining the climate of Indonesia in general. Major climate drivers in Indonesia are El Nino Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), Monsoon Wind, and Sea Surface Temperature in Indonesia and its surrounding areas.

In addition to those major climate drivers in Indonesia, the rainfall pattern in Indonesia is also influenced by local factors such as, topography and local Sea Surface Temperature. It makes the climate in each region of Indonesia vary one each other. In general, Indonesia has three main rainfall types, they are monsoonal, equatorial, and local. Then, from those three main types, the rainfall patterns in Indonesia is clustered more specifically into 342 Seasonal Zones (ZOM) and 65 Non-Seasonal Zones (NON ZOM).

The unique character of climate in each region of Indonesia is a challenge for BMKG to provide climate information that is accurate and easy for users to understand. BMKG holds an important role in improving welfare by providing climate information which is used as a consideration in policy making of various sectors. Therefore, the quality of climate information should be improved, for example by increasing the accuracy of climate forecast. Thus, we need to understand the climate characteristics. One of the ways is to perform analysis of the climate variability of the climate to understand the pattern of climate variation in our region as well as its causes from the atmosphere – ocean dynamics. This study will focus on analyzing the variability of dry season and wet season in ZOM 152 (southern part of Bojonegoro, East Java) which has monsoonal type and ZOM 299 (southern part of Soppeng and Central Bone, South Sulawesi) which has local type.

In the analysis of climate variability, information about climatology of a region is very necessary because it becomes a standard to understand the climate variation of a region. Climatological condition is regarded as normal condition of a region. WMO mentions several categories that can be used as a standard to determine the climatological conditions of an area, they are average, normal, and normal standards. In 2021, an updated normal standard (period 1991-2020) will be applied. Result of this study will be very useful as consideration in updating normal standard and rainfall clusters that will be applied in the near future.

- **Data and Method**

  In this study, we use some data as follows:
  - rainfall data in dasarian from rainfall post of ZOM 152 (East Java) and ZOM 299 (South Sulawesi) during 1981-2019
  - Normal precipitation (period of 1981-2010) in ZOM 152 and ZOM 299
  - Dry and Wet Season's Normal Onset (period of 1981-2010) in ZOM 152 and ZOM 299
  - Monthly data of Sea Surface Temperature Anomaly during January 1981 – December 2019 retrieved from iTacs (http : //extreme.kishou.go.jp/itacs5/)

  Steps that are performed in this study include:
  - Determining the value of observed rainfall in ZOM 152 and ZOM 299 using the average value of rainfall from main rainfall posts in each ZOM
  - Determining observed Dry Season onset and retreat in ZOM 152 and 299
    Dry season onset by BMKG is defined when the rainfall is less than 50 mm/dasarian and followed by the following two dasarians. Dry season retreat is defined 1 dasarian right before the next wet season onset.
  - Determining observed Wet Season onset and retreat in ZOM 152 and 299
    Wet season onset by BMKG is defined when the rainfall is more or equal to 50 mm/dasarian and followed by the following two dasarians. Wet season retreat is defined 1 dasarian right before the next dry season onset.
  - Analyzing the variation of observed Dry and Wet Season onset and retreat to its normal in ZOM 152 and 299 using Standard Deviation as follows:

$$\sigma = \sqrt{\frac{\sum(x-\mu)^2}{N}}$$

Where:
σ : standard deviation
x : value of each data
μ : mean
N : number of data

- Analyzing Dry and Wet Season's cumulative rainfall in ZOM 152 and ZOM 299 using Standard Deviation and Coefficient of Variation as follows:

$$CV = \frac{\sigma}{\mu}$$

Where:
CV : coefficient of variation
σ : standard deviation
μ : mean

- Analyzing the trend of Dry and Wet Season's cumulative rainfall in ZOM 152 and ZOM 299 during 1981 – 2019 using linear regression as follows:

$$y = ax + b$$

Where:
y : dependent variable
x : independent variable
a : slope or gradient (increasing / decreasing rate)
b : y-intercept (level of y when x is 0)

- Testing the trend of Dry and Wet Season's cumulative rainfall in ZOM 152 dan ZOM 299 during 1981 – 2019 using Mann-Kendall Trend Test with a significance level of 95%.
- Analyzing the atmosphere-ocean dynamics in the years which have earliest and latest onset during 1981 – 2019 using composite of SST Anomaly.
- Analyzing the atmosphere-ocean dynamics in the years which have smallest and largest season's cumulative rainfall during 1981 – 2019 using composite of SST Anomaly.

(2) Analysis Result and Discussion

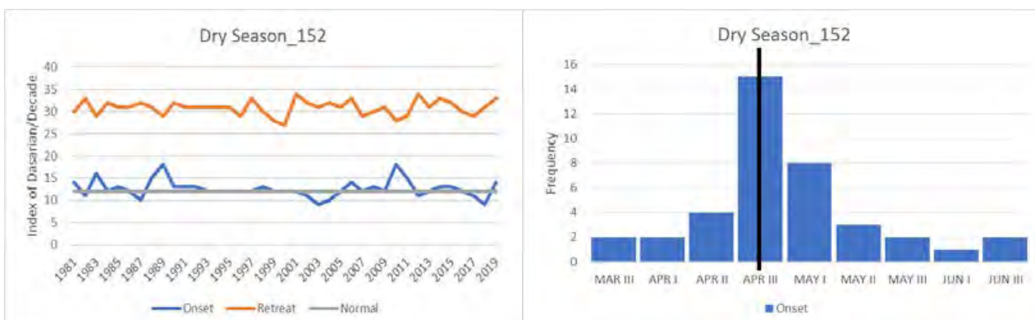
Analysis of Season onset and Cumulative Rainfall

a. ZOM 152 (East Java)

i. Dry Season

Table 1-2-1 Dry Season onset variation in ZOM 152

Dry Season (39 data)		
Standard Deviation	1.94	
Onset (Dasarian)		
MAR III	2	8
APR I	2	
APR II	4	
APR III	15	**Normal**
MAY I	8	16
MAY II	3	
MAY III	2	
JUN I	1	
JUN III	2	



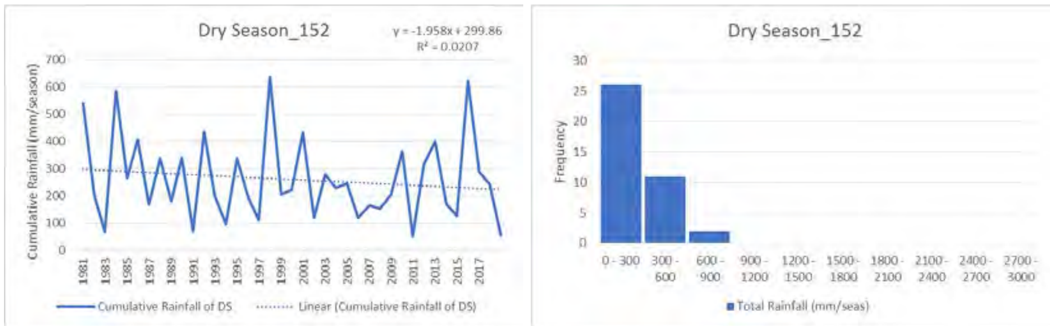
(a) (b)

Figure 1-2-1 Variation (a) and distribution (b) of dry Season onset in ZOM 152 to its normal

Based on the table and Figure above, dry season onset in ZOM 152 during 1981-2019 with a normal index of 12 (April III) has not large variation with a standard deviation of ~ 2 dasarians. The furthest variation from its normal (1981-2010) is 6 dasarian later and 3 dasarian earlier than its normal. Most of the dry season onset during 1981-2019 was later than normal, but the mode of dry season onset in ZOM 152 is the same as normal, April III. The earliest onset occurred in the dry season of 2003 and 2018, while the latest onset occurred in the dry season of 1983, 1989, and 2010.

Table 2. Dry Season's cumulative rainfall variation in ZOM 152

Dry Season (39 data)	
Normal (1981 – 2010)	263
Standard Deviation	155.23
Coefficient of Variation	0.59



(a) (b)

Figure 2. Trend (a) and distribution (b) of dry season's cumulative rainfall in ZOM 152

Normal cumulative rainfall (1981-2010) during dry season in ZOM 152 is 263 mm. Based on the table and Figure above, the variation of cumulative rainfall during the dry season in ZOM 152 is quite large with a standard deviation of 155.23 and a coefficient of variation of 0.59. Dry Season's cumulative rainfall in ZOM 152 during 1981-2019 has a decreasing trend but it is not significant based on the Mann-Kendall trend test. Dry season's cumulative rainfall in ZOM 152 mostly ranges from 0 - 300 mm. Smallest cumulative rainfall occurred in the dry season of 1983, 2011 and 2019, while the largest cumulative rainfall occurred during the dry season of 1998 and 2016.

ii. Wet Season

Table 3. Wet Season onset variation in ZOM 152

Wet Season (38 data)		
Standard Deviation	1.67	
Onset (Dasarian)		
OCT I	1	9
OCT II	2	
OCT III	6	
NOV I	4	**Normal**
NOV II	13	26
NOV III	6	
DEC I	5	
DEC II	2	

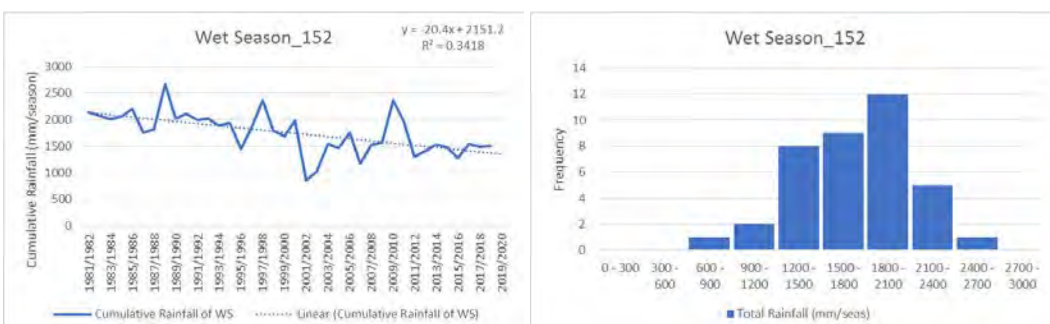
(a) (b)

Figure 3. Variation (a) and distribution (b) of wet season onset in ZOM 152 to its normal

Based on the table and Figure above, wet season onset in ZOM 152 during 1981-2019 with a normal index of 31 (November I) has not large variation with a standard deviation of ~ 2 dasarians. The furthest variation from its normal (1981-2010) is 5 dasarians later and 3 dasarians earlier than its normal. Most of the wet season onset during 1981-2019 was later than normal. The mode of wet season onset in ZOM 152 is on November II which is 1 dasarian later than normal. The earliest onset occurred in the wet season of 1999/2000, 2000/2001, and 2010/2011, while the latest onset occurred in the wet season of 2001/2002 and 2012/2013.

Table 4. Wet Season’s cumulative rainfall variation in ZOM 152

Wet Season (38 data)	
Normal (1981 – 2010)	1837
Standard Deviation	387.77
Coefficient of Variation	0.22



(a) (b)

Figure 4. Trend (a) and distribution (b) of wet season’s cumulative rainfall in ZOM 152

Normal cumulative rainfall (1981-2010) during wet season in ZOM 152 is 1837 mm (much higher than dry season). Based on the table and Figure above, the variation of cumulative rainfall during the wet season in ZOM 152 is smaller than dry season with a standard deviation of 387.77 and a coefficient of variation of 0.22. Wet season's cumulative rainfall in ZOM 152 during 1981-2019 has a decreasing trend but it is not significant based on the

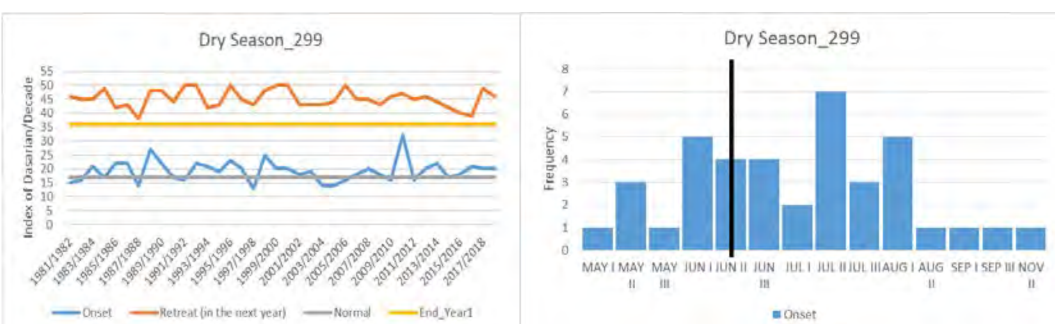
Mann-Kendall trend test. Wet season's cumulative rainfall in ZOM 152 mostly ranges from 1200 - 2100 mm. Smallest cumulative rainfall occurred in the wet season of 2001/2002, 2002/2003, 2006/2007, and 2015/2016, while the largest cumulative rainfall occurred during the wet season of 1985/1986, 1988/1989, 1997/1998, and 2009/2010.

b. ZOM 299 (South Sulawesi)

i. Dry Season

Table 5. Dry Season onset variation in ZOM 299

Dry Season (39 data)		
Standard Deviation	3.77	
Onset (Dasarian)		
MAY I	1	10
MAY II	3	
MAY III	1	
JUN I	5	
JUN II	4	**Normal**
JUN III	4	25
JUL I	2	
JUL II	7	
JUL III	3	
AUG I	5	
AUG II	1	
SEP I	1	
SEP III	1	
NOV II	1	



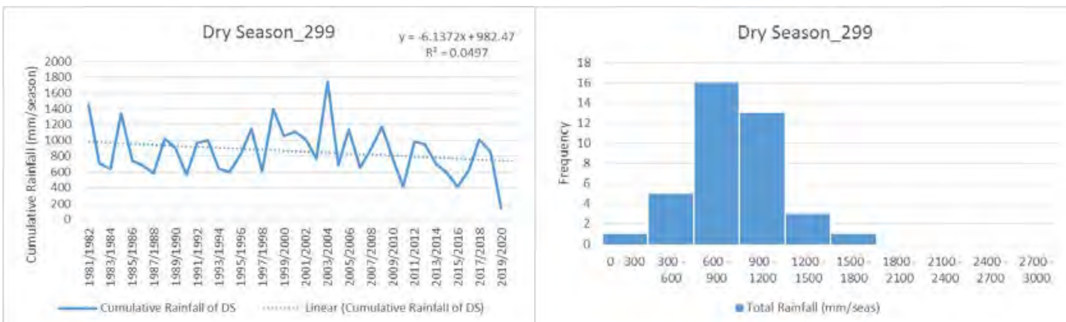
(a) (b)

Figure 5. Variation (a) and distribution (b) of dry season onset in ZOM 299 to its normal

Based on the table and Figure above, dry season onset in ZOM 299 during 1981-2019 with a normal index of 17 (June II) larger variation than ZOM 299 with a standard deviation of ~4 dasarians. The furthest variation from its normal (1981-2010) is 15 dasarian later and 4 dasarian earlier than its normal. Most of the dry season onset during 1981-2019 was later than normal. The mode of wet season onset in ZOM 299 is on July II which is 3 dasarian later than normal. The earliest onset occurred in the dry season of 1987/1988, 1997/1998, 2003/2004, and 2004/2005, while the latest onset occurred in the dry season of 1988/1989, 1998/1999, and 2010/2011.

Table 6. Dry Season's cumulative rainfall variation in ZOM 299

Dry Season (39 data)	
Normal (1981 – 2010)	909
Standard Deviation	313.91
Coefficient of Variation	0.36



(a) (b)

Figure 6. Trend (a) and distribution (b) of dry season's cumulative rainfall in ZOM 299

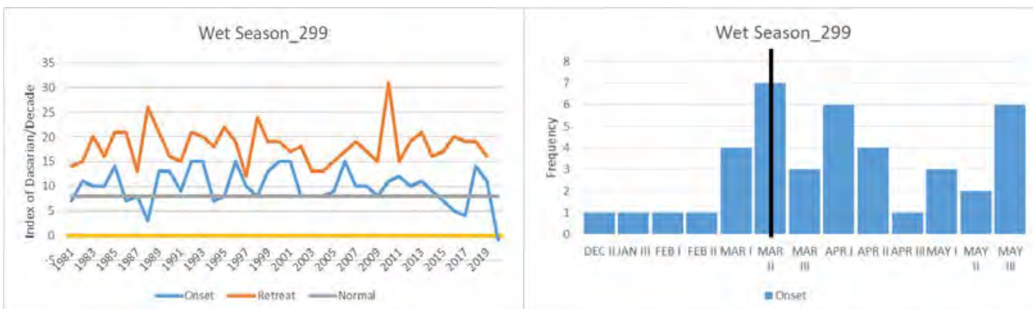
Normal cumulative rainfall (1981-2010) during dry season in ZOM 152 is 263 mm. Based on the table and Figure above, the variation of cumulative rainfall during the dry season in ZOM 299 is not too large with a standard deviation of 313.91 and a coefficient of variation of 0.36. Dry Season's cumulative rainfall in ZOM 299 during 1981-2019 has a decreasing trend but it is not significant based on the Mann-Kendall trend test. Dry season's cumulative rainfall in ZOM 299 mostly ranges from 600 - 1200 mm. Smallest cumulative rainfall occurred in the dry season of 2010/2011, 2015/2016, and 2019/2020, while the largest cumulative rainfall occurred during the dry season of 1981/1982, 1984/1985, 1998/1999, and 2003/2004.

ii. Wet Season

Table 7. Wet Season onset variation in ZOM 299

Wet Season (40 data)		
Standard Deviation	3.63	
Onset (Dasarian)		
DEC II	1	
JAN III	1	
FEB I	1	8
FEB II	1	
MAR I	4	

MAR II	7	**Normal**
MAR III	3	25
APR I	6	
APR II	4	
APR III	1	
MAY I	3	
MAY II	2	
MAY III	6	



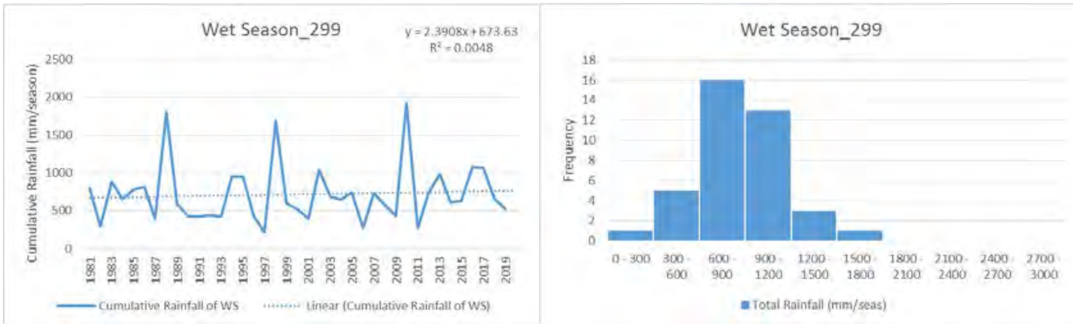
(a) (b)

Figure 7. Variation (a) and distribution (b) of wet season onset in ZOM 299 to its normal

Based on the table and Figure above, wet season onset in ZOM 299 during 1981-2019 with a normal index of 8 (March II) has large variation with a standard deviation of ~4 dasarians. The furthest variation from its normal (1981-2010) is 10 dasarians later and 10 dasarians earlier than its normal. Most of the wet season onset during 1981-2019 was later than normal. The mode of wet season onset in ZOM 299 is same as normal on March II. The earliest onset occurred in the wet season of 1988 2016, 2017, and 2020, while the latest onset occurred in the wet season of 1992, 1993, 1996, 2000, 2001, and 2006.

Table 8. Wet Season's cumulative rainfall variation in ZOM 299

Wet Season (40 data)	
Normal (1981 – 2010)	719
Standard Deviation	391.64
Coefficient of Variation	0.54



(a) (b)

Figure 8. Trend (a) and distribution (b) of wet season's cumulative rainfall in ZOM 299

Normal cumulative rainfall (1981-2010) during wet season in ZOM 299 is 719 mm which is lower than dry season due to much shorter period and small gap of rainfall between wet and dry season. Based on the table and Figure above, the variation of cumulative rainfall during the wet season in ZOM 299 is larger than dry season with a standard deviation of 391.64 and a coefficient of variation of 0.54. Wet season's cumulative rainfall in ZOM 299 during 1981-2019 has a increasing trend but it is not significant based on the Mann-Kendall trend test. Wet season's cumulative rainfall in ZOM 299 mostly ranges from 600 - 1200 mm. Smallest cumulative rainfall occurred in the wet season of 1997, 2006, ad 2011, while the largest cumulative rainfall occurred during the wet season of 1988, 1998, and 2010.

Analysis of Atmosphere-Ocean Dynamics in Significant Years

a. ZOM 152 (East Java)

Dry Season : Early – Late Onset

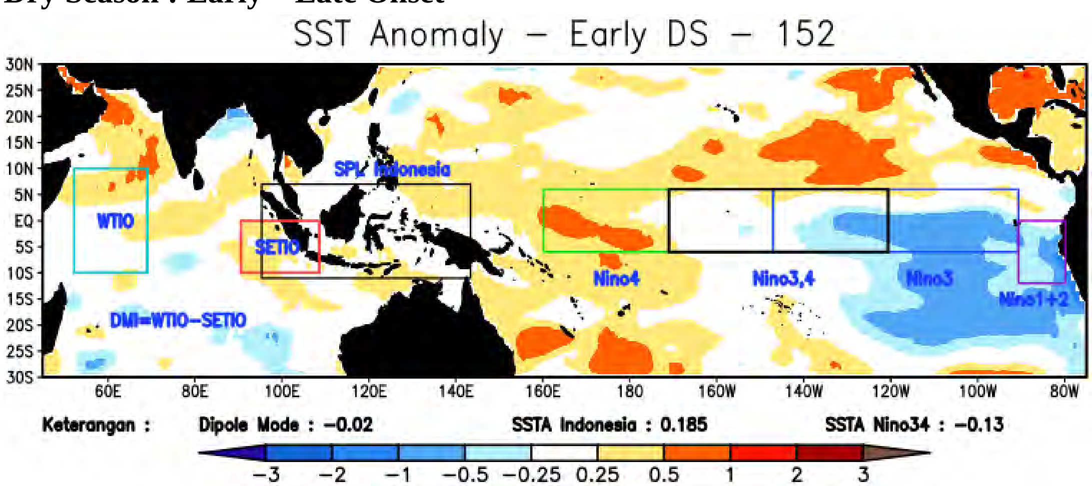


Figure 9. Monthly SST Anomaly of Earliest Dry Season Onset in ZOM 152

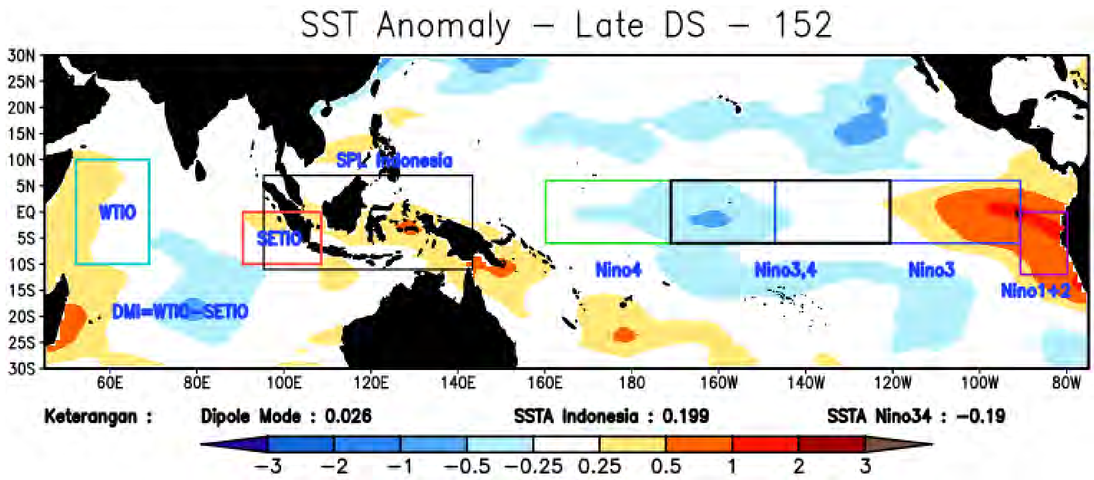


Figure 10. SST Anomaly of Latest Dry Season Onset in ZOM 152

ZOM 152 has normal dry season onset at April III. The earliest dry season onset occurred 3 dasarians earlier at March III in 2003 and 2018. The latest dry season onset occurred around 3 months later at June I (1983) and June III (1989 and 2010). Both composites of monthly SST (Sea Surface Temperature) Anomaly of the earliest onset and latest onset shows neutral condition of ENSO, Indonesian SST, and IOD. Local SST anomaly around East Java also shows similar condition on both composites. It indicates that ENSO, IOD, and Indonesian SST don't influence dry season onset in ZOM 152.

Dry Season : Small – Large Rainfall

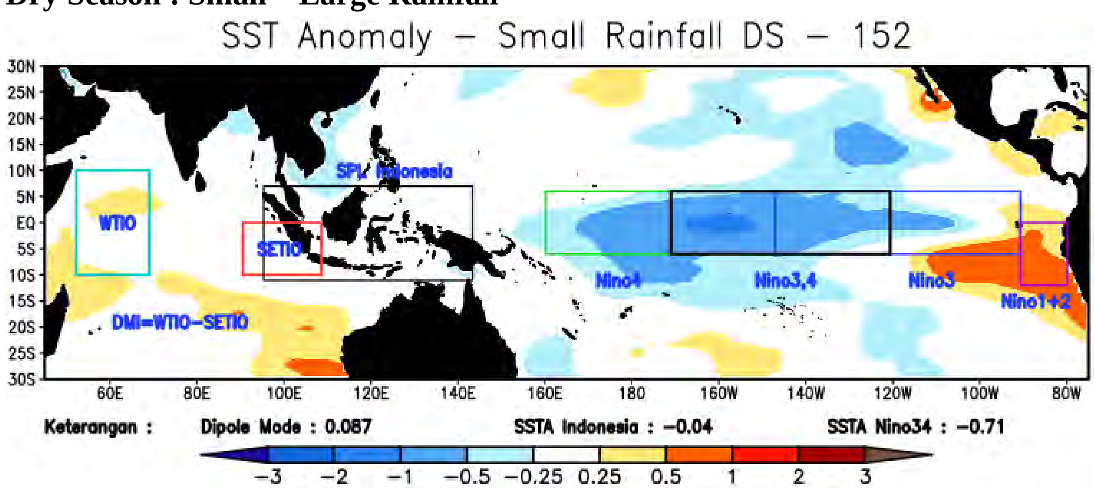


Figure 11. SST Anomaly of Smallest Dry Season's Cumulative Rainfall in ZOM 152

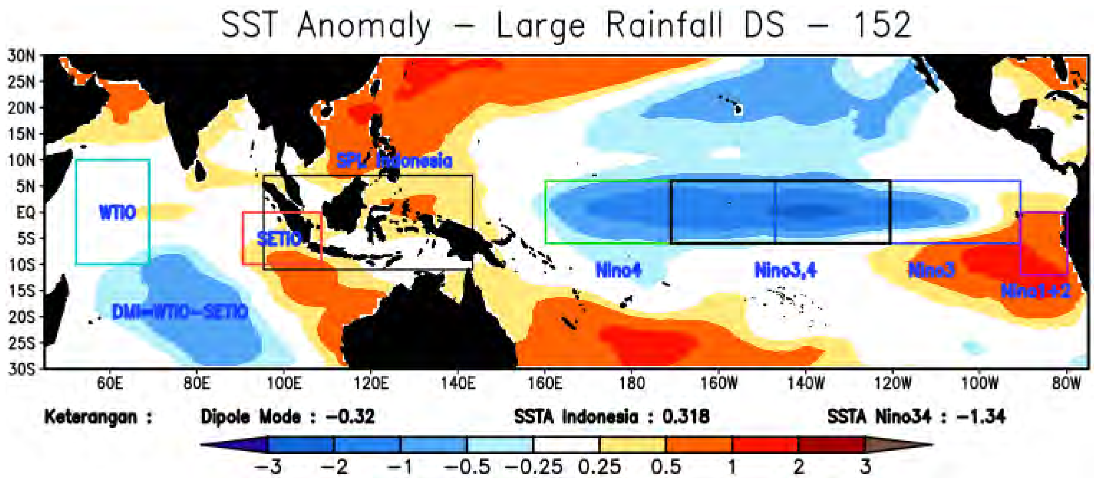


Figure 12. SST Anomaly of Largest Dry Season's Cumulative Rainfall in ZOM 152

Dry season of ZOM 152 has a normal cumulative rainfall of 263 mm. The smallest cumulative rainfall occurred in 1983 (69 mm), 2011 (53 mm), and 2019 (56 mm). The largest cumulative rainfall occurred in 1998 (636 mm) and 2016 (621 mm).

Composites of monthly SST (Sea Surface Temperature) Anomaly during the dry season with smallest rainfall shows La Nina condition. Indonesian SST and IOD show neutral condition. Local SST anomaly around East Java also shows normal condition. It indicates that La Nina has influence on decreasing rainfall during Dry Season in ZOM 152.

Composites of monthly SST Anomaly during the dry season with largest rainfall shows La Nina condition and neutral IOD. Indonesian SST is warmer than normal especially in southern Indonesia which is near from East Java. It indicates that La Nina and warm local SST simultaneously has influence on increasing rainfall during dry season in ZOM 152 since both of them tend to influence more cloud formation and precipitation in Indonesia.

Wet Season : Early – Late Onset

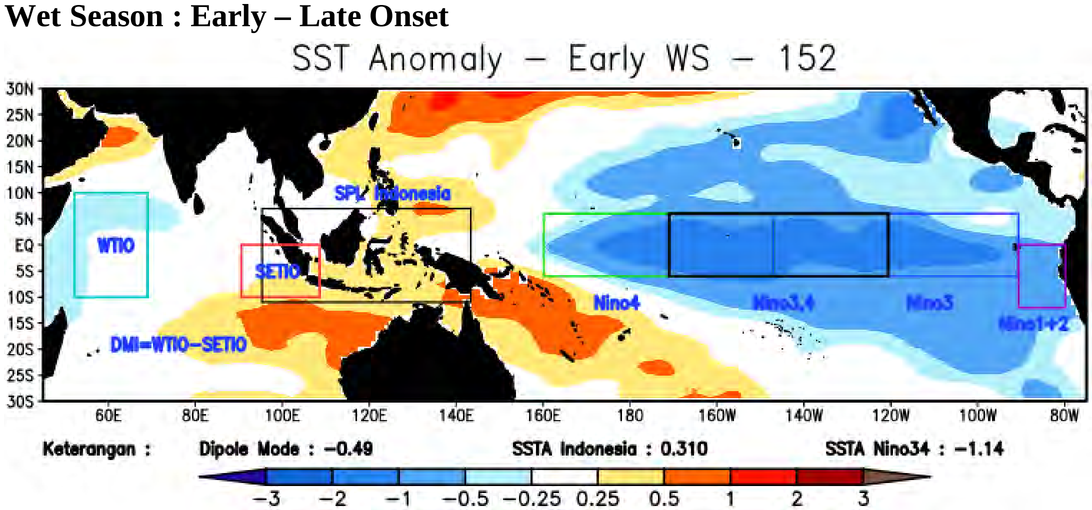


Figure 13. Monthly SST Anomaly of Earliest Wet Season Onset in ZOM 152

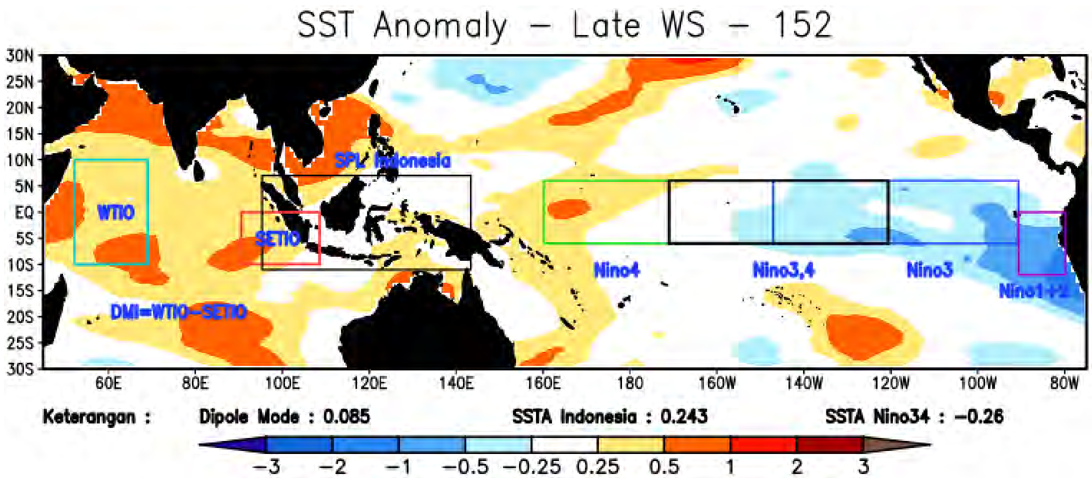


Figure 14. SST Anomaly of Latest Wet Season Onset in ZOM 152

ZOM 152 has normal wet season onset at November I. The earliest wet season onset occurred 3 dasarians earlier at October I (2000/2001) and October II (1999/2000 and 2010/2011). The latest wet season onset occurred around 3 dasarians later at December II in 2001/2002 and 2012/2013.

Composites of monthly SST (Sea Surface Temperature) Anomaly of the earliest onset shows La Nina condition and DM (-). Indonesian SST especially SST around East Java shows normal condition. It indicates that La Nina and DM (-) influence wet season onset comes earlier in ZOM 152 since both of them tend to increase cloud formation and precipitation in Indonesia.

Composites of monthly SST Anomaly of the latest onset shows neutral condition of ENSO, Indonesian SST, and IOD. Local SST anomaly around East Java also shows normal condition. Indonesian SST is slightly warmer than normal yet SST around East Java shows normal condition. It indicates that ENSO, IOD, and Indonesian SST don't influence wet season onset comes late in ZOM 152.

Wet Season : Small – Large Rainfall

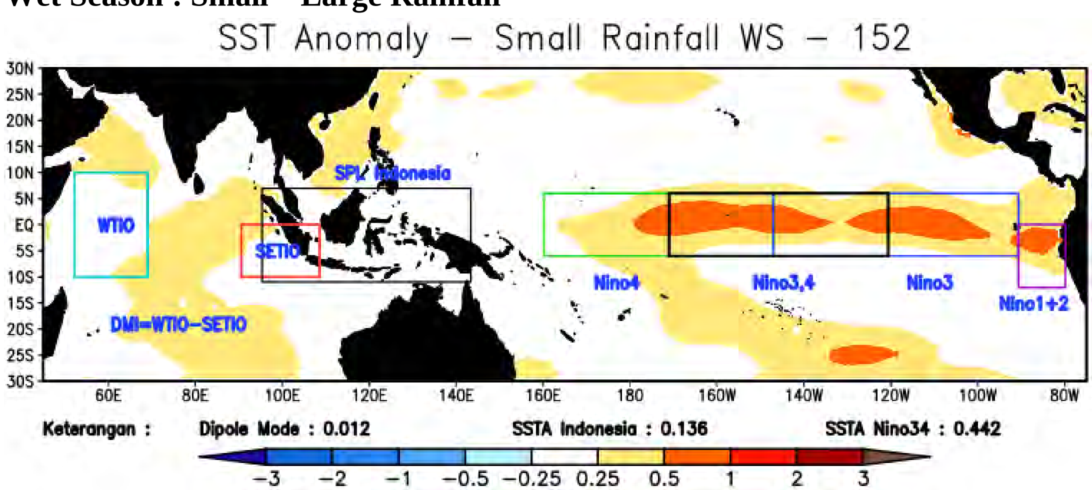


Figure 15. SST Anomaly of Smallest Wet Season’s Cumulative Rainfall in ZOM 152

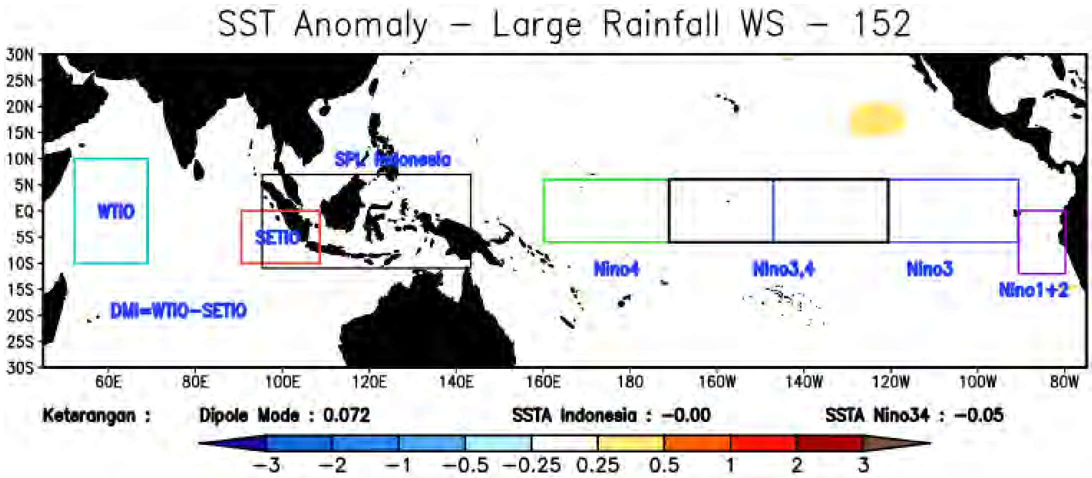


Figure 16. SST Anomaly of Largest Wet Season’s Cumulative Rainfall in ZOM 152

Wet season of ZOM 152 has a normal cumulative rainfall of 1837 mm. The smallest cumulative rainfall occurred in 2001/2002 (847 mm), 2002/2003 (1032 mm), 2006/2007 (1169 mm), and 2015/2016 (1275 mm). The largest cumulative rainfall occurred in 1985/1986 (2213 mm), 1988/1989 (2671 mm), 1997/1998 (2367 mm), and 2009/2010 (2361 mm).

Composites of monthly SST (Sea Surface Temperature) Anomaly during the wet season with smallest rainfall shows neutral condition of ENSO, Indonesian SST, and IOD. But SST Anomaly in Nino 3.4 is warmer than normal at 0.442°C (nearly El Nino threshold). It indicates that warm SST in Nino3.4 have influence on decreasing wet season’s rainfall in ZOM 152.

Composites of monthly SST Anomaly during the wet season with largest rainfall shows neutral condition of ENSO, Indonesian SST, and IOD. It indicates that ENSO, IOD, and Indonesian SST don’t influence on increasing wet season’s cumulative rainfall in ZOM 152.

b. ZOM 299 (South Sulawesi)

Dry Season: Early – Late Onset

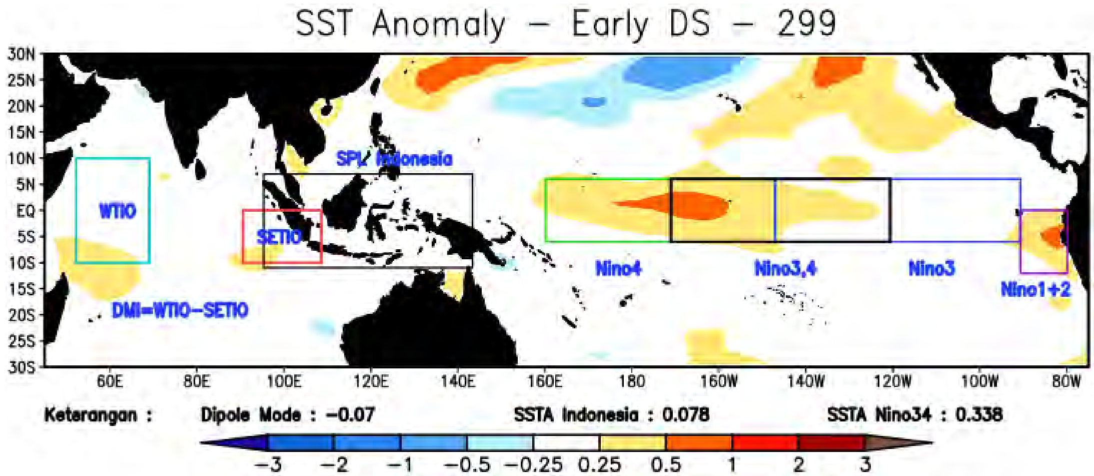


Figure 17. Monthly SST Anomaly of Earliest Dry Season Onset in ZOM 152

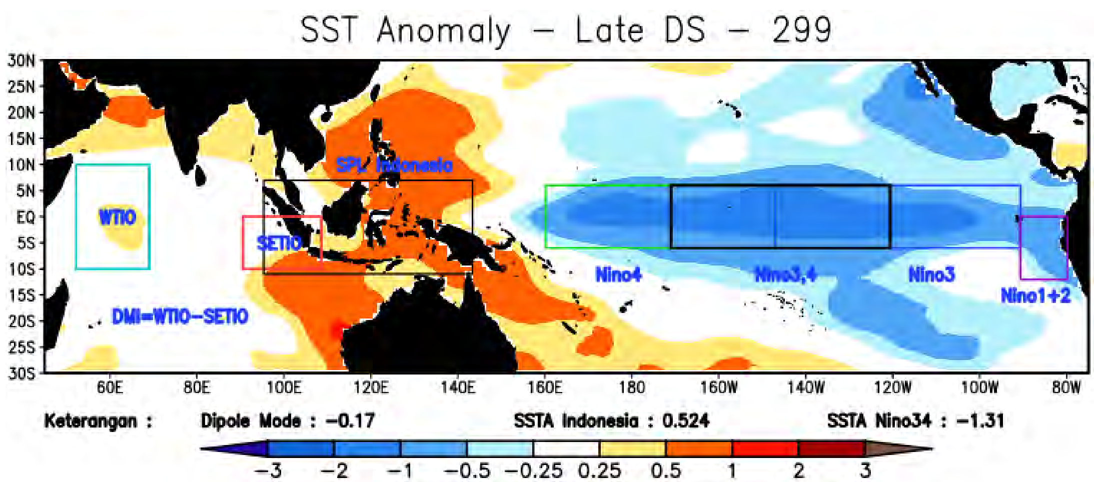


Figure 18. SST Anomaly of Latest Dry Season Onset in ZOM 299

ZOM 299 has normal dry season onset at June II. The earliest dry season onset occurred around 1 month earlier in May I in 1997/1998 and May II in 1987/1988, 2003/2004, and 2004/2005. The latest dry season onset occurred up to 5 months later at November II (2010/2011), September III (1988/1989), and September I (1998/1999).

Composites of monthly SST (Sea Surface Temperature) Anomaly of the earliest onset shows neutral condition of ENSO, Indonesian SST, and IOD. SST in Nino 3.4 shows warmer condition than its normal. It indicates that warm SST in Nino 3.4 influence dry season onset comes earlier in ZOM 299.

Composites of monthly SST Anomaly of the latest onset shows La Nina condition, warm Indonesian SST, and neutral IOD. Local SST around South Sulawesi also shows warmer condition than its normal. It indicates that La Nina (Moderate La Nina) and warm SST in Indonesia influence dry season onset comes later in ZOM 299.

Dry Season: Small – Large Rainfall

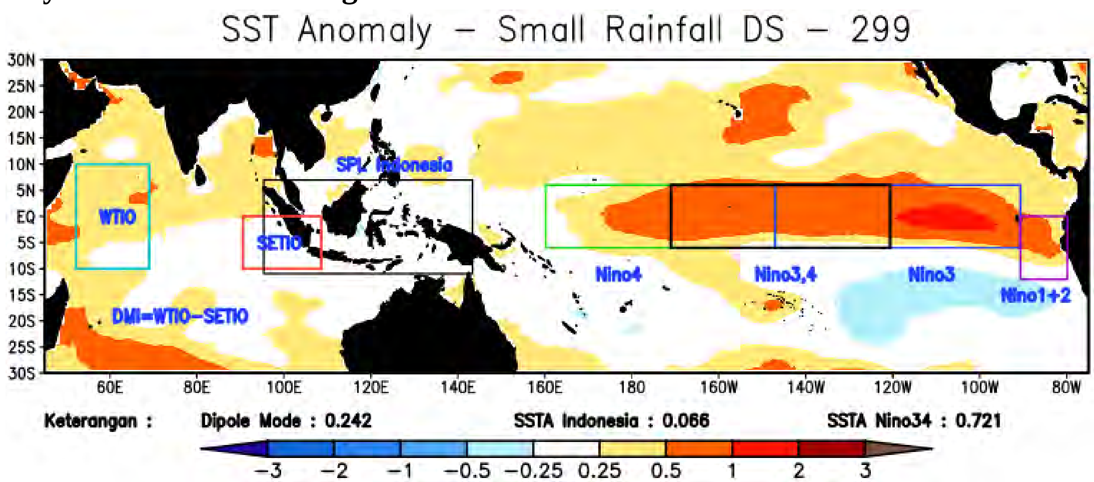


Figure 19. SST Anomaly of Smallest Dry Season's Cumulative Rainfall in ZOM 299

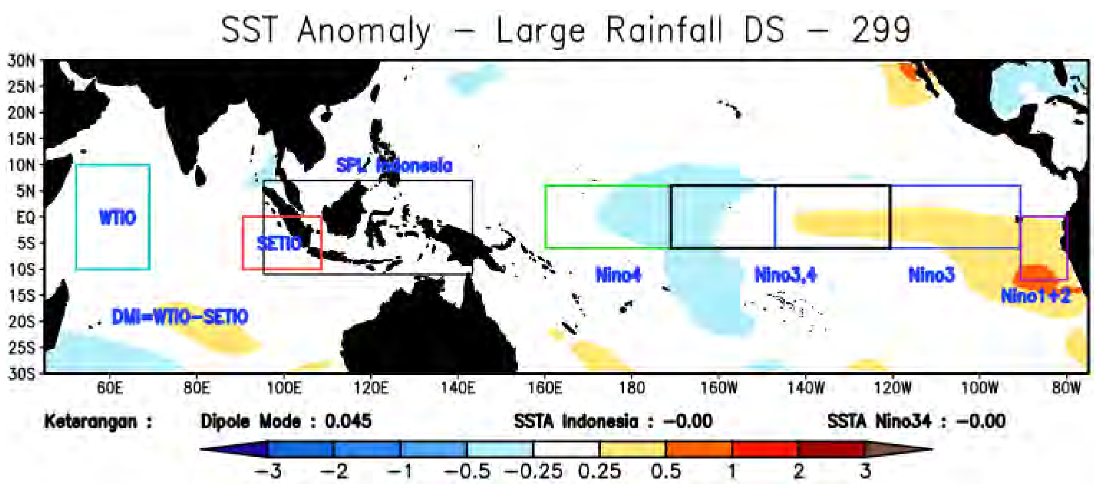


Figure 20. SST Anomaly of Largest Dry Season's Cumulative Rainfall in ZOM 299

Dry season of ZOM 299 has a normal cumulative rainfall of 909 mm. The smallest cumulative rainfall occurred in 2010/2011 (414 mm), 2015/2016 (418 mm), and 2019/2020 (140 mm). The largest cumulative rainfall occurred in 1981/1982 (1447 mm), 1984/1985 (1343 mm), 1998/1999 (1393 mm), and 2003/2004 (1745 mm).

Composites of monthly SST (Sea Surface Temperature) Anomaly during the dry season with smallest rainfall shows El Nino condition. Indonesian SST and IOD show neutral condition. It indicates that El Nino has influence on decreasing rainfall during dry season in ZOM 299.

Composites of monthly SST Anomaly during the dry season with largest rainfall shows neutral condition of ENSO, Indonesian SST, and IOD. It indicates that ENSO, SST in Indonesia, and IOD do not have influence on increasing rainfall during dry season in ZOM 299.

Wet Season: Early – Late Onset

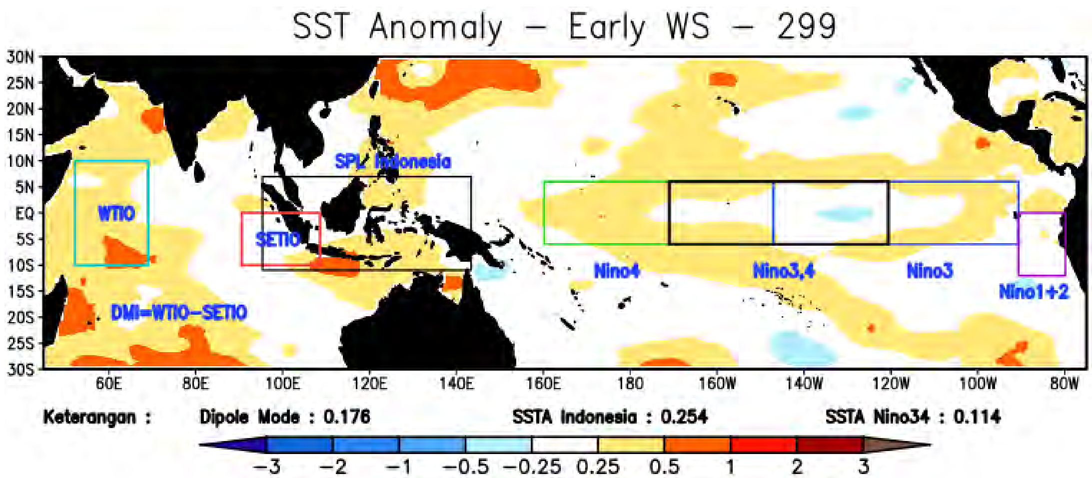


Figure 21. Monthly SST Anomaly of Earliest Wet Season Onset in ZOM 299

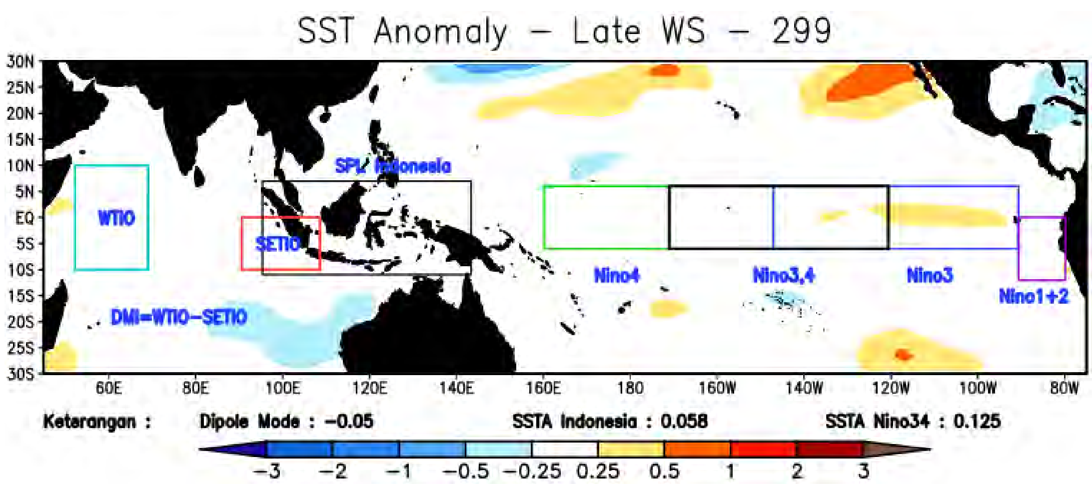


Figure 22. SST Anomaly of Latest Wet Season Onset in ZOM 299

ZOM 299 has normal wet season onset at March II. The earliest wet season onset occurred up to 3 months earlier in December II 2019 (2020), January III (1988), February I (2017), and February II (2017). The latest wet season onset occurred around 2 months later at May III in 1992, 1993, 1996, 2000, 2001, and 2006.

Composites of monthly SST (Sea Surface Temperature) Anomaly of the earliest onset shows neutral condition of ENSO and IOD. Indonesian SST and local SST around South Sulawesi shows warmer condition than normal. It indicates that warm local SST influence wet season onset comes earlier in ZOM 299.

Composites of monthly SST Anomaly of the latest onset shows neutral condition of ENSO, Indonesian SST, and IOD. Local SST anomaly around South Sulawesi also shows normal condition. It indicates that ENSO, IOD, and Indonesian SST do not influence wet season onset comes late in ZOM 152.

Wet Season: Small – Large Rainfall

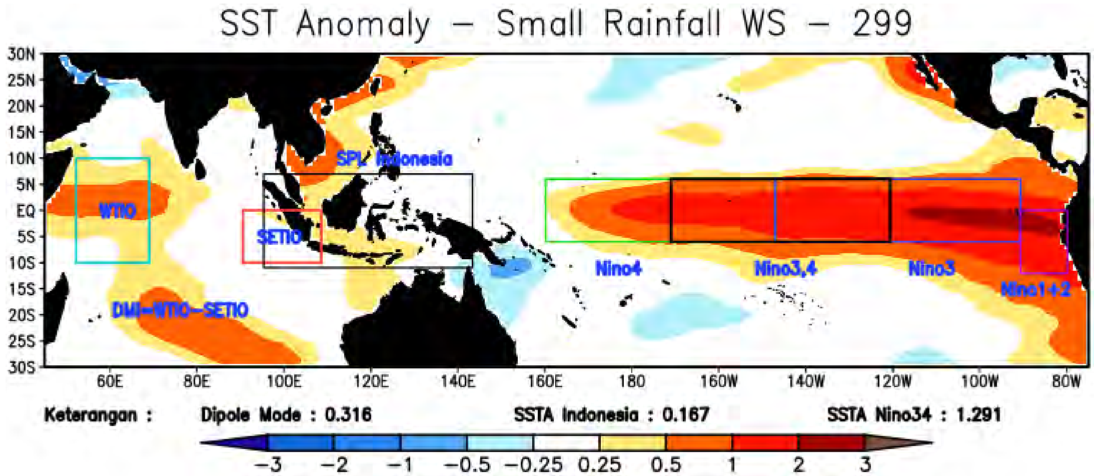


Figure 23. SST Anomaly of Smallest Wet Season's Cumulative Rainfall in ZOM 299

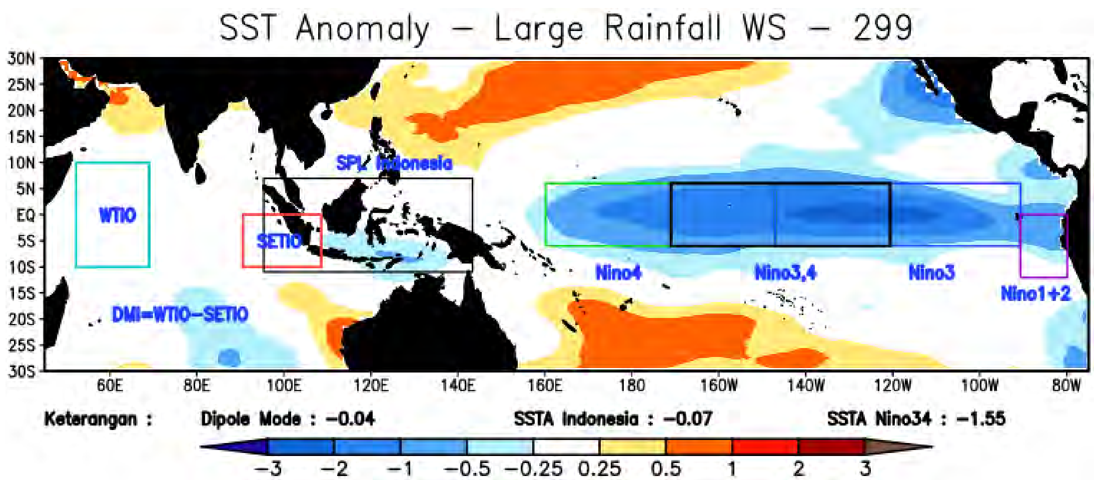


Figure 24. SST Anomaly of Largest Wet Season's Cumulative Rainfall in ZOM 299

Wet season of ZOM 299 has a normal cumulative rainfall of 719 mm. The smallest cumulative rainfall occurred in 1997 (216 mm), 2006 (276 mm, and 2011 (271 mm). The largest cumulative rainfall occurred in 1988 (1798 mm), 1998 (1684 mm), and 2010 (1924 mm).

Composites of monthly SST (Sea Surface Temperature) Anomaly during the wet season with smallest rainfall shows neutral condition of Indonesian SST and IOD. SST in Nino 3.4 shows warmer condition and it shows El Nino condition. It indicates that El Nino have influence on decreasing wet season's rainfall in ZOM 299.

Composites of monthly SST Anomaly during the wet season with largest rainfall shows neutral condition of Indonesian SST and IOD. SST in Nino 3.4 shows cooler condition and it shows La Nina condition. It indicates that La Nina have influence on increasing wet season's rainfall in ZOM 299.

(3) Result and Future Task

From the result and discussion above, there are some points that can be taken as conclusion as follows:

- Variation of Dry and Wet Season onset during 1981 - 2019 in ZOM 152 is not too large with its furthest is up to 2 months (Dry Season) and 1 month (Wet Season) from its normal. While ZOM 299 has large variation with its furthest is up to 6 months (Dry Season) and 3 months (Wet Season) from its normal.
- Mode of season onset during 1981 - 2019 in ZOM 152 is similar to its normal dry season onset and 1 dasarian later than its normal wet season onset. While mode of season onset during 1981 - 2019 in ZOM 299 is 1 month later to its normal dry season onset and similar to its normal wet season onset.
- Dry and Wet Season's cumulative rainfall in ZOM 152 has insignificant declining trend and ZOM 299 has insignificant declining trend (Dry Season) and inclining trend (Wet Season).
- Mostly significant years of season onset in both ZOM 152 and ZOM 299 is associated with ENSO years. For specifically, ZOM 152 La Nina and DM (-) simultaneously lead wet season onset comes earlier than its normal of ZOM 152. In ZOM 299, warm Nino 3.4 SST leads early dry season onset, La Nina and warm Indonesian SST simultaneously lead late dry season onset, and warm Indonesian SST lead early wet season onset.
- Mostly significant years of season cumulative rainfall in both ZOM 152 and ZOM 299 is associated with ENSO years. ENSO has more clear influence on season cumulative rainfall than Indonesian SST and IOD. For specifically, ZOM 152 La Nina leads small rainfall in dry season, La Nina and warm Indonesian SST simultaneously lead large rainfall in wet season, and warm Nino 3.4 SST leads small rainfall in wet season. In ZOM 299, El Nino leads small rainfall in both dry and wet season while La Nina leads large rainfall in wet season.

Future Task

From this study, we found some interesting information, so we are interested in studying more on the relationship and variability of the onset, period, and cumulative rainfall of the season. Based on the results of study that we have carried out, the dynamics of atmosphere-ocean parameters that we used in the analysis are SST Anomaly, ENSO, and IOD. There are other various parameters that can be studied further, especially in the season where those three parameters do not have clear influence on season variability based on this study. Therefore, we also want to study other parameters of atmosphere-ocean dynamics that influence such variations (For example, 850 mb wind, OLR, or other parameters).

1-3 Evaluation of S2S for Extreme Event in Java

(1) Introduction

- **Background**

Extreme rain is one of the natural phenomena that can cause negative impacts from various factors. Extreme rainfall will increase river flow and can be triggered by regional and global atmospheric circulation. One of the negative impacts generated in the form of flooding in the river due to increased runoff. At present the frequency and intensity of extreme rainfall is thought to have increased in Indonesia.

There is increasing interest in extreme weather and climate events, both in order to develop early warning systems to improve societal preparedness, as well as to gain a better understanding of the impacts of climate change. Traditionally weather forecasts cover the time range out to 2 weeks, while climate forecasts start at the seasonal timescale and extend out. There is effectively a weather–climate prediction gap at the subseasonal to seasonal (S2S) range (from two weeks to a season; Fig. 1) Sub-seasonal to seasonal forecasting (defined here as the time range between 2 weeks and 2 months) bridges the gap between the more-mature weather and seasonal climate prediction.

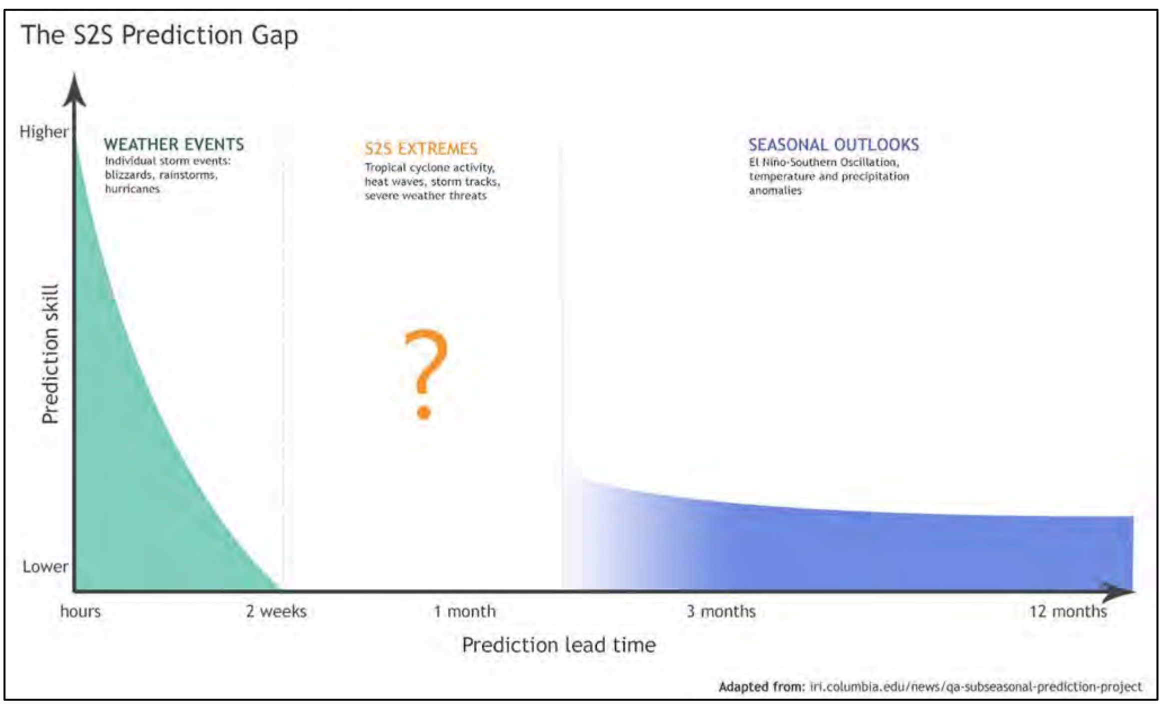


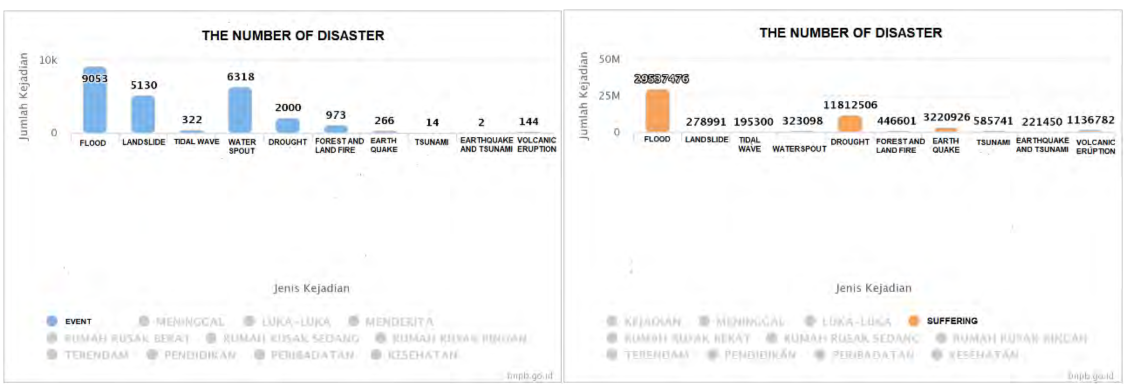
Figure 1. The S2S Prediction Gap (Source : https://iri.columbia.edu/news/qa-subseasonal-prediction-project)

Users need reliable prediction information in decision making. In the time range of weather prediction actions that can be taken by users of information are limited to early warning and evacuation. Whereas the long-term climate prediction that can be done is the contingency of strategic plans to deal with possible risks of extreme events. But in the prediction time range S2S can provide an opportunity for users to do mitigation, preparedness, early warning, and evacuation to reduce the risk of damage or loss from an extreme event.

Java is one of the islands in Indonesia which has the most ideal conditions as an agrarian area, in terms of its geomorphology, climate and culture. Java accounts for almost half the national harvest area of the total national harvest area (Ministry of Agriculture). Indonesia is an agricultural country where agriculture plays an important role in the overall national economy. This can be shown from the large number of residents or workers who live or work in the agricultural sector and national products derived from agriculture (Mubyarto, 1989).

Based on data from the National Disaster Management Agency (Fig.2), Java has a higher frequency of natural disasters compared to other islands in Indonesia. Based on data from the last 10 years, natural disasters that most often occur in Java are caused by meteorological (weather and climate) factors such as floods, droughts, landslides, and tornadoes, where many victims suffer from floods and droughts. These extreme weather and climate events can also damage critical infrastructure, such as roads, railways or power and telecommunication grids. Therefore, this case study was conducted to test the S2S prediction capability for extreme climates in the Java so that national services can make appropriate mitigation actions and contingency plans for public safety.

In addition, this case study is part of JICA's key-activity II project, Improving Seasonal Forecast, it is hoped that through this project it can increase the credibility of BMKG in providing reliable and useful climate information services to the community.



(a) (b)

Figure 2. The Number of Disaster (a) Event (b) Suffering

- **Data and Method**

Currently there are 11 institutions (Table 2) in the world that provide S2S predictions and there are three institutions that archive S2S databases (Table 1). The S2S project database is currently open to the public with 10 models available. This database is an important tool for advancing understanding of the S2S time-scale. In particular, it can be used to assess the model representation and predictions of MJO which is one of the main sources of sub-seasonal predictability.

Table 1. The three institutions responsible as archiving centers

Institution	Start	Website
ECMWF	May 2015	https://apps.ecmwf.int/datasets/data/S2S
CMA (China Meteorological Administration)	Nov 2016	https://S2S.ecmwf.int
IRI (International Research Institute Data Library)	Nov 2016	https://iridl/ldeo.columbia.edu/SOURCES/.ECMWF/.S2S

Table 2. 11 institutions provide S2S predictions

institution	Country
The Australian Bureau of Meteorology (BoM)	Australia
The China Meteorological Administration (CMA)	China
The European Centre for Medium Range Weather Forecasts (ECMWF)	UK
Environment and Climate Change Canada (ECCC)	Canada
The Institute of Atmospheric Sciences and Climate of the National Research Council (CNR-ISAC)	Italy
The Hydrometeorological Centre of Russia (HMCR)	Russia
The Japan Meteorological Agency (JMA)	Japan
The Korea Meteorological Administration (KMA)	Korea
Météo – France/Centre National de Recherche Meteorologiques (CNRM)	France
The National Centers for Environmental Prediction (NCEP)	USA
The Met Office (UKMO)	UK

The latest ECMWF predictions are made 2 times a week on Mondays and Thursdays with 51 ensemble members, with the length of the available reforecast data for the past 20 years. However, only 11 ensemble members are available for the reforecast. The reforecast data is intended to calibrate any recent predictions generated to reduce model errors.

In this study, the 2015 ECMWF model output S2S reforecast data was used with a resolution of 1.5^0X 1.5^0 containing 11 members obtained at https://iridl.ldeo.columbia.edu/ SOURCES/ .ECMWF/.S2S/. The ECMWF data model has a data length of 32 days on every issue with a delayed three weeks, which indicates that the forecast data includes real-time ensemble forecasts (three weeks before near real time) and reforecast data up to 47 days. As for the observation data, the total rainfall data for 10 days is the result of blending of rain post data and CHIRP. This observation data has a spatial resolution of 0.05^0X 0.05^0.

The determination of the analysis period is based on the large amount of high rainfall that occurs in the study area. In this case study the evaluation was carried out in December for 20 years (1999 - 2018) because that month has a high average rainfall so that the potential for extreme rainfall in that month is assumed to occur frequently. This case study uses the 90th percentile of the data period to determine the extreme threshold values for the Java region.

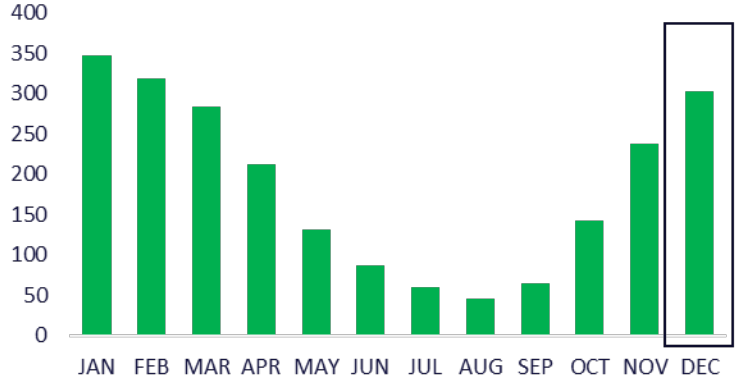


Figure 1. Average rainfall in Java (1999 – 2018)

The latest ECMWF predictions are made 2 times a week on Monday and Thursday with the length of the available reforecast data for the past 20 years. In addition, for the reforecast data, only 11 members were available and for this study, 11 members were used. The S2S period used is 10 days (Dasarian scale) and is divided into 3 forecast date issued. If the forecast period is d + 10, then the forecast issued date d is called Lead Time 1 (LT1), in this study is the forecast issued on Monday and Thursday, the forecast issued date d-10 is called Lead Time 2 (LT2) and the forecast issued date d -20 is called Lead Time 3 (LT3).

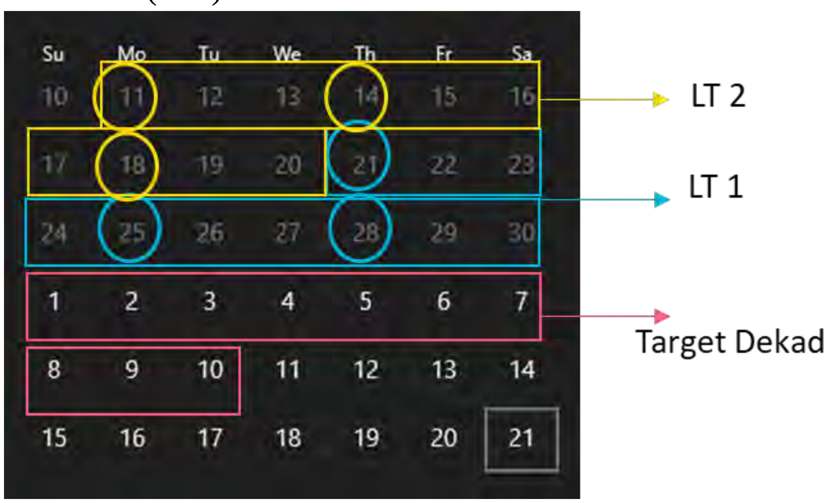


Figure 3. Forecast Issued Data in Every Lead Time

This analysis is carried out by comparing the rainfall during the extreme event period between the observation data with the forecast data of LT1, LT2, and LT4 then the analysis is carried out in a composite and verifying the forecast. The difference in resolution between the observational data and ECMWF is resolved by repacking the resolution, which is changing the resolution of the ECMWF data to the resolution of the observation data (1.5^0 x1.5^0 to 0.05^0 x 0.05^0). The verification method used is the correlation anomaly method with the formulation presented in equation 1.

$$r = \frac{\sum_i^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i^n (x_i - \bar{x})^2}\sqrt{\sum_i^n (y_i - \bar{y})^2}} \quad (1)$$

(2) Analysis Results and Discussion

Based on the results of a composite analysis of extreme events in Java, it is found that ECMWF S2S model can capture the potential for high rainfall in **LT1** or **1 dekad before the target dekad** and shows the potential for high rainfall in LT2 especially in the Central Java. However LT3 does not indicate the potential for high rainfall in the Java region (Figure 4).

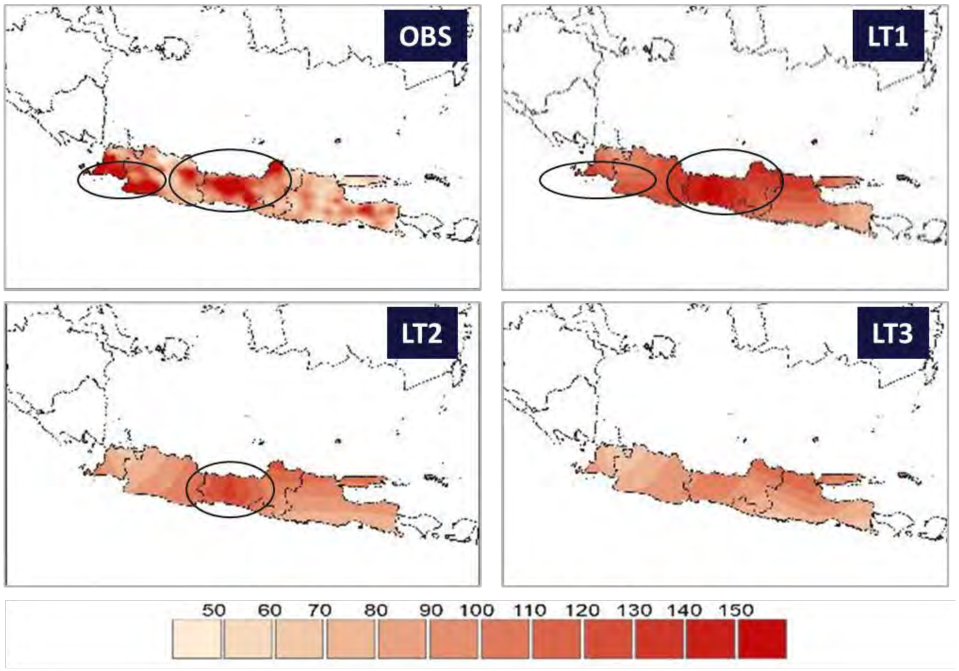


Figure 4. Composite analysis of extreme rainfall between Observation and Forecast at LT1, LT2 and LT3

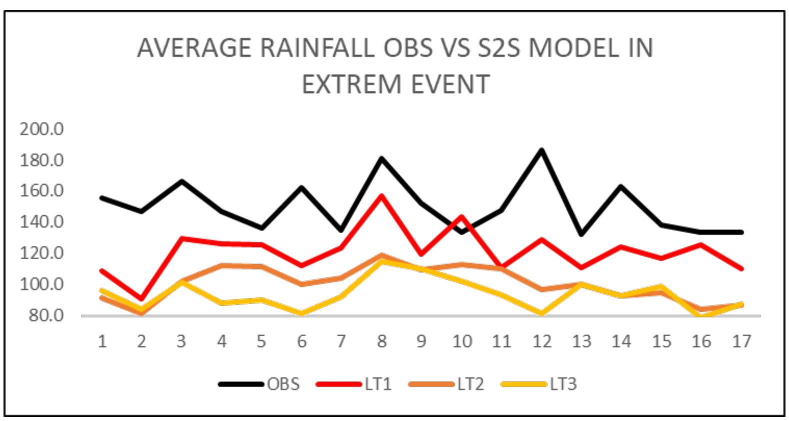


Figure 2. Average Rainfall Observation VS S2S Model In Extreme Event

Figure 2 explains the comparison of the observed rainfall values with the ECMWF S2S forecast model. The LT1 forecast shows the results by following the observed rainfall pattern with an error distance that is not too large, while the forecast on LT2 shows a pattern that is quite similar to the observation but has a large enough error distance, while the forecast on LT3 shows a pattern that is not similar and the error is large.

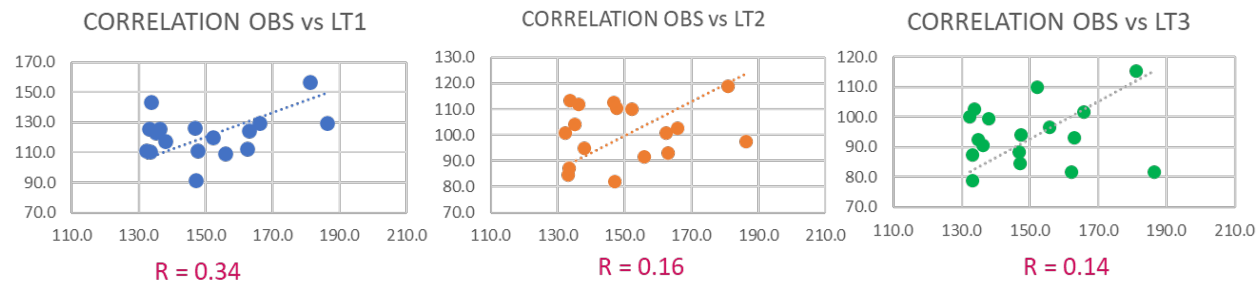


Figure 3. Correlation Observation VS prediction in LT1,LT2 and LT3

The correlation value shows that the LT1 has a fairly good correlation when compared to LT2 and LT3. This shows that the closer the initial conditions are to the target of the decade, the better the forecast of rainfall, especially for extreme events in Java.

(3) Results and Future Tasks

- **Results**

From the National Disaster Management Agency, BNPB data, frequency of flood events in Java is higher than in other regions in Indonesia, especially in Central Java which has the most flood events, this shows that extreme rainfall in these areas often occurs and Based on the results of this study the ECMWF S2S model data is able to provide a warning to LT1 and even LT2 before the event especially in Central Java.

The S2S ECMWF data for this study has lower resolution compare to data for operational in BMKG , so the results of this evaluation could be better if using S2S ECMWF operational data which has a resolution 0.25x0.25.

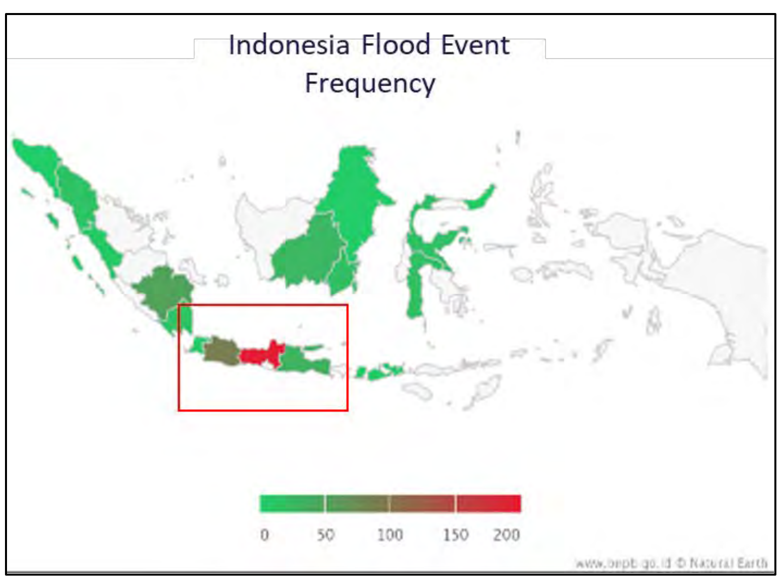


Figure 5. Indonesia Flood Event Frequency (Source : Indonesia National Disaster Management Agency)

- **Future Task**
  - Advanced Analysis for S2S Evaluation during MJO. In addition, this study is expected to examine the conditions of the interaction between the atmosphere and the sea as well as the physical processes that drive MJO, understanding the process behind this relationship can provide the key to improving the prediction system, especially the processes involved in the propagation of MJO on the maritime continent. Therefore, it is necessary to have a study related to evaluation and test the reliability of predictions on the S2S time scale at the time of extreme events such as MJO.
  - Evaluation of S2S for Equatorial, Monsoonal and Local climate types needs to be conducted.

1-4 Verification on JMA Forecast

(1) Introduction

- **Background**

To improve seasonal prediction is to conduct an evaluation to some climate prediction models. Therefore, in addition to verifying the products used for the operation (ECMWF) is also carried out verification of its other global models that JMA one-month forecast for the parameters of rainfall.

- **Data and Method**

In this study case the data used is data from the JMA (Japan Meteorology Agency) one-month forecast. The prediction data is daily rainfall data with a spatial resolution of 2.5^0 x 2.5^0. JMA one-month forecast is issued every 2 times a week with a length of forecast date of 34 days calculated after the initial conditions. Verification is carried out for every month in 2018. Therefore, the initial conditions used are the closest date to the target month. The data is not available for target months June, July, and August 2018. In addition, the available grid data is only for the western part of Indonesia, which covers the regions of Sumatra, Kalimantan, Java, Bali, West Nusa Tenggara, Half of East Nusa Tenggara and some part of Sulawesi.

Verification is done using a contingency table. As it is well known that BMKG issues deterministic PCH products with rainfall categories which are divided into nine QUANTITATIVE categories (0-20, 21-50, 51-100, 101-150, 151-200, 201-300, 301-400,> 500). Therefore, this verification is divided into 9 categories of rainfall and if observation rainfall categories has difference maximum 1 category with the forecast (difference value -1, +1, 0 defined as Match).

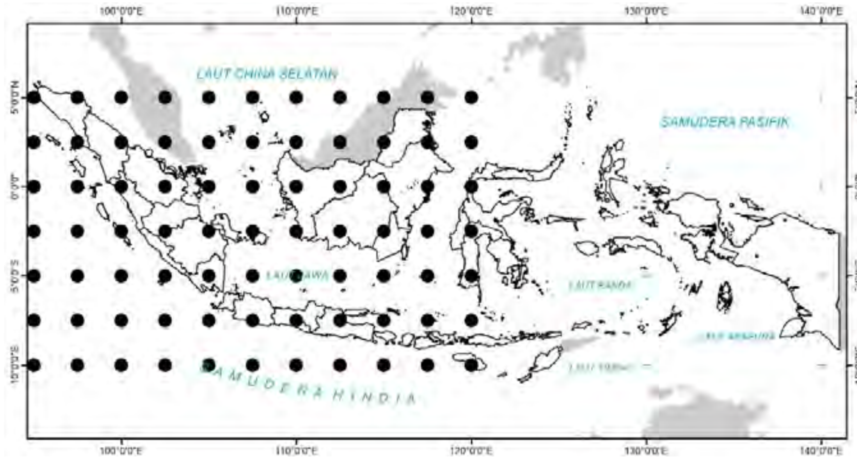
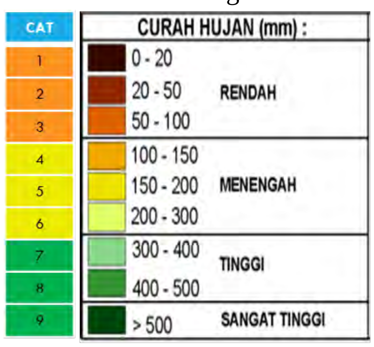


Figure 1. Grid Plot 1 Month Forecast of JMA model.



ij		Observasi				Jml
		1	2	…j…	K	
Prakiraan	1	P_{11}	P_{12}	P_{1j}	P_{1k}	$\sum P_{ij}$
	2	P_{21}	P_{22}	P_{2j}	P_{2k}	$\sum P_{ij}$
	…i…	P_{i1}	P_{i2}	P_{ij}	P_{ik}	$\sum P_{ij}$
	K	P_{k1}	P_{k2}	P_{kj}	P_{kk}	$\sum P_{ij}$
Jml		$\sum P_{ij}$	$\sum P_{ij}$	$\sum P_{ij}$	$\sum P_{ij}$	1

$$\textbf{Match} = \left(\sum P_{ii} + \sum P_{i,i+1} + \sum P_{i+1,i}\right) \times 100\%$$

$$\textbf{Not Match} = 100\,\% - \text{Match}$$

Figure 2. Category rainfall in operational BMKG(Left) and Contigency Table (Right)

(2) Analysis Results and Discussion

The verification results for the JMA model in 2018 show varied results for each month. Spatially, parts of Sumatra have a good Match in Mar - Apr 2018 and Dec 2018 - Jan 2019. For the Java in February 2018 and Apr 2018 which all Java regions have match in that month. Most of Kalimantan match in April - May 2018, Oct 2018, and Jan 2019 and for Bali and West Nusa Tenggara only good in Jan 2019.

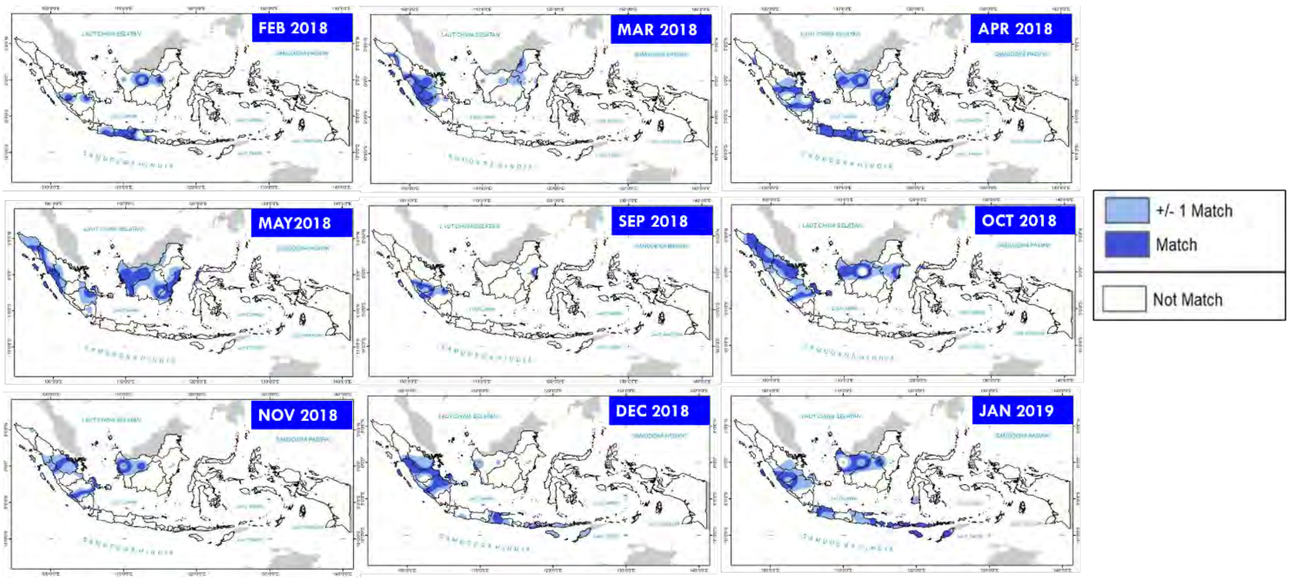


Figure 3. Verification of JMA one month forecast in 2018

Table. Verification of JMA one month Forecast

VERIF	COUNT SCORE											
	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
Match	30	43	37	48				24	38	32	52	33
Not Match	62	49	55	44				68	54	60	40	59
Total	92	92	92	92				92	92	92	92	92

VERIF	PERCENTAGE											
	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
Match	32.6%	46.7%	40.2%	52.2%				26.1%	41.3%	34.8%	56.5%	35.9%
Not Match	67.4%	53.3%	59.8%	47.8%				73.9%	58.7%	65.2%	43.5%	64.1%
Total	100%	100%	100%	100%				100%	100%	100%	100%	100%

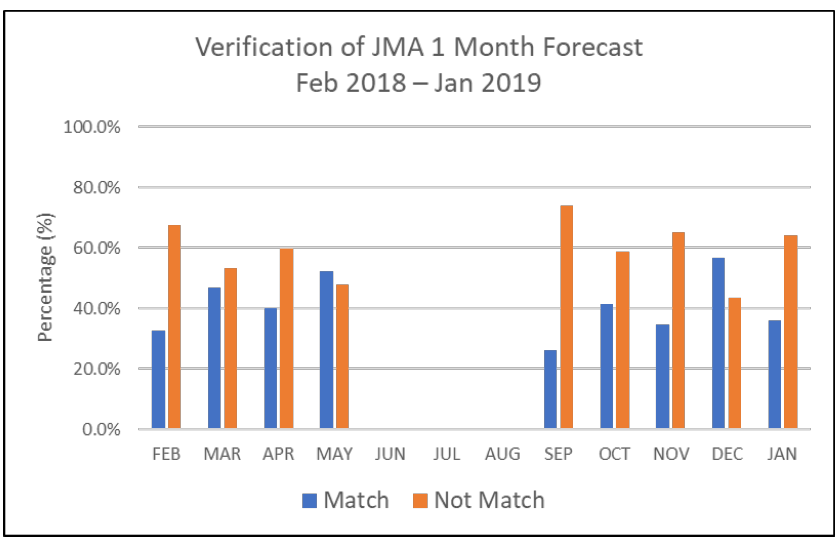


Figure 1. Verification of JMA one month forecast in average for west part Indonesia

From the average spatial, verification of model predictions is generally below 60%. In addition, the verification value is quite variable between months, the highest verification occurred in December 2018 with a value of 56.5%, while the lowest was in September at 26.1%.

(3) Results and Future Tasks

- **Results**

During forecast for Feb 2018 until Jan 2019, generally match forecast occur in middle part of Sumatra and west part of Kalimantan while other regions only for particular months.Verification values are generally below 60%. This verification value will be better if the data used has a higher resolution and this verification only represents western Indonesia.

- **Future Task**

As it is well known that the JMA one month forecast is the S2S product from JMA. Therefore, it would be better to compare S2S JMA products with ECMWF in a certain period

2 Improvement of ENSO Monitoring and Forecast

2-1 The Assessment of skill of ENSO forecast issued by JMA and NCEP

(1) Introduction

- **Background**

In the recent decade, the national climate state has always been considered by Indonesian government in the policy making process particularly for the sector which is sensitive to the climate, such as agriculture, energy, etc. Since Indonesian climate is strongly driven by ENSO, information on the ENSO status during the upcoming months or year is crucial for government to design the next step policy. To support this government strategy, we regularly release the status and ENSO forecast collected from many climate centers which are available freely such as product by JMA (Japan), JAMSTEC (Japan), NOAA (USA), BoM (Australia) etc. However, skill of these products is not clearly known. During this JICA program, we expect to get an access to archive of ENSO forecast of JMA to enable us to conduct a simple analysis on the skill of JMA ENSO forecasts.

It has been reported in many literatures that the impact of ENSO is not spatially coherent over Indonesia, depending on intensity, duration, timing, and local setting of geography. The precise information on the upcoming ENSO will enable government to design a suitable policy related to impact mitigation strategy. In this context, knowledge on the skill of ENSO forecast is essential requirement.

- **Data and Method**

The ENSO forecast data released by JMA is obtained from the ENSO JMA forecast archive file, (data can be accessed via https://ds.data.jma.go.jp/tcc/tcc/gpv/model/CPS2/3-mon/MGPV/YYYYMM/surf_Pss_mb.YYYYMM). The data is available from June 2015 to December 2019. This forecast data consists of three lead times. There are, first lead time; forecasts for the next 1 month, 2nd lead time; forecasts for the next 2 months, and 3rd lead time; forecasts for the next 3 months. For more details see the following illustration

Table 1. Illustration of Lead Time JMA ENSO forecast

		Forecast Period			
		Jan	**Feb**	**….**	**Dec**
Issued Period	**Dec**	Lead Time 1	Lead Time 2	Lead Time ...	Lead Time 12
	Jan		Lead Time 1	Lead Time 2	Lead Time 11
	⋮			Lead Time 1	Lead Time …
	Dec				

The ENSO forecast data released by NCEP is obtained from the ENSO NCEP forecast archive file, (data can be accessed via https://iri.columbia.edu/~forecast/ensofcst/Data/ensofcst_ALLto0520). It is available from JJA 2015 to OND 2019. The product is issued at three-monthly scale and consists of three lead times. For more details see the following illustration. For the observation, we select the JRA-55 data which is accessible via iTacs tool.

Table 2. Illustration of Lead Time for NCEP ENSO forecast

		Forecast			
		JFM	**FMA**	**….**	**DJF**
Issued	**DJF**	Lead Time 1	Lead Time 2	Lead Time ...	Lead Time 12
	JFM		Lead Time 1	Lead Time 2	Lead Time 11
	⋮			Lead Time 1	Lead Time …
	DJF				

As recommended by WMO, the technique of Standardized Verification System (SVS) for Long-Range Forecast will be applied for this study. That is **Mean Square Skill Score (MSSS)** method and **Pearson Correlation method.**

Mean Square Skill Score (MSSS)

MSSS value is required and will provide a comparison of forecast performance relative to "forecasts" of climatology. The three terms of the MSSS decomposition provide valuable information on phase errors (through forecast/observation correlation), amplitude errors (through the ratio of the forecast to observed variances) and overall bias. MSSS can be calculated using equations:

$$MSSS_j = 1 - \frac{MSE_j}{MSE_{cj}}$$

With:
MSE_j : MSE of the forecasts

MSE_{cj}: MSE of the climatology forecast

If MSSS values closed to +1, this indicates forecast model better than climatology, if MSSS values is negative, Climatology model better than forecast model.

Pearson Correlation

The Pearson correlation coefficient r is a measure to determine the relationship (instead of difference) between two quantitative variables (interval/ratio) and the degree to which the two variables coincide with one another. In this study Pearson correlation is used to measure the relationship between ENSO forecast data and ENSO observation data. Pearson correlation coefficient for two sets of values, x and y, is given by the formula:

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2(y-\bar{y})^2}}$$

Where x and y are the sample means of the two arrays of values. If the resultant value – r is close to +1, this indicates a strong positive correlation, its means forecast values similar with observed values. If the resultant value – r is close to -1, this indicates a strong negative correlation, its means forecast values not similar with observed value

(2) Analysis Results and Discussion

Performance of ENSO Predictions Issued By JMA

By using the Pearson and MSSS Correlation method, the results of ENSO verification for the June 2015 - December 2019 period issued by JMA are as follows:

Table 3. Performance of ENSO predictions Issued by JMA

Lead Time	Correlation	MSSS
Lead Time 1	0.97	0.93
Lead Time 2	0.94	0.87
Lead Time 3	0.91	0.80

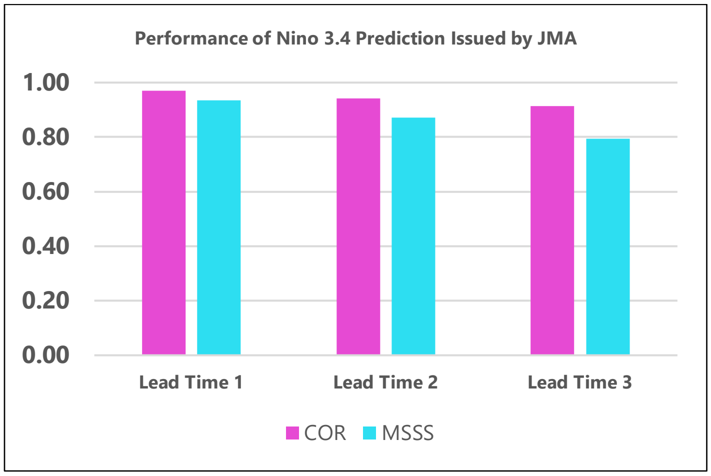


Figure 2-1-1. Performance of ENSO predictions Issued by JMA

Table 3 and Figure 2-1-1 show the results of verification for ENSO index issued by JMA. The correlation test shows high correlation of ENSO forecast for 1 to 3 months ahead. This means ENSO forecast issued by JMA has a high phase similarity with its observational value.

Verification using MSSS method also show similar results with correlation method, where positive MSSS is dominant result. It means ENSO Prediction model issued by NCEP CFS2 is better than climatology (in term of magnitude of bias) for 1 to 3 months ahead.

By using the Pearson Correlation and MSSS methods, the results of ENSO verification for the June 2015 - December 2019 period issued by JMA for each month are as follows:

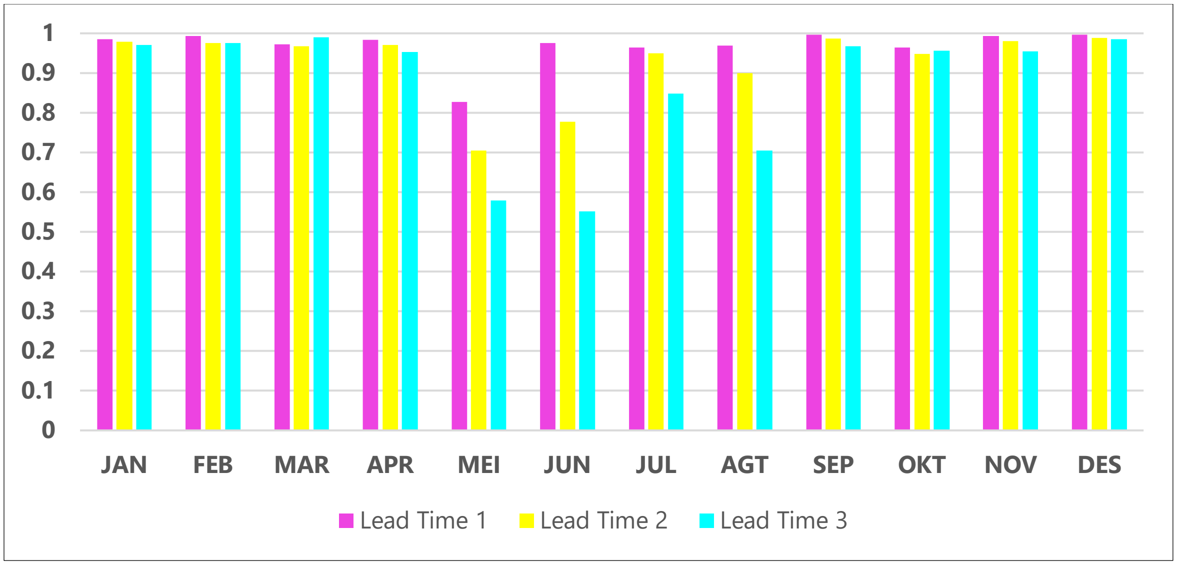


Figure2- 1-2. Performance of Nino 3.4 Prediction Issued by JMA using Correlation method

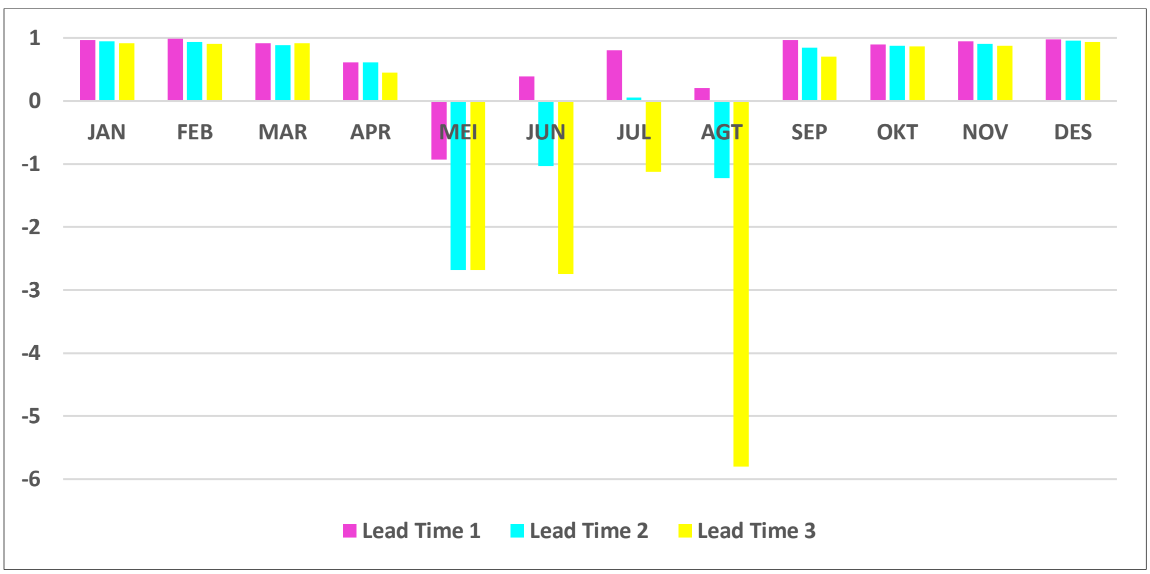


Figure 2-1-3. Performance of Nino 3.4 Prediction Issued by JMA using MSSS method

We also conducted skill assessment at monthly scale as shown in Figure 2-1-2 and Figure2- 1-3. In general, the JMA ENSO forecast has good skill except those issued in May – August. For May-August period, the correlation decrease particularly for lead time of 2 and 3 months and the MSSS scores are negative (mostly for lead time of 2 and 3 months) indicating that the forecast has no added value compared to its climatology.

Performance of ENSO Predictions Method Issued by NCEP (CFSv2 Model)

By using the Pearson and MSSS Correlation method, the results of ENSO verification for the June 2015 - December 2019 period issued by NCEP are as follows:

Table 5. Performance of ENSO predictions Issued by NCEP

Lead Time	Correlation	MSSS
Lead Time 1	0.97	0.94
Lead Time 2	0.93	0.84
Lead Time 3	0.87	0.69

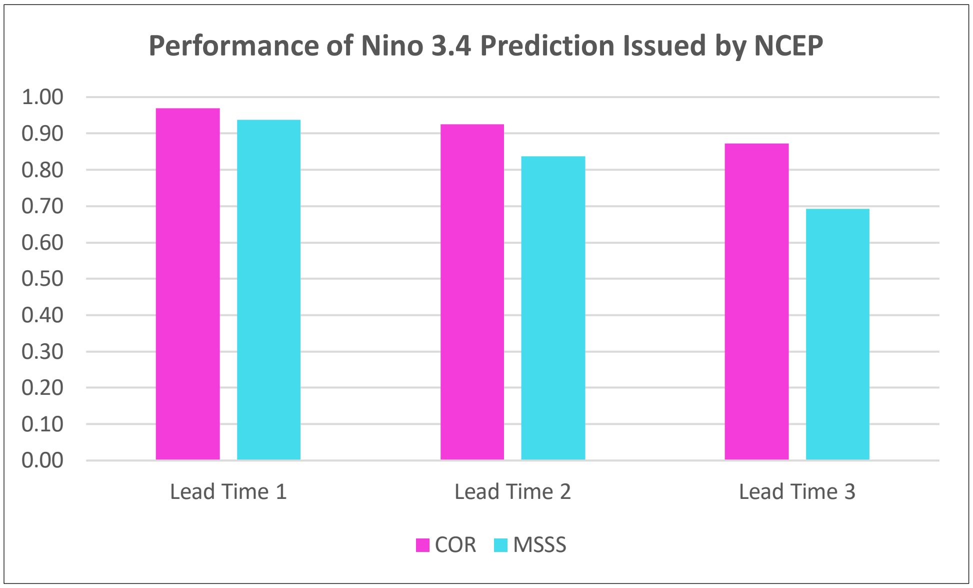


Figure 2-1- 4. Performance of ENSO predictions Issued by NCEP

Table 5 and Figure 2-1- 4 shows the results of verification for ENSO index issued by NCEP. The correlation test shows that the ENSO forecast is highly correlated with observation with coefficient of correlation around 0,8-1. Based on MSSS method, it is found that positive score is dominant result. The detailed result for correlation test at three-monthly scale is shown in the figure 2-1-5 while that for assessment using MSSS method is presented in figure2- 1-6.

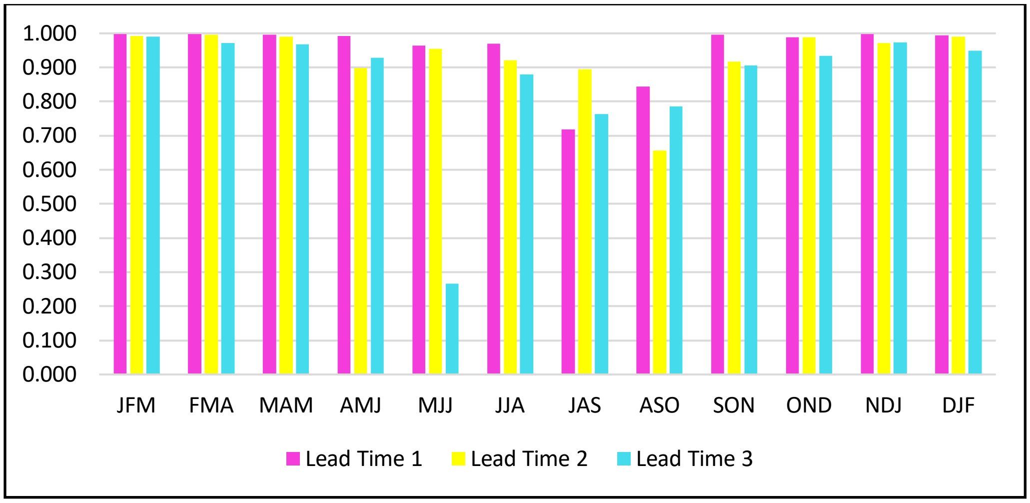


Figure2- 1-5. Performance of Nino 3.4 Prediction Issued by NCEP using Correlation method

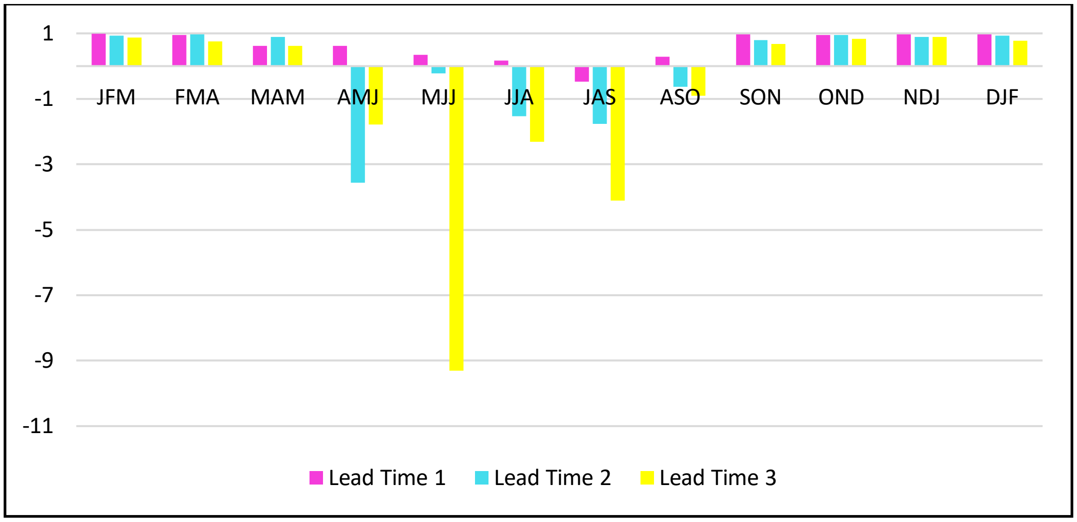


Figure2- 1-6. Performance of Nino 3.4 Prediction Issued by NCEP using MSSS method

(3) Results and Future Tasks

- **Results**

Generally, ENSO Prediction issued by JMA and NCEP CFSV2 have a good skill on forecasting 1 to 3 months ahead indicated by high correlation coefficient and positive value of MSSS score. However, the skill of both JMA and NCEP CFSV2 products reduce for May- August period suggesting that careful interpretation is needed for ENSO forecast issued on the mentioned period.

- **Future Task**

Apart from ENSO conditions, Indonesian climate also strongly driven by IOD (Indian Ocean Dipole). Information on the IOD status during the upcoming months or year is also crucial for government to design the next step policy, therefore the precise information on the upcoming IOD will enable government to design a suitable policy related to impact mitigation strategy. In this context, knowledge on the skill of IOD forecast is essential requirement. In the next project, I hope that we can also examine the skill of IOD predictions issued by JMA since this product are used regularly by BMKG as a reference on monitoring IOD event.

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Collecting Rainpost Data from East Java and South Sulawesi for Agricultural Insurance

Jakarta, 23 September 2020

When this project started ?,

- This project started in December 2018 and focused on two locations in Indonesia, especially in East Java and South Sulawesi.

- Because Agricultural Insurance in this project based on Climate Index, BMKG need provide/prepare reliable meteorological data especially rainfall data to support this project.

Visit Malang Climatology Station in East Java

- 19th December 2018

What's the Purpose ?,

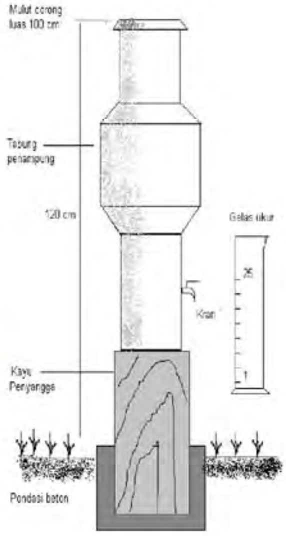
1. To introduce the Project of Capacity Development for Implementation of Agricultural Insurance to BMKG Malang Climatology Station
2. Discussion about how reliable the BMKG observation data in East Java. Such as How long the data, how many missing data, and how about metadata (latitude, longitude, elevation, etc)
3. To see the location of rain post and the process of collecting observational data from rain post in East Java.
4. To see BMKG instrumentations work and how to observe it, record it, input it to the computer, and sent it.

Visit Malang Climatology Station in East Java

- 19^{th} – 21^{st} June 2019

What is the Rain Post?,

- Rain post is a place that has a rain gauge to measure rainfall for 24 hours at that location.
- This rain gauge is observed everyday by local observer (**Non Staff BMKG**) and reported every 10 days by email or SMS to Coordinator Synoptic Station.



Why we need Rain Post data?,

- We assume BMKG Synoptic Stations in the regions already has reliable data. But, the number of synoptic stations is not enough to cover entire regions. So, we need daily precipitation data from the rainpost to cover precipitation data if there are no synoptic stations.

Spatial distribution of rain post in East Java

- The number of rain posts in East Java Province is around 975 posts. but, for sample only 47 rain posts and 3 Synoptic Stations in this project were used.
- Rain posts are selected based on their location in the paddy fields, the nearest to the synoptic stations, and have data length about ten years.

Metadata Rain Post in East Java

1	No	Nama Pos	Conditions	Owner Instruments	Observer Address	Active/Non Active	Ketersediaan Data	Data Tidak Ada/Rusak
2	40	Stamet Banyuwangi	Baik	BMKG	Jl. Jaksa Agung Suprapto No.152 Banyuwangi	Aktif		
3	53	Kalisepanjang	Baik	-	Jl. Pasar No.2 Glenmore Banyuwangi	Aktif	1995-2018	
4	55	Kalirejo	Baik	-	Jl. Pasar No.2 Glenmore Banyuwangi	Aktif	1995-2018	1995
5	57	Macan Putih	Baik	-	JL. Jember 175 Dadapan Banyuwangi	Aktif	1984-2018	
6	63	Kalibaru	Baik	BMKG	Jl. Pasar No.2 Glenmore Banyuwangi	Aktif	1993-2018	
7	71	Kaliklatak	Baik	-	Jl Ahmad Yani No.85 Banyuwangi	Aktif	1989-2018	
8	79	Licin	Baik	BMKG	JL. Jember 175 Dadapan Banyuwangi	Aktif	1984-2018	
9	80	Blambangan	Baik	-	Srono, Banyuwangi	Aktif	1996-2018	2004, 2010, 2011
10	85	Purwoharjo	Baik	-	Bangorejo, Banyuwangi	Tidak Aktif	1995-2018	1998
11	92	Alas Malang	Baik	-	JL. Bolodewo 3 Rogojampi Banyuwangi	Aktif	1989-2018	2000
12	97	Grajagan	Baik	-	Jl Kalipait No.31 Banyuwangi Telp.0333-592754	Tidak Aktif	1996-2018	1998, 2002
13	141	Kaliputih	Baik	-	Jl. S. Supriadi No. 86 Pos Box 24 Telp. (0342) 808897 Kode Pos 66132 – Blitar	Aktif	1990-2018	
14	340	Tumpang	Rusak (kran patah, pakai botol aqua	NON BMG	Jl. Panglima Sudirman No.102 Pare Kediri	Aktif	1990 - 2018	2001, 2002, 2006
15	381	Temas	baik	-	-	Tidak Aktif	1985-2018	
16	386	Tlekung	baik	-	-	Aktif	1979-2018	
17	523	Kedungrejo	Rusak Kran Lepas	Bmkg	Jl. Jend. Panjaitan No.9 Madiun	Aktif	1988-2018	1991, 1995-1997
18	562	Bululawang	Baik	Balai BBWS	Jl. Kawi No 1 kepanjen	Aktif	1981-2018	1984
19	566	Blambangan	Baik	-	Jl. Kawi No 1 kepanjen	Tidak Aktif	1981-2018	1981, 1995, 1996

Visit Maros Climatology Station in South Sulawesi

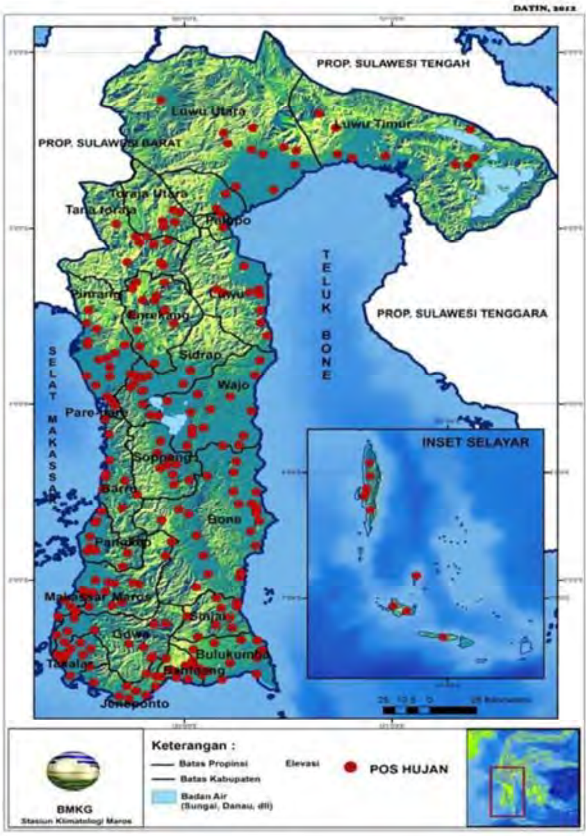
- 26^{th} – 28^{th} June 2019

26^{th}- 28^{th} June 2020 Visit Maros Climatology Station

1. To introduce the Project of Capacity Development for Implementation of Agricultural Insurance to BMKG Maros Climatology Station
2. To visit local rain post and obtain information on the data format and data collecting mechanism
3. To obtain the information on the daily activity of BMKG Maros Station.

Spatial distribution of rain post in South Sulawesi

- The number of rain posts in South Sulawesi Province is around 264 posts. but, for sample only 24 rain posts and 5 Synoptic Stations in this project were used.
- Rain posts are selected based on their location in the paddy fields, the nearest to the synoptic stations, and have data length about ten years.



Metadata Rain Post in South Sulawesi

NO	Rain Post Name	Number	Location			Installation/calibrated Year		Observer	
			City/District	Village	Sub district	Installed	Calibrated	Name	Phone Number
1	2	3	9	7	8	11	12	15	16
1	Bonto Bahari	73020301a	Bulukumba	Tanah Lemo	Bonto Bahari	2012	2012	Suardi, SP	081 342 991 775
2	Bontotanga	73020401a	Bulukumba	Bontotanga	Bontotiro	2010	2010	Samliah, SP	085 299 335 008
3	Bonto Macina	73020101a	Bulukumba	Bontomacinna	Gantarang Kindang/ Gangking	2010	2010	Baharuddin	0812 4191 937
4	Herlang	73020501a	Bulukumba	Singa	Herlang	2012	2012	H. Akhmad Basri, SP.	081 241 494 601 / 081 342 363 115
5	Tanajaya / Kajang	73020601a	Bulukumba	Tanah Jaya	Kajang	2010	2010	Sappewali, SP	085 255 502 129
6	Bulo-bulo / Tanete	73020801a	Bulukumba	Bulo-Bulo	Kindang	2010	2010	Muhlis/H Nurdin	081 343 947 088
7	Borong Rapoa	73020802a	Bulukumba	Borong Rappoa	Kindang	2010	2010	Akhmad	081 354 954 493
8	BPP Tanahkongkong	73020201a	Bulukumba	Tanah Kongkong	Ujung Bulu	2012	2012	Amas, SE.	0812 4210 5068
9	BPP. Paruku/Ujung Loe	73020901a	Bulukumba	Dannuang	Ujung Loe	2010	2010	H Abd.Rahman, SP	081 342 429 321
10	Belajen/ Alle	73160501a	Enrekang	Kel. Kambiolangi	Alla	2010	2010	Bahrun Depa	
11	BPP Anggareja	73160402a	Enrekang	Bubun Lamba	Anggeraja	2013	2013	Syamsul Sompa	085 341 018 519
12	Baraka	73160301a	Enrekang	Kel. Tomegawa	Baraka	2009	2009	Junriati, SP	0853 4286 8620
13	Baroko	73160302a	Enrekang	Desa Tongko	Baraka	2010	2010	Darmiati, SP	081 342 991 775
14	Bungin	73160601a	Enrekang	Desa Bungin	Bungin	2010	2010	Abd. Mail	0821 9725 4115
15	Buntu Batu	73161001a	Enrekang	Desa Eran Batu	Buntu batu	2009	2009	Suriami	0813 4171 6024
16	Kabere / Cendana	73160701a	Enrekang	Desa Taulan	Cendana	2010	2010	Abd. Rahman	0852 5599 0887
17	Curio	73160801a	Enrekang	Desa Curio	Curio	2010	2010	Wahyuddin	0853 4252 2193
18	Enrekang	73160201a	Enrekang	Desa leoran	Enrekang	2012	2012	Arsyad, SP	0852 8969 6118
19	Garutu	73160202a	Enrekang	Buttu Batu	Enrekang	2013	2013	Arsyad.	081 241 040 622
20	Maiwa / Maroangin	73160101a	Enrekang	Kel. Bangkala	Maiwa	2010	2010	Syamsial	0813 4257 0862
21	Malua	73160901a	Enrekang	Desa Malua	Malua	2010	2010	Andi Khaidir	0813 5545 5219
22	Masalle	73161101a	Enrekang	Desa Masalle	Masalle	2009	2009	Latif Qaeda	0852 5670 6116
23	BPP. Angkona	73240501a	Luwu Timur	Ds. Lamaeto	Angkona	2012	2012	Sahirman	0813 4352 4014
24	Bonepute/Wotu/Burau	73240701a	Luwu Timur	Ds. Bone Pute	Burau	2010	2010	I. Wayan Suar SP.	0852 8573 6062
25	Desa Malili	73240401a	Luwu Timur	Ds. Manurung	Malili	2012	2012	Jasmaniar SP.	0813 5566 1509
26	Maleku/ Wonorejo/Mangkutana	73240101a	Luwu Timur	Ds. Balai Kembang	Mangkutana	2010	2010	Ni Made Dian A.	0823 0420 3555
27	Tomoni	73240801a	Luwu Timur	Ds. Beringin Jaya	Tomoni	2010	2010	Milka	0823 4725 0975
28	Towuti	73240301a	Luwu Timur	Ds. Langkea Raya	Towuti	2012	2012	Rusmiaty Rasyid	0852 5565 2146
29	Wasuponda / Nuha	73241101a	Luwu Timur	Ds. Ledu-Ledu	Wasuponda	2012	2012	Imanuel Rampu	0812 3301 7216
30	Wotu	73240601a	Luwu Timur	Ds. Cendana Hijau	Wotu	2010	2010	Suhaema SP.	0821 8727 5499
31	Tampinna	73240501a	Luwu Utara	Tampinna	Angkona	2015		Hasaruddin	

Mini Workshop BMKG and JICA in Jakarta

- 09th July 2019

- Invite people from BMKG Maros and Malang to participate and see the progress of this Project.
- When Climate Index Insurances will be apply, MoU should be involved BMKG Maros and Malang
- Sharing the result of the quality control data to BMKG Maros and Malang.

Conclusion

BMKG has to identified and collect several required data for the purpose of analysis over the area of East Java and South Sulawesi, which are considered as the pilot area of this project. The necessary climate data for this project is the rainfall data from BMKG Synoptic Stations and additional rain post data.

Note : Rain post data was observed by local observer (Non staff BMKG). Before we use the rain post data, we also check if we find outlier data, missing data, error data and do some statistical method to know reliability of the rain post data. (It will be next presented by Noveta-San)

Project of Capacity Development for the Implementation of Agricultural Insurance

Jakarta, 23rd September 2020

Evaluation of Rain Post Data in Indonesia for Agricultural Insurance

Center for Climate Change Information, BMKG

Outline

- Introduction
- Activities
- Conclusions

Introduction

- A better spatial coverage (higher density of precipitation data) is necessary for the practice of climate-based agricultural insurance
- Data from major BMKG synoptic station (hereupon referred as SYNOP data) is assumed to be the ideal and is used as the reference, considering that the WMO standard is adopted and the data is always checked and QC-ed
- The coverage of SYNOP station over Indonesia is sparse
- In addition to SYNOP data, BMKG also store additional climate data from rain post and automatic station network all over Indonesia
- Using rain post data for agricultural insurance is an alternative in providing precipitation data in the area where there are no SYNOP station
- The quality of rain post data should be gauged and assessed before it can be used as a consideration for agricultural insurance purpose

Introduction

- An alternative data that can be used for agricultural insurance purpose is the satellite-based observation datasets, among them is the GSMaP data
- The GSMaP data can be used if there is no SYNOP or rain post data in the area
- The GSMaP performance in Indonesia should be assessed and analyzed, in this case, for the pilot area of East Java and South Sulawesi

Activities

- Data retrieval and identification
  - >> Synop and rain post
  - >> GSMaP daily data
- Data comparison and analysis
  - >> rainpost with synop
  - >> observation data (synop and rainpost) with GSMaP
- Evaluation
  - >> Result
  - >> Summary

Data retrieval and identification

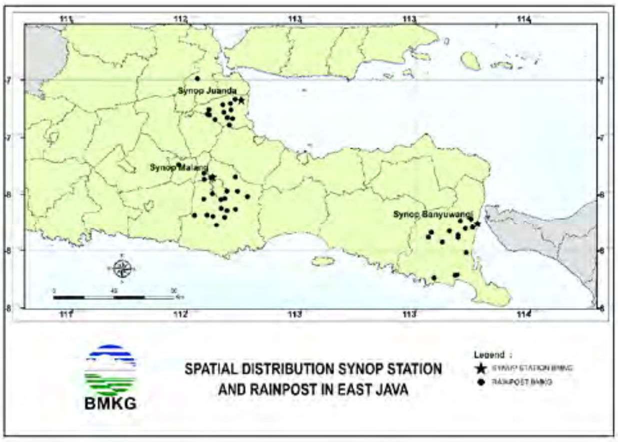
Indonesia : 5426 rain post

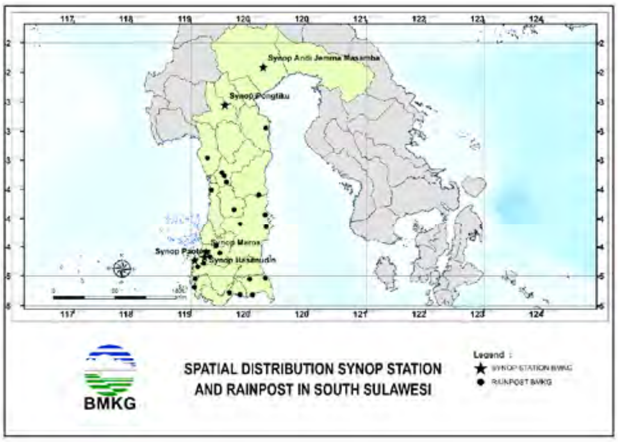
944 ARG/AWS/AAWS

>> short period

Pilot Project:
East Java : 975 rain post
>> 3 synop and 47 rain post
South Sulawesi : 264 rain post
>> 5 synop and 24 rain post

Pilot Project:
The location of rain posts that is used, is selected only those located within the paddy field area





Case study :
East Java and South Sulawesi

Data Comparison and Analysis

- Synop vs Rain Post
- Synop vs GSMaP
- Rain Post vs GSMaP

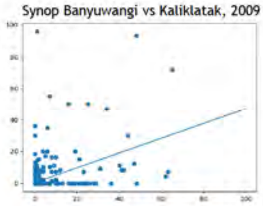
correlation	Smoothness	Hit rate in contingency sheet	
sum	sum	dasarian	daily
>=0.9 OK	Good (smooth) <= 2.5%	>= 0.6667	
	Fair (mostly smooth) 2.5 - 5 %		
<0.9 NG	NG (Not smooth) >5.0	< 0.667	

Calculate in each year for 10 years periode

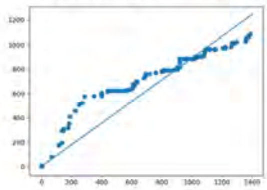
Summary Table

scatter chart and double sum curve for unreliable year

Synop Banyuwangi vs Kaliklatak, 2009



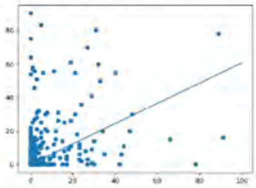
Synop Banyuwangi vs Kaliklatak, 2009



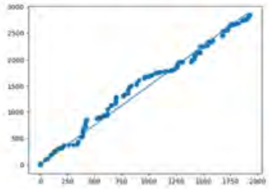
							>=0.9	<=5%	<=5%	>=0.67	>=0.67			
No	Rain Post	Lat	Lon	Year	Distance	Correlation		smoothness		Hit rate in contingency sheet		Reliable	TRUE	FALSE
					(km)	daily	sum	smoothness 2 (average)	smoothness 3 (SD)	daily	dasarian	Dasarian		
	Stamet Banyuwangi	-8.21667	114.3833											
1	Kaliklatak	-8.18533	114.3402	2009	6	0.403	0.967	6.42%	5.37%	0.75	0.918	FALSE		
	Kaliklatak	-8.18533	114.3402	2010	6	0.343	0.996	2.42%	2.03%	0.855	0.778	TRUE		
	Kaliklatak	-8.18533	114.3402	2011	6	0.262	0.982	4.49%	3.27%	0.923	0.722	TRUE		
	Kaliklatak	-8.18533	114.3402	2012	6	0.385	0.983	5.63%	3.26%	0.902	0.806	FALSE		
	Kaliklatak	-8.18533	114.3402	2013	6	0.063	0.988	2.89%	3.10%	0.841	0.833	TRUE		
	Kaliklatak	-8.18533	114.3402	2014	6	0.173	0.991	3.24%	2.31%	0.923	0.806	TRUE		
	Kaliklatak	-8.18533	114.3402	2015	6	0.246	0.99	2.75%	2.85%	0.91	0.917	TRUE		
	Kaliklatak	-8.18533	114.3402	2016	6	0.133	0.99	2.95%	2.41%	0.877	0.806	TRUE		
	Kaliklatak	-8.18533	114.3402	2017	6	0.202	0.977	4.76%	3.93%	0.874	0.75	TRUE		
	Kaliklatak	-8.18533	114.3402	2018	6	0.227	0.98	3.40%	3.12%	0.901	0.806	TRUE	8	2
	Kaliklatak												80	20

scatter chart and double sum curve
for reliable year

Synop Banyuwangi vs Kaliklatak, 2010



Synop Banyuwangi vs Kaliklatak, 2010

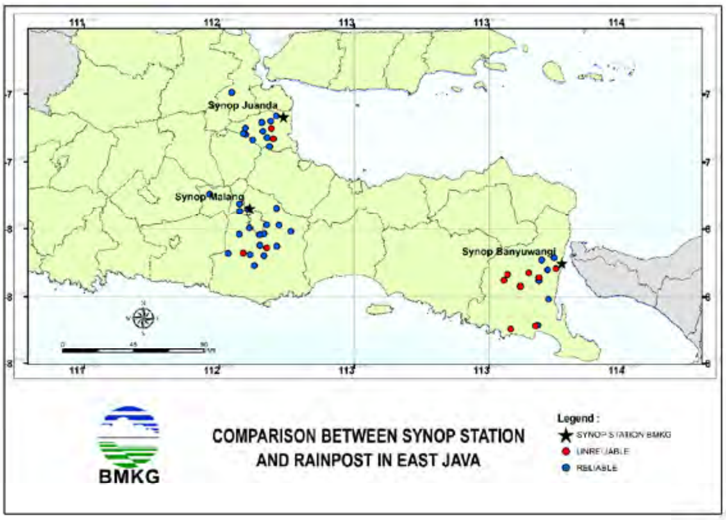


Threshold for reliabilty is greater than 60%

Evaluations

❖ Result

❑ Synop vs rain post (East Java)

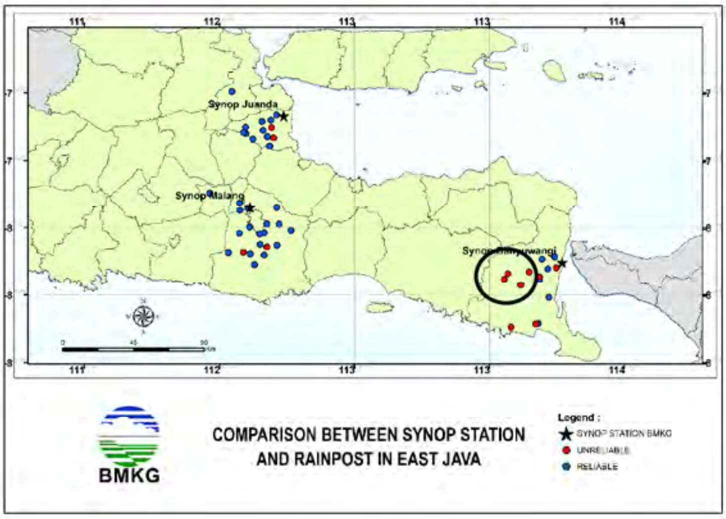


- ➢ 35 out of 47 rain posts shown greater than 60% reliability (10-years period)
- ➢ Rain posts located in Banyuwangi area have low reliability value (only 6 out of 14)
- ➢ The suspected cause of the low reliability are the distance, as well as the difference in altitude of the rain post with respect to the SYNOP station

Evaluations

❖ Result (additional analysis)

❑ Rain post vs rain post (East Java)



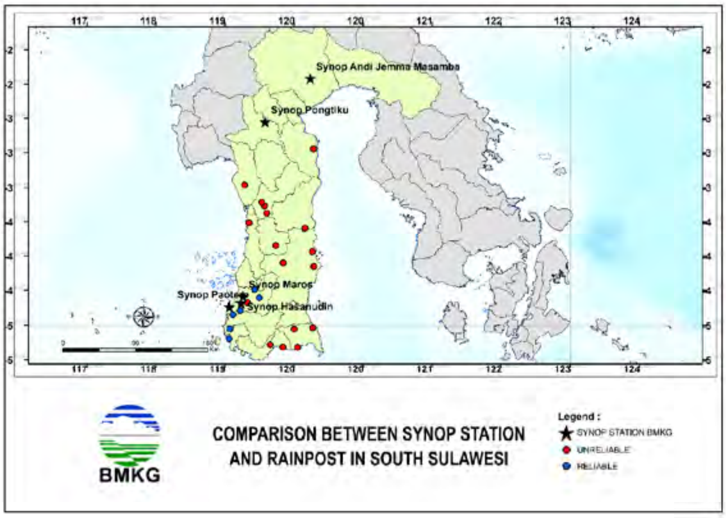
Rain post	kaliputih	sumberbaru	kalisepanjang	sepanjang
kaliputih		90	90	80
sumberbaru	90		70	70
kalisepanjang	90	70		90
sepanjang	80	70	90	

- 4 rain post show good reliability with the other
- The distance between the rain posts relatively close, less than 20 km and the difference of altitude is relatively small, around 100 m.

Evaluations

❖ Result

❑ Synop vs rain post (South Sulawesi)

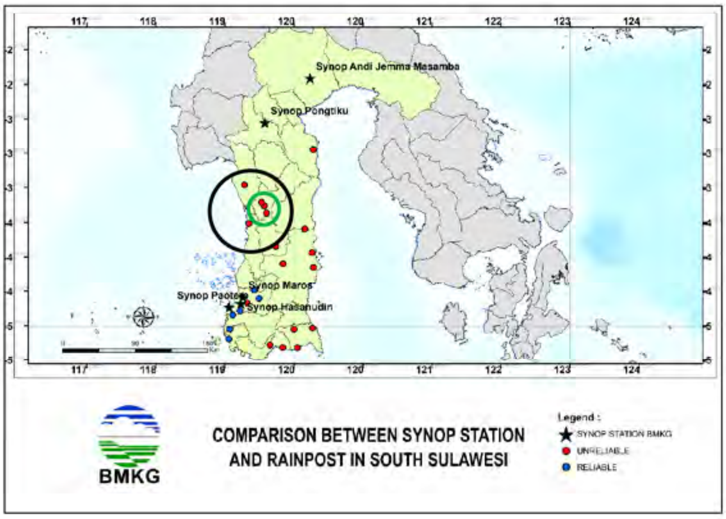


- 6 out of 24 rain posts shown greater than 60% reliability (10-years period)
- Most of the rain posts have a significant distance from the reference SYNOP station
- Additional analysis has been done for the central and northern part of South Sulawesi to clarify and further justify the impact of the distance towards the reliability value

Evaluations

❖ Result

❑ Rain post vs rain post (South Sulawesi)



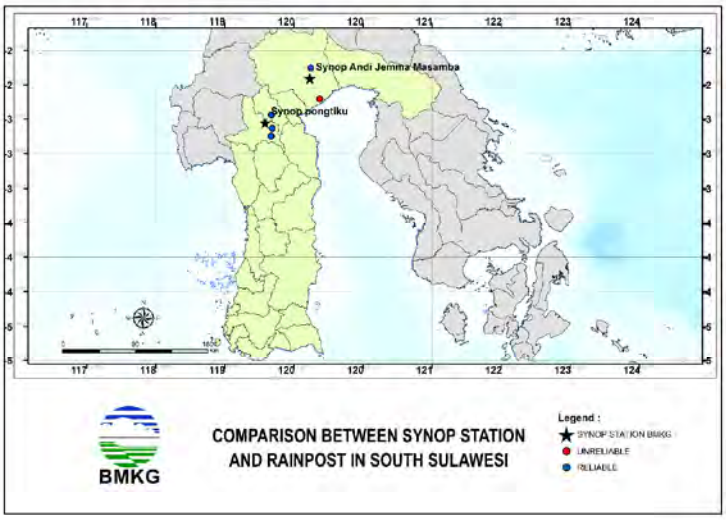
Rain post	Amparita	Bilokka	Sereang	Mallawa	Cempa
Amparita		80	70	30	20
Bilokka	80		70	30	20
Sereang	70	70		40	30
Mallawa	30	30	40		20
Cempa	20	20	30	20	

- 3 out of 5 rain post shown greater than 60% reliability (10-years periode)
- The distance between 3 rain post relatively close less than 20 km

Evaluations

❖ Result

❑ Additional analysis for five years periode in South Sulawesi

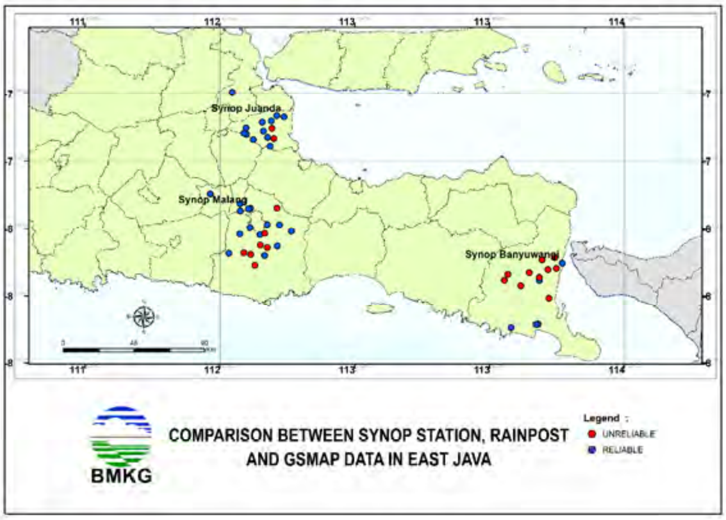


- 4 out of 5 rain posts shown greater than 60% reliability (5-years period)
- This additional analysis suggests that the distance play a bigger role in affecting reliability

Evaluations

❖ Result

❑ Observations vs GSMaP (East Java)

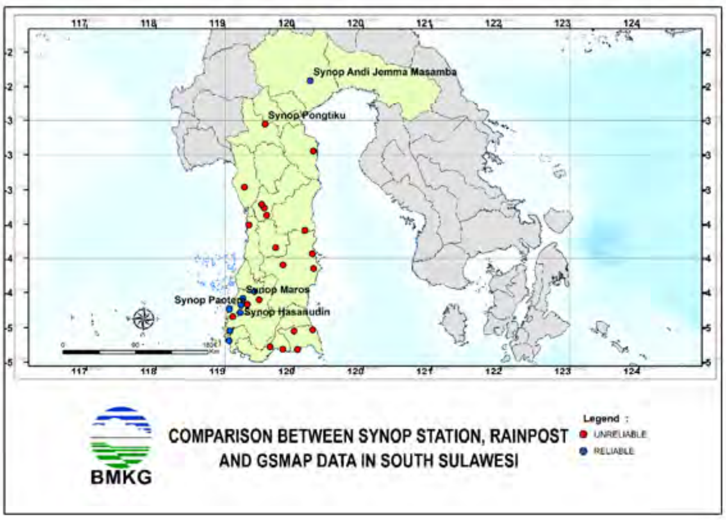


- GSMaP data is reliable in 36 out of 50 analyzed observation points (in 10-years period)
- GSMaP data is already validated by SYNOP data (according to Ms. Yamaji of JAXA)
- GSMaP data has a good reliablity in 3 Synop Station

Evaluations

❖ Result

❑ Observations vs GSMaP (South Sulawesi)

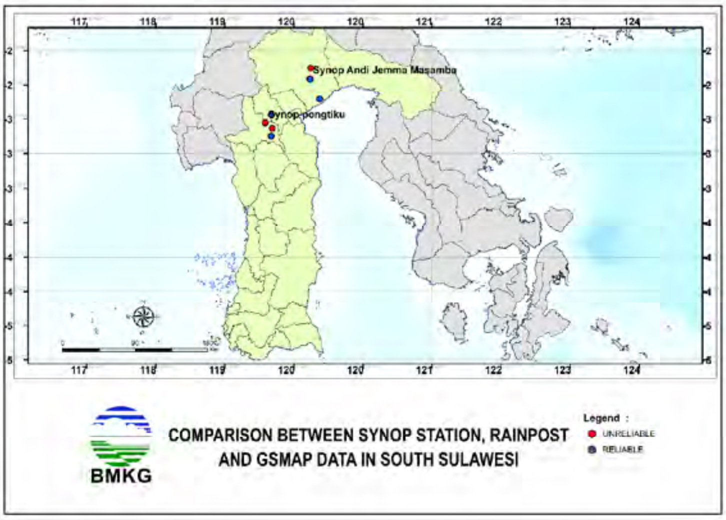


- GSMaP data is reliable only in 8 out of 29 analyzed observation points (in 10-years period)
- GSMaP data has a good reliablity in 4 Synoptic Station

Evaluations

❖ Result

❑ Additional analysis for five years periode in South Sulawesi

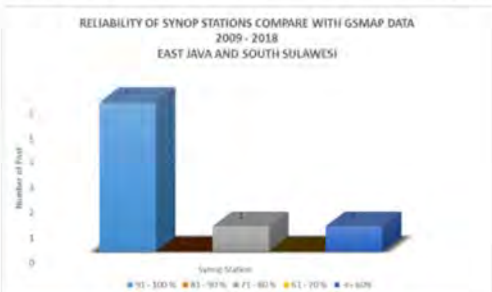


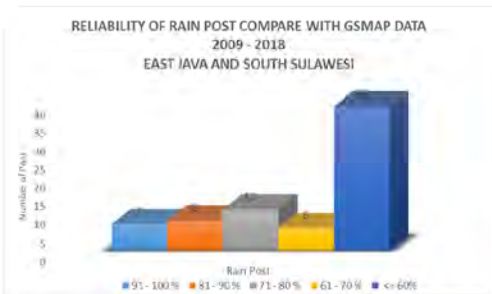
- GSMaP data is reliable in 4 out of 7 analyzed observation points (in 5-years period)
- The SYNOP station of Pongtiku Tana Toraja shows low reliability
- One of the causes could be that SYNOP Pongtiku station is not a part of GSMaP calculation and algorithm

Evaluations

❖ Result

❑ Observations vs GSMap





- SYNOP
  >> 7 of 8 Synop station have **greater than** 60% reliability for 10 years
  >> GSMaP have a good relation with Synop Station
- RAIN POST
  >> 39 of 71 rain posts have **less than 60%** reliability for 10 years
  >> The reliability of GSMaP data over the rainposts location is relatively low

Evaluations

❖ Summary

❑ Synop vs rainpost

- In East Java (in 3 area as pilot project), the cumulative and dasarian precipitation from rain posts data provides **good reliability**, with respect to the SYNOP data as the reference observation
- Meanwhile, in South Sulawesi, the cumulative and dasarian precipitation from rain posts data provides **low reliability**, with respect to the SYNOP data as the reference observation
- The distance and altitude difference might be the biggest affecting factors

❑ GSMaP Data Performance

- GSMaP data have a good relation with Synop Station
- The reliability of GSMaP data over the rain-posts location is relatively low

Conclusions

a. A further evaluation needs to be done in other regions. The results of the evaluation should be compared to the East Java and South Sulawesi results.

b. Considering the frequent event of convective rainfall over Indonesia, it might be good to add more criteria into the reliability justification (among them might be the number of jumps from the double sum curve).

c. Comparison between rain posts data with lower difference in distance and altitude could provide an alternative in the further effort of assessing reliability.

d. For the purpose of agricultural insurance, the top priority reference data should be the SYNOP ground observation data. In the case of the location is significantly far from the SYNOP data, the rain posts data can be used after applying the previously explained quality control method. Other options is to use satellite-based observations like GSMaP data.

e. In addition to the agricultural insurance project, the collection, analysis, and evaluation that are performed might as well be very important for other BMKG activities, hence, should be continued in the future.

Launching Final Report JICA Summary and Future Plans

Agus Sabana Hadi

Summary of Key Activities 1 and 3

- Key activities 1 : Provide/prepare reliable meteorological data for agricultural insurance
- Key activities 3 : Enhance analysis abilities of risk analysis for climate change data-set

- Meeting with JICA experts to discuss the preparation, activity plans and methods of rainfall data processing for the provinces of East Java and South Sulawesi
- Made an official trip to Japan which was accommodated by JICA to conduct a comparative study related to agricultural insurance activities
- Made an official trip to MRI Japan to conduct the study to improve the performance of the MRI-Non hydrostatic Regional Climate Model as a collaborated research and it was accommodated by JICA, MRI and Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
- Made an official trip to East Java and Makassar with JICA experts to see the routine activities at the BMKG observation station, and see the nearest rain post.
- Processing data to see the reliability of rainfall data by comparing rainfall data from synop stations, rain posts and GSMap.

Future Plans

- future plans for key activities are
  - Increase the number of rainfall data source for comparison with synop and rain post data, for example by adding AWS data or other satellite data
  - make comparisons between synop station data, rain posts and GSMap for other regions besides East Java and South Sulawesi
  - adding other criteria or parameters in comparing rainfall data between observation locations to determine reliability
  - continue to study and training in downscale climate projection data to high resolution and try to downscale independently assisted by experts from Japan
  - utilizing high-resolution climate projection data to be useful information for national planning and related sectors

Thank You
ありがとう ございます

Final reporting

BMKG Observation Data for Agricultural Insurance

Project of Capacity Development
for the Implementation of Agricultural Insurance
in the Republic of Indonesia

Jakarta, 23rd September 2020

Michihiko Tonouchi (JICA expert)

1. Outline of the Project

Goal	Agricultural insurance is continuously implemented in Indonesia
Project Purpose	Capacity of the key ministries/institutions, the concerned local governments, and other relevant organizations to enhance the implementation of agricultural insurance is strengthened.
Outputs	1.Capacity to implement the current scheme of agricultural insurance for paddy is strengthened.
	2.Capacity to analyze and improve agricultural insurance scheme is strengthened.
Activity	2-1. Conduct assessment of meteorological observation and climate/disaster risk data, communicate the results and recommendations for capacity development, as well as relevant training for capacity building in order for such data to be utilized for insurance implementation/development incl. weather-index based insurance.
(only for output2)	2-2. Prioritize and conduct desk-top/field studies concerning yield based insurance, other commodities to be insured, use of remote sensing, etc., and relevant training as necessary.
	2-3. Prioritize and conduct policy studies concerning financial and fiscal issues relating to agricultural insurance.
	2-4. Develop and communicate recommendations, based on the results of the activities 2-1, 2-2 and 2-3.

2. Data for agricultural insurance

Insurance companies require data BMKG guaranteed (daily precipitation al least 10 years hopefully for 30 years). The most reliable data set in Indonesia is the BMKG manual observation data (SYNOP data),which quality checked monthly basis in BMKG Database center. Required data set is,

(a) Raw and cleaned (missing data alternated or estimated) data
(b) Its average, standard deviation for dasarian, monthly data at the station
(c) Meta data (latitude, longitude, elevation, equipment and so on)

BMKG rain data

179 SYNOP (quality checked)

944 ARG/AWS/AAWS (several years history)

5426 Rain post

Pilot area

Collect precipitation data (SYNOP, rain-post)

Evaluate and quality check data

-> (a) Increase reliable data

Re-analysis (assimilation technique) with map data and station data.

-> (b) reliable re-analysis precipitation (map) data

3. Develop software (python) and evaluate data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	1: aveX=	5.282	aveY=	7.797	sdX=	12.03	sdY=	15.511	cov=	7.999						
2	2: cor=	0.343	cor^2=	0.118	r2a=	0.118	r2c=	0.291	r2d=	0.752	coa=	0.442	cob=	5.462	coc=	0.609
3	3: aveX=	1115.15	aveY=	1707.56	sdX=	554.112	sdY=	792.418	cov=	661.165						
4	4: cor=	0.996	cor^2=	0.991	r2a=	0.991	r2c=	0.995	r2d=	0.802	coa=	1.424	cob=	119.899	coc=	1.51
5	5:smoothness1=	14.78%	N=	204												
6	6:smoothness2=	0.82%	smoothn	3.05%	N=	363										
7	7:ctg(day).table: a=	13	b=	20	c=	33	d=	299	Rprop:	0	R>3&F	10				
8	8:N=	365	hit rate=	0.855	threat	0.197										
9	9:ctg(day).table: a=	15	b=	1	c=	7	d=	13	Rprop:	1	R>3&F	0				
10	10:N=	36	hit rate=	0.778	threat	0.652										

	yes	no
Yes	a	b
no	c	d

Important parameters,
Correlation factor should be bigger than 0.9
Smoothness2 (average) and smoothness3 (standard deviation) should be smaller than 5%.

Parameters should be checked,
Rprop : both stations observed rain and the proportion was bigger than 3.0
R>3&..: one station observed stronger than 20mm/day but the other station did not observed rain.

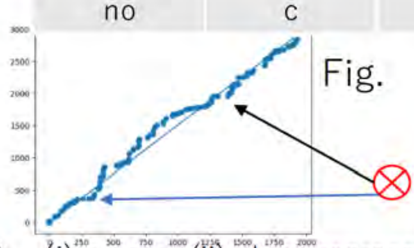


Fig.

Please check thee parameters watching fig. (smoothness and gap) = (i) no gap, (ii) along regression line is better.

No	Rain Post	Lat	Lon	Year	Distance (km)	Correlation daily	Correlation sum	smoothness 2 (average)	smoothness 3 (SD)	Proportion daily	Proportion sum	Hit rate in contingency sheet daily	Hit rate in contingency sheet dasarian	Reliable
	Stamet Hasanudin	-5.07	119.55											
1	Balleangin	-4.92056	119.702	2017	23	0.672	0.99	2.07%	1.60%	0.485	0.877	0.838	0.75	TRUE
	Balleangin	-4.92056	119.702	2010	23	0.234	0.994	2.19%	1.44%	0.565	1.274	0.715	0.833	TRUE
	Balleangin	-4.92056	119.702	2011	23	0.291	0.987	2.72%	1.74%	0.537	1.349	0.767	0.917	TRUE
	Balleangin	-4.92056	119.702	2012	23	0.193	0.989	4.26%	4.36%	0.407	1.13	0.814	0.778	TRUE
	Balleangin	-4.92056	119.702	2013	23	0.517	0.989	3.87%	2.59%	0.691	1.139	0.805	0.806	TRUE
	Balleangin	-4.92056	119.702	2014	23	0.685	0.994	1.37%	1.57%	0.922	1.447	0.893	0.833	TRUE
	Balleangin	-4.92056	119.702	2015	23	0.71	0.99	2.32%	2.45%	0.838	1.244	[illegible]	[illegible]	TRUE
	Balleangin	-4.92056	119.702	2016	23	0.369	0.989	3.34%	1.98%	0.586	1.447	[illegible]	[illegible]	[illegible]
	Balleangin	-4.92056	119.702	2017	23	0.672	0.989	2.38%	1.95%	1.049	1.709	0.866	0.833	TRUE
	Balleangin	-4.92056	119.702	2018	23	0.49	0.995	1.45%	2.06%	0.572	0.936	0.849	0.861	TRUE

Indonesian data

4. Results

(1)
Sharing Japanese analysis sample and tried evaluation of rain-post data in pilot area.

(2)
Nearby rain-post in 20km shows reliability.
Most of rain post data has reliability.

(3)
Collect rain data, Evaluate them and then
Add to data-set

5. GSMaP data usage

GSMaP MVK (standard)

* 3-day latency
* past duration available since March 2000

GSMaP data in HD.
2005.01 to 2014.02 is gsmap_gauge_RNL
2014.03 to 2019.02 is gsmap_gauge

JAXA's GSMaP products

Version	Product Name: only Satellite	Product Name: Gauge adjusted	domain	Resolution	Update Interval	Latency
Standard	MVK	Gauge	Global	0.1 deg. lat/lon hourly rainfall	hourly	3-day
	RNL	Gauge_RNL				
Near Real Time	NRT	Gauge_NRT	Global		hourly	4-hour
Real Time	NOW	Gauge_NOW			30min	a few min
Nowcast	RNC	-	Global		hourly	several hour in advance

Accuracy

Calibrated with 'NOAA CPC Global Daily Gauge'

Good relationship with SYNOP data exchanged through GTS.
Rainpost nearby SYNOP shows good relationship

We found through the project.

At first, we collect observation data as many as possible
Evaluate them and exclude unreliable data.

In future

Re-analyze GSMaP MVK by reliable SYNOP, AWS/ARG, rain post data, provides reliable precipitation map for agricultural insurance.

6. Achievement of Outputs (key activity 1)

Verifiable Indicator		Achievement
2-1	BMKG staff trained.	8 in Climate change section 4 in Climate Variability section 4 each in Malang and South Sulawesi observatory
2-2	Meteorological and climate database's quality improved.	47 Rain-post data in East Java and 24 Rain-post data in South Sulawesi were collected and evaluated from 2009 to 2018. GSMaP MVK data was collected (2005-2018). Data evaluation process for agricultural insurance was developed.

- The requirement from insurance companies to BMKG is to share reliable weather information guaranteed by BMKG as the national meteorological service. BMKG already established quality check system and steadily implements monthly basis authorized data for SYNOP stations.
- In recent several years, AWS (Automatic Weather Station) and ARG (Automatic Rain Gauge) network have been developed and as for a Map 'Days Without Rain' operationally provided on BMKG web site. AWS and ARG observation data is also used for precipitation re-analysis data using GSMaP data calibrating with AWS/ARG data.
- As mentioned in previous analysis, if BMKG collect reliable data also for Rain-post and properly evaluate them, these data contributes as indexes for agricultural insurance and also for more reliable re-analysis precipitation data (map). => reliable data contributes for climate change evaluation and statistical downscaling.

Terima kasih untuk jenis anda mendukung untuk proyek.

Evaluation of Season Onset Forecast & Case Study on Dry and Wet Season's Variability

-KEY ACTIVITY 2-

Presented by:
Rosi Hanif Damayanti, S.Tr

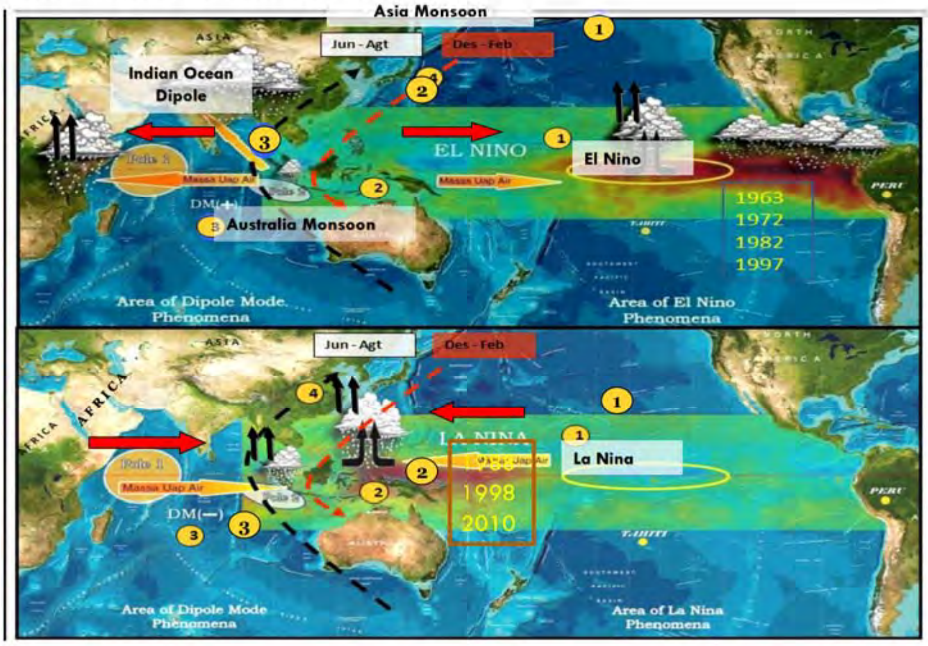
FINAL REPORT LAUNCH

Wednesday
September 23, 2020

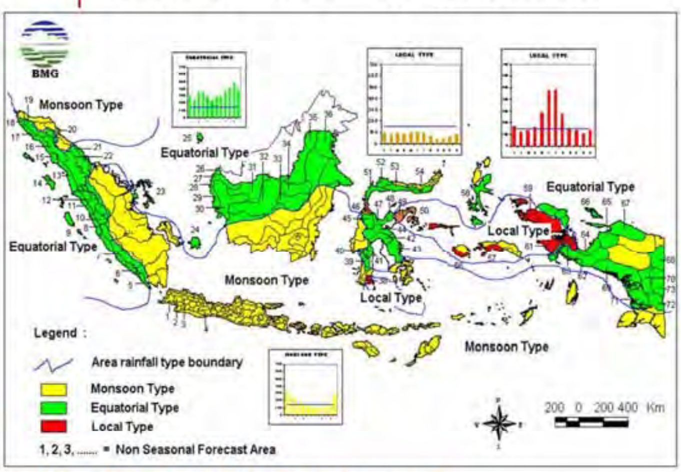
OUTLINE

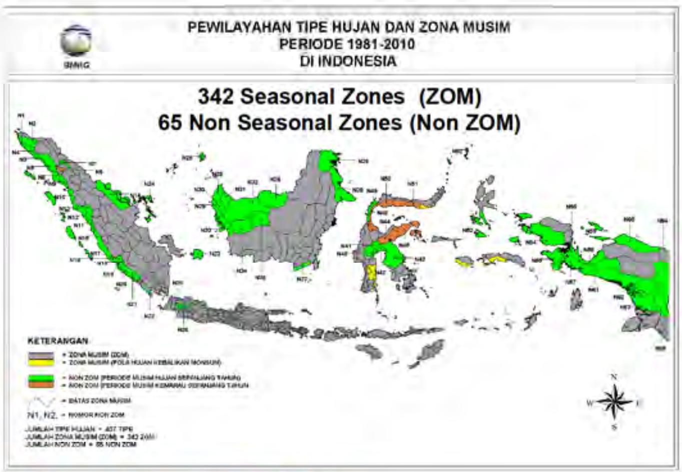
- ✓ **Introduction**
- ✓ **Evaluation of Season Onset Forecast**
- ✓ **Case Study on Dry and Wet Season's Variability**

INTRODUCTION
MAJOR CLIMATE DRIVERS IN INDONESIA



INTRODUCTION
RAINFALL TYPES IN INDONESIA





Three Major Rainfall Type in Indonesia

❖ **Monsoonal :**
Dry : Apr – Sep
Wet : Oct – Mar

❖ **Equatorial**
Dry: Jan-Feb/Jun-Jul
Wet: Mar-May/Aug-Dec

❖ **Local/Anti-Monsoon**
Dry : Sep – Apr
Wet : May - Aug

Clustered more specifically into :
342 Seasonal Zones (ZOM)
65 Non Seasonal Zones (Non ZOM

INTRODUCTION

How To Determine Season Onset

Dry Onset

Dry Retreat

Annual Rainfall

No Zon	JAN			FEB			MAR			APR			MEI			JUN		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
152	115	106	139	28	125	97	119	106	125	85	89	46	34	27	24	19	27	15

No Zon	JUL			AGT			SEP			OKT			NOV			DES			JUMLAH
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	
152	8	11	8	2	1	9	10	8	9	19	27	40	53	70	89	108	93	108	2099

1 month is divided into 3 decade/dasarian:
Dasarian I: date 1st up to 10th
Dasarian II: date 11th up to 20th
Dasarian III: date 21st up to end of the month

Wet Retreat in the next year

Wet Onset

Wet Season

Dry Season

Dry Season Onset is determined based on cumulative rainfall less than 50 mm in one decade/dasarian and followed by next 2 or more decade/dasarian.

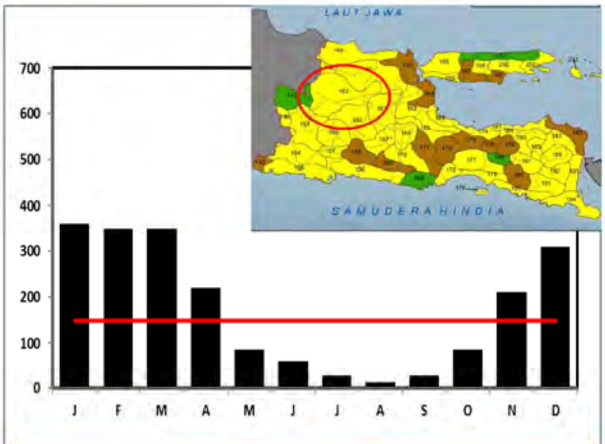
- **Wet Season Onset** is determined based on cumulative rainfall equal or more than 50 mm in one decade/dasarian and followed by next 2 or more decade/dasarian.

- **Dry & Wet Season Retreat** forecast is not issued by BMKG. But observed Dry and Wet Season Retreat is defined as 1 decade/dasarian before the following season.

INTRODUCTION

SITES' PROFILE

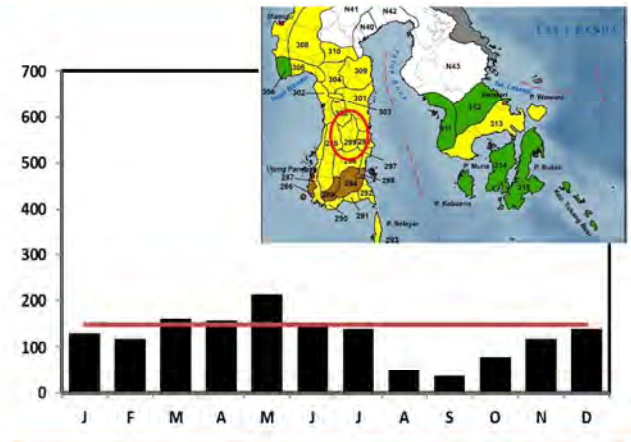
ZONE 152



Normal Rainfall 1981-2010

Monsoonal Type

ZONE 299

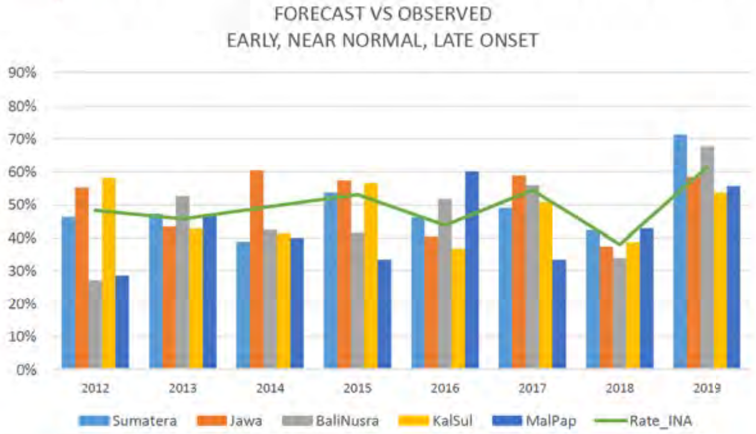


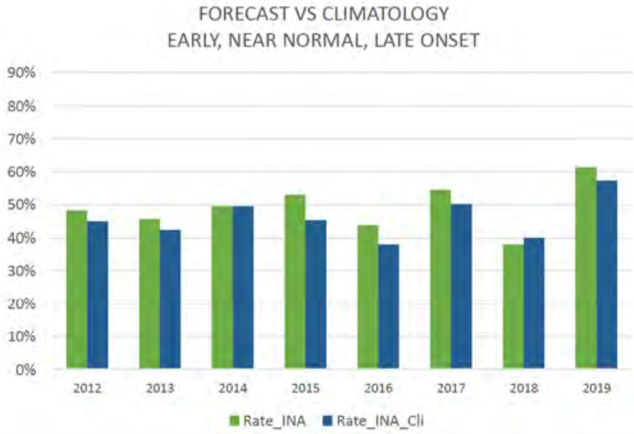
Normal Rainfall 1981-2010

Anti-Monsoonal Type

Evaluation on Season Onset Forecast

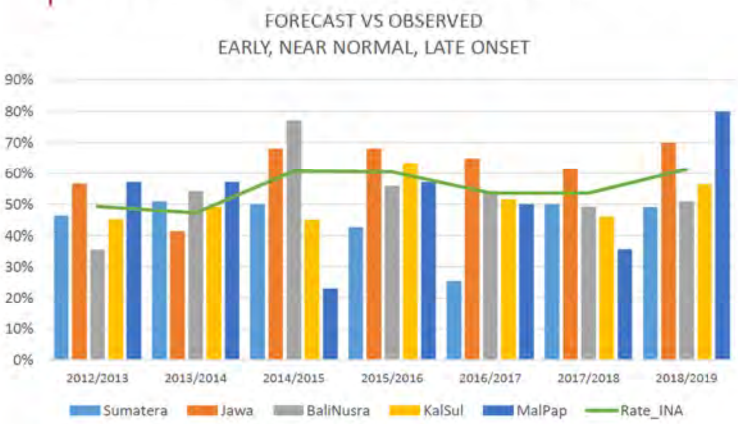
HIT RATE – DRY SEASON

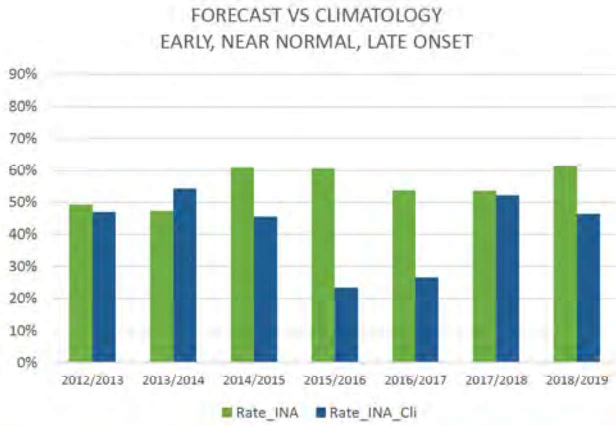




- Hit Rate for Dry Season's Onset forecast in Indonesia is about ~ 40-60%, as for hit rate in each major island is more diversed.
- Overall, Dry Season's Onset forecast during 2012-2018 is better than climatological forecast, except 2018.

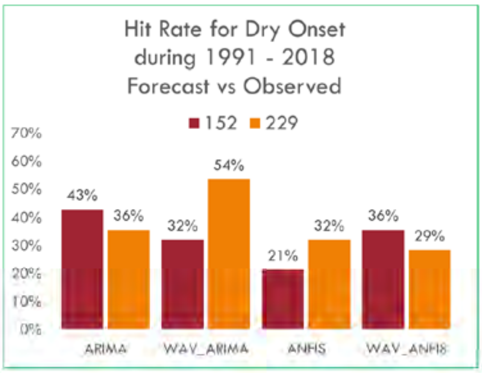
HIT RATE - WET SEASON

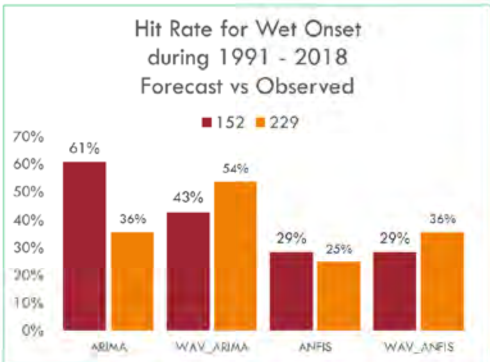




- Hit Rate for Wet Season's Onset forecast in Indonesia is about ~ 50 -60%, as for hit rate in each major island is more diversed.
- Overall, Wet Season's Onset forecast during 2012-2018 is better than climatological forecast, except 2013/2014.

RE-FORECAST SEASON ONSET IN ZOM 152 AND 299





- Data: observed rainfall data form rainfall post
- Re-forecast using 4 statististical methods:
  - ARIMA
    ANFIS
  - WAVELET ARIMA
  - WAVELET ANFIS

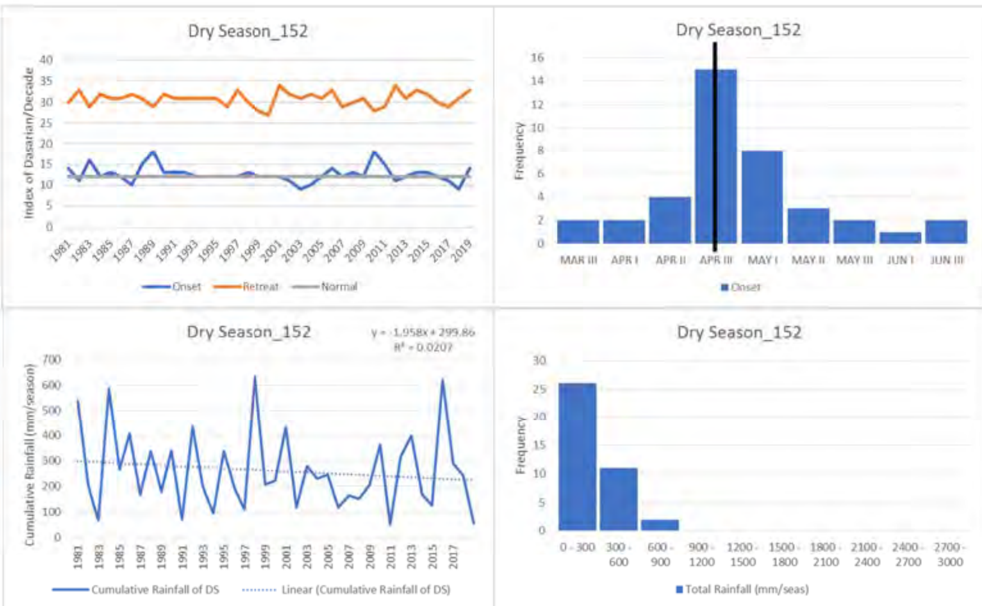
- Overall, for both Dry and Wet Season's Onset forecast in Zone 152 and 299 using ARIMA and WAV_ARIMA has higher hit rate than ANFIS and WAV_ANFIS.
- Best Hit Rate for both Dry and Wet Season's Onset forecast in Zone 152 is using ARIMA.
- Best Hit Rate for both Dry and Wet Season's Onset forecast in Zone 299 is using WAV_ARIMA.

Case Study on Dry and Wet Season's Variability

ANALYSIS
ZOM 152 – EAST JAVA
DRY SEASON

- Normal onset: APR III
- Onset variation is not too large and the mode of onset is same as its normal.
- Early onset : 2003, 2018
- Late onset : 1983, 1989, 2010

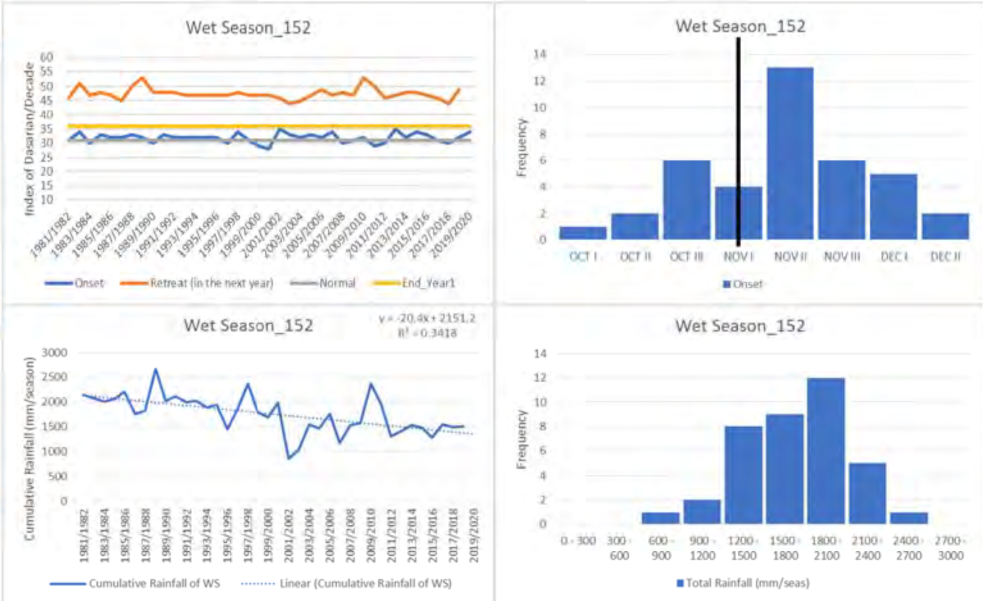
- Normal season rainfall: 263 mm
- Trend: decreasing, not significant
- Small rainfall : 1983, 2011, 2019
- Large rainfall : 1998, 2016



ANALYSIS
ZOM 152 – EAST JAVA
WET SEASON

- Normal onset: NOV I
- Onset variation is not large. The mode of onset is 1 dasarian later (Nov II) than normal (Nov I)
- Early onset : 1999/2000, 2001/2001. 2010/2011
- Late onset : 2001/2002, 2012/2013

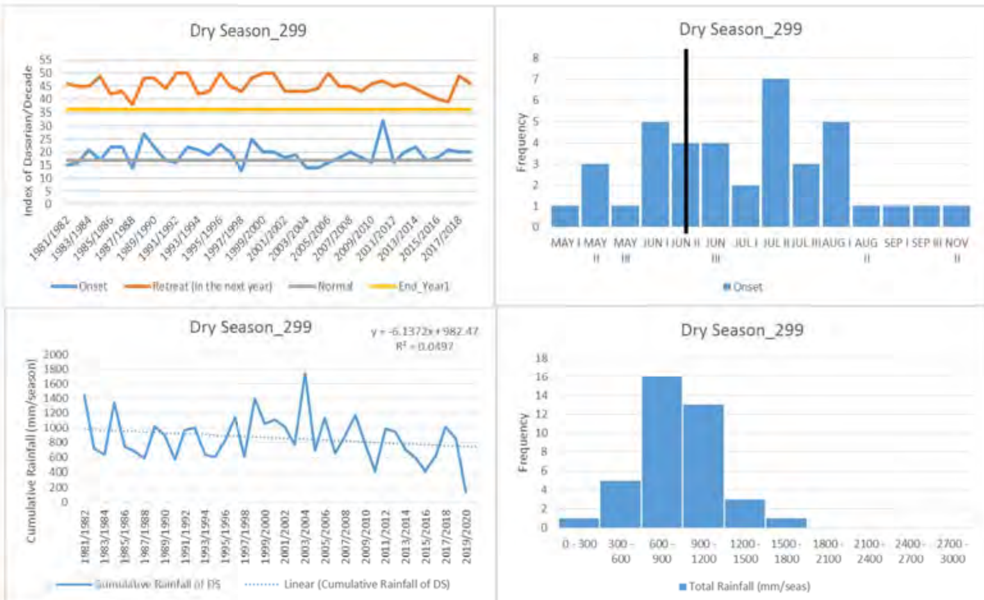
- Normal season rainfall: 1837 mm
- Trend: decreasing, not significant
- Small rainfall : 1983, 2011, 2019
- Large rainfall : 1998, 2016



ANALYSIS
ZOM 299 – SOUTH SULAWESI
DRY SEASON

- Normal onset: JUN II
- Onset has large variation. The mode of onset is 1 month later (Jul II) than normal (Jun II)
- Early onset : 1987/1988, 1997/1998, 2003/2004, 2004/2005
- Late onset : 1988/1989, 1998/1999, 2010/2011

- Normal season rainfall: 909 mm
- Trend: decreasing, not significant
- Small rainfall : 2010/2011, 2015/2016, 2019/2020
- Large rainfall : 1981/1982, 1984/1985, 1998/1999, 2003/2004



ANALYSIS
ZOM 299 – SOUTH SULAWESI
WET SEASON

- Normal onset: MAR II
- Onset has large variation. The mode of onset is similar to its normal (Mar II)
- Early onset : 1988 2016, 2017, 2020
- Late onset : 1992, 1993, 1996, 2000, 2001, 2006

- Normal season rainfall: 719 mm
- Trend: increasing, not significant
- Small rainfall : 1997, 2006, 2011
- Large rainfall : 1988, 1998, 2010

SUMMARY

ZONE 152 (EAST JAVA)

- Onset Variation during 1981-2019 for both dry and wet season is not too large (-/+ around 1 month from its normal)
- Mode of Dry Season Onset during 1981-2019 is similar to its Normal (Apr III)
- Mode of Wet Season Onset 1981-2019 is 1 dasarian later (Nov II) than its Normal (Nov I)
- Large gap of the rainfall fluctuation to the threshold makes it easier to determine the onset
- There is insignificant decreasing trend in both season's cumulative rainfall
- ENSO has more clear influence on season cumulative rainfall than Indonesian SST and IOD. La Nina leads small rainfall in dry season, La Nina and warm Indonesian SST simultaneously lead large rainfall in wet season, and warm Nino 3.4 SST leads small rainfall in wet season.

ZONE 299 (SOUTH SULAWESI)

- Onset Variation during 1981-2019 for both dry and wet season is very large (up to -/+3 month from its normal).
- Mode of Dry Season Onset during 1981-2019 (Jul II) is 1 month later to its Normal (Jun III)
- Mode of Wet Season Onset during 1981-2019 (Jul II) is similar to its Normal (Mar II)
- Small gap of the rainfall fluctuation to the threshold makes it difficult to determine the onset
- There is insignificant decreasing trend for dry season's cumulative rainfall and increasing for wet season.
- ENSO has more clear influence on season cumulative rainfall than Indonesian SST and IOD. El Nino leads small rainfall in both dry and wet season while La Nina leads large rainfall in wet season.

EVALUATION OF SUBSEASONAL TO SEASONAL PREDICTION (S2S) FOR EXTREME EVENT IN JAVA

Climate Information Analysis Sub Division

OUTLINE

01 Background

02 Data and Method

03. RESULT

04. Conclusion

1 BACKGROUND

BACKGROUND

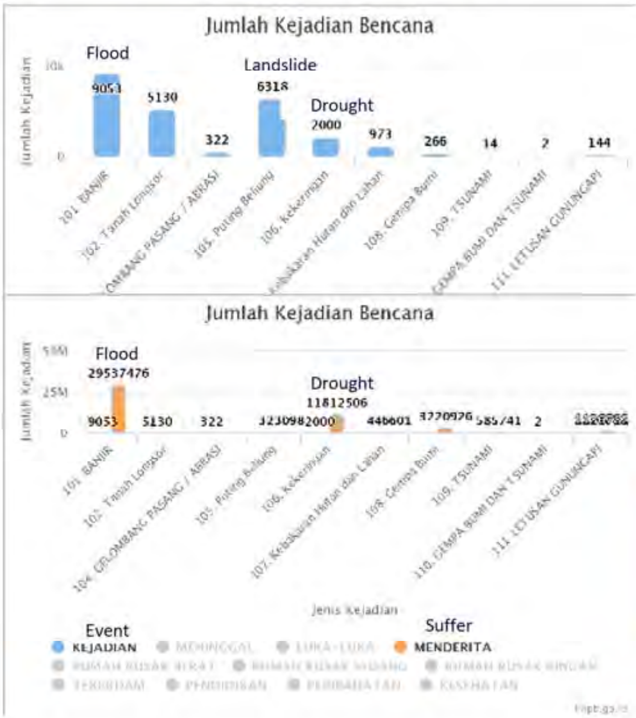
Climate Early Warning for Meteorological Drought

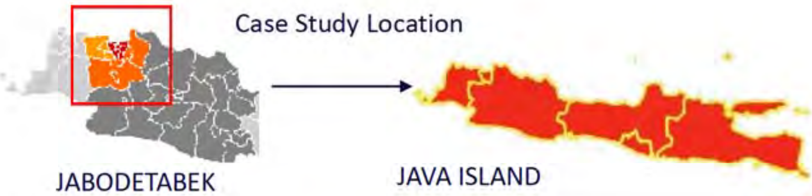
Climate Early Warning for Extreme Rainfall

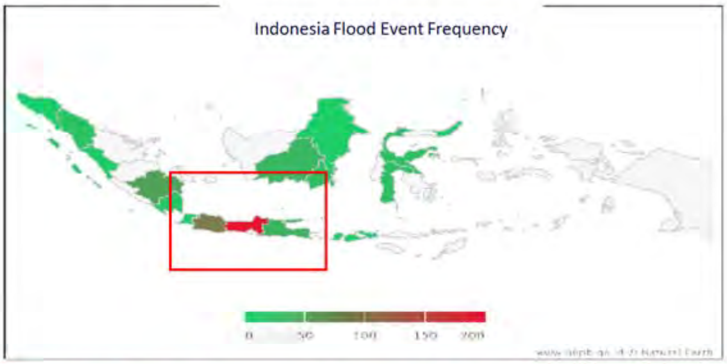
ECMWF S2S product in operational BMKG not only use to predict dekad rainfall but also it use for Climate Early Warning. Both Drought and Extreme rainfall potential.

The utilization of this product actually for medium range forecast but there was still lack of research related to this product. Therefore, it is necessary to evaluate the product.

BACKGROUND







Java Island was chosen as location of this study because natural disasters caused by meteorological conditions are very common in the Java islands such as flood, drought, landslides with many victims suffering from flooding and drought.

Source: https://bnpb.cloud/dibi/

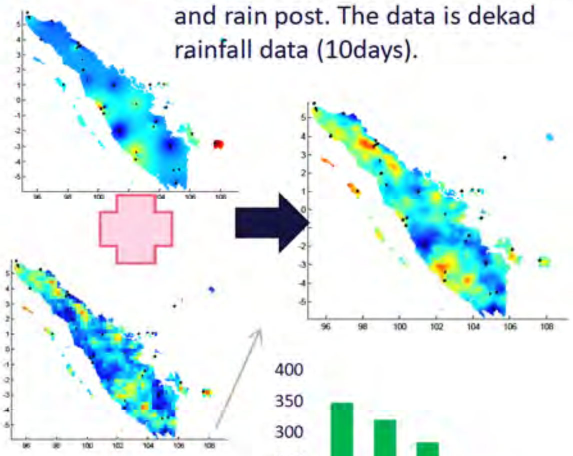
2 DATA AND METHOD

DATA

Extrem Rainfall + 1998-2014 + December

OBS DATA

Satellite blending rainfall data (GSMaP) and rain post. The data is dekad rainfall data (10days).



MODEL DATA

S2S ECMWF reforecast data model output with a resolution of 1.5^oX 1.5^o contains 11 members obtained at :
https://iridl.ldeo.columbia.edu/SOURCES/.ECMWF/.S2S/

It is operationalized by 11 international prediction institutions with three of them as archiving data centers.

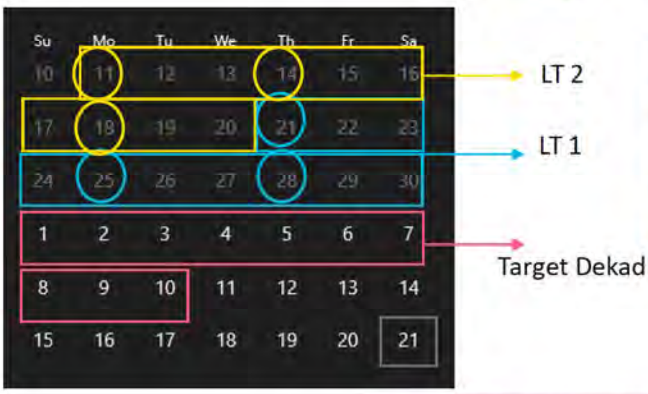
Reforecast is needed in the S2S database to calculate the bias or error in the model

The evaluation carried out for December in period time 1999-2018. Normally the rainfall in December had high rainfall. so that the potential for extreme rainfall was also higher.

DATA PROCESSING

To determine the extreme value by utilizing the 90th percentile of the data series as the extreme threshold.

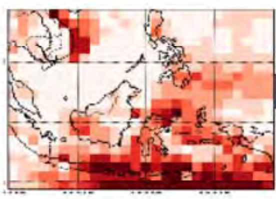
Monday + Thursday = ECMWF S2S Model Prediction — Date of issued → 47 Days (3-4 dekad)



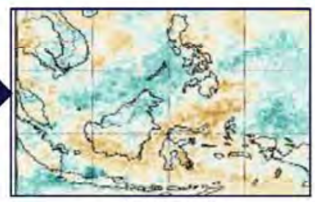
The evaluation is divided into 3 lead times

Lead time 1 = Predictions from the initial conditions at 1 dekad before the target decade.
Lead time 2 = Predictions from the initial conditions at 2 dekad before the target decade.
Lead time 3 = Predictions from the initial conditions at 3 dekad before the target decade.

Re-Grid ECMWF data from resolution 1.5 to 0.05 according to the observation data grid



1.5x1.5



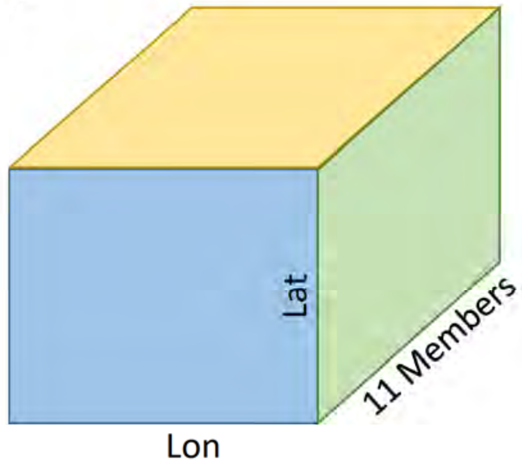
0.05x0.05

DATA PROCESSING

ECMWF Data Structure

The data is 6 dimensional data which are lon, lat, initial conditions, hdate, member and leadtime

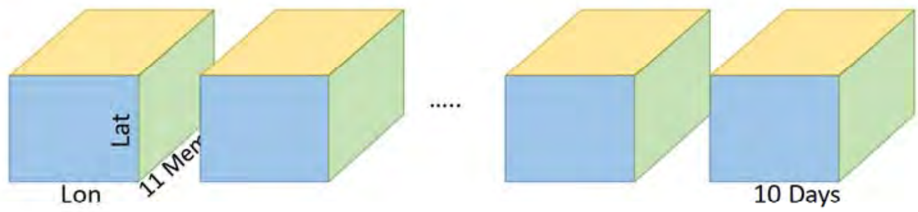
ECMWF Data:
3 LT
3 Dekad
20 years
10 days
11 members
Latitudes
Longitudes



DATA PROCESSING

ECMWF Data Structure

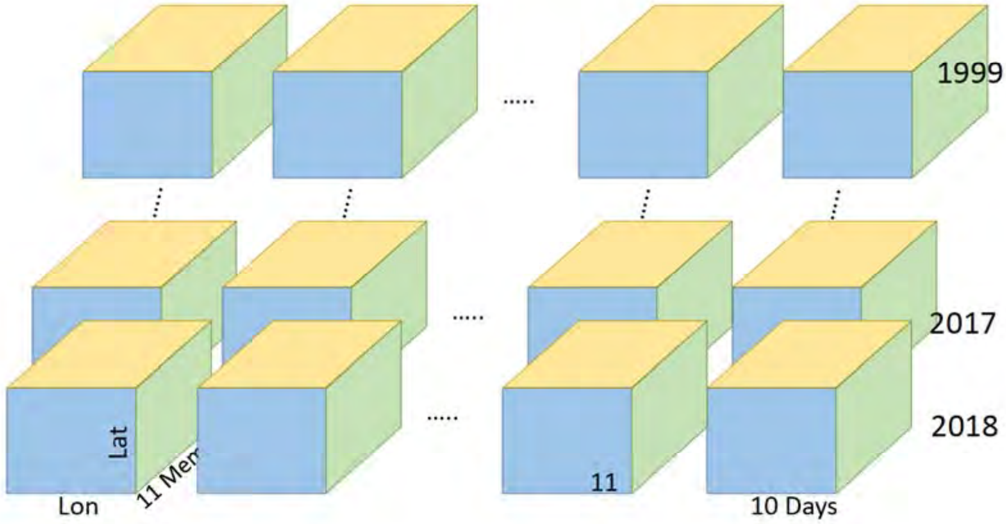
ECMWF Data:
3 LT
3 Dekad
20 years
10 days
11 members
Latitudes
Longitudes



DATA PROCESSING

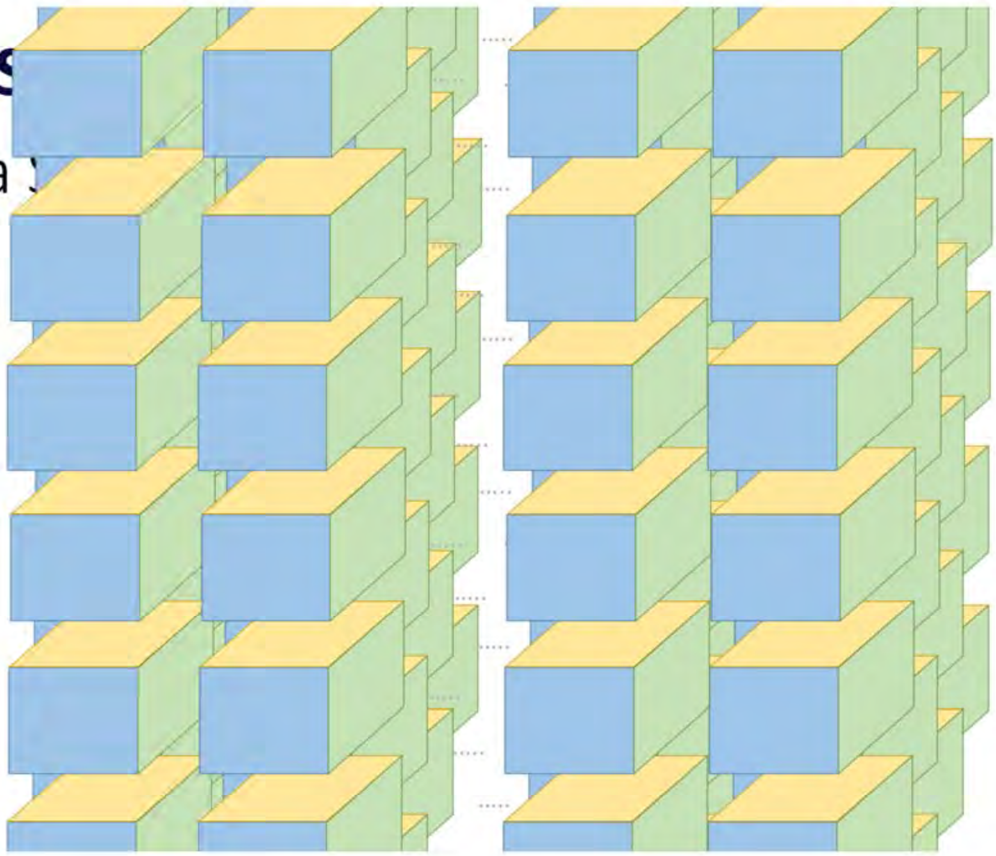
ECMWF Data Structure

ECMWF Data:
3 LT
3 Dekad
20 years
10 days
11 members
Latitudes
Longitudes



DATA PROCESS

ECMWF Data



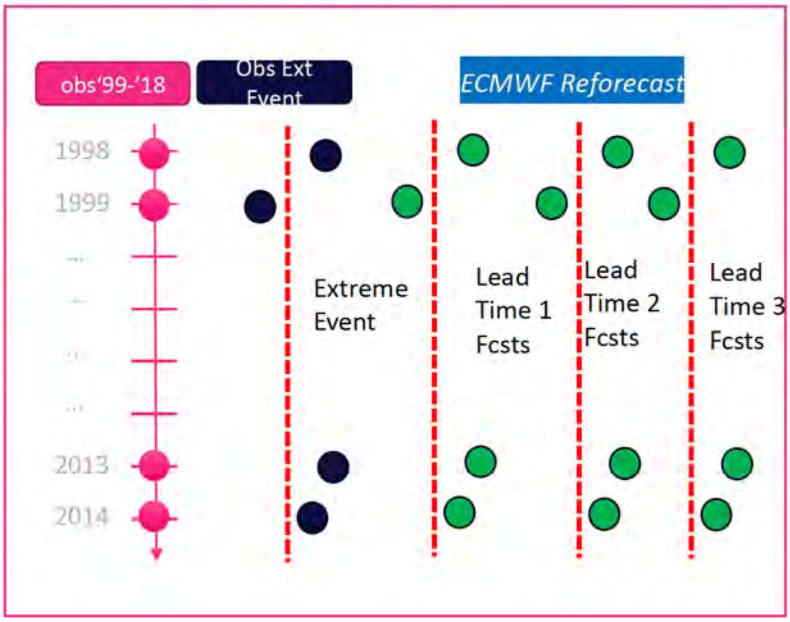
ECMWF Data:
3 LT
3 Dekad
20 years
10 days
11 members
Latitudes
Longitudes

DATA PROCESSING

ECMWF Data:
3 LT
3 Dekad
20 years
10 days → Summation daily rainfall in to Dekad (10days)
11 members → Average
Latitudes
Longitudes

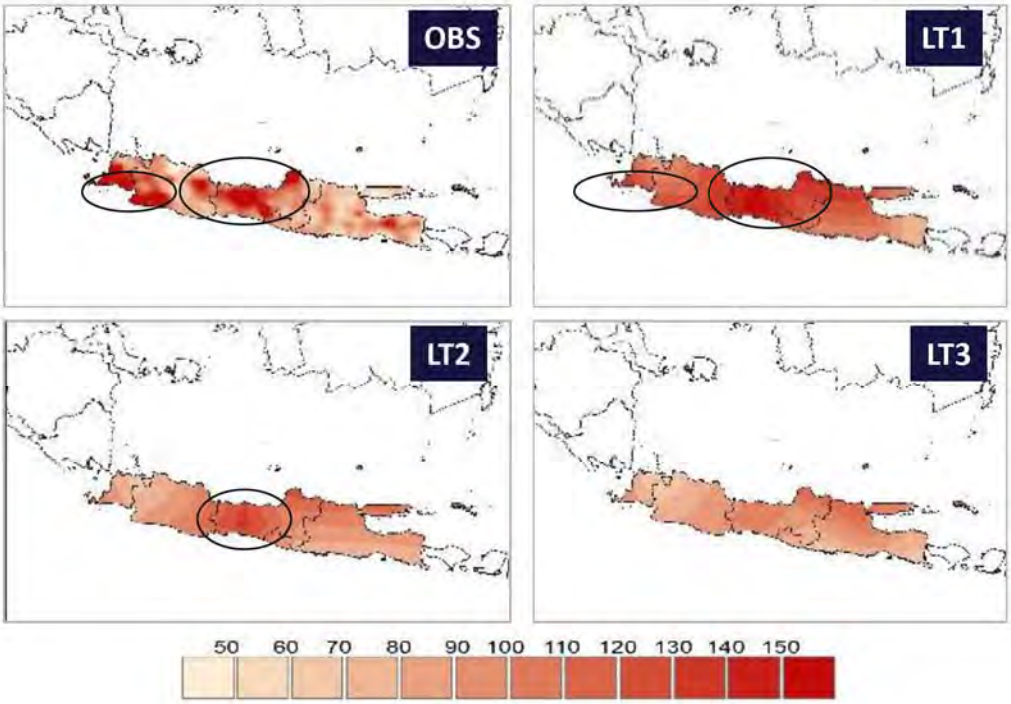
ECMWF Data:
3 LT
3 Dekad
20 years
~~10 days~~
~~11 members~~
Latitudes
Longitudes

Collected extreme data based on 90th percentile data from observational data. And do a **Composite** analysis to do a comparison.



3 RESULT

RESULT

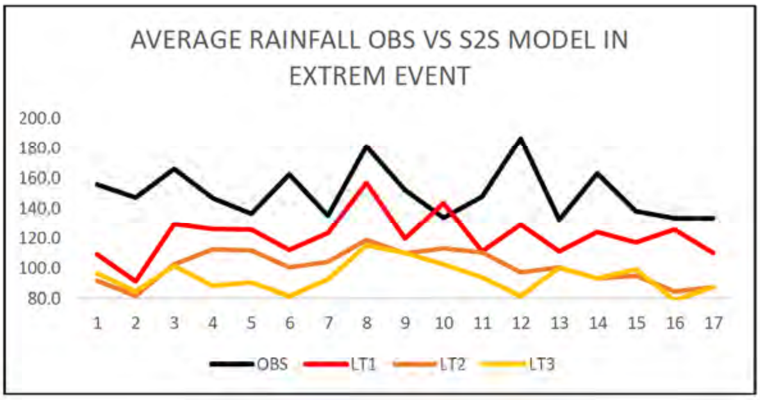


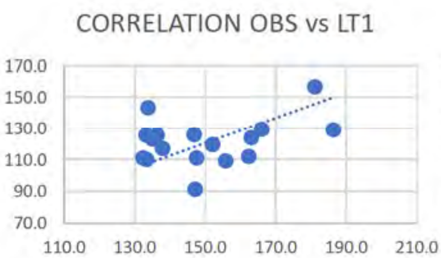
ECMWF S2S model can capture the potential for high rainfall in LT1 or **1 dekad before the target dekad** and shows the potential for high rainfall in LT2 especially in the Central Java. However LT3 does not indicate the potential for high rainfall in the Java region

RESULT

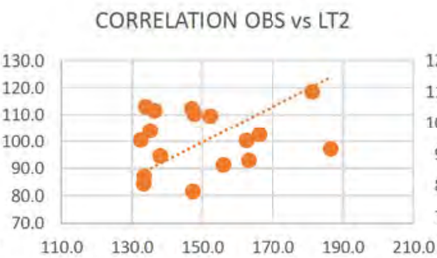
Based on the average of Java grid in extreme events it was found that LT1 has a pattern that is quite following the observation data pattern.

Correlation shows that the longer the lead time of prediction, the smaller the correlation. This shows that the closer the initial conditions predictions with the target Dekad, the better the prediction ECMWF model and vice versa.

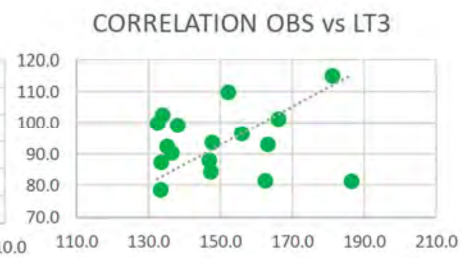




R = 0.34



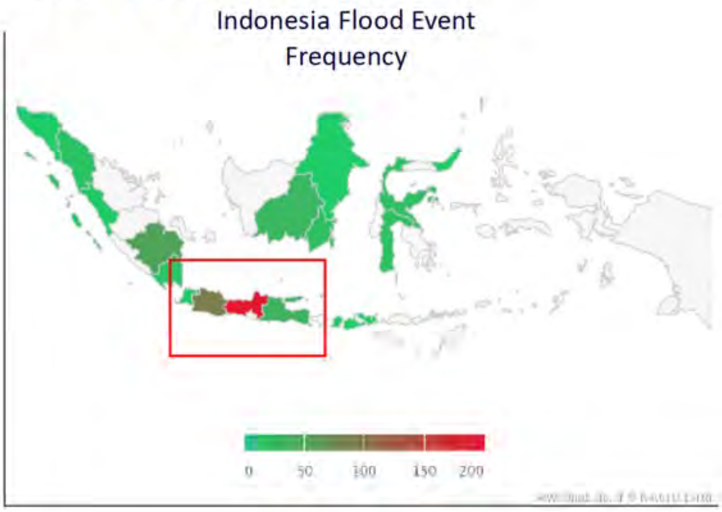
R = 0.16



R = 0.14

4 CONCLUSION

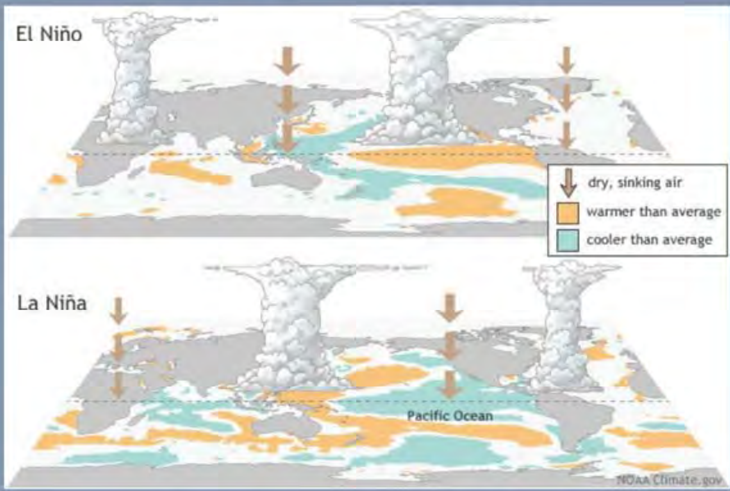
CONCLUSION



From the National Disaster Management Agency, BNPB data, frequency of flood events in Java is higher than in other regions in Indonesia, especially in Central Java which has the most flood events, this shows that extreme rainfall in these areas often occurs and Based on the results of this study the ECMWF S2S model data is able to provide a warning to LT1 and even LT2 before the event especially in Central Java.

The S2S ECMWF data for this study has lower resolution compared to data for operational in BMKG , so the results of this evaluation could be better if using S2S ECMWF operational data which has a resolution 0.25x0.25.

The Assessment of Skill of ENSO Forecast Issued by JMA And NCEP



Ridha Rahmat, Supari, Amsari Muzakir S.

Agency for Meteorology, Climatology, and Geophysics (BMKG)

Introduction

- The national climate state has always been considered by Indonesian government in the policy making process particularly for the sector which is sensitive to the climate, such as agriculture, energy
- Information on the ENSO status during the upcoming year is crucial for government to design the next step policy
- BMKG develop ENSO forecast model using Singular Spectrum Analysis (SSA)
- BMKG release the status and ENSO forecast collected from many climate centers such as product by JMA (Japan) and NCEP (USA)
- Skill of those products is not clearly known

Objective and Method

Objective

To examine the skill of ENSO predictions issued by JMA and NCEP since those two products are used regularly by BMKG as a reference on monitoring ENSO event

Method

As recommended by WMO, the technique of Standardized Verification System (SVS) for Long-Range Forecast will be applied for this study.

Data

The ENSO forecast data released by JMA :

ENSO forecast data :
https://ds.data.jma.go.jp/tcc/tcc/gpv/model/CPS2/3-mon/MGPV/YYYYMM/surf_Pss_mb.YYYYMM)

Observed Data : *iTacs*

Table 1. Illustration of Lead Time JMA ENSO forecast

		Forecast Period			
		Jan	Feb	….	Dec
Issued Period	Dec	Lead Time 1	Lead Time 2	Lead Time ...	Lead Time 12
	Jan		Lead Time 1	Lead Time 2	Lead Time 11
	⋮			Lead Time 1	Lead Time …
	Dec				

The ENSO forecast data released by NCEP :

ENSO forecast data :
https://iri.columbia.edu/~forecast/ensofcst/Data/ensofcst_ALLto0520).

Observed Data : *iTacs*

Table 2. Illustration of Lead Time for NCEP ENSO forecast

		Forecast			
		JFM	FMA	….	DJF
Issued	DJF	Lead Time 1	Lead Time 2	Lead Time ...	Lead Time 12
	JFM		Lead Time 1	Lead Time 2	Lead Time 11
	⋮			Lead Time 1	Lead Time …
	DJF				

Method

Mean Square Skill Score (MSSS)

MSSS value is required and will provide a comparison of forecast performance relative to "forecasts" of climatology.

$$MSSS_j = 1 - \frac{MSE_j}{MSE_{cj}}$$

With:

MSE_j : MSE of the forecasts

MSE_{cj}: MSE of the climatology forecast

Pearson Correlation

The Pearson correlation coefficient r is a measure to determine the relationship (instead of difference) between two quantitative variables (interval/ratio).

$$r = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{\Sigma(x-\bar{x})^2(y-\bar{y})^2}}$$

PERFORMANCE OF ENSO PREDICTIONS METHOD ISSUED BY BMKG

- **Data** : 2013-2018 (Reforecast Data)
- **Observation Data** : NCEP Nino3.4 Data

	RMSS	COR	MSSS
lag 1	0.52864385	0.8841499	0.77782338
lag 2	0.26742463	0.7288515	0.46333332
lag 3	0.11645849	0.6082248	0.21935440
lag 4	0.01723417	0.5025265	0.03417133
lag 5	-0.06780200	0.3828811	-0.14020112
lag 6	-0.09707285	0.2990808	-0.20356884
lag 7	-0.08186499	0.2744851	-0.17043185

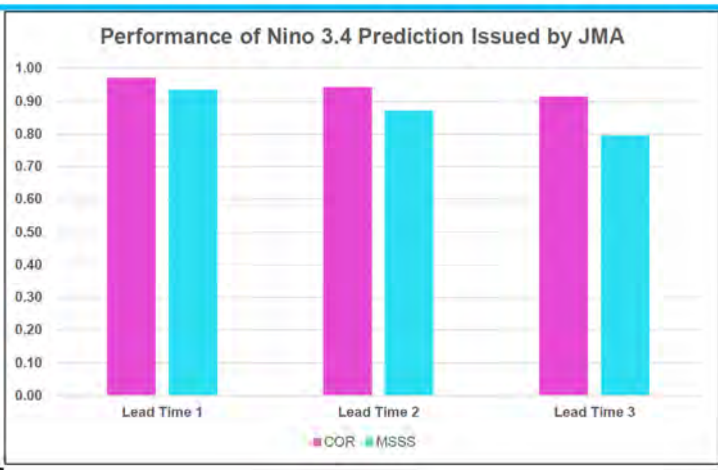
- Positive MSSS is dominant result
- It means SSA model is better than climatology (in term of magnitude of bias) on forcasting 1 to 4 months ahead

- The model is generally highly correlated with observations on forecasting 1 to 3 months ahead
- It is weakly correlated with observations on forecasting 4 to 7 months ahead

PERFORMANCE OF ENSO PREDICTIONS METHOD ISSUED BY JMA

- **Reforecast Data** : June 2015 – January 2020
- **Reforecast Data Source** : https://ds.data.jma.go.jp/tcc/tcc/gpv/model/CPS2/3-mon/MGPV/YYYYMM/surf_Pss_mb.YYYYMM
- **Observation Data Source** : ***iTacs***

Lead Time	COR	MSSS
Lead Time 1	0.97	0.93
Lead Time 2	0.94	0.87
Lead Time 3	0.91	0.80

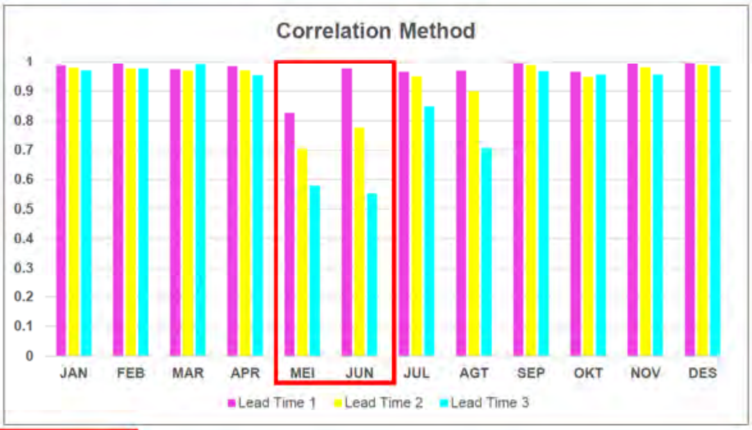


- The model is generally highly correlated with observations on forecasting 1 to 3 months ahead

- Positive MSSS is dominant result
- It means ENSO Prediction model issued by JMA is better than climatology (in term of magnitude of bias) on forcasting 1 to 3 months ahead

PERFORMANCE OF ENSO PREDICTIONS METHOD ISSUED BY JMA

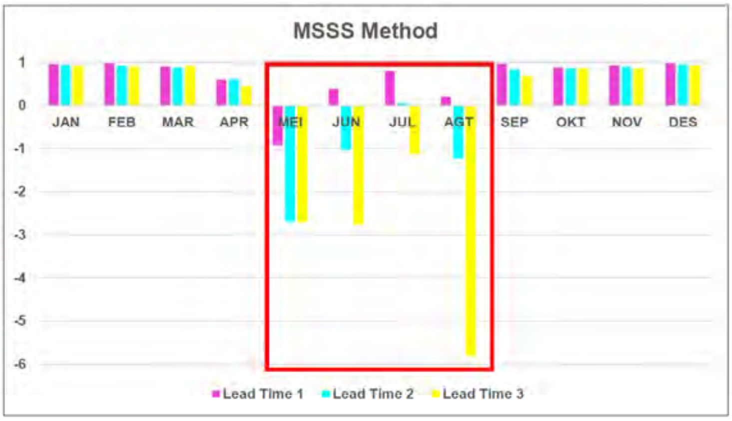
- Verification of Nino 3.4 using ***Person Correlation*** method
- Model ***is generally strongly correlated*** with observation
- Model is ***weakly correlated*** during ***May*** and ***June***



Lead Time	JAN	FEB	MAR	APR	MEI	JUN	JUL	AGT	SEP	OKT	NOV	DES
Lead Time 1	0.986	0.994	0.973	0.984	0.827	0.976	0.964	0.969	0.997	0.964	0.993	0.996
Lead Time 2	0.979	0.976	0.968	0.97	0.704	0.777	0.949	0.899	0.987	0.948	0.98	0.989
Lead Time 3	0.97	0.976	0.99	0.953	0.579	0.551	0.848	0.705	0.967	0.956	0.955	0.985

PERFORMANCE OF ENSO PREDICTIONS METHOD ISSUED BY JMA

- Verification of Nino 3.4 using ***MSSS*** method
- ***Positive MSSS*** is dominant result
- It means model is ***better than climatology*** (in term of magnitude of bias) on forcasting 1 to 3 months ahead
- Model has ***negative MSSS*** in **May, June, July and August.**
- It means ***climatology is better than model*** (in term of magnitude of bias)

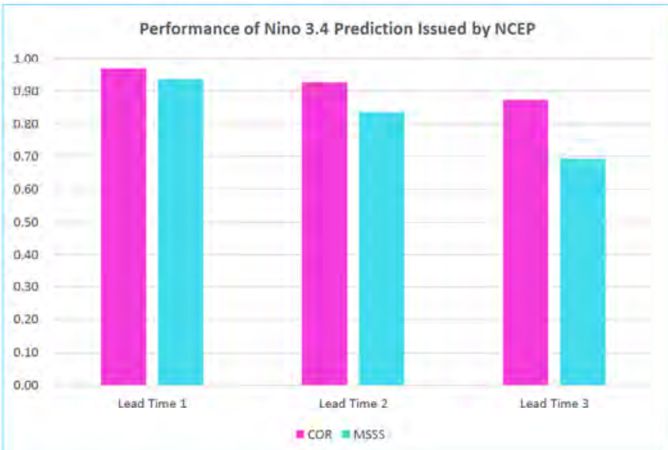


Lead Time	JAN	FEB	MAR	APR	MEI	JUN	JUL	AGT	SEP	OKT	NOV	DES
Lead Time 1	0.964	0.984	0.914	0.611	-0.926	0.387	0.807	0.205	0.971	0.891	0.943	0.979
Lead Time 2	0.944	0.934	0.888	0.614	-2.687	-1.036	0.055	-1.227	0.847	0.873	0.903	0.955
Lead Time 3	0.918	0.908	0.92	0.449	-2.687	-2.751	-1.126	-5.796	0.698	0.865	0.871	0.937

PERFORMANCE OF ENSO PREDICTIONS METHOD ISSUED BY NCEP

- **Reforecast Data** : SON 2015 – NDJ 2020
- **Forecast Data Source** : https://iri.columbia.edu/~forecast/ensofcst/Data/ensofcst_ALLto0520
- **Observation Data Source** : ***iTacs***

Lead Time	COR	MSSS
Lead Time 1	0.97	0.94
Lead Time 2	0.93	0.84
Lead Time 3	0.87	0.69

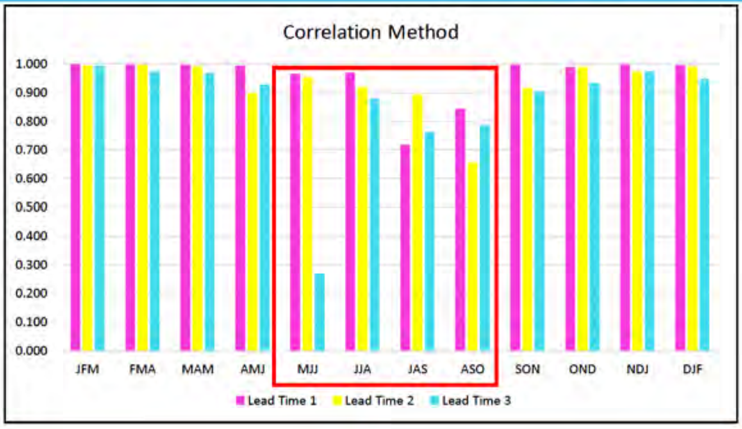


- The model is generally highly correlated with observations on forecasting 1 to 3 months ahead

- Positive MSSS is dominant result
- It means ENSO Prediction model issued by NCEP CFS2 is better than climatology (in term of magnitude of bias) on forcasting 1 to 3 months ahead

PERFORMANCE OF ENSO PREDICTIONS METHOD ISSUED BY NCEP

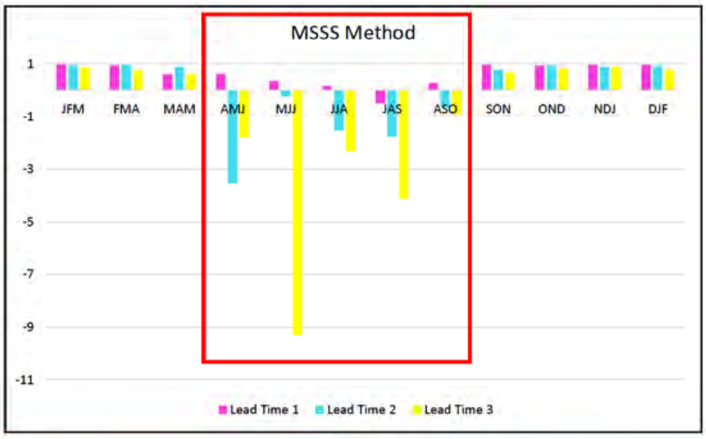
- Verification of Nino 3.4 using ***Person Correlation*** method
- Model ***is generally strongly correlated*** with observation
- Model is ***weakly correlated*** during ***MJJ*** and ***ASO***



Lead Time	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ	DJF
Lead Time 1	0.998	0.997	0.995	0.993	0.964	0.969	0.718	0.844	0.996	0.988	0.997	0.994
Lead Time 2	0.992	0.996	0.990	0.899	0.954	0.921	0.894	0.656	0.918	0.989	0.972	0.990
Lead Time 3	0.991	0.972	0.967	0.929	0.267	0.880	0.763	0.786	0.905	0.934	0.973	0.949

PERFORMANCE OF ENSO PREDICTIONS METHOD ISSUED BY NCEP

- Verification of Nino 3.4 using ***MSSS*** method
- ***Positive MSSS*** is dominant result
- It means model is ***better than climatology*** (in term of magnitude of bias) on forcasting 1 to 3 months ahead
- Model has ***negative MSSS*** in **AMJ, MJJ, JJA and ASO.**
- It means ***climatology is better than model*** (in term of magnitude of bias)



Lead Time	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ	DJF
Lead Time 1	0.993	0.949	0.618	0.626	0.352	0.166	-0.479	0.286	0.966	0.949	0.976	0.974
Lead Time 2	0.939	0.964	0.901	-3.553	-0.215	-1.531	-1.76	-0.627	0.786	0.955	0.9	0.93
Lead Time 3	0.882	0.75	0.614	-1.792	-9.303	-2.318	-4.104	-0.899	0.684	0.826	0.899	0.778

RESULTS

Generally, ENSO Prediction Issued by JMA and NCEP CFSV2 has a good skills on forecasting 1 to 3 months ahead

- Model has strong correlation
- Model has Positive MSSS (Relatively low bias)

Model needs improvement on forecasting ENSO during May, June, July and August Period.

THANK YOU

Ridha Rahmat, Supari, Amsari Muzakir S.

Agency for Meteorology, Climatology, and Geophysics (BMKG)

Overview, Future Task and Expectation

Project of Capacity Development for the Implementation of Agricultural Insurance in the Republic of Indonesia

-KEY ACTIVITY 2-

Develop weather/climate information and strengthen abilities for producing products for agriculture.

Adi Ripaldi

Team of Climate Variability Divison
Center for Climate Change Information - BMKG

Presented at JICA Final Report Launch
Jakarta, September 23rd 2020

The Difference of Rainfall Pattern/Type and Seasonal Zone?

Clustered more specifically into :
342 Seasonal Zones (ZOM)
65 Non Seasonal Zones (Non ZOM

Rainfall Pattern / Type: The average monthly rainfall pattern (January – December) which describes when period of high rainfall and low rainfall happen.

Seasonal Zone (ZOM) is the result of grouping / clustering of areas that have similar rainfall pattern and have clear boundaries between the rainy season and dry season.

Non-ZOM is an area where the rainfall is always high or always low throughout the year

POTENTIAL AGRICULTURE IN INDONESIA

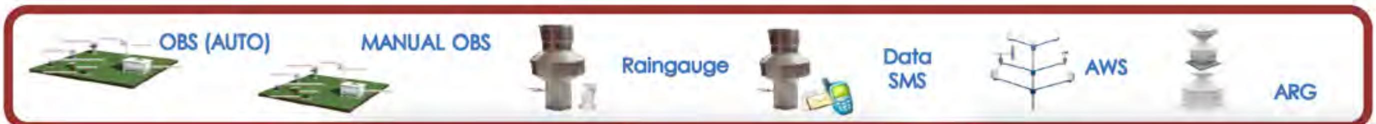
From 191,09 juta ha land of Indonesia, about 95,90 juta ha (50,19%) potential for agriculture (Ritung et al, 2015)

26.5% of rice field all over Indonesia is rainfed rice field, while 20% is simple irrigated rice field. [*Wahyunto, Agriculture Journal , 2009*]

The rainfed rice field is very sensitive to the climate anomaly or event.

Rainfall tends to be higher (may lead to flood) during La nina years and lower (may lead to drought) during El nino years.

OBSERVATION – PROCESSING – ANALYZE - DISSEMINATION



Integration
- Observation Data
- Integration of Information
- Stability of Server and Networking

STEP BY STEP HOW BMKG PROVIDE SEASONAL CLIMATE FORECAST

Division to Centre then to Climatology Deputy level Meeting

BMKG Centre Outlook Forum (Meteorology, RnD, STMKG) meeting

National Meeting with all Indonesia Climate Station

National Climate Outlook Forum (University, Gov. Agency, User)

Press Conf

SCHEME OF PROCESSING BMKG SEASONAL CLIMATE FORECAST

Data Broadcast by Global Model to BMKG database server

↓

Download ECMWF,CFS data — GRIB format

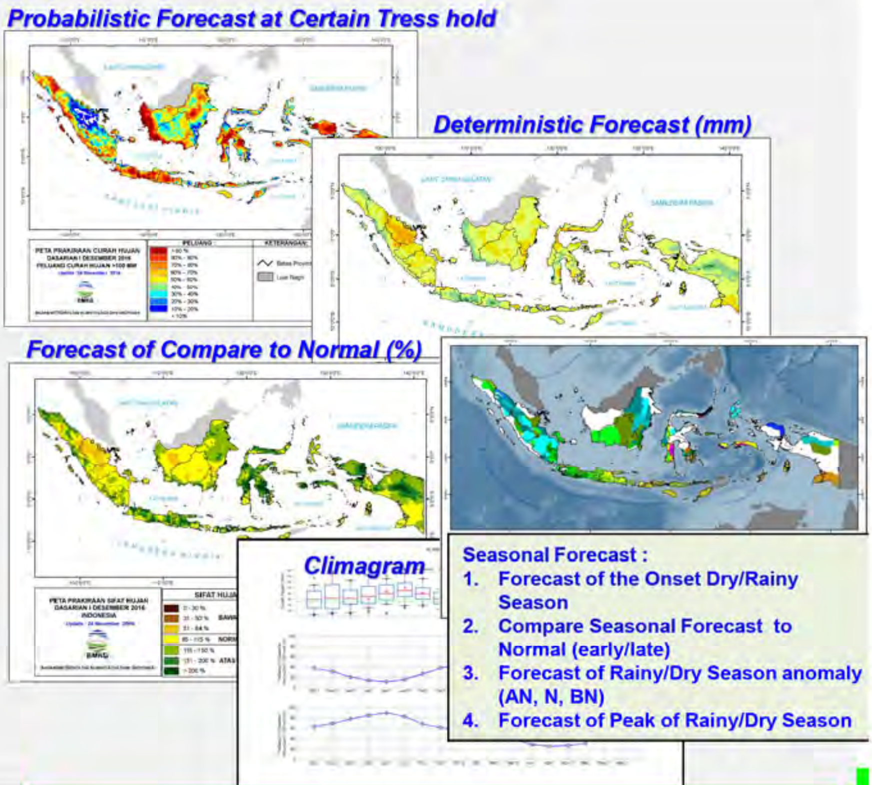
↓

Processing Data — Convert GRIB format To NETCDF and applied several Statistical method

↓

Display Product in Maps, graphics, etc

Display data using GIS or several tools such as GrADS, MATLAB, etc



Seasonal Forecast :

1. Forecast of the Onset Dry/Rainy Season
2. Compare Seasonal Forecast to Normal (early/late)
3. Forecast of Rainy/Dry Season anomaly (AN, N, BN)
4. Forecast of Peak of Rainy/Dry Season

Extreme Climate Variability Impact :

Extremely Wet vs Extremely Dry

Due to 'Wet' Dry Season, Salt Production Decreased by 50%

'Wet' Dry Season, hundreds hectares of tobacco died

Rainy Season, Minister of Agriculture: La Nina 2016 is more terrible, 70,000 rice fields impacted

Feby Novalius, Jurnalis · Senin 04 Desember 2017 15:17 WIB

'Wet' Dry Season, Farmers are reluctant to plant tobacco

Sawah terendam banjir. (ANTARA FOTO/Lucky R)

Facing La Nina, Ministry of Agriculture anticipates flooded agriculture land

Ekonomi elnino

NASIONAL EKONOMI LUAR NEGERI PENDIDIKAN TEKNOLOGI HIDUP GAYA

Drought, 100 hectares of rice fields in Ciamis threatened with crop failure

Nurhandoko Selasa, 24 Jul 2018, 13:49 JAWA BARAT

JPNN.COM / Daerah / Jatim / Bencana Kekeringan, 150 Sawah Gagal Panen

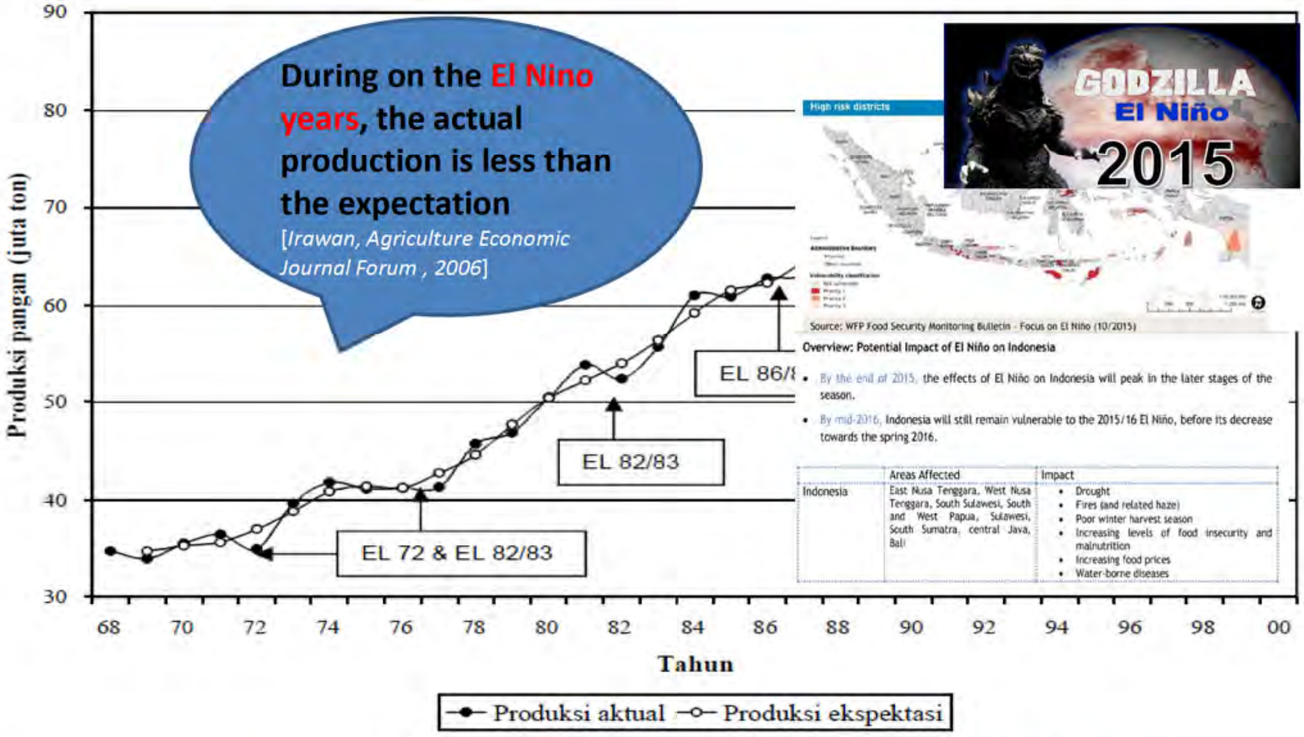
Drought, 150 rice fields encounter crop failure

Drought in Indonesia due to El Nino

Dry Season, 100 thousands hectares of rice fields encounter drought

Musim kemarau melanda sejumlah wilayah di Indonesia dan diperkirakan masih akan berlangsung hingga September dengan puncaknya pada bulan Agustus 2019.

El Nino impact for Agriculture production



Actual Production vs expectation Production

BMKG – JICA COLLABORATION PROJECT ACTIVITY

BMKG and JICA collaborate in the Project of Capacity Development for the Implementation of Agricultural Insurance in Indonesia

Key Activities

1. Provide/prepare reliable meteorological data for agricultural insurance.
2. Develop weather information and strengthen abilities for producing products for agriculture.
3. Enhance analysis abilities of risk analysis for climate change data-set.

Key Person :
JICA : Koichi Kurihara, Michihiko Tonouchi, Akiko Aikawa , Cometta Guritno, Diah Putri Utami
BMKG : Dr. Indra Gustari Head of Climate Variability Division
Mr. Adi Ripaldi and Team Climate Analysis Information Sub Division
Dr. Supari and Team Climate Early Warning Sub Division

Activities done by September 2020

Lead By Dr Kurihara and Dr. Tonouchi

Improvement of Seasonal Forecast
(Adi Ripaldi, Damiana Fitria K, Novi Fitrianti, Rosi Hanif D,)

- Evaluation of Operational Seasonal Forecast
- Case Study on Dry and Wet Season's Variability
- Evaluation of Subseasonal to Seasonal prediction for Extreme Event in Java
- Verification on JMA forecast

Improvement of ENSO Monitoring and Forecast
(Dr. Supari; Dr. Amsari Mudzakir Setiawan; Ridha Rahmat)

- The Assessment of of Skill of ENSO Forecast

Training and Capacity Building For BMKG Team at JICA

Technical meeting and training For BMKG Team at BMKG

FUTURE TASK

Improvement of Seasonal Forecast
(Adi Ripaldi, Damiana Fitria K,Novi Fitrianti, Rosi Hanif D)

- Enhanced analysis on seasonal variability (SST Anomaly, ENSO and IOD) and other factors, especially when those three factors don't have clear influence.
- Improving analysis for Subseasonal to Seasonal (S2S) Evaluation during MJO and others Equatorial Atmosphere Wave (Kelvin,Rosbi) for prevention agricultural and hidrological disaster.
- Continued Evaluation of Seasonal forecast in three main rainfall types (Equatorial, Monsoonal, and Local type)
- Evaluation on JMA Subseasonal to Seasonal forecast Product (1-6 month forecast)

Improvement of ENSO Monitoring and Forecast
(Dr. Supari, Dr. Amsari Mudzakir Setiawan; Ridha Rahmat)

- Analysis on Skill of IOD Forecast Issued by JMA

THE EXPECTATION FOR THE NEXT PROJECT

Supporting the Agriculture and the National Food Estate program, BMKG should improve Seasonal Climate Forecast Information and Services :

Here we proposed and expect some program which possible to be collaborate between BMKG and JICA for the Project :

1. **Evaluation of seasonal forecast skill for All Seasonal Zone are to be continued.**
2. **Continuining and Improving S2S prediction for Agriculture and hidrological disaster prevention**
3. **Preparing the New Normal Map (period of 1991-2020) that could be change the number/cluster of existing seasonal zone (ZOM)**
4. **Developing Multi Model Ensemble for Monthly and Seasonal Forecast (involving ECMWF, CFSv2, JMA)**
5. **Improving monitoring and forecast for ENSO, IOD, monsoon variability and other factor for better seasonal forecast.**
6. **More frequent requests from Government (National Development Planning Agency) /stake holder/ Public needed to prepare the long range forecast (1 years forecast)**
7. **Application of seasonal forecast information for climate insurance**

BMKG

@infoBMKG

Jl. Angkasa 1 No.2 Kemayoran Jakarta Pusat, Indonesia

www.bmkg.go.id

Thank You

Info Iklim : 021 4246321 ext. 1707
Info Cuaca : 021 6546315/18
Info Gempabumi : 021 6546316

2020/9/23

08:30～12:15(Jakarta local time)

Launching Final Report BMKG-JICA

Project of Capacity Development for the Implementation of Agricultural Insurance in the Republic of Indonesia

Session II: ***Status of Seasonal Forecasting and Recommendation Towards Further Utilization in Agriculture Sector***

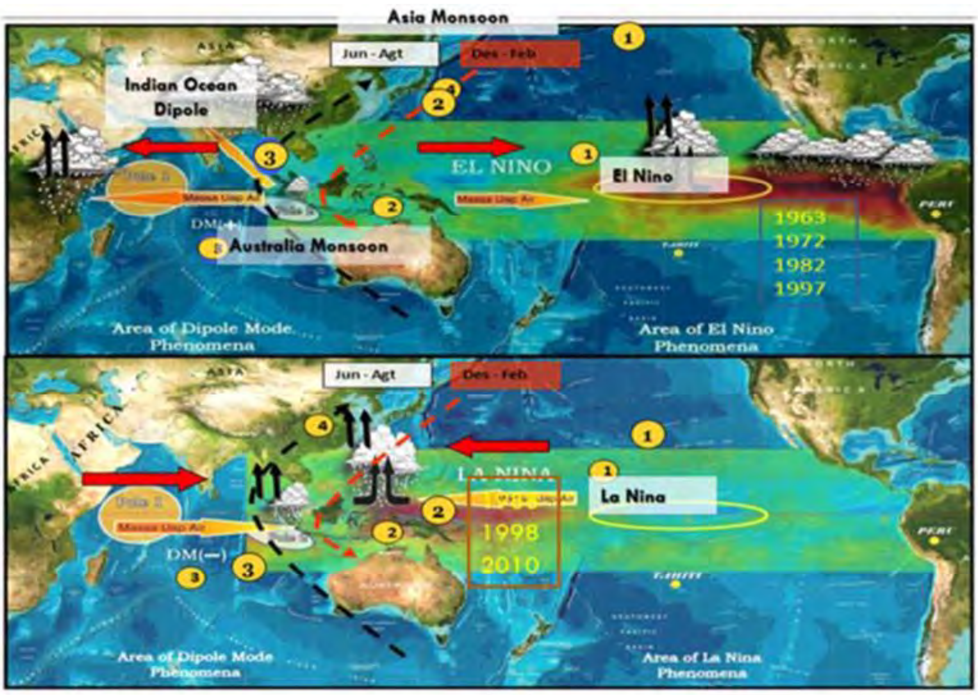
For Enhancing Long-range Forecasting Ability

Koichi Kurihara (JICA expert)

Contents

Introduction_ Key activities for the Project

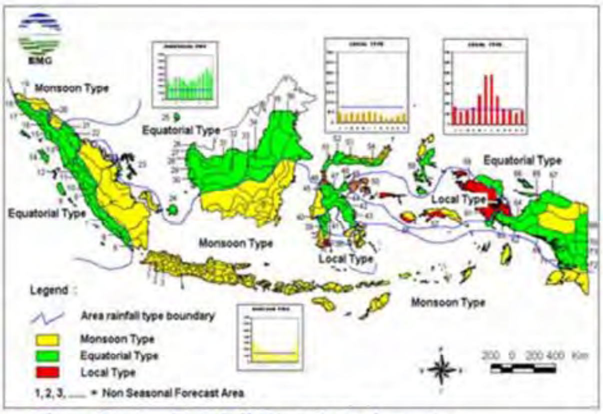
1. Provide/prepare reliable meteorological data for agricultural insurance.
2. Develop weather information and strengthen abilities for producing products for agriculture.
3. Enhance analysis abilities of risk analysis for climate change data-set.



Schematic chart for major climate drivers in Indonesia (from BMKG)

Driving forces:

- ENSO
- IOD
- SST local
- Asia-Australia monsoon
- MJO
- Others?!



Three Major Rainfall Type in Indonesia

- **Monsoonal :**
  Dry : Apr – Sep
  Wet : Oct – Mar
- **Local/Anti-Monsoon**
  Dry : Sep – Apr
  Wet : May - Aug
- **Equatorial**
  Dry: Jan-Feb/Jun-Jul
  Wet: Mar-May/Aug-Dec

Clustered more specifically into :
342 Seasonal Zones (ZOM)
65 Non Seasonal Zones (Non ZOM

Major rainfall types and seasonal forecast regions (from BMKG)

Key activity 2: Develop weather information and strengthen abilities for producing products for agriculture.

Main tasks and working group members

Tasks	Staff
I. Enhancement of Seasonal forecast I-1 Evaluation of operational forecasts I-2 Case study on monsoon variability I-3 Evaluation of Subseasonal- to-seasonal(S2S) prediction for extreme events	Adi* Novi Rosi Dmiana
II. Enhancement of ENSO monitoring and forecast	Supari** Amsari Ridha

* PIC of Key activity 2 and Team leader, ** Leader for Task II.

Results (Achievement of the project)

➢Evaluation of LRF

- Generally dry and wet season's onset forecast for 342 Seasonal Zones in Indonesia issued by BMKG since 2012 is better than the climatological forecast, except 2018 for dry season and 2013/2014 for wet season. Generally wet season's onset forecast has higher hit rate and skill than dry season's onset forecast. We can say that wet season's onset forecast is better than dry season's onset forecast.
- Among 4 statistical methods (ARIMA, WAVELET ARIMA, ANFIS, and WAVELET ANFIS) dry and wet season's onset forecast in ZOM 152 is best using ARIMA while ZOM 299 is best using WAVELET ARIMA.
- Verification on probabilistic forecast for monthly rainfall during 2018 shows that generally there is no significant difference among the lag-6 until lag-0 forecasts. Probabilistic forecast for categories less than 100mm/month, less than 150 mm/month, and more than 200 mm/month tend to be relatively good. Hit rate of the probabilistic forecast during 2018 for less than 100 mm/month and less than 150 mm/month tend to decrease a lot around June – August 2018 (the target month) while more than 200 mm/month is at its peak.

Results (Achievement of the project)

➢ Case study on monsoon onset/retreat variability

- Variation of Dry and Wet Season onset during 1981 - 2019 in ZOM 152 is not too large as its furthest is up to 2 months (Dry Season) and 1 month (Wet Season) from its normal. While ZOM 299 has large variation as its furthest is up to 6 months (Dry Season) and 3 months (Wet Season) from its normal.
- Mode of season onset during 1981 - 2019 in ZOM 152 is similar to its normal dry season onset and 1 dasarian later than its normal wet season onset. While mode of season onset during 1981 - 2019 in ZOM 299 is 1 month later to its normal dry season onset and similar to its normal wet season onset.
- Dry and Wet Season's cumulative rainfall in ZOM 152 has insignificant declining trend and ZOM 299 has insignificant declining trend (Dry Season) and inclining trend (Wet Season).
- Mostly significant years of season onset in both ZOM 152 and ZOM 299 is associated with ENSO years. For ZOM 152, La Nina and negative IOD simultaneously lead that wet season onset comes earlier than its normal of ZOM 152. In ZOM 299, warm Nino 3.4 SST leads to early dry season onset. La Nina and warm Indonesian SST simultaneously lead to late dry season onset, and warm Indonesian SST lead to early wet season onset.
- Mostly significant years of season cumulative rainfall in both ZOM 152 and ZOM 299 is associated with ENSO years. ENSO has more clear influence on season cumulative rainfall than Indonesian SST and IOD. For ZOM 152, La Nina leads to small rainfall in dry season, La Nina and warm Indonesian SST simultaneously lead to large rainfall in wet season, and warm Nino 3.4 SST leads to small rainfall in wet season. In ZOM 299, El Nino leads to small rainfall in both dry and wet season while La Nina leads to large rainfall in wet season.

Results (Achievement of the project)

➢ Subseasonal-to-Seasonal(S2S) Prediction for Extreme Events

- Numerical forecast utilization was started for disaster prevention purpose. The present study suggests that we may apply S2S prediction information for better forecast of possible occurrence of severe weather.
- Frequency of flood events in Java is higher than in other regions in Indonesia, especially in Central Java and extreme rainfall in these areas often occurs. From the results of this study, the ECMWF S2S model data is able to provide a warning to LT1(lead time of 1 dasarian) and even LT2 before the event especially in Central Java.
- The S2S ECMWF data for this study has lower resolution compare to data for operational in BMKG , so the results of this evaluation could be better if using S2S ECMWF operational data which has a resolution 0.25x0.25.

Results (Achievement of the project)

➢ Evaluation of the ENSO forecast by JMA and NCEP

- Evaluation of the ENSO forecast by JMA and NCEP was done for the first time. Generally, ENSO Prediction issued by JMA and NCEP have good skills on forecasting 1 to 3 months ahead indicated by high correlation coefficient and positive value of MSSS score.
- However, the skills of both JMA and NCEP products are to decrease for May-August period suggesting that careful interpretation is needed for ENSO forecast issued on the mentioned period.
- It is noted that these results will lead to improvement of ENSO monitoring/forecast technics presently used.

Future tasks
(for the achievement of overall goals after the project completion)

➢ Evaluation of seasonal forecast

- To enhance seasonal forecast ability and continue improving seasonal forecasts, it is important to monitor forecasts skills continuously. Thus, it is necessary to continue evaluation of operational forecast, which will provide useful information for improving operational forecast.
- From this study, it was found that season onset forecast's skill is better than the climatology but still need some improvement. In the future we are interested in studying the variability of season onset in East Java (ZOM 152) and South Sulawesi (ZOM 299) and their relation to driving factors that influence it.

Future tasks
(for the achievement of overall goals after the project completion)

➢ Case study of monsoon variability

- As for case studies of monsoon variability, present study was limited to two pilot areas. There remain other areas and islands to be studied. It is expected that the same kind of studies should be conducted in other major islands and regions in the future project.
- Moreover, it is also advised that factors affecting on the monsoon variability be studied further. Studies of to what extent ENSO, IOD and other factors influence on atmospheric circulation and climate variability around Indonesian region are to be studied.
- We are interested in studying more on the relationship and variability of the onset, period, and cumulative rainfall of the season. In the present study, the dynamics of atmosphere-ocean parameters that we used in the analysis are SST Anomaly, ENSO, and IOD. There are other various parameters that can be studied further, especially in the season where those three parameters don't have clear influence on season variability. Therefore, we also want to study other parameters of atmosphere-ocean dynamics that influence on such variations (For example, 850 mb wind, OLR, or other parameters).

Future tasks
(for the achievement of overall goals after the project completion)

➢ S2S Prediction for Extreme Events

- To better forecast severe weather conditions is highly requested for disaster prevention presently because of recurrence of severe weather-related hazard in Indonesia as well as all over the world under the changing global climate conditions. Studies of S2S prediction based on advanced numerical prediction systems should be continued for providing better weather and climate information for disaster prevention.
- Advanced Analysis for S2S Evaluation during MJO: In addition, this study is expected to examine the conditions of the interaction between the atmosphere and the sea as well as the physical processes that drive MJO. Understanding the process behind this relationship can provide the key to improving the prediction system, especially the processes involved in the propagation of MJO on the maritime continent. Therefore it is necessary to study reliability of predictions on the S2S time scale at the time of extreme events such as MJO.

Future tasks
(for the achievement of overall goals after the project completion)

➢ ENSO forecast evaluation

- Forecast and information of ENSO, which is believed to be one of the main driving forces on the weather and climate in the Indonesian regions, are presently effectively used for agricultural management in Indonesia while better forecast is much expected. There are some other important factors affecting on the weather and climate in Indonesia. Further studies are needed for better information of ENSO monitoring/forecast and other factors.
- Apart from ENSO conditions, Indonesian climate is also strongly driven by IOD (Indian Ocean Dipole). Information on the IOD status during the upcoming months is crucial for some government sectors and the public to design activity plans, and the precise information on the IOD status will enable them to design a suitable policy and plans. In this context, knowledge on the skill of IOD forecast is essentially required. In the next project, it is hoped that we can also examine the skill of IOD predictions issued by JMA since this product is used regularly by BMKG as a reference on monitoring IOD event.

Concluding remarks For Enhancing Long-range Forecasting Ability

To enhance ability of seasonal forecast, there remain lots to be tackled:

- Evaluation of the BMKG seasonal forecast is to be continued.
- Case study of monsoon variability should be conducted for other parts of Indonesia.
- S2S prediction experiments should be encouraged further. It is expected to provide useful information to the government sectors and the public for disaster prevention and so on.
- To enhance monitoring/forecast and evaluation studies for ENSO, IOD and other factors is expected to lead to better seasonal forecast.
- Finally it must be emphasized that exchange of information with users should be done continuously for us to produce/provide user-oriented seasonal forecast.

Thank you for your kind attention

TERIMA KASIH

ご清聴ありがとうございました

NHRCM high-resolution climate simulation over INDONESIA

Ari Kurniadi / Apriliana Rizqi Fauziyah

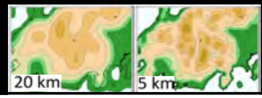
1

OUTLINE


1. Background


2. Earth Simulator


3. MRI Cluster System



4. NHRCM for INDONESIA

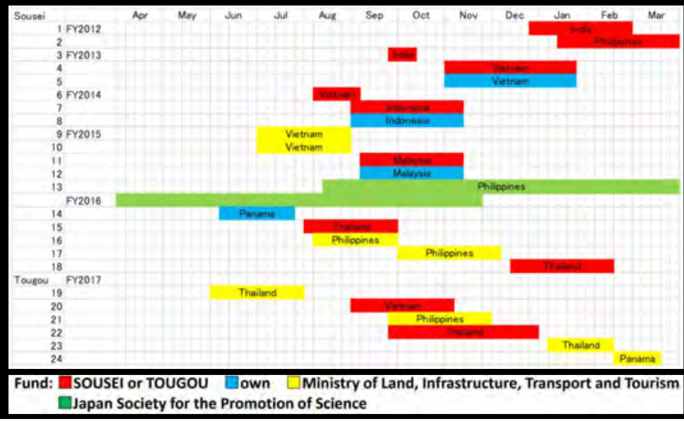
2

BACKGROUND

- The international collaborative research with developing countries is conducted by the MRI to produce the detail structure of the future climate change projection in tropical and sub-tropical Asian regions.
- This work was partially conducted under the framework of "the Integrated Research Program for Advanced Climate Modeling" supported by the TOUGOU Program of MEXT of Japan.

3

BACKGROUND



4

Sistem yang digunakan selama di MRI

1. ES (Earth Simulator) ; supercomputer milik JAMSTEC yang kami gunakan untutk running model NHRCM

2. MRI Cluster system ; pengolahan sekaligus penyimpanan output hasil downscaling

5

Earth Simulator komponen

1. lunar (lunar.jamstec.go.jp)

2. moon (moon.es3.jamstec.go.jp)
3. mars (mars.jamstec.go.jp)

6

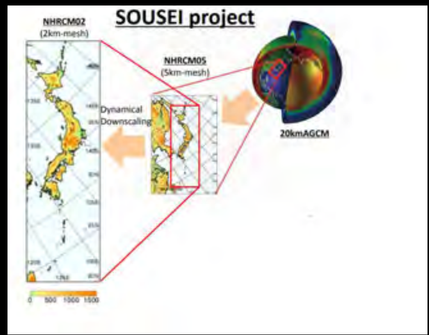
MRI cluster

appc130.mri-jma.go.jp

- tempat penyimpanan hasil keluaran NHRCM

7

Methodology



8

Methodology

- AGCM 20 km sebagai forcing
- Downscale ke resolusi 5 km (1081 x 421 grid) dengan Batasan longitude 93.7 – 144.1 dan latitude 12.2 – 7.2
- Waktu 1 September 1981-1990 untuk present (target 20 years)
- Waktu 1 September 2079-2088 untuk future (target 20 years)
- Menggunakan satu scenario yaitu RCP8.5
- Untuk data 1 bulan pertama tidak dipakai menghindari efek dari model spin-up

9

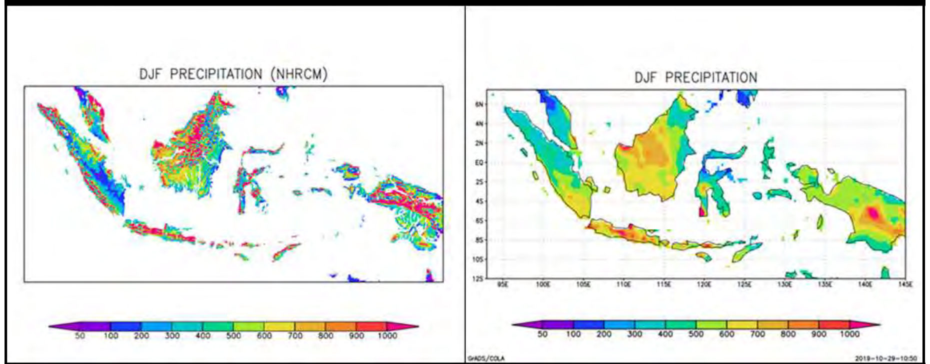
Running

10

Hasil Hujan

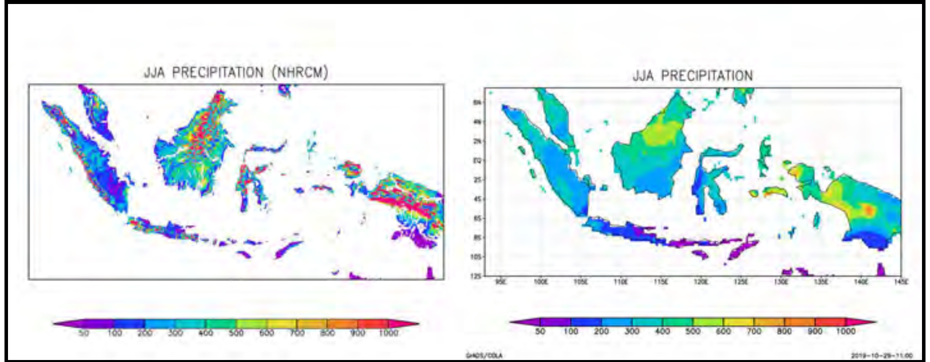
11

Hasil (Hujan DJF NHRCM vs Aphrodite)



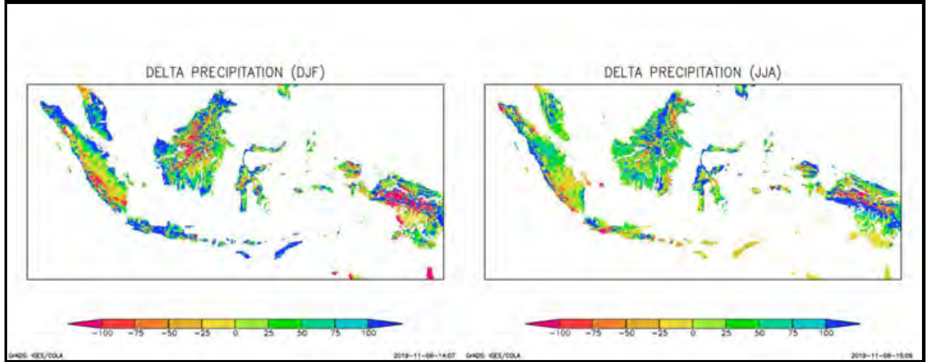
12

Hasil (Hujan JJA NHRCM vs Aphrodite)



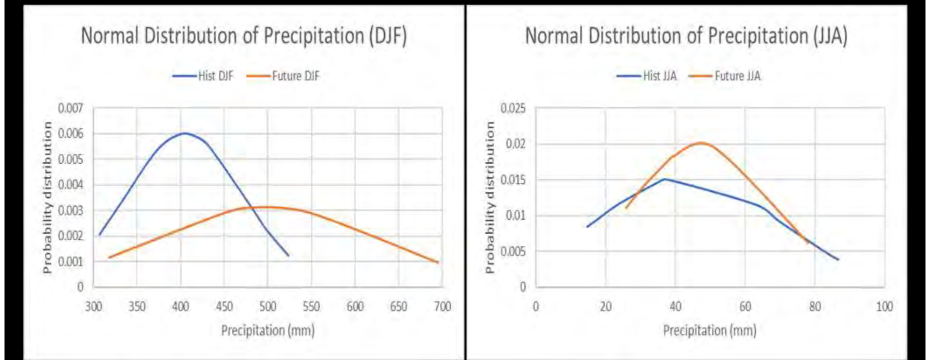
13

Hasil (Delta Hujan DJF dan JJA)



14

Hasil (Probability Distribution Hujan Indonesia)

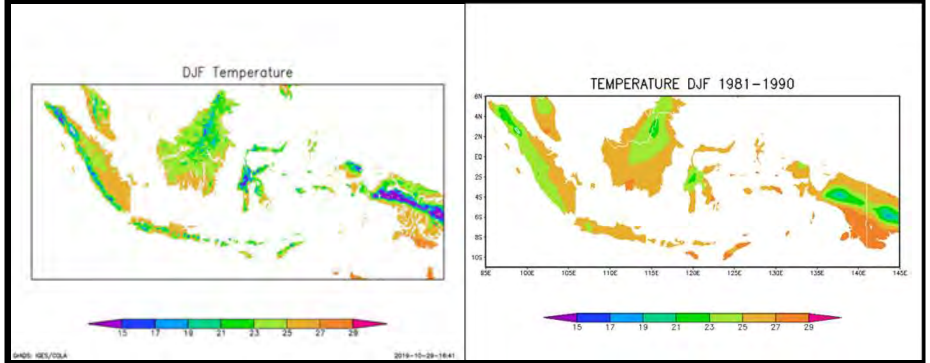


15

Hasil Temperatur

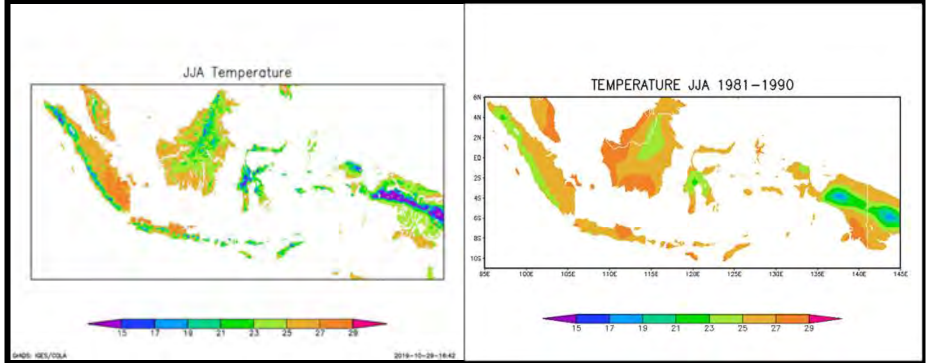
16

Hasil (Temperatur DJF – NHRCM vs APHRODITE)



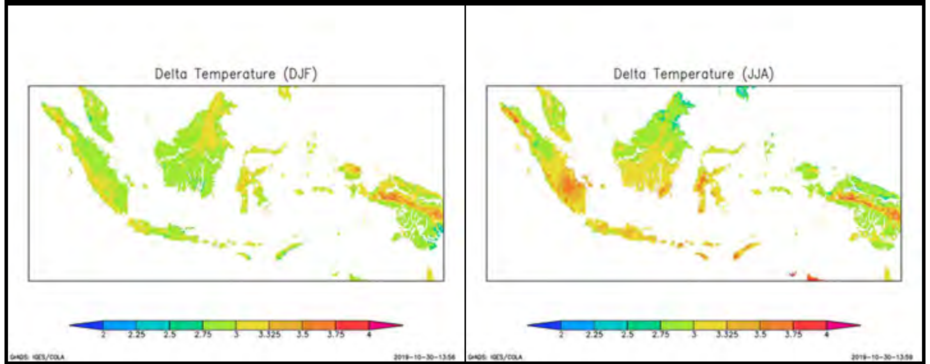
17

Hasil (Temperatur JJA – NHRCM vs APHRODITE)



18

Hasil (Delta Suhu DJF danJJA)



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CONCLUSION

- Simulasi NHRCM dengan resolusi 5 km untuk Indonesia selama 10 tahun periode present (1981-1990) dan 10 tahun periode future (2079-2088) telah dilaksanakan untuk wilayah Indonesia.
- Hasil simulasi NHRCM dapat merepresentasikan hujan musiman di Indonesia
- Hasil simulasi NHRCM dapat merepresentasikan suhu Indonesia, namun overestimate di wilayah dataran tinggi terutama wilayah gunung.
- NHRCM memiliki keunggulan dalam merepresentasikan topografi Indonesia baik dalam menampilkan hujan dan suhu.

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Next

- Untuk memenuhi target proyek mereka, NHRCM untuk Indonesia masih perlu dilakukan untuk perioda 10 tahun baik untuk present dan future dengan resolusi 5 km dengan menggunakan RCP8.5.
- Target selanjutnya adalah resolusi 2 km untuk pulau tertentu.
- Manual proses pengerjaan NHRCM berdasarkan proses yang sudah dilakukan sudah dibuatkan (https://drive.google.com/file/d/1nDIlQFYJxWJ4iU-xahkkGHSaaDBfsEvo/view?usp=sharing)

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22

Climate Projection for Java, Bali and Nusa Tenggara

Noveta Chandra

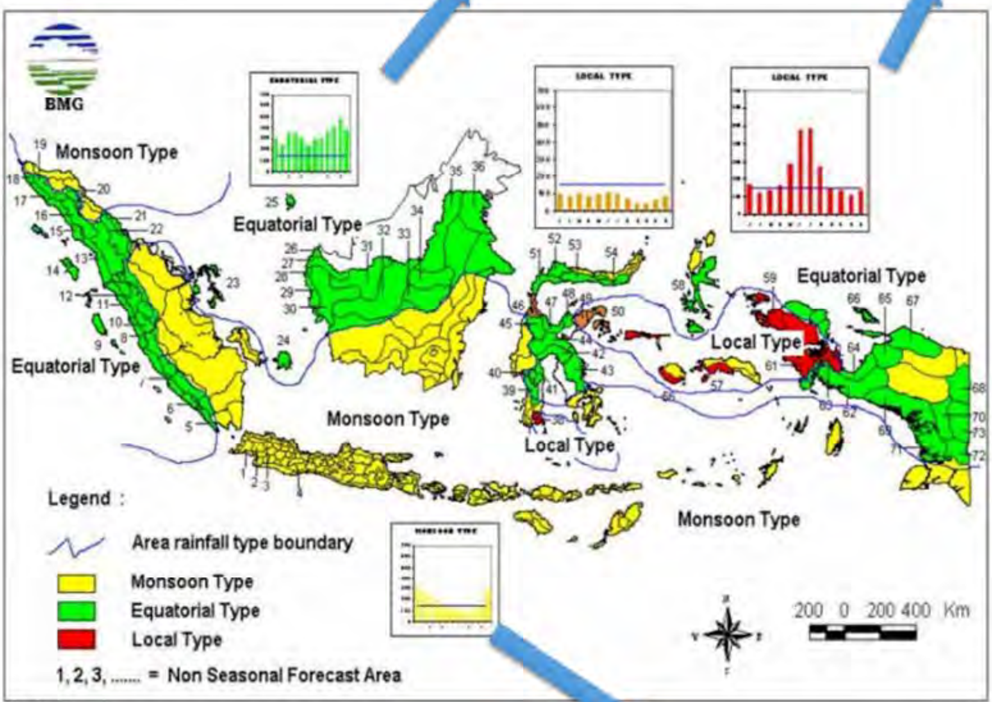
MRI, Tsukuba

August 07, 2019

Annual Rainfall Pattern of Indonesia

Equatorial ~ 2 Ridges ~ ITCZ

Anti-Monsoonal ~ 1 Ridge ~ ITF

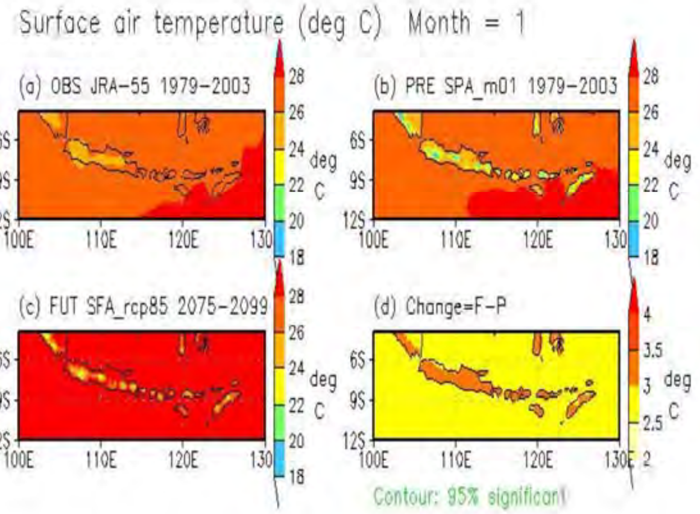


BMKG (2012)

Monsoonal ~ 1 Trough ~ Indo-Australian Monsoon

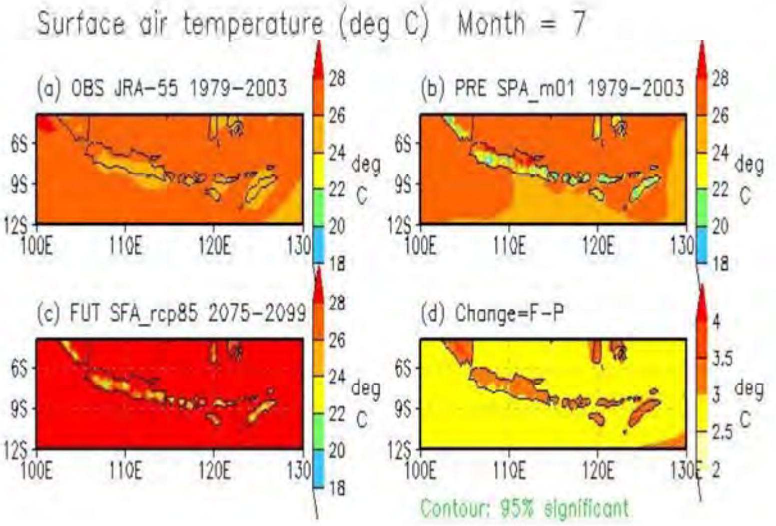
Sea Surface Temperature

Surface air temperature January



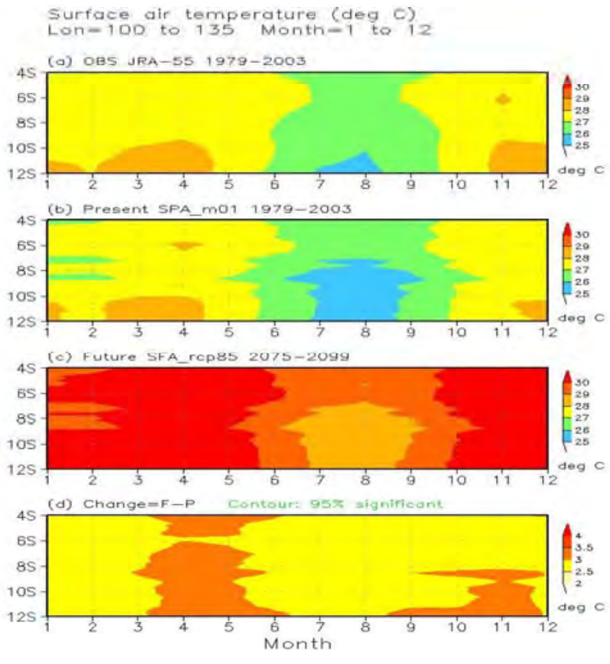
1. Model present simulation is little different to observation, model present simulation underestimate temperature mostly in java, Bali and Nusa Tenggara
2. Temperature will rise about 3 degrees C over Java, Bali and Nusa Tenggara

Surface air temperature July



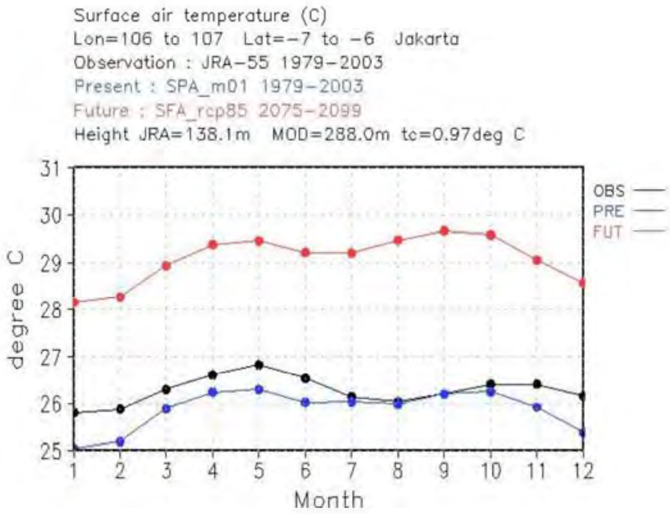
1. Model present simulation is little different to observation
2. Model present simulation underestimate temperature mostly in java, Bali and Nusa Tenggara, but in Northen Java, model present simulation overestimate
3. Temperature will rise about 3 degrees C over Java, Bali and Nusa Tenggara

Seasonality of change



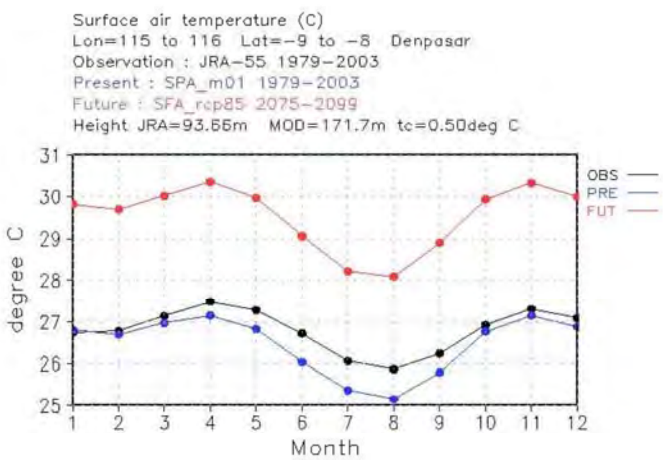
1. Model present simulation is close to observation, but in july – august model present simulation underestimate temperature
2. Temperature change 3 degrees C jan – feb and june - sept, and about 3.5 degrees C march – may and sept - dec

Change near Jakarta



1. Model present simulation is close to observation, simulation underestimate temperature
2. Temperature will rise about 3 degrees C

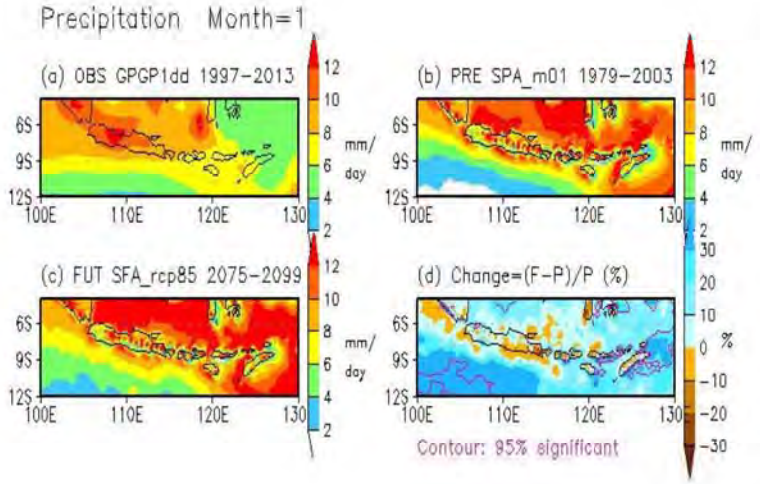
Change near Denpasar



1. Model present simulation is close to observation, simulation underestimate temperature
2. Temperature will rise about 3 degrees C

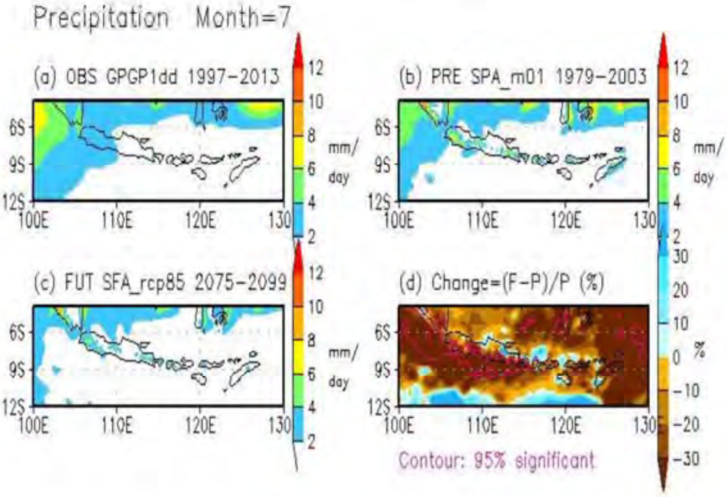
Precipitation

Precipitation January



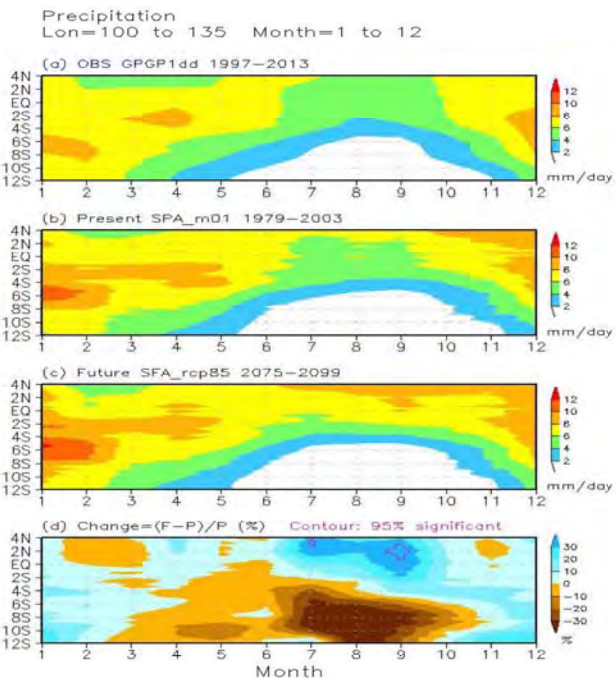
1. Model present simulation is different to observation. Based on location, there are overestimate and underestimate
2. Precipitation will rise and decrease depanding on location

Precipitation July



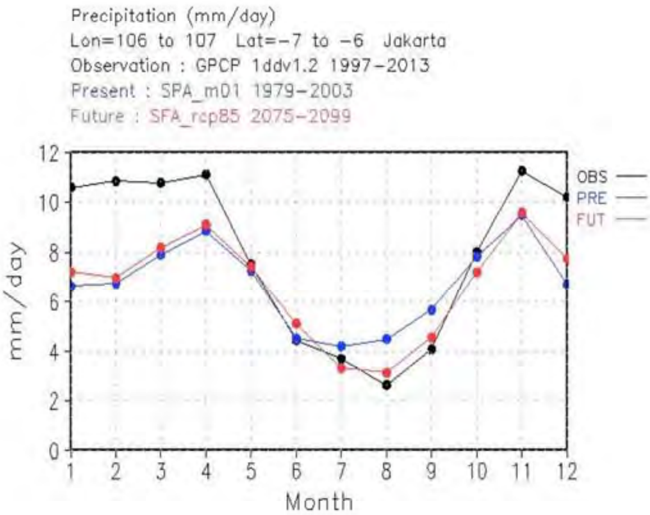
1. Model present simulation is different to observation. Based on location, there are overestimate and underestimate
2. Precipitation will decrease 20 -30 % over Java, Bali and Nusa Tenggara

Seasonality of change



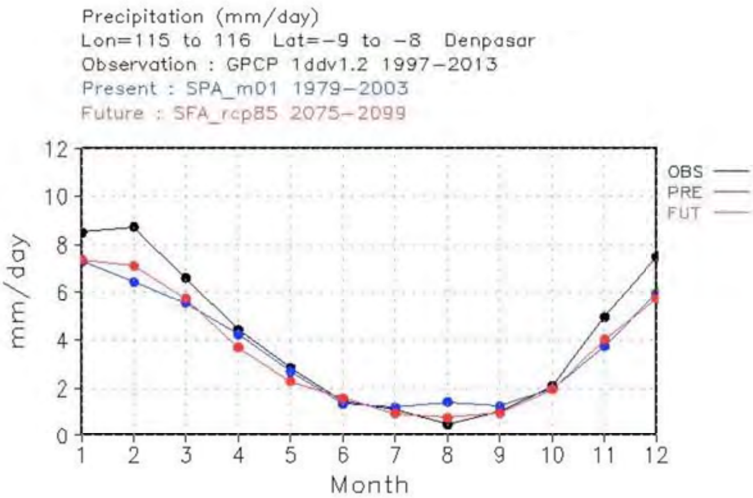
1. Model present simulation is close to observation
2. Precipitation will rise in rainy season, and decrease in dry season.

Change near Jakarta



1. Model present simulation is close to observation, simulation underestimate precipitation in rainy season, and overestimate in dry season
2. Precipitation will rise in rainy season, and decrease in dry season.

Change near Denpasar



1. Model present simulation is close to observation, simulation underestimate precipitation in rainy season.
2. Precipitation will change a little in the future, both in dry season or rainy season.

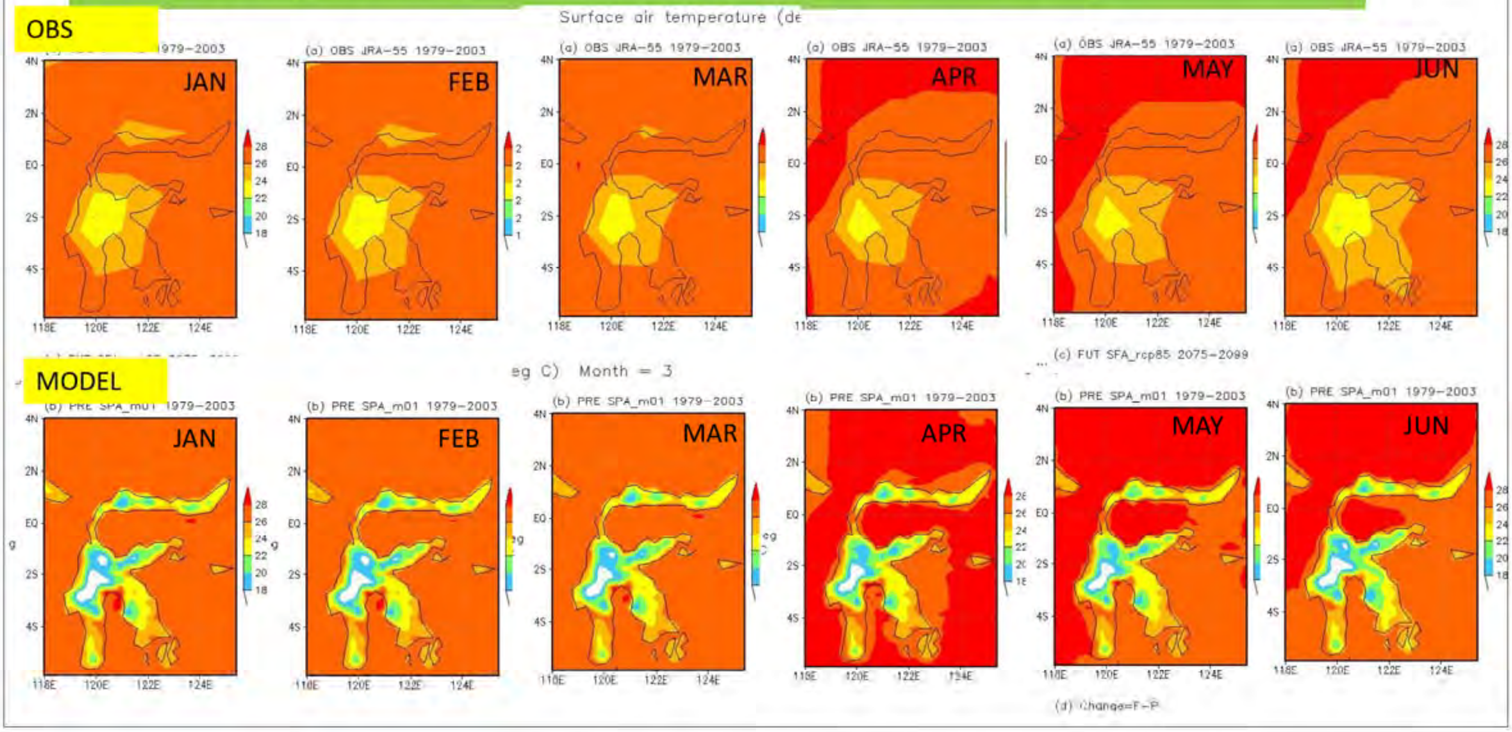
Summarize future change

- Temperature will rise in the future about 3 degrees C over Java, Bali and Nusa Tenggara, in all month
- Precipitation will rise in rainy season and will decrease in dry season

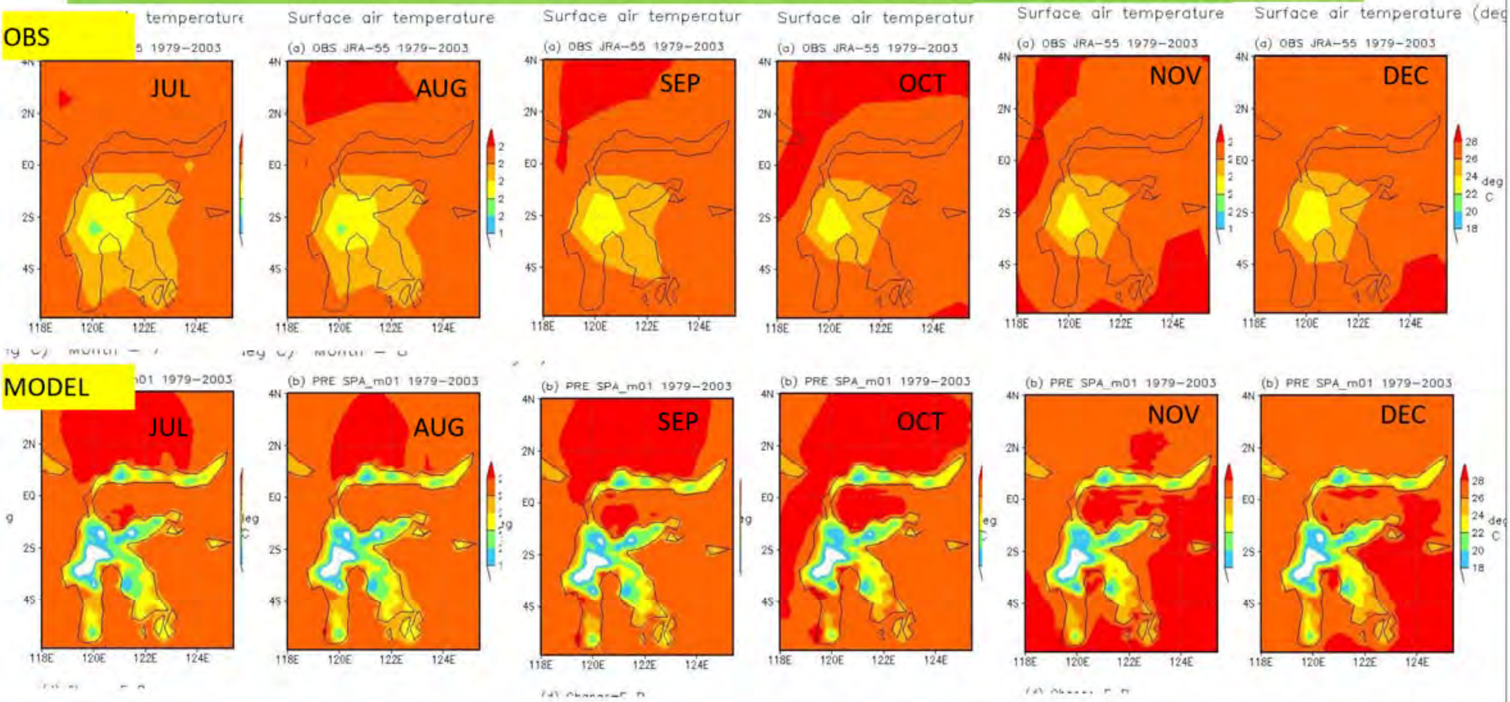
Climate Projection For Sulawesi

Short Report by Novi Fitrianti

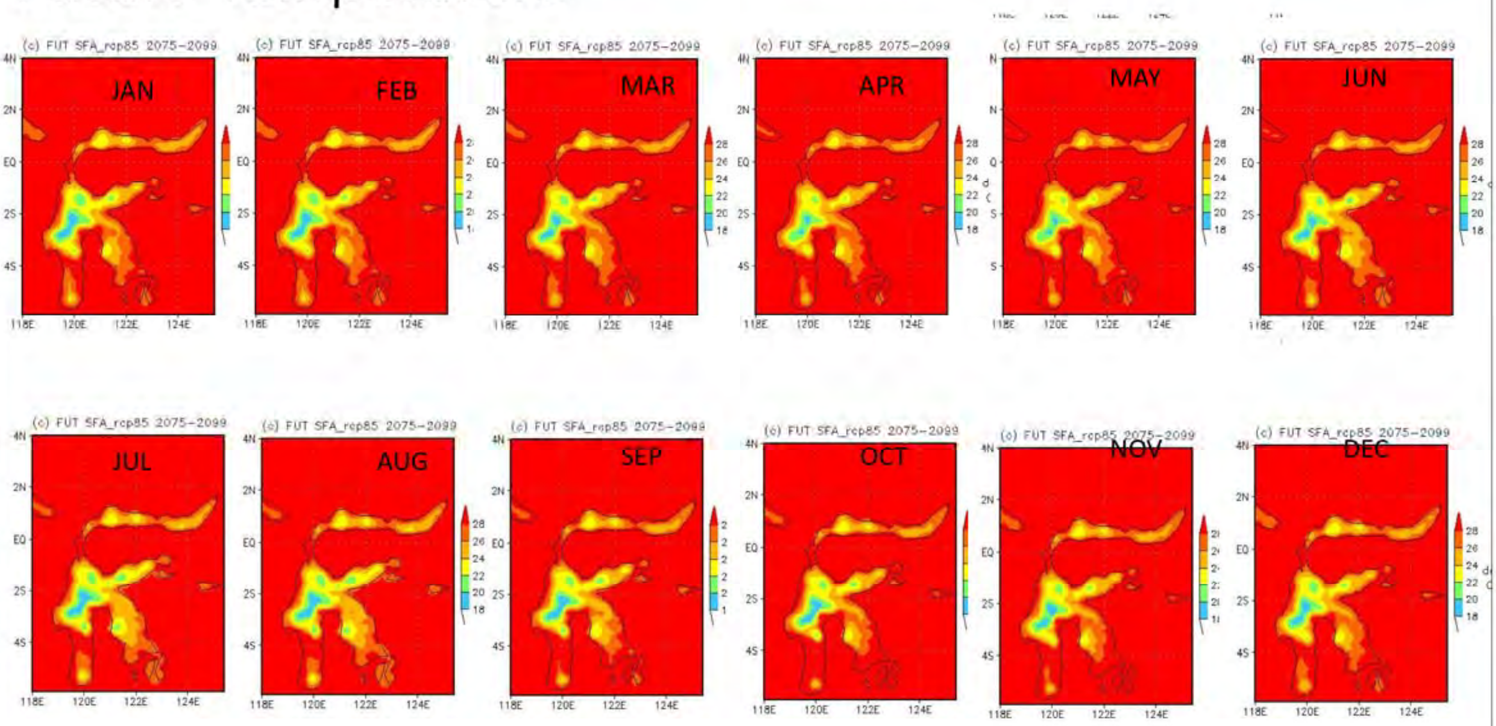
Monthly Temperature (OBS vs Model)



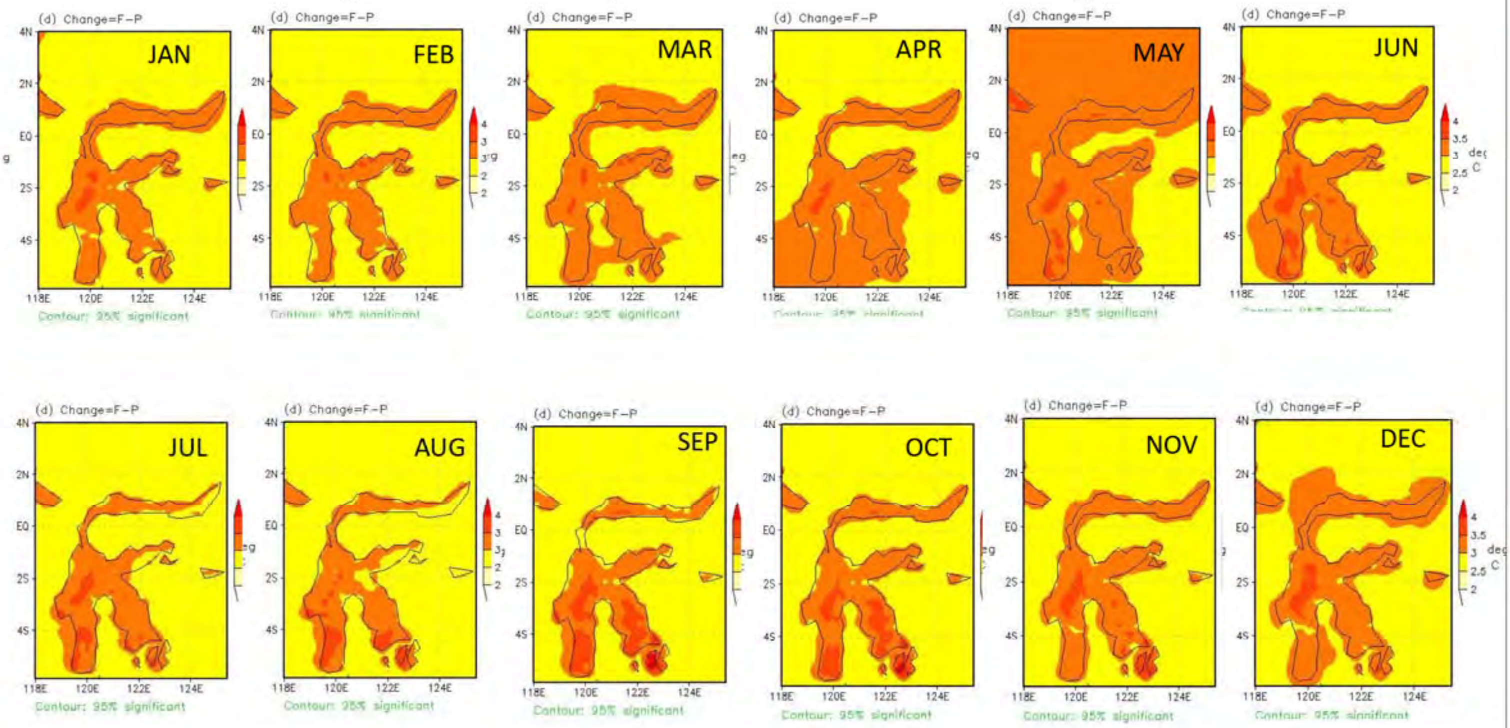
Monthly Temperature (OBS vs Model)

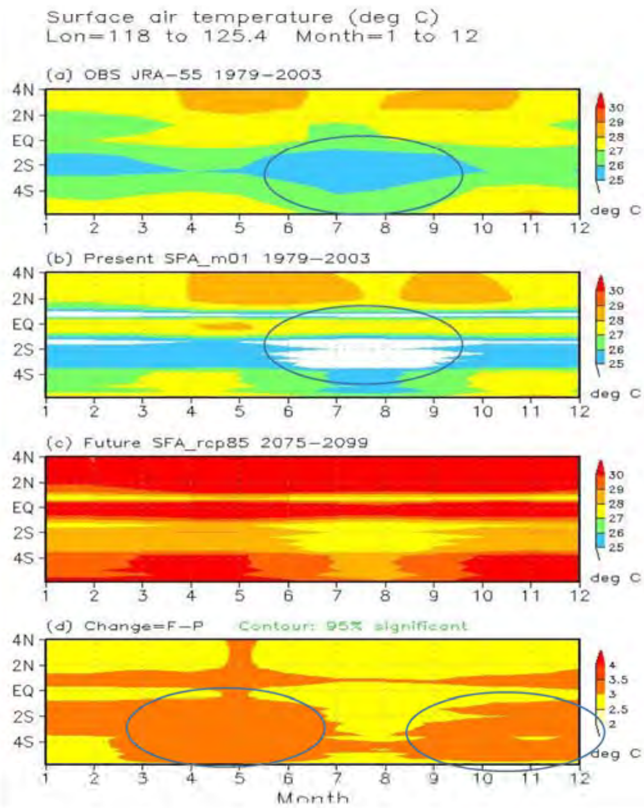


Future Temperature



Future Temperature (Future – Present)

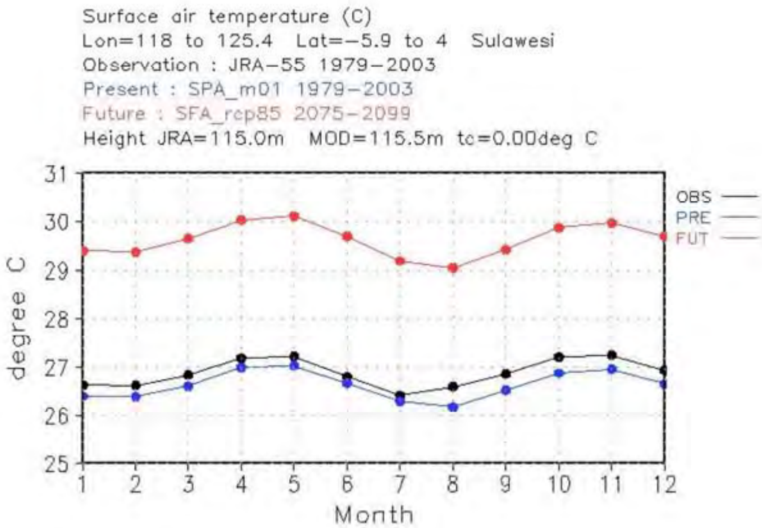




Seasonality of Change

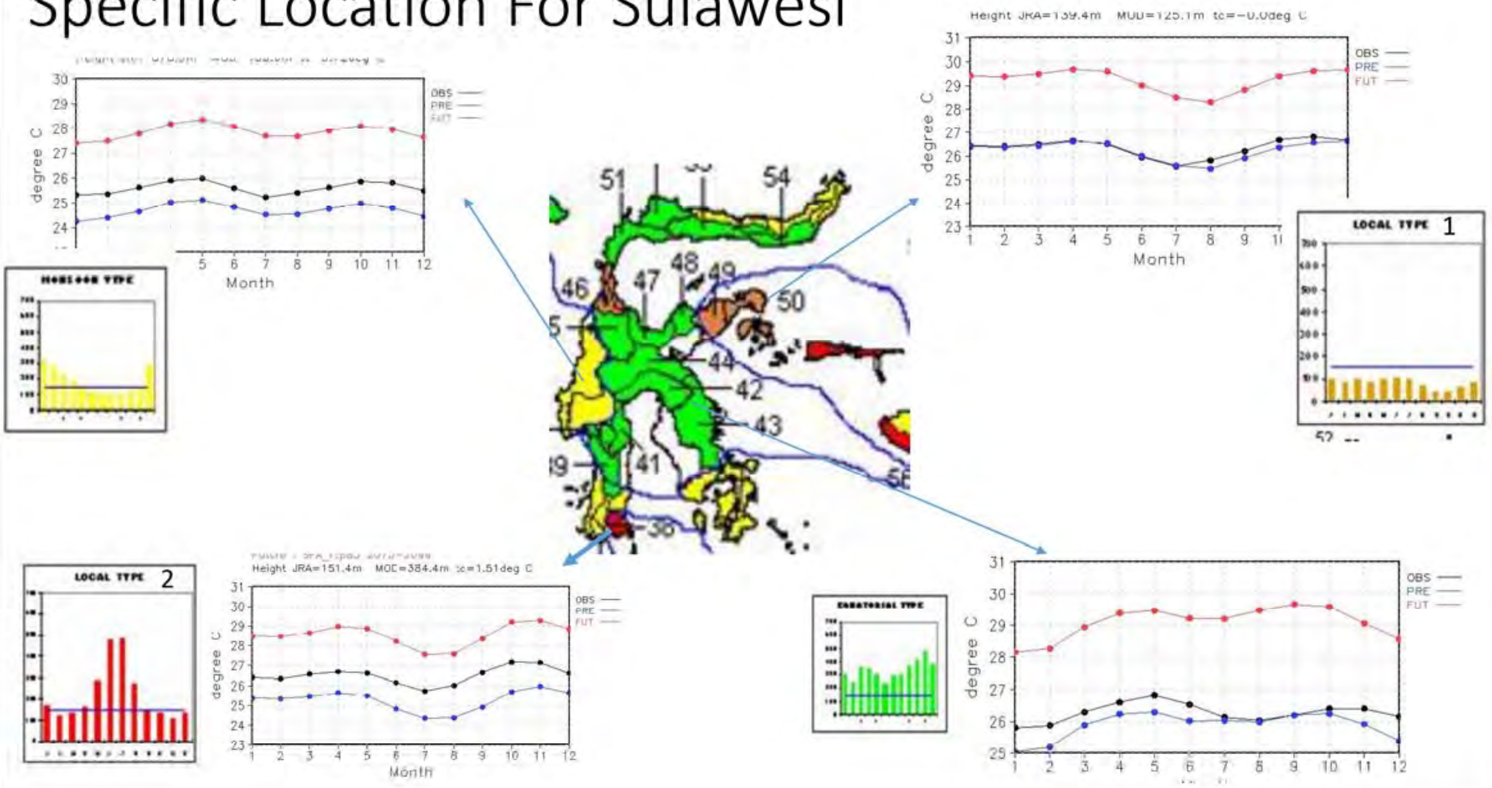
1. Model Show that the Similarity between the Nothern and Southern But not in Central Sulawesi
2. Temperarute rise almost in Sulawesi Especially in Souther Part it Become Warmer than Other in (March-Jun) and (Sep-Dec)

Time Series of Change

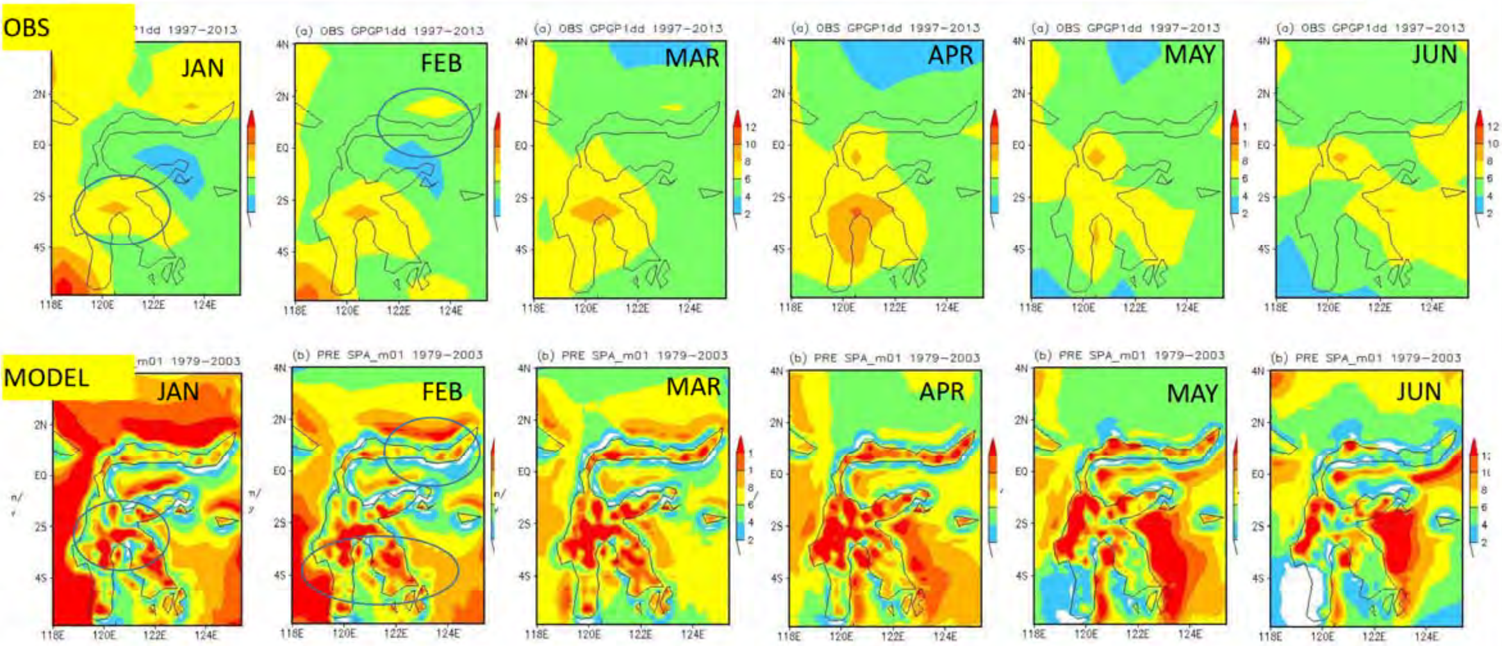


1. Model Present Simulation is Close to Observation
2. Temperature rises significantly, more than 3 degree

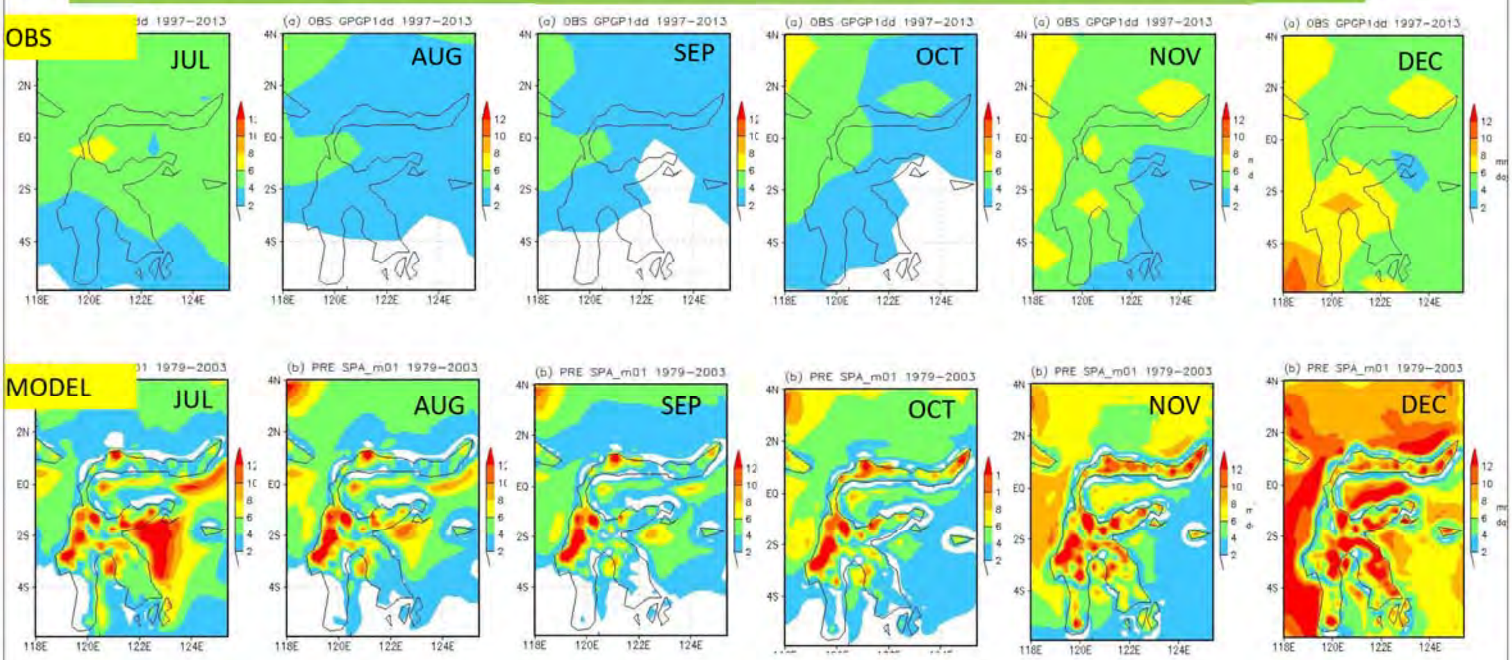
Specific Location For Sulawesi



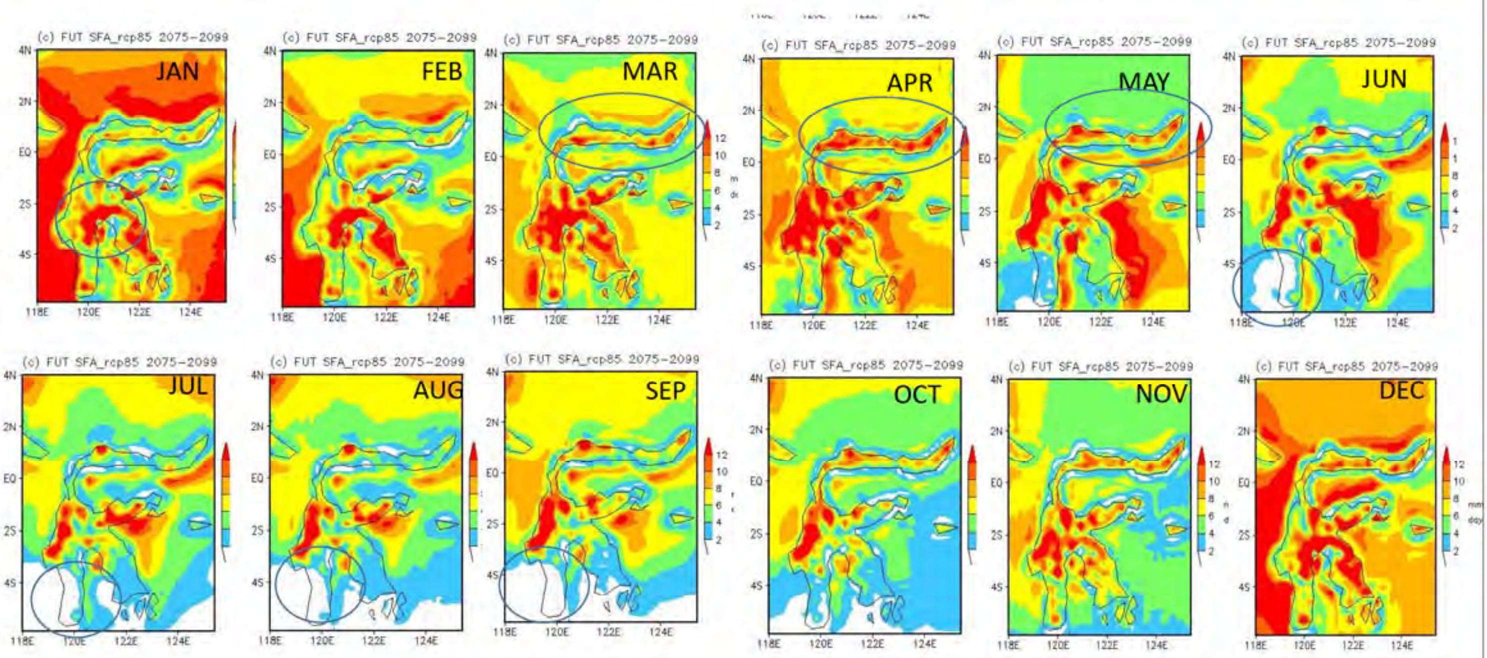
Monthly Rainfall (OBS vs Model)



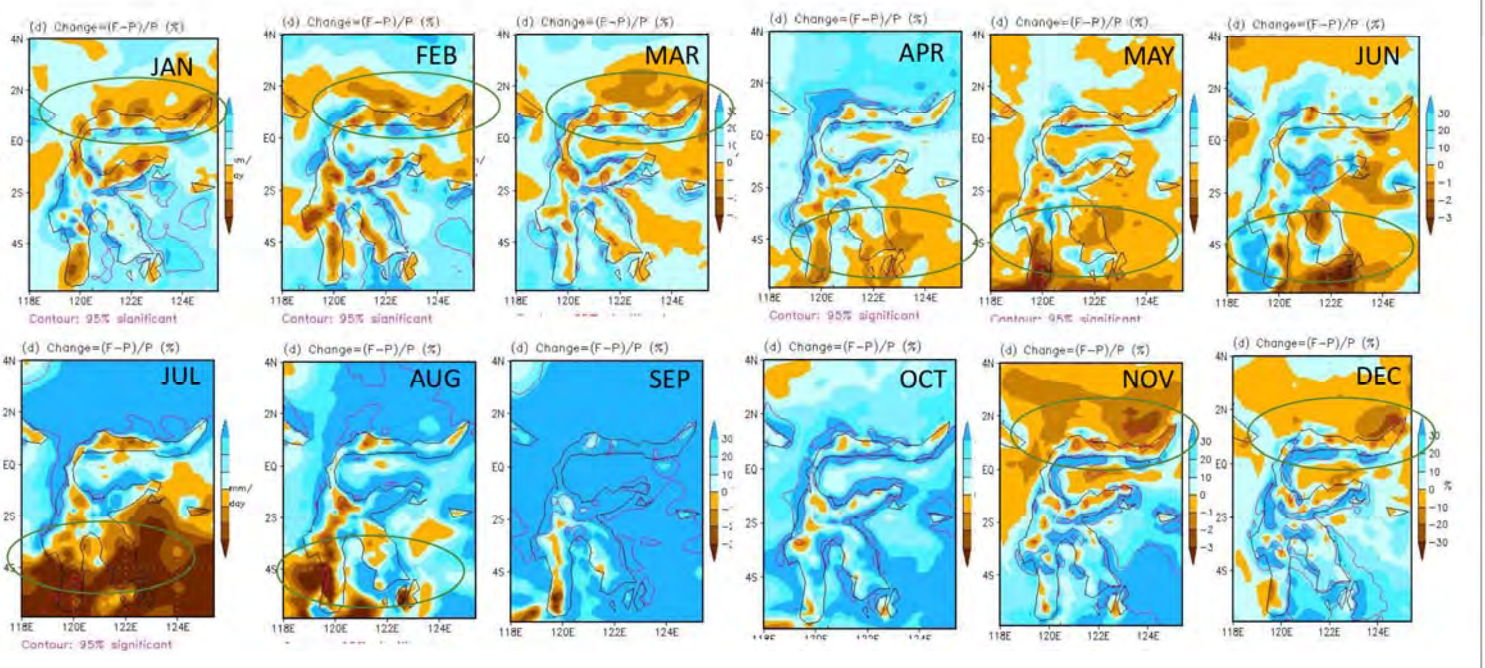
Monthly Rainfall (OBS vs Model)

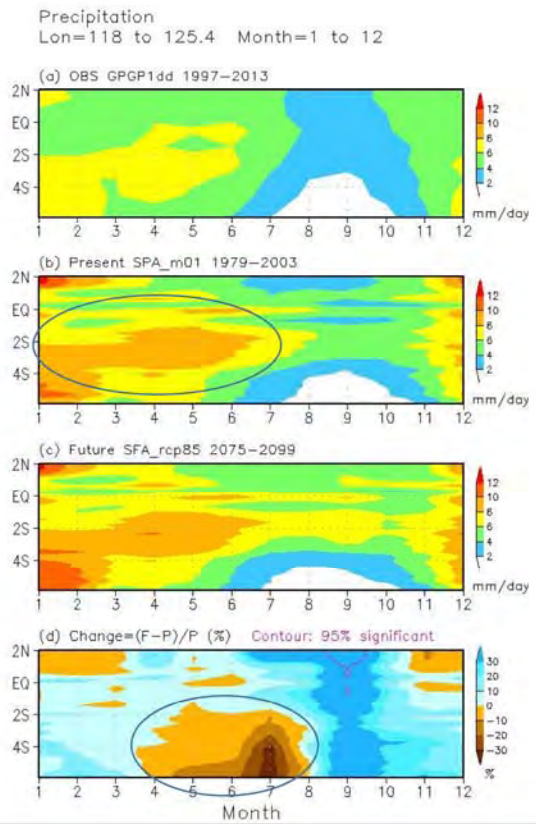


Future Rainfall



Future Rainfall (Future – Present)

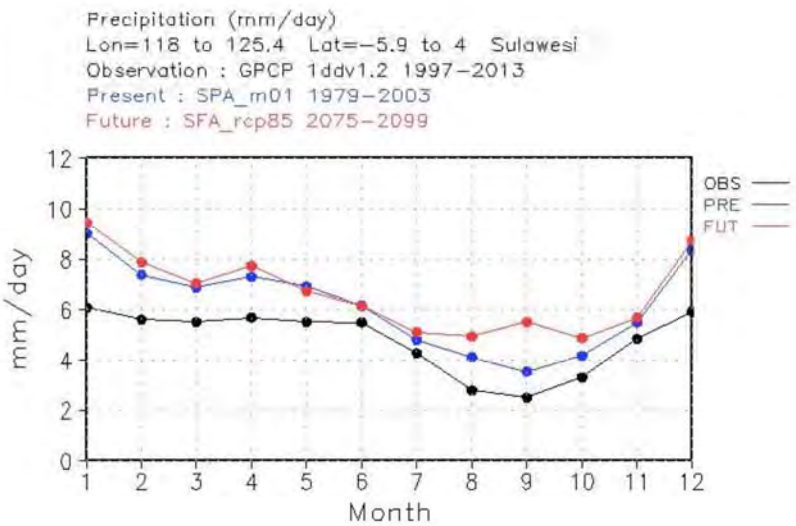




Seasonality of Change

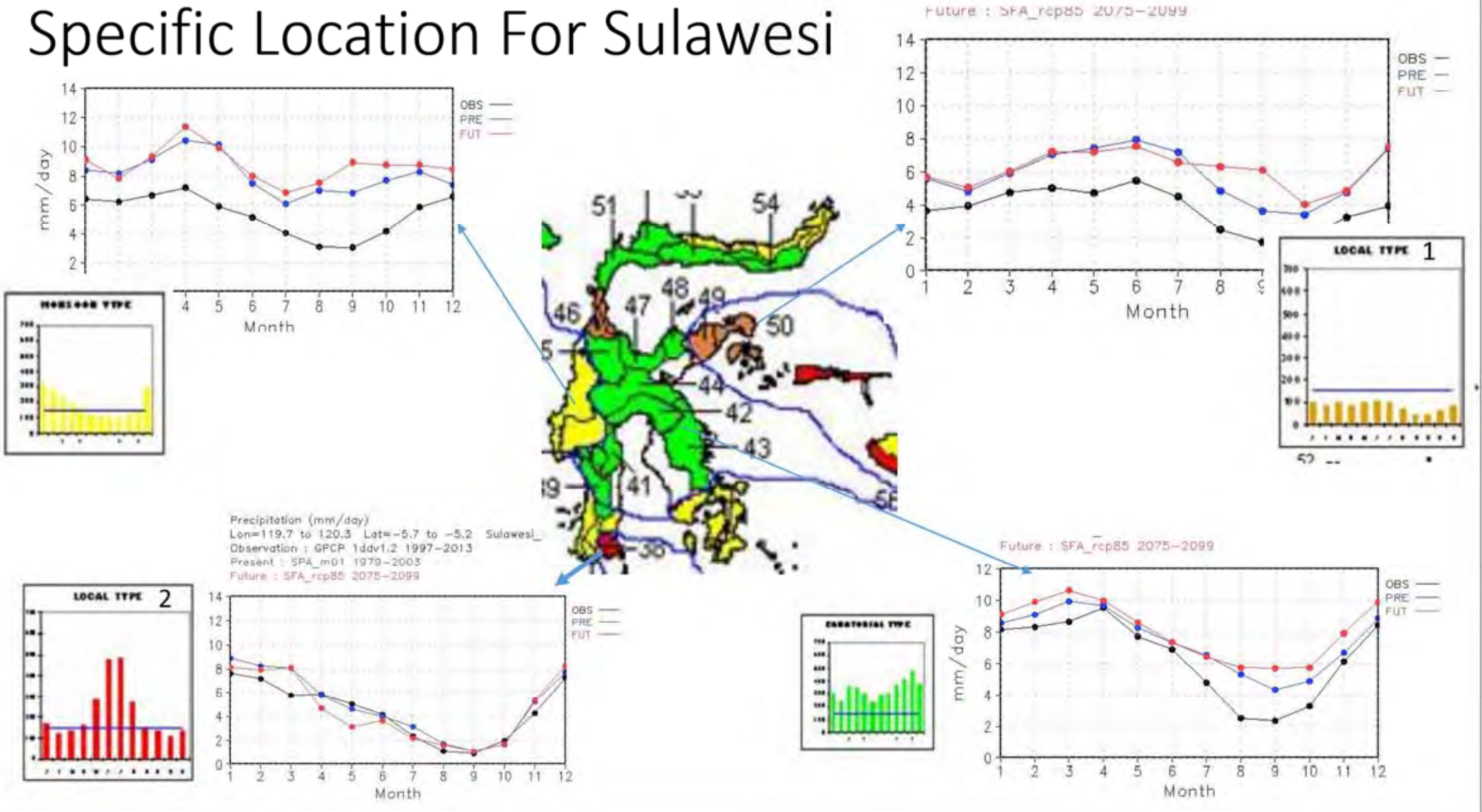
1. The Model present that there are more rainfall in the south to equator in Jan to Jun compare it with model
2. In May to Aug there are decreasing in rainfall in South to near Equator, but there are an increase in Rainfall in Sep - Oct

Time Series of Change



1. Model Present Simulation is quite similar to Observation
2. The Rainfall in the Future is similar with the present Except in September.

Specific Location For Sulawesi



Summary

- There is a temperature difference between Observation and Model data, Especially in Central Sulawesi
- Temperature rise is almost same in all months, Temperature will rise more than 3 degree.
- For temperature in Monsoon and Local type 2 the Model data shows not too similar with Obs data but it follows obs data pattern . And For Temperature in Equatorial and Local type 1 the Model data quite similar with the obs data.
- Temperature in specific area (Monsoon, Equatorial, Local type1, Local type2) will rise about more than 3 degree in average.
- For central of Sulawesi, the model can capture the highest rain but the obs data can't capture it. For Nothern Part of Sulawesi, the obs data present similar result but model can capture there are additional rainfall each month. For Southern part of Sulawesi, the obs data present similar result but model shows there are decreasing in rainfall.
- For Central of Sulawesi the rainfall significantly increase each month in the Future, In Northern part of Sulawesi there the rainfall increase in Mar to May and in Southern part of Sulawesi in Jun to Sep there is no difference between present and future in Rainfall.
- Future rainfall in Sulawesi shows that in Nov to Mar there are decreasing in Rainfall at Northern part of Sulawesi but in Apr to aug there are decreasing in Southern part of Sulawesi.
- Model Present Simulation is Close to Observation in average. The Rainfall in the Future is similar with the present Except in September.
- For rainfall in Monsoon and Local type 1 the Model data shows not too similar with Obs data but it follows obs data pattern . And For rainfall in Equatorial and Local type 2 the Model data quite similar with the obs data.
- Rainfall in specific area (Monsoon, Equaorial, Local type1, Local type2) will not significant rise in the future.