Suitability Analyses of Paddy Fields and Coffee Plantations in Indonesia Under Climate Change Scenarios

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Agency for Research and Innovation of Indonesia (BRIN)

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Team members

Climate extreme
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Climate modeling
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Syafrianno
Aulia Nisa'ul Khoir
Ganesha Tri Chandrasa, Robi Muharsyah,
Suradi,

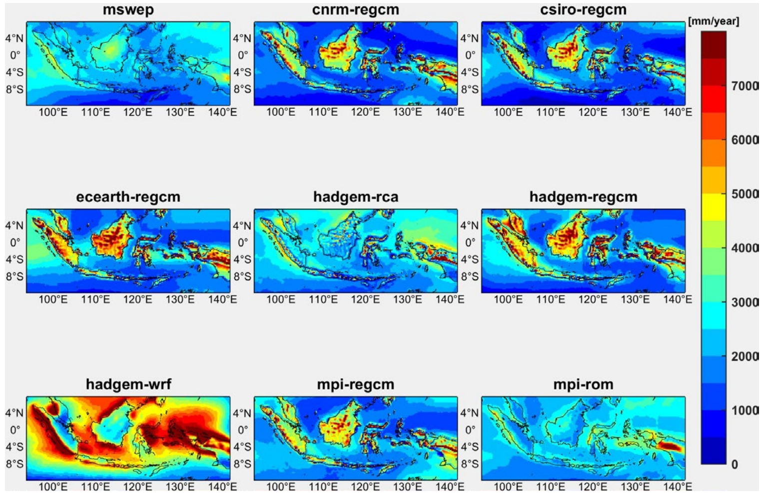
Purpose :
to provide scientific findings on the impact of climate change on paddy and coffee production over the past few years

Economic Analyses
Perdinan
Lukytawati Anggraeni
Ryco Farysca Adi
Raden Eliasar Prabowo Tj
Delta Yova Dwi Infrawan
Dewi Sulistyowati

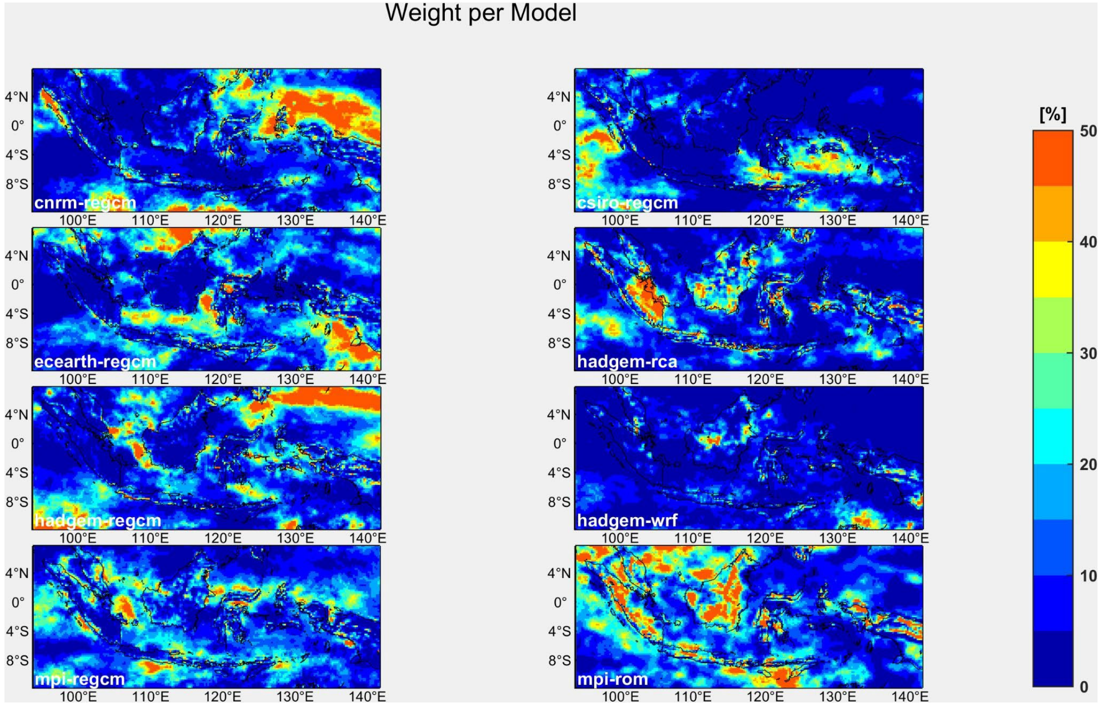
Non technical expert
Mahawira Dillon
Sheila D A Kusumaningtyas

- Rice in the coastal area
- Rice in the Swampland
- Rice in the Rice field
- Coffee in the lowland and highland

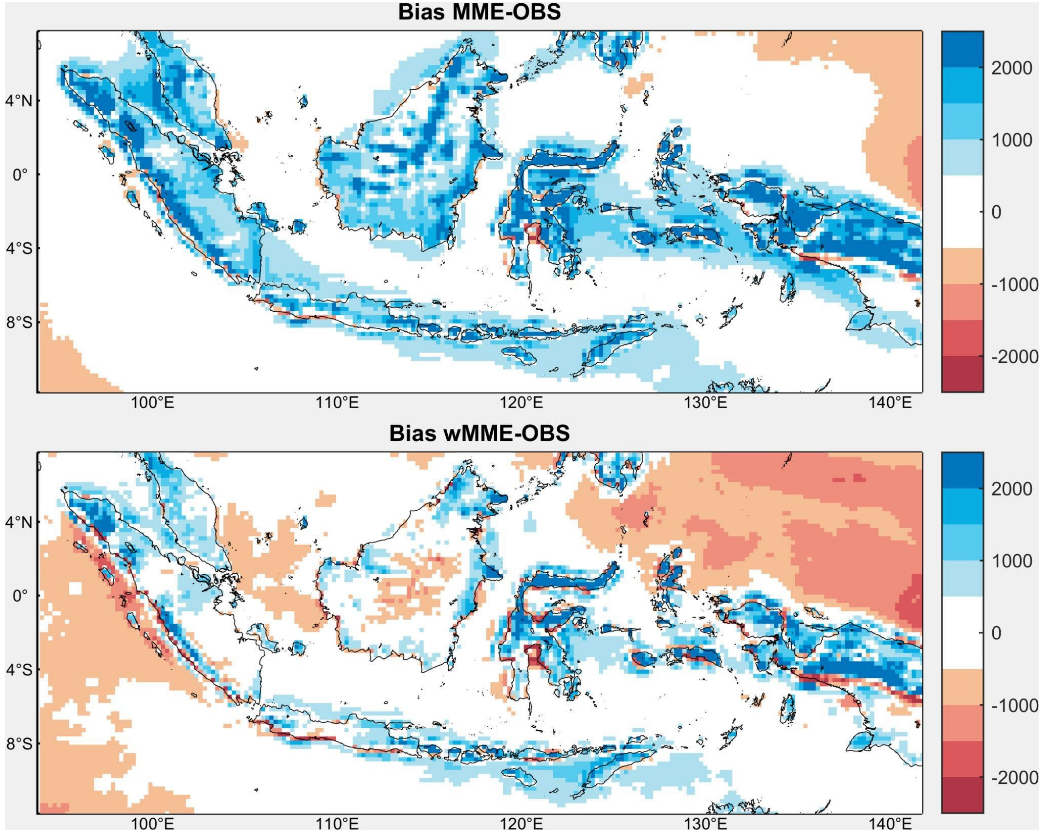
WEIGHTED ENSEMBLE (PRECIPITATION)



Individual model results



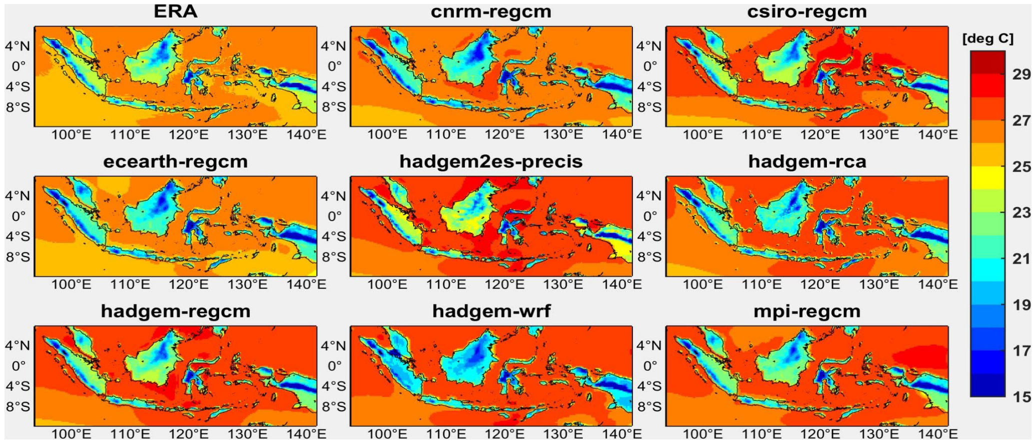
Individual model weighted index



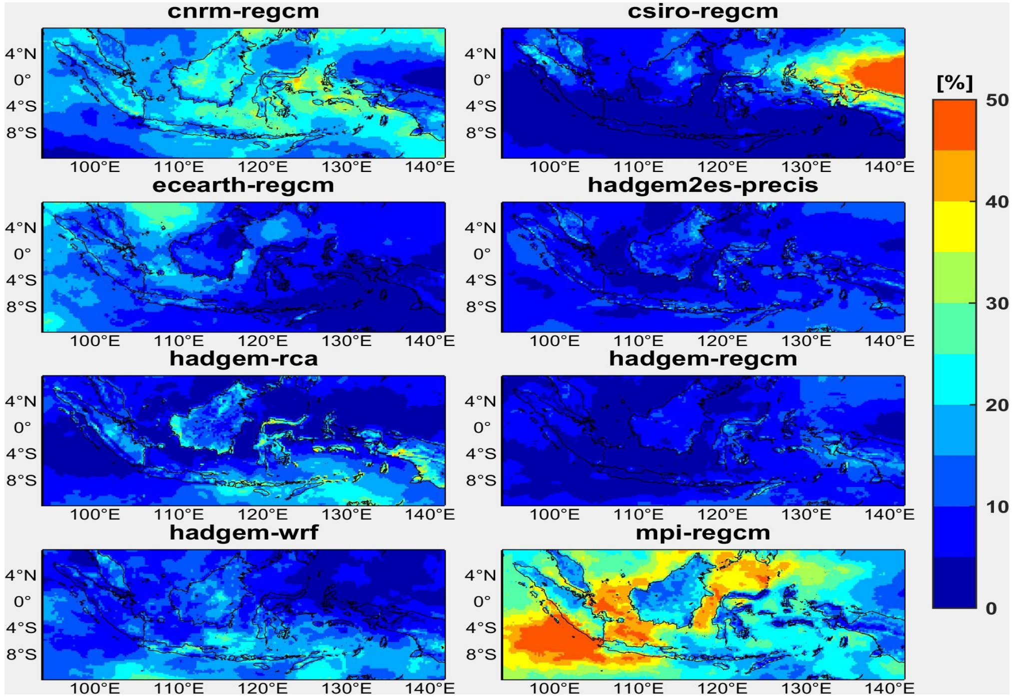
Bias comparison

>An effort to reduce the possible future bias from ensemble average
>Based on the capability of the model in replicating cumulative precipitation
>Calculated using an extended application of the Taylor diagram analysis from model historical simulations
>Weighted ensemble results display a higher skill

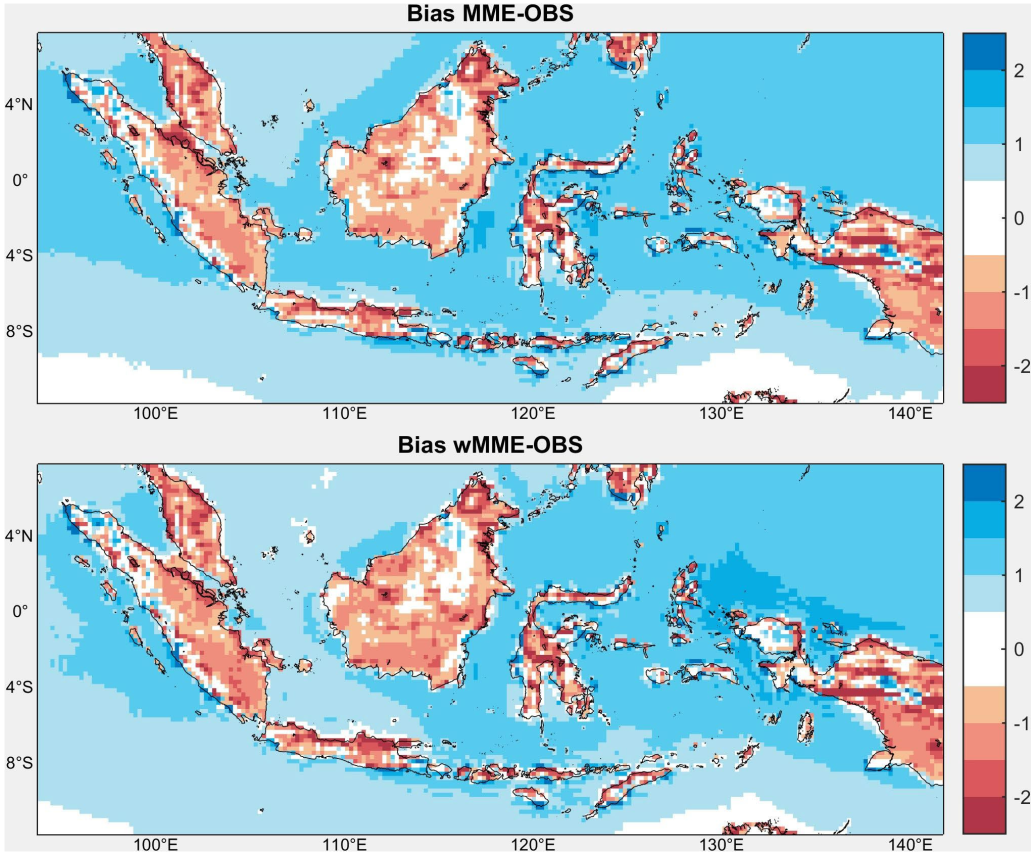
WEIGHTED ENSEMBLE (TEMPERATURE)



Individual model results



Individual model weighted index



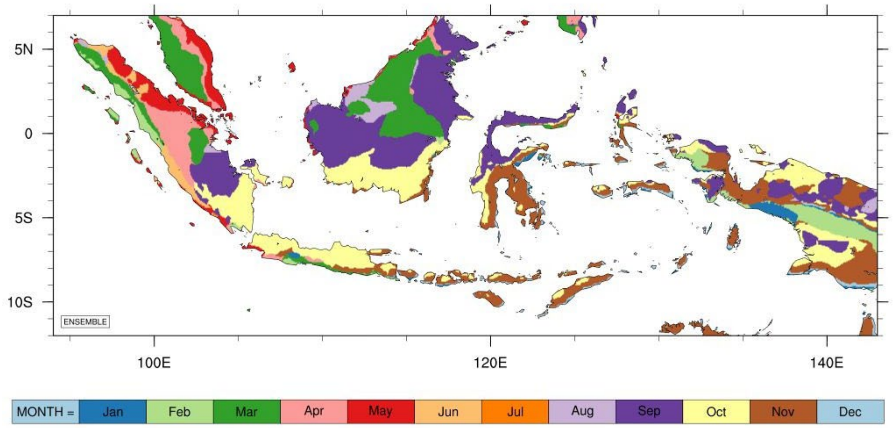
Bias comparison

>An effort to reduce the possible future bias from ensemble average
>Based on the capability of the model in replicating average temperature
>Calculated using an extended application of the Taylor diagram analysis from model historical simulations
>Weighted ensemble results display a relatively similar skill

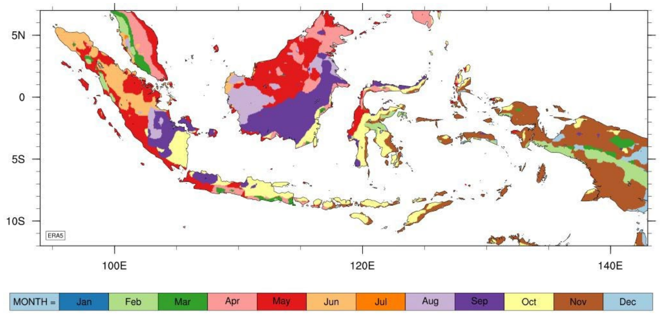
Validation

MODEL VALIDATION for TX and TN

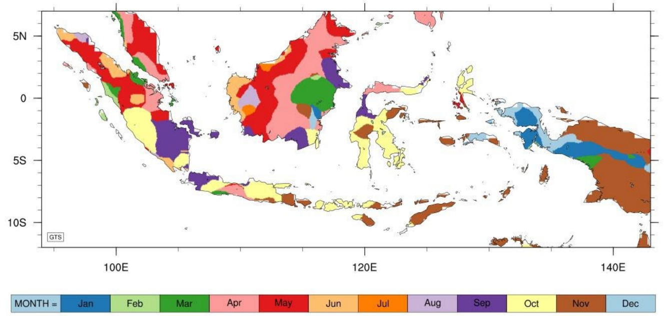
Month with Maximum Temperature (Climatology) - 1986-2005



Multi-model ensemble

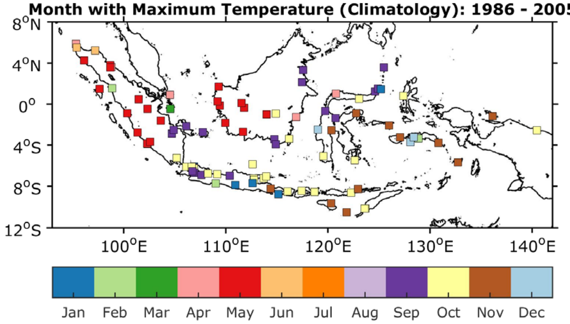


ERA5 observation

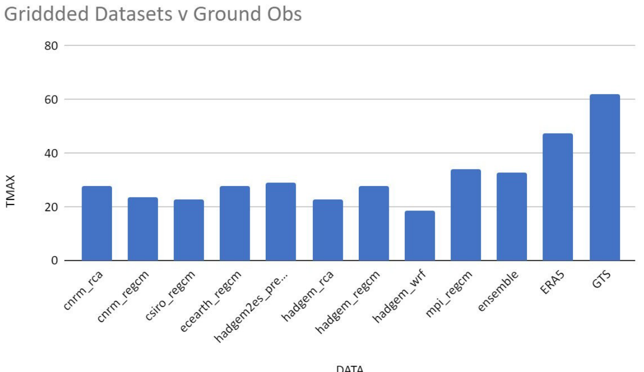


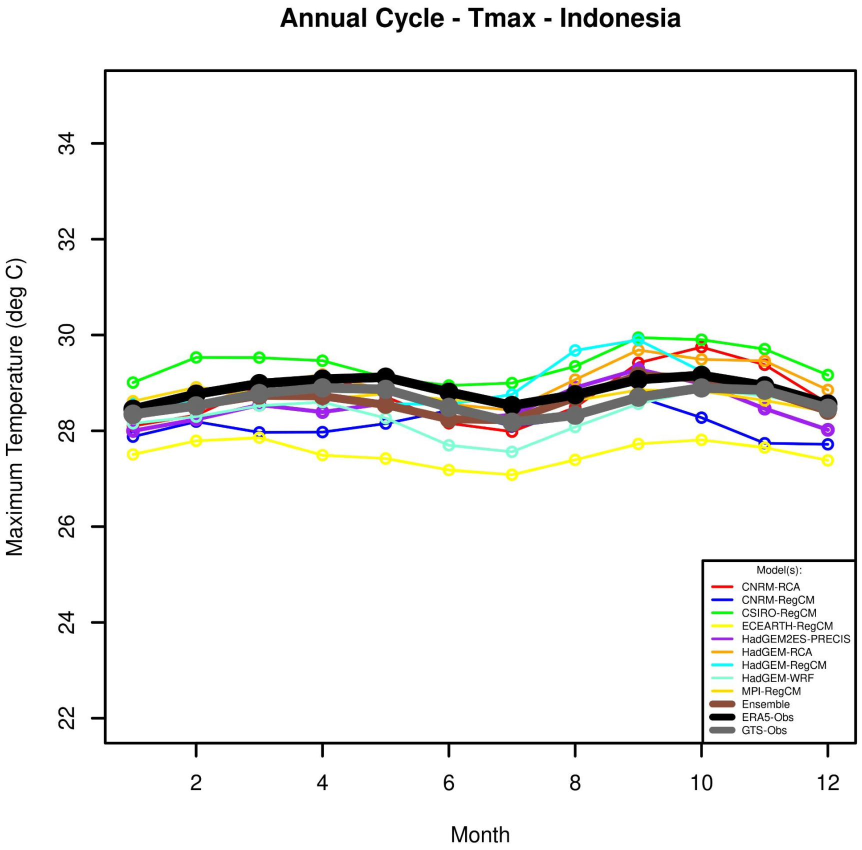
GTS observation

Month with Maximum Temperature (Climatology): 1986 - 2005



Ground observation



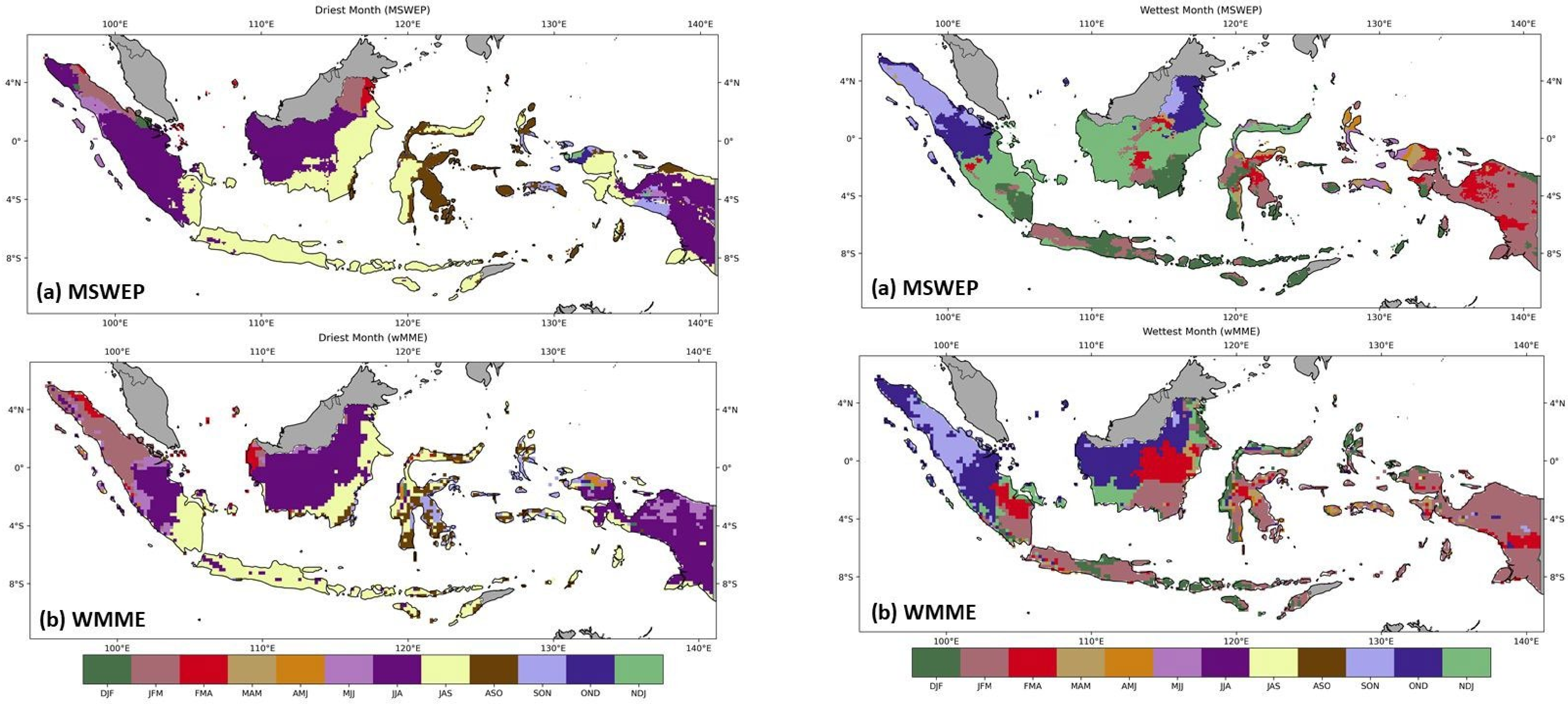


>Model simulations shows a relatively low capabilities in replicating the spatial coverage of temperature compared to gridded obs. data

>Model simulations have good performance in representing the annual cycle based on (monthly average)

>Both models and gridded observation data has a rather low similarities with ground observation data in terms of spatial variability

MODEL VALIDATION for Rainfall



Observation (MSWEP) vs Model (WMME) for driest and wettest season

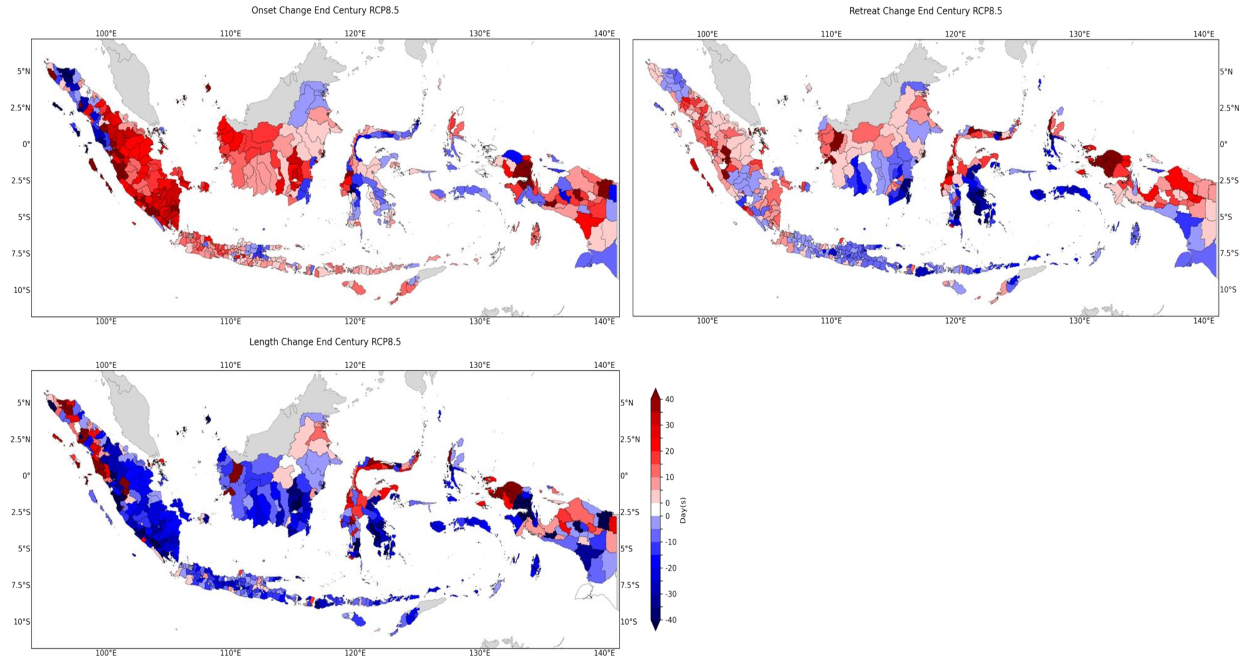
Projection

MONSOON ONSET

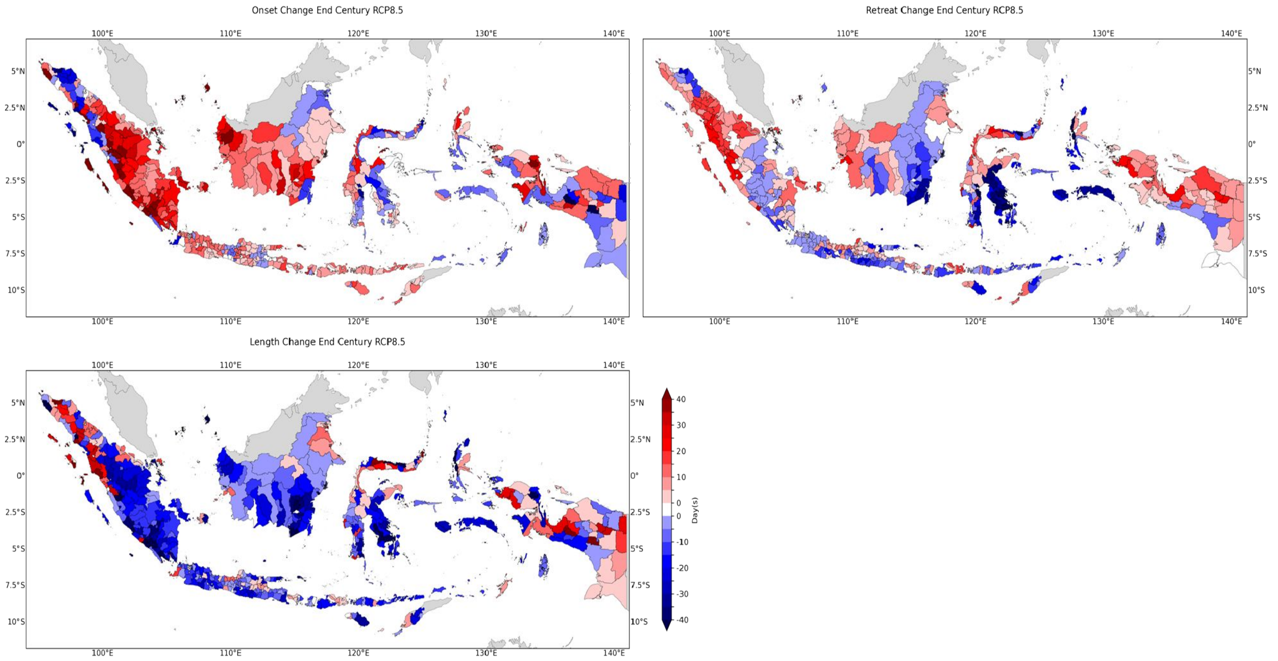
Monsoon Onset

1. Calculate daily climatology for each individual models.
2. Make *Weighted MME* daily climatology prec, based on Skill Score (Taylor 2001) from annual data between *MSWEP (obs)* and models.
3. Averaging climatological precipitation for each regency/district.
4. Find onset and retreat for each regency/district, using cumulative anomaly method from Liebmann (2012).
5. Changes = onset/retreat date on projection period *minus* historical period
6. Also defined is “changes in monsoon length/duration”.

Ref: 1986-2005

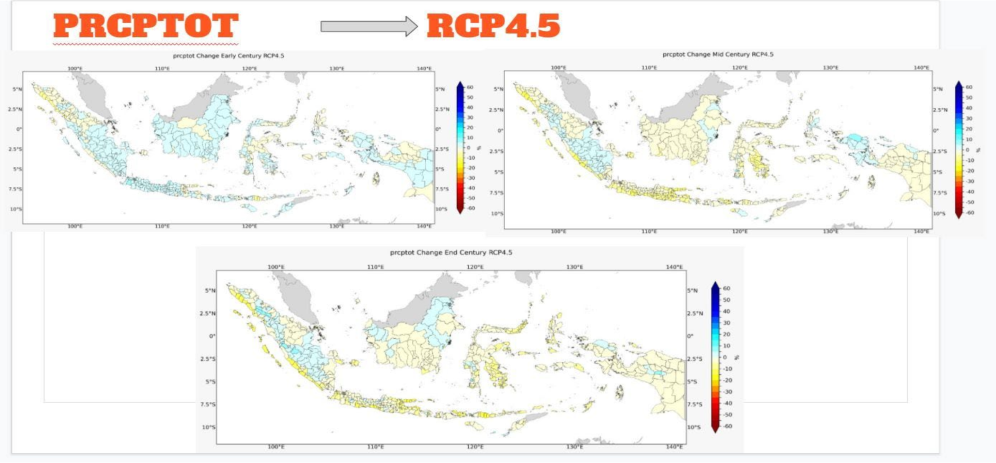


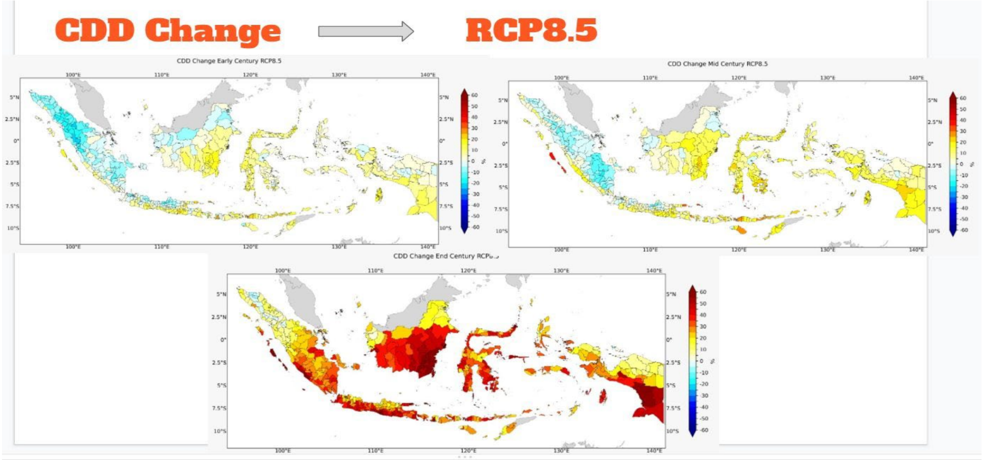
Ref: 2001-2020
(2006-2020 from RCP8.5 run)

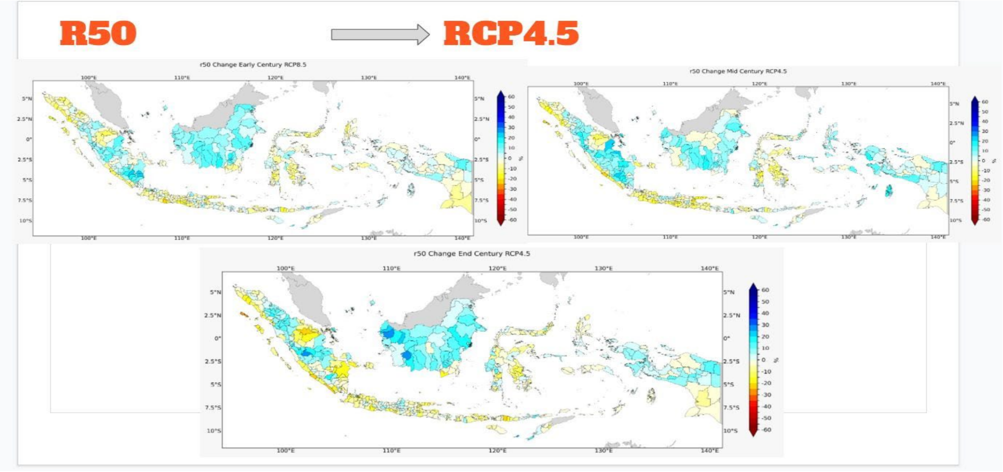


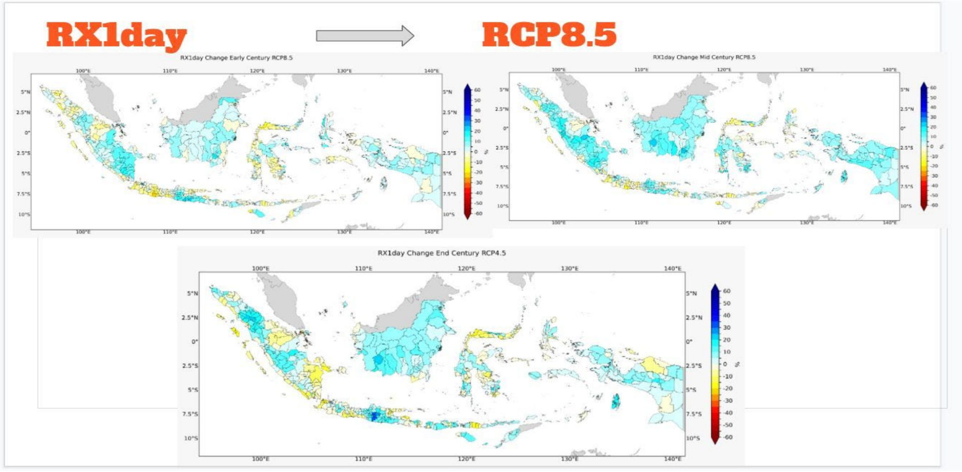
EXTREME INDICES

Support for other groups

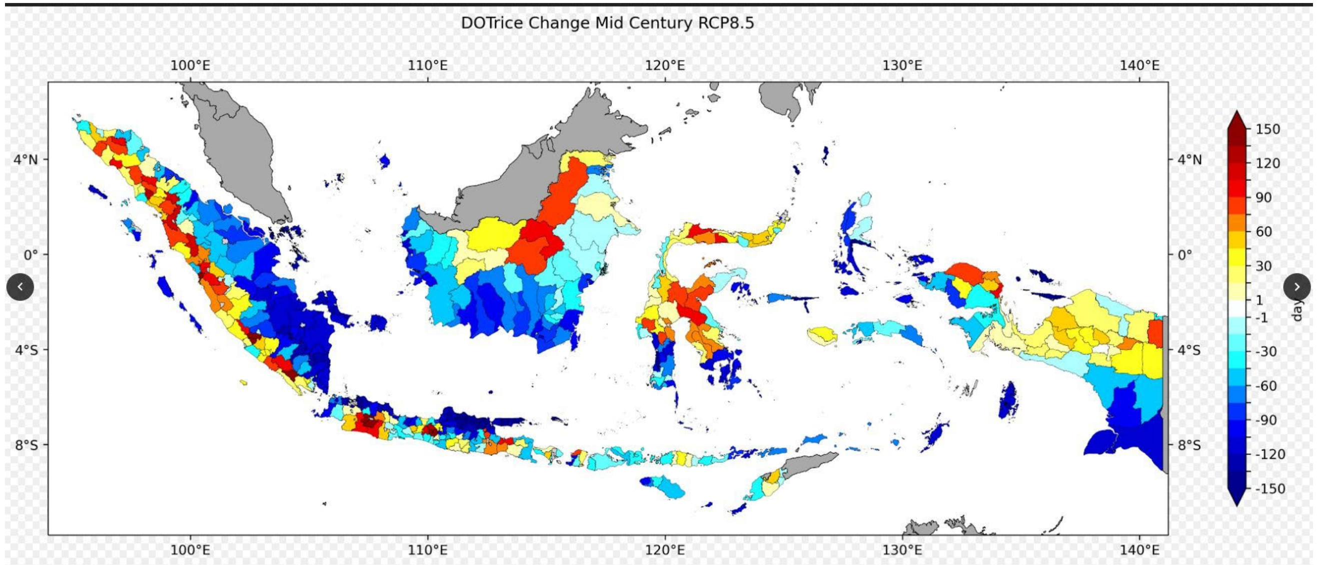




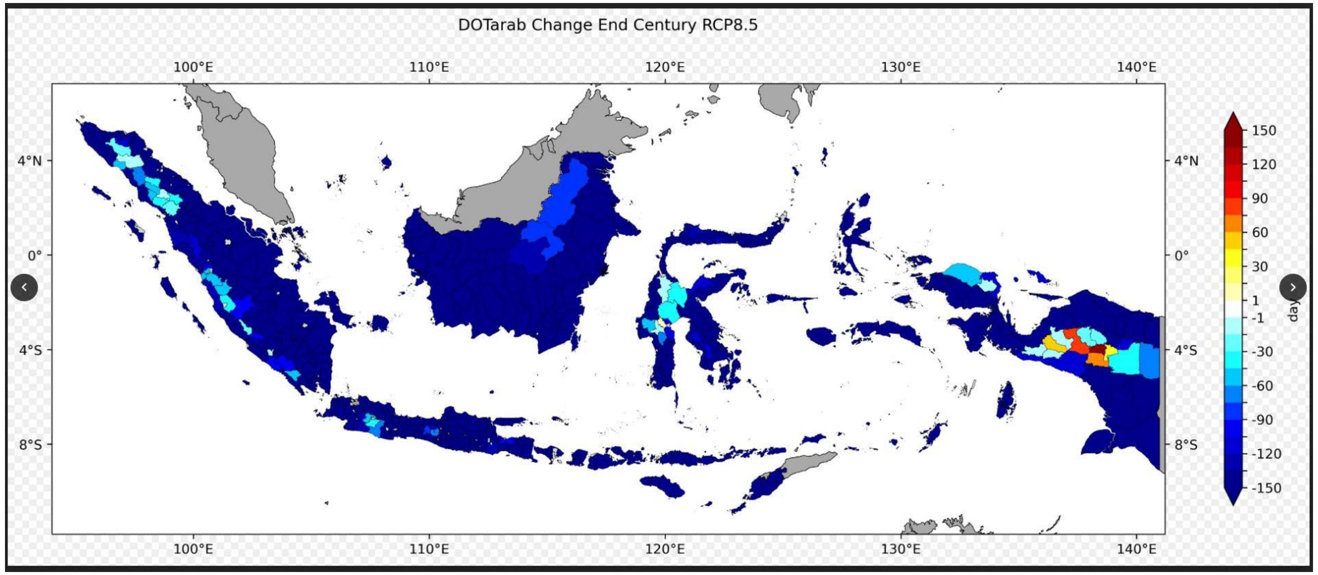




CROP RELATED INDICES - OPTIMUM DAYS



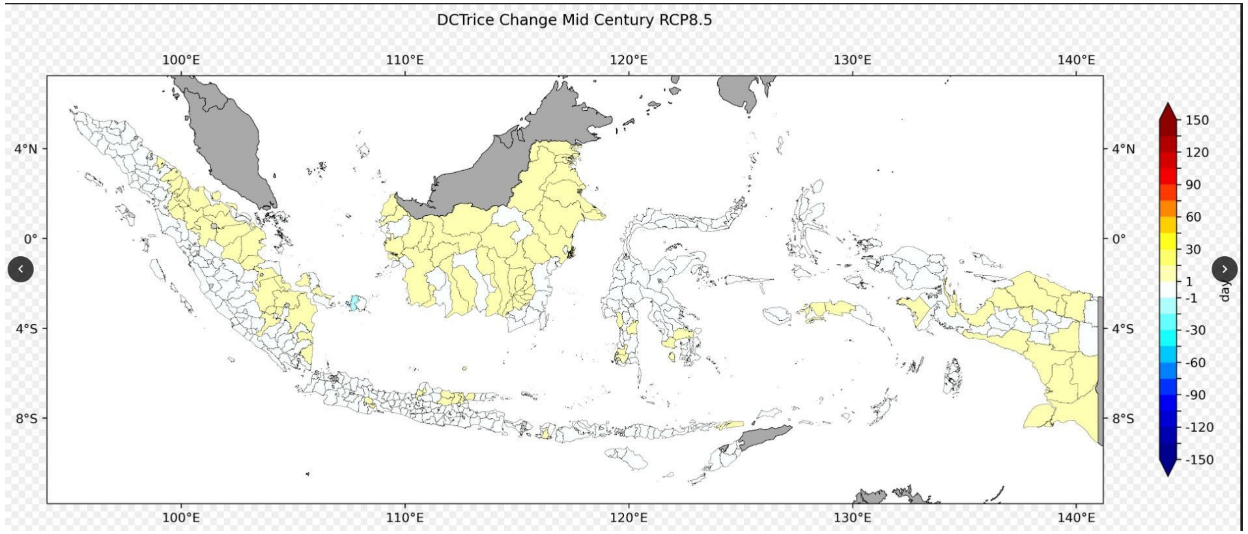
Optimum-Mid-8.5-Rice



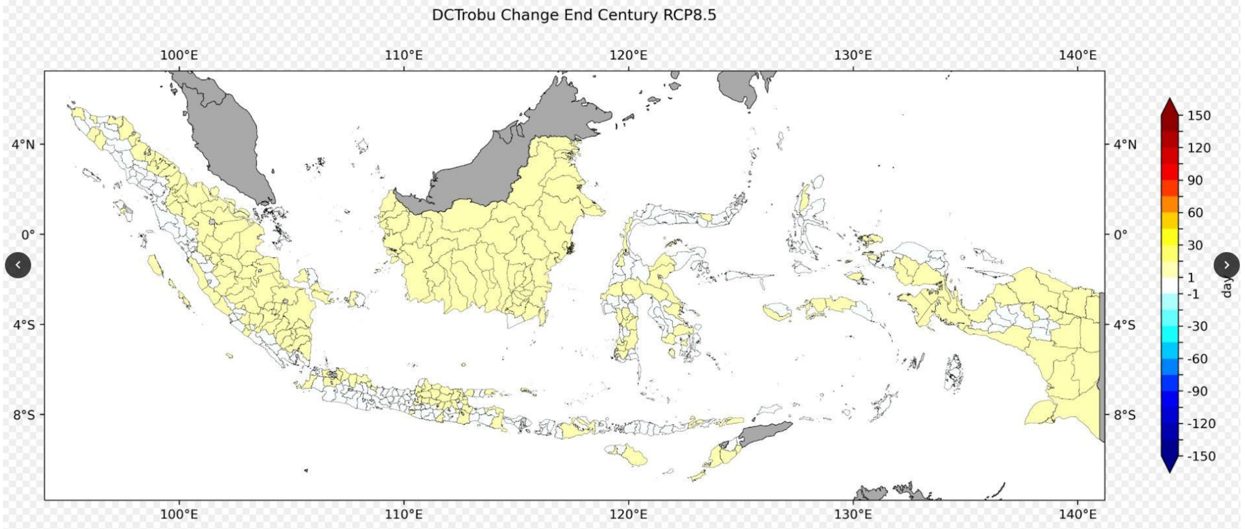
Optimum-End-8.5-Arabica

	Kab	DOTarab	DCTarab	DOTrice	DCTrice	DOTrobu	DCTrobu	tx	tn	tm
1	Kab	DOTarab	DCTarab	DOTrice	DCTrice	DOTrobu	DCTrobu	tx	tn	tm
2	Aceh	-32.6934	0.000736	22.75875	0	-16.5638	0	1.113654	0.832608	0.953104
3	Bali	-52.1715	0	7.658467	0	-65.6678	0	0.957594	1.015432	0.918387
4	Banten	-66.0069	0	-19.3468	0	-58.5537	0	1.110708	0.653971	0.795902
5	Bengkulu	-26.9698	0	40.97279	0	-18.714	0	1.146342	0.583541	0.829621
6	DKI Jakarta	-62.4202	0	-68.3216	0	-15.7297	0	1.270294	0.693586	0.688244
7	stimewa Yo	-50.8665	0	-5.84511	0	-58.0194	0	0.727251	0.853876	0.71481
8	Gorontalo	-39.4682	0	47.69721	0	-63.2197	0	1.179744	1.143823	1.142784
9	Jambi	-64.8031	0.000172	-22.1813	0	-23.9105	0	1.101216	0.581216	0.893448
10	Jawa Barat	-30.9214	0	25.39444	0	-35.9731	0	1.308961	0.7799	0.823381
11	awa Tenga	-46.8602	0	-1.58698	0	-53.4145	0	1.223775	0.744326	0.78567
12	Jawa Timur	-54.3519	-3.6E-05	-8.95805	-0.00016	-52.2587	-0.00016	1.203193	0.745003	0.896645
13	imantan Ba	-39.3811	0.000198	0.119404	0	-64.8715	0	0.860287	0.568525	0.79163
14	nantan Sel	-71.095	0.001476	-43.317	0	-72.6072	0	1.220736	0.662507	0.994
15	nantan Ter	-64.8431	0.015306	-24.639	7.33E-05	-68.898	0	1.154686	0.568911	1.010517
16	mantan Ti	-34.8275	-0.00021	8.466643	-0.00014	-71.5185	-8.9E-05	1.025341	0.630137	0.897367
17	mantan Ut	-23.204	0	26.80696	0	-18.1377	0	0.998785	0.609642	0.890168
18	an Bangka	-101.504	-0.00018	-69.3832	-0.00018	-30.2184	-0.00012	1.055463	0.729752	0.874217
19	pulauan Ri	-74.172	0	-63.9414	0	-18.2585	0	0.690654	0.813146	0.677777
20	Lampung	-78.2667	-0.00012	-30.3746	0	-45.406	0	1.081141	0.637941	0.903131
21	Maluku	-77.1344	0.00016	-29.58	0.000142	-61.7657	0	1.222371	0.965036	1.04542
22	laluku Uta	-71.339	0	-42.3481	0	-62.5107	0	1.111959	1.11532	1.023567
23	Tenggara	-64.8868	0	-3.45467	0	-73.5544	0	1.1251	0.992092	1.026417
24	Tenggara T	-59.2039	0	-9.61967	0	-55.7568	0	0.996031	0.874985	0.894997
25	Papua	-37.774	0.017636	-9.28517	0.000687	-32.2969	-1.2E-05	1.129294	0.741474	0.998712
26	Papua Bara	-44.4227	0.006771	0.141647	9.29E-05	-49.7327	0	1.011335	1.001599	0.986347
27	Riau	-67.0765	0.000397	-36.8795	0	-62.3338	0	0.901118	0.639646	0.837826
28	lawesi Bar	-37.6438	0	26.09213	0	-5.52172	0	1.140285	0.678699	1.036361
29	awesi Sela	-48.6985	-0.00011	-1.93846	-4.8E-05	-26.7022	-4.8E-05	1.180154	0.796403	0.984361
30	awesi Teng	-36.0994	0.000332	33.66597	0	-33.6627	0	1.253483	1.013341	1.132386
31	wesi Teng	-65.5329	-0.00051	-9.13419	-0.00044	-47.552	-0.00018	1.236166	0.895198	1.118932
32	lawesi Uta	-59.6702	0.001025	18.49464	0	-106.989	0	1.390351	1.384169	1.384205
33	matera Ba	-52.7936	0.000138	40.44973	0	-41.0457	0	1.340422	1.18586	1.294682
34	natera Sela	-127.984	0.084825	-80.5077	0.000568	-50.9288	3.16E-05	1.54786	1.087006	1.489318
35	matera Uta	-57.223	0.079066	13.93829	0.001301	-30.3136	0	1.347946	1.264499	1.361002

CROP RELATED INDICES - CRITICAL DAYS



Critical-Mid-8.5-Rice



Critical-End-8.5-Robusta

A	B	C	D	E	F	G	H	I	J
Kab	DOTarab	DCTarab	DOTrice	DCTrice	DOTrobu	DCTrobu	tx	tn	tm
Aceh	-136.144	2.105203	-5.58353	0.413989	-68.2232	0.048531	3.400505	3.126665	3.334732
Bali	-212.318	0.31447	-130.93	0.01217	-154.591	0	3.084865	2.965568	3.003354
Banten	-245.15	3.187356	-216.634	0.317823	-102.732	0.002727	3.180685	2.791467	3.110883
Bengkulu	-145.741	0.060731	37.27378	0.008365	-131.117	0.000324	3.393271	2.649962	3.022999
DKI Jakarta	-169.738	31.30984	-238.763	5.004746	-25.8874	0.089737	3.510853	3.127644	3.506582
stimewa Yo	-230.391	0.043472	-167.17	0.006868	-148.219	0.001262	3.15573	2.748365	2.942956
Gorontalo	-170.602	0.307008	-22.6915	0.008689	-194.8	0	3.395694	3.361255	3.286288
Jambi	-191.281	8.689357	-119.85	2.269145	-71.1488	0.347314	3.380195	2.970134	3.273181
Jawa Barat	-172.28	5.771106	-51.0394	0.942063	-139.792	0.040824	3.581967	2.949816	3.307156
awa Tenga	-214.978	5.59457	-150.69	1.08231	-141.246	0.081921	3.532676	2.941663	3.255667
Jawa Timur	-204.535	7.744669	-147.072	1.579654	-131.425	0.109922	3.518924	3.012952	3.322899
imantan Ba	-193.738	6.828395	-115.412	2.093069	-182.684	0.411851	3.065722	2.973855	3.095819
nantan Sel	-228.996	6.890108	-203.68	1.369941	-135.871	0.18226	3.529496	3.099971	3.286935
nantan Ter	-213.543	10.92717	-149.443	2.380447	-151.174	0.314647	3.415966	2.875446	3.273844
mantan Tir	-186.666	3.055425	-70.0049	0.655174	-185.816	0.10448	3.314428	2.910944	3.176253
mantan Ut	-135.135	1.650685	42.57224	0.31158	-102.578	0.043769	3.258753	3.119744	3.291413
an Bangka	-246.879	1.771794	-272.383	0.072444	-35.7874	0.001793	3.167212	2.946682	3.0293
pulauan Ri	-211.836	0.422271	-270.287	0.019709	-23.1456	0	2.697326	2.858979	2.723631
Lampung	-222.621	3.492622	-183.618	0.301706	-103.201	0.009218	3.5328	2.837196	3.255632
Maluku	-220.085	0.830527	-187.323	0.035234	-114.624	0.001186	3.22462	3.153783	3.132809
Maluku Uta	-218.293	0.659251	-212.096	0.089965	-114.518	0.003137	3.091262	3.092557	3.032391
Tenggara	-231.95	0.605934	-161.356	0.023946	-148.08	0.000704	3.309053	3.06871	3.202303
Tenggara T	-212.713	1.952943	-154.458	0.239818	-135.566	0.009204	3.319366	3.013001	3.192163
Papua	-135.314	9.894094	-79.2234	2.28709	-89.4157	0.266815	3.255071	3.152653	3.314229
Papua Bara	-175.553	1.466351	-76.2281	0.188991	-128.938	0.017369	3.141227	3.238505	3.168575
Riau	-233.239	8.299687	-203.926	2.363279	-115.1	0.485731	3.029716	3.012021	3.142358
lawesi Bar	-146.938	0.185456	4.787616	0.015544	-40.7898	0.000436	3.405315	2.937175	3.241195
awesi Sela	-152.818	1.608274	-71.7475	0.177634	-57.1151	0.010922	3.445034	3.112499	3.264836
awesi Teng	-144.351	0.920269	1.644425	0.089848	-103.262	0.002944	3.404648	3.213887	3.261745
wesi Teng	-196.087	1.484346	-118.537	0.051511	-113.484	0.001728	3.395366	3.014273	3.27567
lawesi Uta	-59.6702	0.001025	18.49464	0	-106.989	0	1.390351	1.384169	1.384205
matera Ba	-52.7936	0.000138	40.44973	0	-41.0457	0	1.340422	1.18586	1.294682
natera Sela	-127.984	0.084825	-80.5077	0.000568	-50.9288	3.16E-05	1.54786	1.087006	1.489318
matera Uta	-57.223	0.079066	13.93829	0.001301	-30.3136	0	1.347946	1.264499	1.361002

DATA PREPARATION FOR OTHER GROUPS

Waktu			Resolusi Temporal	Resolusi Spasial	Model	Parameter (Format)		
Baseline (1991-2020)	1991-2005	Historical Run	Bulanan	0.25 Derajat	Ensemble Mean	Hujan (CSV)	Suhu Max (NC)	Suhu Min (NC)
	2006-2020	RCP8.5	Bulanan	0.25 Derajat	Ensemble Mean	Hujan (CSV)	Suhu Max (NC)	Suhu Min (NC)
Future (2021-2100)	2021-2100	RCP4.5	Bulanan	0.25 Derajat	Ensemble Mean	Hujan (CSV)	Suhu Max (NC)	Suhu Min (NC)
		RCP8.5	Bulanan	0.25 Derajat	Ensemble Mean	Hujan (CSV)	Suhu Max (NC)	Suhu Min (NC)

https://bit.ly/3sAmN8O

My Drive > LAPORAN EKSTERNAL > TMin

Name ↑

- tn-allyears-base-monthly-sMME.nc
- tn-allyears-base-monthly-wMME.nc
- tn-allyears-rcp45-monthly-sMME.nc
- tn-allyears-rcp45-monthly-wMME.nc
- tn-allyears-rcp85-monthly-sMME.nc
- tn-allyears-rcp85-monthly-wMME.nc

My Drive > LAPORAN EKSTERNAL > TMax

Name ↑

- tx-allyears-base-monthly-sMME.nc
- tx-allyears-base-monthly-wMME.nc
- tx-allyears-rcp45-monthly-sMME.nc
- tx-allyears-rcp45-monthly-wMME.nc
- tx-allyears-rcp85-monthly-sMME.nc
- tx-allyears-rcp85-monthly-wMME.nc

My Drive > LAPORAN EKSTERNAL > CH Bulanan Untuk Pak Per

Name ↑

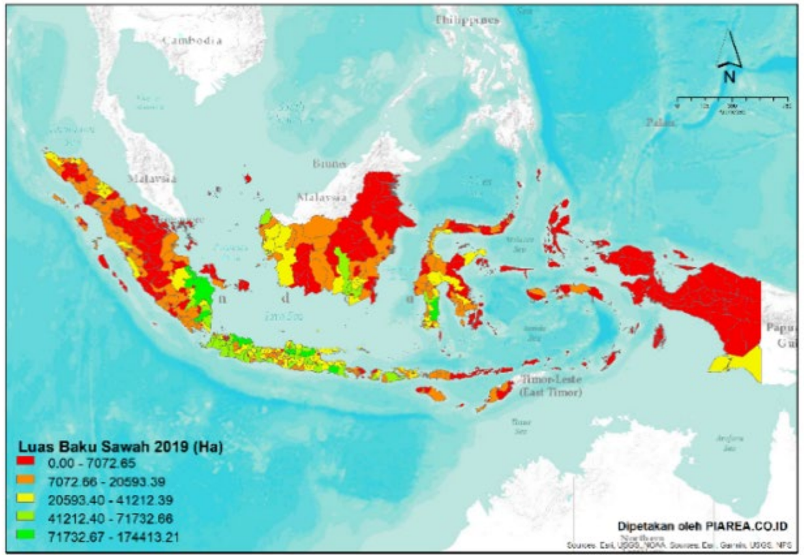
- wMME_hist.xlsx
- wMME_rcp45.xlsx
- wMME_rcp85.xlsx

https://bit.ly/3Ln1nVo

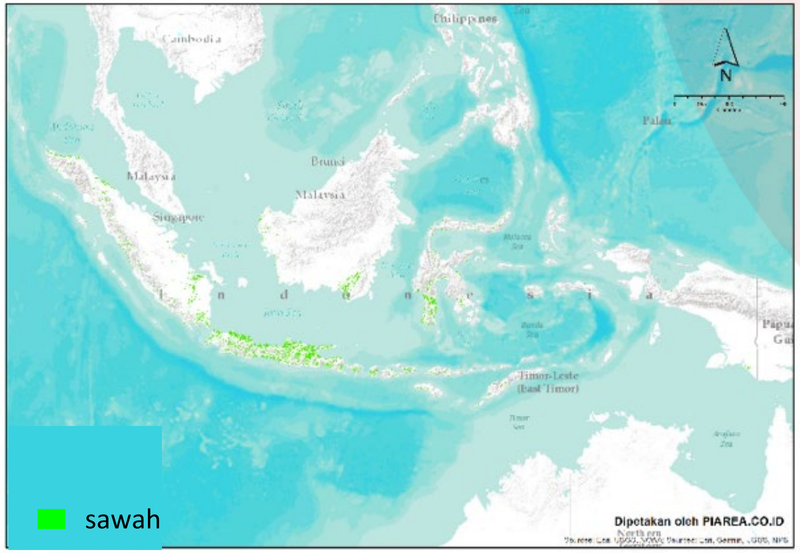
https://bit.ly/3LqCbx5

Goal

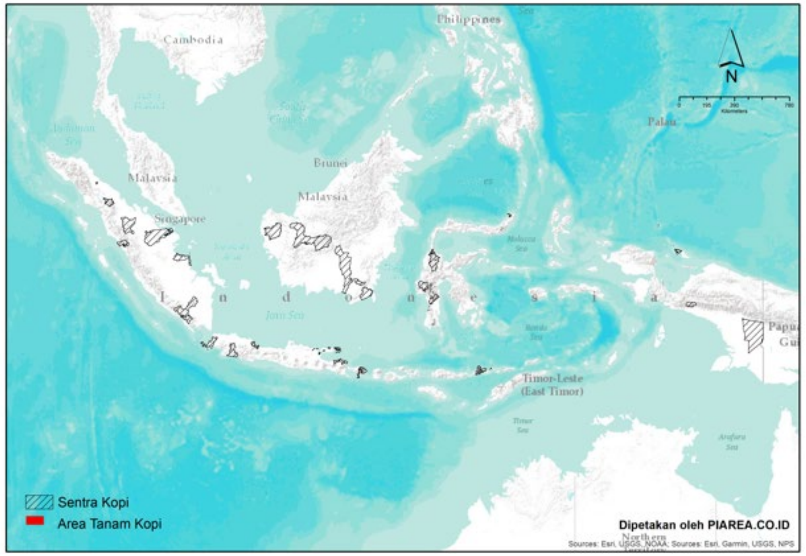
Analysis Area



(a) Rice field area map, 2019 (ha)



(b) Land distribution map, 2019

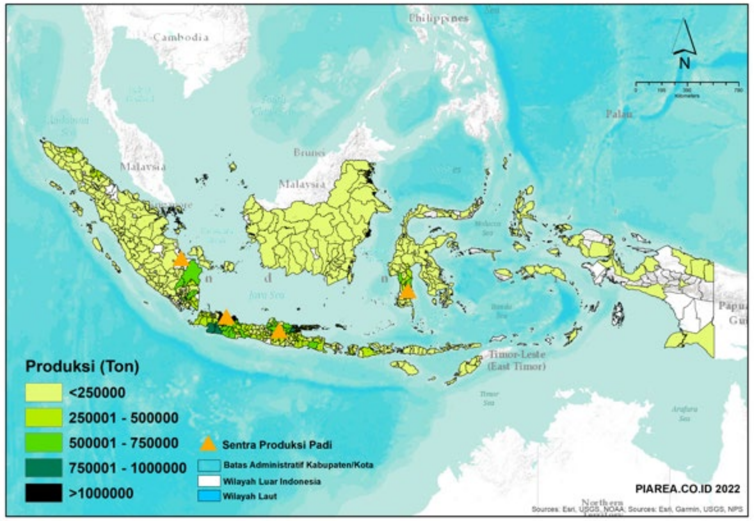


(c) Coffee field distribution map, 2019

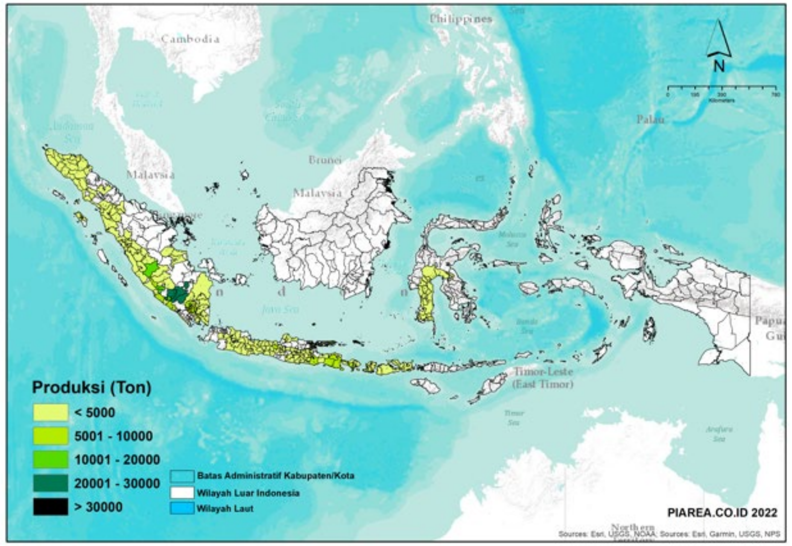
Source : Kementan Rest Service, 2022

Goal

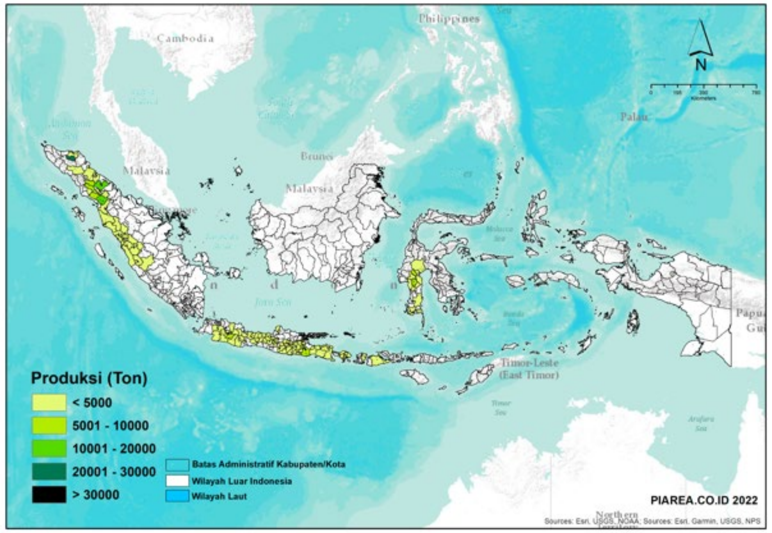
Analysis Area



(d) Paddy production map, 2020 (ton)



(e) Robusta production map, 2020 (ton)

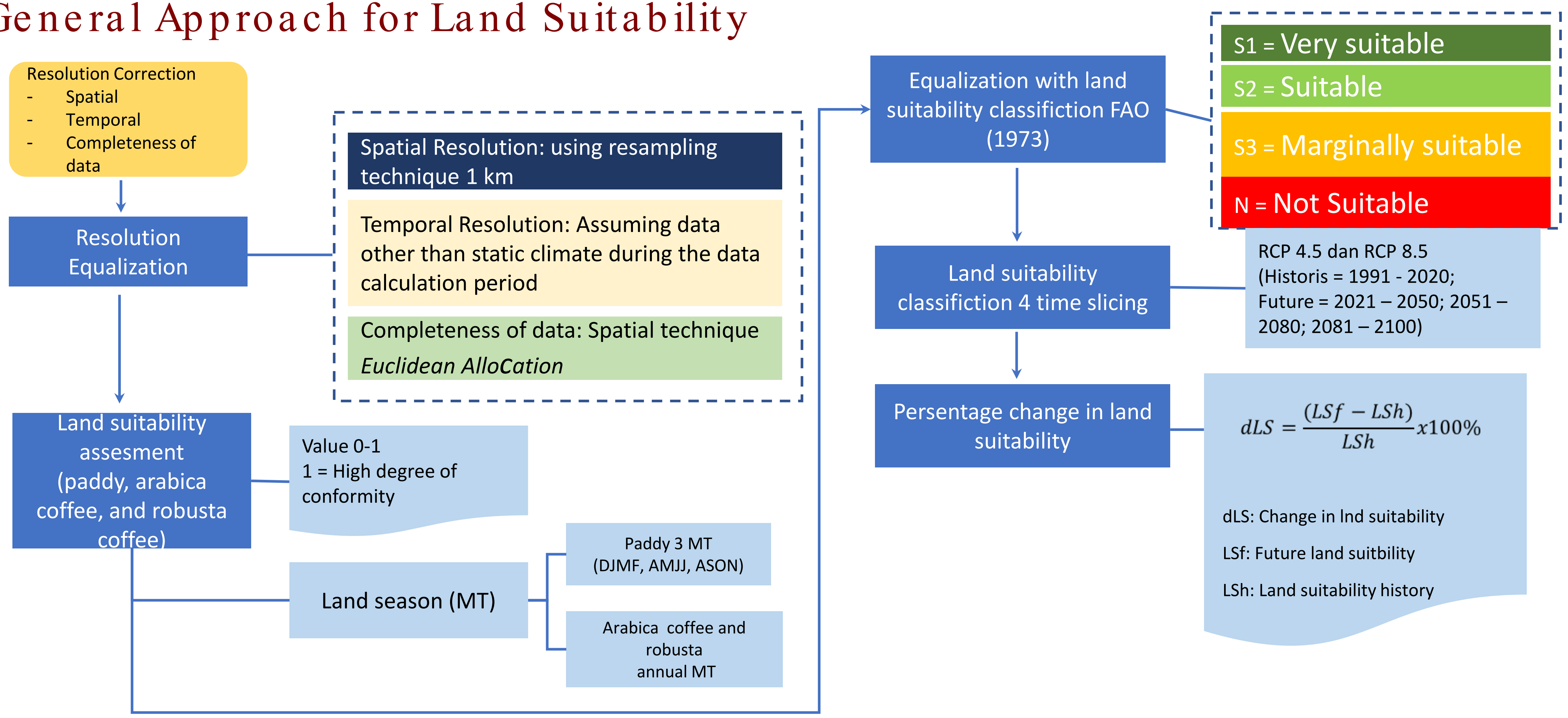


(f) Arabica production map, 2020 (ton)

Source: BPS Dalam Angka, 2020

GENERAL APPROACH AND METHODOLOGY

General Approach for Land Suitability



PRODUCTIVITY ESTIMATION MODELING

Coefficient Productivity Estimation Modeling

$$Y = \alpha + \beta_1 * CH + \beta_2 * CH\ Kuadratic + \beta_3 * Tmean + \beta_4 * Tmean\ Kuadratic + \varepsilon\ (faktor\ koreksi)$$

Modeling is carried out using a Fixed Effect Model on productivity in year 2015 - 2020 (paddy) dan 2016 - 2020 (Arabica dan Robusta)

Coefficient	Paddy	Arabica	Robusta
Constant	4.715262	-1.843466	-1.343464
Rainfall	0.0004857	0.0001046	0.0000688
Rainfall quadratik	-0.0000000923	-0.0000000158	-0.00000000845
Average air temperature	0.0493533	0.2777177	0.14086
Average air temperature quadratik	-0.0028918	-0.0074677	-0.0027586


RICE
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1.1. Rice in the coastal areas

- Indonesia's vast coastal zones are vulnerable to the effects of sea level rise and salinity. A substantial proportion rice growing areas in Indonesia are located in coastal areas

- We used the scenario of 1 and 2 meter of sea-level rise (SLR-1 and SLR-2), which is set based on RCP 4.5 and RCP 8.5 projection for 2100 (Kopp et al. 2017; Strauss et al. 2021)

- SLR -1 affects the loss of 134,510 ha of rice fields, where 51% is located on the Java Island. This loss of rice field area bring consequences to the loss of rice production up to 976,688 t of unhusked rice.

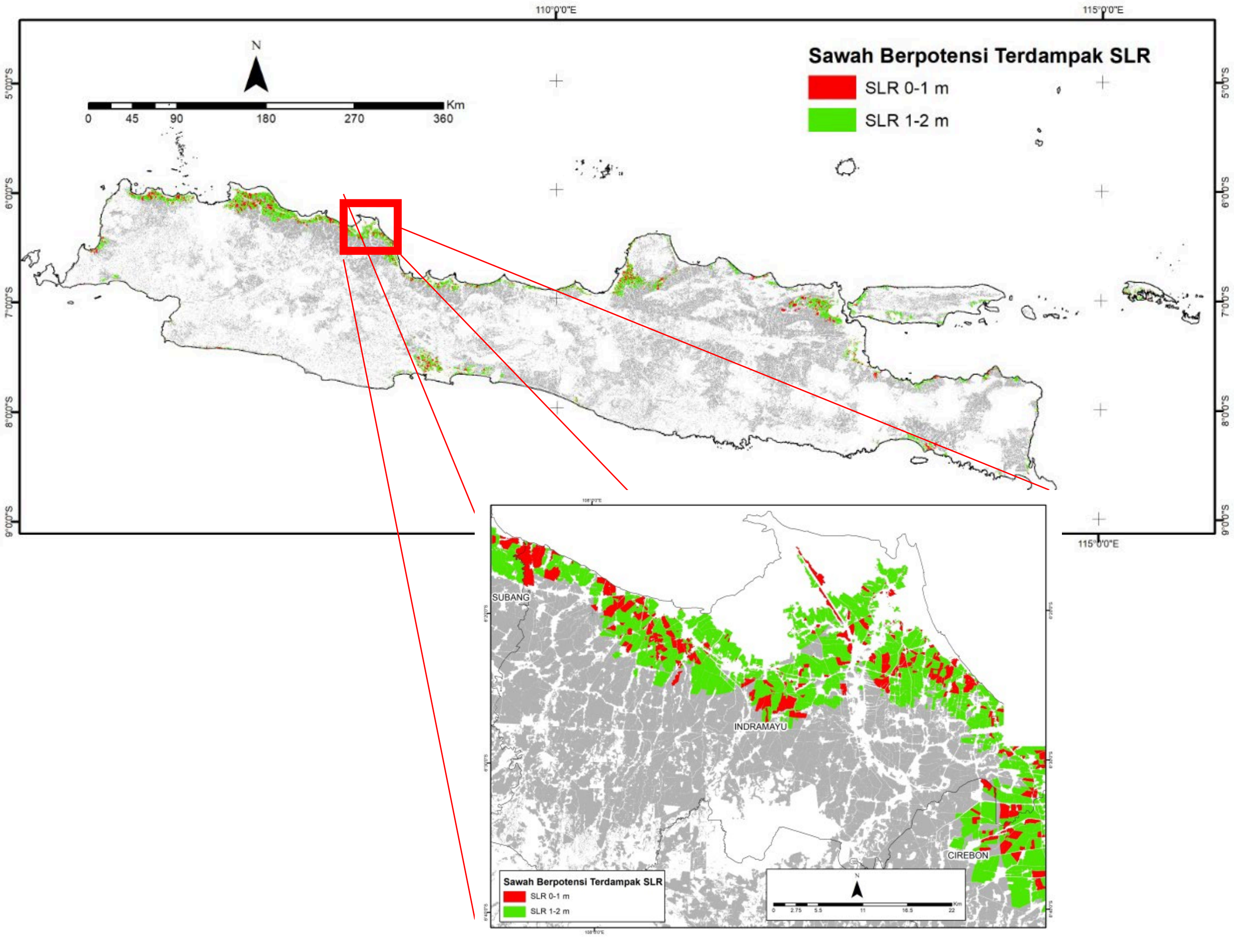


Figure 1. Rice growing area in Java Island affected by SLR-1 and SLR-2

Impact of Increased Salinity due to Seawater Intrusion on Indonesian Rice Production

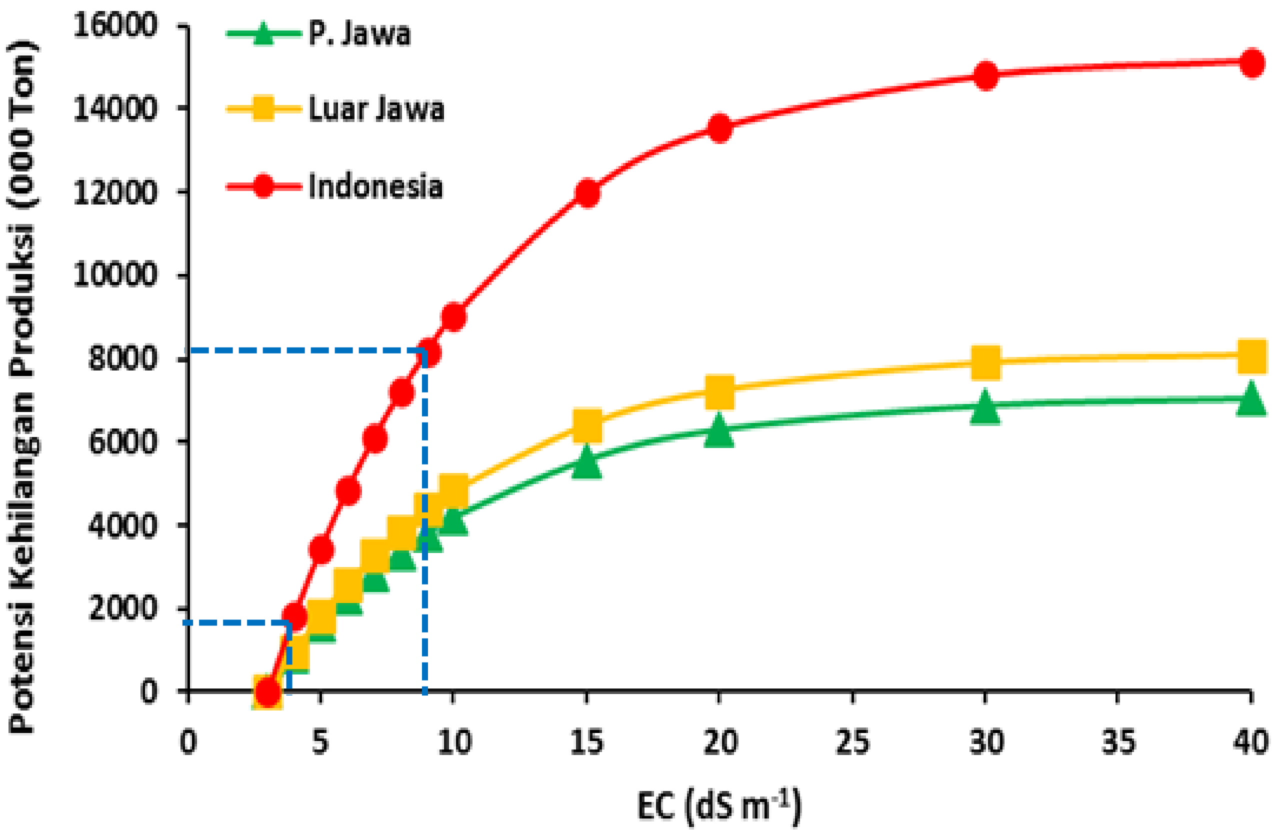


Figure 1. Correlation between EC and rice production loss

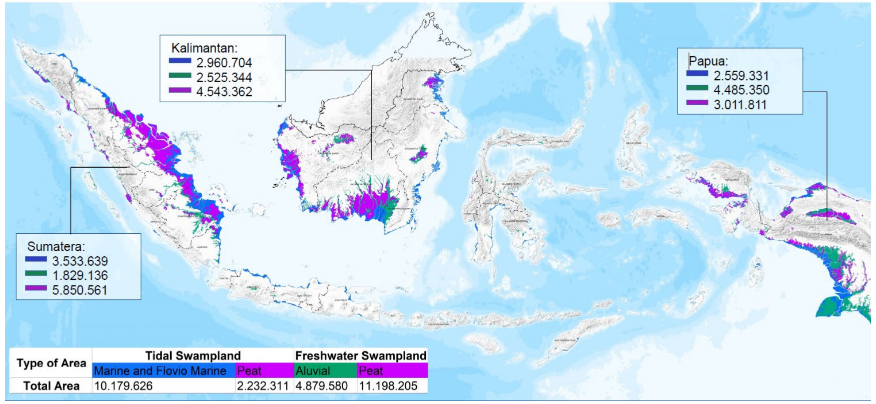
Salinity is expressed by the electric conductivity (EC) unit, while the threshold for rice is 3 dS m^{-1}. The exceeding threshold per 1 dS m^{-1} will pose a rice yield reduction to 12% (Radanielson et al., 2018; Zeng and Shannon, 2000).

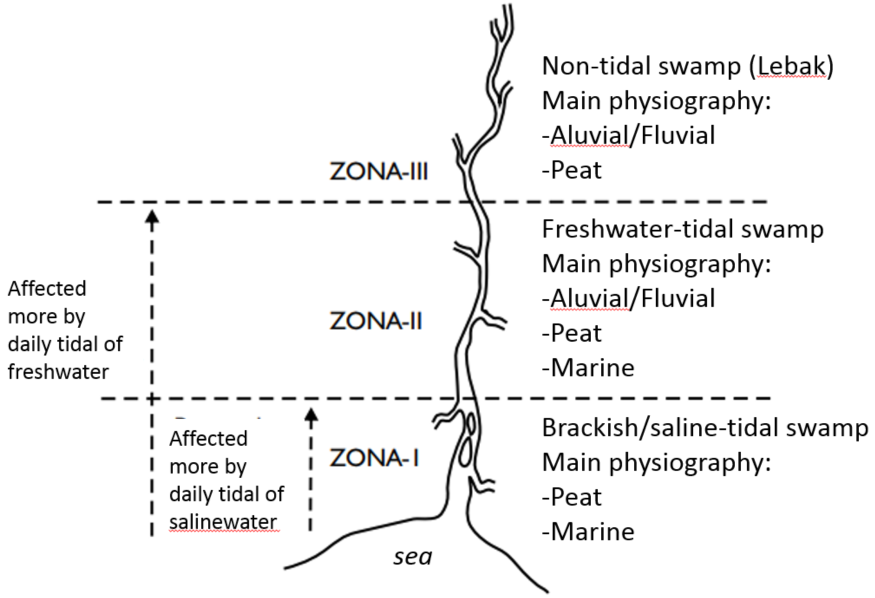
- The scenario of increasing salinity in rice fields within 10 km from coastline → the increase in salinity will have an impact on reducing rice production following a logarithmic function.
- An increased EC up to 4 dS m^{-1} in all coastal rice field causes a loss of 1,835 t of unhusked rice per year, where Java contributed 46.5%.
- An increased EC up to 9 dS m^{-1} in all coastal rice field causes a loss of rice production by 50% of its potential yield or 8,189 t of unhusked rice per year This threatens the sufficiency of rice for 42 million people.

1.2. Rice in swampland

- Changes in rainfall patterns and extreme climatic events due to ENSO are the dominant factors affecting rice and coffee production.
- We used Ocean Nino Index (ONI) $+0.5^{0}$C for El Nino, while La Nina with ONI -0.5^{0}C lasts for five consecutive months to quantify planted area, harvested area, and production for lowland and Swampland rice, lowland and highland coffee at the district level in Indonesia.
- Swamp land is a natural resource partially or throughout the year inundated with water from overflowing rivers or rain. It is very vulnerable to extreme climatic events.
- Heavy rainfall due to La Nina will increase the water level to reduce the available land. On the other hand, during El Niño, there is an increase in planted area due to lower water levels, especially in swamplands.

SWAMPLAND AREA DISTRIBUTION IN INDONESIA





The highest growth in planting area during El Niño reached 82% in Pulang Pisau Regency (Central Kalimantan), which was dominated by swamp land, and Banyuasin Regency (South Sumatra Province) reached 57%, which was dominated by tidal land.

Fig 3. The change of rice planting areas in swampland under El Niño condition

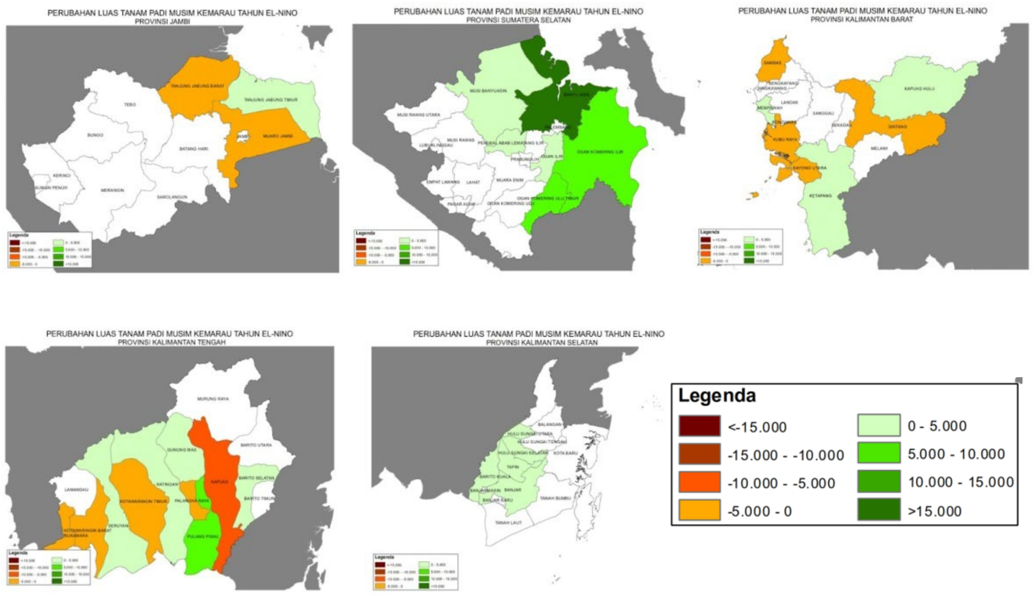
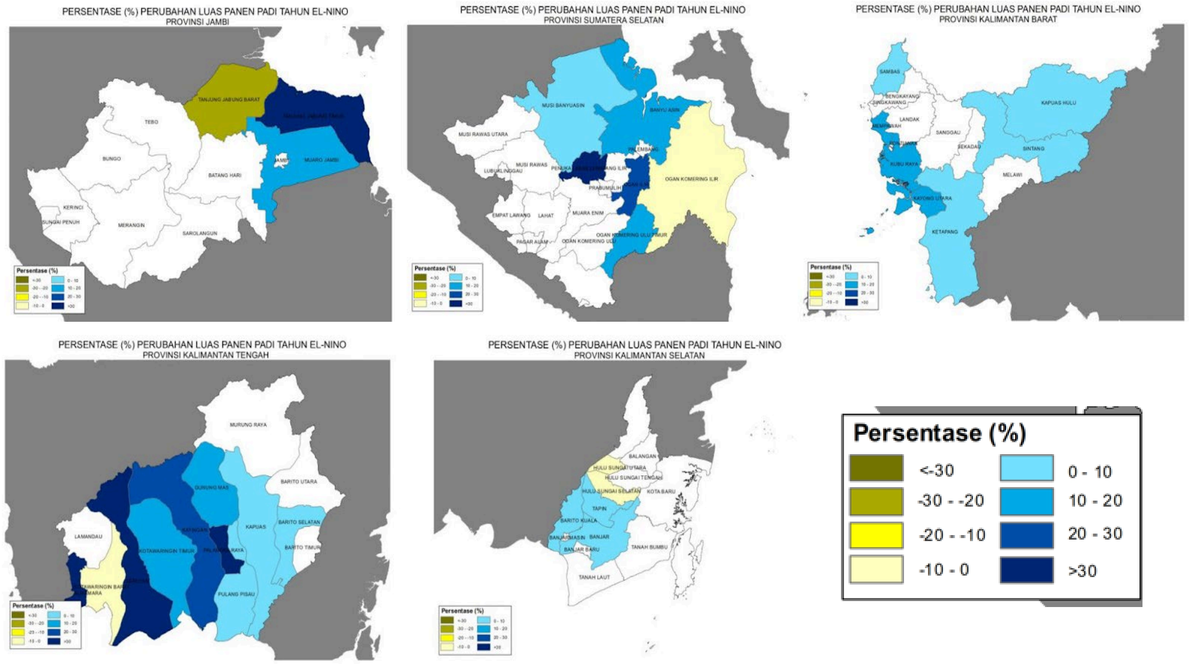


Fig 4. The change of rice harvested areas in swampland under El Niño condition



The increase in harvested area under El Niño condition ranged from 6-20%, the highest being in Tapin Regency (Central Kalimantan), Mempawah Regency (West Kalimantan), Muaro Jambi Regency (Jambi Province), Musi Banyuasin Regency (South Sumatra Province), and Seruyan Regency (South Kalimantan).

1.3. Rice in the rice field

Rice production in Indonesia is highly correlated with the incidence of ENSO.

El Nino correlates with a decrease in rice production due to drought, whereas La Nina in some areas increases production due to an increase in planted area. On the other hand, several districts on the north-coast of West Java and Central Java experienced a decline in production due to flooding.

The results of this study show rice fields affected by drought in El Nino occurred in wet season and dry season. The affected areas are an average of 450,000 hectares, with the highest area reaching more than 800,000 hectares

Fig 5. Anomaly of rice production under El Nino and La Nina condition

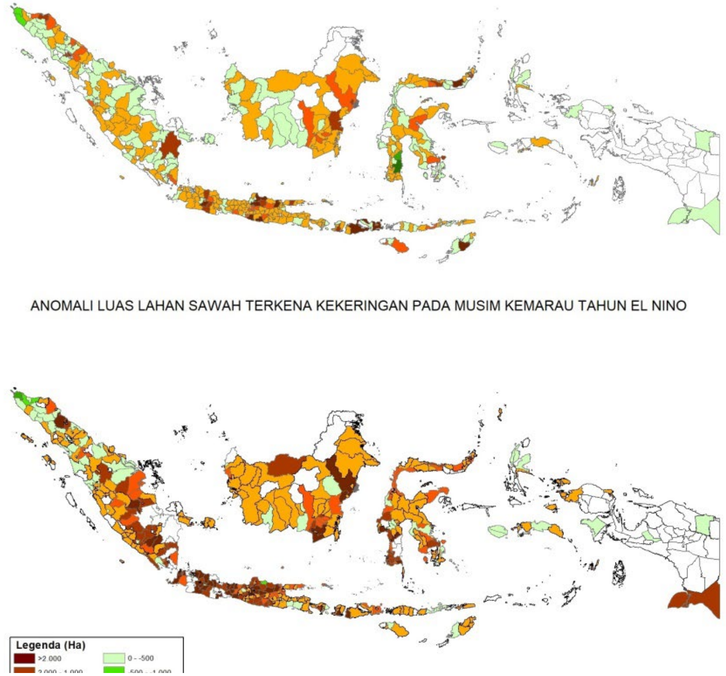


Fig 6. Rice field affected by drought in El Nino

Damage to rice crops in paddy fields due to flooding in La Nina averaged around 145,000 hectares, with the highest area reaching more than 250,000 hectares.

In wet season more districts affected by flooding with higher affected areas

At the time of La Nina, the damage area of rice crops due to the attack of the Brown Planthopper increase sharply. The heavy rainfall and high RH is favorable for BPH reproduction

Fig 7. Rice field affected by flooding in La Nina

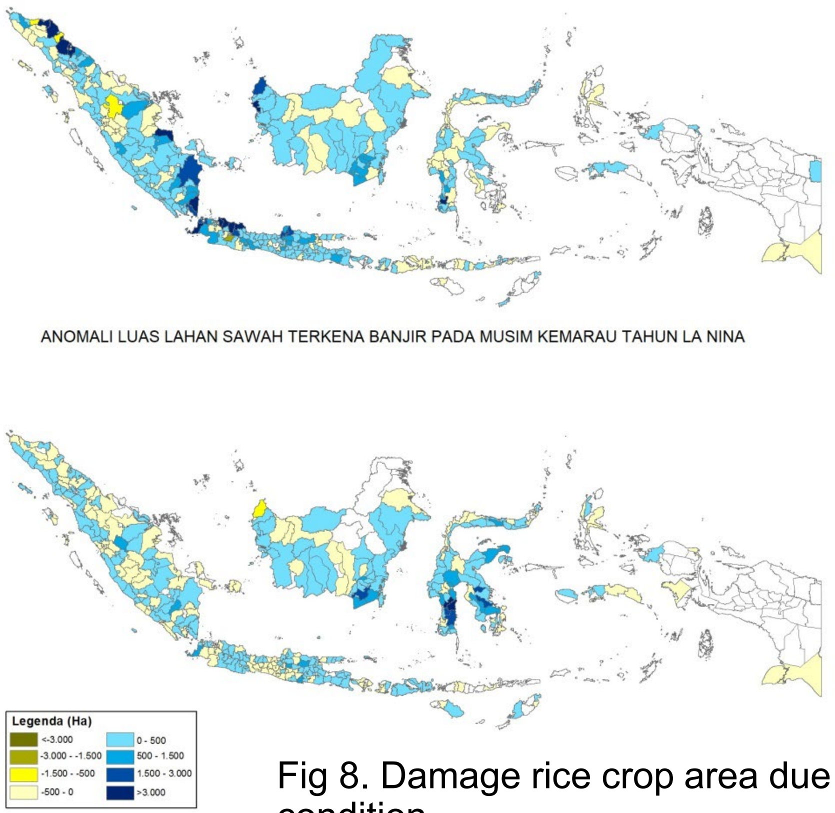
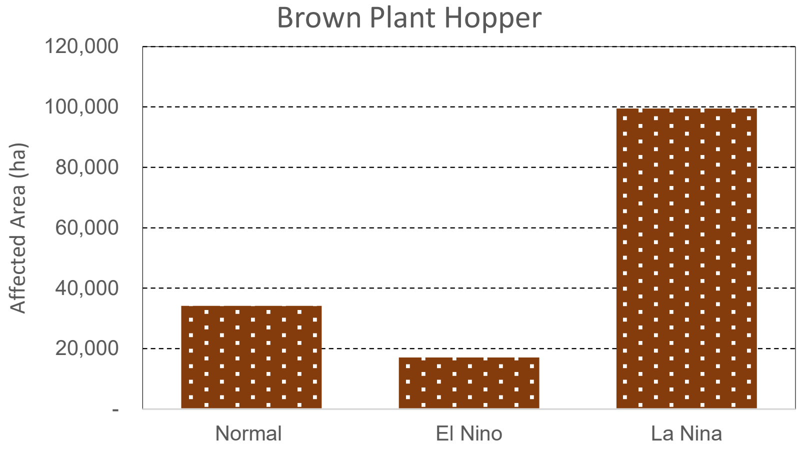


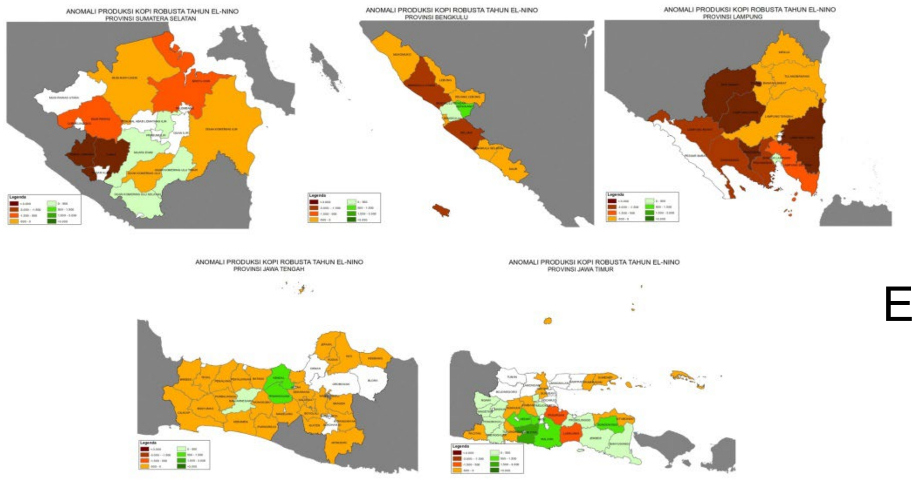
Fig 8. Damage rice crop area due to BPH under ENSO condition



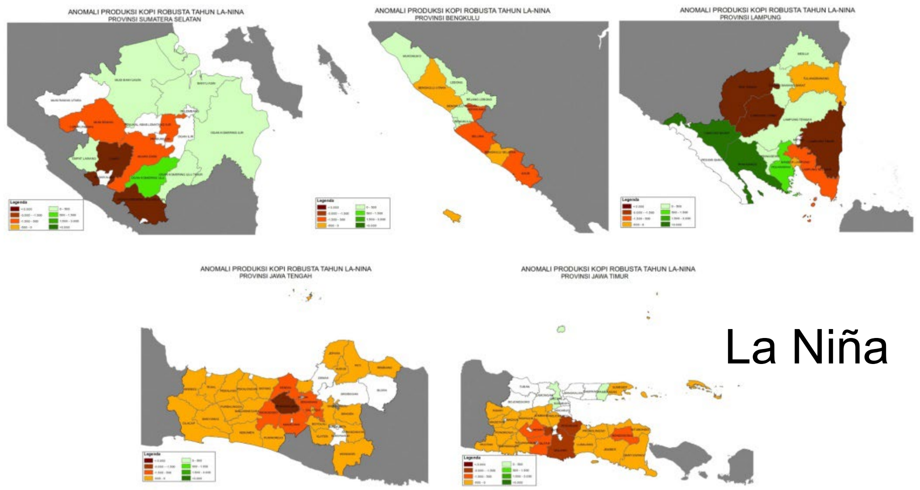

COFFEE
www. /guildfordgardencentre.com.au/

2. Low land and highland coffee

Fig 9. The change of Robusta coffee production in El Nino and La Nina



El Niño



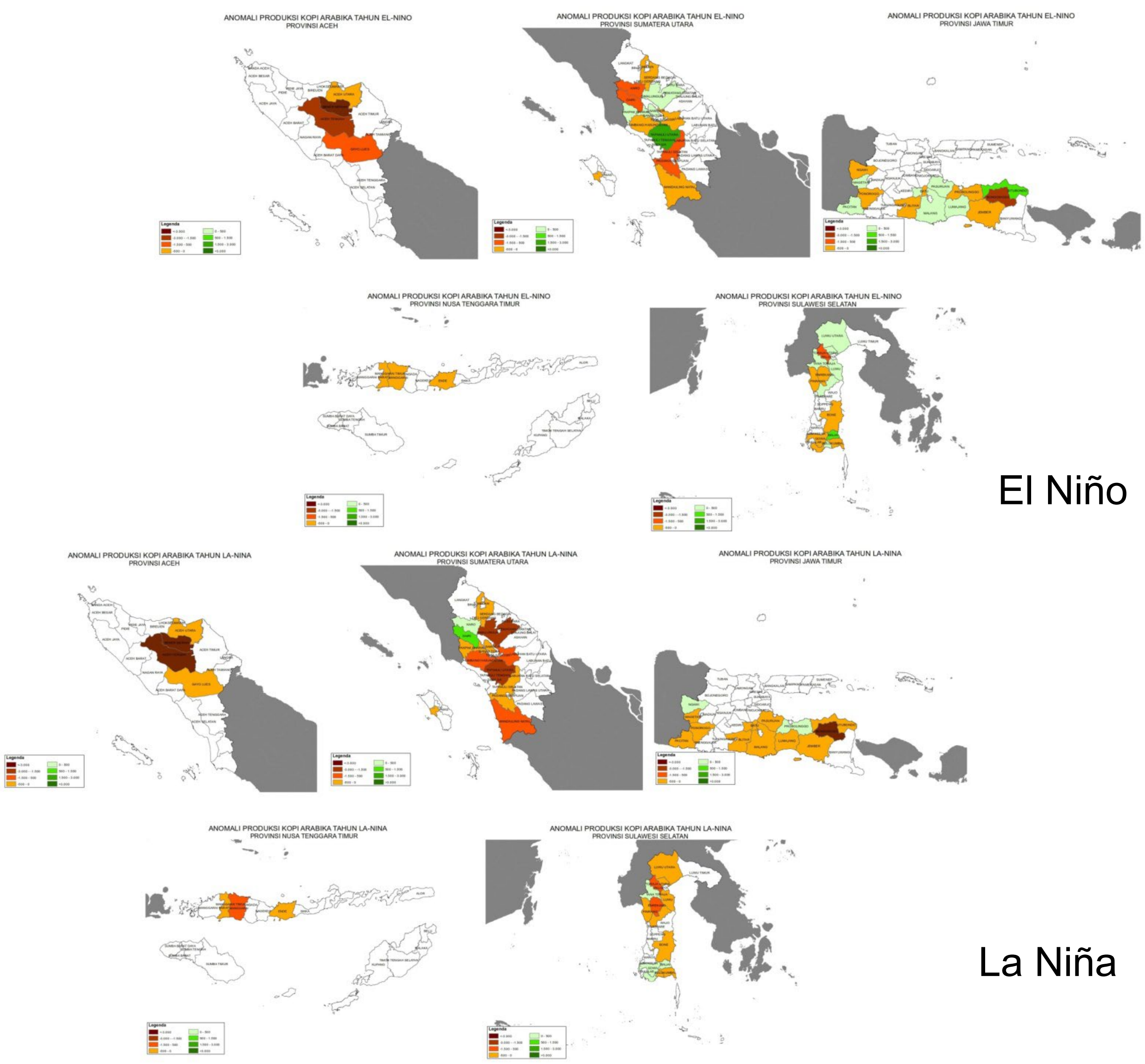
La Niña

- The two dominant types of coffee cultivated are Robusta coffee in the lowlands and Arabica coffee in the highlands.
- The decline in Robusta coffee production during El Niño and La Nina occurred in most of the production centers.
- The highest drop in Robusta coffee production during El Nino occurred in Bengkulu and Lampung Provinces, while during La Nina the highest declines occurred in Central Java and East Java.

Fig 10. the change of Arabica coffee production in El Nino and La Nina

- The impact of El Nino on the decrease in Arabica coffee production is not as high as that of Robusta coffee.

- The impact of La Niña is more significant than El Nino on Arabica coffee production, where almost all Arabica coffee-producing districts experience a decline in production.

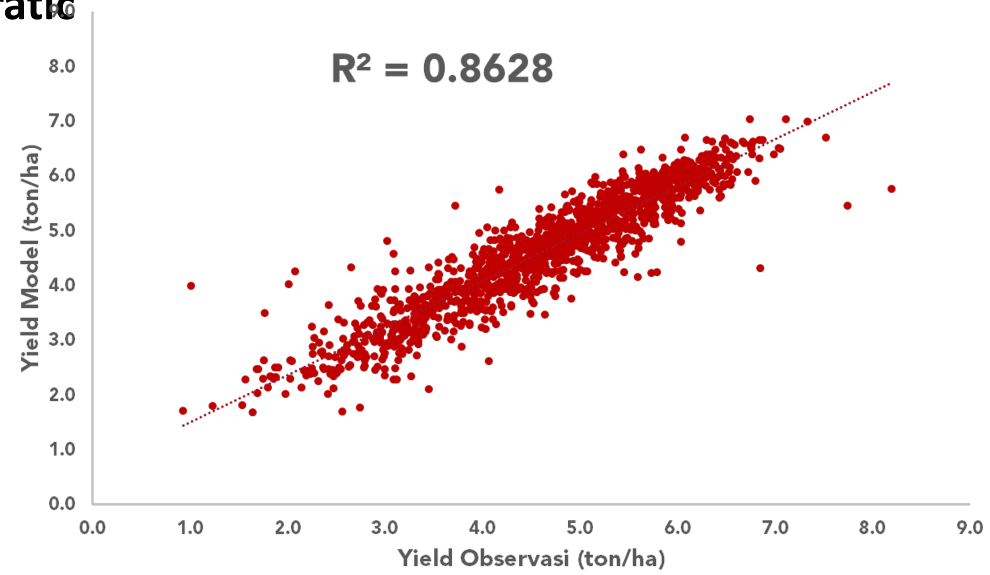


CLIMATE MODEL ANALYSES OF PRODUKTIVITY ESTIMATE

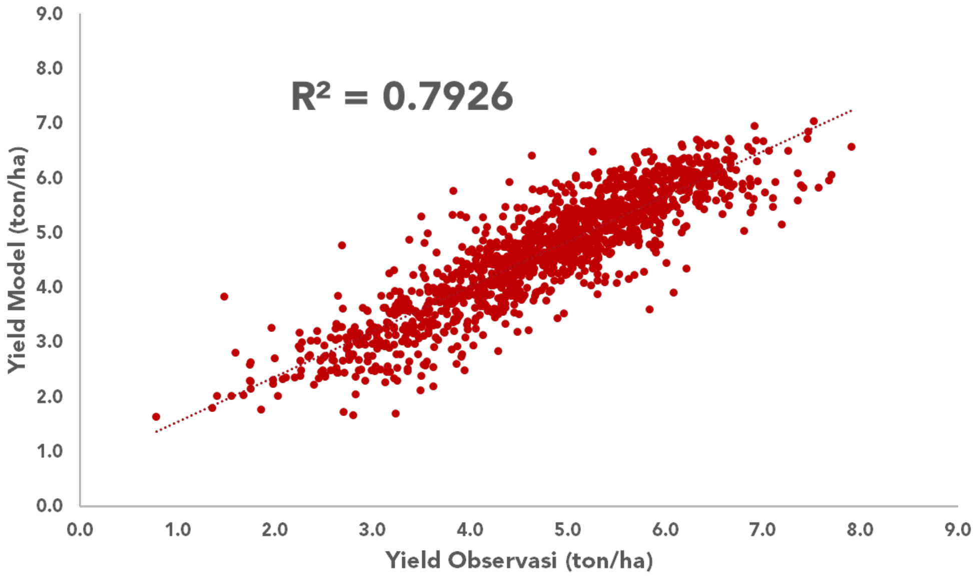
Paddy Productivity estimate model

The model that is used:

Yield = 4.715262 **+** 0.0004857 * **CH** - 0.0000000923 * **CH Kuadratic +** 0.0493533 * **T Rataan** - 0.0028918 * **T Rataan Kuadratic**



(A)



(B)

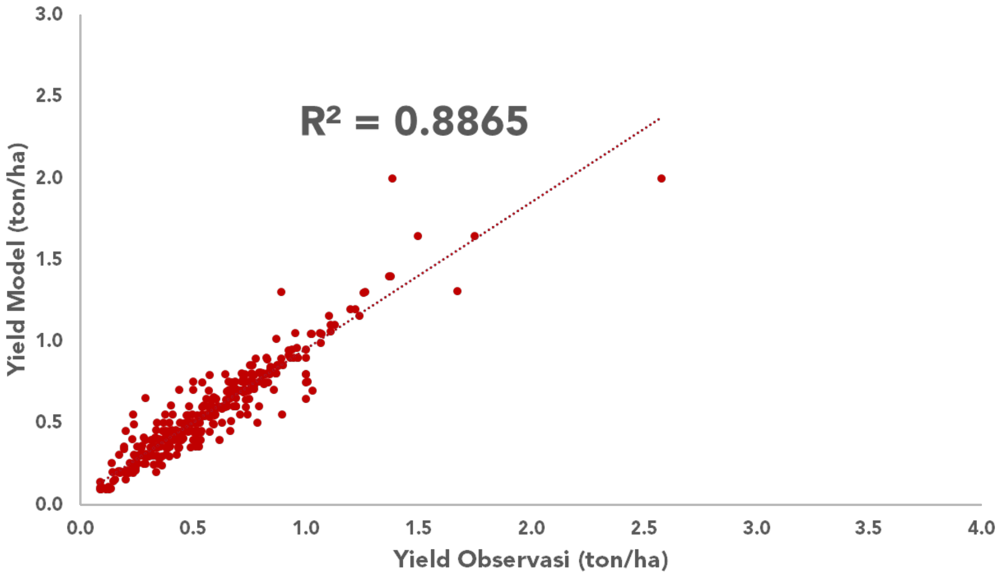
Hasil kalibrasi (A) dan validasi (B) model pendugaan produktivitas padi

CLIMATE MODEL ANALYSES OF PRODUKTIVITY ESTIMATE

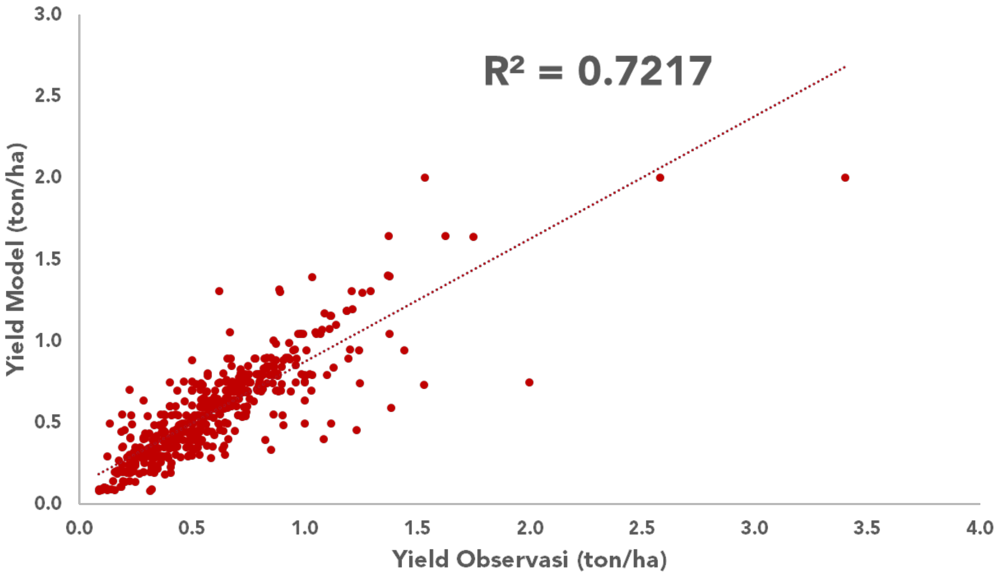
Robusta coffeee Productivity estimate model

Persamaan model yang digunakan :

Yield = -1.343464 **+** 0.0000688 * **CH** - 0.00000000845 * **CH Kuadratic +** 0.14086 * **T Rataan** - 0.0027586 * **T Rataan Kuadratic**



(A)



(B)

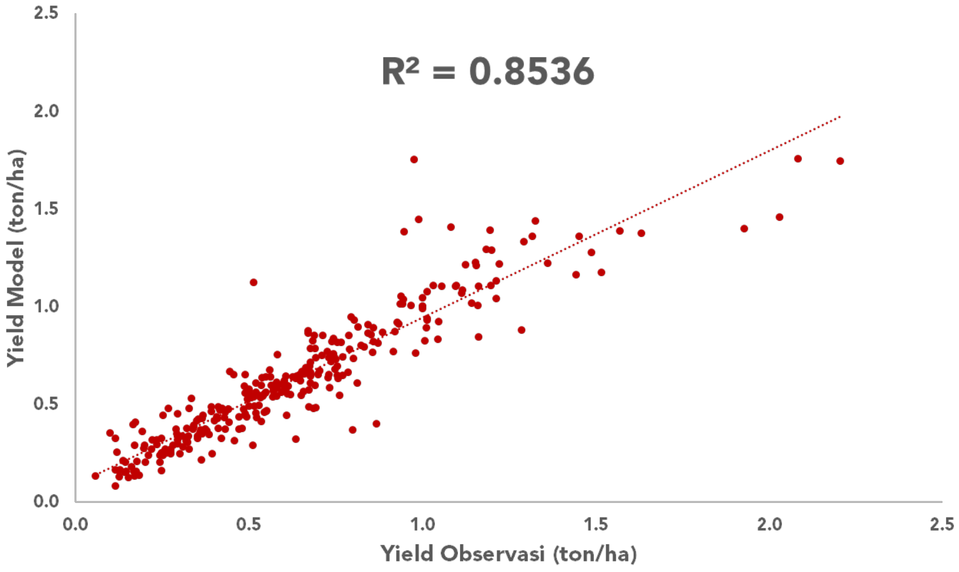
Hasil kalibrasi (A) dan validasi (B) model pendugaan produktivitas robusta

CLIMATE MODEL ANALYSES OF PRODUKTIVITY ESTIMATE

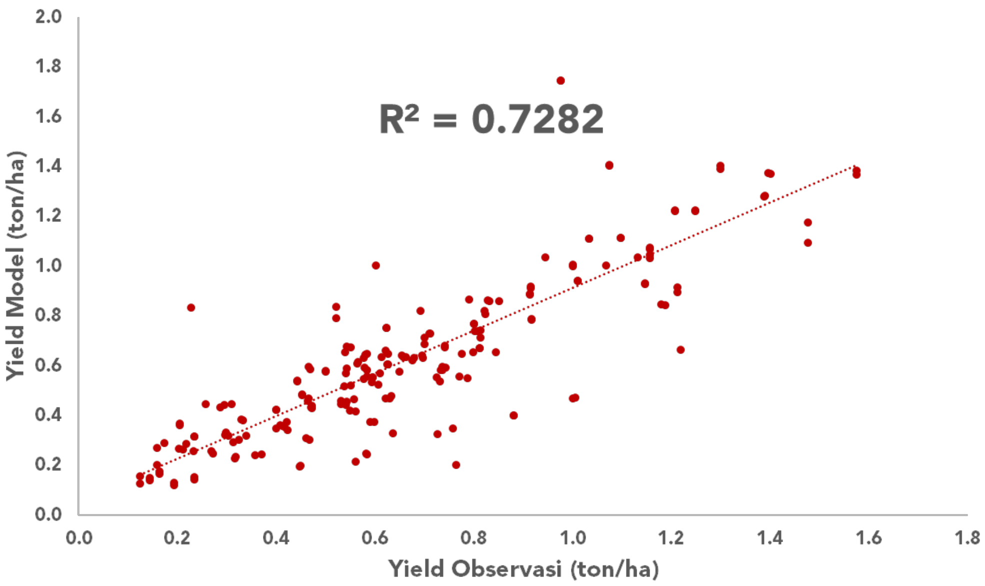
Arabica coffeee Productivity estimate model

Persamaan model yang digunakan :

Yield = -1.843466 **+** 0.0001046 * **CH** - 0.0000000158 * **CH Kuadratic +** 0.2777177 * **T Rataan** - 0.0074677 * **T Rataan Kuadratic**



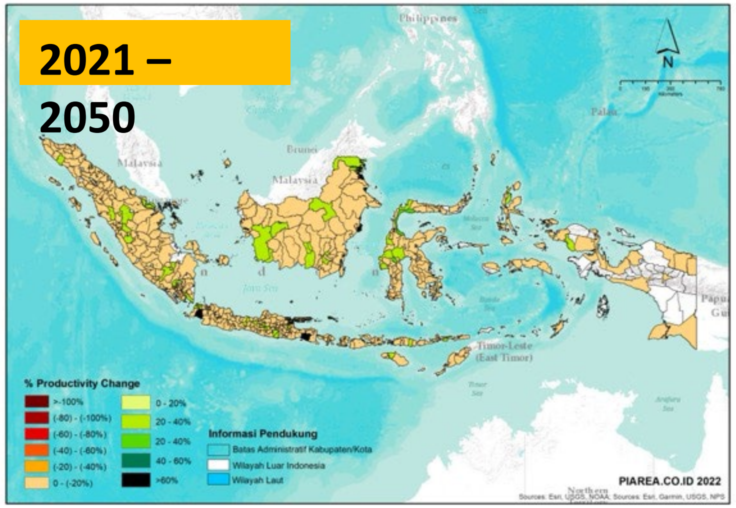
(A)

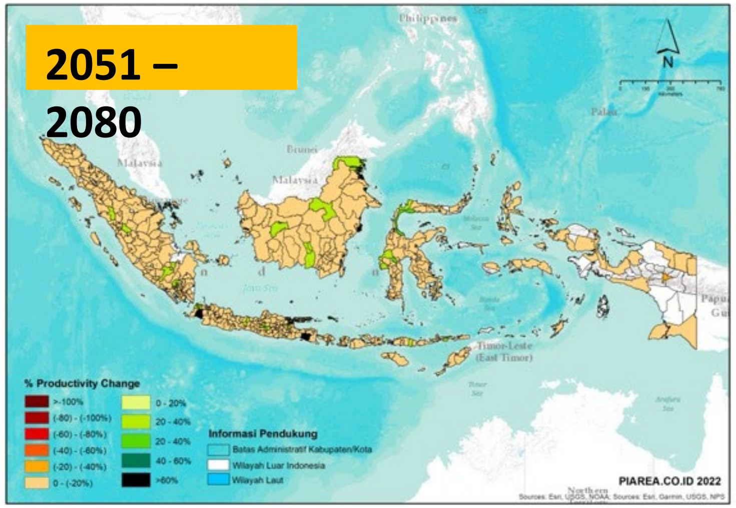


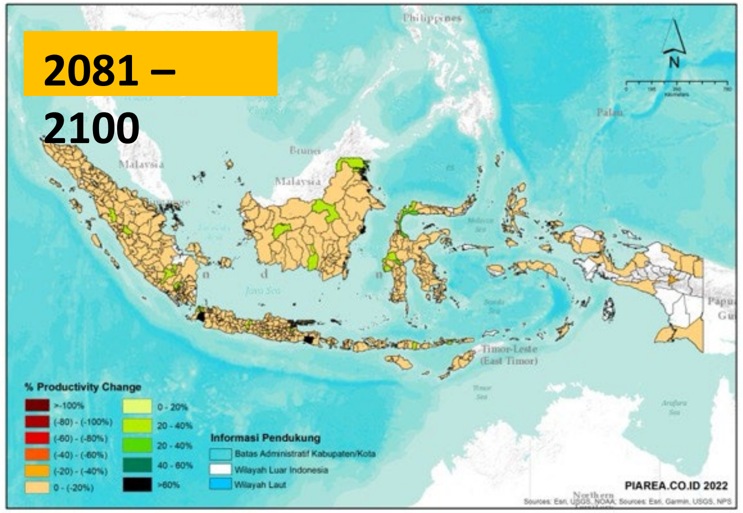
(B)

Hasil kalibrasi (A) dan validasi (B) model pendugaan produktivitas arabika

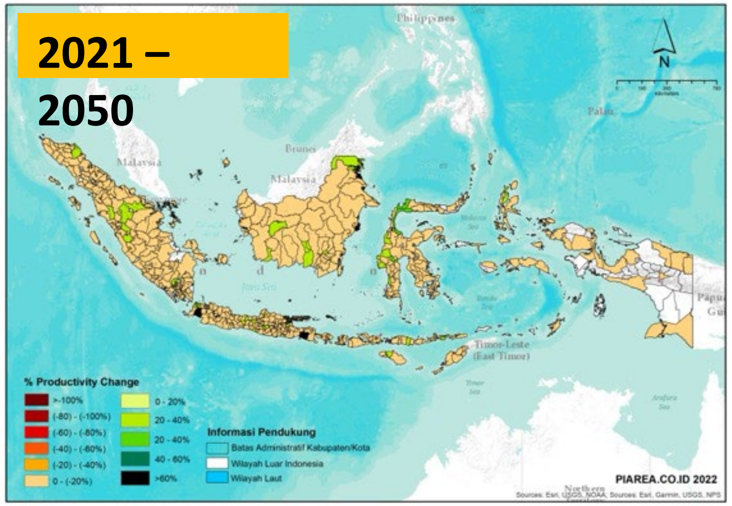
Changes in Padi Productivity

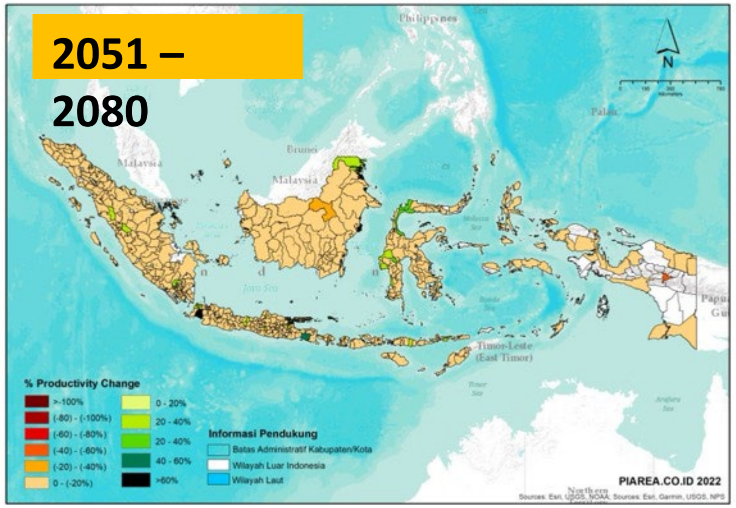


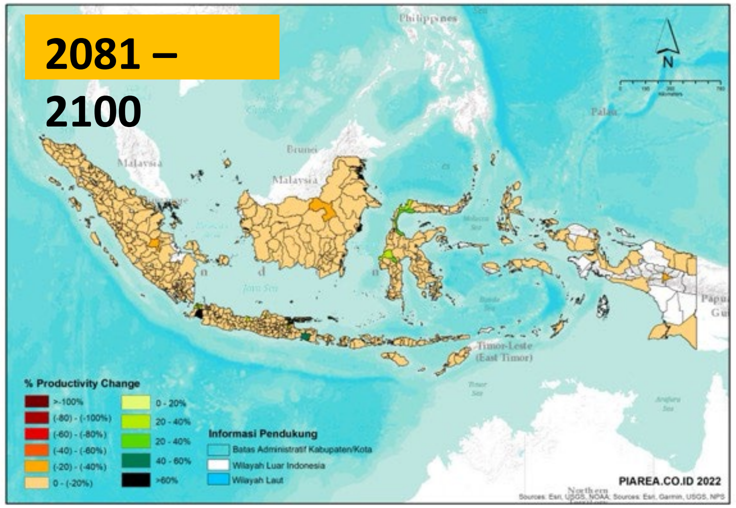




RCP 4.5



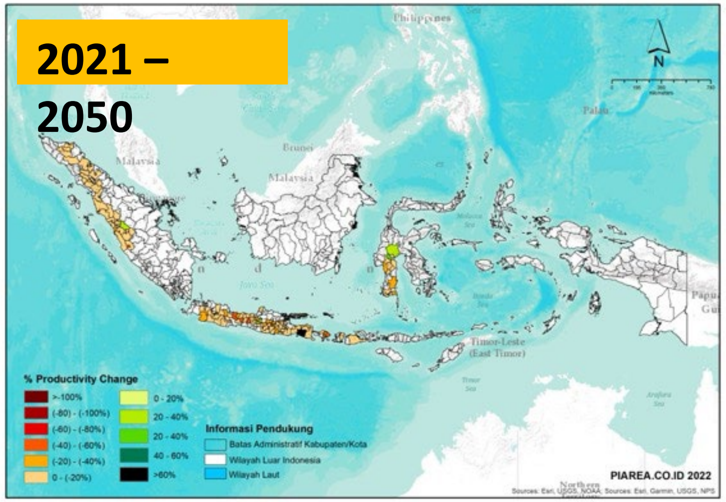


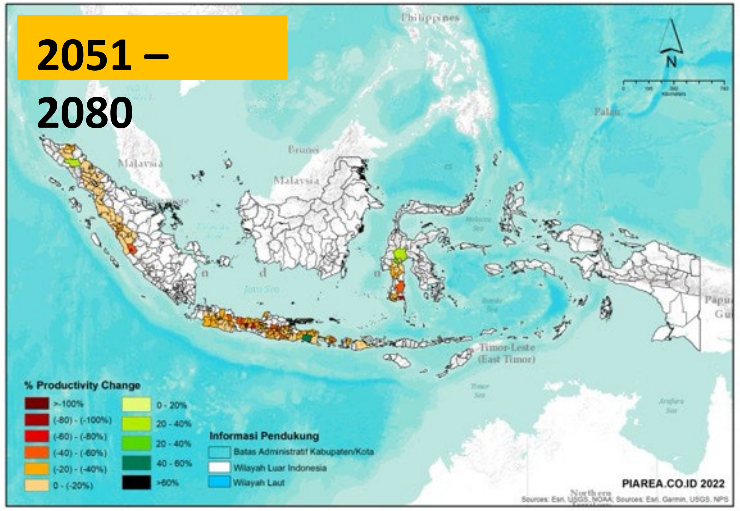


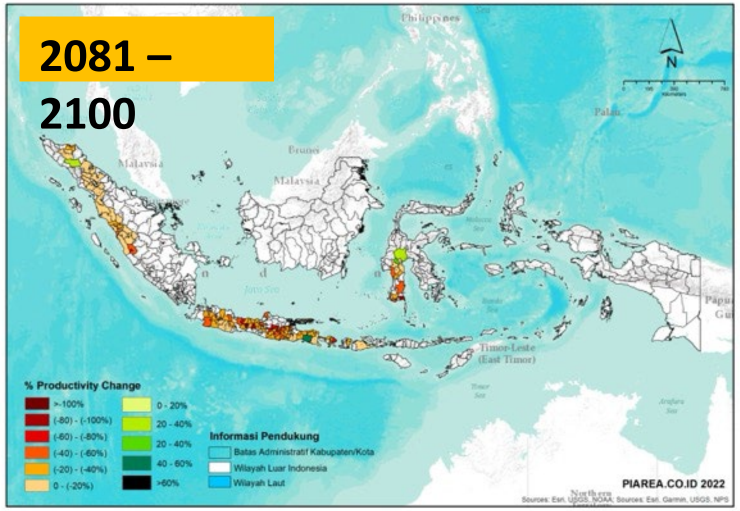
RCP 8.5

Changes Arabika Coffee Productivity

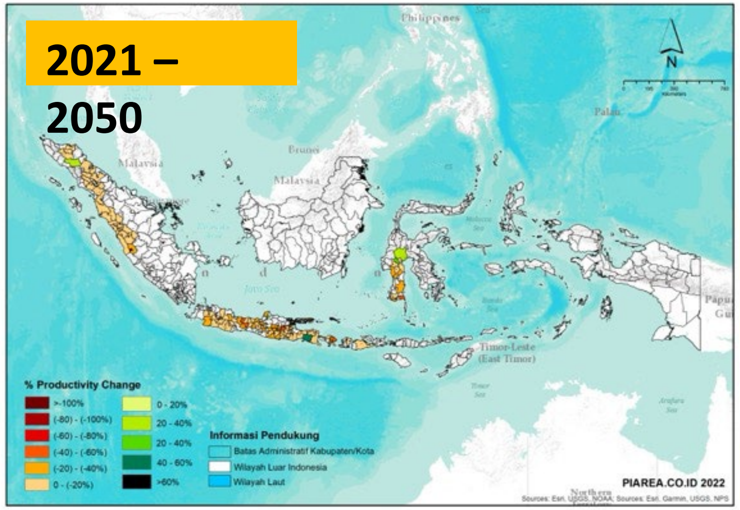
RCP 4.5

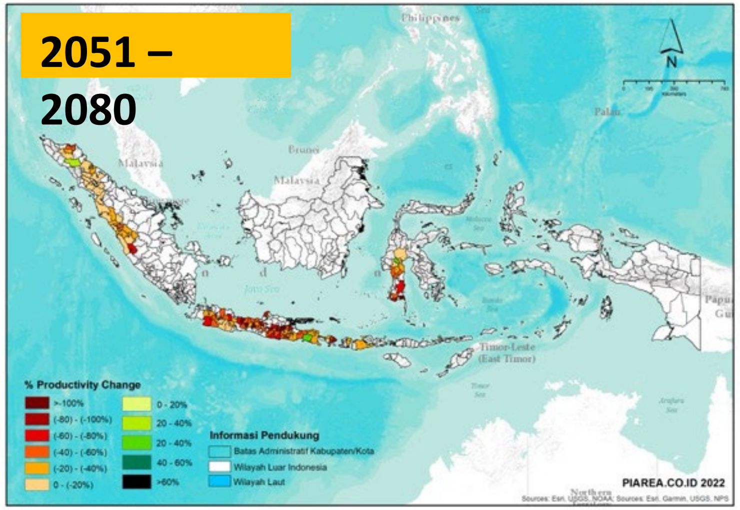


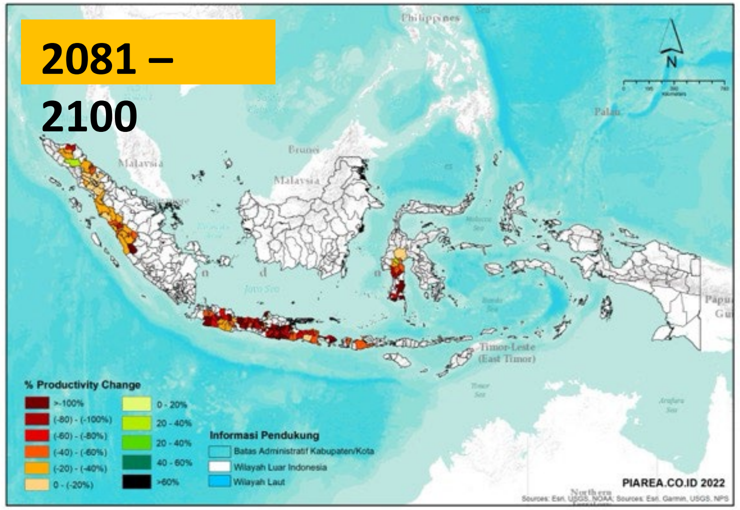




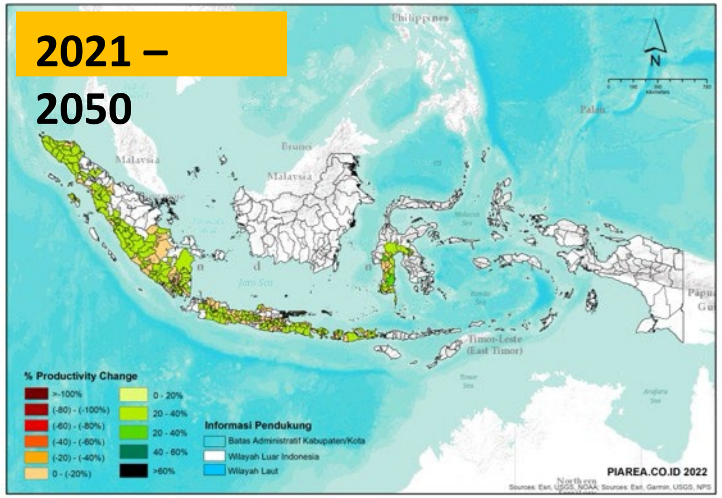
RCP 8.5

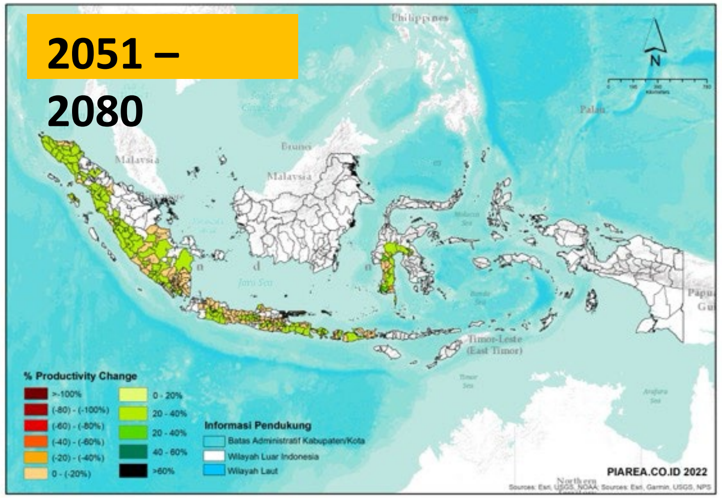


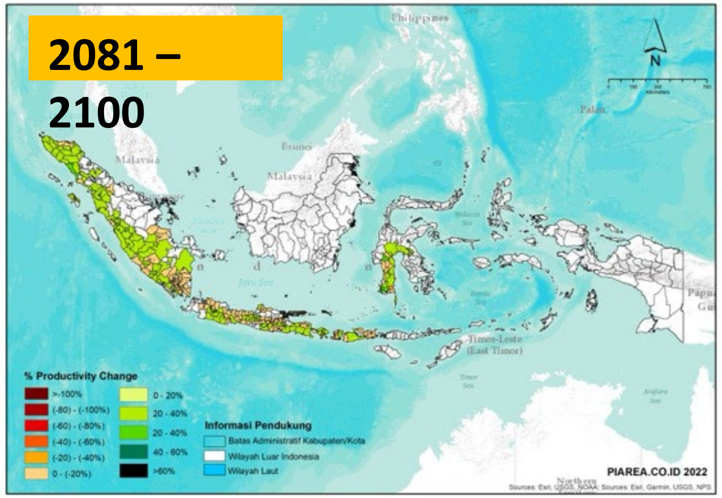




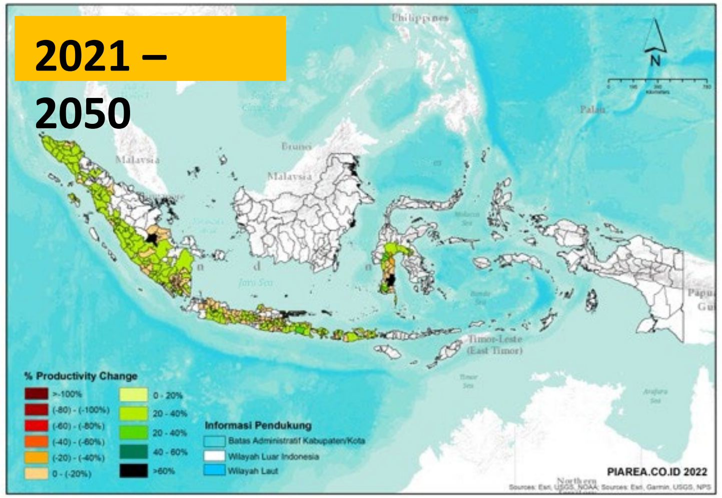
Changes in Robusta Coffee Productivity

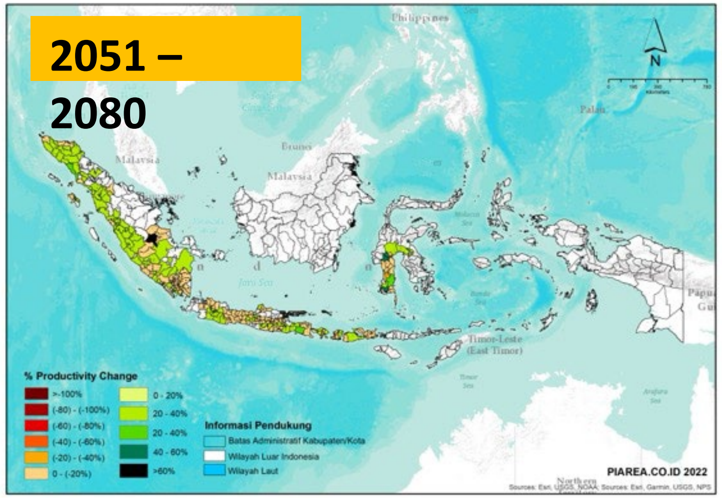


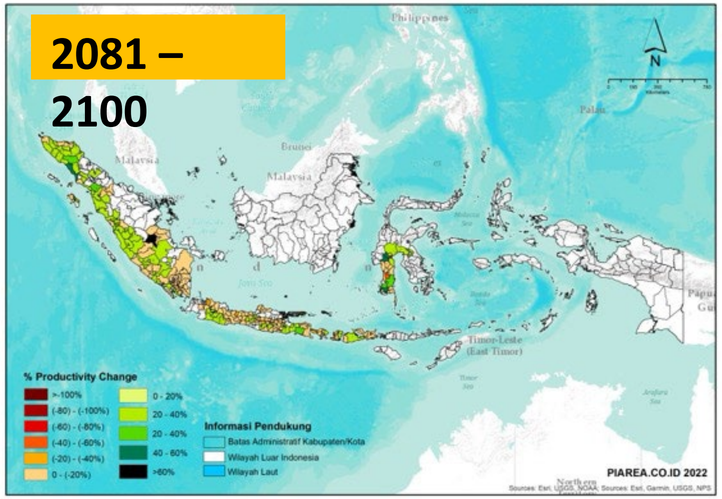




RCP 4.5







RCP 8.5

Adaptation efforts

Rice in the coastal areas

- create saline-resistant and high-yielding varieties.
- Improvements to irrigation infrastructure, including rubber dams
- soil amendment materials such as organic matter and gypsum,
- conservation farming practices,
- phytoremediation and bioremediation
- utilization of planting calendars
- granting of credit and insurance for farming

Rice in the swampland

- setting up macro and micro water systems to facilitate drainage/ irrigation,
- using tolerant submergence varieties
- adjusting planting time and pattern
- soil amelioration and balanced fertilization

Rice in the rice field

- adjusting planting time and pattern
- using high yielding tolerant varieties of drought and submergence,
- optimizing the use of alternative water sources
- intermittent irrigation
- balanced fertilization.

Lowland and highland coffee

- Use of shade, organic mulch, and cover crop,
- Technology of land management with Rorak
- Technology of rain harvesting and surface runoff through the construction of dams and ditches, water pump, used to meet crop water needs, especially during the dry season,
- Water-saving technologies such as sprinkler irrigation and drip irrigation
- Development of drought-tolerant varieties.

Conclusions

The study concludes that:

- Sea level rise has proven affected rice and coffee production with the reduction of 3.5 million tons of rice production, equivalent to the fulfillment of rice for 26.6 million people.
- ENSO appears to have different influence to rice production in the swamp area. La Nina will increase the water level to reduce the available land. On the other hand, planted area increase during El Niño due to lower water levels, especially in lowland swamps.
- The decline in Robusta and Arabica coffee production occurred during El Niño and La Nina in most of the production centers.
- Analyses of temperature suitability on various crops (rice and coffee beans) illustrate a consistent decrease in the number of days within the range of optimum temperature and an increase in the number of days over the threshold of critical temperature
- In general, changes under RCP8.5 condition provide a more significant change compared to the lesser scenario of RCP4.5
- The change of productivity of the two important commodities eventually influences the economic aspects such as prices, imports and exports. The range of rice price changes increase to a maximum of 33% and 55% with the scenario of RCP 4.5 and RCP 8.5, respectively in 2100. For the projected year up to 2050, the optimum price change rate is in the range of 32%. For coffee plants (Arabica and Robusta) a change of 56% - 109% for the period from 2050 to the end of 2100.
- Export yield also decreases ranging from 2% - 35% which consequently increase the demand for import reaching the range a maximum of 117% under RCP 8.5 scenario.

Thank you.

More Information:

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https://climatetracker.asia/experts/edvin-aldrian/

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