# Projection of paddy production using crop model Aquarop 4.0 based on RCP-6.0 scenario in Java Island

**Dara Kasihairani [1], Dodo Gunawan [2]**

*[1] School of Meteorology Climatology and Geophysics (STMKG)*
*Jl. Perhubungan 1 No.5 Bintaro, Tangerang, Indonesia*
*[2] Meteorological Climatology and Geophysical Agency*
*Jl. Angkasa 1 No. 2 Kemayoran, Jakarta, Indonesia*

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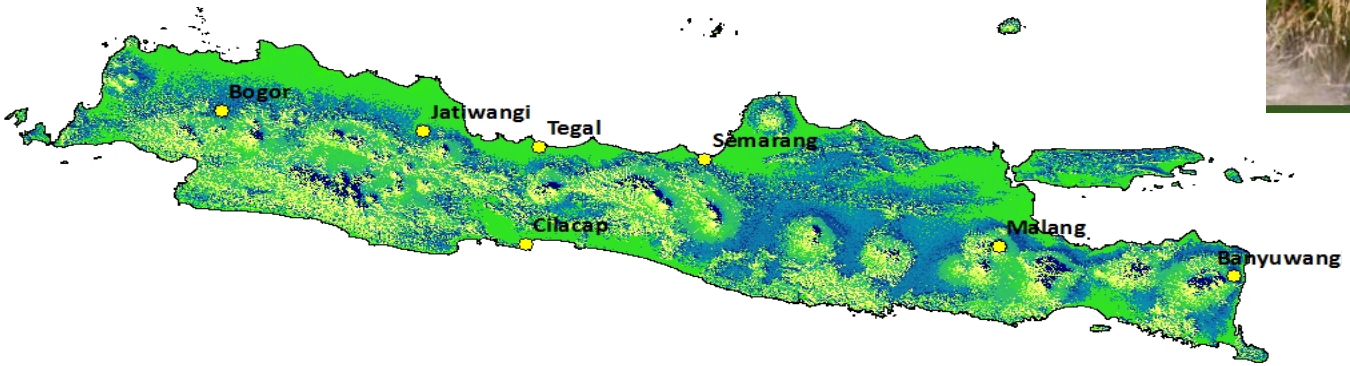
# Outline

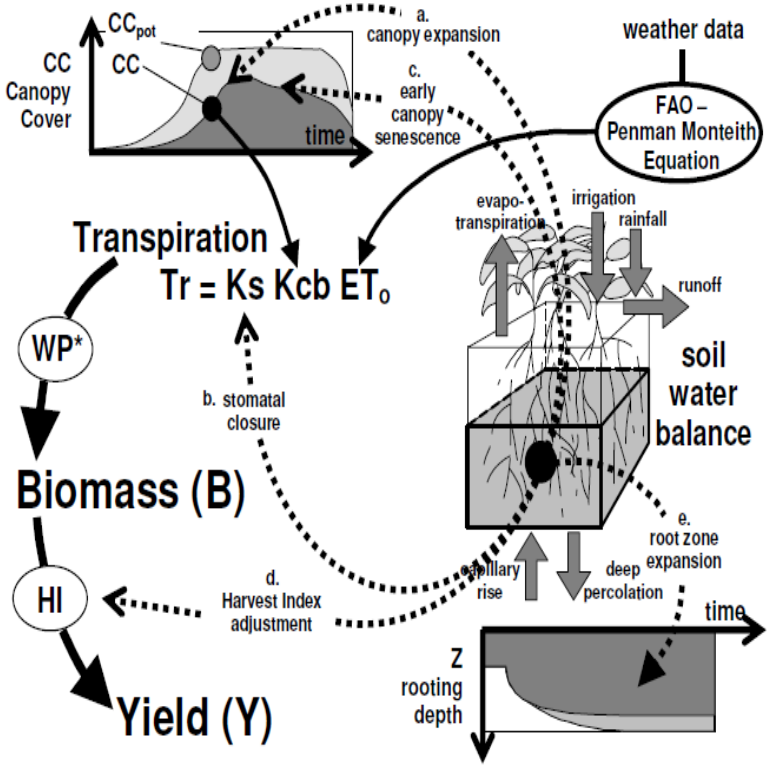
- Introduction
- Data and Method
- Result and Analysis
- Conclusion

# Introduction

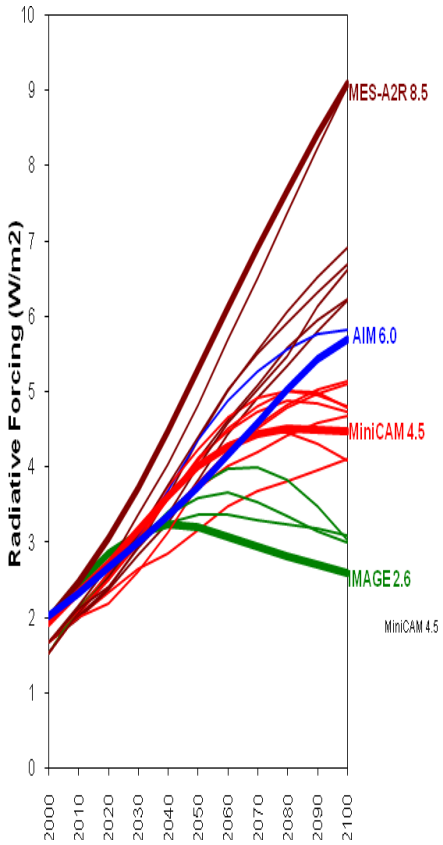
- Paddy as a staple food for Indonesian
- Indonesian population growing
- Food sufficiency
- Climate change impact to agriculture as the temperature rising and the CO2 concentration increasing
- Java as the biggest producer for paddy yield play an important role to support the national food security represented by seven location

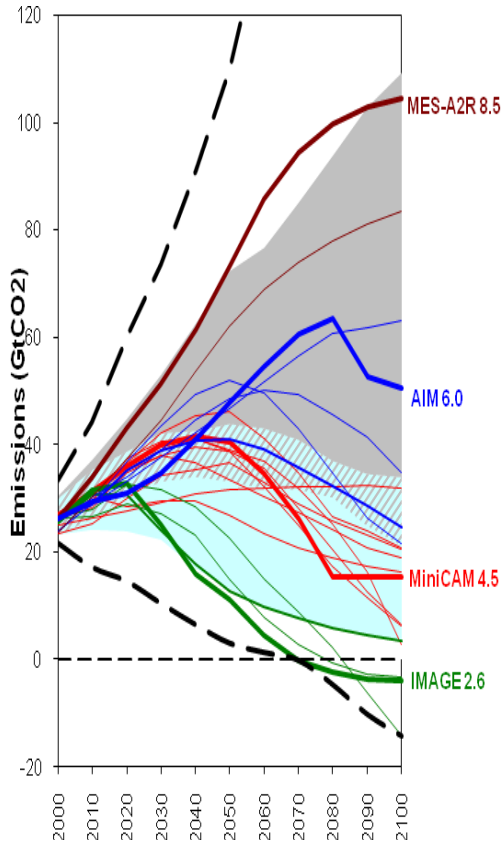


- Simulated projection using Aquacrop 4.0 (Raes, 2012) needed to see the picture and possibilities in the future
- Simulation based on RCP 6.0 (IPCC, 2013) as the moderate scenario as Indonesia plan to reduce the rate of CO2 increasing up to 26% (National Action Plan on GHG, 2010). The simulation divide into three future period of time, near-future, mid-future and end-future.




Raes, 2012




Moss, 2010

# Data and Method

- Data
  - Projection Data Model RCP scenario 6.0 from Fifth Assessment Report (AR5) IPCC, 2013

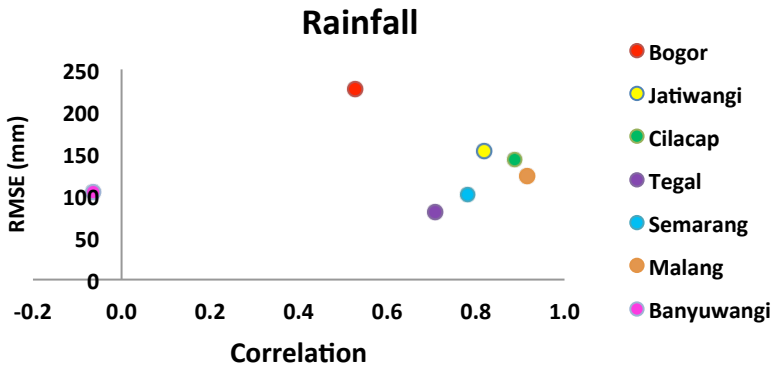
    projection model of downscaled CSIRO-MK3 using Regional Climate Model CCAM based on RCP scenario 6.0 (experimentally) available by Research and Development Center (Puslitbang) of BMKG
  - Observation data from BMKG Stations
    - Daily rainfall, maximum temperature, minimum temperature, 10m wind speed and sunshine hours
    - Observed Carbon Dioxide from GAW Station Kototabang
  - Carbon Dioxide concentration of RCP 6.0 Scenario

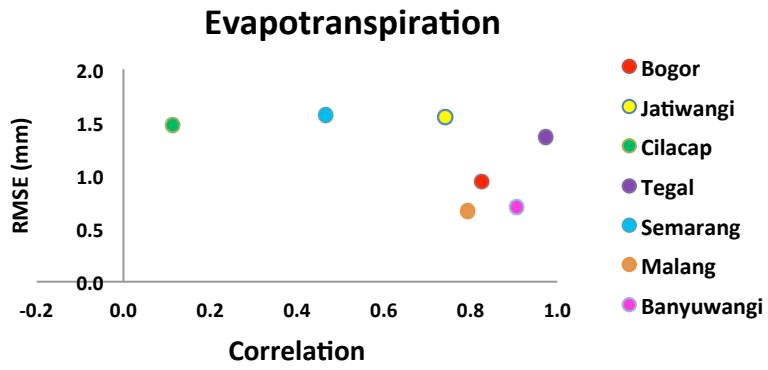
    Source Data Group PIK-Potsdam Institute.
  - Agriculture Data(Paddy)

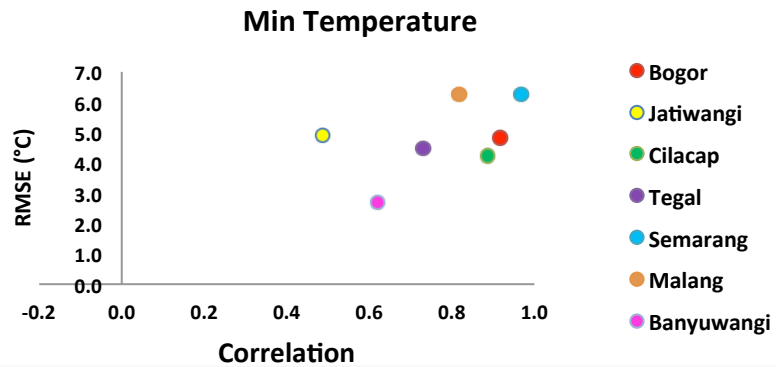
    Production, Crop Calendar from Agriculture Ministry

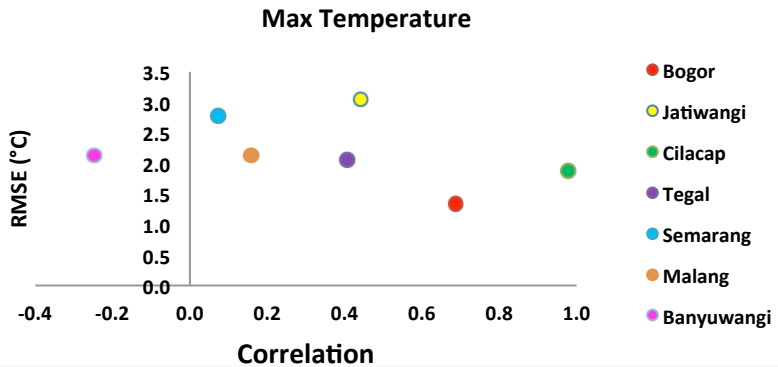
- Method
  - Forcing the data model to represent the local condition by correcting the model using the correction factors (Weiland, et.al., 2010)
  - Calculating the Evapotranspiration Penmann-Monteith of amount from the climatic parameter (Raes, 2012)
  - Running the Crop Model Aquacrop 4.0 to simulate the production of paddy

**Error of the model data to observation**



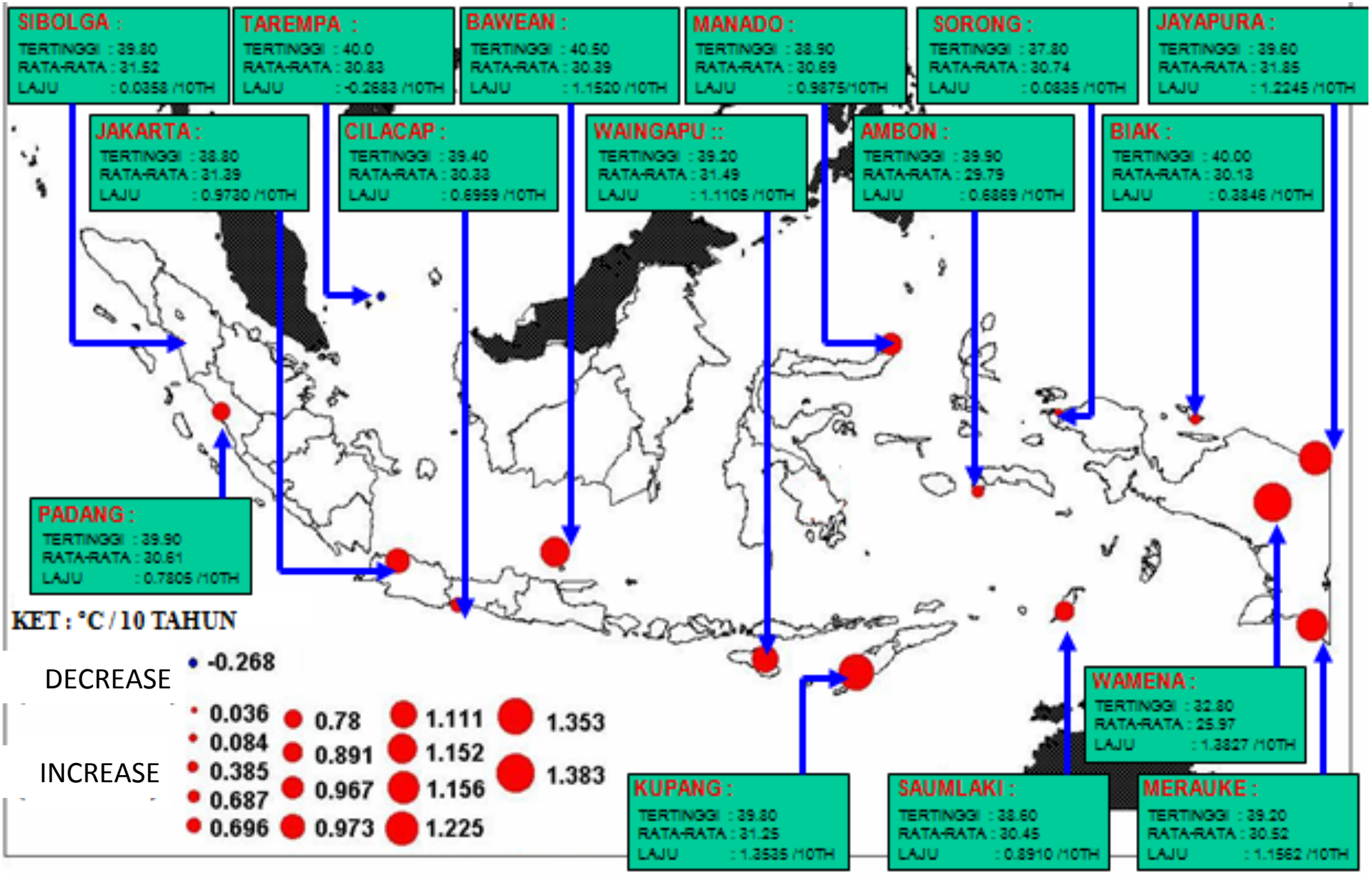



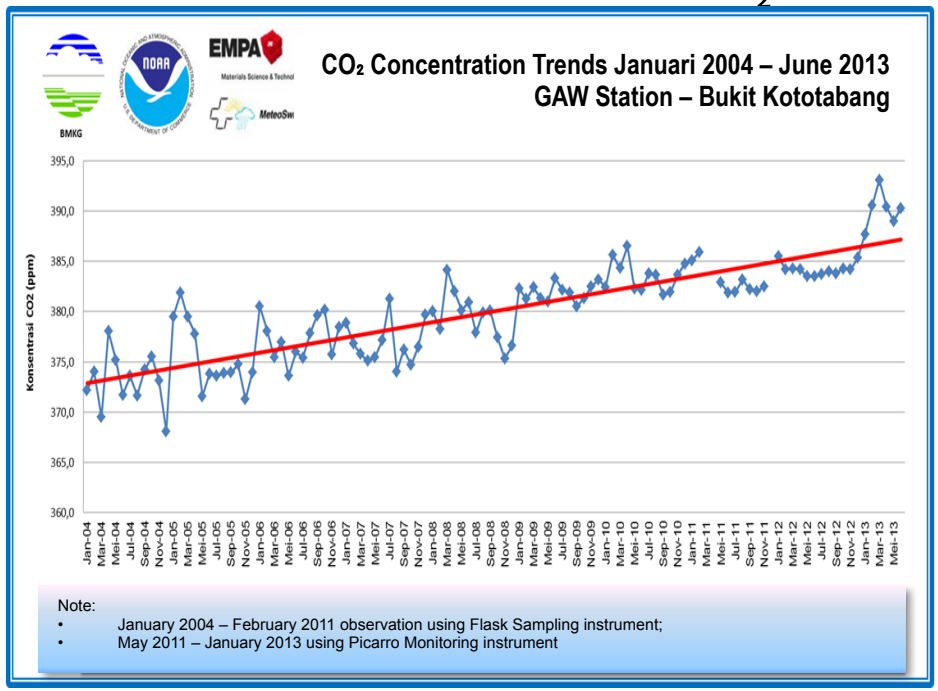
# RESULT
# AND
# DISCUSSION

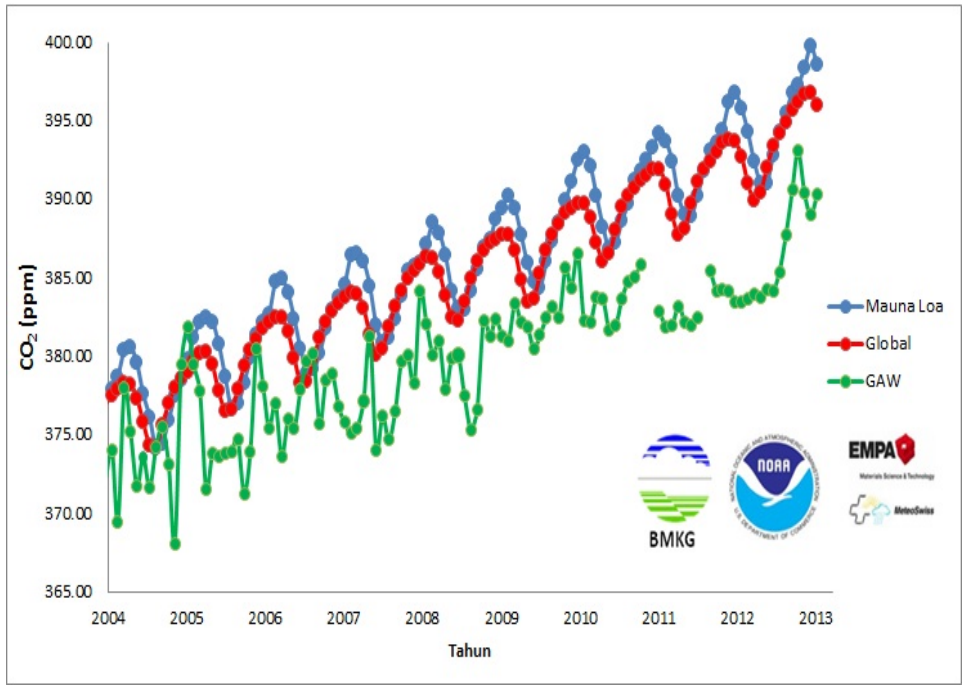
# LINEAR TREND OF MAXIMUM DAILY TEMPERATURE 1983 – 2003 IN INDONESIA CITIES

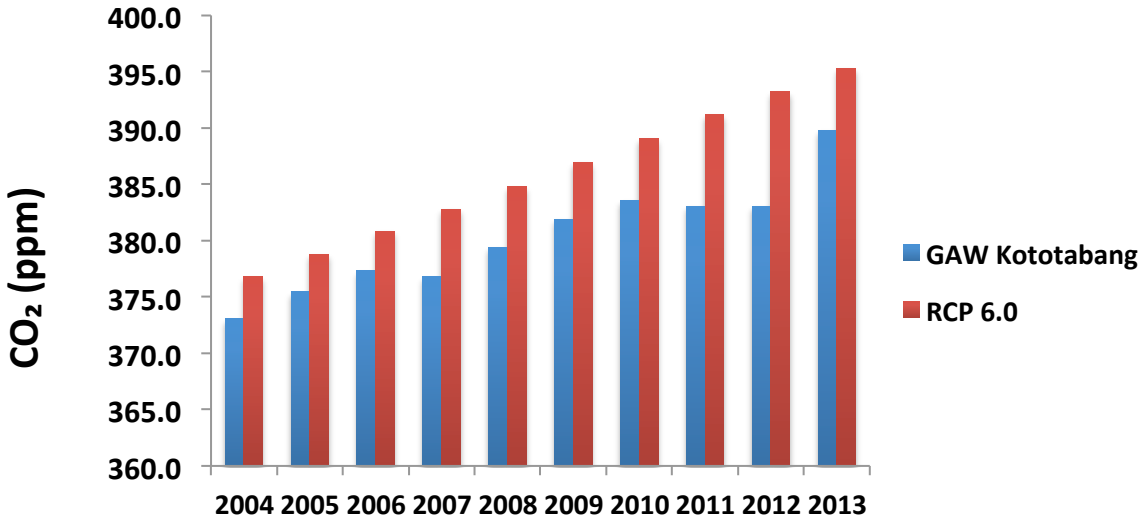



*Source: Aldrian, et. al, 2010*

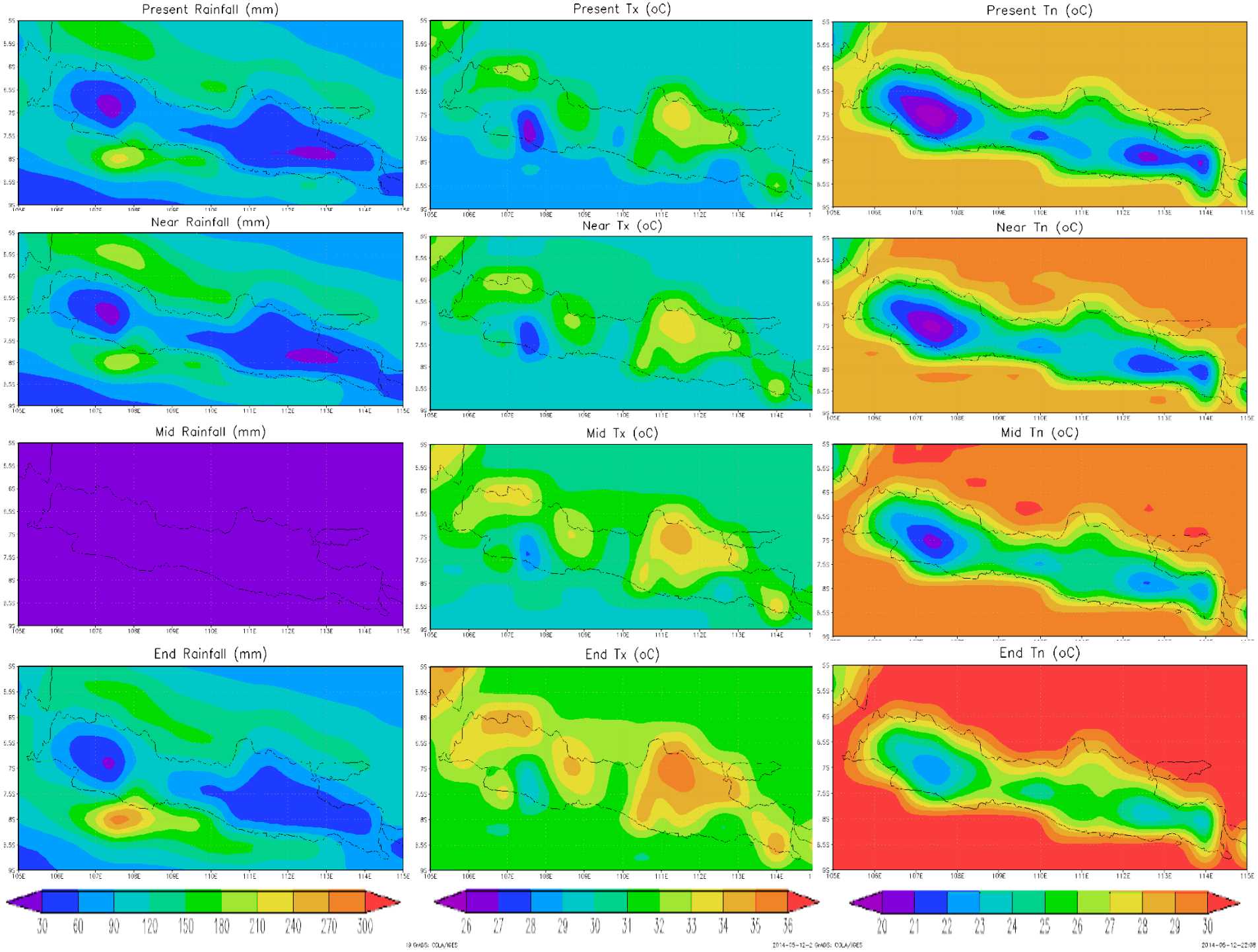
# Indonesian $CO_2$ Concentration Measurement



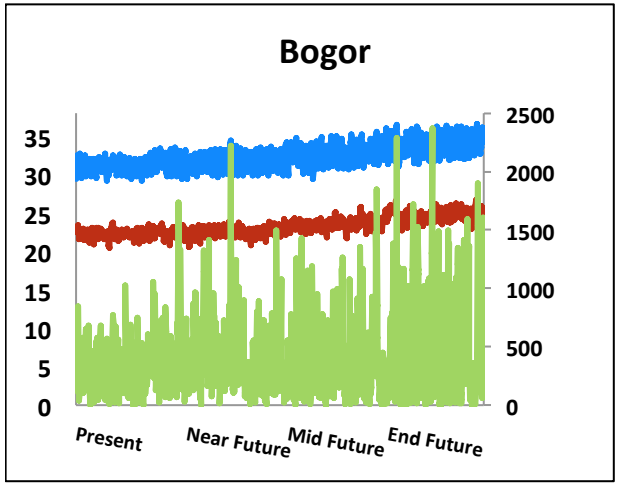



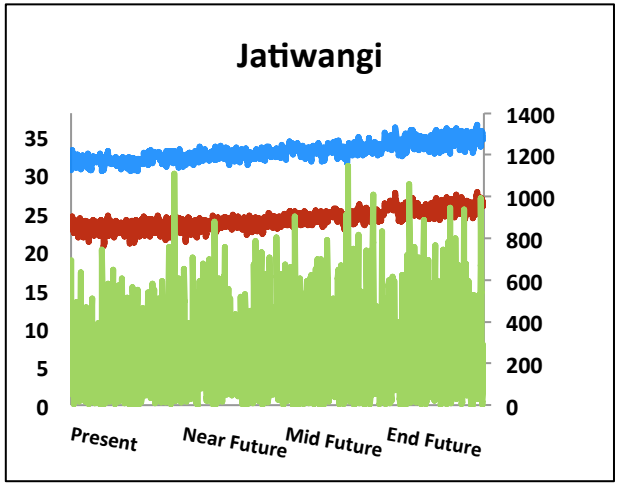



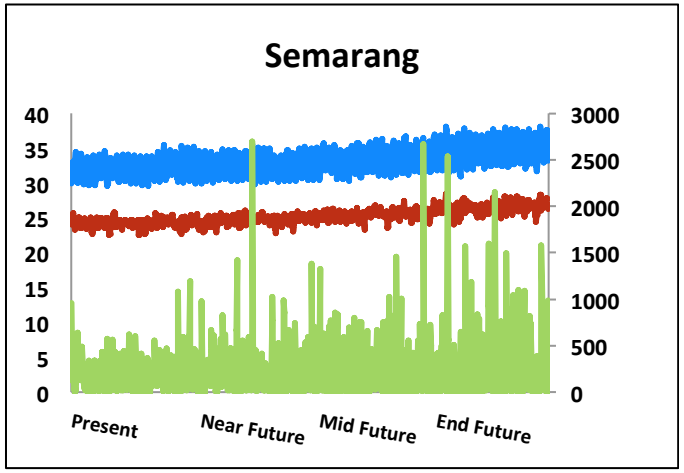
# Java's climate figure in The RCP 6.0 scenario

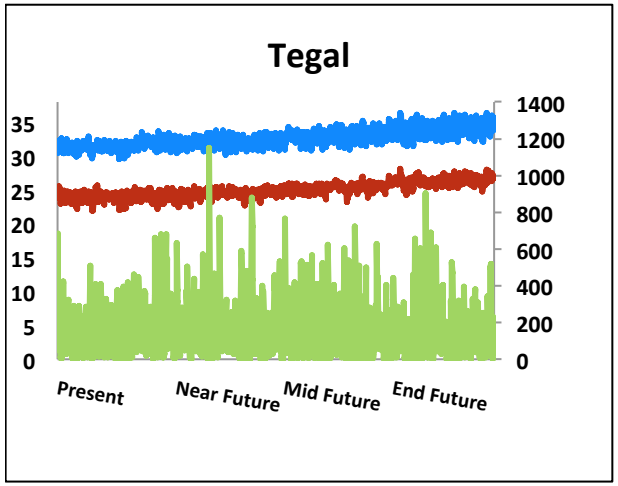

Present Rainfall (mm)
Present Tx (oC)
Present Tn (oC)
Near Rainfall (mm)
Near Tx (oC)
Near Tn (oC)
Mid Rainfall (mm)
Mid Tx (oC)
Mid Tn (oC)
End Rainfall (mm)
End Tx (oC)
End Tn (oC)
30 60 90 120 150 180 210 240 270 300
26 27 28 29 30 31 32 33 34 35 36
20 21 22 23 24 25 26 27 28 29 30
18 GrADS: COLA/IGES
2014-05-12-2 GrADS: COLA/IGES
2014-05-12-22:08

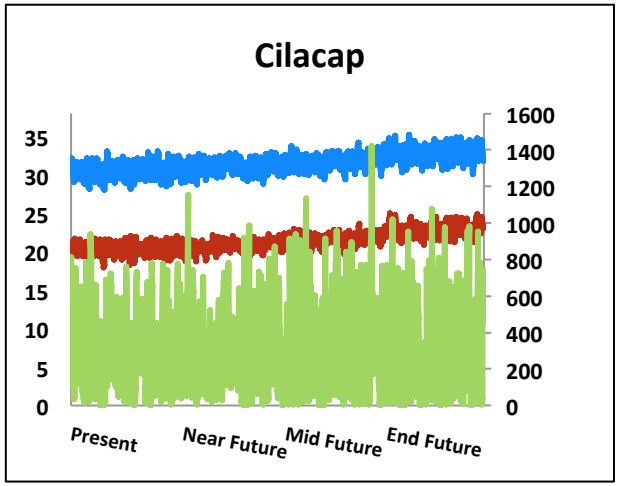
# RCP 6.0 data model corrected to local character

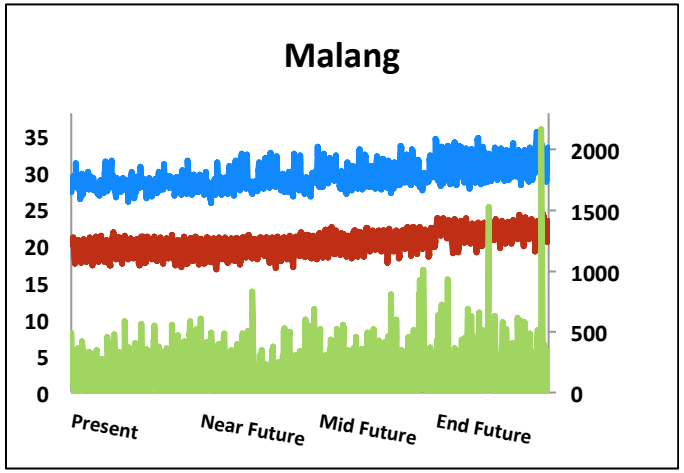


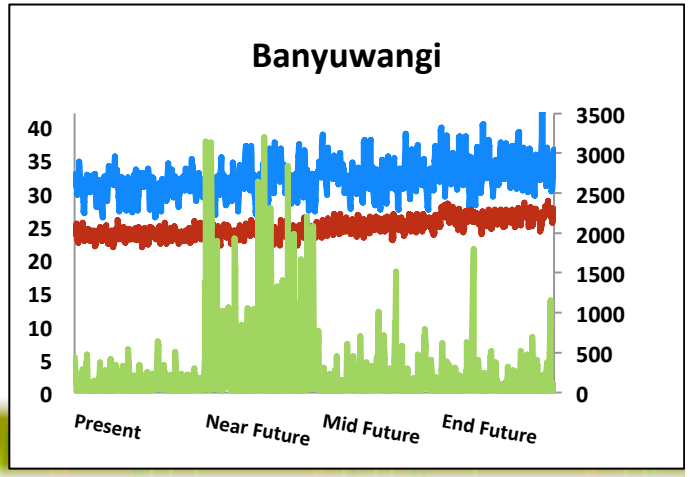



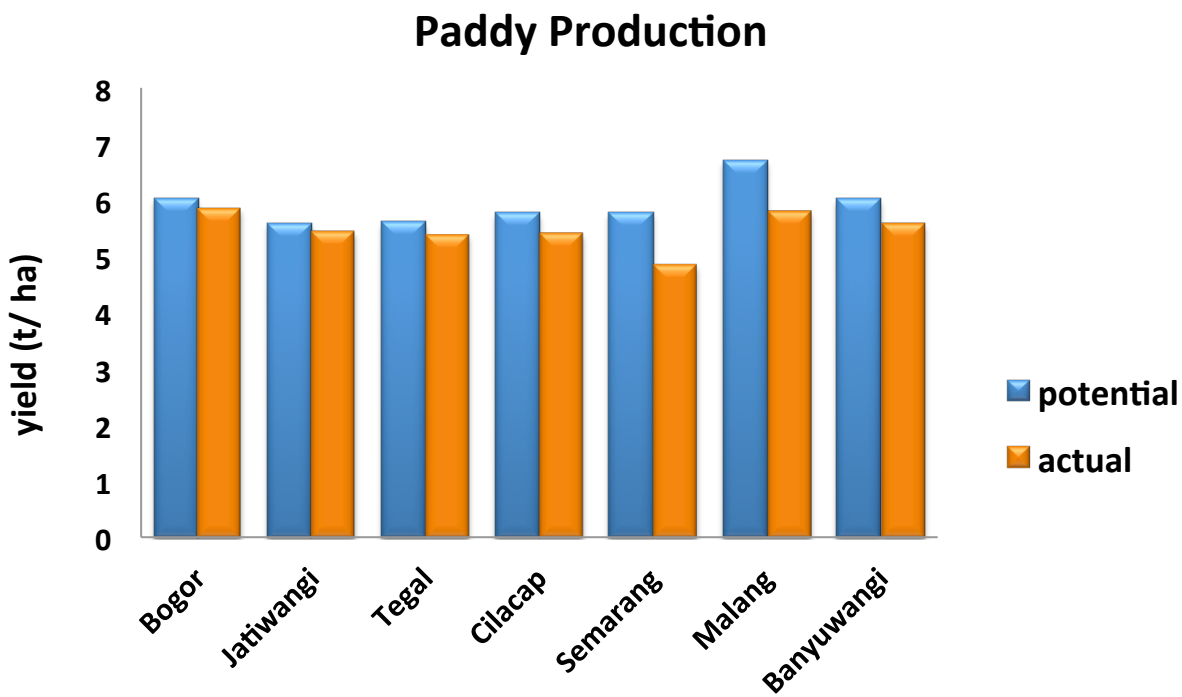



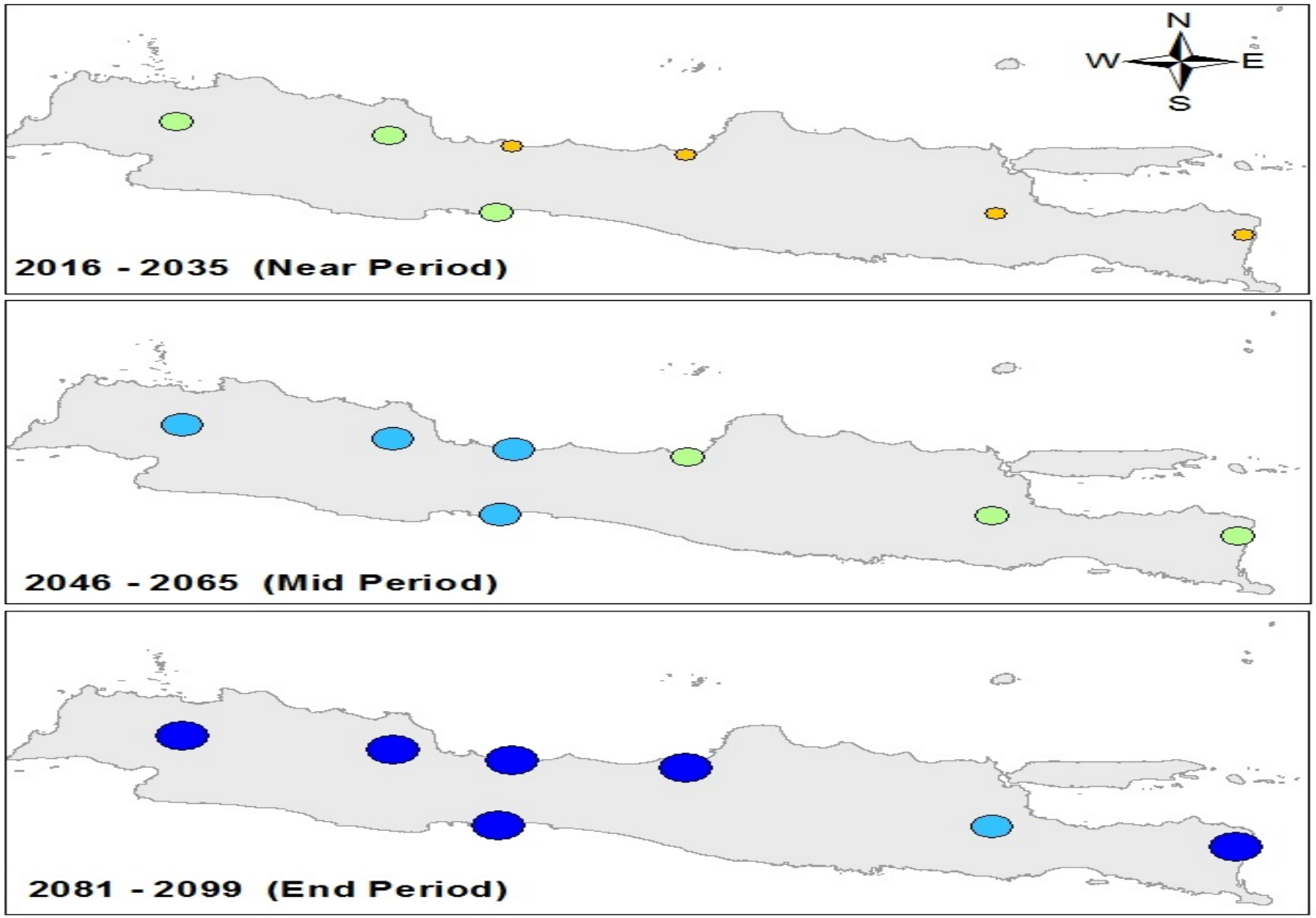




Tx (°C) Tn (°C) RR (mm)

# Current Paddy Production




*Indonesian potential yield is higher than it's actual yield. It shows that there are more tons of paddy that could be produce as the climate supply it source (the temperature, radiation, rainfall, etc.). More food can be obtain from the field.*




**Production growth rate >**

**Near period : 0.4 % per year**
**Mid period : 0.8 % per year**
**End period : 1.3 % per year**

**Production Change:**

- < 0.5 ton/ha
- 0.5 - 1.0 ton/ha
- 1.1 - 1.5 ton/ha
- 1.6 - 2.0 ton/ha

# Climate change (as in the RCP 6.0) have a good effect to paddy production, what might be the possibility cause?

| | |
|---|---|
| $CO_2$ | • Increase grain production by 6-50%<br>• Increase photosynthetic rates by 20 to 60% (Cure, 1985).<br>• Decreases in stomatal conductance and transpiration rates of approximately 16 and 33% (Cure, 1985).<br>• Increased water use efficiency |
| Temp | • Increased plant growth rate<br>• decreased growth duration leading to shorter grain filling period (Swaminathan, 1984). |
| $CO_2$+Temp | • Complex interactions may occur for components of the rice ecosystem which may have profound effects on rice production, e.g., increased CO2 may overcome adverse high temperature effects on Azolla (Idso et al, 1989; Allen et al, 1988). |

And as the projection, the increasing of temperature and $CO_2$ is followed by the addition of the rainfall amount. The water loss through transpiration due to higher temperature overcome by the rainfall.

# Uncertainties of the Study

- The environment of agriculture might also change
- The variability of each season will affect the plants and the schedule of planting (IFAP, 2008)
- The change of climate might also change the disease, pest and or outbreak pattern.

## Indonesian Rice Statistic

| | |
|---|---|
| Populations, 2011 (millions) | 241 |
| Annual growth population in last 10 years (%) | 1.49 |
| Total rice area (million hectares) | 7.79 |
| Average rice yield, 2011 (tons/ha) | 5.03 |
| Total rice production (2011) (million tons) decrease by 1.08 million tons compared to 2010 | 65.39 |
| Annual rice consumption (kg/ capita/year) | 139 |
| Rice ecosystem (%, million hectares): | |
| Irrigated | (61.7) 4.785 |
| Rainfed | (26.0) 2.015 |
| Flood prone | (7.0) 0.615 |
| Upland | (5.2) 0.333 |

National Family Planning Coordinating Board (BKKBN) assume that:

1. Population growth and consumption steady, paddy productivity increasing stable l (1.3% /year) however will not enough to produce rice

2. Population growth increase 1.7 %, consumption 1.253 kg/capita/ year, decreasing paddy production lead to negative food balance

3. Population growth down to 1.3 %, consumption 125.3 kg/capita/ year, paddy production increase up to 1.56% per year will meet the food sufficiency to the people.

# How to adapt?

- Control the growth of population
- Introducing the food diverse consumption
- Increasing the intensification of cropland
- Increasing the agriculture management quality therefore the yield gap can be narrowed
- Increase the capita income

# Conclusion

- The rising of temperature and carbon dioxide concentration is a clearly seen in Indonesia from present research and observations.
- Indonesia climate provide a wide source to agricultural sector to produce a numerous crop yield.
- The yield gap shows the potential that could be optimize. If it happens then the more production will occur
- The RCP 6.0 scenario projected the temperature increasing and also the rainfall amount. However the impact of the increasing change give positive effect to the paddy production in Java.
- Development in food production is not enough to cope the food security of Indonesia. In the condition of population growth decrease and the consumption rate as now, at least the paddy production have to increase up to 1.56 to meet the need of Indonesia people.
- The adaptation to the climate change condition is the solution

# THANK YOU

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