Impact of Climate Change on Food System in Indonesia

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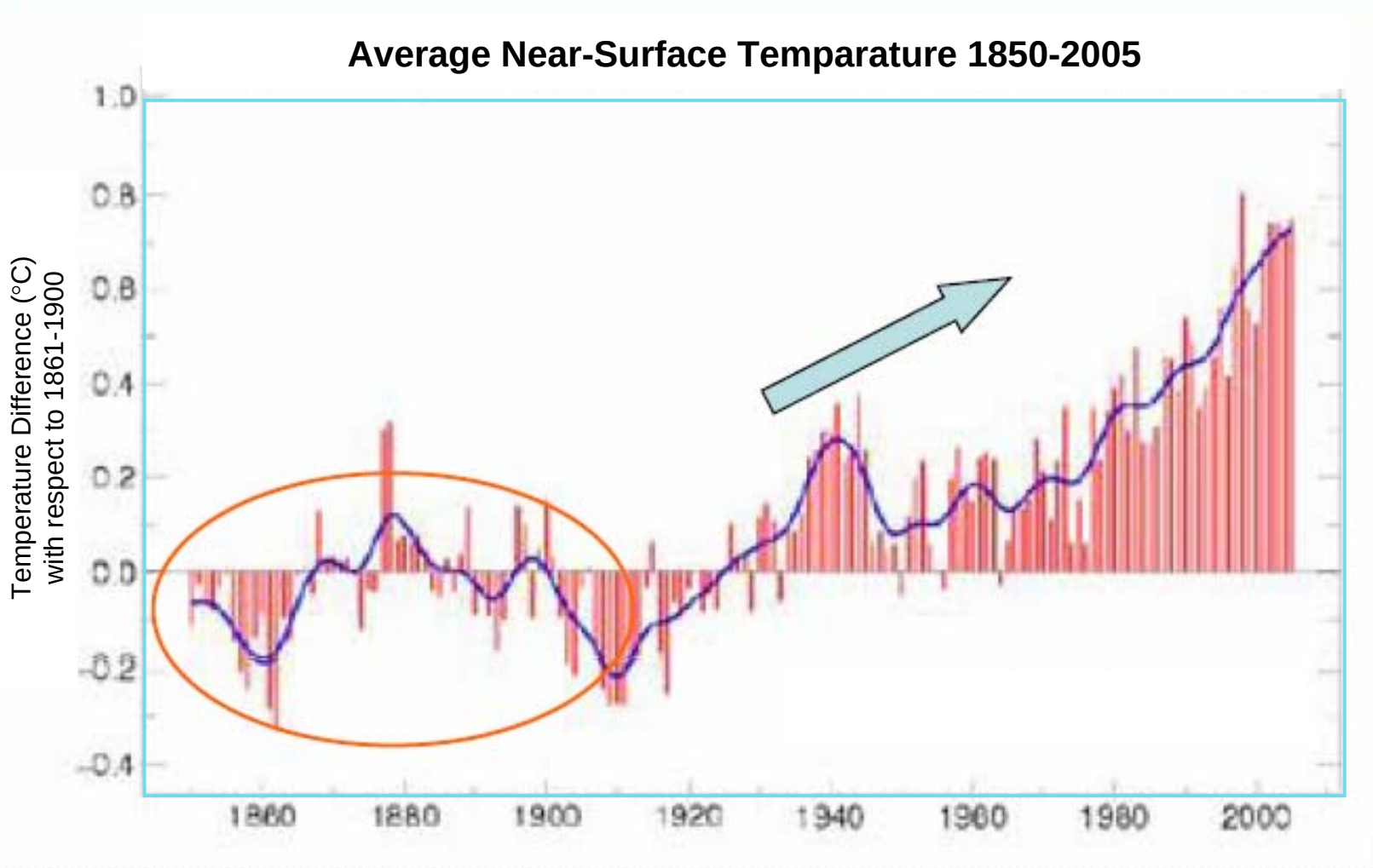
GLOBAL WARMING: Global Average Temparature has been increasing since early 19th Century



Source: Brohan et al., 2006

Increase in Global Temperature leads to a Climate changes (direct impact):

- Affect on the hydrological cycle: alter evaporation, transpiration, run-off, soil moisture, and finally precipitation → increased intensity of rainfall but in shorter periods:
  - Risk of flooding
  - Prolonged dry seasons (drought)
- Increase the average temperature of ocean water (ocean warming):
  - Impact marine fish behavior and population
  - risk of sea-level rise
- Increase of unussual climate variability
- Outbreak of tropical deases (malaria, dengue, plaque, etc.)

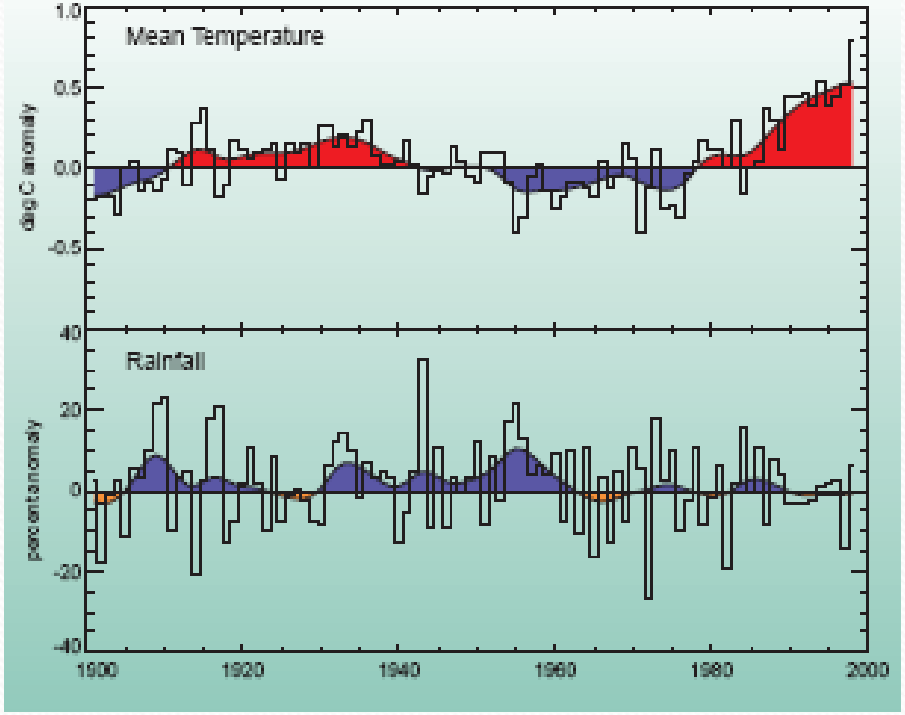
Evidence of Climate Changes in Indonesia

- The temperature has been increasing
- There has been changes in Seasonal Cycle and Rainfall Patterns
- Depletion of Water Resources

The Temperature is increasing

- Indonesia has become warmer since 1900. The annual mean temperature has increased by 0.3°C. The 1990s was the warmest decade in the century and 1998 was the warmest year, almost 1°C above 1961-90 average (Hulme and Sheard, 1999)
- Data from 12 selected climate station in Indonesia show an increase between 0.2°C and 0.4°C/decade since 1970 (PEACE, 2007)
- It was predicted that the temperature in Indonesia will increase rather slowly compare to the global average, mainly because of the slowly warming equatorial ocean water surrounding the islands, with a rate between 0.1-0.3°C/decade. The increase quite uniformly throughout the year for the whole region, including Java (Hulme and Sheard, 1999)

Temperature increases, and Overall Precipitation is also increases with some regional variations



Changes in annual mean temperature during 1901 – 1998
→ Increased by 0.3°C

Changes in annual rainfall during 1901 – 1998
→ overall inreased by 2-3% accross Indonesia, most occuring in December – February, the peak rainfall in a year

Source: Hulme and Sheard (1999)

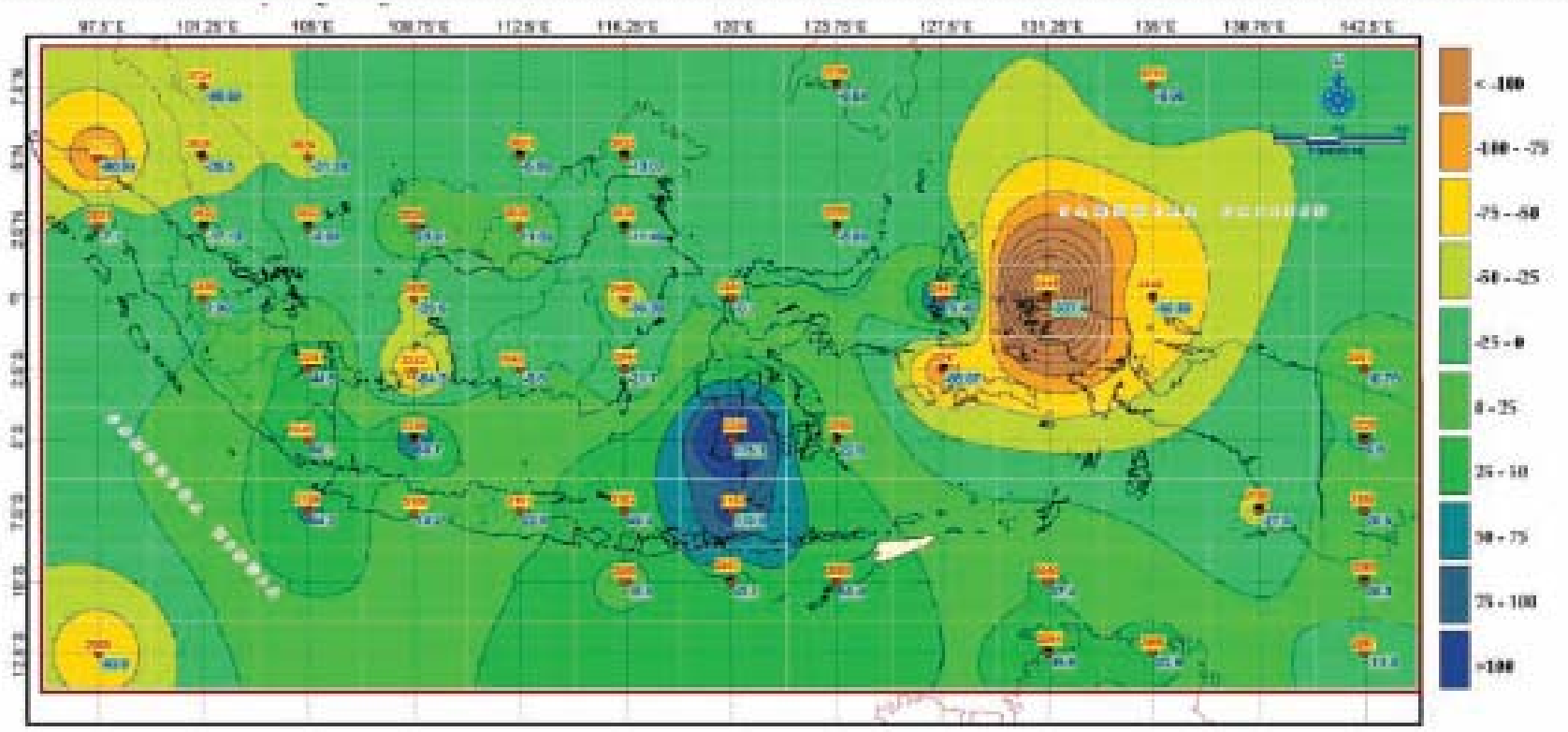
Changes in Rainfall Patterns

There is a significant spatial variability in the changes (Boer and Faqih, 2004):

- There has been a **decline** in annual rainfall in the Southern regions (e.g. Java, Lampung, South Sumatra, South Sulawesi, and Nusa Tenggara)
- However, there was an **increase** in precipitation in the Nothern regions (e.g. Most of Kalimantan, Nort Sulawesi

The Average Change of Precipitation Period of 1900-2000 in mm/100 years

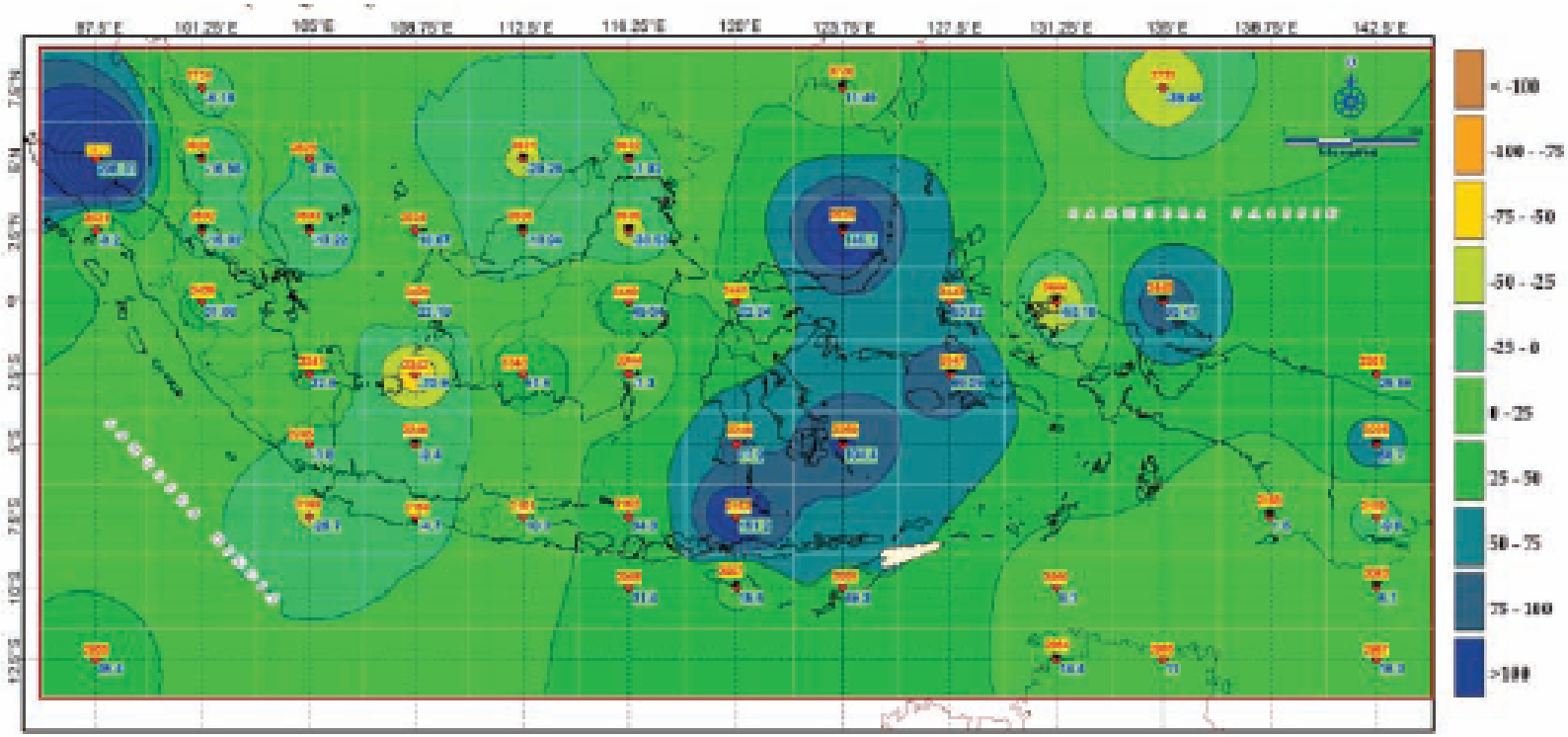
September - November



Source: Ratag, 2007

The Average Change of Precipitation Period of 1900-2000 in mm/100 years

December - February



Source: Ratag, 2007

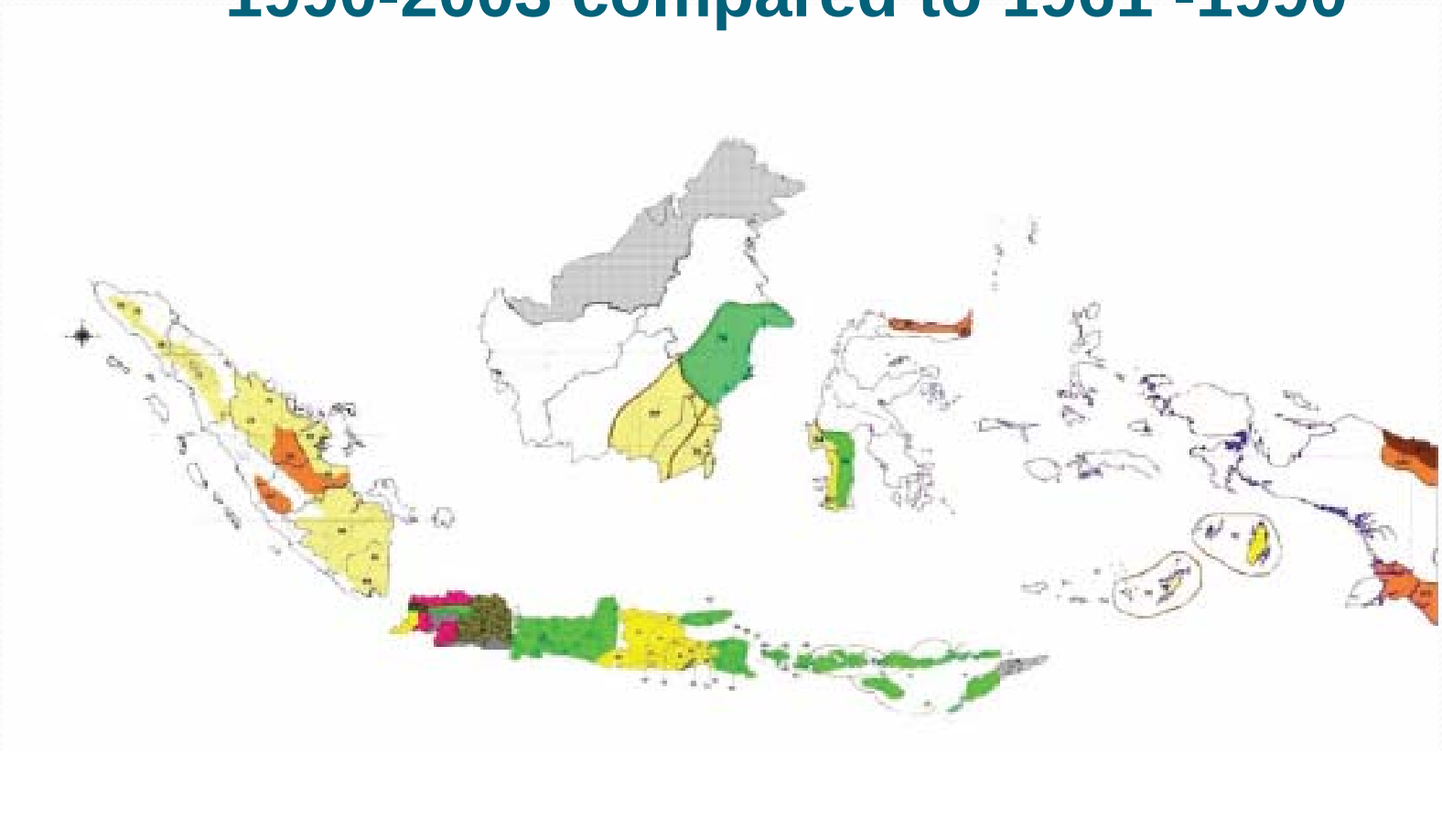
Changes in Seasonal Cycle

Based on the BMG data, seasonal anomalies from 1990 to 2003 was compared to 1930-1990 (Ratag, 2007):

- There are regions in which **the wet season shifted forward by 60 days**, such as those in West Sumatera, Jambi, Jayapura, and Merauke
- There are regions where **the wet season sfifted backward more than 30 days**, such as those in Banten and Jakarta
- Some regions, **the pattern did not change at all**, such as Ujung Kulon, Ujung Pandang, Madiun, Kediri, Pacitan, Gresik, Tuban, and Blitar

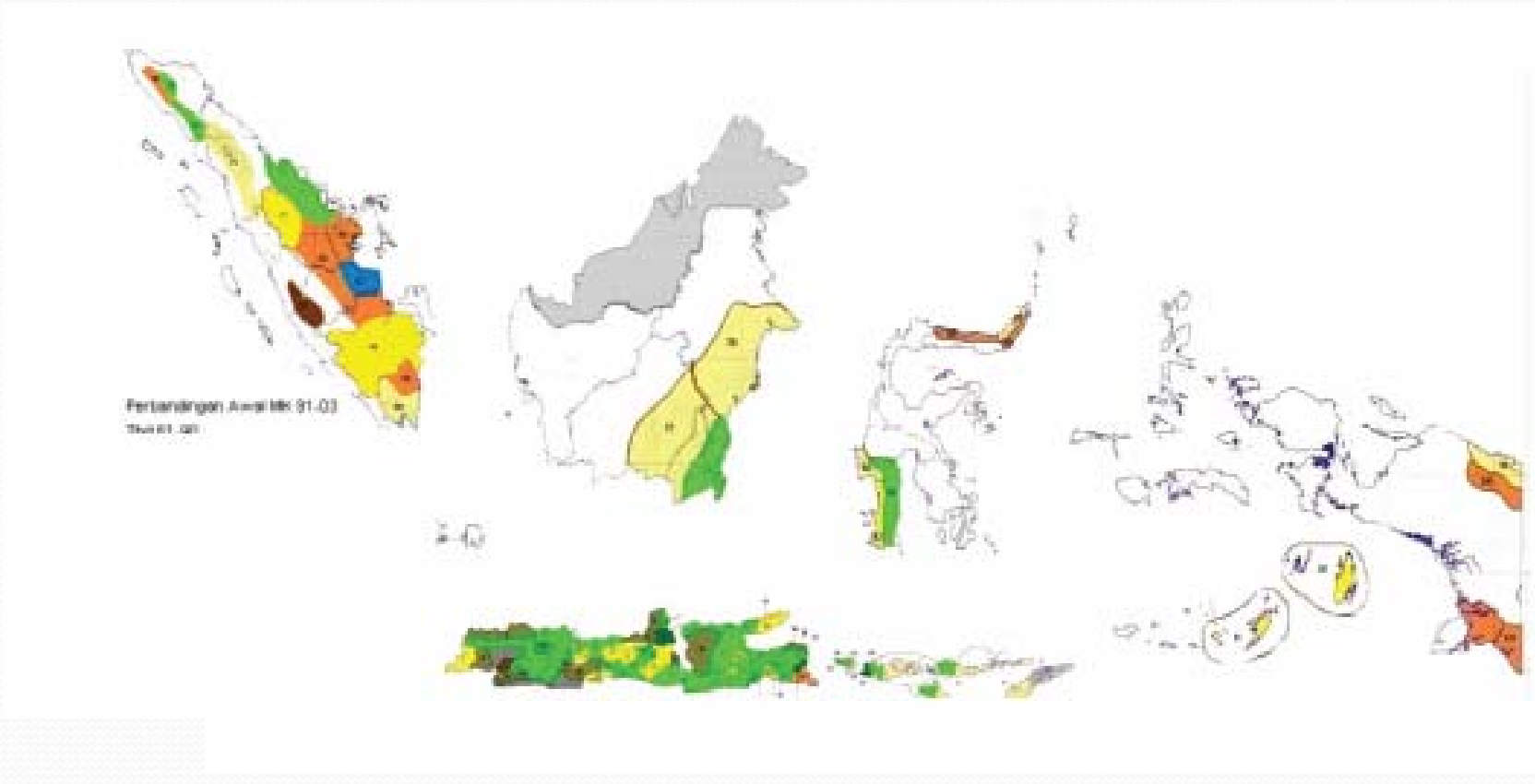
Wet Season Anomaly

1990-2003 compared to 1961 -1990



Source: Ratag, 2007

Dry Season Anomaly
1990-2003 compared to 1961 -1990



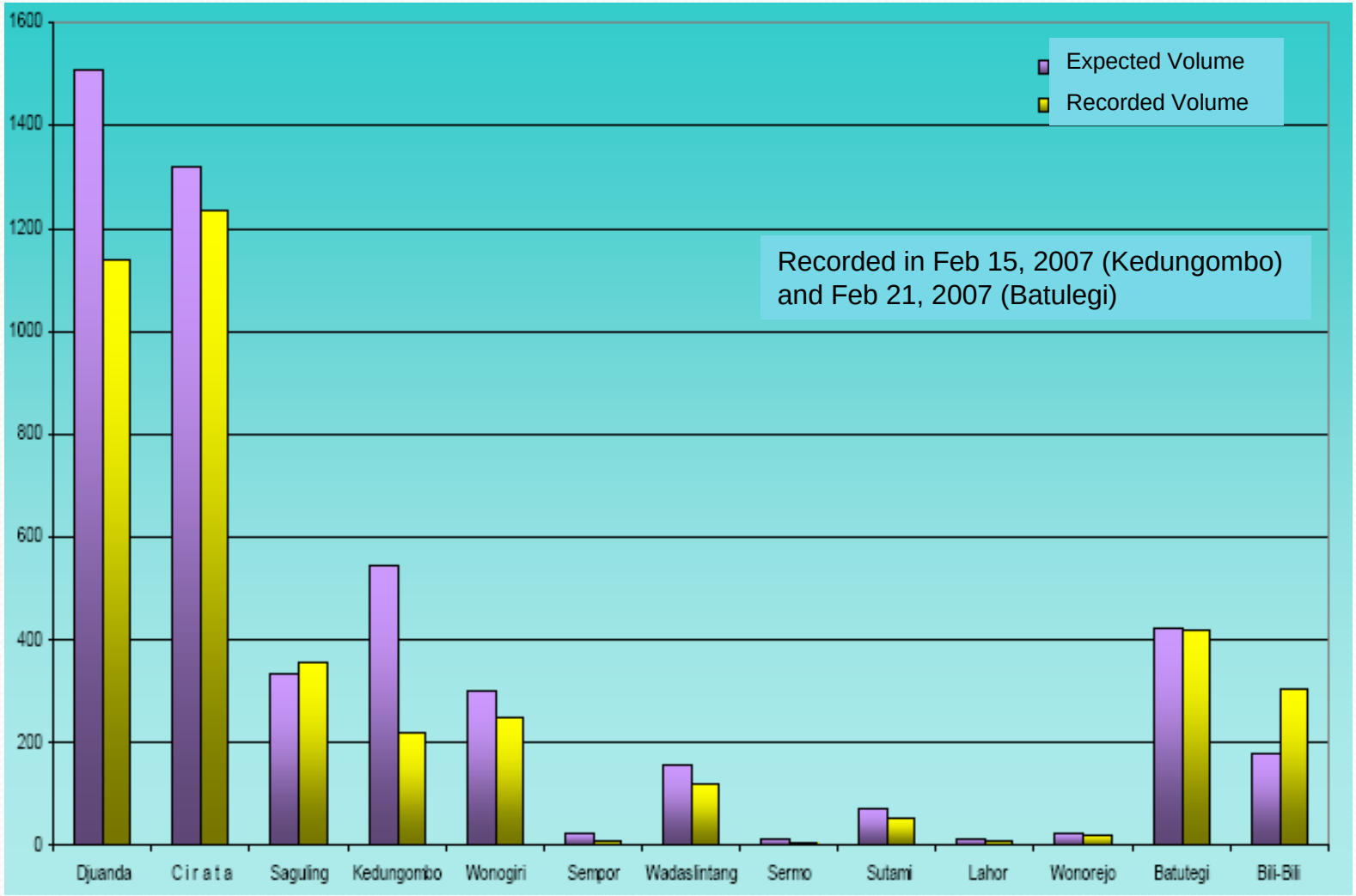
Source: Ratag, 2007

Depletion of Water Resources

The combination of increased in average temperature, a disrupted hydrological cycle in term of prolonged dry season, and a shorter but more intense wet season lead to a depletion (unsustainable) of water resources:

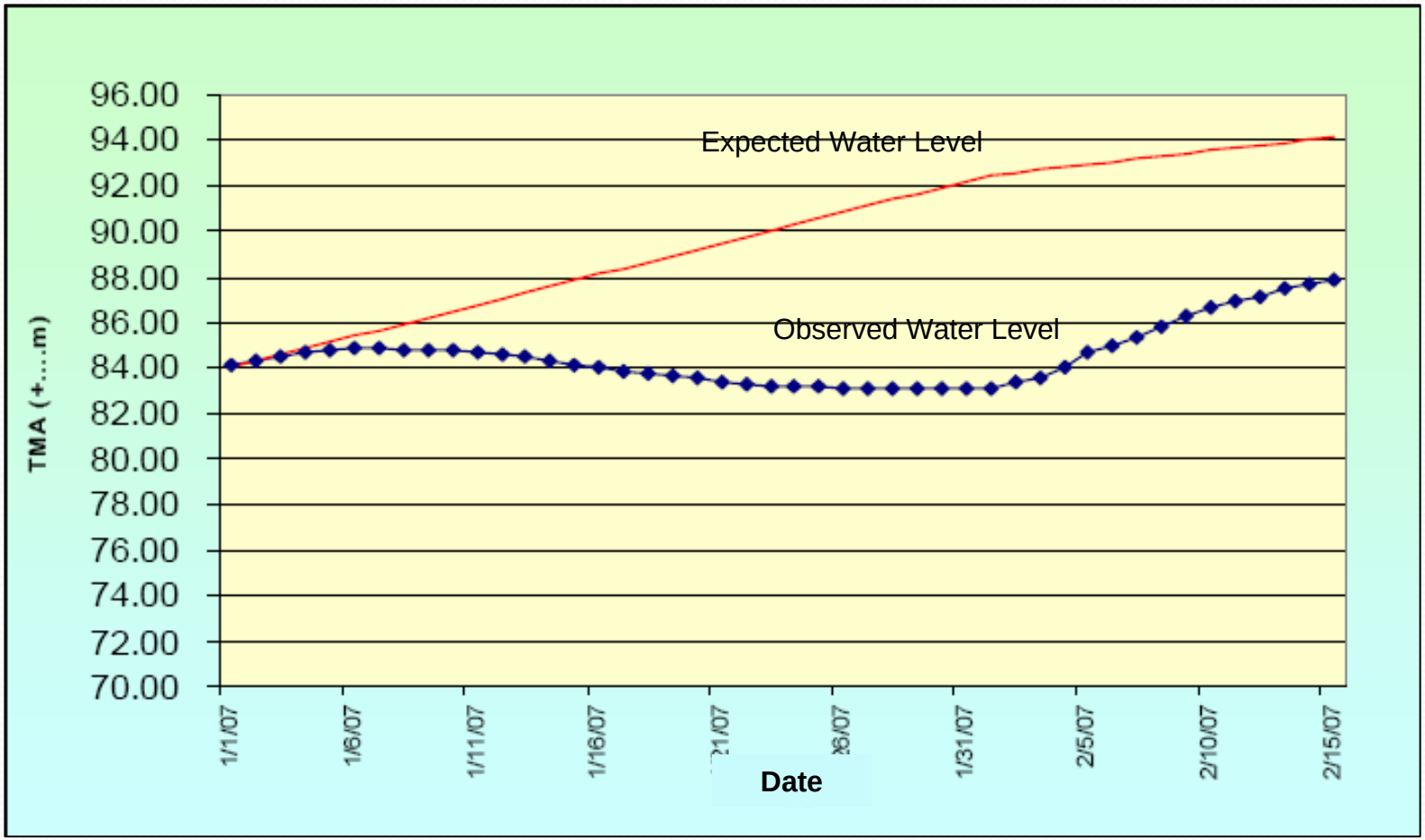
- **Rainfall was increased** by 7-33% in the Citarum watershed, 8-50% in the Brantas watershed, 8-56% in the Sadang watershed during the peak of rainy season
- Water level during the peak season in 2007 at most of the main dam and reservoar were **below the average maximum level**
- **Spread between max and min of water level** at all of the main dam and reservoar have been critically increasing.

Water Availability at the Main Dam



Source: PJT II

Water Level at Juanda Dam (Jan 1-Feb 15, 2007)

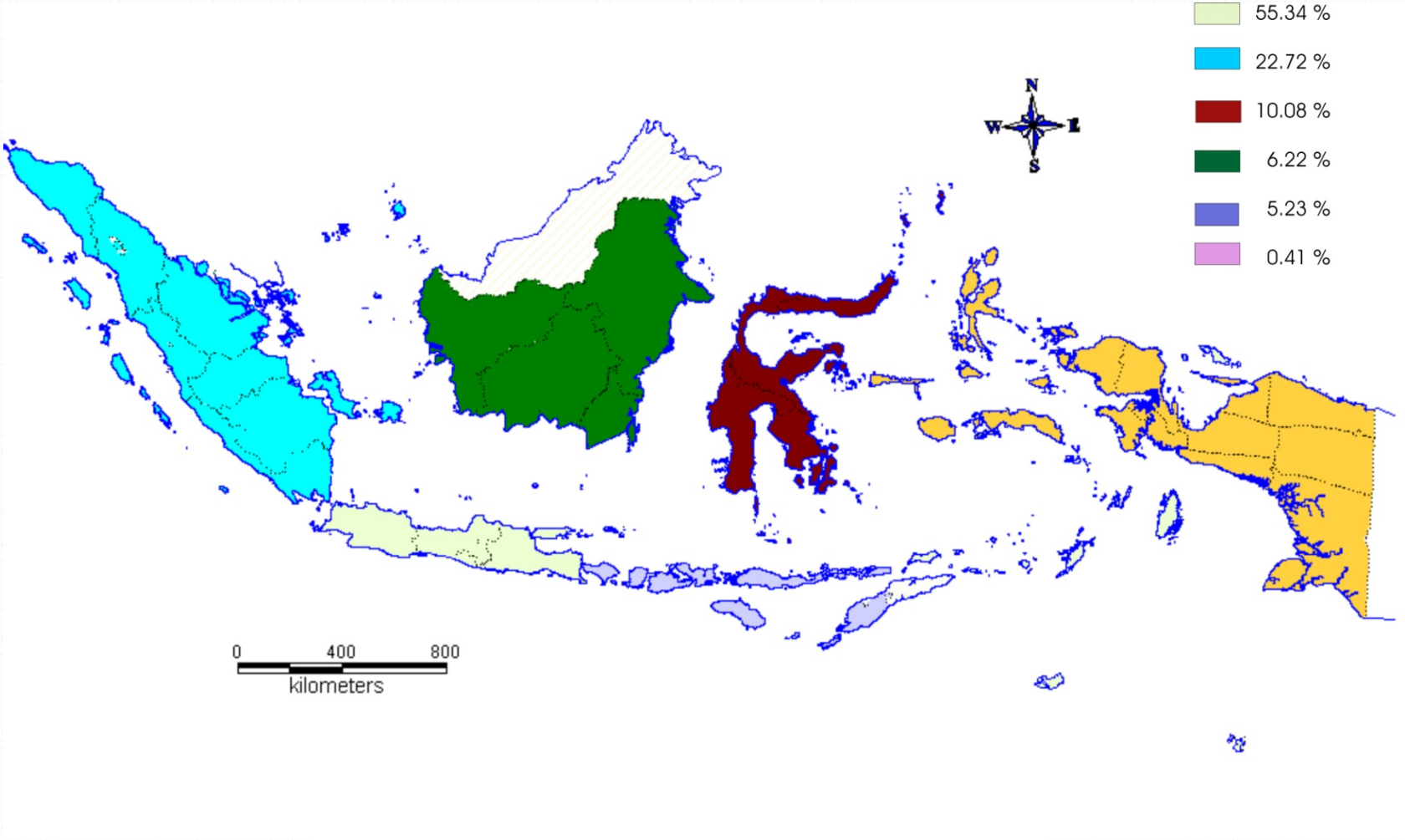


Source: PJT II

Impact on Agriculture and Food Security

- Combined effect of **climate variability** and **climate changes** could create dramatic impact on agriculture production in Indonesia
- Agricultural related activity still provides 46% of work employment but only contribute to 17% of the GNP
- Indonesia is the 4th most populous country, one of the biggest producers and consumers of rice is characterized by a rural poor who depend on agriculture for their livelihood
- High dependency on agriculture production translate to food security issue and threaten the livelihood of rural poor income group:
  - Farmers in Indonesia have an average land holding of 0.3-0.6 ha per household
  - Farming contribute to 60-100% of income source, where as rice farming contribute only 30-50% of those farm income
  - Farmers in Java spend 60-80% of their income for food expenditures

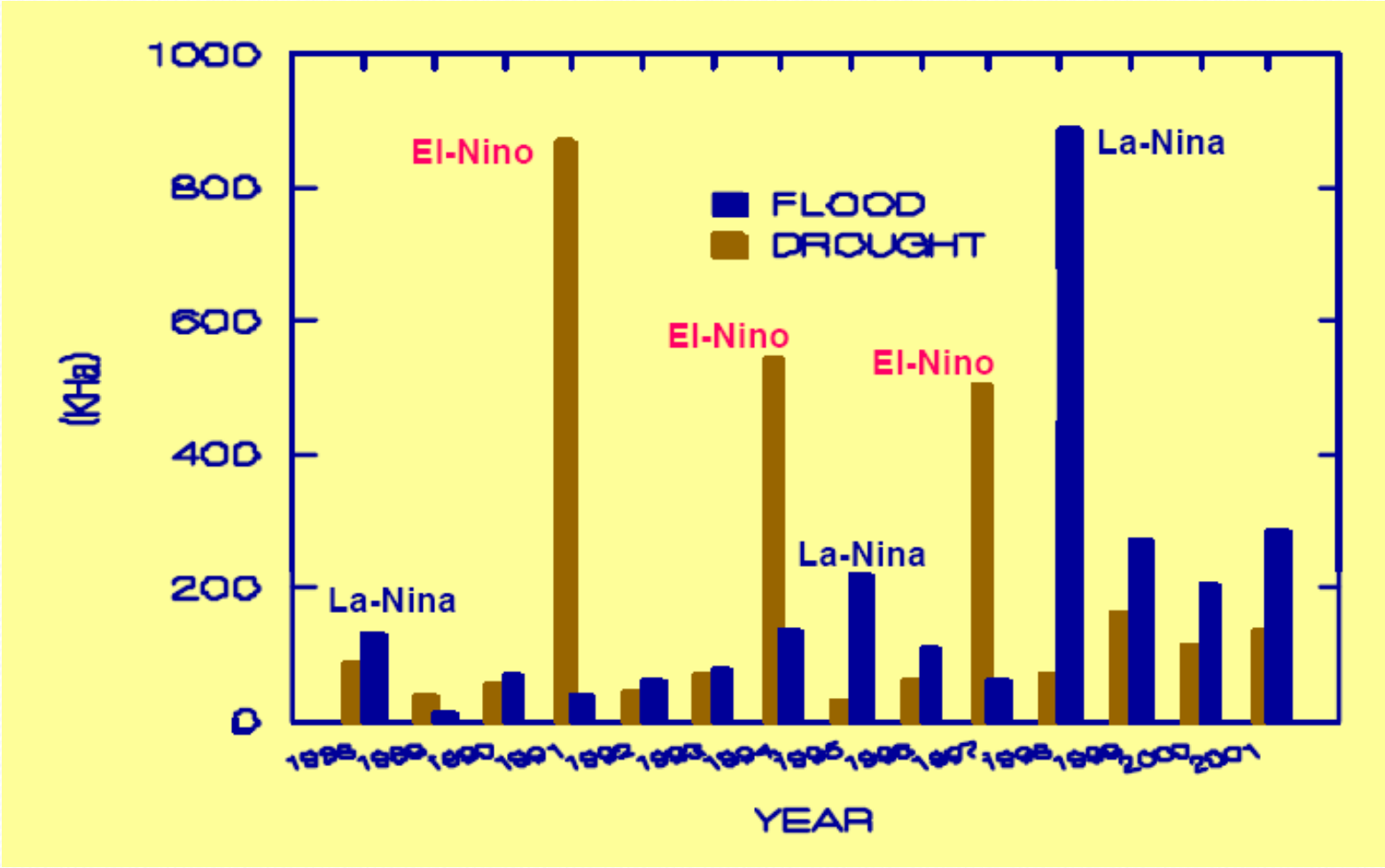
Share of Islands on Food (Rice) Production



Impact of Climate Variability

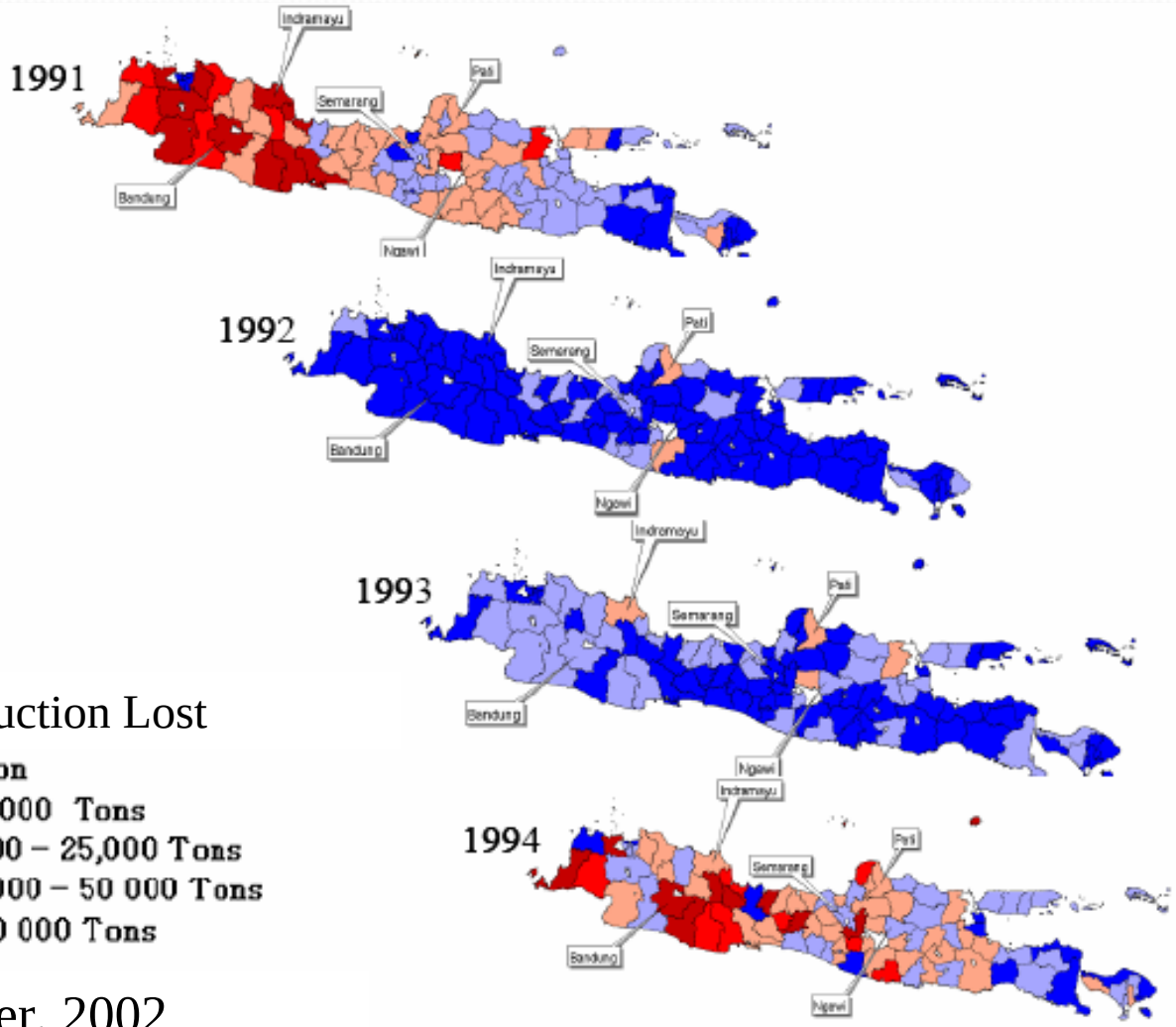
- The El Nino-Southern Oscillation (ENSO) cycles which occur in the Pasific Ocean every 2-7 years is believe to be the main cause of climate variability in Indonesia
- During a warm El Nino, the arival of the moonson rains is delayed, prolonging the dry season typically results in widespread droughts
- La Nina period results in flooding because of high intensity of the rainfall

Impact of Flood and Drought on Rice Production in Indonesia (1988-2001)



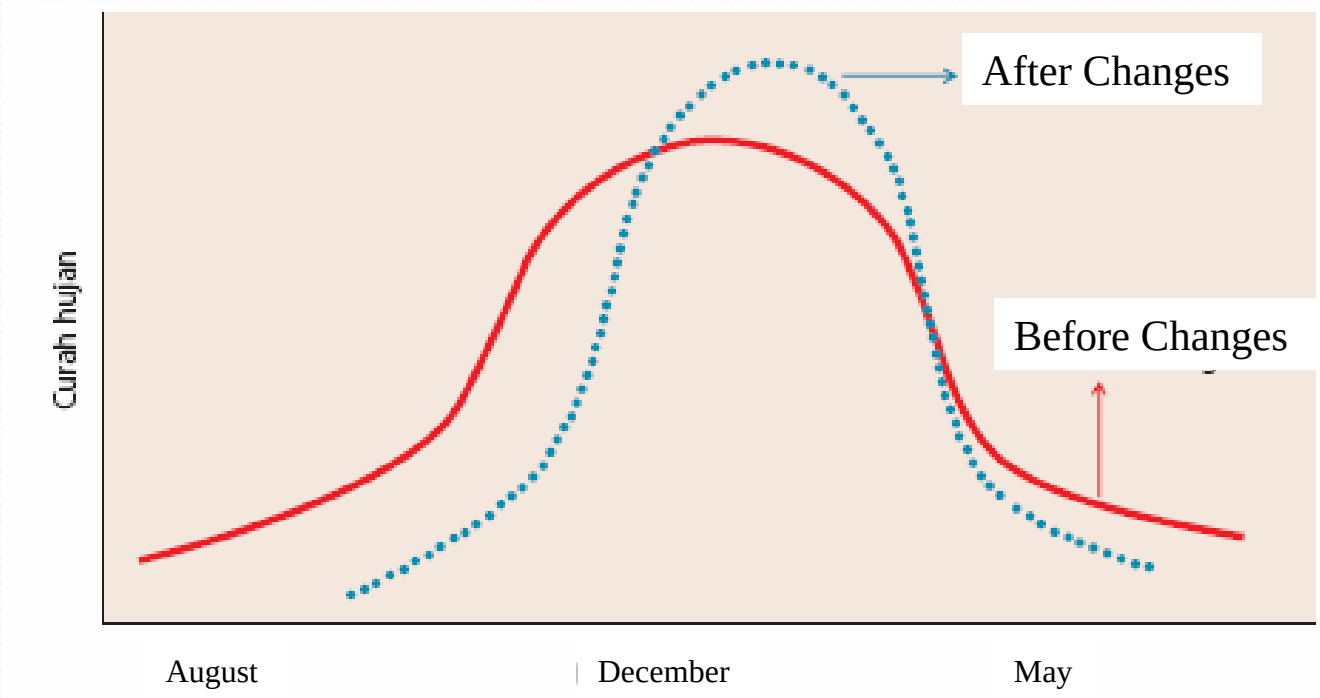
Source: Ministry of Agriculture, 2004

Production Lost on Java Island during El Nino (1991 and 1994) and Normal Year (1992 and 1993)



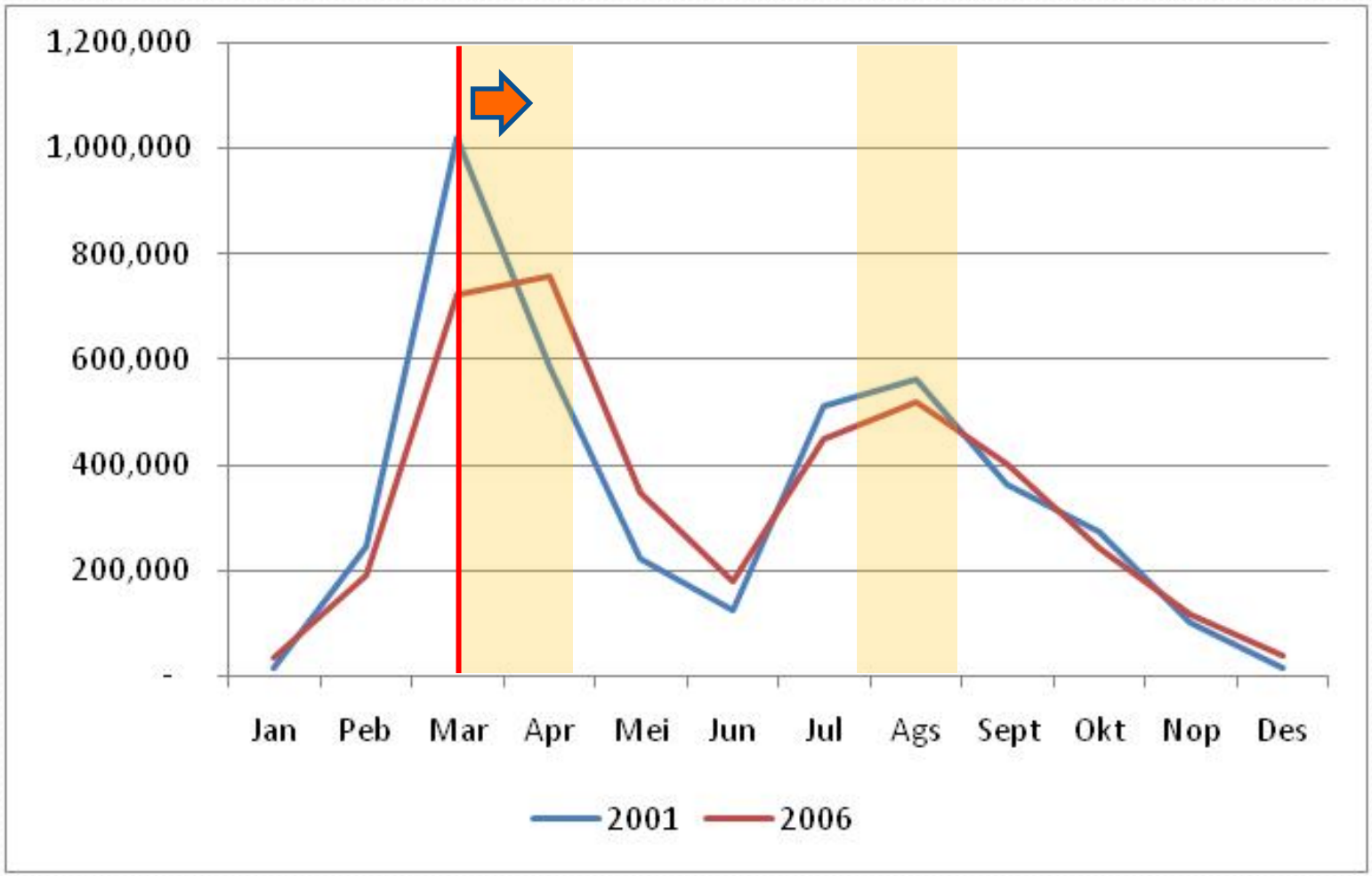
Source: Boer, 2002

Impact of Changes in Rainfall Pattern

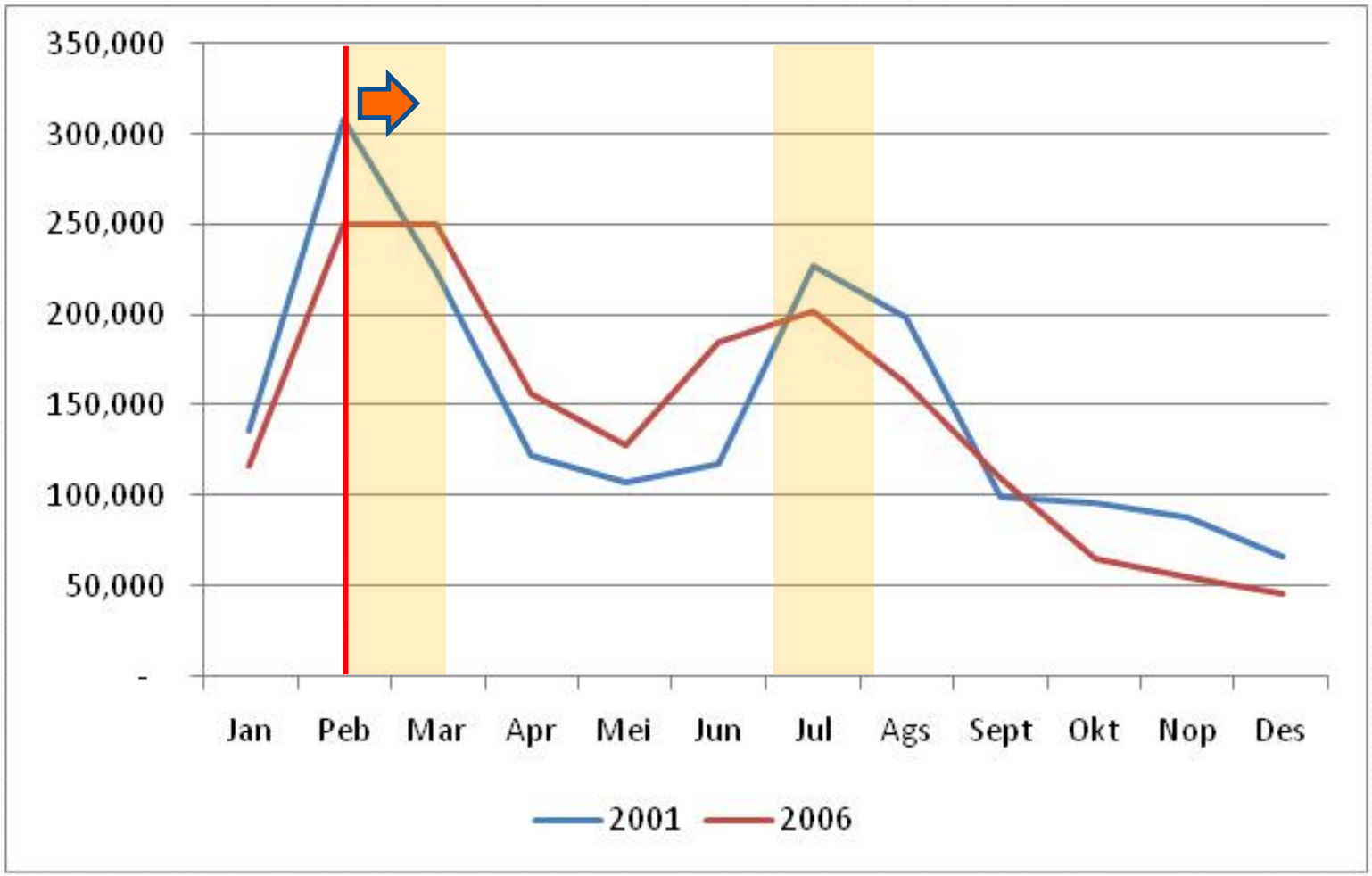


Source: Naylor et al, 2007

Harvest Pattern at North Coast Production Zone in the last 5 years (2001-2006)



Harvest Pattern at South West Java Production Zone in the last 5 years (2001-2006)



Farmers Adaptation

- Most farmers in Indonesia are not farming by choice, but because of no other income source alternatives → **rational but not professional** (**bounded rationality**)
- Those farmers preceive farming activities as rutin and subsisten cultural activities rather than commercial/market oriented activities
- Not fully informed on what is going on and not too responsive to market insentive
- Farmers in middle and high land area (vegetables) started to shift to commercial (high value) commodity since the last 5-10 years:
  - More aware on the climate changes, including market modernization
  - Already adapting to the changes by appying technology

Government Adaptation

- The awereness started just prior to the Climate Changes Converence in Bali in 3-14 December 2007
- Several research (DIFD, World Bank, Ministry of Environmental) and several committee initiated during 2006-2007
- Several modeling have been developed (2004-2007)
- Adaptation strategy assisted by several international organization

Adaptation Strategy and Policy Implication

- Development of information and mitigation system, and disaster early warning system
- Improvement on monitoring, and public awareness on the climate change
- Improvement on water management:
  - Preserving the ground water and water cathment area
  - Investment in irrigation, dam and water reserve system
- Adaptive agricultural production system:
  - Adjusted planting and harvesting period
  - New harvesting system
  - Development of drought-tolerant variety of food crops
- Crop diversification
- Protection and preservation of coral and manggrove
- Research and monitoring on the coastal zone and ecosystem