Geoinformatics Research Centre

Modelling the climate change effects on Malaysia's oil palm yield

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and

Prof Ajit Narayanan

overview

- Introduction
  - on a world scale (food source, biofuel and economy)
  - Current situation and issues
- Literature
- Methodology
- Results & conclusions
- Acknowledgements

world population and oil demand

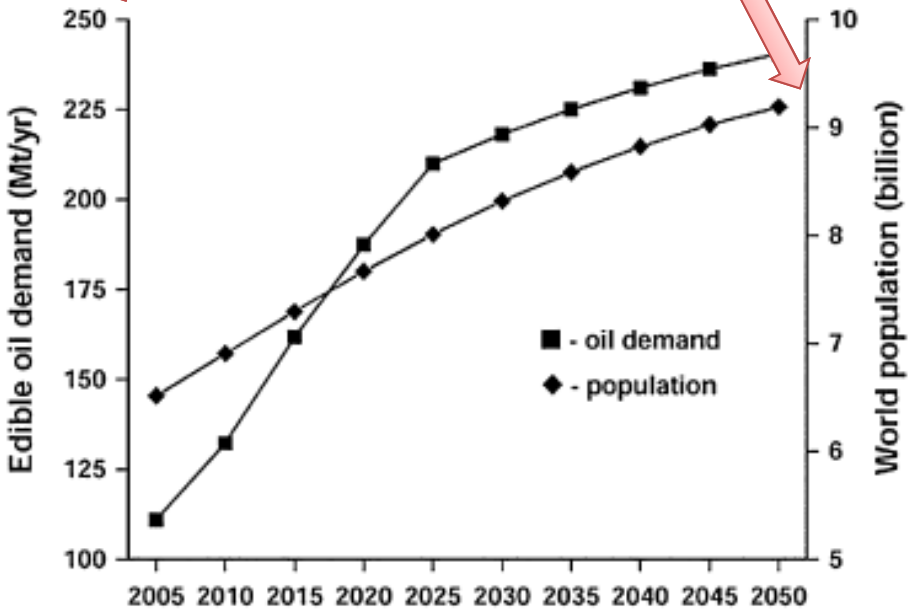
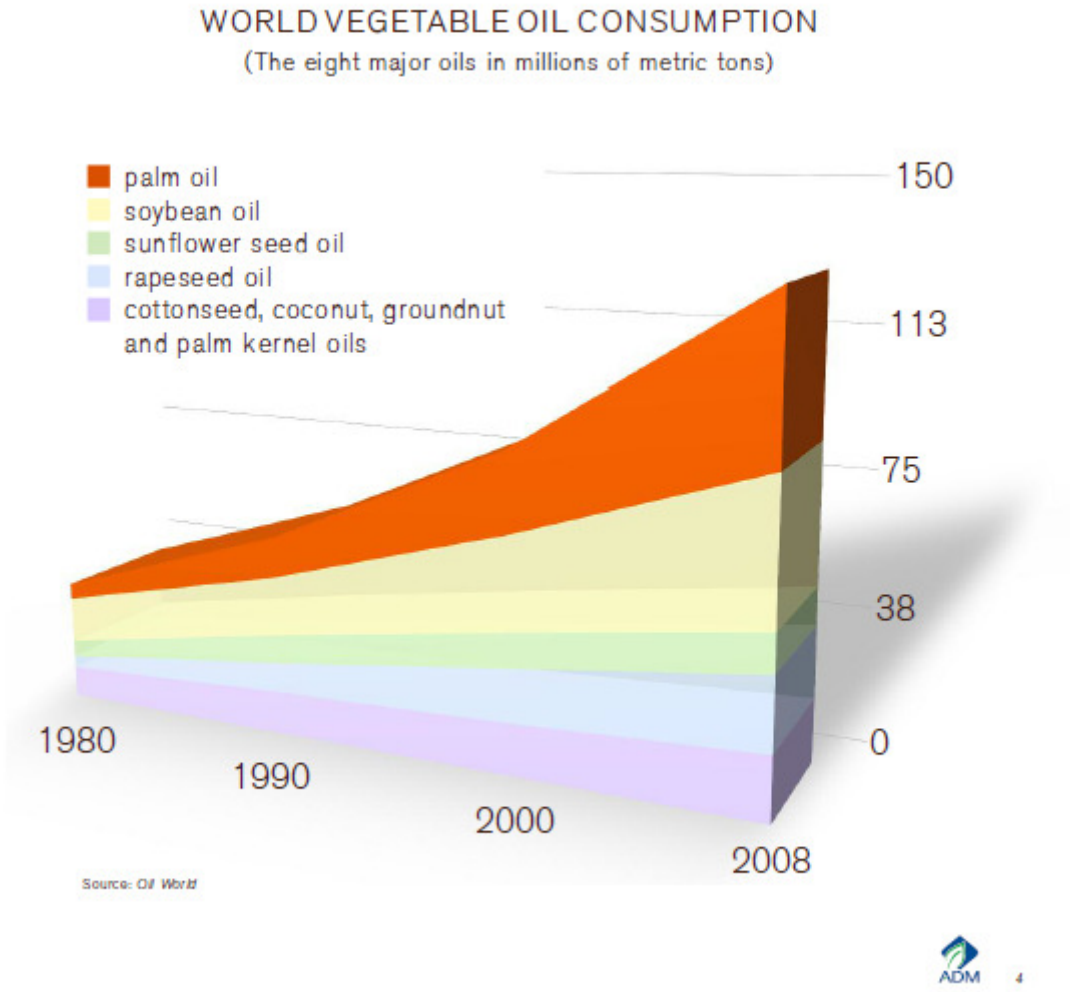
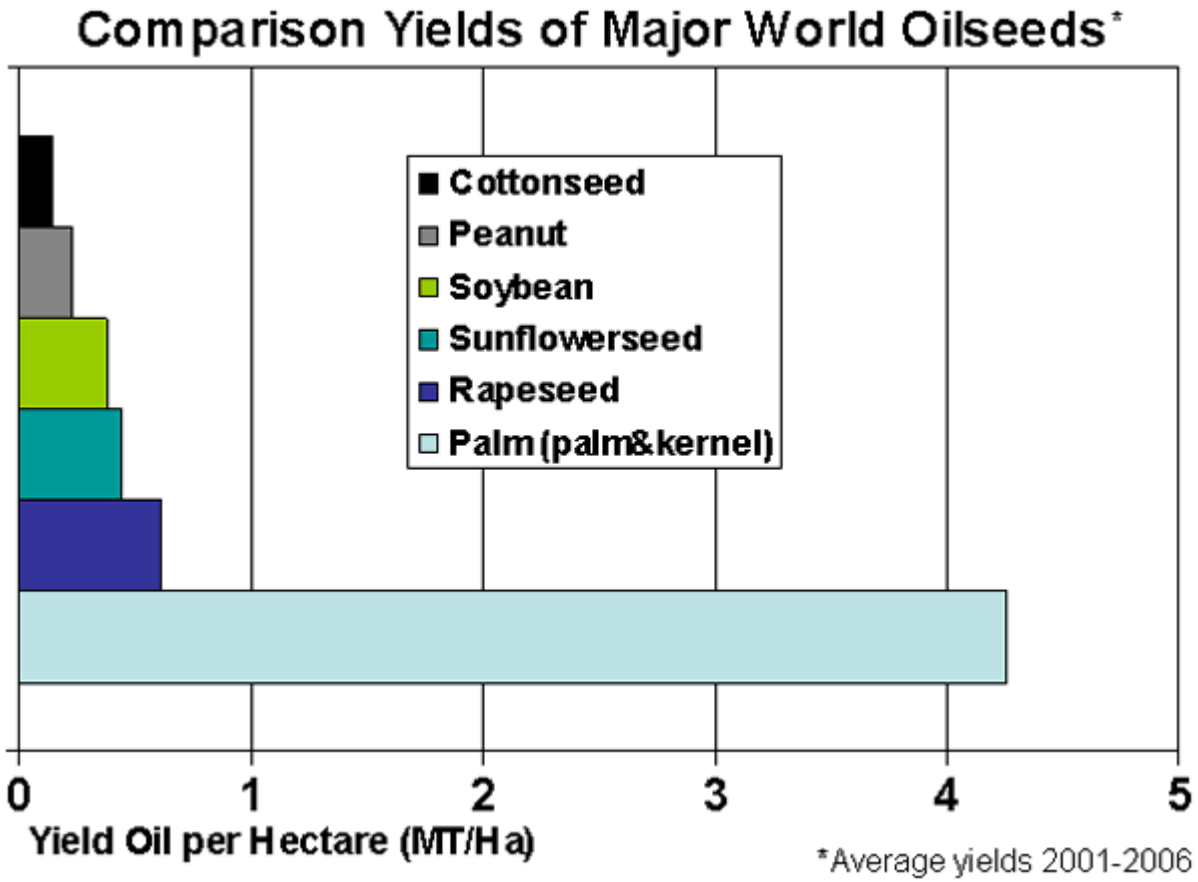


Fig. 1 – Expected trends in world population and edible use of vegetable oil. Population from UNPD (2006). Demand estimated from population and per capita consumption, as described in text.

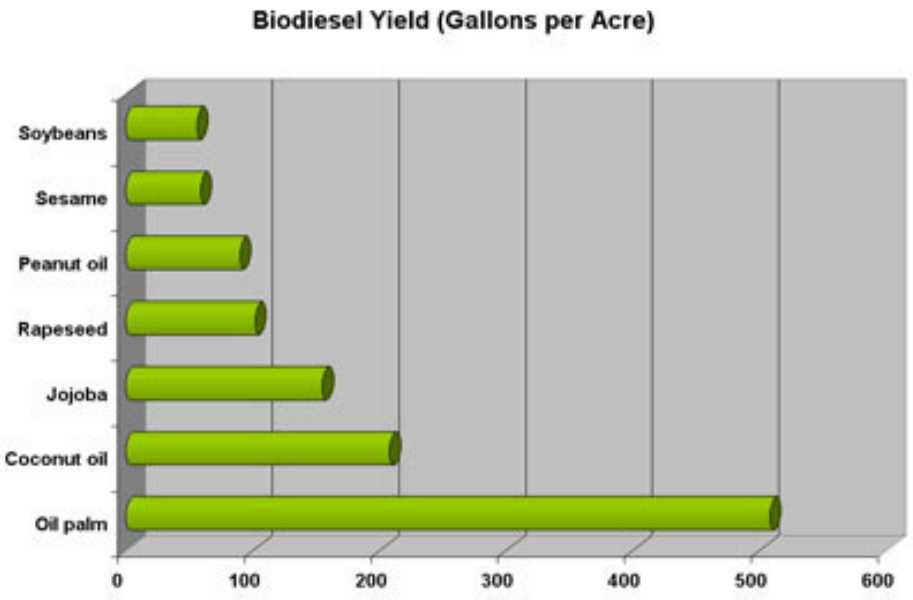
Source: Corley R H V (2009) How much oil do we need? Env Science & Policy 12 (2009) 134-119



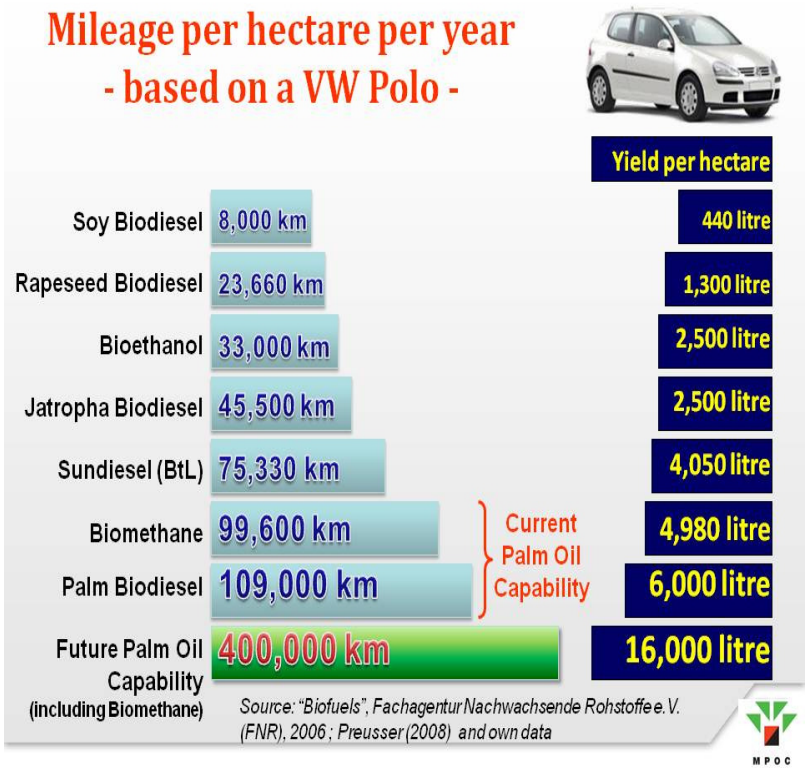
www.greenpalm.org



http://www.pecad.fas.usda.gov/highlights/2007/12/Indonesia_palmoil/



http://news.mongabay.com/2008/1203-palm_oil.html

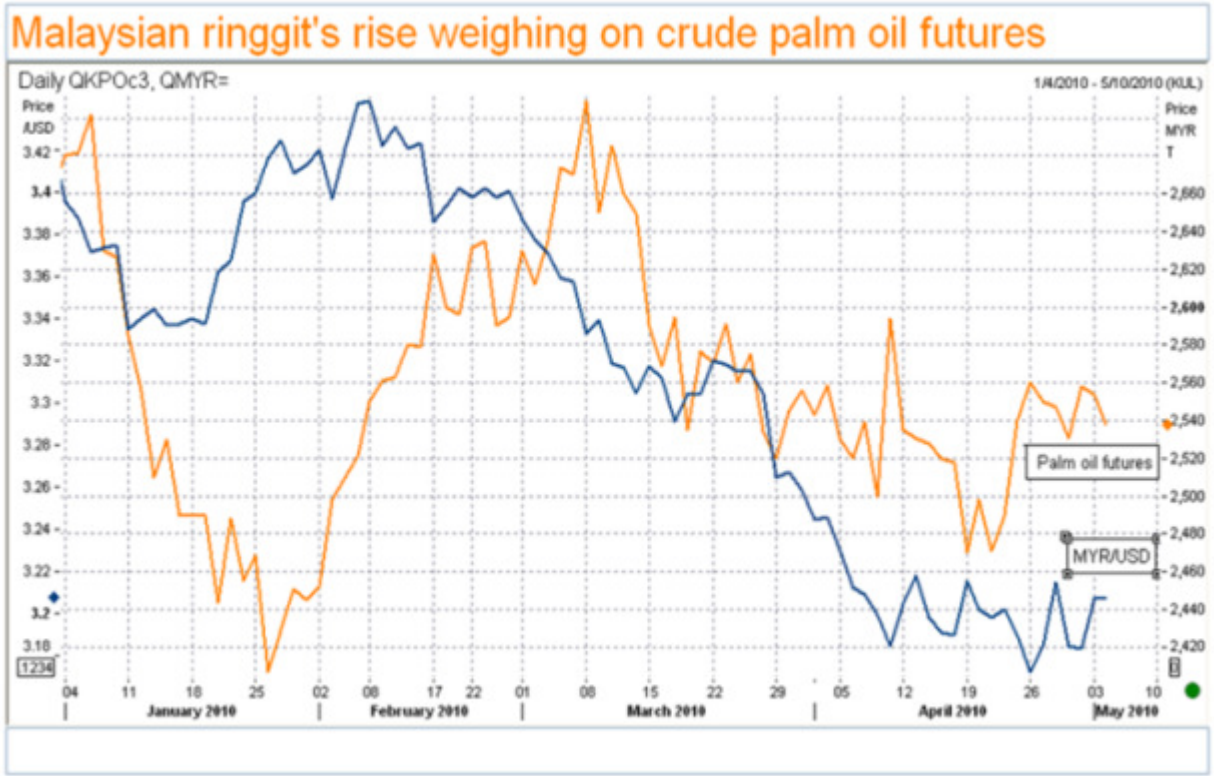


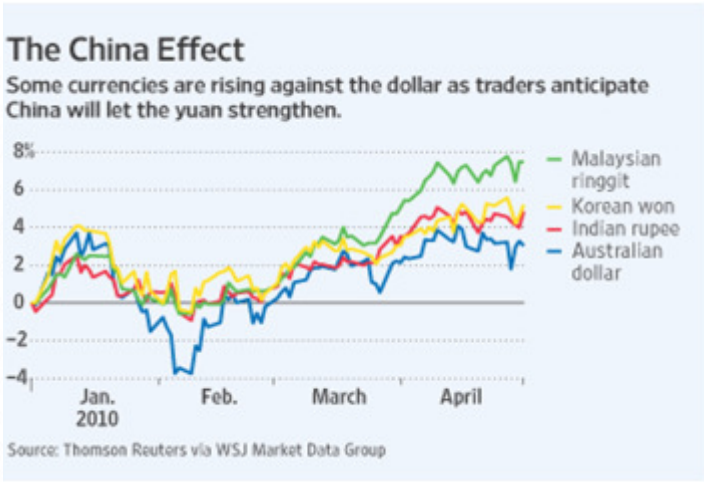
http://cspo-biodiesel.blogspot.co.nz/2009/05/palm-oil-based-biofuel-dilemma.html

palm oil producing countries

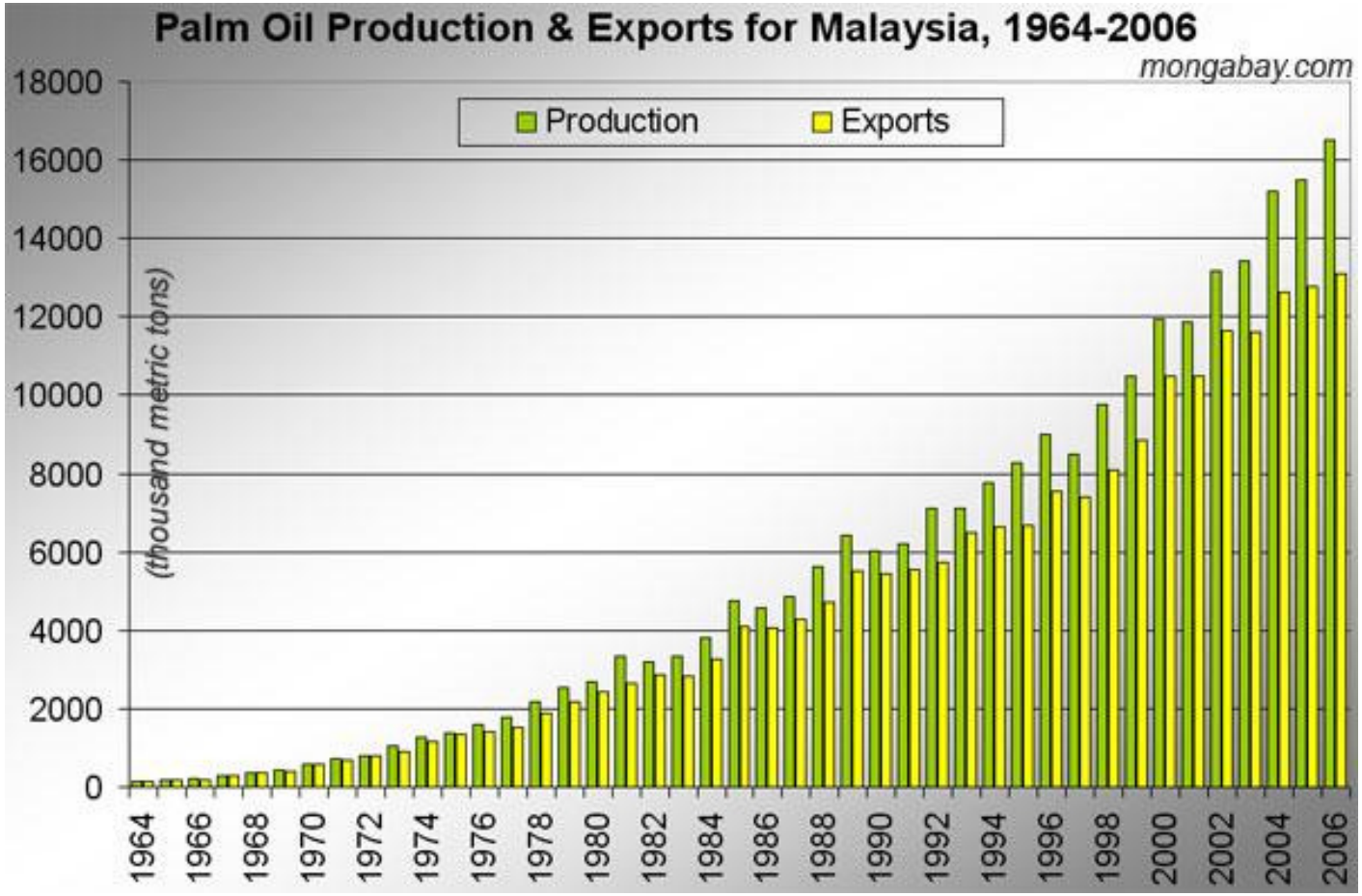
http://www.greenpalm.org/en/about-palm-oil/where-is-palm-oil-grown

palm oil & Malaysia's economy



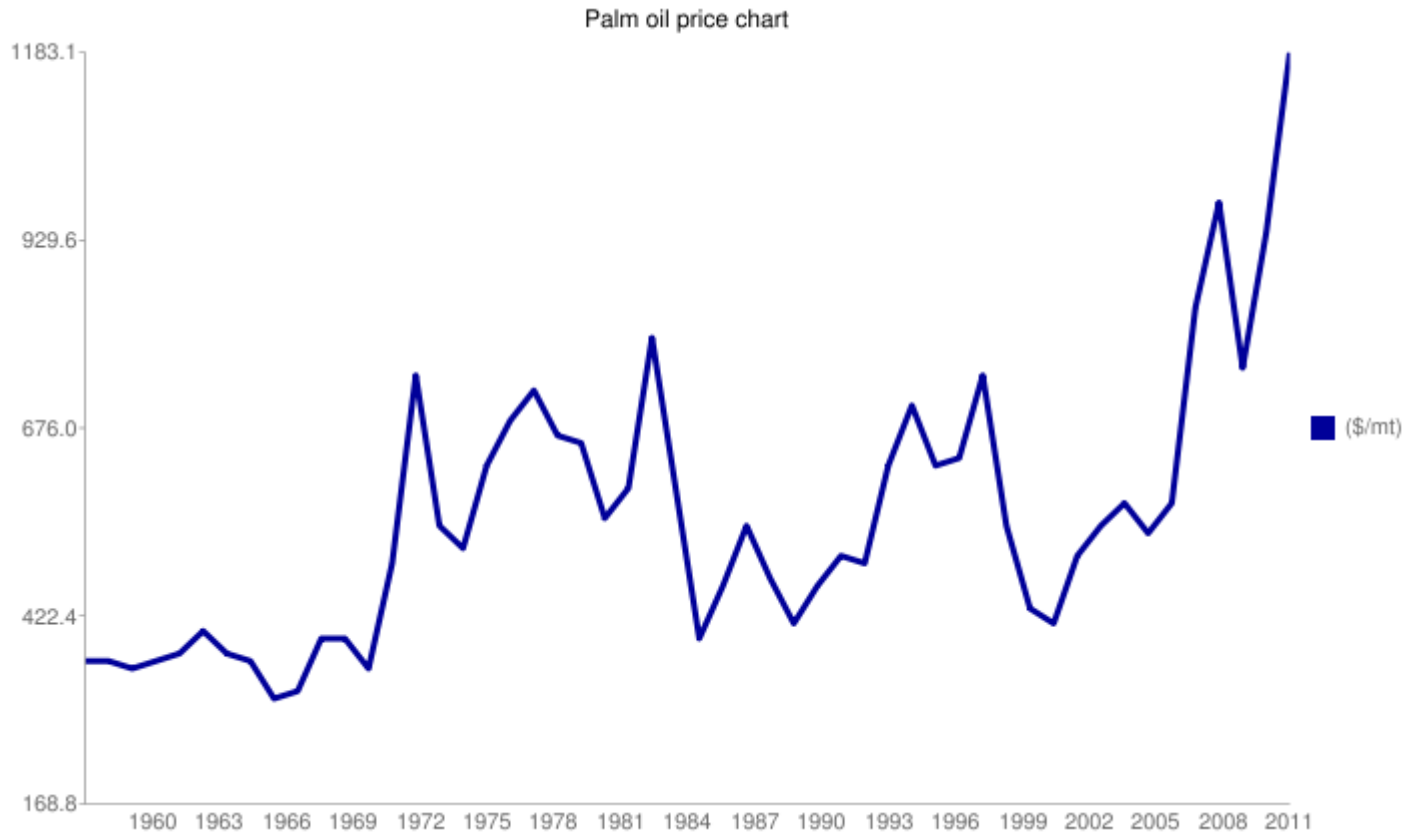


http://seekingalpha.com/article/211037-malaysian-ringgit-asia-s-best-performing-currency



http://mohdshahnom.blogspot.com/2009/03/kemusnahan-hutan-malaysia.html

palm oil price chart



http://www.mongabay.com/images/commodities/charts/palm_oil.html

MPOC data

MONTHLY STATUS

1. Malaysia's Exports & Imports

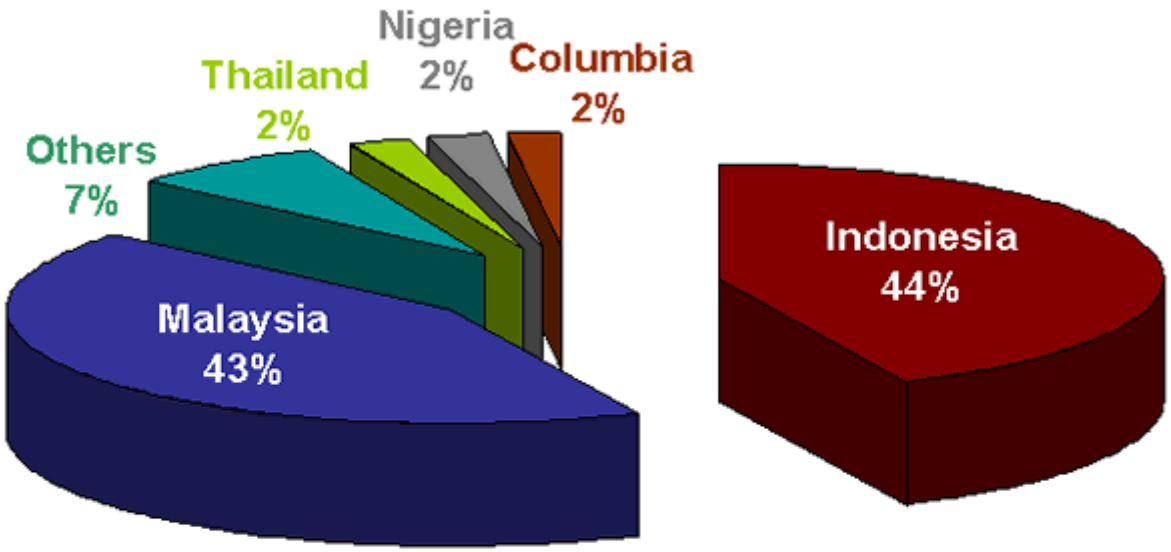
	Exports		Imports	
	2009	2010	2009	2010
Jan	1,353,686	1,461,731	29,863	139,378
Feb	1,257,482		27,423	
Mar	1,260,797		15,693	
Apr	1,193,524		42,579	
May	1,230,449		114,681	
Jun	1,279,701		87,078	
Jul	1,454,541		93,288	
Aug	1,317,093		97,796	
Sep	1,322,900		118,328	
Oct	1,478,462		75,486	
Nov	1,501,504		56,384	
Dec	1,224,353		153,797	
Jan-Dec	15,874,492		912,396	

http://www.mpoc.org.my/

where are we today?

- since first commercial 1972 plantation op price fluctuated significantly
- the good news is increasing global demand for oil palm solutions i.e., edible oil & biodiesel
- Malaysia's production of edible oil
  - four major source crops namely, palm, soybean, rapeseed, and sunflower
  - oil from palm seed kernel 27% highest world's oil and fat consumption

2006 World Palm Oil Production



- Indonesia
- Malaysia
- Others
- Thailand
- Nigeria
- Columbia

Country	%	'000 Tons
Indonesia	44%	15900
Malaysia	43%	15881
Others	7%	2718
Thailand	2%	820
Nigeria	2%	815
Columbia	2%	711
Source Data: Oil World, GAPKI		

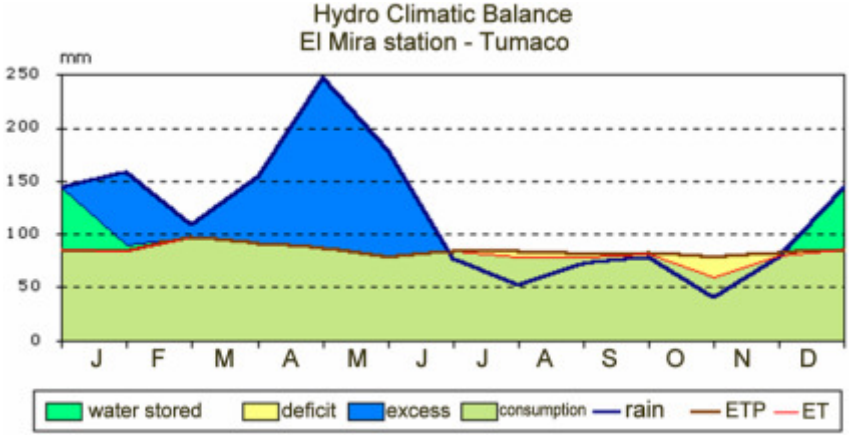
http://www.pecad.fas.usda.gov/highlights/2007/12/Indonesia_palmoil/

issues

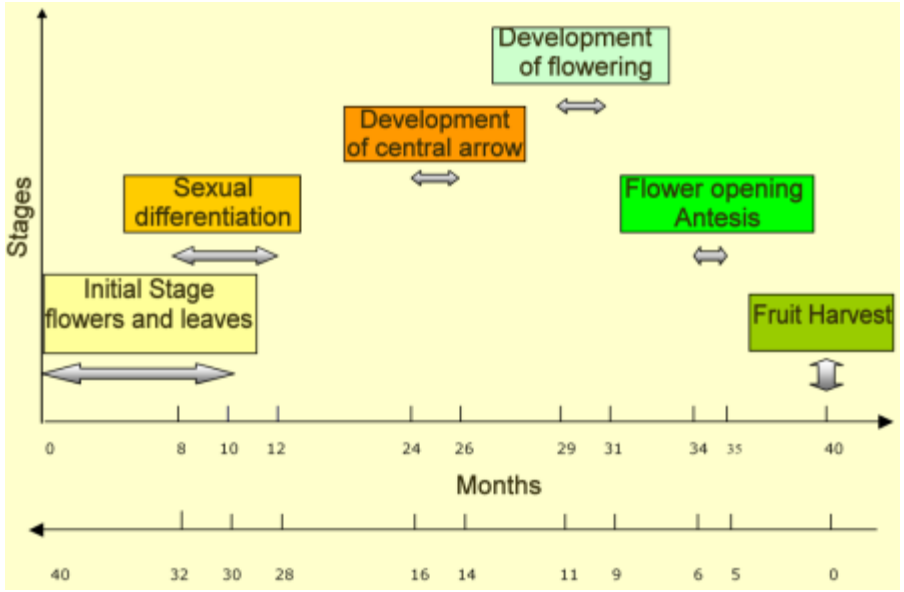
http://www.treehugger.com/tag/deforestation
http://earthissues.multiply.com/journal/item/112/DOVE_Unilever_Stop_destroying_rainforests
http://www.greenpeace.org/eastasia/campaigns/forests/problems/palm-oil/
http://www.wri.org/stories/2011/01/converting-palm-oil-companies-forest-destroyers-fores-protectors
http://www.businessgreen.com/bg/opinion/2031931/war-palm-oil-avoid-taking
http://redskynews.com/?cat=1043

LITERATURE

phenology -tree level interactions

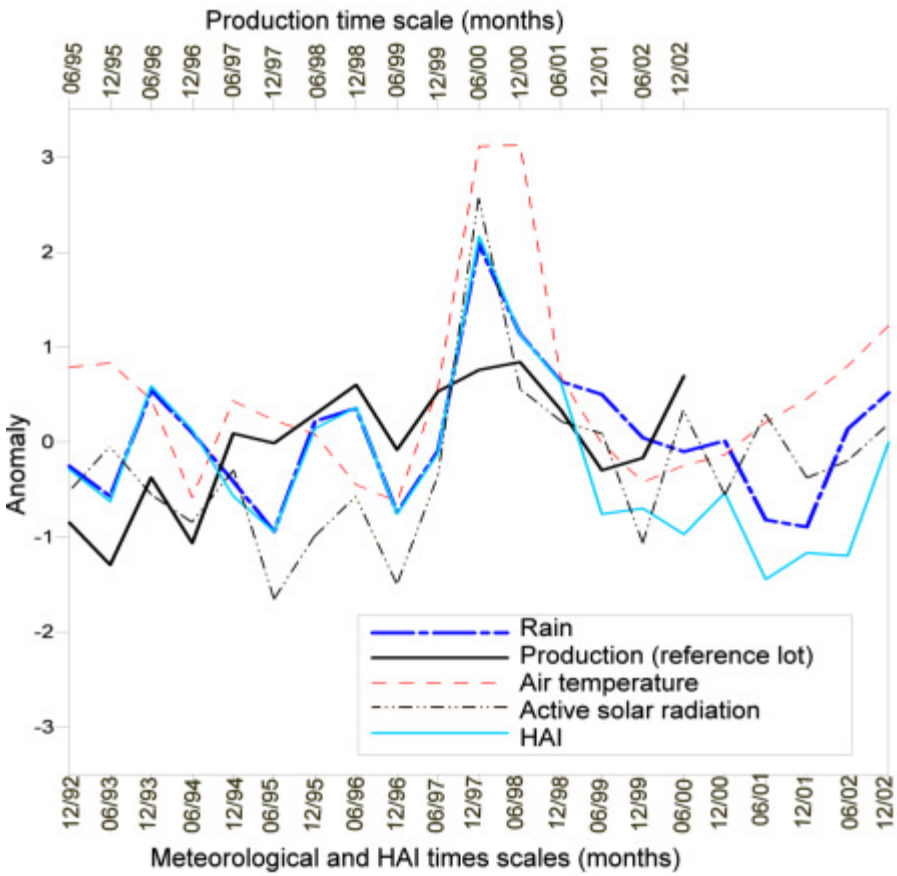


Hydro-climatic Balance (from Palmer, 1968) of Tumaco (Granja ElMira). During the first and last months of an average year there is storage of water on the soils.
The first semester (**rainiest** indicated by the blue line) has excess of water while during the second semester (less rainy) there is more consumptions (evo-transpiration) that could cause **sever droughts**



Oil palm tree life cycle stages from the initial stage (t=0), to the fruit harvest (t=40 months).

M. C. Cadena1,3, A. Devis-Morales1,2, J. D. Pab´on4, I. M´alikov1, J. A. Reyna-Moreno1, and J. R. Ortiz1` Relationship between the 1997/98 El Ni ˜no and 1999/2001 La Ni˜na events and oil palm tree production in Tumaco, Southwestern Colombia Advances in Geosciences, 6, 195–199, 2006vSRef-ID: 1680-7359/adgeo/2006-6-195



Highest cross-correlation found (r=0.86) between climatic and agro-climatic anomalies (1992–2002) and production anomaly (1995–2002) at Granja El Mira experimental Lot-Tumaco, Colombia.

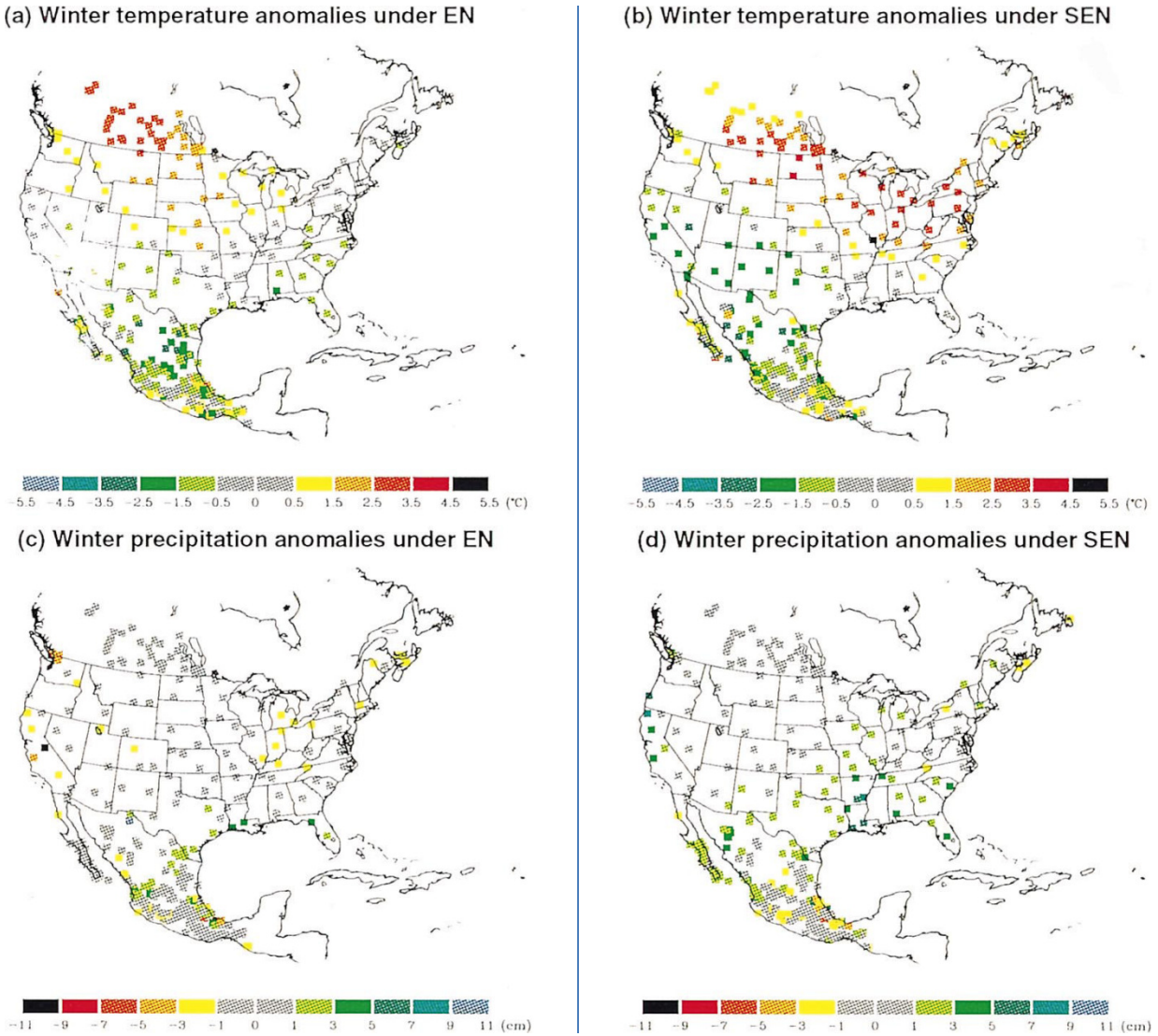
The meteorological variability of July 1992 affected the January 1995 oil palm production (**2.6 years later**).

Table 1. Annual yields of crude palm oil production (tons/hectare) of Tumaco region (Fedepalma, 2004b).

Year	1999	200	2001	2002	2003	Growth rate (%)
Annual yield (tons/hect)	4.2	4.1	3.9	3.9	3.7	−6.3

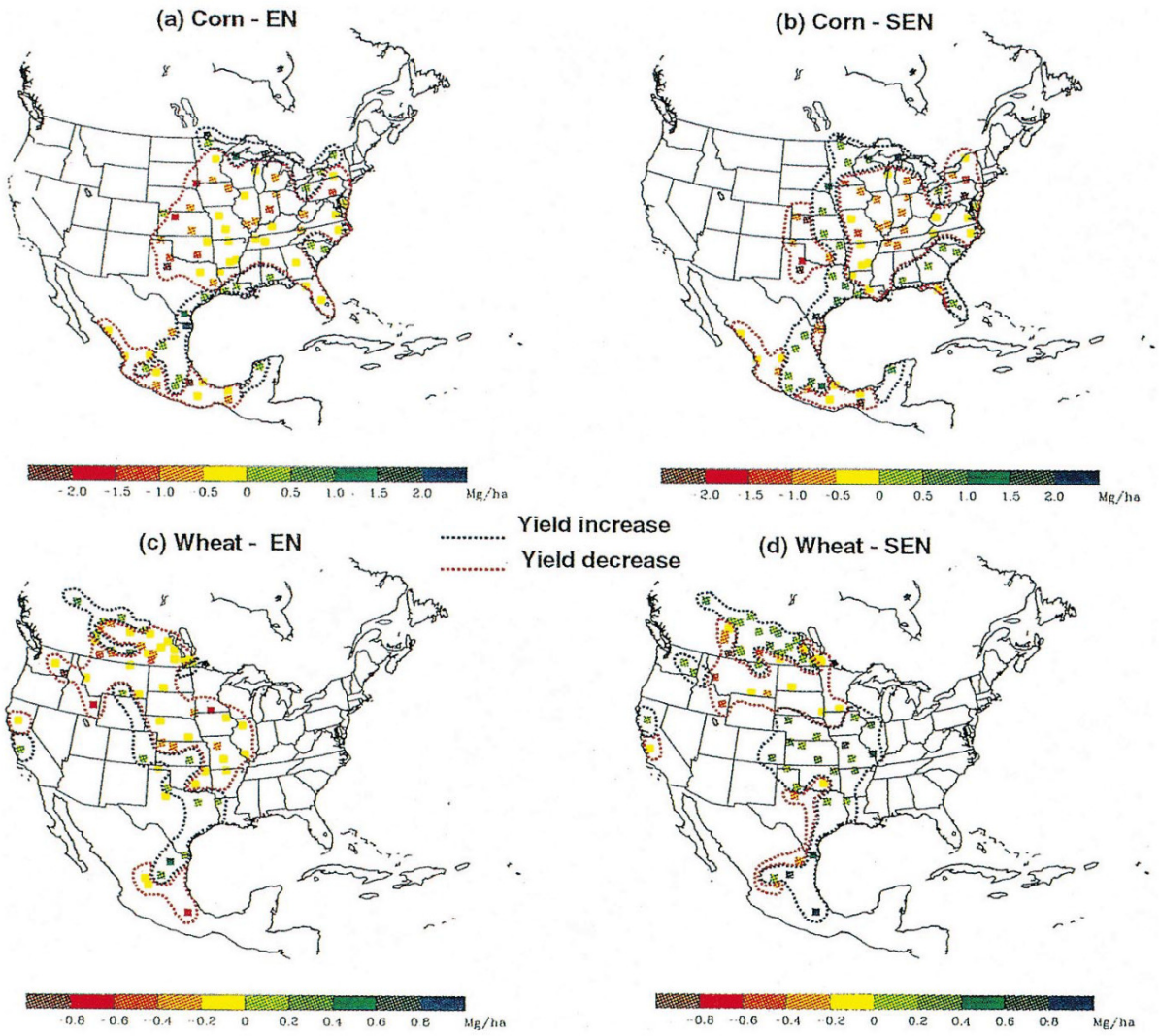
oil palm growth stages

- Frond emergence or initial stage: high temperatures (or prolonged droughts) can lead to reduced evapotranspiration and delays in leaf opening (27 months prior to harvest and with lagged effects shown on harvest)
- Sexual differentiation or bunch formation:
  - high temperatures and low solar radiation lead to reduced female / male flower ratio (17 months prior to harvest and with lagged effects shown on harvest)
- Central arrow development:
- Flower development:
- Flower opening or anthesis:
- Fruit maturation (final stage/ 6 months prior to harvest).



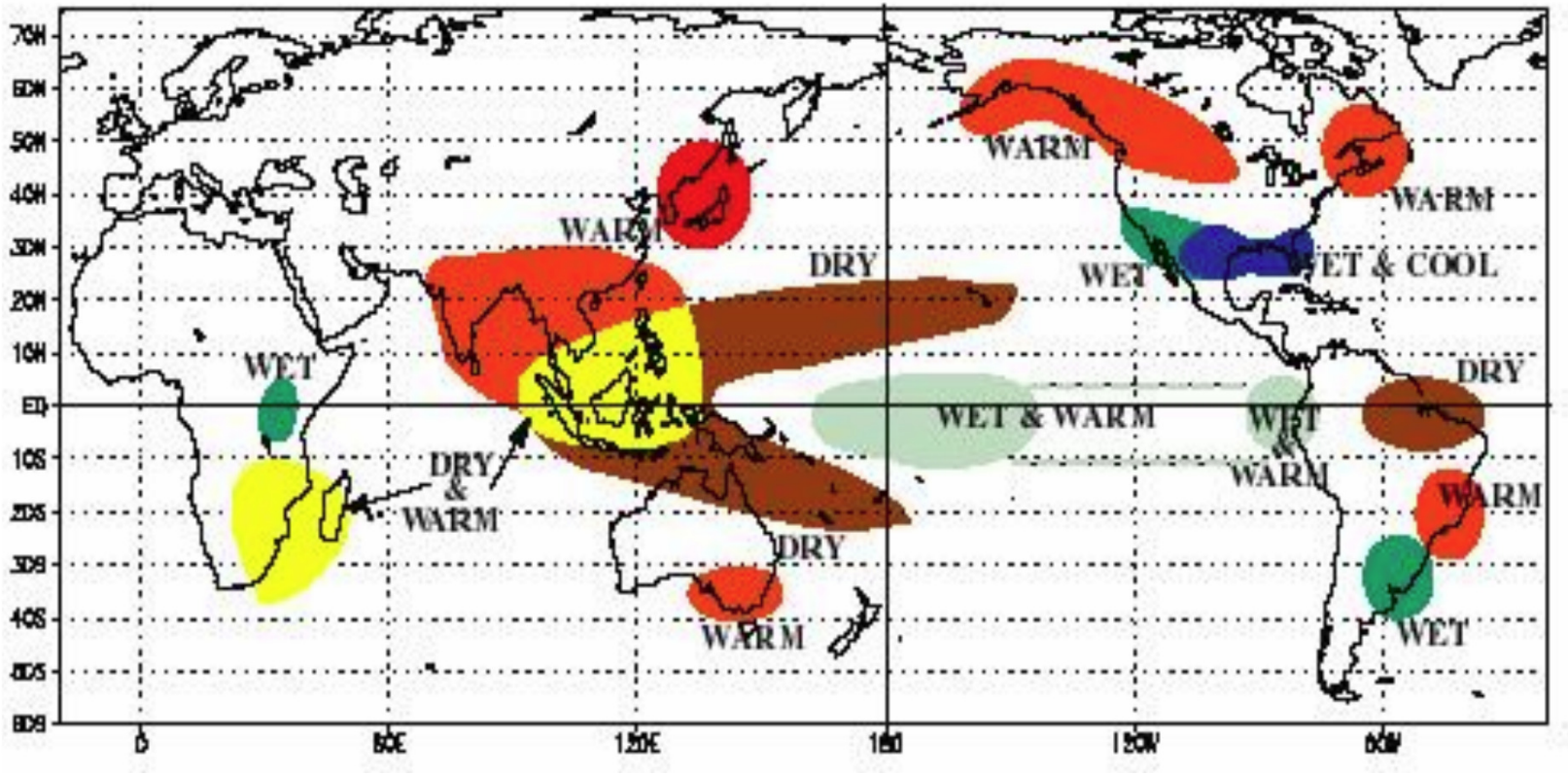
Geographic distribution of temperature and precipitation anomalies under EN and SEN.

R. C. Izaurralde, N. J. Rosenberg, R. A. Brown, D. M. Legler, R. Srinivasan and M. Tiscareno Lopez, "Modeled effects of moderate and strong 'Los Ninos' on crop productivity in North America," *Agricultural and Forest Meteorology, 94 (3-4) , pp. 259-268. ,* 1999



Geographic distribution of corn and wheat yield deviations under EN and SEN.

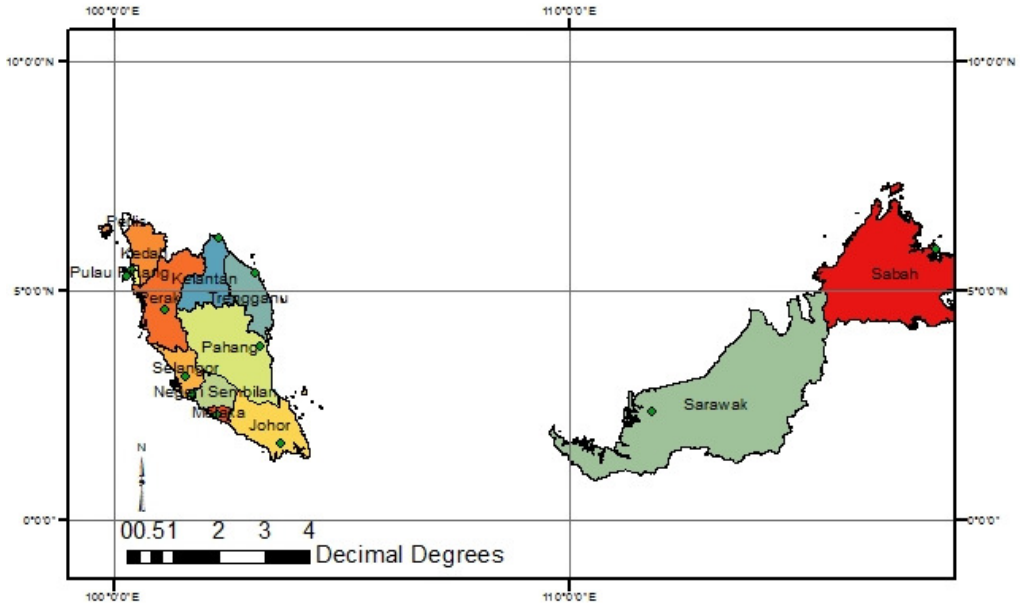
regions affected by El Niño



Malaysian Meteorological Department, "What are the climate changes during an El Niño?," [Online]. http://www.met.gov.my/index.php?option=com_content&task=view&id=73&Itemid=160&limit=1&limitstart=2&lang=english. page 3

the Methodology

Peninsular Malaysia

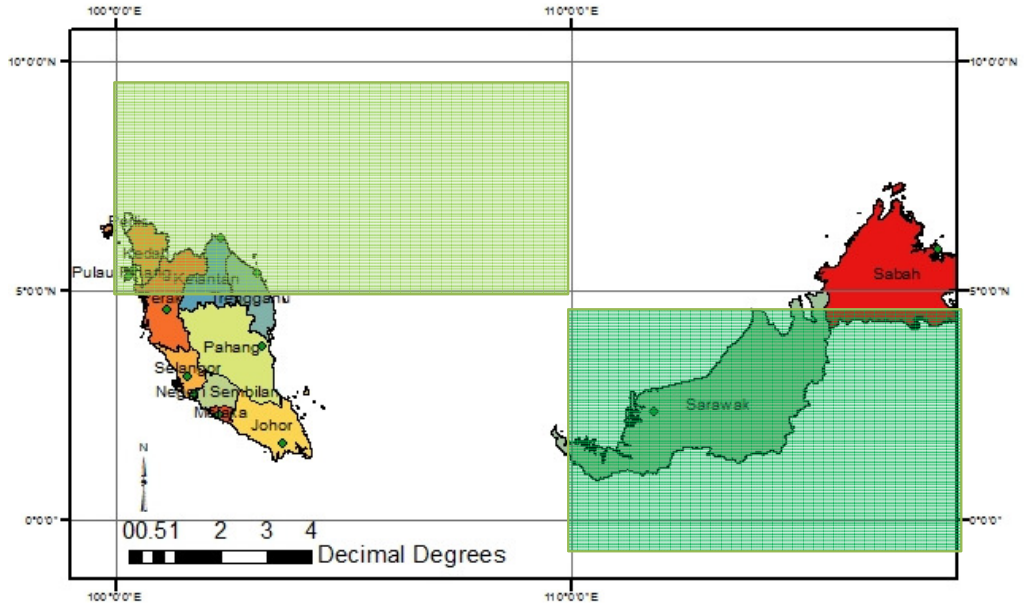


Borneo (Sarawak & Sabah) Malaysia

Lag variable: 36 month temperature anomaly is regressed against monthly yield

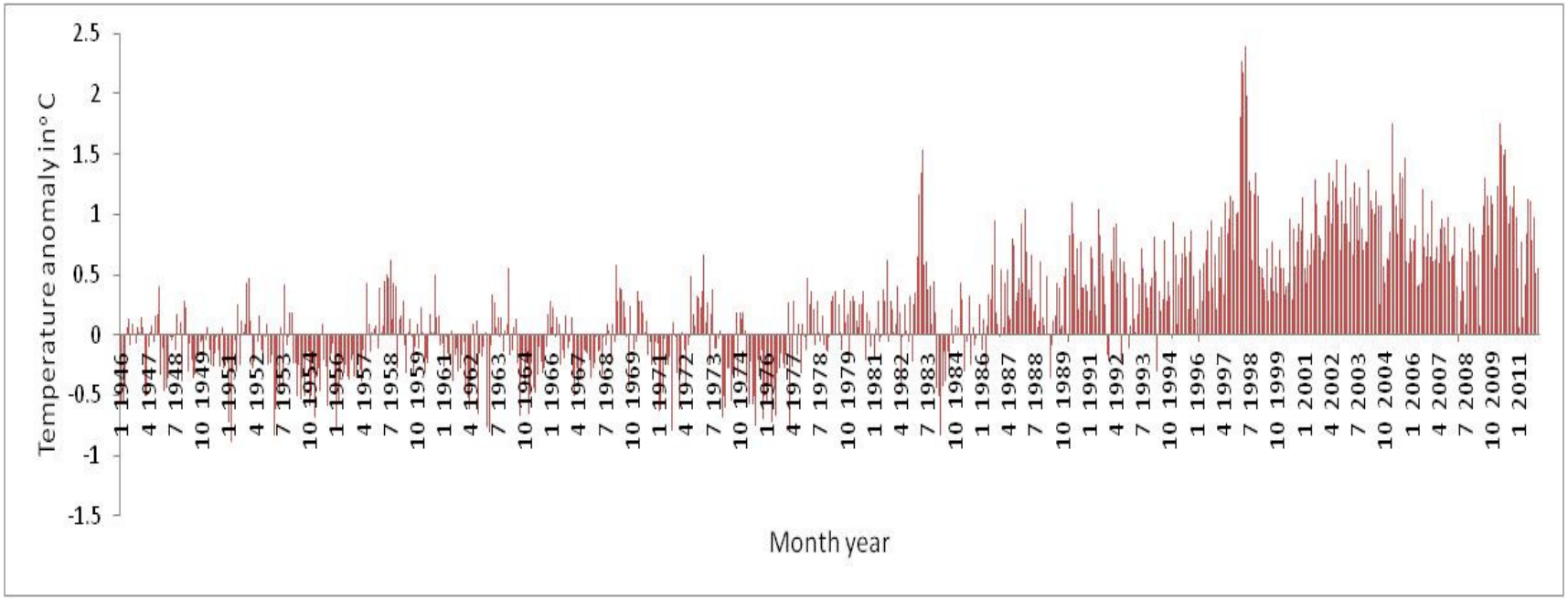
the data

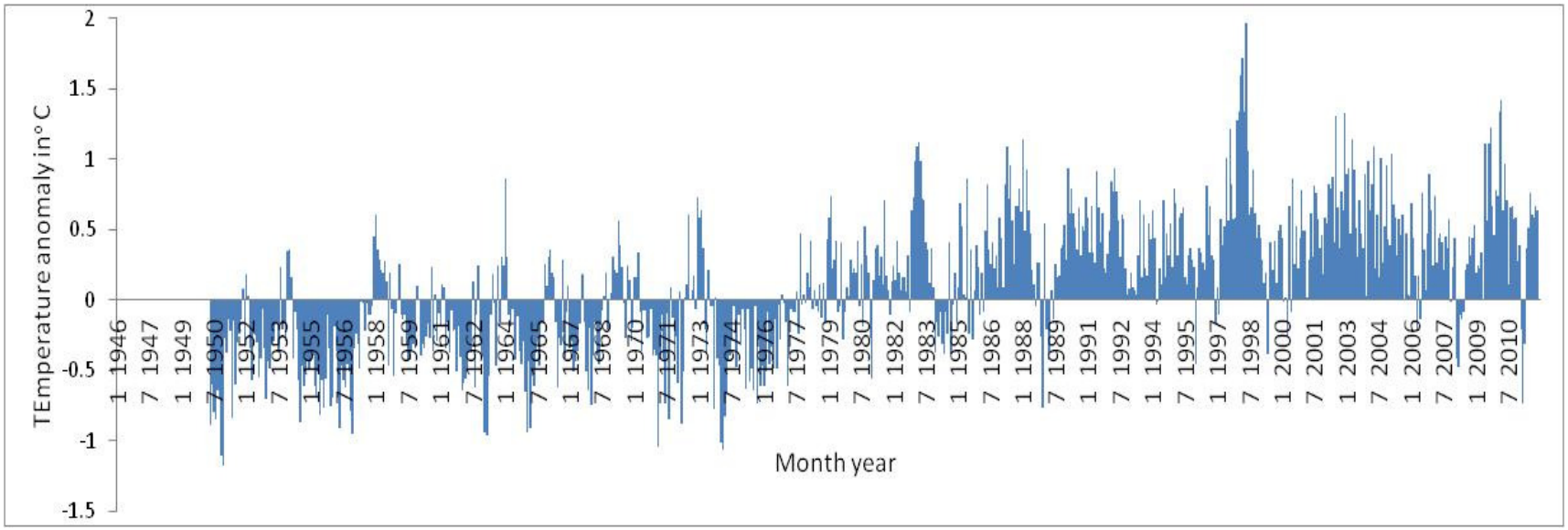
Peninsular Malaysia



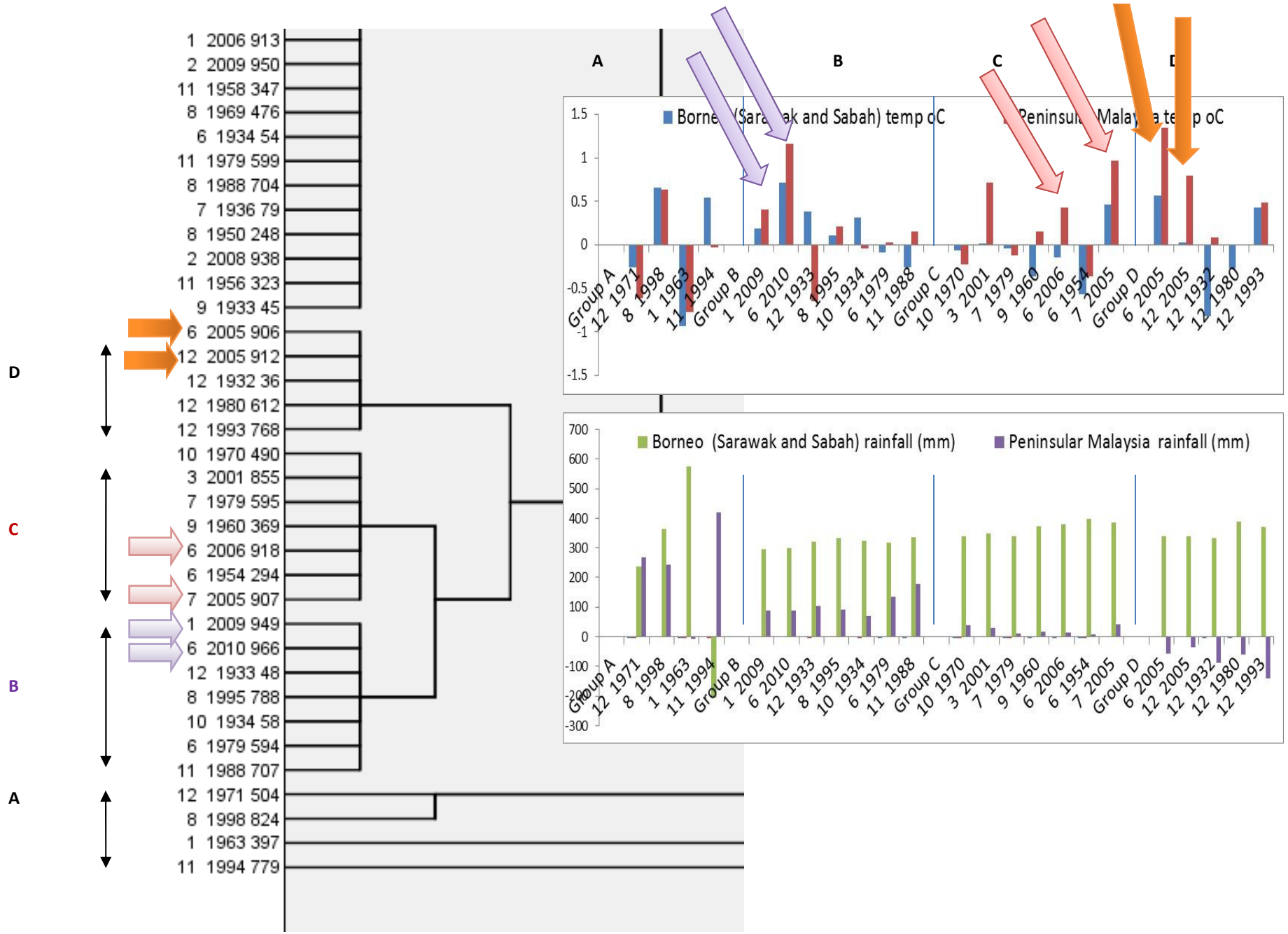
Borneo (Sarawak & Sabah) Malaysia

N.O.A.A. Administration, “Global Historical Climatology Network,” 2012. [Online]. Available: http://www.ncdc.noaa.gov/temp-and-precip/ghcn-gridded-products.php.

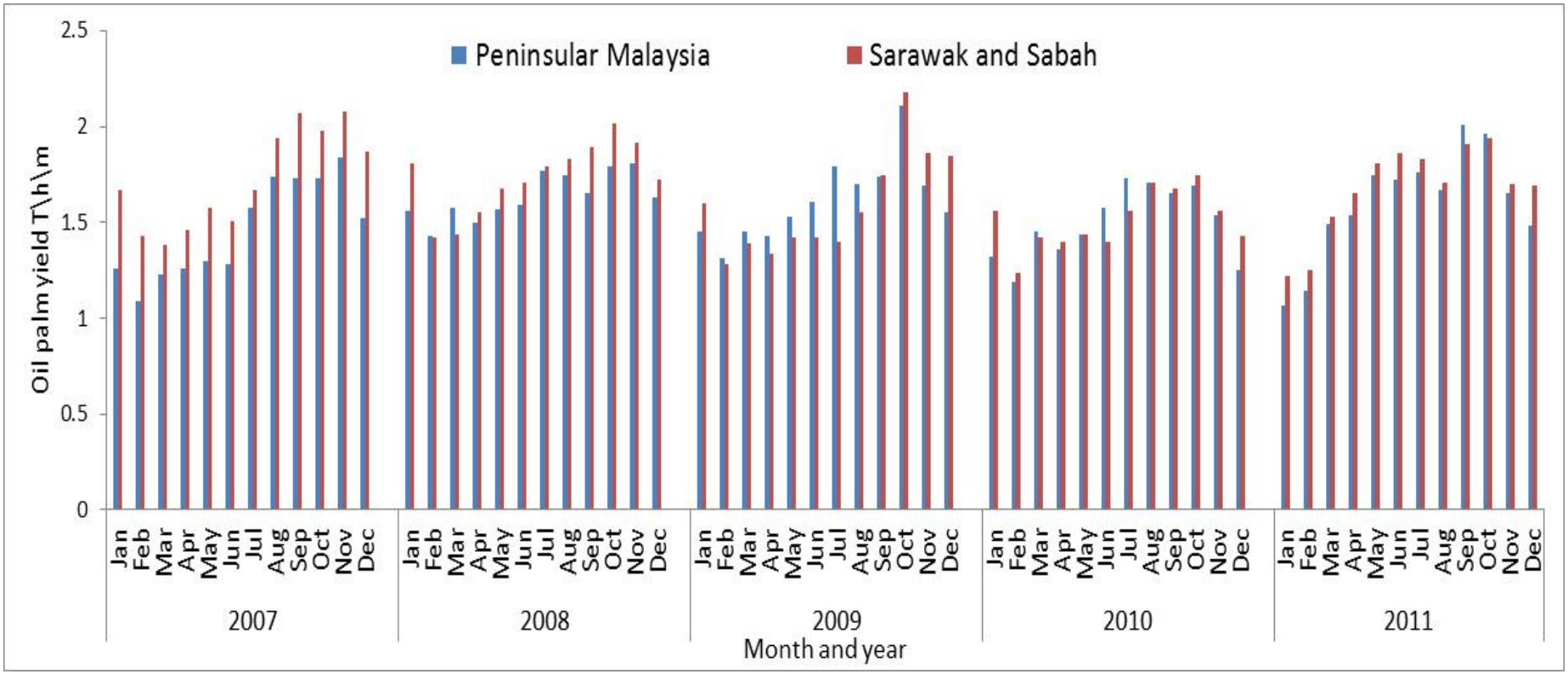




Graphs showing monthly temperature anomalies since January 1946 to Jan 2011 in Peninsular Malaysia (above) and Sabah and Sarawak (below).


A
B
C
D
1 2006 913
2 2009 950
11 1958 347
8 1969 476
6 1934 54
11 1979 599
8 1988 704
7 1936 79
8 1950 248
2 2008 938
11 1956 323
9 1933 45
6 2005 906
12 2005 912
12 1932 36
12 1980 612
12 1993 768
10 1970 490
3 2001 855
7 1979 595
9 1960 369
6 2006 918
6 1954 294
7 2005 907
1 2009 949
6 2010 966
12 1933 48
8 1995 788
10 1934 58
6 1979 594
11 1988 707
12 1971 504
8 1998 824
1 1963 397
11 1994 779
Borneo (Sarawak and Sabah) temp oC
Peninsular Malaysia temp oC
Borneo (Sarawak and Sabah) rainfall (mm)
Peninsular Malaysia rainfall (mm)
Group A
Group B
Group C
Group D

yield


Peninsular Malaysia
Sarawak and Sabah
Oil palm yield T\h\m
2.5
2
1.5
1
0.5
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
2007
2008
2009
2010
2011
Month and year

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.398[a]	.159	.146	.21227	.159	12.460	1	66	.001	
2	.535[b]	.286	.264	.19703	.127	11.606	1	65	.001	
3	.607[c]	.368	.339	.18680	.082	8.311	1	64	.005	.889

a. Predictors: (Constant), -7

b. Predictors: (Constant), -7, -13

c. Predictors: (Constant), -7, -13, -19

d. Dependent Variable: Yield

Figure 1. Predictors from linear regression ran for monthly yield of Peninsular Malaysia and Sabah and Sarawak against 36 month lagged temperature anomalies.

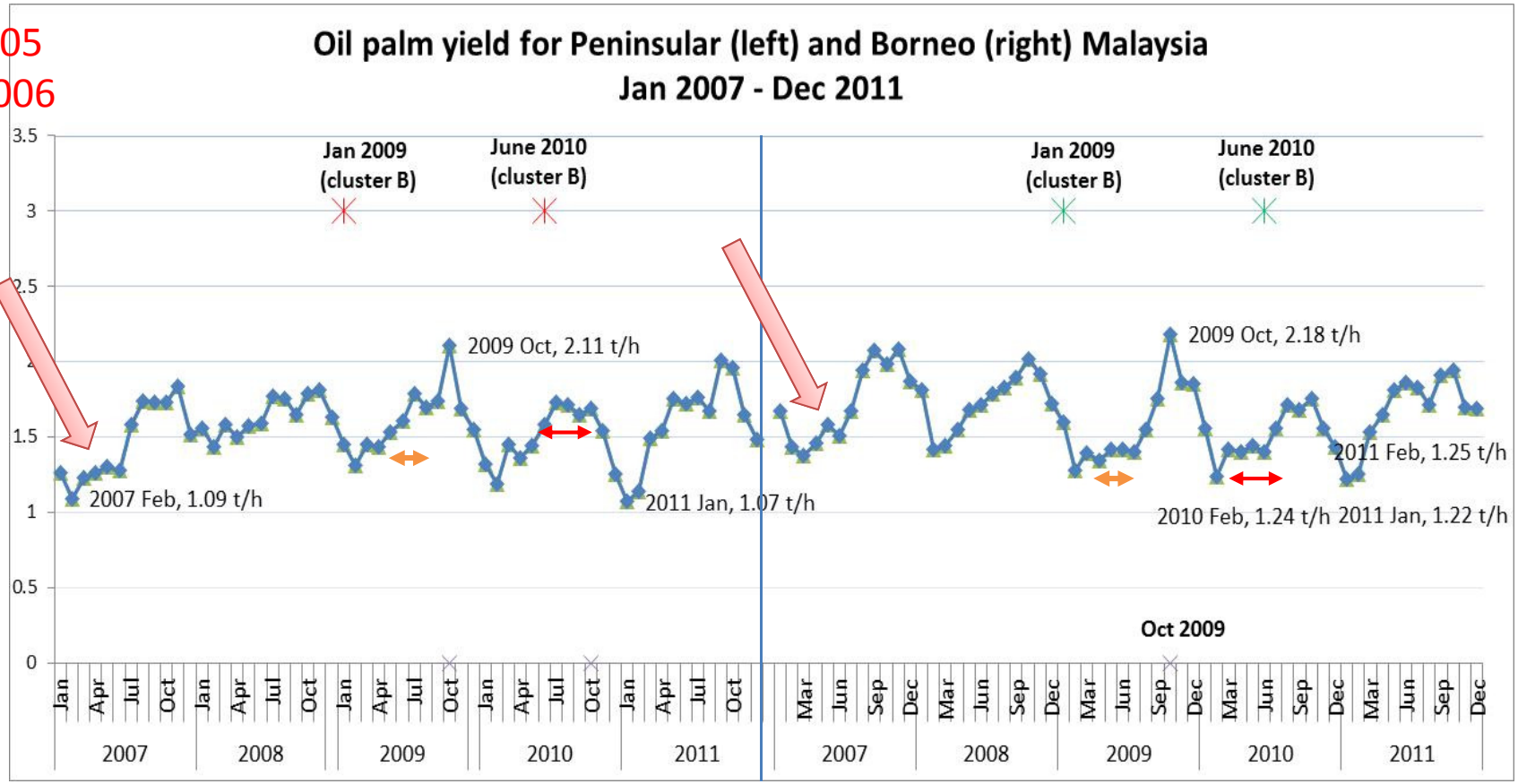
Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.718	.049		35.127	.000
	-7	-.207	.059	-.398	-3.530	.001
2	(Constant)	1.614	.055		29.544	.000
	-7	-.264	.057	-.509	-4.640	.000
	-13	.198	.058	.374	3.407	.001
3	(Constant)	1.720	.063		27.105	.000
	-7	-.264	.054	-.509	-4.894	.000
	-13	.244	.057	.461	4.255	.000
	-19	-.182	.063	-.299	-2.883	.005

the results

events and yield

Jul 2005
Jun 2006

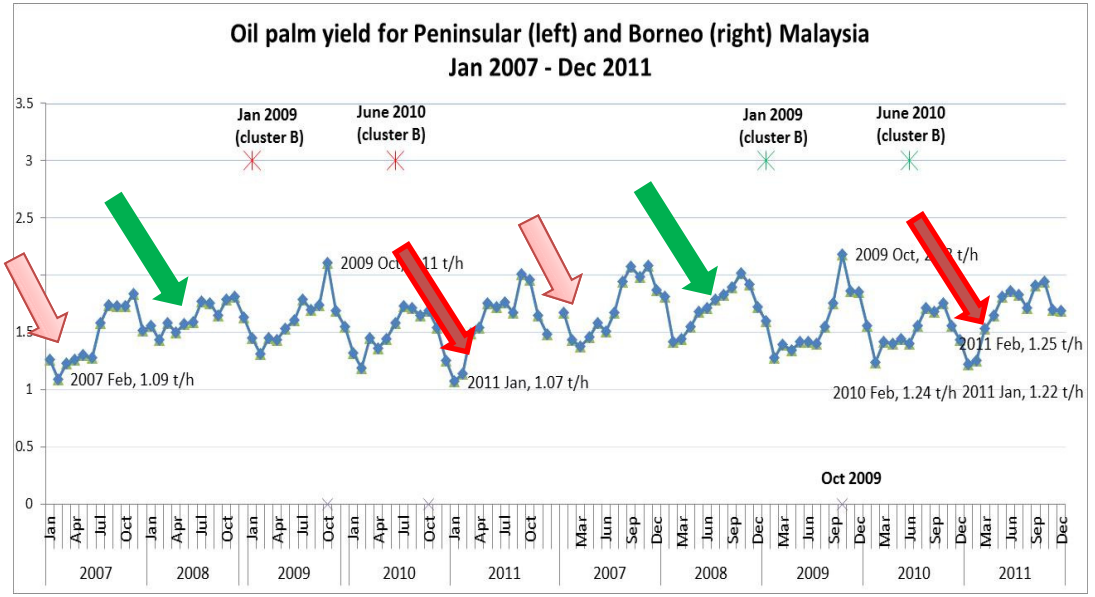


a. Predictors: (Constant), -7
b. Predictors: (Constant), -7, -13 (negative)
c. Predictors: (Constant), -7, -13, -19 (19 positive)
d. Dependent Variable: Yield - in the 6, 17 and 27 in Colombian study

conclusions

July 2005 (17-month lagged), Dec 2005 (13-month lag) and June 2006 (8-month lag) -> Peninsular Malaysia's February 2007 yield (negative) not so bad in Sarawak and Sabah

Jul 2005
Dec 2005
Jun 2006



<u>January 2009 and June 2010</u> i.e., 24- and 14-month lag -> Peninsular and Borneo Malaysia (negative)-> January 2011

June 2006 (13 month) → early 2008

Predictors: (Constant), -7 (negative) , -13 (negative) and -19 (positive)

Further research required to establish possible auto-correlation or some periodicities (e.g. seasonal cycles within the lag variables)

acknowledgements

- Prof Philip Sallis, Pro-Vice Chancellor, AUT
- Prof Datin Dr Maryati Mohammad
- Dr Kahlid (Principle researcher, MPOB, Kluang)
- Dr Alona and Amania