

# **Workshop on Climate Change, Land Use, Forestry Resources Management and Payment for Environmental Services/REDD:**

**Kokoda Motel, 7-8 February 2013**

**“Sciences of Climate Change & Variability  
and International Development.”**

***Prof Chalapan Kaluwin***  
***University of PNG***

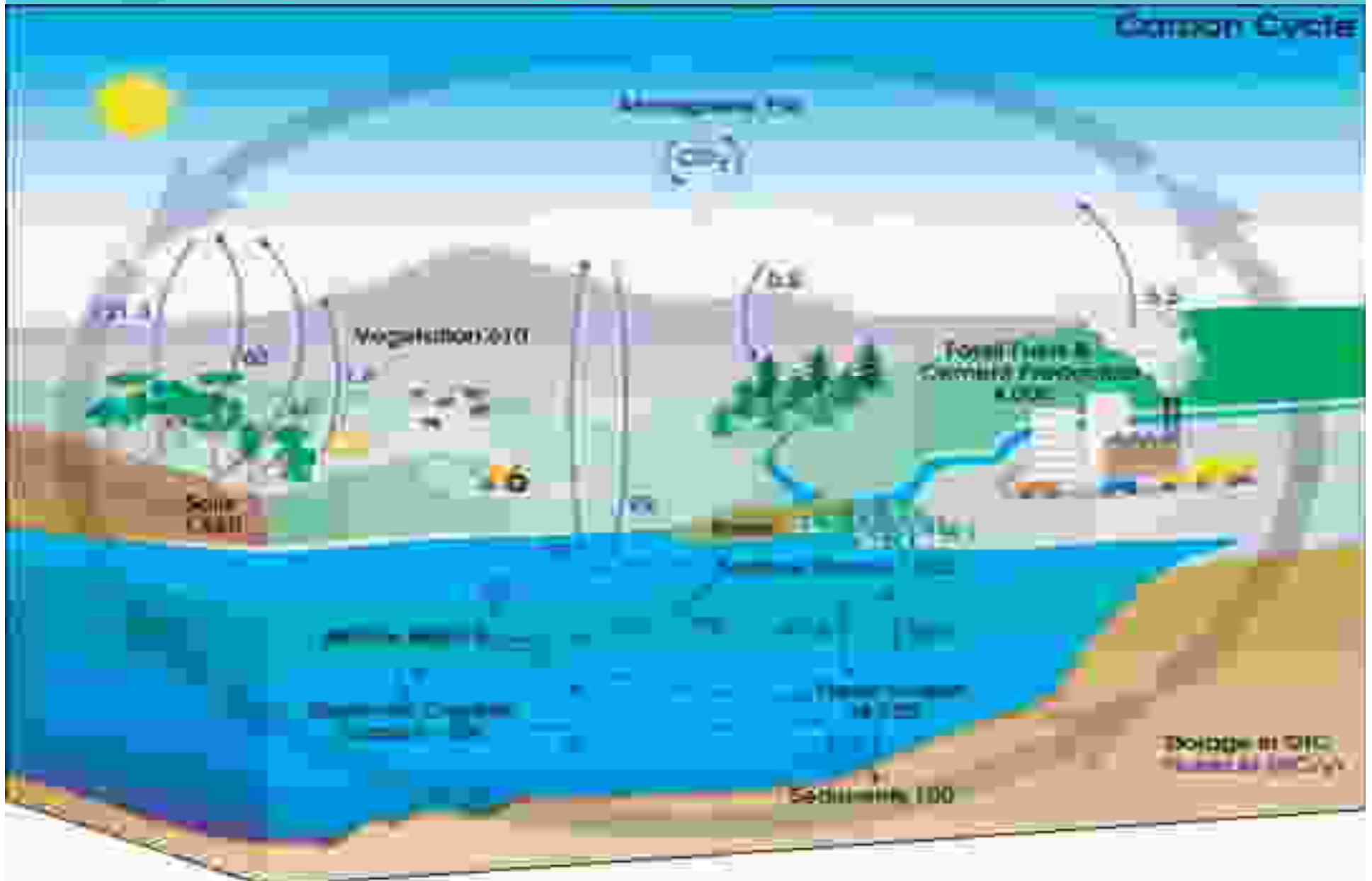


The earth is warming!!!-

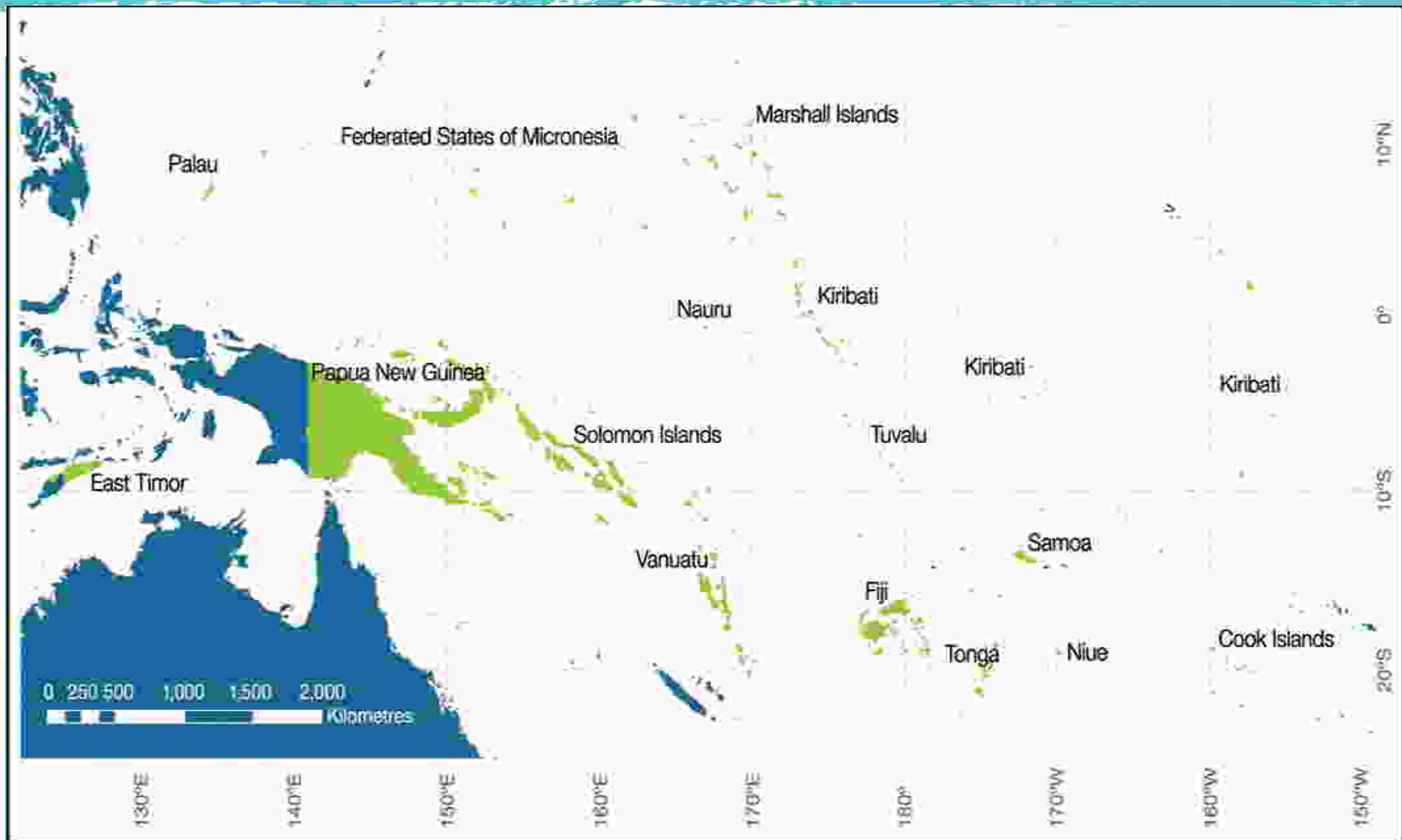
The Greatest challenge  
to Man-kind



# Carbon Cycle



# Region



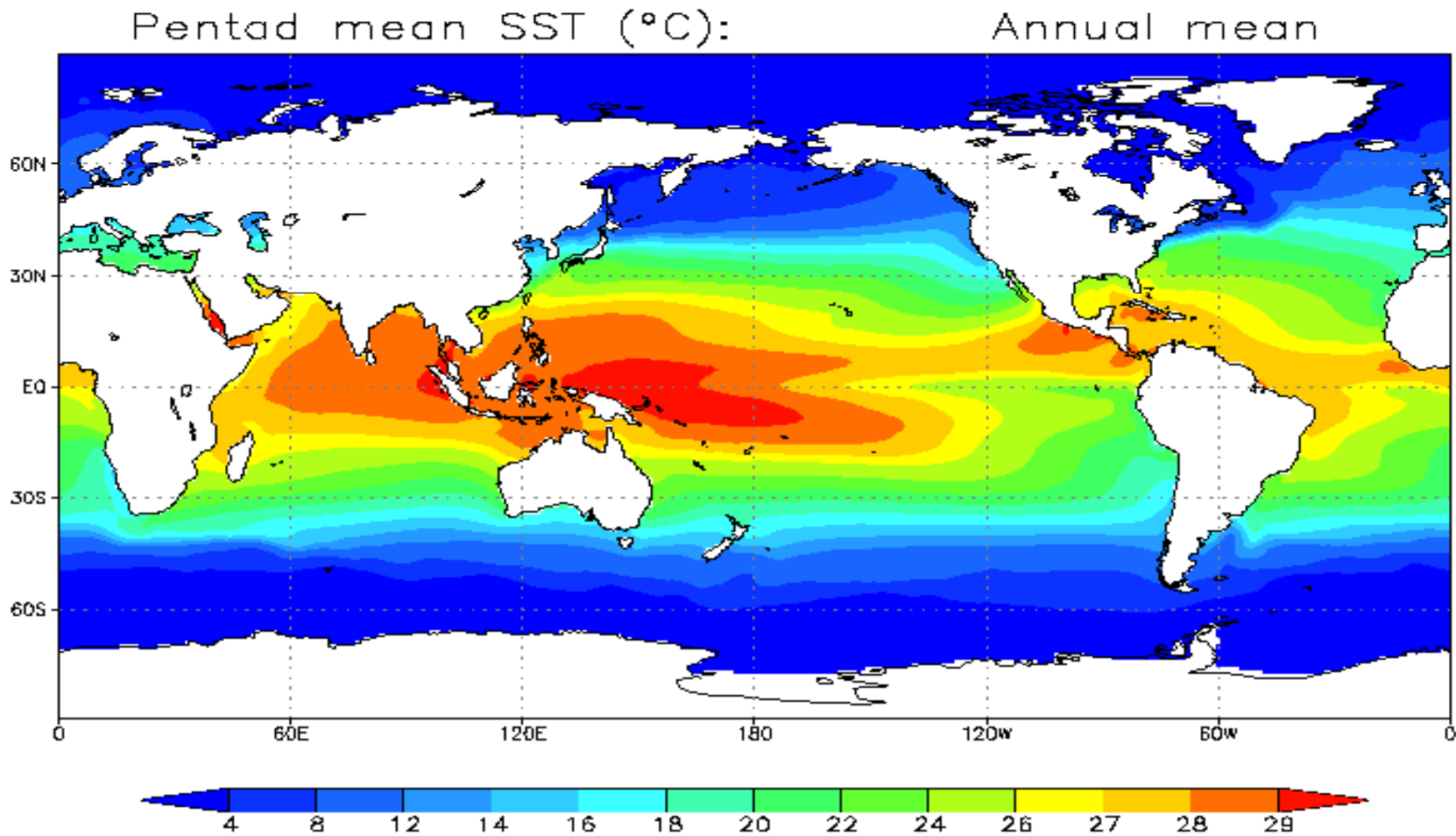


## A: Understanding Science

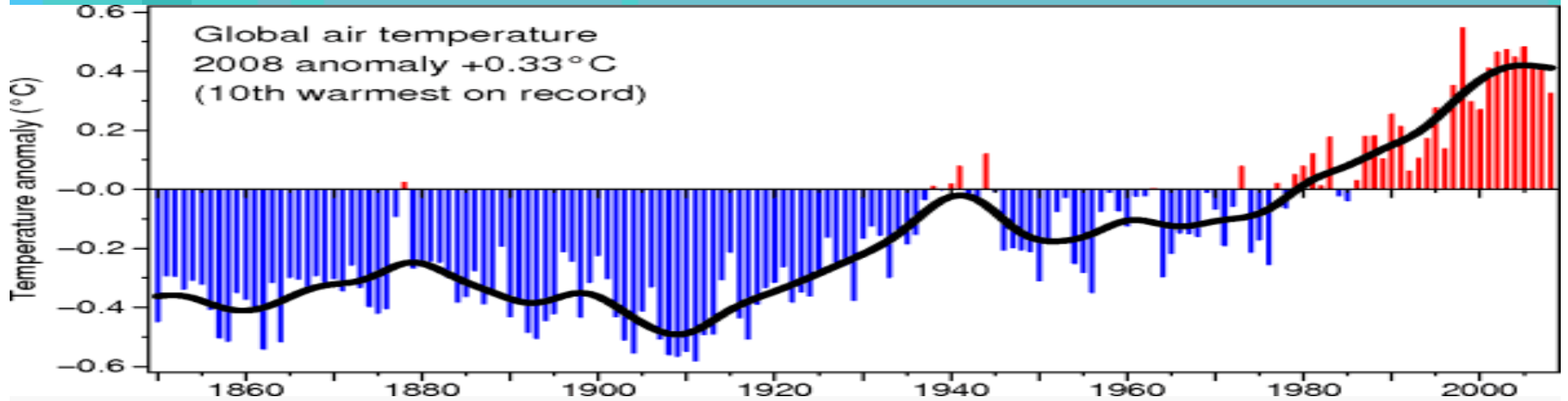
# “CLIMATE CHANGE & VARIABILITY DRIVERS OF PNG & Pacific Region”



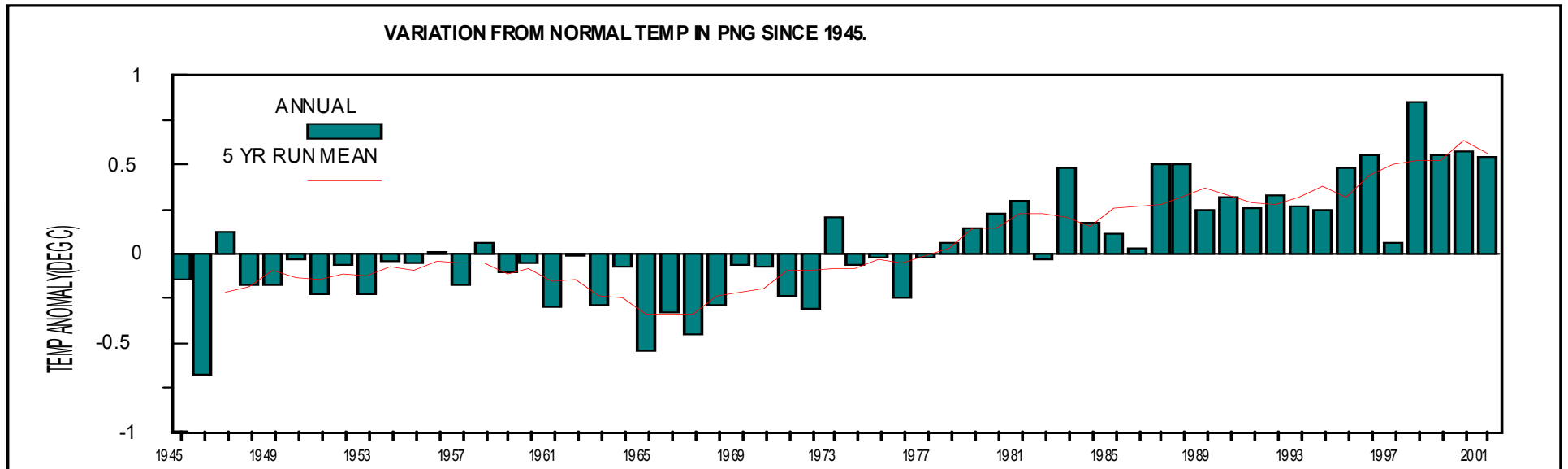
# GLOBAL MEAN SEA SURFACE TEMPERATURE



# GLOBAL TEMPERATURE TRENDS



## PNG IS ALSO WARMING



# Region's CO<sub>2</sub> Emissions

## Global Carbon Dioxide Emissions

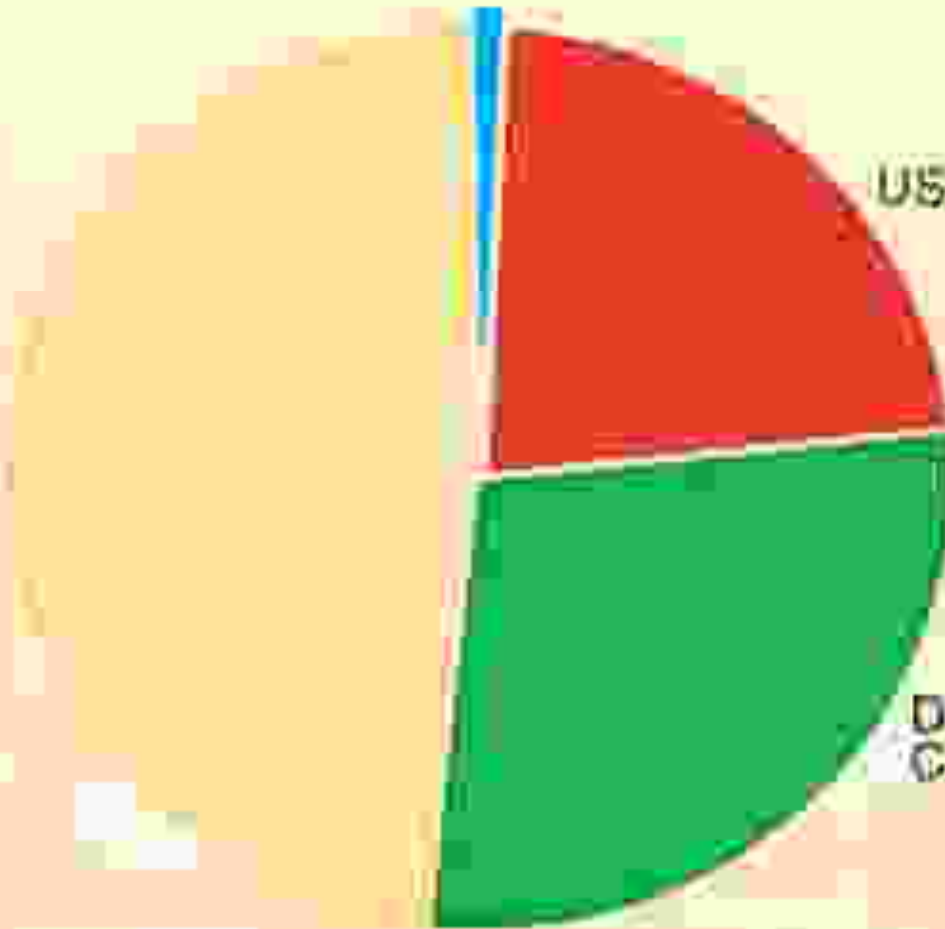
Pacific Island countries - 0.01%

USA 23%

Other industrialized  
Countries 48.3%

World Commission on Environment  
and Development  
1987

Developing  
Countries 28.9%



# Climate variability

## Natural Patterns of Variability are associated with:

- **El Nino Southern Oscillation (ENSO)**
- **Inter-decadal Pacific Oscillation and**
- **Pacific Decadal Oscillation**

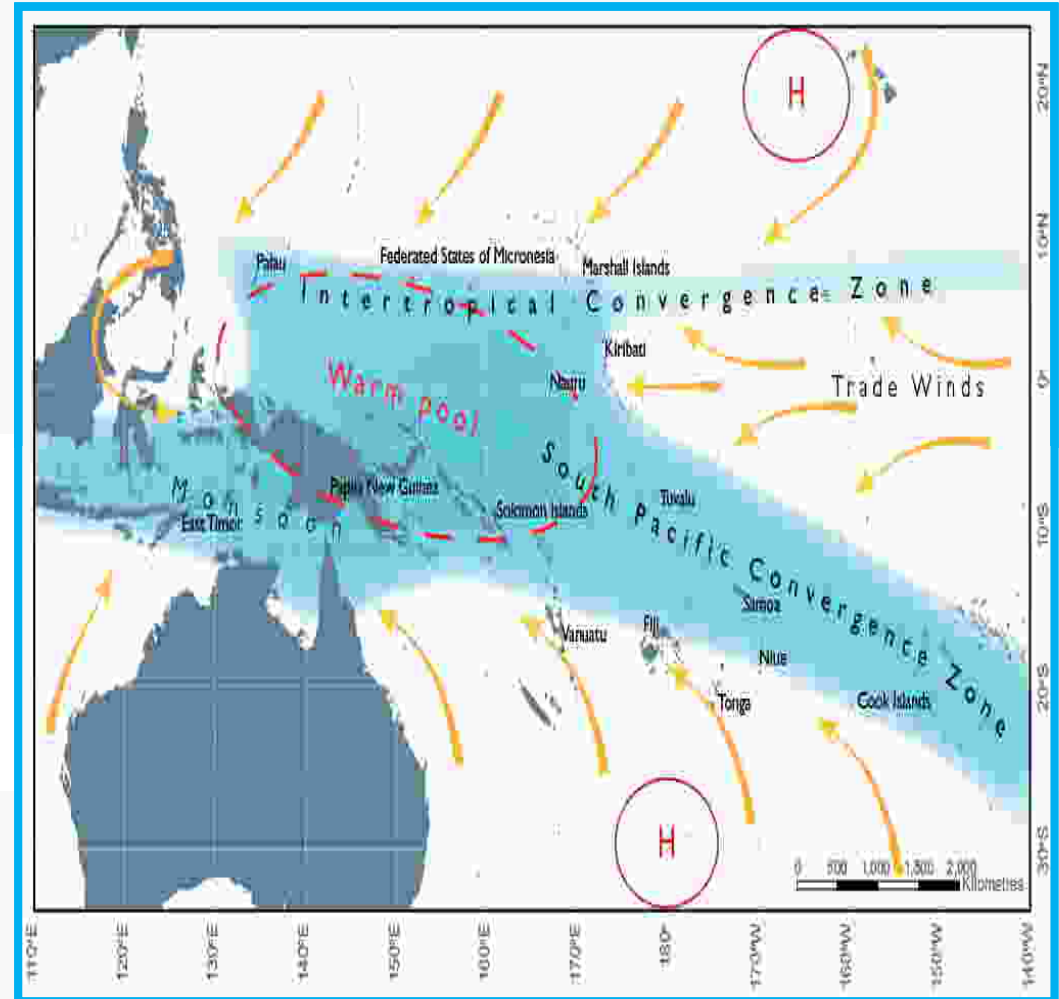
The major pattern of climate variability in the Pacific is associated with ENSO.

- El Niño – basin wide warming of tropical Pacific Ocean east of Dateline.
- La Niña - basin wide cooling of tropical Pacific Ocean east of Dateline.
- Associated with global to sub-tropical scale pressure fluctuation called Southern Oscillation

# Climate features impacting this region

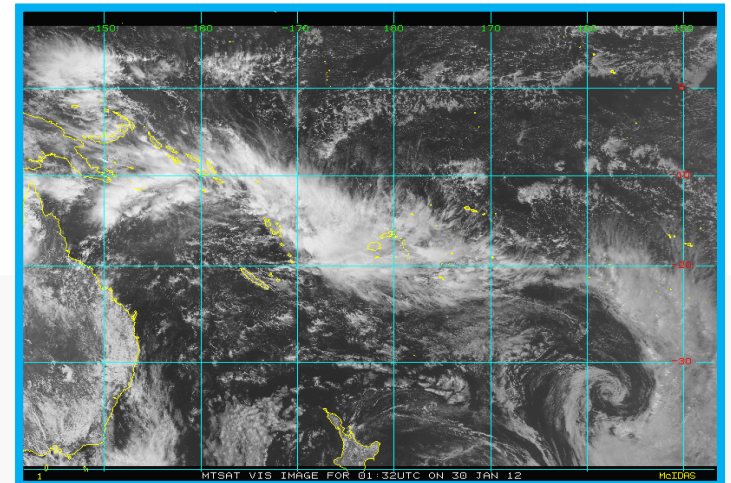
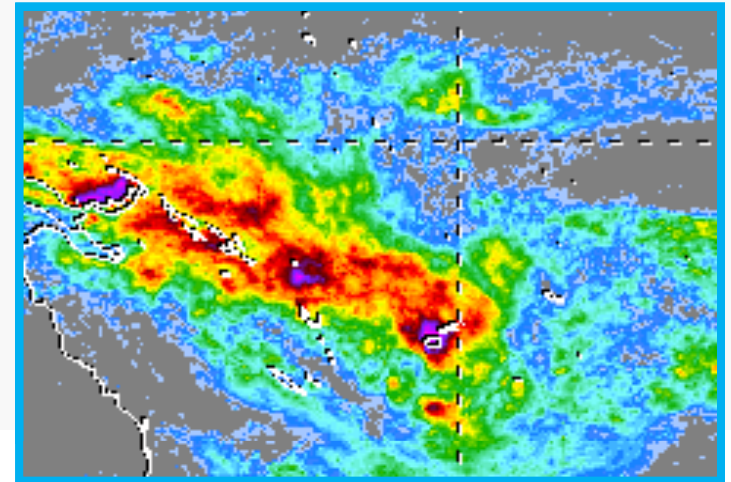
## Key climate features of the Pacific are:

- El Niño Southern Oscillation (ENSO);
- Monsoon Trough (East Timor and West Pacific),
- ITCZ (NH) and SPCZ (SW Pacific)
- SPCZ affects most countries of the SW Pacific;
- *ENSO impacts weather and climate phenomena including tropical cyclones, winds, temperature, rainfall, sea level and other climate drivers.*



# Climate variability - SPCZ

- The SPCZ is a band of cloud and rainfall extending from near the Solomon Islands to the east of Cook Islands;
- This climate feature drives the seasonal variations in rainfall;
- Resulting in in wet seasons (November to April – SH) and dry seasons (May to October – SH);
- Seasonally migrates north and south
- ENSO events influences its strength – weakens (El Niño) and enhances (La Niña)



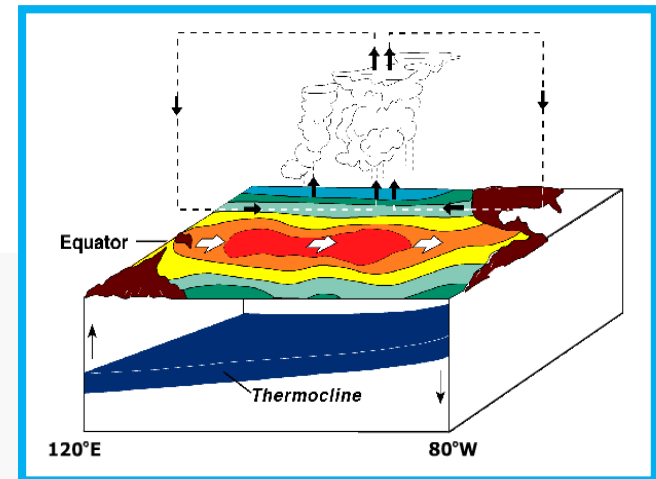
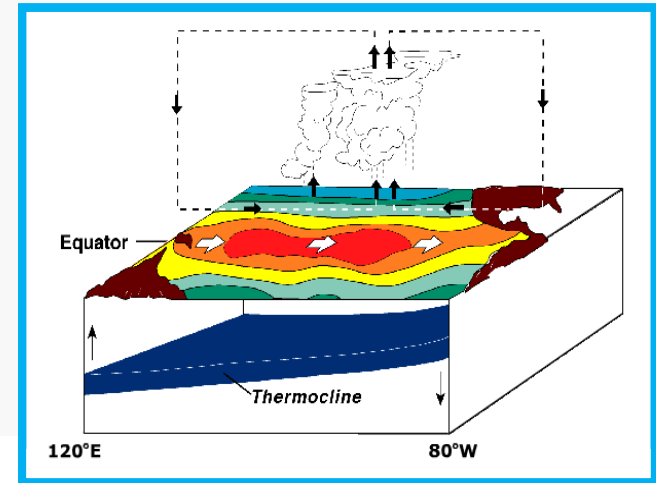
# Climate variability - SPCZ

**ENSO is strongly linked to variations in climatic features like SPCZ.**

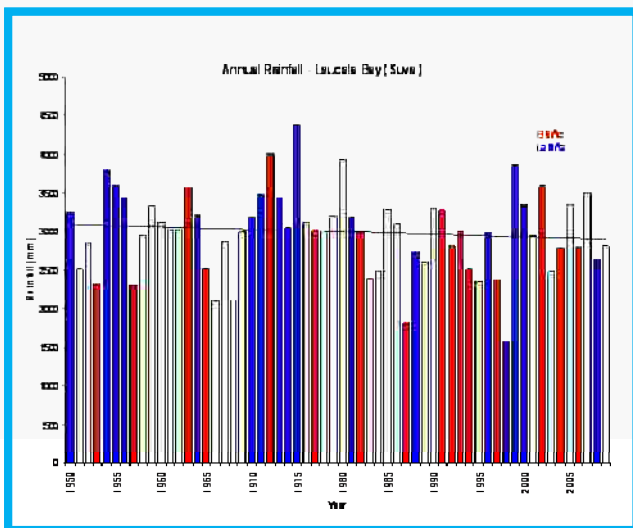
**El Niño – SPCZ tends to shift towards NE and influence:**

- ✓ rainfall
- ✓ Sea level
- ✓ Temperature
- ✓ Risk of tropical Cyclones

**La Niña – Tends to shift towards SW and has similar effects but opposite to El Niño.**

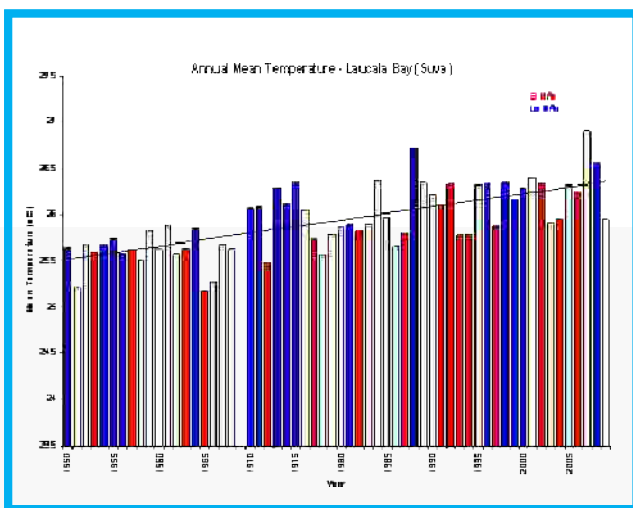


# Trends



Over the past 50 years:

- Rainfall – Rainfall has increased to the Northeast of SPCZ and decreased to the South;
- Temperature- trends mostly between 0.08C to 0.20C per/decade;

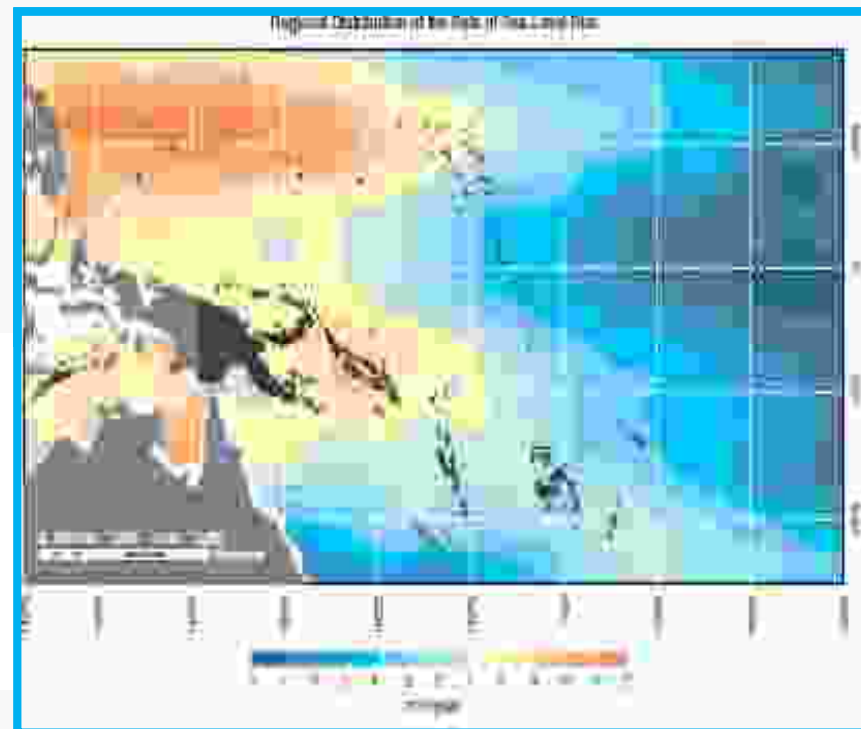


Over the 1981 – 2007 (satellite) period:

- No significant trends in overall numbers of tropical cyclones nor in the number of intense cyclones.
- These trends linked with the relative positions of the SPCZ

# Trends

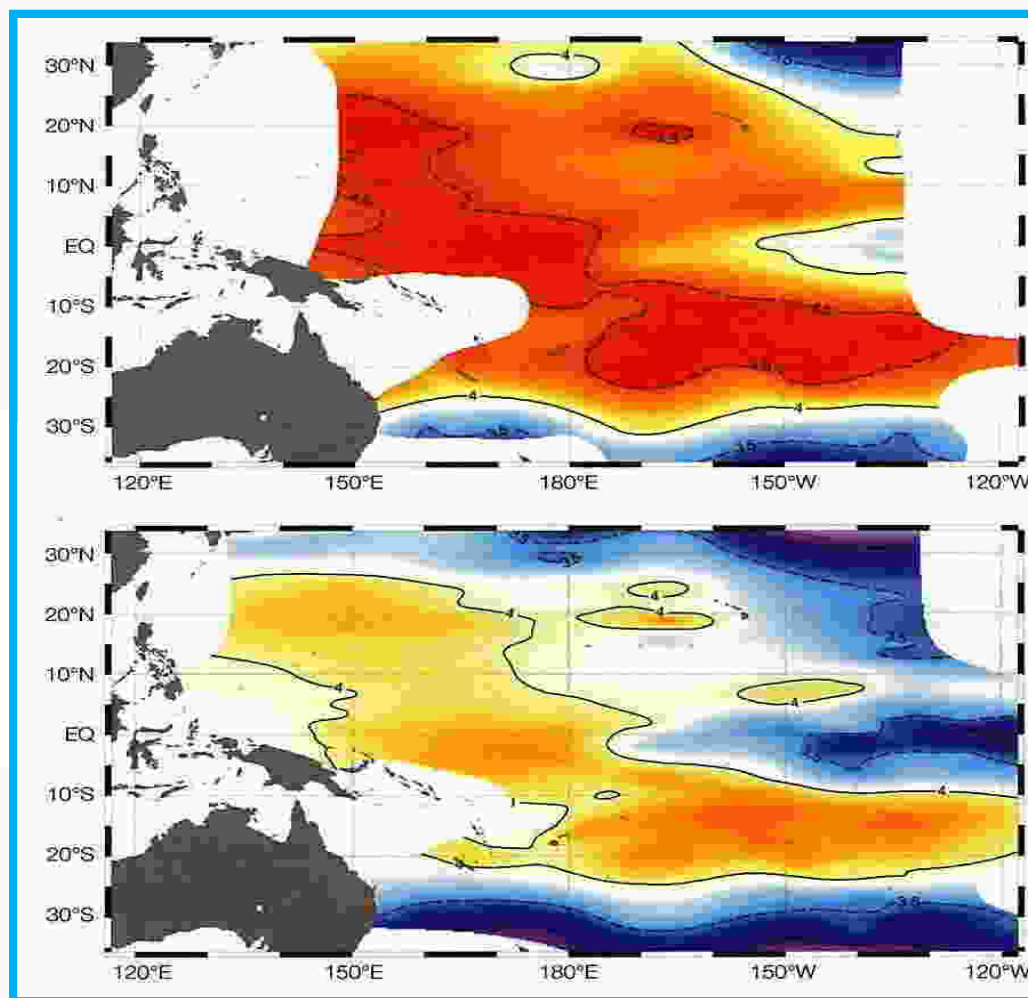
- Average Temperatures – have increased by  $0.1^{\circ}\text{C} - 0.2^{\circ}\text{C}/\text{decade}$  since 1970, however, warming has not been consistent everywhere, with the greatest warming occurred near the equator and west of  $180^{\circ}\text{E}$ .
- Sea Surface temperature –increased by  $0.7\text{C}$  over the 1950 - 2000 period in the region.
- Sea level – rising globally including the Pacific region with the greatest rise ( $>8\text{mm}/\text{year}$ ) in the western Pacific (high inter-annual variability associated with ENSO)



# Trends

- Aragonite levels in the ocean have continued to decline from the pre-industrial times.
- Ocean acidification has continued to increase in the region.

( A comparative analysis of pre-industrial (Top) period saturation values were above 4 than current levels (Bottom).



# Projections

## SPCZ

- Not expected to shift position in the Wet Season;
- Some evidence of equator ward shift in the dry season;
- Increased rainfall is projected within the SPCZ in the wet season.

## ENSO

- Year to year variability will continue to be affected by ENSO;
- It is uncertain how frequency, intensity and pattern of ENSO would change in future as there is no general agreement among the climate models;
- Aspects of climate experienced during El Niño or La Niña may differ from the past in some regions (e.g. temperatures experienced during future El Niño events may tend to be higher).



# Projections

<b>Temperature</b>	<p><b>By 2030:</b> The warming is in the range of +0.5C to +1.0C, regardless of emission scenario.</p> <p><b>By 2055:</b> The warming is generally in the range of +1.0 to 1.5C, with regional differences depending on emission scenario.</p> <p><b>By 2090:</b> 1.5C to 2.0C for B1 (low emission scenario); 2.0C to 2.5C for A1B (medium emission scenario); 2.5C to 3.0C for A2 (low emission scenario).</p>
<b>Rainfall</b>	<ul style="list-style-type: none"><li>• Increases in mean annual rainfall near SPCZ and little change elsewhere;</li><li>• Annual number of rain days, light and moderate of rain days projected to increase near equator, little change elsewhere;</li><li>• Widespread increase in the number of heavy rain days (20-50mm) is projected to increase;</li><li>• Droughts are expected to occur less frequently.</li></ul>



# Projections

<b>Sea Level</b>	<ul style="list-style-type: none"><li>• Projected to rise in the region, however, there will be regional differences largely due to natural variability and vertical movement;</li><li>• Total sea level rise is projected to be similar to global average (18cm to 59cm) but larger increases cannot be ruled out;</li><li>• Improved understanding of ice-sheet changes is need to estimate a reasonable rate and timing of 21<sup>st</sup> century sea level rise.</li></ul>
<b>Acidification</b>	<ul style="list-style-type: none"><li>• The ocean acidification is projected to rise in the region;</li><li>• The aragonite saturation will continue to decline with values below 3.5 to become more widespread;</li><li>• The lowest values are expected to occur in the eastern equatorial Pacific;</li><li>• Highest values expected to occur in the region of south equatorial current.</li></ul>
<b>Tropical Cyclones</b>	<ul style="list-style-type: none"><li>• Decrease in tropical cyclone frequency is projected in the region;</li><li>• An increase in the proportion of more intense storms are projected;</li><li>• A pole ward shift of more intense storms south of 20S;</li><li>• However, in the North Pacific, a decrease in proportion of intense storms are projected;</li></ul>

# Impacts

<b>Sea Level Rise</b>	A Sea Level Rise by 50cm will have far reaching impact on coastal ecosystems such as accelerated coastal erosion, salt water intrusion into fresh water lens and ground aquifers, increased sea flooding, loss of arable land and settlement, etc.
<b>Aragonite</b>	If aragonite falls below 3.5 in next few decades, this will affect the food chains connected with the oceans and have a negative impact on coral reef ecosystem in terms of coral reef bleaching, loss of habitat, fisheries and thus become unattractive for tourism activities.
<b>Tropical Cyclones</b>	The combination of sea level rise, high intensity rainfall and stronger tropical cyclones would further exacerbate the vulnerability of communities, which are exposed to more frequent coastal flooding, storm surge and strong winds.
<b>Rainfall and Temperature</b>	The combination of change in rainfall and increase in surface air temperature will have a compounding effect on agricultural production and a threat to food security, water resources and human health. For instance, an increase in extreme hot days would have negative effect on health of young children and elderly people.



# Climate Change Policy Development



# Overview of the Kyoto Protocol

- **The Kyoto Protocol was adopted by party States in 1997. PNG signed on 2 March 1999 and ratified the treaty on 28 March 2002**
- Basically contains two main outcomes:
  1. sets greenhouse gas (GHG) emission targets relating to six GHG for 38 developed countries (Annex B countries); and
  2. adopts three Kyoto Mechanisms-
    - (a) Joint Implementation (JI)
    - (b) Clean Development Mechanism (CDM)
    - (c) International Emissions Trading (IET)
- Key dates are:
  - (a) 1997-2008 (transition period); and
  - (b) 2008-2012 (GHG limits period)
- The main focus for developing countries would be on outcome two (2). In developing an appropriate regulatory framework, PNG should consider which of the three Kyoto Mechanisms is relevant for PNG.



# The Three Kyoto Mechanisms

- **Joint Implementation**

- Annex B country investing in emissions reduction in another Annex B country

- **Clean Development Mechanism**

- Annex B country investing in CDM projects in non-Annex B country (developing country) to generate certified emission reductions (CERs) towards its emissions limitation commitment

- **International Emissions Trading**

- Annex B country transfers allowable emissions (assigned amount unit (AAU)) to another Annex B country

- **REDD ????**

Pacific-Australia Climate Change Science and Adaptation Planning Program

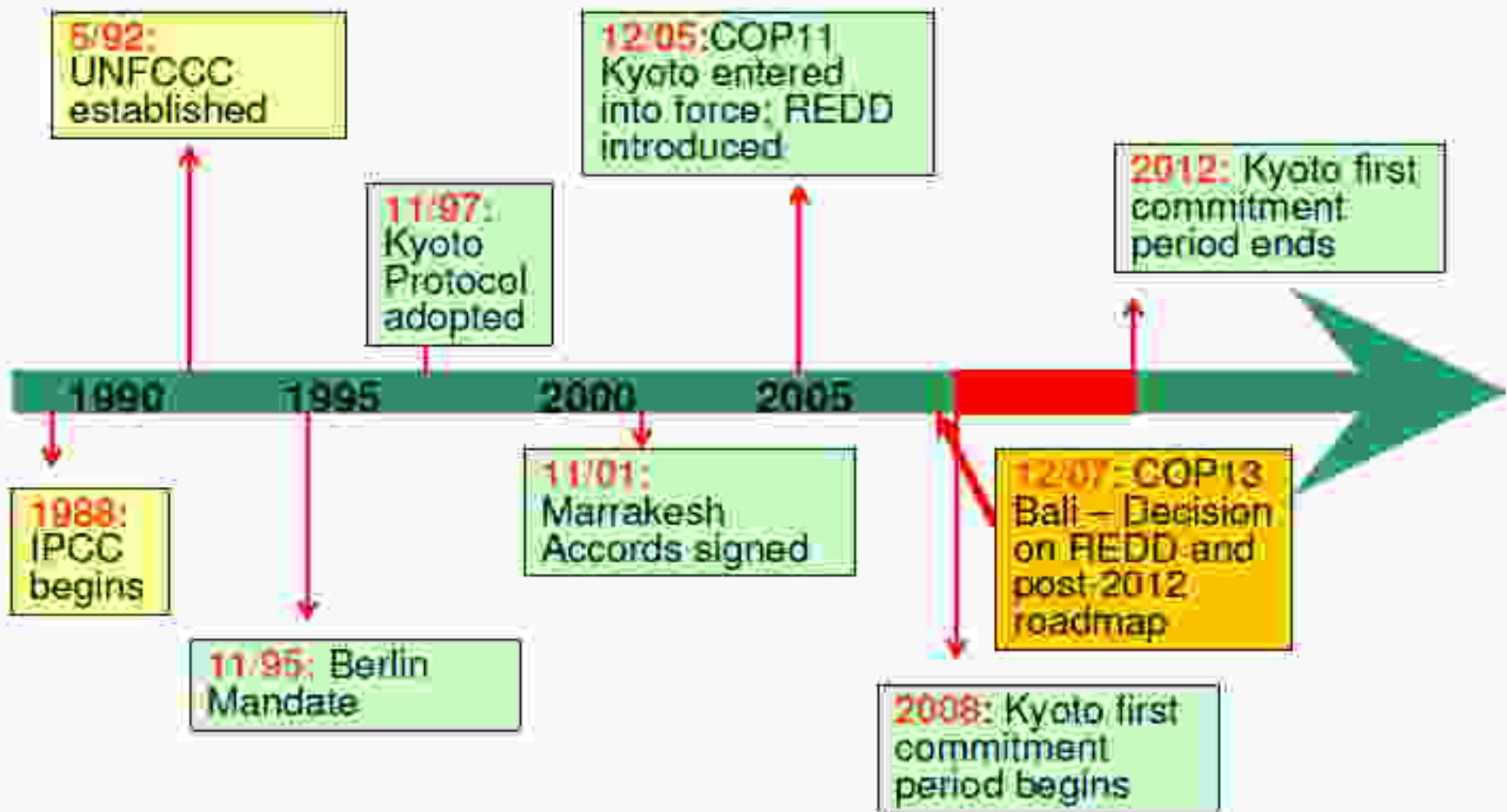


Australian Government

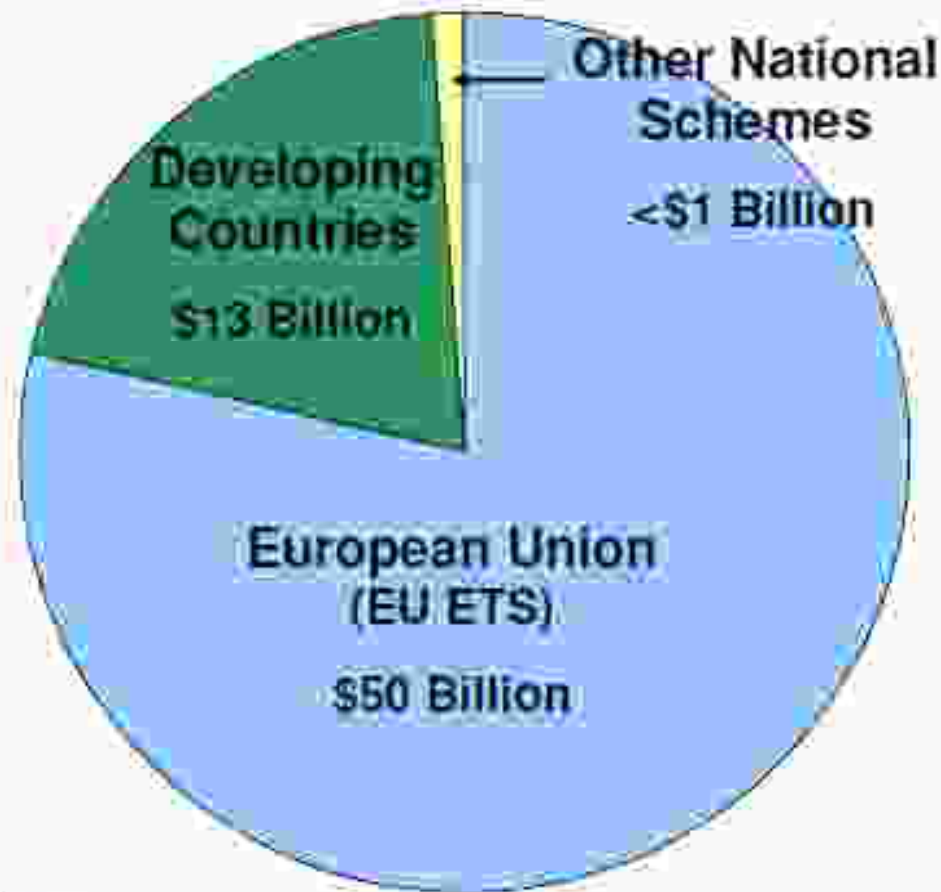
# Main Features of Kyoto Protocol

- The relevant Articles for our purposes are:
  1. Article 3(1) – *emission reduction targets for Annex 1 countries (comprising mostly developed and transition countries)*
  2. **Article 12 – clean development mechanisms (CDM)**
  3. Article 10 – *formulate policies and strategies for addressing GHG*
  4. Article 11 – *accessing resources to implement national strategies on reducing GHG*
- These provisions will be considered in the light of the three Kyoto Mechanisms

# Climate Policy Timeline



# As a result of Kyoto, there is a large and growing carbon market




**TOTAL: ~\$65 Billion**

**GROWTH:**  
2005-2006 – 300%  
2006-2007 – 106%

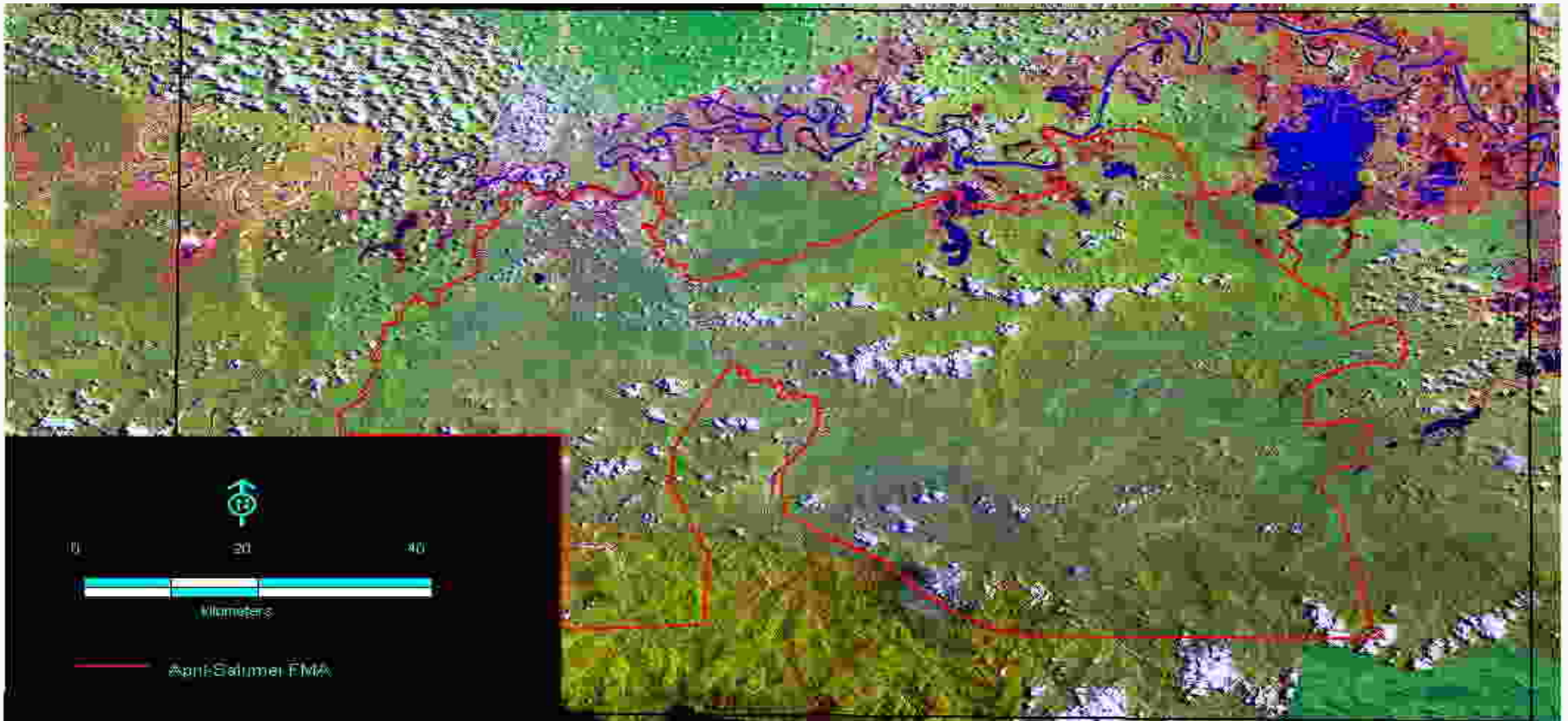
**ESTIMATED  
VALUE 2020:  
~\$1 Trillion**

**\$2 Trillion if US adopts  
national emissions trading**

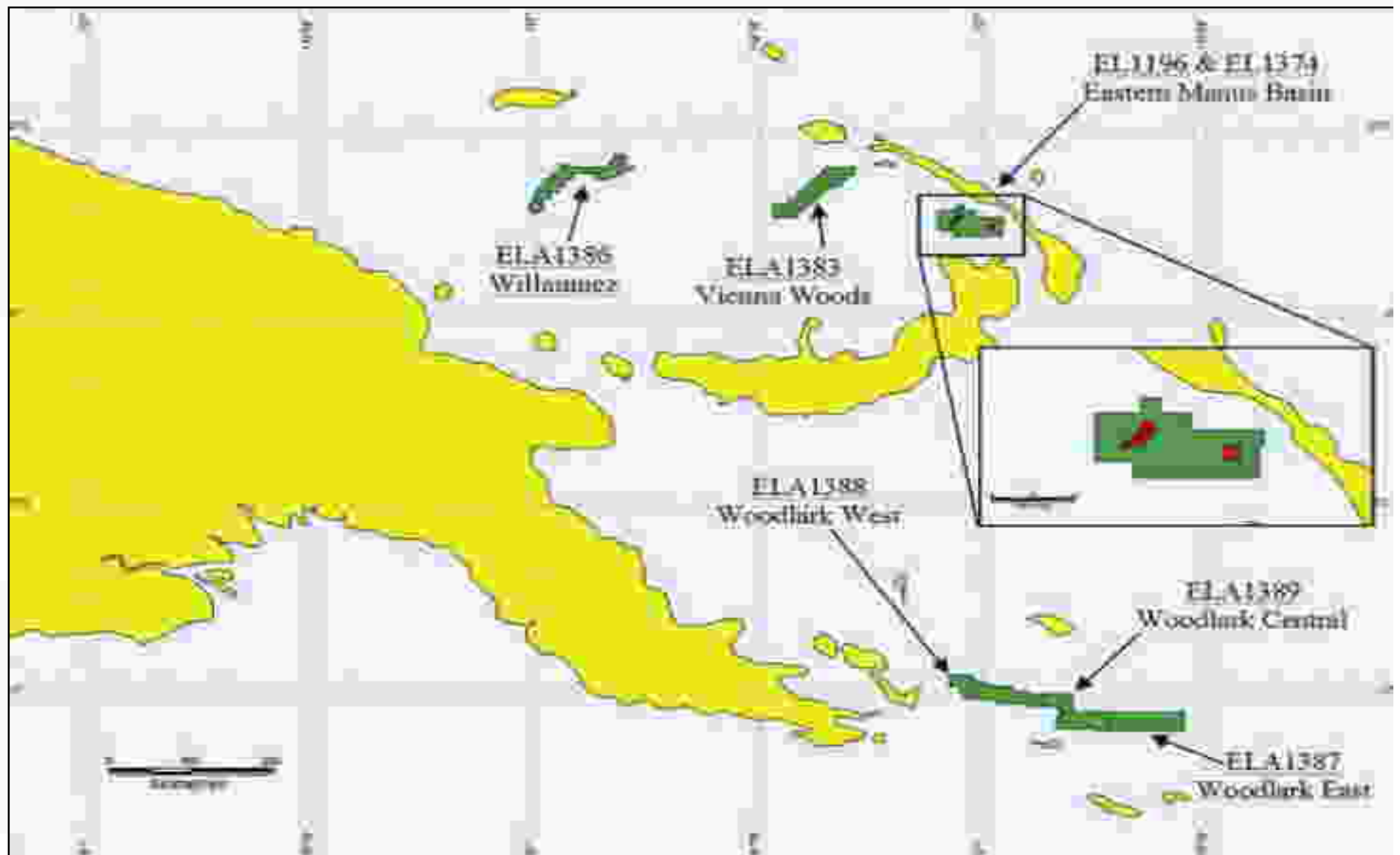


# **REDD & Forestry OPTIONS**

# Forestry Opportunity- REDD/REDD+



# Mining in the Oceans





**BLUE CARBON OPPORTUNITY**

Thank you

**PNG National Weather Office and Australian Adaptation Project**

**PACIFIC FOREST ALLIANCE (PFA)**



**Australian Government**  
**Bureau of Meteorology**



**Australian Government**  
**Department of Climate Change  
and Energy Efficiency**



**CSIRO**

Pacific-Australia **Climate Change Science** and Adaptation Planning Program