National Symposium on Climate Change Adaptation

SETTING THE SCENE FOR MALAYSIA – PROJECTED VULNERABILITIES TO CLIMATE CHANGE

IR. HAJI AHMAD JAMALLUDDIN SHAABAN
Director General
National Hydraulic Research Institute of Malaysia
Ministry of Natural Resources & Environment

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PULLMAN PUTRAJAYA LAKESIDE

1. OVERVIEW OF CLIMATE CHANGE IMPACTS
2. THE NEED FOR ADAPTATION
3. SETTING THE SCENE – PROJECTED IMPACTS & VULNERABILITY
4. APPLICATION & ADAPTATION TOOLS TO CLIMATE CHANGE

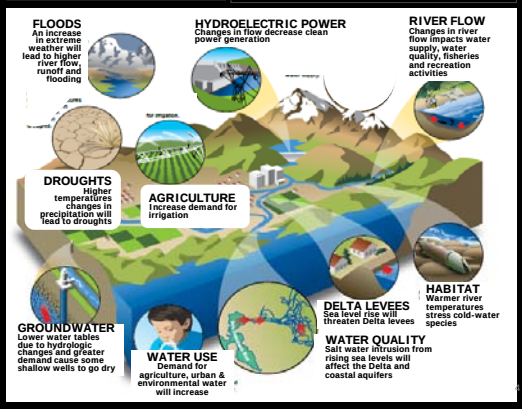
OVERVIEW

Physical Effects of Climate Change on the Water Cycle (IPCC, 2007)

- **Mean annual precipitation:** Projected to increase at high latitudes and in some tropical monsoon regions, and decrease in some subtropical
- **Heavy precipitation:** It is very likely will become more frequent, especially in tropical and high-latitude regions
- **Annual average river Runoff:** Projected to increase at high latitudes and in some wet tropical areas, and decrease at mid-latitudes and in the dry tropics.
- **Water Quality :** Expected to worsen many forms of water pollution as a result of higher water temperatures, increased precipitation intensity, and low flow periods.
- **Potential evapotranspiration:** projected to increase almost everywhere due to increasing temperatures
- **Soil moisture:** Projected to decrease in the subtropics and the Mediterranean regions, and at high & increase in East Africa and central Asia
- **Seasonal discharge pattern:** Expected in many regions

OVERVIEW

Key Area of Probable Vulnerabilities to Climate Change



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THE NEED FOR ADAPTATION

- Observed climate change (CC) impacts have already appeared
- NAHRIM CC research shows further impacts are inevitable
- Infrastructure built now will still be around in the design period (i.e 30-50 years)
- Demographic changes are increasing exposure
- Early planning would ensure Malaysian industries and communities are well placed to cope with change


Bekok Dam


Tanjung Piai Mangrove


Redang Island

PLANNERS AND CLIMATE CHANGE

- **Planners face two major challenges in a changing climate**
  - **How to reduce greenhouse emissions**
  - **How to build resilience or adapt to climate change impacts**
- **Acting with imperfect knowledge - global climate change science robust, BUT**
  - **Uncertainty over timing, nature, magnitude of change**
  - **Costs and benefits difficult to calculate**

MEETING THE CHALLENGE	FILLING KEY KNOWLEDGE GAPS
▪ Early planning ▪ Best available information ▪ Existing planning mechanisms and infrastructure ▪ Risk management	▪ Building standards and design ▪ Water and coastal (marines) resources ▪ Other sectors – agriculture, energy and transportation, biodiversity & forestry, health

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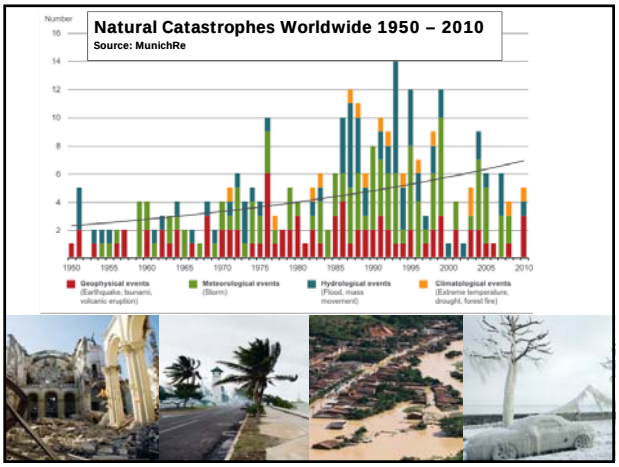
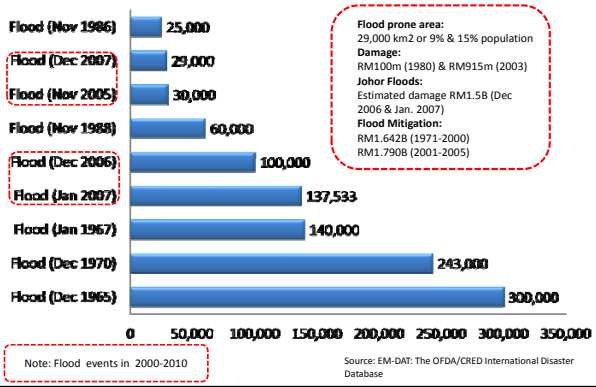


Setting the Scene

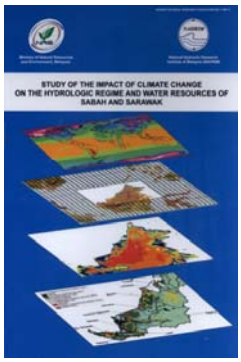
Total affected due to Floods



Setting the Scene – Climate Change Study, Peninsular Malaysia (2006)

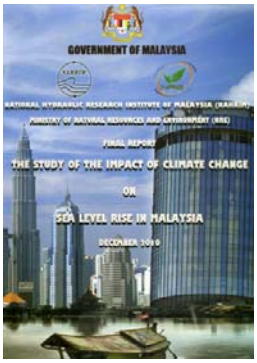
- **2006:** A regional hydrologic-atmospheric model of Peninsular Malaysia called as '**Regional Hydro-climate Model of Peninsular Malaysia (RegHCM-PM)** was developed
- **Downscaling** global climate change simulation data (Canadian GCM1 current and future climate data) that are at very **coarse resolution** (~ 410km), to Peninsular Malaysia (West Malaysia) at **fine spatial resolution** (~9km) – for future period of 2025 to 2050 (**2025-2034 & 2041-2050**)

Setting the Scene – Climate Change Study, East Malaysia (2010)



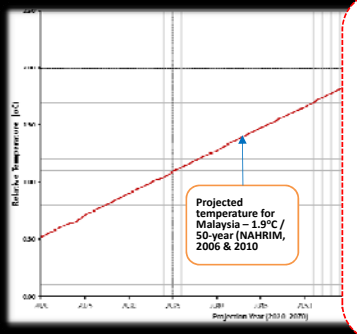
- **2010:** A regional hydrologic-atmospheric model of Peninsular Malaysia called as '**Regional Hydro-climate Model of Sabah and Sarawak (RegHCM-SS)** was developed
- **Downscaling** global climate change simulation data (ECHAM5 GCM and MRI GCM2.3.2 at control run simulation and future climate simulation data) that are at very **coarse resolution** (~ 208/310km), to Sabah & Sarawak (East Malaysia) at **fine spatial resolution** (~9km) – for future period of **2010 to 2100**

Setting the Scene – Sea Level Rise Study Conducted in Malaysia (2010)



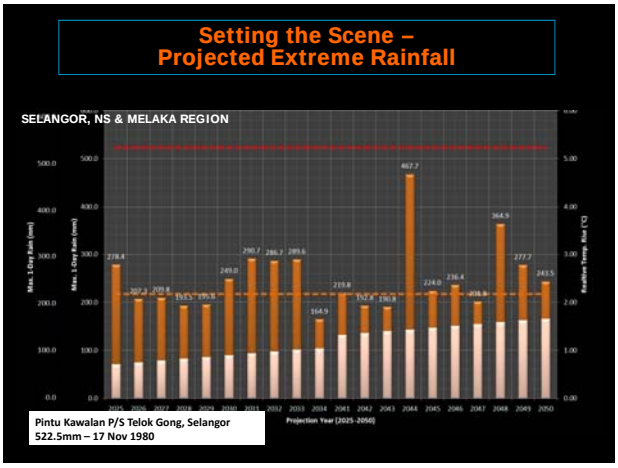
- **Objective : produce a few projections of SLR for 21st century (2010 to 2100):**
  - **Historical tide gauge data (Dept. of Survey & Mapping Malaysia, JUPEM);**
  - **Satellite altimetry data; and**
  - **Global Climate Model (GCM) projections.**
- **Methodology:**
  - **Linear Trend Analysis on Historical Tide Gauge data and Satellite Altimetry data – obtain rate of SLR.**
  - **Assimilation of mean projection of SLR with 49 simulations of 7 Atmospheric Oceanic GCM models at satellite altimetry locations along Malaysian coastlines**

Setting the Scene – Projected Temperature Increase



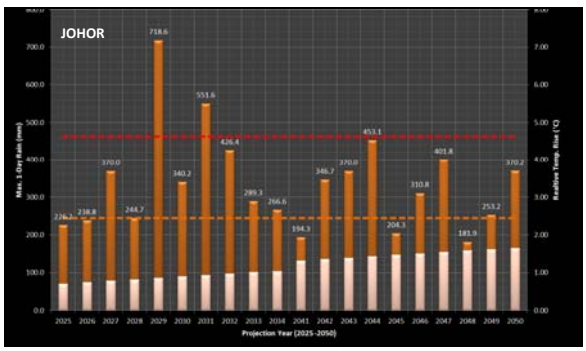
- **Agriculture** – higher temp will lead to decrease yield
- **Forestry And Biodiversity** - altering the montane environment
- **ENERGY** - increases in ambient temperature can be expected to reduce gas and hydro turbine power
- **COASTAL & MARINE** (sea-water temperature)- to decrease heat transfer in cooling facilities
- **TRANSPORTATION** - decrease transportation efficiency of vehicles and accelerate the deterioration of infrastructure;
- **PUBLIC HEALTH** - greater and wider transmission of diseases for malaria and dengue
- **URBAN AREAS** - may increase urban heat island effect and enhance pollutant trappings in the air
- **EXTREME HEAT WAVES** - escalate mortality associated with cardiovascular, cerebrovascular and respiratory problems
- **SEA SURFACE TEMPERATURE** - coral bleaching & affect the physiology of aquatic life

Setting the Scene – Projected Extreme Rainfall



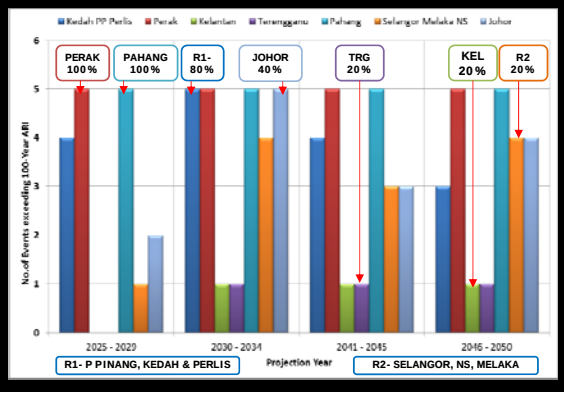
Pintu Kawalan P/S Telok Gong, Selangor
522.5mm – 17 Nov 1980

Setting the Scene – Projected Extreme Rainfall



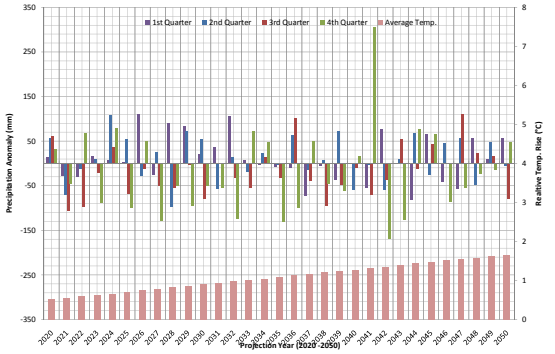
*Spg. Mawai – Kuala Sedili
462.6mm – 24 Jan 2004

Setting the Scene – Projected vs. 100-year 1-Day Rainfall

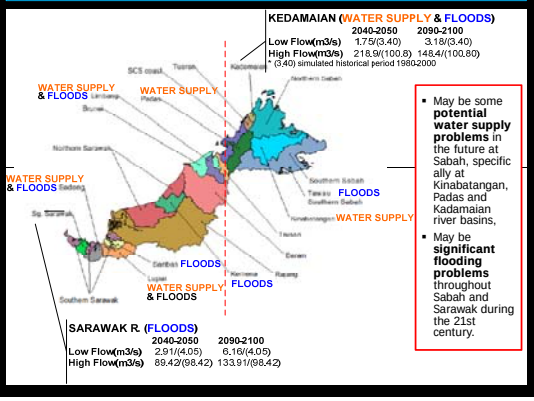


Setting the Scene – Projected Potential Drought

Kadamaian, Tuaran, and South China Sea Coast

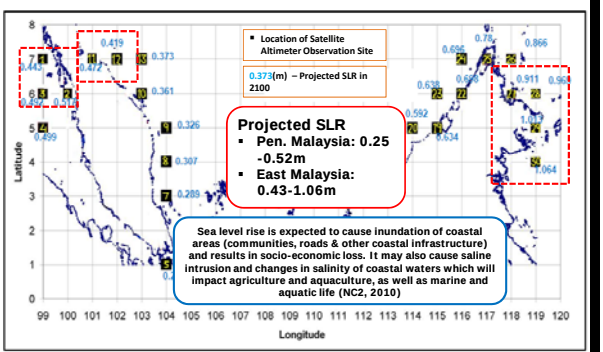


Setting the Scene – Projected High and Low Flows by 2100



- May be some **potential water supply problems** in the future at Sabah, specifically at Kinabatangan, Padas and Kadamaian river basins,
- May be **significant flooding problems** throughout Sabah and Sarawak during the 21st century.

Setting the Scene – Projected Sea Level Rise



Projected SLR
- **Pen. Malaysia: 0.25 -0.52m**
- **East Malaysia: 0.43-1.06m**

Sea level rise is expected to cause inundation of coastal areas (communities, roads & other coastal infrastructure) and results in socio-economic loss. It may also cause saline intrusion and changes in salinity of coastal waters which will impact agriculture and aquaculture, as well as marine and aquatic life (NC2, 2010)

SUMMARY OF PROJECTED CLIMATE CHANGE IN MALAYSIA

Climate Parameter	Peninsular Malaysia [RegHCM-PM]	Sabah [RegHCM-SS]	Sarawak [RegHCM-SS]
Annual mean surface temp.	1.0-1.5ºC [2050]	[2050] 1.3-1.7ºC [2100] 2.9–3.5ºC	[2050] 1.0-1.5ºC [2100] 3.0-3.3ºC
Max. Monthly Rainfall	[2050] +113mm(12%)	[2050] +59mm (5.1%) [2100] +111mm (9%)	[2050] +150mm (8%) [2100] +282mm (32%)
Sea Level Rise	0.25-0.52m [2100]	0.64-1.03m [2100]	0.43-0.63m [2100]

Summary of Projected Change, Vulnerability & Impacts

Climate Change Parameter	Projected Change	Vulnerability & Impacts	Sector
Temperature [2050] ▪ Pen Msia ▪ Sabah ▪ Sarawa	1.0-1.5ºC 1.3-1.7ºC 1.0-1.5ºC	▪ Agriculture yield & crop productivity ▪ Montane environment ▪ Heat transfer in cooling facilities ▪ transportation efficiency ▪ Vector capacities & ▪ transmission of diseases ▪ Pollutant trapping	Agriculture, Biodiversity, Energy, Transportation & Public Health
Rainfall [2050] ▪ Pen Msia ▪ Sabah ▪ Sarawak	+113mm(12%) +59mm(5.1%) +150mm(8%)	▪ Floods ▪ Water supply ▪ Erosion ▪ Landslides ▪ Crop productivity ▪ Power generation ▪ Water contamination ▪ Diarrhoeal diseases ▪ capacity of the vector diseases	Water resources Agriculture Public health Energy

Summary of Projected Change, Vulnerability & Impacts

Climate Change Parameter	Projected Change	Vulnerability & Impacts	Sector
Streamflow ▪ Pen Malaysia ▪ Sabah & Sarawak	• An increase in inter-annual and intra-seasonal variability with increased hydrologic • extremes varies with the geographical location within the region, with seasonality, and with the considered time interval in the future	▪ Damage water control structure (dam, barrages,etc) ▪ Decrease agriculture yield ▪ Power generation ▪ Damage transportation infrastructure (road, rail lines & bridges)	Water Resources Agriculture Energy Transporatation
Sea level rise	0.25- 1.06 m	▪ inundation of coastal areas ▪ socio-economic loss ▪ saline intrusion ▪ Aquatic life	Coastal and riverine area Agriculture & aquaculture Marine area

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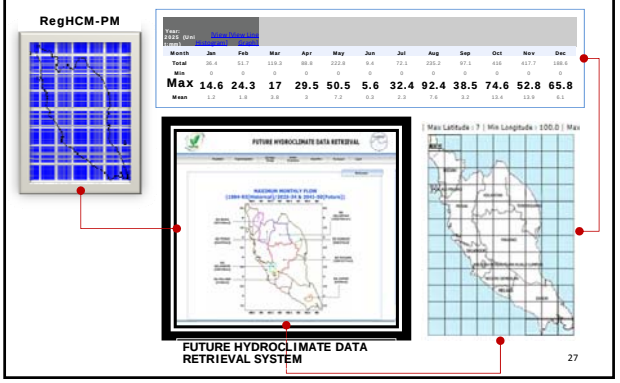
Adaptation Tool - Regional **Future Hydroclimate Data Retrieval System** for extreme events (9km x 9km)



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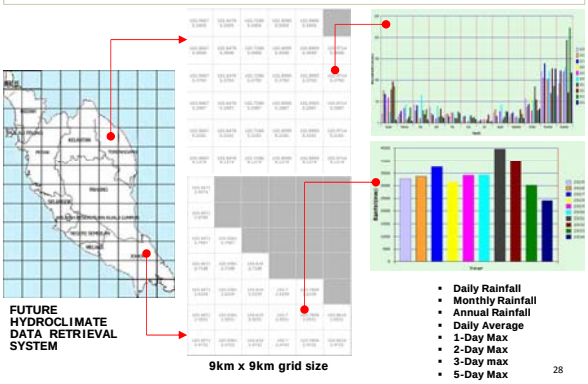

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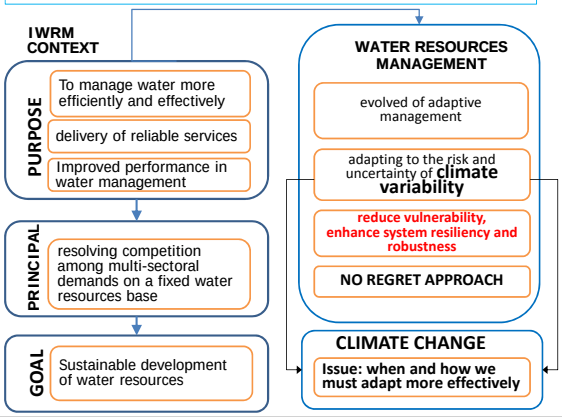
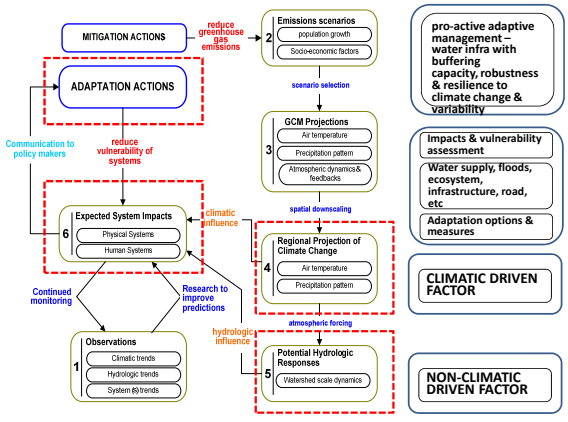
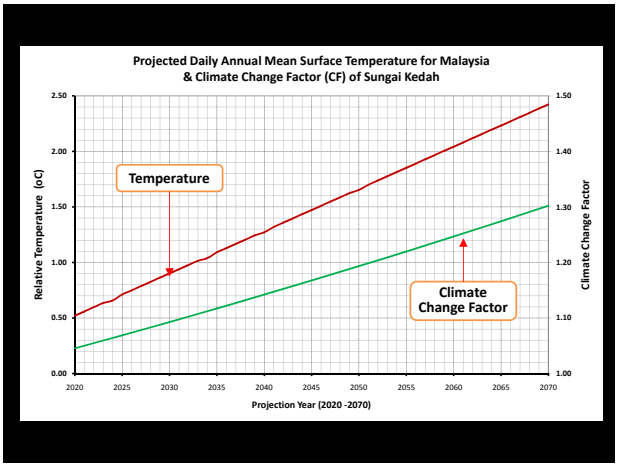
FRAMEWORK OF WATER RESOURCES MANAGEMENT



ADAPTATION & VULNERABILITY IMPACT ASSESSMENT





Estimated Average GCMs Climate Change Factor for 1-day Design Rainstorm at 100-years ARI

JOHOR (2046-2065)

Region	Muar	Batu Pahat	Endau	Johor	Mersing	Sedili	Pulai-Skudai-Tebrau	South East	South West
CCF	1.31	1.31	1.25	1.23	1.23	1.26	1.24	1.12	1.23

LANGAT RIVER BASIN (2046-2065)

Station	MMD PJ	Ladang Brooklands	JPS Sg Manggis	JPS Telok Gong	JPS Kajang	JPS Ampang	Stn Janalektrik Ldg Ponsun
CCF	1.04	1.20	1.23	1.10	1.16	1.14	1.18

ON-GOING RESEARCH

- **Details analysis and guidelines of Climate Change Factor (CCF) for Design Floods in Malaysia**
- **Inundation maps of Sea Level Rise (SLR) for Malaysia**
- **Options and Cost of Adaptation for Water – related Infrastructure**

CONCLUSIONS

1. **Climate change adaptation planning involves scientific modelling, model interpretation, vulnerability assessment, and development of tools for decision-makers.**
2. **Climate change is expected to have wide-ranging effects on the environment, socio-economic and related sectors including water resources, agriculture, energy, transportation, human health, biodiversity and forest, and coastal and marine zones.**
3. **Malaysian water resources sector is vulnerable, including floods and extreme weather events, as a result of climate variability.**
4. **In the context of climate change uncertainty, there is a need of paradigm shift for the water management by designing system with additional safety factors by incorporating the climate change factor.**
5. **Climate data should be observed, monitored and evaluated continuously to refine climate change and variability as well as to enhance climate change projection data and analysis.**
6. **Successful climate change adaptation and vulnerability reduction cannot be achieved with respect to climate change alone, and vulnerability reduction appears to be most effective if undertaken in combination with other strategies and plans at various levels.**

OBSERVED CLIMATE CHANGE

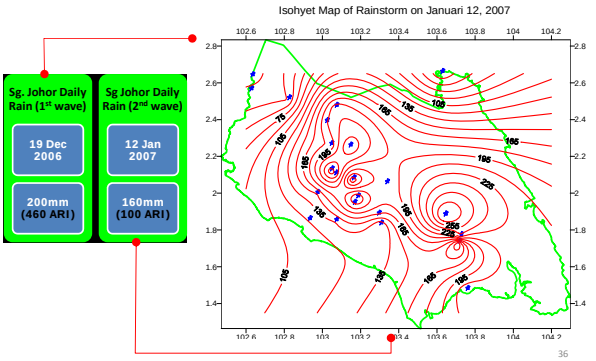
Malaysia

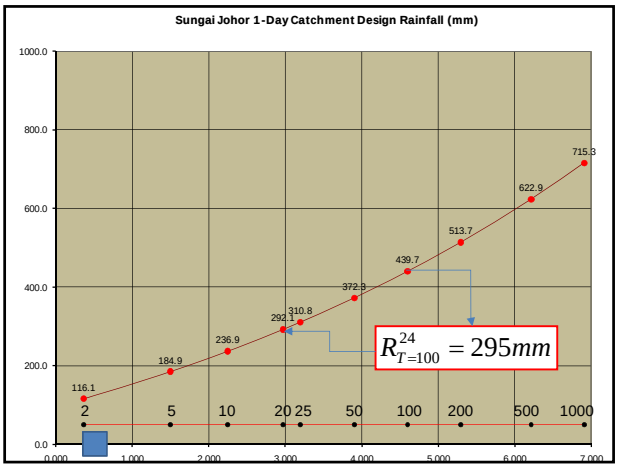
- **Rate of warming (temperature): 1969-2009**
  - **1.1°C/50-yr - Semenanjung Malaysia;**
  - **0.6°C/50-yr - Sarawak;**
  - **1.2°C/50-yr - Sabah;**
- Sea level rise (satellite altimetry) – **2.73 – 7.00 mm/year (1993 to 2010)**
- Short duration max. rainfall intensity – Period of 2000-2007 greater than 1970s (1971-80);
- 1-hr & 3-hr rainfall intensity in 2000-2007) increased 17% & 29% respectively compared to 1970s

Global

- **Rate of warming (temperature): (AR4, IPCC)**
  - **1906-2005: 0.74°C**
- Global average sea level rise (AR4, IPCC) – **1.8 [1.3 to 2.3] mm per year (1961 to 2003)**

JOHOR FLOODS SCENARIO IN DEC. 2006 & JAN. 2007




Sungai Johor 1-Day Catchment Design Rainfall (mm)
1000.0
800.0
600.0
400.0
200.0
0.0
116.1
184.9
236.9
292.1
310.8
372.8
439.7
513.7
622.9
715.3
2
5
10
20
25
50
100
200
500
1000
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
$R^{24}_{T=100} = 295mm$