Malaysia Experience on Floods With Climate Change Impacts

National Disaster Management Agency (NADMA), Malaysia & Department of Irrigation and Drainage (DID), Malaysia

Presentation Outline

1. Introduction
2. Resilience to Climate Change: Malaysia Initiatives
3. Conclusion
1. Introduction

Natural Disasters in Malaysia

**Disaster Types**

- **Flood**
  - Kajang Town (2014)
- **Landslide**
  - Kuala Lumpur (2008)
- **Tropical Storm**
  - Pendang (2014)
- **Earthquake**
  - Ranau, Sabah (2015)
- **Tsunami**
  - Kuala Muda, Kedah (2004)
- **Peat Forest Fire**
  - Selangor (2013)
- **Haze**
  - Kuala Lumpur (2014)
- **Drought**
  - Chuping, Perlis (2016)

Flood Prone Area – Hotspots for Vulnerability

- Flood-prone areas ≈ 33,298 km² out of 330,436 km² (10.1%);
- Population directly affected by flood ≈ 5.7 million Malaysian (> 21%).
- Estimated Flood Damage ≈ RM 1.15 billion

Source: Updating of Condition of Flooding, 2012

Excess Water → Floods

Segamat Town - Dec 2006 / Jan 2007

East Coast Floods, Dec 2013

Chukai Town, Dec 2013

Kelantan, 2014
Last 20 Years Water Related Disaster in Malaysia

<table>
<thead>
<tr>
<th>Year</th>
<th>Flood Event</th>
<th>Death</th>
<th>Evacuated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Sabah</td>
<td>27</td>
<td>22,000</td>
</tr>
<tr>
<td>1995</td>
<td>Shah Alam / Klang Valley, Klang, Selangor,</td>
<td>8</td>
<td>23,870</td>
</tr>
<tr>
<td>1996</td>
<td>Keningau, Sabah (Tropical Cyclone Greg)</td>
<td>238</td>
<td>39,687</td>
</tr>
<tr>
<td>1998</td>
<td>Pos Dipang, Perak; Kuala Lumpur</td>
<td>49</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>1999</td>
<td>Penampang, &amp; Sandakan, Sabah</td>
<td>9</td>
<td>4,481</td>
</tr>
<tr>
<td>2000</td>
<td>Kg. La, Terengganu</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>2001</td>
<td>Kelantan, Pahang, Terengganu; Gunung Pulai, Johor; Besut, Marang, Terengganu</td>
<td>14</td>
<td>&gt; 11,000</td>
</tr>
<tr>
<td>2006/07</td>
<td>Johor &amp; Kelantan</td>
<td>18</td>
<td>110,000</td>
</tr>
<tr>
<td>2008</td>
<td>Johor</td>
<td>28</td>
<td>34,000</td>
</tr>
<tr>
<td>2010</td>
<td>Kedah &amp; Perlis</td>
<td>4</td>
<td>50,000</td>
</tr>
<tr>
<td>2013</td>
<td>Kemaman, Terengganu, Kuantan Pahang, Johor, Kelantan</td>
<td>3</td>
<td>&gt;34,000</td>
</tr>
<tr>
<td>2014</td>
<td>Kelantan, Terengganu, and Pahang</td>
<td>25</td>
<td>500,000</td>
</tr>
<tr>
<td>2015</td>
<td>Kota Belud, Sabah</td>
<td>-</td>
<td>&gt; 1,800</td>
</tr>
<tr>
<td>2017</td>
<td>Pulau Pinang</td>
<td>7</td>
<td>&gt; 2,000</td>
</tr>
</tbody>
</table>

Sources: Department of Irrigation and Drainage Malaysia, Malaysian National Security Council and Chan (2012)

El Nino & La Nina Pattern

- **El Nino** (Warm)
- **La Nina** (Cool)

- El Nino and La Nina → global patterns of climatic variability;
- El Nino → intensity and duration of events are varied and hard to predict.

Source: GGWS, 2018
Rainfall Event Trend → More Extreme Wet Spells

- Increasing number of wet spells;
- Leads to severe floods.

Source: Disaster and Climate Change Projection for Malaysia, 2016

Mean Annual Rainfall - Trend

40 Years
1978-2017

Source: Kajian Penyediaan Perubahan dan Taburan Hujan Di Malaysia (JPS-NAHRIM, 2018)
Temporal and Spatial Distribution of Rainfall

10 Years

1978 - 1987
1988 – 1997
1998 - 2007
2008 - 2017

Source: Kajian Penyediaan Perubahan dan Taburan Hujan Di Malaysia (JPS-NAHRIM, 2018)
Possible Future Climate Projection
Average Annual Rainfall & Mean Temperature (1984-93 vs 2025-34 & 2041-50)

Regions / Sub-regions / States

<table>
<thead>
<tr>
<th></th>
<th>Temperature (°C)</th>
<th>Rainfall (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North East Region</td>
<td>+1.88</td>
<td>+32.8</td>
</tr>
<tr>
<td>Terengganu, Kelantan, Northeast-coast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North West Region</td>
<td>+1.80</td>
<td>+6.2</td>
</tr>
<tr>
<td>Perlis (west coast), Perak, Kedah</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Region</td>
<td>+1.38</td>
<td>+8.0</td>
</tr>
<tr>
<td>KL, Selangor, Pahang</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern Region</td>
<td>+1.74</td>
<td>+2.9</td>
</tr>
<tr>
<td>Johor, Southern Peninsula</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Change in Maximum Monthly Value

Source: NAHRIM, 2006
2. Resilience to Climate Change: *Malaysia Initiatives*

Enhance the resilience of water-related infrastructures

Improve the resilience of communities in context of climate change adaptation
Resilience to Climate Change: **Malaysia Initiatives**

**Integration of climate change adaptation on policy & guidelines;**

**Improvement of technologies in engineering practices**

**Improvement of hydrometric network coverage**

**Improvement of warning system → future flood & drought**

- National Flood Forecasting and Warning Program
- National Water Balance System

Integration of Climate Change Adaptation on Policy & Guidelines

**National Policy on Climate Change, 2009**

- Policy Statement → Ensure climate-resilient development to fulfil national aspirations for sustainability;
- Instrument to harmonise and integrate with national priorities, measures on CCA, mitigation and DRR;
- Consist of 5 Principles, 10 Strategic Thrusts, and 43 Key Actions.

**Malaysia’s Second National Communication (NC2) to the UNFCCC**

- prepared to meet Malaysia’s obligation as a signatory party of the United Nations Framework Convention on Climate Change (UNFCCC);
- Malaysia have agreed to prepare a report periodically on national greenhouse gas (GHG) emissions and measures taken to address climate change.
Technology Guidance – GEF UNEP

- Specify technologies that best suited to a country’s specific climate change situation;
- Provide information on how to set priorities and identify appropriate technologies to mitigate or adapt climate change.

Source: http://www.tech-action.org/Publications/TNA-Guidebooks

Climate Change Study

Peninsular Malaysia (West Malaysia) (NAHRIM, 2006)
A regional hydrologic-atmospheric model of Peninsular Malaysia called ‘Regional Hydro-climate Model of Peninsular Malaysia (RegHCM-PM) was developed.

East Malaysia (NAHRIM, 2010)
A regional hydrologic-atmospheric model of East Malaysia called ‘Regional Hydro-climate Model of Sabah and Sarawak (RegHCM-SS) was developed.
Improvement of Hydrometric Network Coverage

**National Network (RHN)**
- Equipments & system upgrades;
- 1,458 stations.

**PRAB (775 → 1,870 stations)**
- RF : from 443 nos. → 1100 nos;
- WL : from 332 nos. → 650 nos;
- SF : → 50 nos;
- SM : → 50 nos;
- EV : → 20 nos.

*RF Station Coverage Ratio;*  
Malaysia - 1 in 220km²; Bangladesh - 1 in 68 km²; Japan - 1 in 42km²

Source: DID, Malaysia (2018)

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Hydrological Procedure No. 1 & No. 26

- HP1 → Peninsular Malaysia;
- HP26 → Sabah & Sarawak;
- Estimation of design rainfall under climate change scenario;
- Climate Change Factor (CCF) → adding certain percentage to the design storm.

http://h2o.water.gov.my
DID Circular on CCF → Design of Water Related Structures

- Permanent structures (culverts, control gate, bridge, etc.) → to apply CCF in the estimation of design rainstorm;
- Non-permanent structures (flood levees, bunds, etc.) → to check freeboard adequacy based on CCF.

### Climate Change Factor (CCF)

- CCF → adding certain percentage to the design storm;
- To assist engineers in design and planning of water-related infrastructure under changing climatic conditions.

#### Table 10.1: Summary of Minimax, Mean, Median and Maximum Values of Climate Change Factors for Region 1

<table>
<thead>
<tr>
<th>State No</th>
<th>Station Name</th>
<th>Climate Change Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JPS Kemanaman</td>
<td>1.12</td>
</tr>
<tr>
<td>5</td>
<td>Kg. Bt. Hampsar, setu</td>
<td>0.93</td>
</tr>
<tr>
<td>6</td>
<td>Kg. Tan Ho, Kemanaman</td>
<td>1.06</td>
</tr>
<tr>
<td>7</td>
<td>Kg. Menengan, Hulu Trg</td>
<td>0.99</td>
</tr>
<tr>
<td>9</td>
<td>Kg. Seladang, Hulu Setu</td>
<td>0.91</td>
</tr>
<tr>
<td>10</td>
<td>Klinik Kg. Raju, Besut</td>
<td>1.06</td>
</tr>
<tr>
<td>11</td>
<td>Setor JPS K. Terengganu</td>
<td>0.99</td>
</tr>
<tr>
<td>13</td>
<td>S K Jenangku</td>
<td>1.97</td>
</tr>
<tr>
<td>14</td>
<td>Sir Panchar, Setu</td>
<td>0.96</td>
</tr>
<tr>
<td>15</td>
<td>SM Sultan Omar, Dungun</td>
<td>1.09</td>
</tr>
<tr>
<td>16</td>
<td>Sungai Gant, Hulu Trg</td>
<td>0.95</td>
</tr>
<tr>
<td>17</td>
<td>Sungai Tong, Setu</td>
<td>1.04</td>
</tr>
</tbody>
</table>

 Minimum 0.91  1.06  1.11  1.12  1.13  1.15  1.16  1.17  1.17  1.17
 Mean 1.07  1.17  1.22  1.27  1.28  1.31  1.34  1.36  1.36  1.36
 Maximum 1.23  1.37  1.44  1.50  1.52  1.57  1.61  1.64

Source: JPS, 2015
Climate Change Factor

Design Rainstorm with CCF

\[ I = \frac{75.826T^{0.239}}{(d + 0.381)^{0.73}} \]

\[ I_{50} = 5.94 \text{ mm/hr} = 428 \text{ mm} \]

Flood Hazard Map (50 yrs ARI): Existing Condition

- Flood Defence at Kemaman River @ Chukai Town;
- L = 105.2 km;
- A = 2,191 km²;
- Population = 197,800 people;
- 2013 flood → 20 ARI;
- 2013 flood → 39,000 victims.

Source: DID Malaysia, 2015
Flood Hazard Map (50 yrs ARI): Flood Mitigation Condition

- 14km Earth Bund at Kemaman River (total 28km);
- 12km Binjai Bund;
- Bund height → varies 3m-4m;
- Earth Bund → RM62 Million.

Source: DID Malaysia, 2018

Flood Hazard Map (50 yrs ARI + CCF): Flood Mitigation Condition

- CCF → +30% of Design RF Depth;
- 50 ARI + CCF ≈ >100 ARI;
- Earth Bund Cost +40%.

Source: DID Malaysia, 2018
Improvement of Technology

- Combines floodgate and submersible pump → performs the function of floodgate and pump at the same time;
- Smaller land area → no pump house needed;
- Easy to maintain and shorten the construction period.

Improvement of Technology

- Rock armour and seawall as protection against erosion, flooding and sea level rise;
- Cost effective and longer lasting.
3. Conclusion

Conclusion

- The benefits of the integration of flood risk management into wider development management, urban planning and climate change adaptation are clear;
- The most successful long-term flood risk management strategies will balance the implementation of short-run, quick gain, non-structural measures with a vision of the best suite of structural and non-structural measures to be implemented for the longer term;
- Understanding the required resources, the best and worst case scenarios and the tipping points at which action becomes imperative, rather than justified, can lead to better decisions.
Acknowledgement

For the material used in this presentation:

• Dato’ Ir. Hj. Nor Hisham Bin Mohd. Ghazali (DID)
• Dato’ Ir. Sabri bin Abdul Mulok (DID)
• Mohamad Hafiz Bin Hassan (DID)
• Thayalam a/l Sekaran (DID)
• Wan Hazdy Azad bin Wan Abdul Majid (DID)

Thank You

National Disaster Management Agency (NADMA), Malaysia &
Department of Irrigation and Drainage (DID), Malaysia