DAM MANAGEMENT IN MALAYSIA

Flood Risk Management Case Visit

by

ASEAN Committee on Disaster Management (ACDM)

8th JULY 2019

Mohd Hazri Moh Khambali
Dam Section, DID
CONTENTS

• Dams in Malaysia
• Dam Safety Issues
• Government initiatives and Action Plan
• Future Direction
Introduction – Dams in Malaysia

BATU DAM
GOMBAK, SELANGOR

Department of Irrigation and Drainage, Malaysia
DAM

“All man-made barriers, together with appurtenant works, constructed for storage or control of water or other fluids”.

- This classification normally excludes canals and levees, but MyDAMS may be used as a basis for developing safety management plans for these structures, if the need exists.

- Applicable to dams that are 10 m or more in height and storage more than 20,000 m³
  Or;
  dams that higher than 5 m and storage more than 50,000 m³

*Malaysia Dam Safety Management Guideline (MyDAMS)
### Dams in Malaysia

<table>
<thead>
<tr>
<th>States</th>
<th>Total no.</th>
<th>Water Supply</th>
<th>Irrigation</th>
<th>Flood Mitigation</th>
<th>Hydroelectricity</th>
<th>Sedimentation</th>
<th>Recreation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johor</td>
<td>17</td>
<td>13</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kedah</td>
<td>8</td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kelantan</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N. Sembilan</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melaka</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Pahang</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>P. Pinang</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perak</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td></td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Perlis</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Selangor</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terengganu</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Sabah</td>
<td>10</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Sarawak</td>
<td>9</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Labuan</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Putrajaya</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>104</strong></td>
<td><strong>62</strong></td>
<td><strong>14</strong></td>
<td><strong>5</strong></td>
<td><strong>16</strong></td>
<td><strong>4</strong></td>
<td><strong>2</strong></td>
</tr>
</tbody>
</table>
16 Dams under DID

- Padang Saga, Langkawi
- Timah Tasoh, Perlis
- Beris, Sik
- Bukit Kwong, Pasir Mas
- Bukit Merah, Kerian
- Repas Lama, Bentong
- Repas Baru, Bentong
- Perting, Bentong
- Pontian, Rompin
- Anak Endau, Rompin
- Labong, Mersing
- Batu, Gombak
- Bekok, Batu Pahat
- Sembong, Batu Pahat
- Machap, Kluang

Department of Irrigation and Drainage, Malaysia
Overview

- Average age of dams has exceeded 40 years.
- Majority dam are earth fill dam.
- Own by different agencies.

The main function:
1. Raw water supplier
2. Irrigation
3. Flood mitigation
4. Generating hydro-electricity
5. Impediment to sediment and silts (silt retention)
Some interesting facts

WATER SUPPLY SECTOR

- Water supply has the most number of dams (65 dams).
- Total storage about 2,400 MCM.
- Biggest dam is Linggiu Dam in Johore (760 MCM).
- Largest in term of surface area is Chereh Dam in Pahang (16 km²).
- Highest water supply dam is Selangor Dam at 110 m.

References: Dam in Malaysia, 2014, RPM Engineer Sdn, Bhd.
HYDROPOWER SECTOR

- 16 Hydropower Dams.
- Biggest capacity dams with total storage about 80,000 MCM.
- Bakun Dam is the largest dam (44,000 MCM).
- Bakun Dam is listed by ICOLD as ranked at 41 out of 60 highest dam in the world.
- Kenyir Dam (Terengganu) is the second largest dam in Malaysia (13,600 MCM, surface area of 369 km², height 155 m).

References: Dam in Malaysia, 2014, RPM Engineer Sdn, Bhd.
Some interesting facts

IRRIGATION SECTOR

- 14 dams with total storage about 2,000 MCM.
- Pedu Dam is the largest volume at 1,073 MCM.
- Pedu Dam is largest surface area at 84 km².

FLOOD MITIGATION

- 5 dams with total storage of 130 MCM.
- **Timah Tasoh** Dam is the largest with 33 MCM capacity. (Will increase to 87 MCM, once dam upgrading project completed)
- The highest flood mitigation dam is **Batu Dam** at 44 m.

References: Dam in Malaysia, 2014, RPM Engineer Sdn, Bhd.
## Dam Built in Various Periods

<table>
<thead>
<tr>
<th>Period</th>
<th>No. of Dams Built</th>
<th>Period</th>
<th>No. of Dams Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1900</td>
<td>17</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1901 - 1910</td>
<td>1</td>
<td>1961-1970</td>
<td>10</td>
</tr>
<tr>
<td>1911-1920</td>
<td>0</td>
<td>1971-1980</td>
<td>6</td>
</tr>
<tr>
<td>1921-1930</td>
<td>2</td>
<td>1981-1990</td>
<td>28</td>
</tr>
<tr>
<td>1931-1940</td>
<td>9</td>
<td>1991-2000</td>
<td>12</td>
</tr>
<tr>
<td>1941-1950</td>
<td>2</td>
<td>2001-2010</td>
<td>18</td>
</tr>
<tr>
<td>1951-1960</td>
<td>3</td>
<td>2011-2016</td>
<td>12</td>
</tr>
</tbody>
</table>

Department of Irrigation and Drainage, Malaysia
## Distribution of Dams According to Dam Type

<table>
<thead>
<tr>
<th>Item</th>
<th>Dam Type</th>
<th>No.</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth fill</td>
<td>70</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>Rock fill</td>
<td>14</td>
<td>13.2</td>
</tr>
<tr>
<td>3</td>
<td>Concrete gravity</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>Others</td>
<td>4</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Department of Irrigation and Drainage, Malaysia
## Dam Hazard Rating

<table>
<thead>
<tr>
<th>Dam Hazard Rating</th>
<th>PAR(^1,2)</th>
<th>Environmental and cultural values(^2)</th>
<th>Infrastructure and economics(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0</td>
<td>Minimal short-term loss; No long-term loss</td>
<td>Low economic losses; Area contains limited infrastructure or services</td>
</tr>
<tr>
<td>Significant</td>
<td>1 – 10</td>
<td>No significant loss; Marginal deterioration of important flora and fauna habitat; Restoration is highly possible</td>
<td>Significant economic losses involving recreational facilities, infrequently used workplaces and transportation routes</td>
</tr>
<tr>
<td>High</td>
<td>11 – 100</td>
<td>Significant loss or deterioration of critical flora and fauna habitat; Restoration is possible but impractical</td>
<td>High economic losses affecting infrastructure, public transportation and commercial facilities</td>
</tr>
<tr>
<td>Very high</td>
<td>&gt; 100</td>
<td>Major loss or deterioration of critical flora and fauna habitat; Restoration is impossible.</td>
<td>Very high economic losses affecting important infrastructure or services (e.g. hospital, highway, industrial area, storage facilities for dangerous substances)</td>
</tr>
</tbody>
</table>

**Note 1:** Definitions for Population at Risk (PAR):
The number of people who would be directly exposed to inundation greater than 0.5 m in depth within the dam break affected zone if they took no action to evacuate.

**Note 2:** Inference for PAR, environment and cultural values, and infrastructure and economic losses:
Losses or damages stated above are incremental, which dam failure might inflict on, are over and above any losses which might have occurred for the same natural event or conditions, had the dam not failed.

*Malaysia Dam Safety Management Guideline (MyDAMS)*
<table>
<thead>
<tr>
<th>Dam Hazard Rating</th>
<th>Comprehensive Dam Safety Inspection (Formal Safety Inspection)</th>
<th>Intermediate Dam Safety Inspection (Periodic Safety Inspection)</th>
<th>Routine Visual</th>
<th>Unusual/ Special/ Emergency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>On first filling then every 5-yearly</td>
<td>Annual</td>
<td>Daily¹</td>
<td>Whenever necessary and when event occurs</td>
</tr>
<tr>
<td>High</td>
<td>On first filling then every 5-yearly</td>
<td>Annual</td>
<td>Daily to¹ Tri-Weekly</td>
<td>Whenever necessary and when event occurs</td>
</tr>
<tr>
<td>Significant</td>
<td>On first filling then every 7-yearly</td>
<td>Annual to 2-yearly</td>
<td>Twice Weekly to Weekly¹</td>
<td>Whenever necessary and when event occurs</td>
</tr>
<tr>
<td>Low</td>
<td>On first filling then every 5-yearly</td>
<td>On first filling then every 5-yearly</td>
<td>Monthly</td>
<td>Whenever necessary and when event occurs</td>
</tr>
</tbody>
</table>

*Malaysia Dam Safety Management Guideline (MyDAMS)*
Dam incident in Malaysia

Sultan Abu Bakar, Hydropower Dam (2013).
Dam incident in Malaysia

Sultan Abu Bakar, Hydropower Dam (2013).
Issues related to dam management
Issues Related To Dam Management

1. Importance of Dam Safety
2. Ownership
3. Dam Safety Management (DSM)
4. Legislation
5. Gazetting Catchment Area
6. Insufficient of Dam Technical Expertise
7. Enforcement
1. Importance of Dam Safety

- Average dam exceed 40 year.
- Development of downstream area.
- DSM practices by self regulation (before MyDAMS introduced in 2017)
- Limited number of element of DSM.
- Emergency Action Plan (EAP) does not exist or inadequate.
- Surveillance inspector are not adequately qualified and trained.
EMERGENCY ACTION PLAN OVERVIEW

STEP 1: Event Detection

Detect Event

STEP 2: Emergency Level Determination

Asses Situation
Determine Emergency Level

Level 1
Unusual Event;
Slowly Developing

Level 2
Potential Dam Failure
Situation; Rapidly
Developing

Level 3
Urgent; Dam Failure is
Imminent or in
Progress

STEP 3: Notification and Communication

Notify Level 1

Notify Level 2

Notify Level 3

STEP 4: Expected Action

Monitor & Record
Monitor
Procedures

Save Dam
Emergency Actions,
Preventive Actions

Save People
Evacuation
Management

STEP 5: Termination and Follow-up

Termination
Termination Responsibility
Follow Up

Detect Event

Notify Level 1

Notify Level 2

Notify Level 3

Monitor & Record
Monitor
Procedures

Save Dam
Emergency Actions,
Preventive Actions

Save People
Evacuation
Management

Termination
Termination Responsibility
Follow Up

Detect Event

Notify Level 1

Notify Level 2

Notify Level 3

Monitor & Record
Monitor
Procedures

Save Dam
Emergency Actions,
Preventive Actions

Save People
Evacuation
Management

Termination
Termination Responsibility
Follow Up
<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Distance from Bukit Merah Dam (km)</th>
<th>Max. Flood Depth (m)</th>
<th>Max. Flood Flow Velocity (m/s)</th>
<th>Flood Arrival Time (hrs)</th>
<th>Time to Peak Water Level (hrs)</th>
<th>Time to Subside (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kg. Sg. Semambu</td>
<td>10.4</td>
<td>0.03</td>
<td>0.03</td>
<td>10.1</td>
<td>11.58</td>
<td>&gt; 3</td>
</tr>
<tr>
<td>2</td>
<td>Kg. Matang Jelutong</td>
<td>12.1</td>
<td>0.33</td>
<td>0.23</td>
<td>8.67</td>
<td>13.42</td>
<td>&gt; 3</td>
</tr>
<tr>
<td>3</td>
<td>Kg. Sg. Bogak</td>
<td>47.9</td>
<td>0.76</td>
<td>0.21</td>
<td>20.42</td>
<td>31.67</td>
<td>&gt; 3</td>
</tr>
</tbody>
</table>
1. Importance of Dam Safety

- Malaysia Inter-Departmental Committee (MIDC) was formed in 1986.
2. Dam Ownership

- Water supply is under the ownership of State Government.

- Hydroelectric dam owned by Tenaga National Berhad (Power Generator- Peninsular Malaysia), Sarawak Energy Berhad (Sarawak)

- JPS Dam through Federal Government allocation. Ownership?....Federal or State Government.

Need to be coordinated to ensure compliance with the policy and regulation.
2. Dam Ownership

Who’s involved?

and many more...
3. Legislation

- Water and land fall under State Government jurisdiction.
- Law related to dam are under State Government.
- Federal Government to ensure the dam management is in line with International Best Practices.

A legal framework to be established to standardized surveillances and restoration of dams.
To ensure conformance to safety standards, the framework will address beyond the structure alone.

**Catchment Area**
- Area drained by the streams or water courses to the point at which the dam is located

**Reservoir**
- Area of water body impounded

**Dam structure**
- A barrier that impounds water or underground streams

**Downstream**
- Areas moving away from dam structure further towards the mouth of a river

**Definition**
- Slope clearing affects velocity of water
- High activity increases siltation at dam
- Hazardous pollutant discharge

**Serious risk concern**
- Siltation decreases reservoir capacity to hold water and cause additional pressure on dam upstream scenarios
- Water quality
- Illegal dumping of garbage affects flow at intake and spillway
- Water quality corrodes mechanical parts

- Cracks due to seismic
- Lack of adequate early warning system
- Reliability of mechanical parts

- Sufficient water passage route
- Adequate early warning system

*Department of Irrigation and Drainage, Malaysia*
5. Gazetting of operation and basin area.

- Secure from encroachment or trespassing.
- To curb pollution and disturbances of catchment area.
- The law is under States Government.
- Prevent land being developed may incur loss of revenue for States Government.
- Protected Areas and Protected Places Act 1959
- National Key Point Central Committee Directive.
6. Lack of Dam Technical Expertise

- Surveillance task must be lead by accredited/qualified dam engineer.
- Shortage of trained worker to be placed full time at a dam.
- To ensure dam always in good condition
- Blue Ocean Strategy.
  - Flying Squad (under KATS)
  - 41 High Risk Dam (hazard rating)
  - Dam Technical Centre (DTC)
7. Enforcement

• Need to create a proper legislation and guidelines. (MyDAMS 2017 and Proposed Dam Safety Act)

• The responsibilities of the state and federal governments.

• The responsibility of dams owner/ dam operator and stakeholders
1. Conduct immediate proper maintenance work for 41 Dam

2. Prepare an Emergency Response Plan (ERP/EAP)

3. Strengthen the capacity of technical team and Dam operator

4. Establish Dam Technical Centre (DTC)

5. Establish a special committee on Dam safety at the federal level
ACTION PLAN

1. Conduct immediate proper maintenance work for 41 dam (high risk)

Collaboration between NRE and KETTHA (KATS) (Flying Squad)
1. Conduct immediate proper maintenance work for 41 dam (high risk dam)

Flying Squad:-
1) National Blue Ocean Strategies (NBOS) – involved several technical agencies.
2) Use existing expertise from various ministries and agencies.
3) Conduct safety inspection at 41 high risk dam.
4) Generate dam safety report on an annual basis.
ACTION PLAN

2. Prepare an Emergency Response Plan (EAP/ERP)
ACTION PLAN

2. Prepare an Emergency Response Plan (EAP/ERP)

In 2012, 43% of Malaysian Dams do not have a well maintained ERP.
Scope of Work

- Operation
- Routine surveillance
  - Inspection, Monitoring and Reporting
- Minor maintenance works
- Implementation of ERP
  - drill, modify, updating
- Gazettement and ownership
- Secure any required development budget
- Other works stipulated in the O&M manual
ACTION PLAN

4.0 Establish Dam Technical Centre (DTC)

i. Initial proposal - led by KETTHA

ii. Integrated implementation of surveillance work by federal agencies.

iii. Database of dam inventories and surveillance information.

iv. Assist dams operator in terms of technical advices and expertise.

v. Currently led by Flying Squad (KATS)
ACTION PLAN

4.0 Establish Dam Technical Centre (DTC)

1. Periodic safety inspection (Annually).
2. Formal safety inspection (5-yearly).
3. Emergency safety inspection.
4. Special safety inspection.
5. Review dam operator’s routine surveillance report.
7. Prepare design solutions for problems identified in safety surveillance.
5.0 Establishment of Special Committee on Dam Safety at Federal Level

➢ Led by the Ministry of Water, Land and Natural Resources (KATS) to regulate the management of dams in Malaysia.
➢ To ensure that the dam management standard are complied with MyDAMS.
5.0 Special Committee on Dam Safety at Federal Level

Special Committee On Dam Safety

GOV
- DTC
  - DO  DO
- DTC
  - DO  DO

Non GOV
- DTC
  - DO  DO  DO  DO
5.0 Special Committee on Dam Safety at Federal Level

• National Dam Safety Management Guidelines - (MyDAMS)

• Draft of National Dam Safety Management Act (NDSMA) – currently being drafted
Government Initiatives

MyDAMS

Objectives:

• To manage dams in Malaysia in a systematic and sustainable manner.

• To ensure uniform dam safety management practices according to acceptable standards.
Government Initiatives

MyDAMS

• Provides a framework for the management of dam safety and guidelines for development and implementation of dam safety practices throughout Malaysia.

• Outlines guidelines on dam safety practices that should be considered during the investigation, design, construction, commissioning, maintenance, operation, safety surveillance, safety review, emergency preparedness and lifecycle management of dams in Malaysia.
These guidelines reflect current international dam safety management practices.

It complements Malaysia key environmental and safety legislations applicable on dams.

It assists dam owners and operators, government authorities, consultants and contractors in establishing good dam safety practices.

It complements the Dam Safety Act currently being drafted.
Conclusion:

- The current dam safety management practices is progressively toward in line with good international practice.
- Need to reduce the common cases of non-conformances of local DSMS by strengthening technical capacity among dam owner and dam operator.
- To reduce dam owner/operator which are not in line with good international practice.
- The model Law of Dam Safety Act will improve any deficiencies in the dam safety management system of dam owner.
- A real need to establish a government body (federal or/and states level) to regulate development and operation of dams.
- MyDAMS to assist dam owner and all parties in understanding the legal obligation and liabilities of those associated with the development, ownership and operation of dams in Malaysia.
Anyway ...

Who says Dams are RISKY?

Thank you

Mohd Hazri Moh Khambali
Email: mohdhazri@water.gov.my