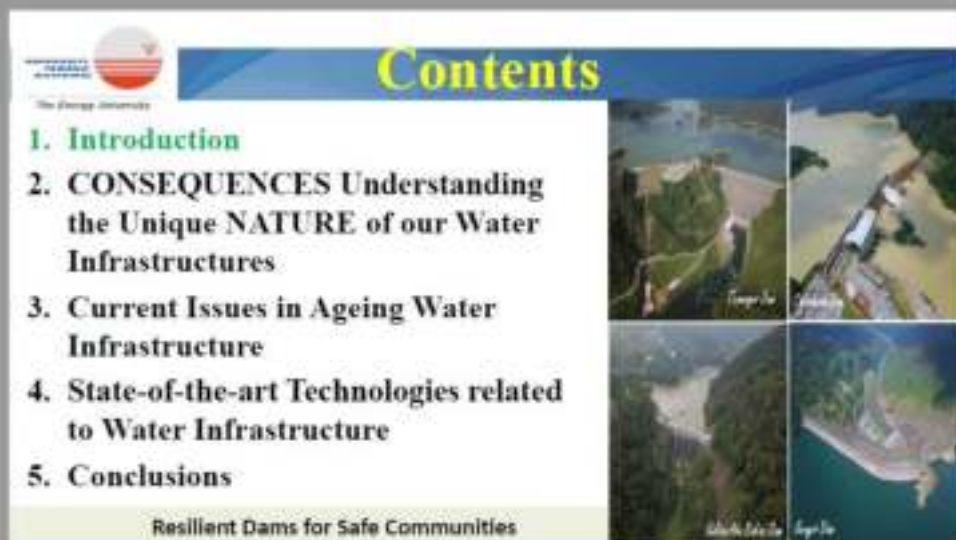


VALUING WATER - RESILIENT WATER INFRASTRUCTURE FOR SAFE COMMUNITIES

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 Co-President MYCOLD
 27th April 2021

Resilient Dams for Safe Communities



Contents

1. Introduction
2. CONSEQUENCES Understanding the Unique NATURE of our Water Infrastructures
3. Current Issues in Ageing Water Infrastructure
4. State-of-the-art Technologies related to Water Infrastructure
5. Conclusions

Resilient Dams for Safe Communities

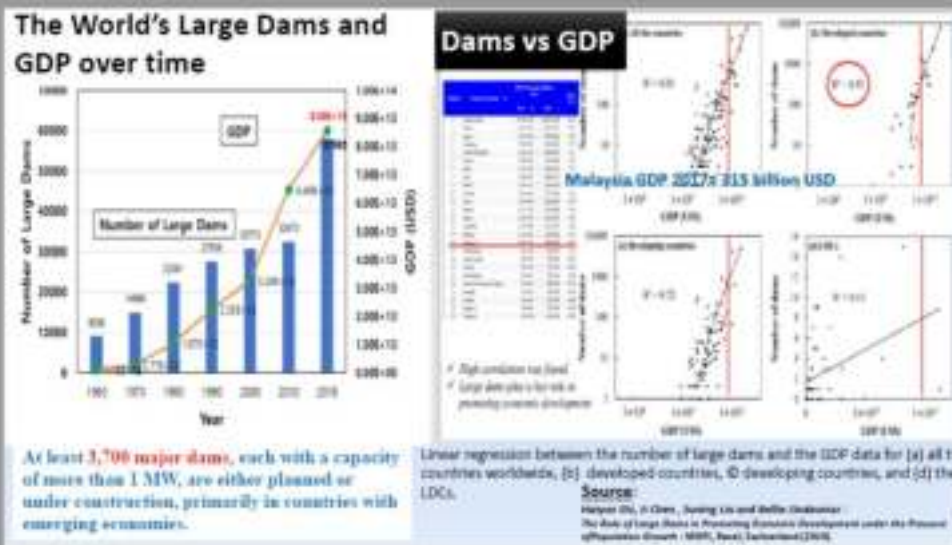
Valuing water means recognizing and considering all the **diverse benefits** and **risks** provided by water, and encompassing its **economic, social, and ecological** dimensions as well as its diverse cultural and religious meanings.

Safeguarding ecosystems, and the poor, the excluded, and the vulnerable is required in all,



From Catchment Area to Downstream.....





Dam Sustainability - Alignment with UN SDGs



United Nations Sustainable Development Goals

"Managing our business to minimise any negative impact of our operations and maximise the positive impact of what we do for our community."

Five Main Goals related to Dam Infrastructure



Function of Dam Infrastructure



Flood Mitigation



Water supply for domestic consumption



Water supply for agriculture irrigation



Eco-tourism (income for state government)



Commercial inland fishing and aquaculture



Hydroelectric power generation (renewable energy)



Source: TNB, 2019

DAMS OF MALAYSIA

FUNCTIONS OF DAMS



DAM NAME	BUKIT KEMUNING DAM
LOCATION	PERAK
TYPE OF DAM	CONCRETE GRAVITY DAM



DAM NAME	DETAH DAM
LOCATION	SEMPURAN & MUKOH LANGAT
TYPE OF DAM	CONCRETE DAM



DAM NAME	TEPAJA RESERVOIR DAM
LOCATION	SEKUPANG
TYPE OF DAM	CONCRETE GRAVITY DAM






DAM NAME	LABANAN DAM
LOCATION	LABANAN
TYPE OF DAM	CONCRETE GRAVITY DAM





DAM NAME	TEPAJA RESERVOIR DAM
LOCATION	SEKUPANG
TYPE OF DAM	CONCRETE GRAVITY DAM


TNB Hydroelectric Dams in Malaysia







Baram Dam



Temenggor Dam



Kuala Terengganu Dam

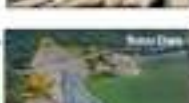

Rengas Dam



Bera Dam



Chenderoh Dam


Puhai Dam


Sultan Idris Shah Dam


Selat Dam


Malim Nawar Dam


Air Dam

Source: TNB, 2019



63 Water Supply Dam

Owned by State Water Authority

Air Itam Dam, Penang

- ✓ First dam built in Penang Island
- ✓ Completed by 1962
- ✓ Storage capacity of 2.6 million m³
- ✓ Earth fill type with bellmouth type of spillway

63 Water Supply Dam

Owned by State Water Authority

Number of Dam: 63

Majority dams used for water supply (90%)

2,400 MCM Total Storage

Only 3% of total dam storage (84,000 MCM)

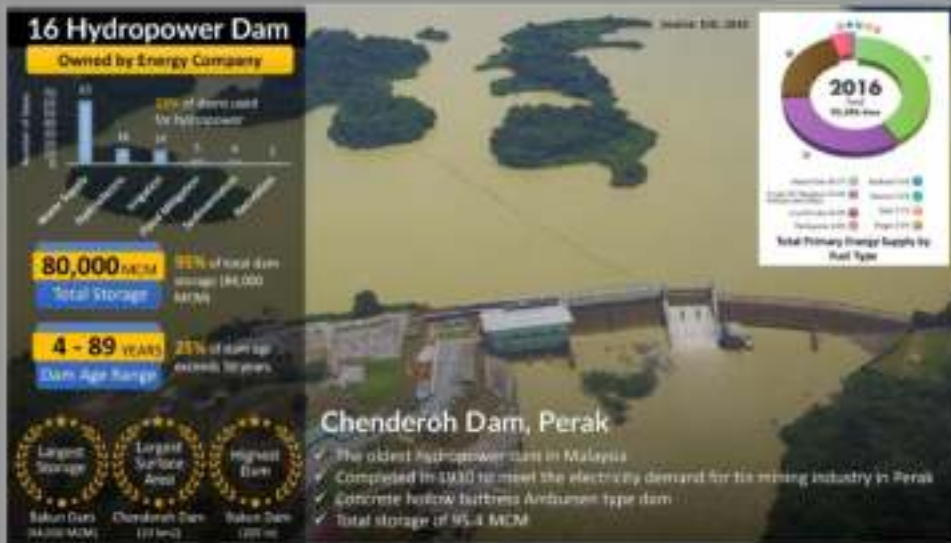
4 - 185 YEARS Dam Age Range

25% of dam age exceeds 50 years

Largest Storage: Lingga Dam (100 MCM)

Largest Surface Area: Cheroh Dam (16 km²)

Highest Dam: Telaga Dam (200m)



Let's look at **DAM INCIDENTS IN MALAYSIA**

41 dams classified as **HIGH HAZARD** dams
56% dams without EAP

RISK & FAILURE MODES
Cyber Physical
Non-Hydrologic

Contents

1. Introduction
2. **CONSEQUENCES** Understanding the **Unique NATURE** of our Dams
3. Current Issues in Ageing Water Infrastructure
4. State-of-the-art Technologies related to Water Infrastructure
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Resilient Dams for Safe Communities

KENYIR DAM
Type of Dam: Concrete Gravity Upright Slab

Key Features of Critical Infrastructure

- Provide **SIGNIFICANT BENEFITS** to Humankind
- Natural & Renewable: Sun - Wind - Water
- "With great power comes great responsibility"

Resilience is Defined: "...as toughness and the capacity to recover quickly from difficulties..."

Welfare is the Maintenance of Health

Basic Features of HEALTH & WELFARE

Resilient Dams for Safe Communities

- **HEALTH of a Dam:**
 - Serves the Design Intent
 - **AND Protects:**
 - People
 - Property
 - Environment
- **WELFARE of a Dam:**
 - Structural Safety
 - Surveillance and Maintenance
 - Emergency Planning



Why do we need to monitor dams?

A dam can fail!

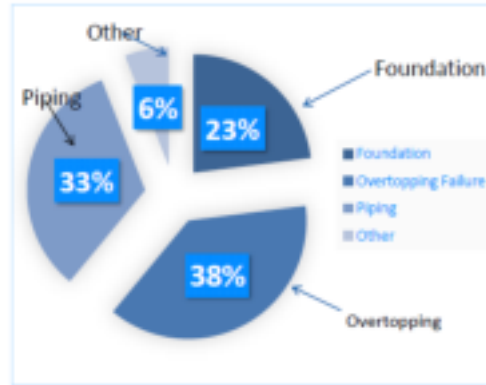
Example Of Dam Failures



There can be major consequences to DAM FAILURE!

Why Dams Fail – Principal Failure Modes

- Overtopping 38%**
 - Gate Failure to Open
 - Hydrological Risks
- Internal erosion (Piping) 33%**
 - Embankment, foundation or abutment
- Foundation 23%**
 - Concrete Dam Stability (Sliding)
 - Embankment dam stability
- Other 6%**
 - Gate failure
 - Operator error
 - Design errors



Dams do fail – at a somewhat predictable rate

Area	Reference	No. of Failures	Total Dam Years (x10 ⁶)	Failure Rate
USA	Grover (1961), 1967	33	71.8	4.6 x 10 ⁻⁴
	Sabb & Messert (1968)	72	43.9	1.6 x 10 ⁻³
	USCOLD (1975)	74	113.8	7 x 10 ⁻⁴
	Mark & Stuart-Alexander (1977)	1	4.5	2 x 10 ⁻²
World	Mark & Stuart-Alexander (1977)	125	399.8	3.1 x 10 ⁻⁴
	Middlebrooks (1976) and Mark & Stuart-Alexander (1977)	9	47.8	1.9 x 10 ⁻³
Japan	Takano (1967)	1046	30,000.0	3.5 x 10 ⁻³
Spain	Grover (1967)	150	335.8	4.5 x 10 ⁻⁴
Overall Average Dam Failure Rate				4 x 10⁻⁴



Dam Break Cases around World (1911 – 2019)

Dam	Location	Type of dam	Year failure	Type of failure	Impact
Bumayyeh Dam	Israel	Telling dam	2018	Catastrophic failure	110 deaths
De Namme Dam	Spain	Earthfill dam	2018	Faulty Construction	71 deaths 1,200 injuries straggled
El Estero de San Juan Dam	Mexico	Earthfill dam	2009	Overtopping	90 deaths 400 injuries straggled
Armenak Inger Dam	India	Earthfill	2007	Overtopping	7 people injured
Tham Shes	USA	Concrete	2006	Overtopping	Damage of several vehicles
Pradham Dam	India	Earthfill	2006	Sliding	4000 men, 80 deaths
Big Bay Dam	USA	Earthfill	2004	Overtopping	100 homes straggled
Falsum Dam	USA	Concrete	1992	Ballast Failure	22 deaths 248 deaths
Wall of Shame Dam	Italy	Earthfill	1990	Foundation Failure	100 million in damages
Isack Dam	Spain	Earthfill	1989	Sliding Failure	70 deaths
Monte Moro Dam	India	Earthfill	1989	Overtopping	10,000 deaths
Cooper Hill Dam	USA	Earthfill	1987	Overtopping	40 deaths 5.9 million in damages
Kate Barbara Dam	USA	Earthfill	1977	Sliding	97 deaths 2.8 million in damages 14 deaths
Teton Dam	USA	Earthfill dam	1976	Sliding	2 billion in damages
Beiyuan Dam	China	Embankment Dam	1975	Overtopping	300,000 deaths
Moudamit Dam	France	Concrete Arch	1959	Overtopping	400 deaths
St Francis Dam	USA	Concrete Arch	1928	Foundation	484 deaths
Quincy Dam	USA	Concrete	1917	Foundation	87 deaths

EXAMPLE 1: XE-PIAN XE-NAMNOY DAM, LAOS (2018)

Report of Dam Breaching the span of Dams
(Source: English News)

ATTACHED LAOS

Failure Mode:

- Collapse of Saddle Dam

Location: Abajay Province, Laos
Dam Type: Earthfill Dam – Saddle Dam II
Height: 16 m
Date of Failure: 23rd July 2018
Impact:

- 38 tons of life, 130 missing
- 6,200 people were displaced

EXAMPLE 1: XE-PIAN DAM, LAOS (2018)

Xe-Pian Xe-Namnoy Dam (Laos)

- ◆ Attapeu Province, Laos
- ◆ Saddle Dam D (part of dam) under construction collapsed during rainstorms
- ◆ Dam was 8m wide, 770m long and 16m high designed to help divert water around a local reservoir
- ◆ Failed on Monday 23 July 2018
- ◆ Damage
 - Loss of 36 live, 130 missing

22 July 2018 Sunday
 21:00 - The dam is found to be partially damaged. The authorities are alerted and villagers near the dam start to be evacuated. A team is sent to repair the dam - but is hampered by heavy rain, which has also damaged heavy roads.
 23 July 2018 Monday
 03:00 - Water is discharged from one of the main dams (Xe-Namnoy dam) to try to lower water levels in the subsidiary dam.
 12:00 - The state government orders villagers downstream to evacuate after warning that there could be further damage to the dam.
 18:00 - More damage is confirmed at the dam.
 24 July 2018 Tuesday
 01:36 - A village near the subsidiary dam is flooded, and by 09:30 seven villages are flooded.

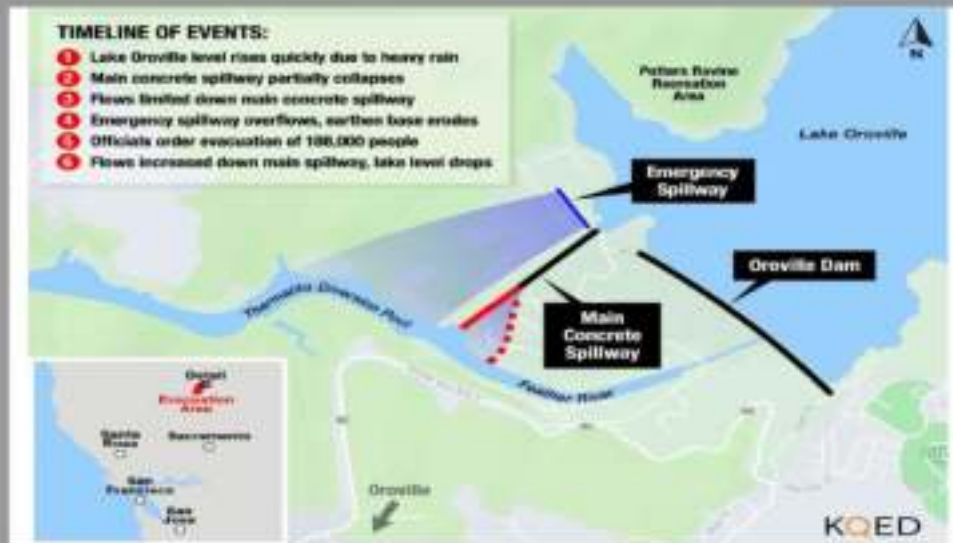


EXAMPLE 2: OROVILLE DAM, USA (2017)



Location: California, USA
 Dam Type: Earthfill Embankment
 Height: 770 ft (235 m)
 Storage: 3.5 Million acre-ft
 Constructed: 1967 - 1968
 Date of Failure: 17th February 2017
 Impact:
 - 100,000 people were reported to be evacuated.
 - About 110,000 m³ of erosion debris were also carried downstream and girdled the river.

Failure Mode:
 - Concrete Spillway Failed



EXAMPLE 3: BRUMADINHO DAM, BRAZIL (2019)

Brumadinho Dam, Brazil

- ◆ Belo Horizonte, Brazil
- ◆ 282-ft high of mining/tailing dam
- ◆ Failed on 25 January, 2019 due to liquefaction of mud stored behind the dam
- ◆ Loss of 115 lives



EXAMPLE 4: SHIH KANG DAM, TAIWAN (1999)



Location: Da-Jia River, Taiwan
Dam Type: Concrete Gravity
Height: 21.40 m
Storage: 3.38 million m³
Constructed: 1924 - 1926
Date of Failure: 21 Sept 1999

Failure Mode:

- Concrete failure due to earthquake

Contributing Factors:

- Large ground surface displacement, ground motion and fast burst
- Still much to learn in term of seismic studies

The Chi-Chi earthquake in Taiwan, in September 1999, destroyed the right wing of the Shih Kang Dam, the breach resulted in severe water shortage in Tai-Chung.
 Photo: Tim Lefter/BC-Hydro

EXAMPLE 5: TETON DAM, USA (1976)



Failure Mode:


- Rapid Piping

Contributing Factors:

- Large open in joints and fissures
- Zone material prone to erosion
- Design issues on key trench and filters, grout curtains


Location: NE Idaho, Falls, US
Dam Type: Zone embankment
Height: 305 ft (93 m)
Storage: 288,250 acre-ft
Constructed: 1972 - 1976
Date of Failure: 5 June 1976



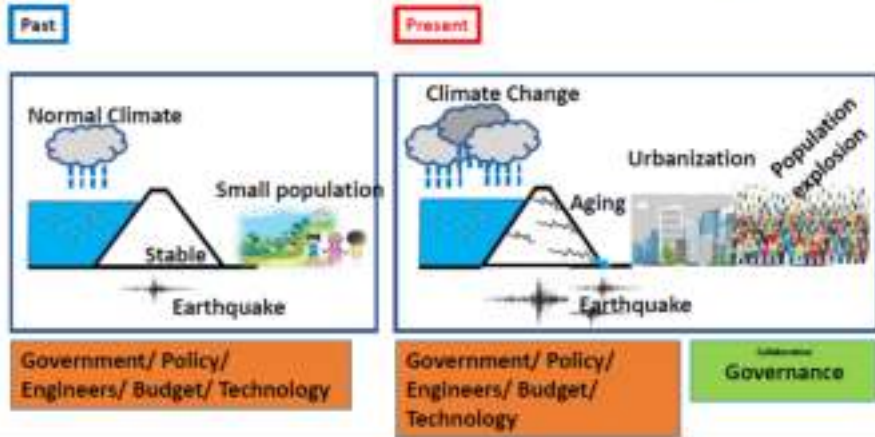
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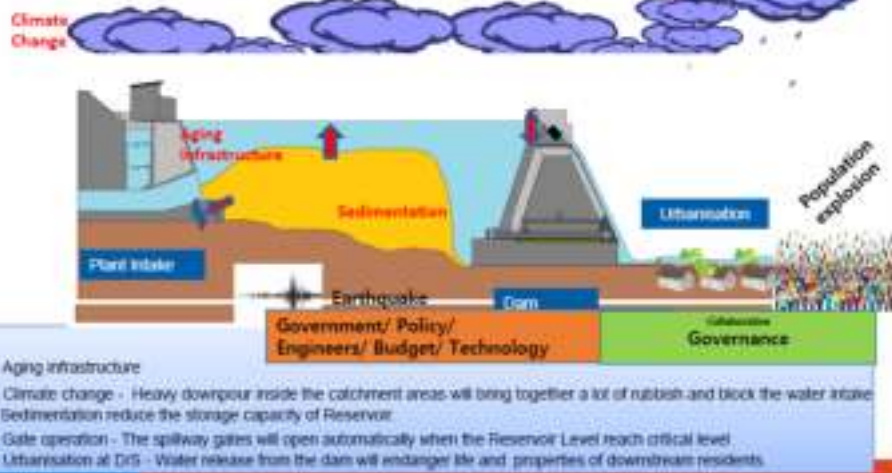
Resilient Dams for Safe Communities



Current Issues on Safety Management of Aging Dams



DAM RISK RESERVOIR FLOOD SIMULATION





As former rupture of an damage fall de condouzeo vefines

Resilience
Recognizes
and Adapts
to

- Ageing of existing Infrastructure
- New countries are now building dams
 - New Dams
 - New Engineers
- Increasing influence of the private sector
 - A New Governance
- Climate Change
 - Resilience and Environmental Awareness

Changing Conditions of Dam Safety

Resilient Dams for Safe Communities




CLIMATE RESILIENCE PROGRAM

- Integrate & coordinate non-climatic and climatic forcing issues
- Build resilience or adapt to CC impacts
- Make decisions on how to use CC information
- Communicating results, uncertainties and analyses to Decision-Makers



Source: Pusatajian Sumber Air dan Perubahan Iklim, NAWARA, 2014

CLIMATE CHANGE MALYSIAN APPROACH

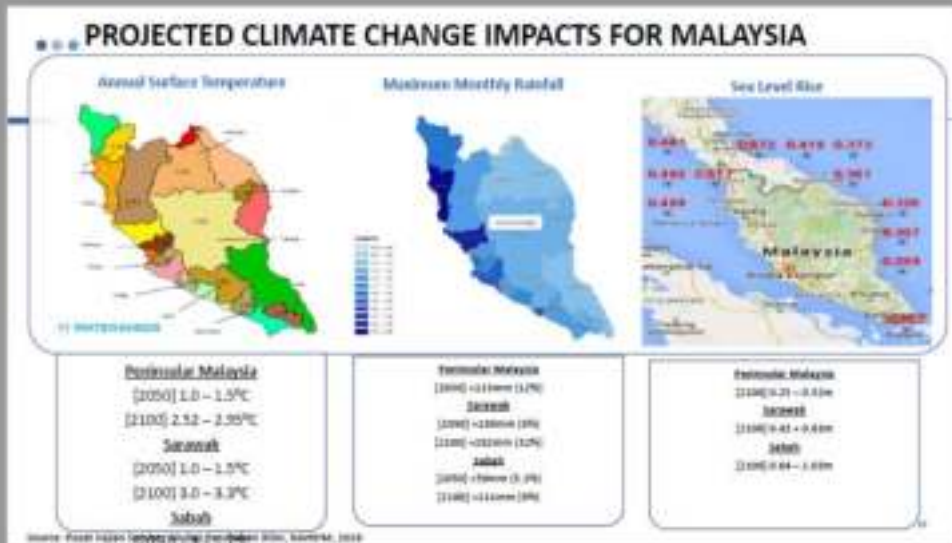
N-HYDAA: TECHNOLOGY

(1) Data Capture & Acquisition Customise & Pre-processed Data based on local context & requirement


- Predict future rainfall, trends, distribution and magnitude
- Minimises risk management cost, loss of lives, infrastructures, proper & environmental degradation
- Reduce water-related crisis - water supply & water demand
- Sustainable development - water-energy-food security

(2) Engine Set-up (DCA)
-Customise N-HYDAA's engine (arithmetic logic and algorithms) based on local requirement

BIG DATA ANALYTICS
-General Purpose Graphics Processing Unit (GP-GPU)
MS-Galactic Technology



ACCOMODATING LARGER FLOODS ADAPTING TO A LARGER FUTURE PMF



Structural Adaptation:
Altering structures to increase magnitude of flood that can be safely passed.

Operational Adaptation:
Changing operations to better manage flood risk with existing infrastructure


Regulatory Adaptation:
Managing flood risk by reducing consequences of failure
Changing the way flood risk is considered in provincial legislation

- PMF method for spillway ODF is only a guideline to ensure dam safety. In the absence of Malaysian Dam Safety Act, dam owner has taken all the necessary measures (structural & non-structural) and have employed best practices and guidelines according to international standard.
- It is recommended for Dam owner to improve on the non-structural measures for the dam that does not meet PMF requirement.
- It is recommended that the management of all dam owners follow the newly established Malaysia Dam Safety Guidelines (MyDams, 2017).
- Enhance the existing non-structural measures for the dams that are

	Structural	Non-structural
Advantages	<ul style="list-style-type: none"> Runoff delay and increase of infiltration Flood attenuation Downstream discharge control Groundwater control 	<ul style="list-style-type: none"> Save huge cost for modification works No significant environmental changes Improved organisational relations Effectively in dealing with flood impacts and damages
Disadvantages	<ul style="list-style-type: none"> Reduction of floodplain fertility High potential of ecological impacts Land subsidence High transverse cost 	<ul style="list-style-type: none"> Flare of property value and erosion of floodplains Higher level of insurance coverage needed

**At least RM 1.25 Billion of Property Damages
At least 2,654 lives are at risk in the event of Dam Break**

TEMENGOR DAM INFLOW FORECASTING SYSTEM



- A large flood event in December 2003 resulted in Temengor reservoir spilling for a period of weeks causing considerable devastation downstream of the dam.
- Reduction of dam reservoir allows help in better managing of water release thus mitigating flood downstream.
- The inflow forecasting system developed for 301 kg peak will provide operators and managers with additional time to plan operations being undertaken with a better understanding of dam safety and downstream flooding risk.
- Furthermore, the Temengor inflow forecast system can provide additional lead time such that they could provide information or warnings to downstream communities in the event of a large flood release from their storages, ensuring public safety.

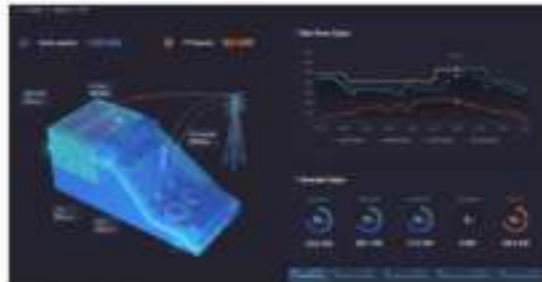
Reservoir Spilling & Flood Condition in Temengor Reservoir

The Dam is in normal operating mode

Floods occurred across the flood with dam operations ending shortly

DYNAMIC WATER AND DISPATCH MANAGEMENT SYSTEM (DWDM)

- to provide weather forecast, inflow forecast and dynamic energy dispatch management system for Bakun Dam, Murum Dam and Batang Ai Dam
- to establish efficient hydro operational tool for all Hydro dams ensuring dam's flood safety
- DWDM System will be operation in December 2020



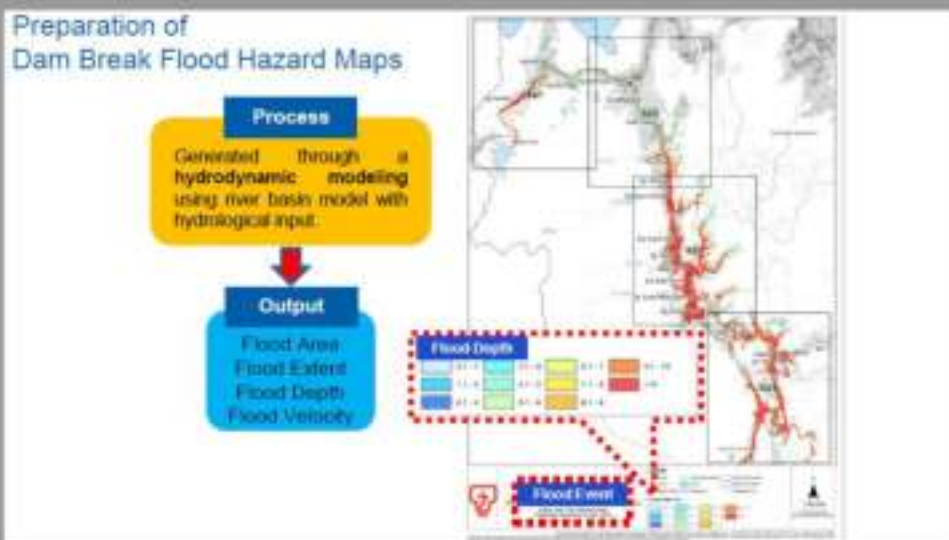
Benefits of DWDM

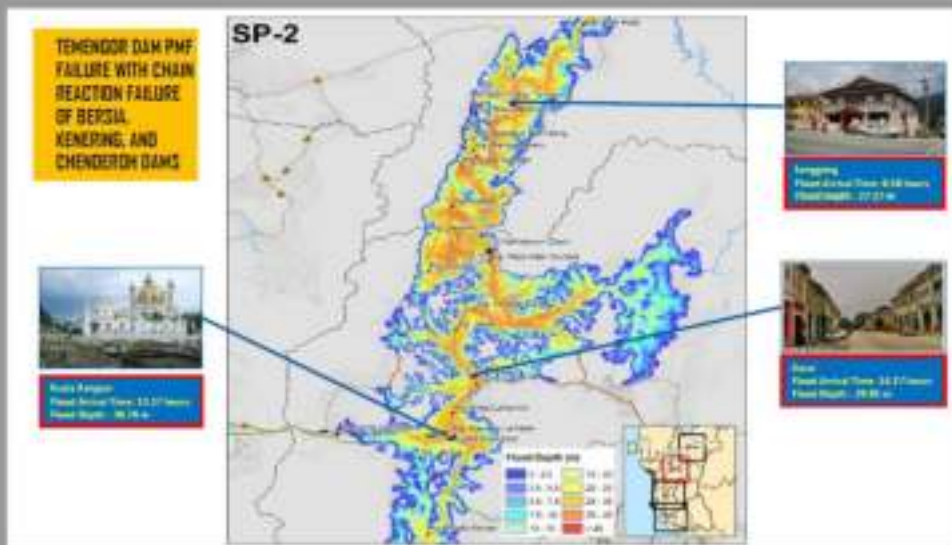
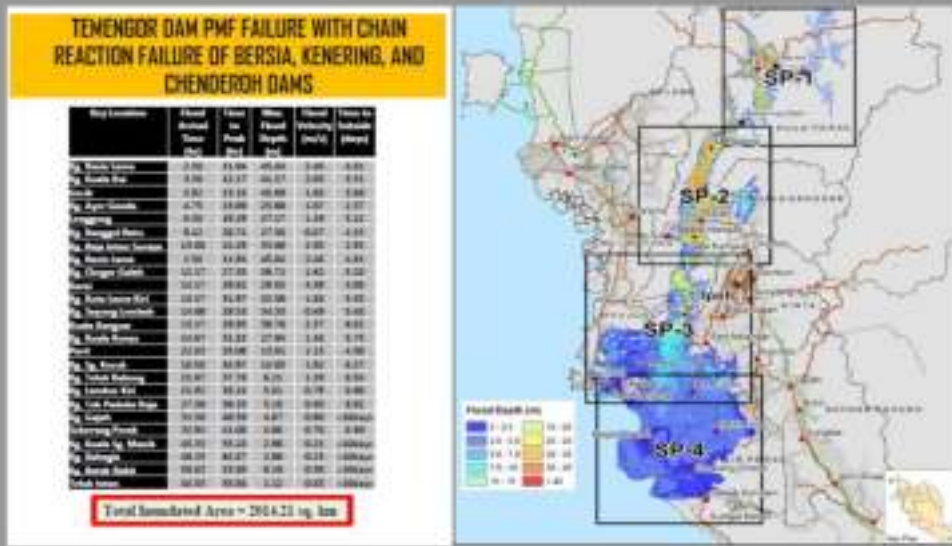
1. Reduced water release, less negative downstream impacts
2. Water security and safe hydro operation
3. Long term dispatch planning capability of the system can be utilized to feed into system dispatch planning
4. Balanced hydro-thermal generation (with the help of weather forecast)
5. Power & energy run assessment for future power development projects

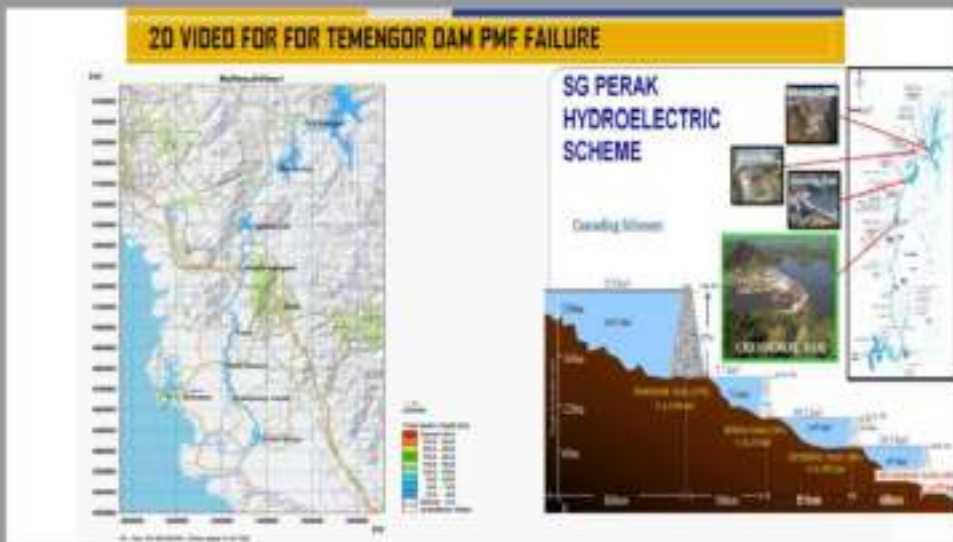
DAM SAFETY ERP PROGRAM FOR TNB HYDROPOWER SCHEME

Year	Key Safety Program
2003	Dam final study for Tg. Porek Hydro Scheme
2006	Dam Break Study for Kempi Dam
2010	TNB combined and integrated the final developed (AP and DBP of Tg. Porek Hydro Scheme and Kempi Power Station) to a standardized format, formed the Emergency Response Plan (ERP)
2011	ERPs (TNB & Agencies) developed has been tested during Civil exercises (TNB) and tabletop exercise (Agencies). During the exercises, an assessment and refinement will be conducted to review the ERPs developed would suit both internal staffs/personnel and local agencies
2011	Dam Break study for Cameron Highlands Hydro Scheme
2012	Dam Break Study for Pagar Power Station
2017	Ultimate Hydroelectric Dam Break Study

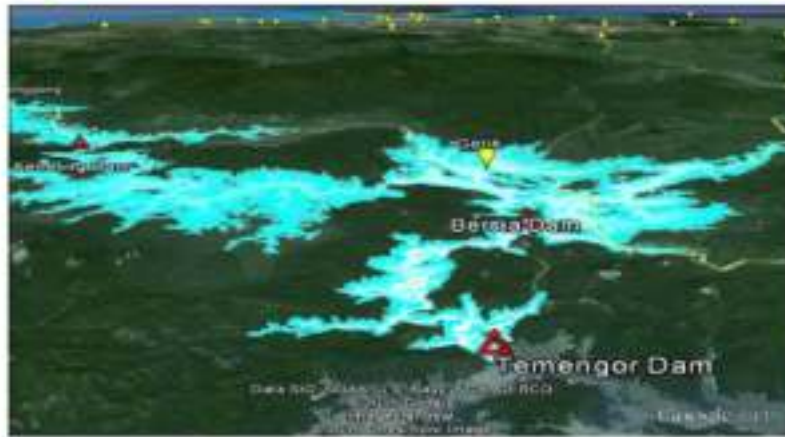








3D TOUR VIDEO FOR TEMENGOR DAM PMF FAILURE



PROPOSED MITIGATION

Country: Canada

Problem: The dam required extra 40 m³/s discharge capacity in order to water affected inflow Design Flood (French, 2013)

(I) Overlapping Protection for the embankment dams

Adding riprap to crest & downstream face of embankment to protect against erosion

Adding RipRap



(II) Raising Allowable Reservoir Level

Embankment dam can be raised using rockfill, sheetpile & jersey barrier

Raising level



(3) Lowering Operation Water

To capture more enough flood water to safely pass the inflow Design Flood

Lowering Operation WL



(4) Lengthen Spillway

To increase discharge capacity at flood level

Emergency Preparedness Plan (EPP)

(5) EPP

Reduce inflow Design Flood





Examples of Structural Measure (Korea)

Type1. Tunnel spillway



Type2. Open channel spillway



Type3. Installation of Watergate



Type4. Parapet wall





Tunnel Type: Imha Dam

●Necessity

✓ The updated design flood exceeds the original design flood based on a 200 year frequency flood, and thus when an inflow of PMF happens, then Imha dam shall be overflowed.



●Hydrological Safety

	Original Design	Updated Design		Remarks
		Only Existing Spillway	With Auxiliary Spillway	
Residual (mm)	424 (75.0%)	581 (75.0%)	581 (75.0%)	+ 37
Design Flood (m ³ /s)	7,534 (75.0%)	14,305 (75.0%)	14,305 (75.0%)	+ 7,239
Peak Discharge (m ³ /s)	5,305 (75.0%)	8,275 (75.0%)	8,211(PMF) (Existing: 5,133)	+ 8,099
SLFL (EL-m)	163.80 (75.0%)	178.97 (75.0%)	163.41 (75.0%)	Overflow (Cost : TL.108.8m)

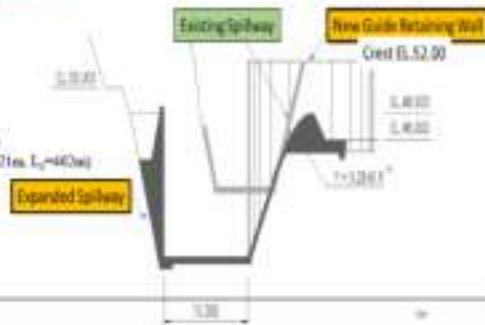
Examples of Structural Measure (Korea)

● Requirements

- ✓ To maintain the R.W.L below M.F.L (EL. 165.0m) in association with the existing spillway during PMF.
- ✓ To build a **factory** that does not interfere the flow of existing spillway
- ✓ To determine type and location of the emergency spillway structure **by considering topographical and geological conditions, structural and hydraulic safety and environment**
- ✓ To take into account impacts on downstream river

● Structures built

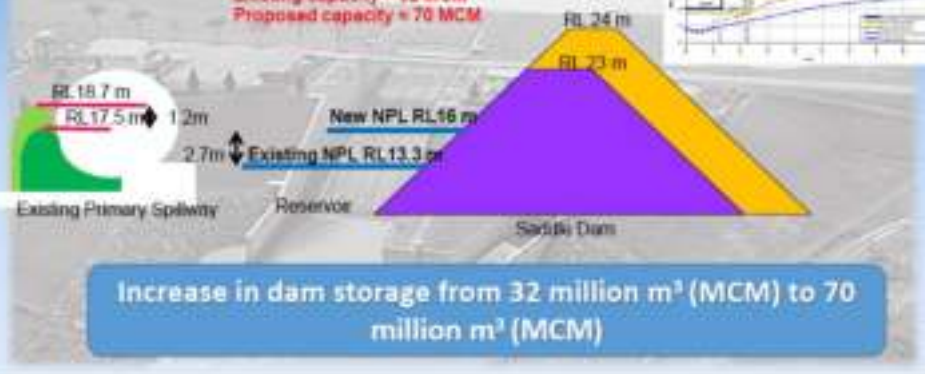
- ✓ Emergency Spillway
 - Location: 100m apart from the left abutment
 - Type: Tunnel Type Spillway
 - Gates: Radial Gates (B 11.8m x H 14.65m x 6EA)
 - Size: D 15m x 3 EA, L₁=1,262m (L₂=179m, L₃=421m, L₄=462m)
- ✓ Appurtenant Structures
 - Access Road: L=1,28m(D=10m), 2 Lines
 - Restoration of Soil Damage Yard: 2 sites
- ✓ Costs: 150 M USD
- ✓ Construction Period: 2004-2009

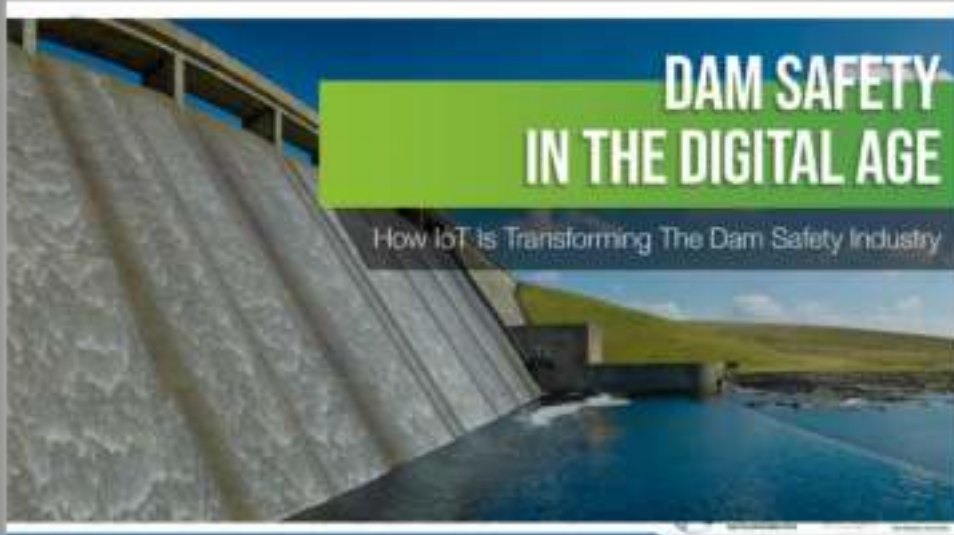


BEKOK DAM, MALAYSIA UPGRADING PROJECT

PROJECT OBJECTIVES

Existing capacity = 32 MCM
Proposed capacity = 70 MCM





Introduction – risk based safety management

- Advanced integrated dam safety management
 - From deterministic safety evaluation to probabilistic risk management



Relationship between Risk Analysis, Risk Assessment and Risk Management (FEMA, 2013)



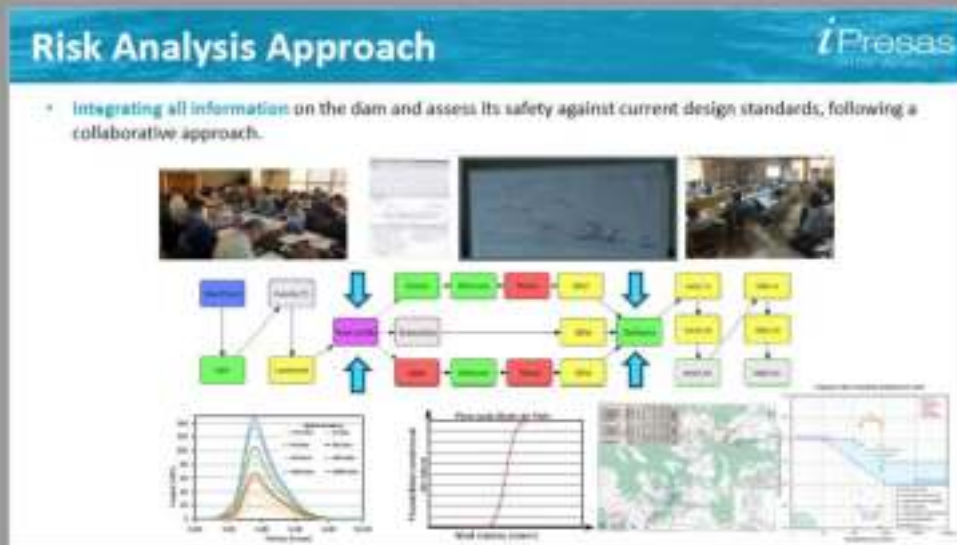
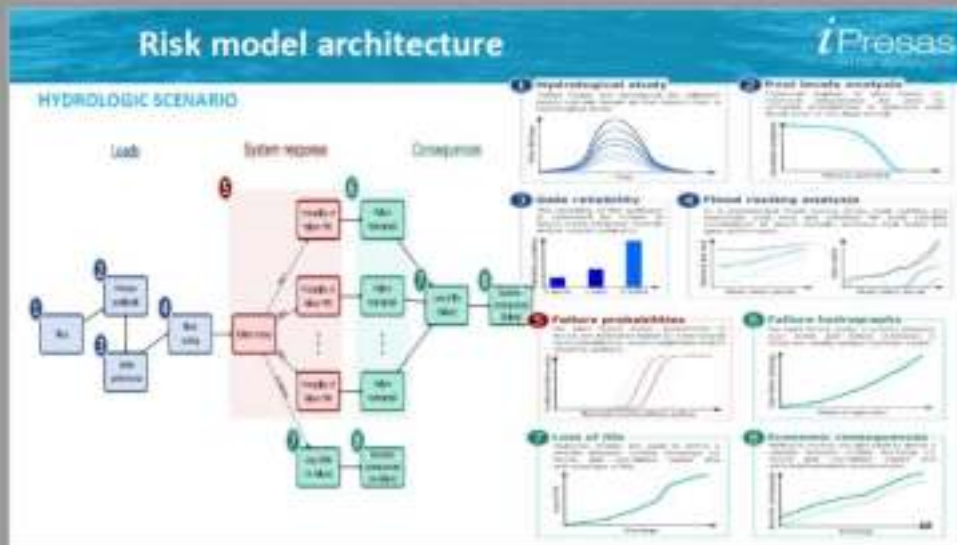




Fig. 10. Sensor installation and data monitoring system.

Source: Dong Shin, 2019



Fig. 11. GIS data monitoring system for water monitoring and data monitoring system.

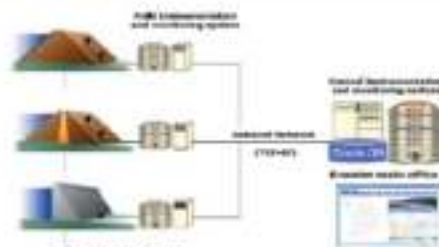


Fig. 12. Schematic diagram of data transmission and work flow of data assessment.

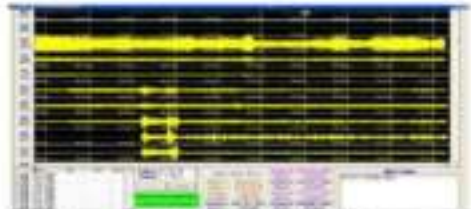


Fig. 13. Real-time monitoring system for water monitoring and data monitoring system.

IMPLEMENTING NEW INSPECTION TECHNOLOGY FOR DAM FACILITIES

for Dam Facilities



- ✓ Real time instrumentation data collection
- ✓ Automation and remote monitoring
- ✓ The usage of UAV
 - Crack Investigation using UAV (Unmanned Aerial Vehicles)
 - Inspection of Dam Concrete Using Infrared Camera

Leakage Detection Technology





Electro-magnetic field method

- ✓ Accurate
- ✓ Fast
- ✓ Verified
- ✓ Many Examples

Rhykin Co., Ltd.







Advanced inspection and monitoring technologies

- Various NDE technologies to evaluate integrity of dams
 - Visualizing spatial variation of material properties inside of the structure; identify location of anomaly or potential deteriorated zone
 - Advanced electro-magnetic technology; potential seepage path

MASW survey

Resistivity tomography

Willowstick technology
- Seepage induced EM field & inversion

Source: Dong Shin, 2019

K water

This slide details advanced non-destructive testing (NDE) technologies for dam inspection. It includes three main categories: MASW survey (shown with a photo of a dam surface), Resistivity tomography (shown with a 3D color-coded cross-section), and Willowstick technology (shown with a photo of a person in a yellow jacket and a 3D visualization of seepage-induced EM fields). The slide also includes a logo for 'K water'.

Advanced monitoring technologies

- Installation of real-time ubiquitous integrity monitoring system
 - ER monitoring system; identify potential progressive damage

Source: Dong Shin, 2019, K-water, K-water Institute

Smart grouting based rehabilitation technology

- Development of low pressure smart grouting technology
 - Research program initiated in 2018; research grant from MLTM

Low pressure smart grouting technology
Pressure/flow control to avoid fracturing

Source: Dong Shin, 2019, K-water, K-water Institute

Self healing type rehabilitation using micro

- **Rehabilitations of embankment dams by bio clogging**
 - **Soil improvement using micro organism**
 - cation precipitation (sulfide, sulfate & biopolymer (stickily & permeability), lignin, carbon, etc.
 - **Biofilm & biopolymers**
 - Formation of EPS fills pore in soil and reduces permeability
 - Can be utilized for self-healing rehabilitation of dams
 - Started in EU, US, etc.
 - **Research of K-water**
 - Rehabilitation of impervious core
 - Seepage control






Source: Dong Shin, 2019  K-water Institute

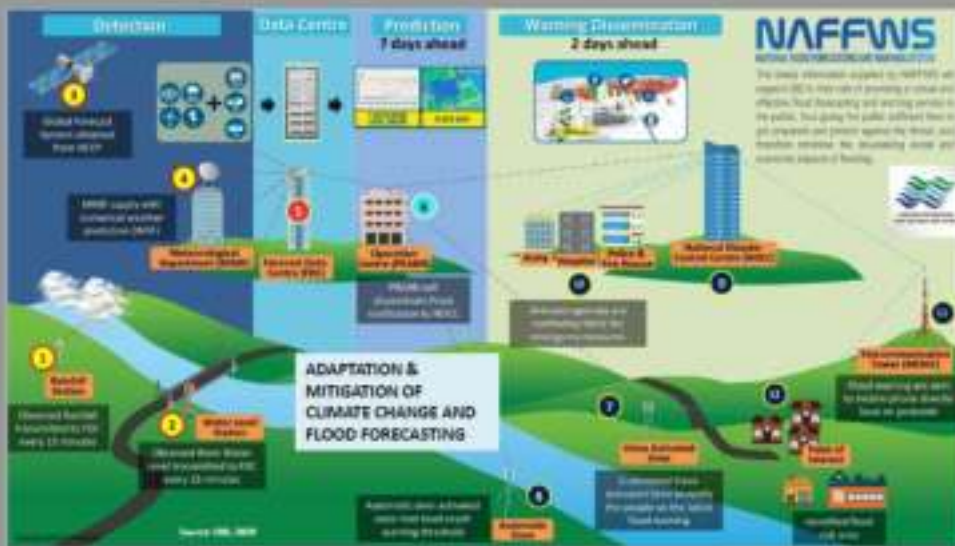
AI technology for Water Infrastructure

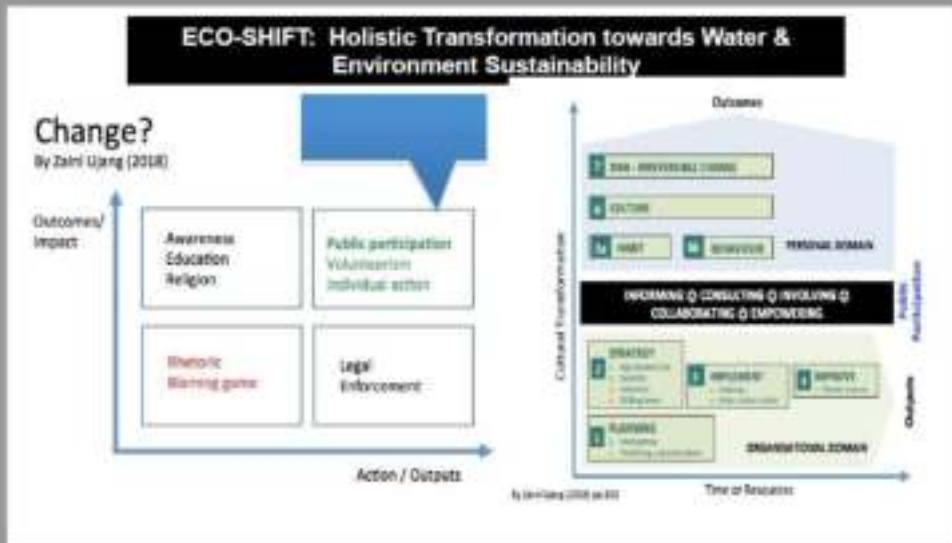
Using artificial intelligence to locate risky dams



Data from: Data source and identification of high-potential river basins, David J. Douglas, et al., 2018

A project out of the **Columbia Water Center** aims to help guide the process of repairing or decommissioning these dams. **The team is pinpointing the riskiest dams, using climate models, GIS data, and artificial intelligence** to predict the likelihood that rainfall will overtop a dam and cause significant downstream damages to population and **critical infrastructure**.







Objective Denai Sungai Kebangsaan

Kementerian Alam Sekitar dan Air (KASA) is targeting the construction of 10,000 kilometer of Denai Sungai Kebangsaan (DSK) by 2030. This program a strategy to prevent pollution through a control approach at the source by using nature based solutions.

To control pollution activities

To encourage recreational & nature based activities



DENAI SUNGAI KEBANGSAAN

To create shared responsibility among the community and maintaining the river

To encourage eco-tourism

To improve water quality of the river




Denai Sungai Pengisian Batu di Kubang Keratan is one of the pilot projects of the Denai Sungai Kebangsaan introduced by TN.Mesta, Government and Pihak KASA (top row).
Denai Sungai Kebangsaan (DSK) di Kampung Pulau Sungai Kubang Keratan.

fppt.com

Denai Sungai Kebangsaan

KERJA KERJA PEMBERSIHAN, PERULIHARAAN DAN KECANTIKAN DENAI SUNGAI BATU PAHAT

<p>1 Membina denai trail hingga ke jalan besar / sepanjang sungai</p> <p>2 Bina trail jemput (Simple Tracking)</p> <p>3 Membina peribon sebagai kawasan sandar</p> <p>4 Bina area, jalan dan dgn longkang batu beton yg sesuai di kawasan sungai</p> <p>5 Membina jambatan overwater sungai</p>	<p>6 Bercik & catilkan bendi di kawasan tadahan air sebagai kawasan rekreasi</p> <p>7 Wujudkan polintar garden @ tadahan rumah</p> <p>8 Tancap pokok utk tadahan longkang sepanjang sungai & bukit</p> <p>9 Lebihkan pasir di kawasan bendi di rata dan di selaraskan longkang di kawasan pylon</p> <p>10 Wujudkan peralihan laluan kawasan bendi di bukit pasir sekitar.</p>
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Kerja Bermanaan

- Gotong royong bertumpukan - Guci/Berik jaring plastik mat.
- Bercik & lalap sampah sekitar sungai
- Bersihkan trap / sump longkang ke sungai
- Car & Mundul tembok



Proposed Healthy River for Healthy People Program

This collage illustrates the 'Healthy River for Healthy People' program. It features several key elements:

- Water Quality:** A central image shows water being tested with a device, with text indicating 'Water quality monitoring program' and 'resulting in water pollution in Batu Pahat'.
- Agriculture:** Images of various agricultural products like fruits and vegetables, with text 'WISMA MALU TERBUKA (CCTV)' and 'Program Healthy Market'.
- Community Engagement:** Photos of people participating in water-related activities, such as cleaning up a riverbank or using water filters.
- Water Treatment:** An image of a water filter with text 'Healthy River for Healthy People' and 'Good drinking water & food system will be sufficient & will be based on local food and food items'.

The collage is framed by a blue border and includes the logo 'fsspt.com' in the bottom right corner.

Proposed River Revival Programme with Local Community

Red blood and dark colour water due to direct discharge of sewage from houses and industries

Amang Kuning

SEP 1

Direct discharge of sewage

Red blood and dark colour water

Water for Nature Program—
Bioremediation Technology Using Aquatic Plants that can remove TN, TP and Nitrate Nitrogen such as water lettuce, water hyacinth and cattails

Water for Nature Program (WNP)

Organic and inorganic matter, nutrient and toxic substances are removed by aquatic plants through their root system and leaves.

River Revival Program— making and throwing enzymatic mudballs helps to decompose sewage

fppt.com

Proposed Dam Safety Awareness Program with NGO & Community

Dam in Batu Pahat

Bekoh Dam

SEP 2

Sebanjing Dam

SEP 3

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Community Based Disaster Management
- Hold a Dam Safety Awareness Day community event and an outreach campaign to raise dam safety awareness

Program Penanaman Akuat Dam dan Penanaman Tanaman Beracun Komoditi (Penanaman 1000 Tanaman 2021)

Evacuasi Dam Bencana (DAB Dam)

CDM Program— Public Safety Around the Dams

DISASTER RISK REDUCTION GUIDANCE FOR PUBLIC SAFETY AROUND THE DAMS

1. **PLAN SAFETY CHECKLIST FOR PUBLIC CONSUMER**
Plan and check the following on:
 - Dam Safety
 - Emergency
 - Evacuation
2. **SAFETY BY PROGRAM**
Be aware of the following:
 - Dam Safety
 - Emergency
 - Evacuation
3. **WARNING SIGNALS**
Be aware of the following:
 - Dam Safety
 - Emergency
 - Evacuation
4. **BEFORE EMERGENCY**
BEFORE EMERGENCY
Be aware of the following:
 - Dam Safety
 - Emergency
 - Evacuation
5. **BEFORE EMERGENCY**
BEFORE EMERGENCY
Be aware of the following:
 - Dam Safety
 - Emergency
 - Evacuation

10/00/0000

Proposed "Zero to Hero" Program for Squatters & Indigenous Community

Zero To Hero Program –
build awareness and sense of belonging to nearby river

Fig. 10.10
Perkampungan Kg. Cheng Ahit Desa Bert Bawang

Fig. 10.11
Kg. Mukimbat Pelandok (Direct Discharge)

Fig. 10.12
Log Screen

- Log Screen is fairly easy to deploy in most cases to collect and contain floating rubbish.
- The proposed log screen is basic, simple and low-cost materials and can be reused.
- Advantages: simple, low installation costs, easy to maintain, monitoring method, length and size of the log screen can be specified later that best suits the river conditions.

Fig. 10.13
Net Screen

- Net is stretched over the width of a pipe or treatment.
- The net is typically attached on a collector and length is dependent upon the conditions.
- Advantages: simple, low installation costs, replace and parts size of the net can be changed at any time, easy to maintain and to avoid breaching of pollutants.


Socio Survey Social Media

Program for River Conservation Likely Chosen by Participants

WEBINAR

WHATSAPP INVITATION





Conclusions

- **BEST PRACTICES** in **WATER INFRASTRUCTURE** Begin With **RESILIENCE**
- **Safety** is a **CORE VALUE** of our Dams Profession (Protect People, Property & Environment)
- **CURRENT ISSUES & STATE OF THE ART TECHNOLOGIES** related to **WATER INFRASTRUCTURE SAFETY MANAGEMENT** under **CLIMATE CHANGE** and **AGING DAMS**
- **TRADITIONAL** Approach (Deterministic – good practices) to **EMERGING** Approach (RIDM, PFMA and Life Cycle Risk Assessment)
- **GOVERNMENT SUPPORT** or Political will & Financial Support and Societal Consensus
- Capacity building & R&D needs to be accelerated to minimize the impact of ageing dams

Resilient Dams for Safe Communities

