



# **“KEPENTINGAN KUALITI AIR TASIK SEBAGAI SUMBER BEKALAN AIR”**

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**DR ZATI SHARIP**

*UNIT TASIK DAN EMPANGAN*

*PUSAT KAJIAN KUALITI AIR DAN ALAM SEKITAR*

*INSTITUT PENYELIDIKAN AIR KEBANGSAAN MALAYSIA (NAHRIM)*

*KEMENTERIAN ALAM SEKITAR DAN AIR (KASA)*

# Kandungan

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- Pengenalan
- Sumber tasik
- Fungsi dan Perkhidmatan Ekosistem Tasik
- Ancaman dan Impak
- Kepentingan air tasik sebagai sumber bekalan air
- Pemantauan dan governan kualiti air tasik

# Pengenalan

Penglibatan NAHRIM dalam bidang tasik

- ❑ Desktop study on the eutrophication of lakes in Malaysia
- ❑ Pembangunan Pelan Strategik Pengurusan Lestari Tasik
- ❑ Pembangunan Pelan terperinci Pengurusan Tasik

Mandat yang diberikan MSAN-07

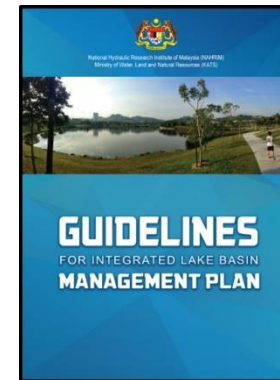
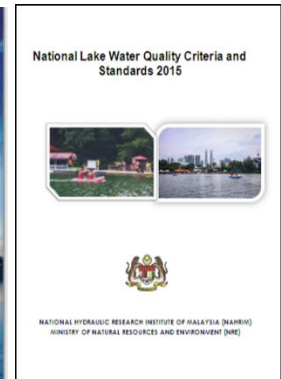
- ❑ NAHRIM sebagai Pusat Sumber dan Penyelidikan Tasik



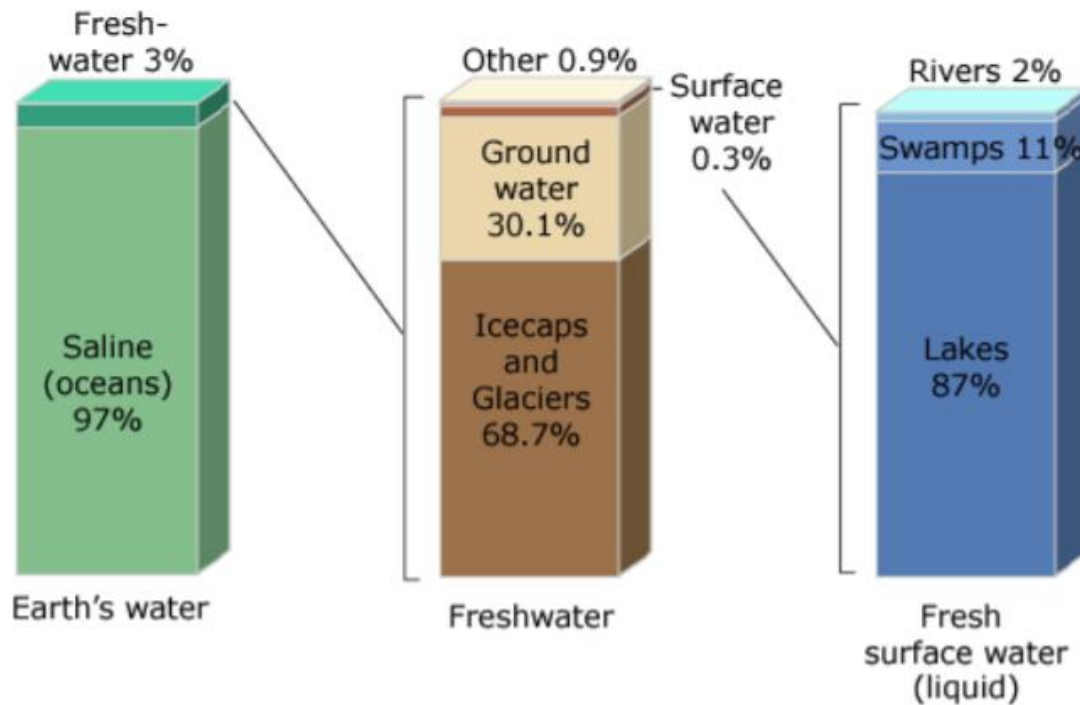
# Pengenalan

## Penyelidikan NAHRIM

- ❑ Blueprint for Lake and Reservoir Research & Development
- ❑ National Lake Water Quality Criteria and Standards
- ❑ Garis Panduan ILBM
- ❑ Inventory and classification of lentic ecosystems in Malaysia



# Agihan air bumi



- ❑ Air tawar meliputi 3% daripada air bumi
- ❑ Air permukaan meliputi 0.3% dari air tawar
- ❑ Tasik menyumbang 87% dari air permukaan

# Sumber Badan Air Bertakung di Malaysia

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Badan air bertakung seperti tasik adalah ekosistem “LENTIC” yang meliputi

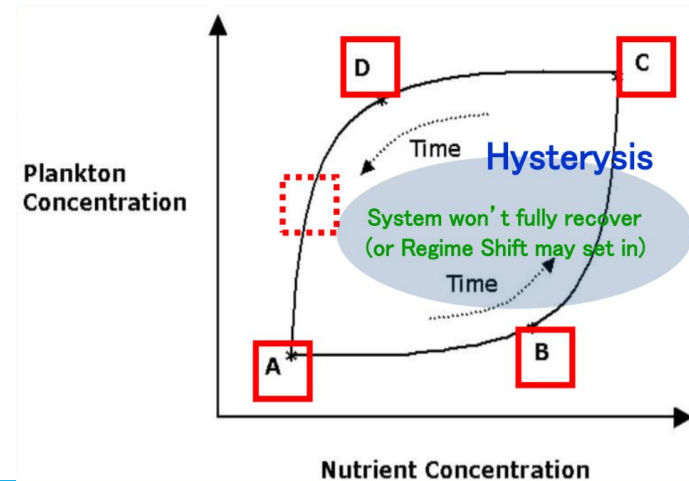
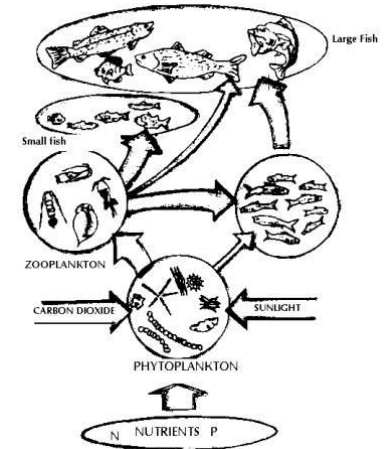
- Tasik semulajadi
- Empangan
- Kolam bekas lombong



# CIRI-CIRI EKOSISTEM TASIK

Ciri-ciri ekosistem 'Lentic'

- *Integrating Nature*
- Masa takungan panjang
  - tempoh 1 bulan – beratus tahun
  - kelajuan arus  $< 0.01 \text{ m s}^{-1}$
  - perubahan ekosistem perlahan (*gradual & invisible*)
- Dinamik respon kompleks
  - pergerakan *multi-directional*
  - sukar diramal dan dikawal



# Sumber Badan Air Bertakung di Malaysia (Inventori awal)

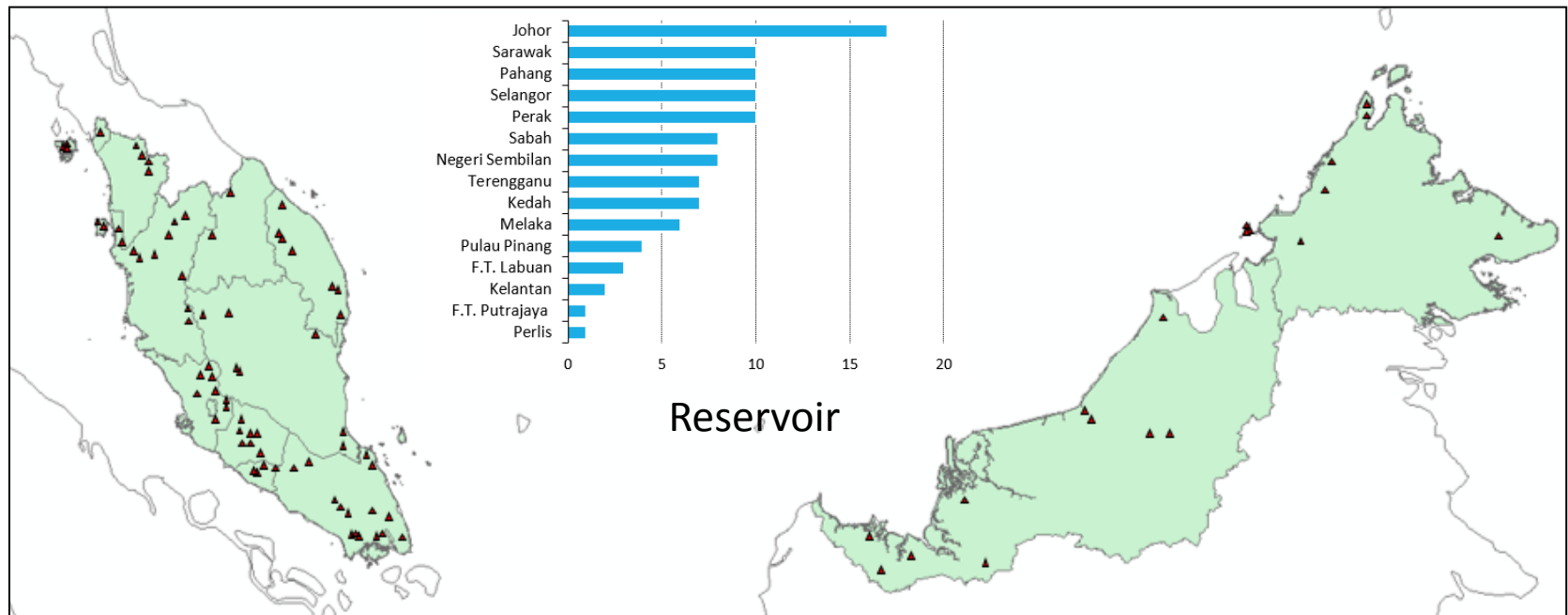
No.	State	Number	Area (km <sup>2</sup> )	Volume (Mm <sup>3</sup> )
1.	Perlis	2	13.33	40.00
2.	Kedah	7	105.63	1,384.76
3.	Perak	11	285.69	6,794.25
4.	Selangor	14	27.25	531.56
5.	Pahang	10	94.69	355.71
6.	Terengganu	2	370.80	13,600.00
7.	Kelantan	3	11.34	76.80
8.	Johor	13	108.26	986.24
9.	Labuan	3	1.20	4.58
10.	Melaka	4	11.41	78.60
11.	N. Sembilan	6	11.69	185.83
12.	P. Pinang	4	2.95	45.44
13.	Sabah	8	7.18	66.41
14.	Sarawak	7	793.74	46,496.88
15.	Wilayah Persekutuan	2	7.63	45.00
<b>Total</b>		<b>96</b>	<b>1,852.79</b>	<b>70,692.06</b>

Excluding ox-bow lakes, ex-mining pools, bunded storage and flood detention pond



# Sumber Badan Air Bertakung di Malaysia

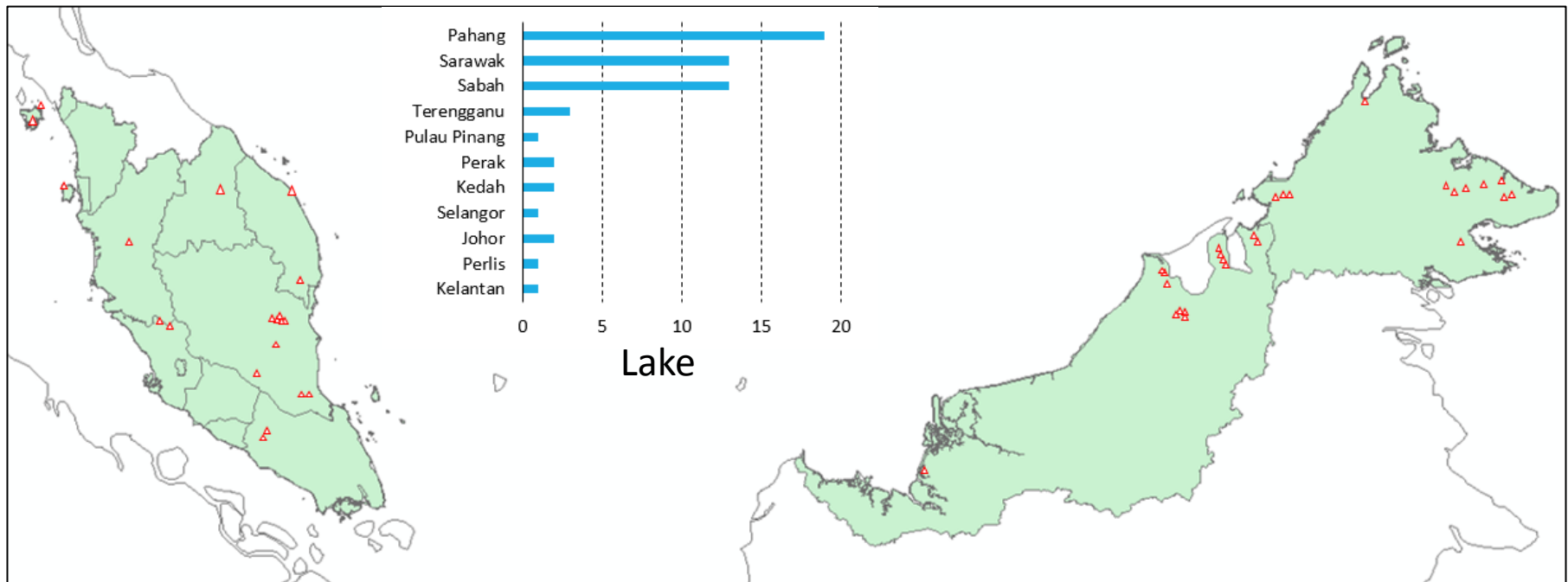
- Terdapat 104 empangan di Malaysia termasuk sistem takungan 'bunded'



Source: NAHRIM 2020; Sharip et al. (2020)

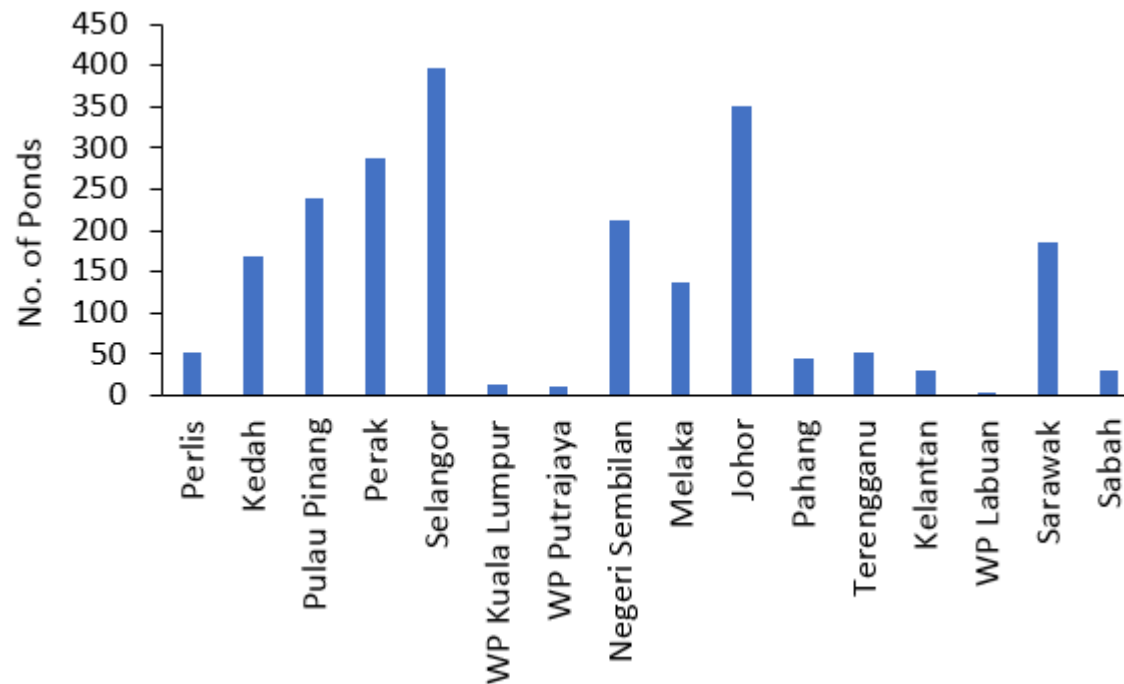
# Sumber Badan Air Bertakung di Malaysia

>50 tasik semulajadi: floodplain lakes, doline lake, meromictic lake, tasik ladam



Source: NAHRIM 2020; Sharip et al. (2020)

# Sumber Badan Air Bertakung di Malaysia

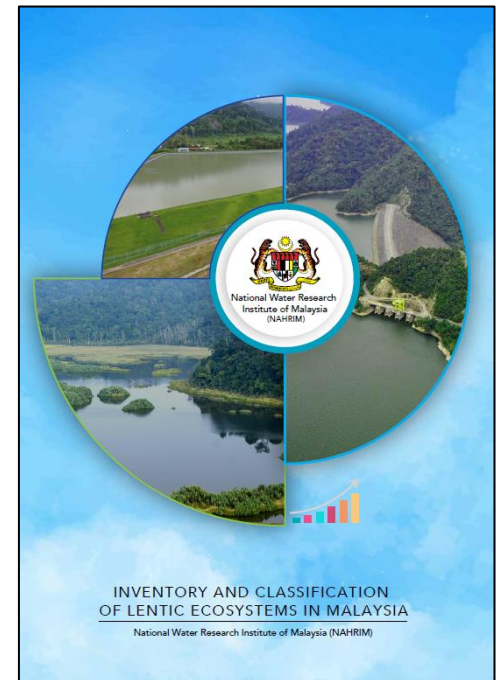
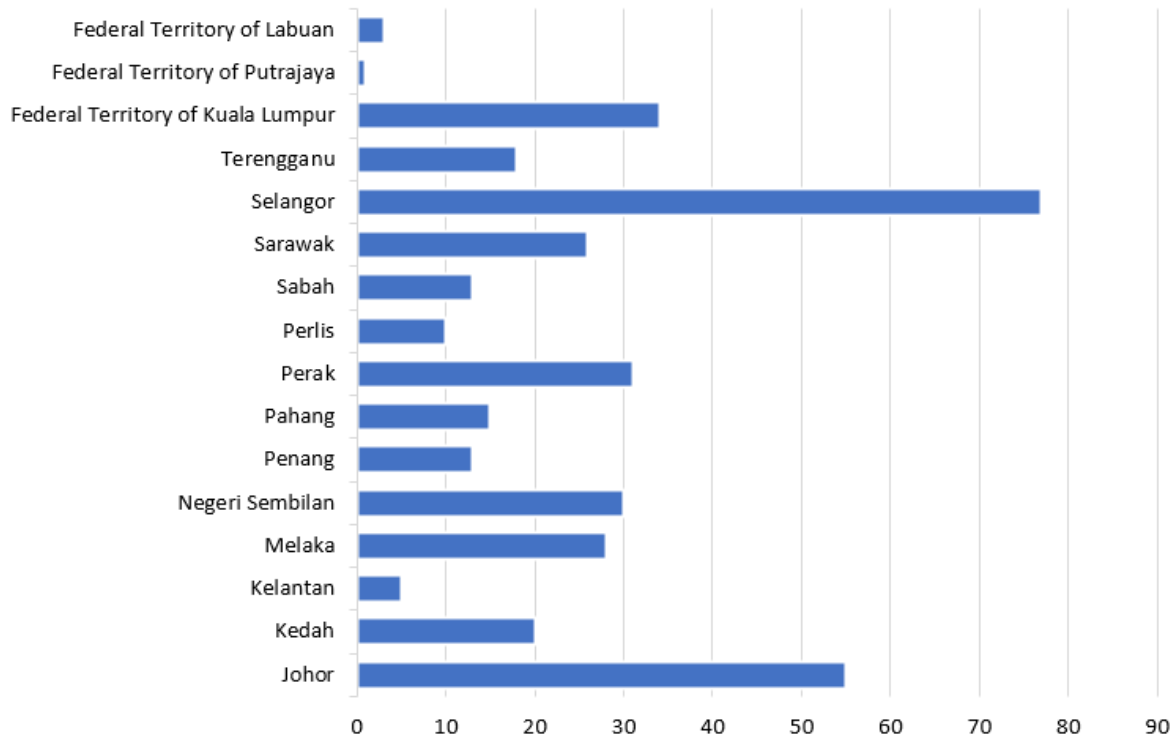


- >2200 kolam; detention and retention ponds (dry and wet)
- Cover ~4000 ha

Source: MAMPU (2018)

# Sumber Badan Air Bertakung di Malaysia (Inventori Terkini)

- Klasifikasi 379 badan air bertakung: saiz, kedalaman, bentuk, jenis dan kegunaan



NAHRIM (2020)

# FUNGSI DAN PERKHIDMATAN EKOSISTEM SUMBER AIR TASIK

## Resource provision



## Regulating services



## Cultural service



Supporting  
service

# FUNGSI DAN PERKHIDMATAN EKOSISTEM SUMBER AIR TASIK



## Water Supply

- **Domestic and industrial water supply:** > 60 empangan air; kolam takungan sebagai sumber air alternatif
- **Irrigation:** ~10 empangan i.e. Bukit Merah, Muda, Pedu and Ahning



## Flood mitigation

- 16 empangan i.e. Timah Tasoh, Batu Dam, Semberong Dam, Bekok Dam & Machap Dam – mengurangkan risiko banjir
- >1500 kolam takungan banjir

# FUNGSI DAN PERKHIDMATAN EKOSISTEM SUMBER AIR TASIK



## Hidroelektrik

- 16 empangan hidroelektrik i.e. Kenyir, Bakun & Chenderoh Dam; menyumbang 5% keperluan elektrik negara. Empangan pelbagai fungsi



## Akuakultur & perikanan

- Penternakan akuakultur / perikanan dalam sangkar - Kenyir, Batang Ai & Temenggor Reservoir
- Chenderoh & Beris Reservoir – Sport fishing



# FUNGSI DAN PERKHIDMATAN EKOSISTEM SUMBER AIR TASIK

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- **Biodiversiti**

- Tasik menyumbang pelbagai species akuatik air tawar
- Bera and Bukit Merah Reservoir: arowana



- **Rekreasi dan pelancongan**

- Amenity to urban populations: Putrajaya, Titiwangsa & Taiping Lake Garden
- Tourism: Kenyir, Batang Ai, Temenggor



# Ancaman dan Impak

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# ANCAMAN DAN IMPAK

Aktiviti pembalakan, perlombongan dan pembukaan tanah yang tidak lestari – beban nutrien dan sedimen

## Aktiviti pembalakan haram skala besar terbongkar

Mohd Rafi Mamat  
am@hmetro.com.my



JALAN ditutup bagi mengelak Unit Penguatkuasa Pejabat Hutan Daerah (PHD) Lipis membuat pemeriksaan dalam Hutan Ulu Jelai. FOTO Mohd Rafi Mamat



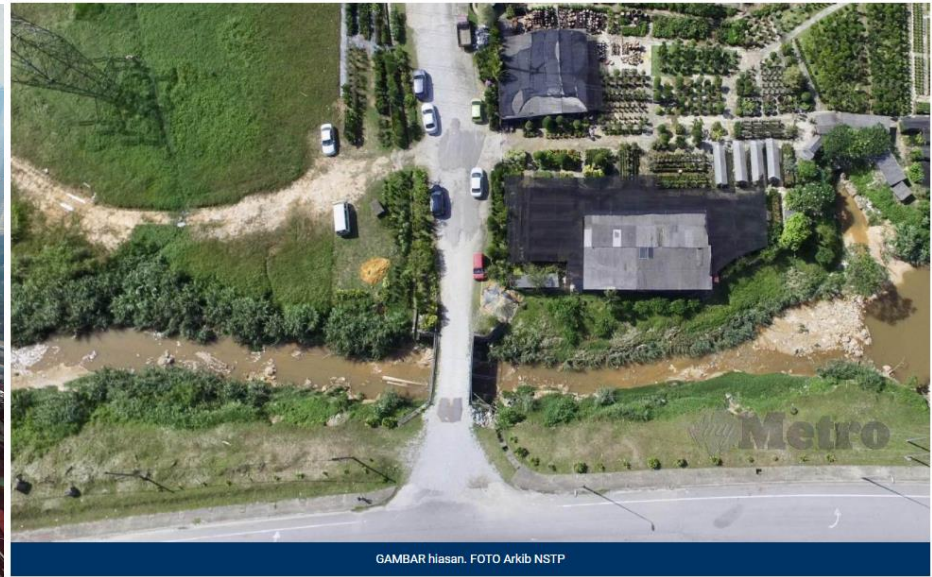
BERNAMA

CUBAAN menceroboh Hutan Simpan Ulu Jelai untuk aktiviti pembalakan secara haram menggunakan surat kuning tidak menjadi kenyataan apabila dikesan anggota Unit Penguatkuasa Pejabat Hutan Daerah (PHD) Lipis, semalam.

# ANCAMAN DAN IMPAK

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Pembangunan bandar & perkilangan – beban pencemar mikroorganisma/nutrien (air sisa)



GAMBAR hiasan. FOTO Arkib NSTP

# ANCAMAN DAN IMPAK

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Aktiviti pertanian – pencemar nutrien dan racun pertanian



# ANCAMAN DAN IMPAK

## UNJURAN IMPAK PERUBAHAN IKLIM MALAYSIA

### Suhu Permukaan Tahunan

Semenanjung Malaysia  
[2050] 1.29 - 1.37°C  
[2100] 1.85 - 1.93°C

Sarawak  
[2050] 1.35 - 1.43°C  
[2100] 1.94 - 2.05°C

Sabah  
[2050] 1.33 - 1.43°C  
[2100] 1.95 - 2.08°C

### Hujan Tahunan

Semenanjung Malaysia  
[2050] +291mm (11%)  
[2100] +364mm (14%)

Sarawak  
[2050] +420mm (12%)  
[2100] +567mm (16%)

Sabah  
[2050] +616mm (19%)  
[2100] +813mm (25%)

### Kajian NAHRIM

- ❑ Peningkatan suhu permukaan
- ❑ Peningkatan jumlah hujan tahunan
- ❑ Peningkatan extreme events

Nota: Berdasarkan unjuran IPCC AR5 untuk Malaysia (NAHRIM, 2019)

# ANCAMAN DAN IMPAK

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## Peningkatan suhu

- Peningkatan kadar evaporasi dan stabiliti stratifikasi tasik
- Peningkatan insiden 'algal- bloom'
- Penurunan kualiti sumber air tasik

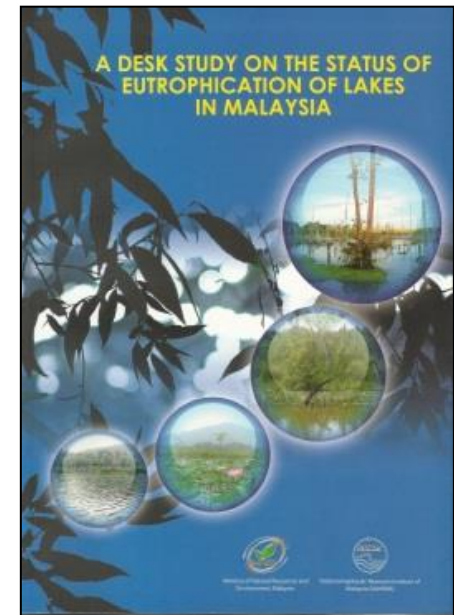
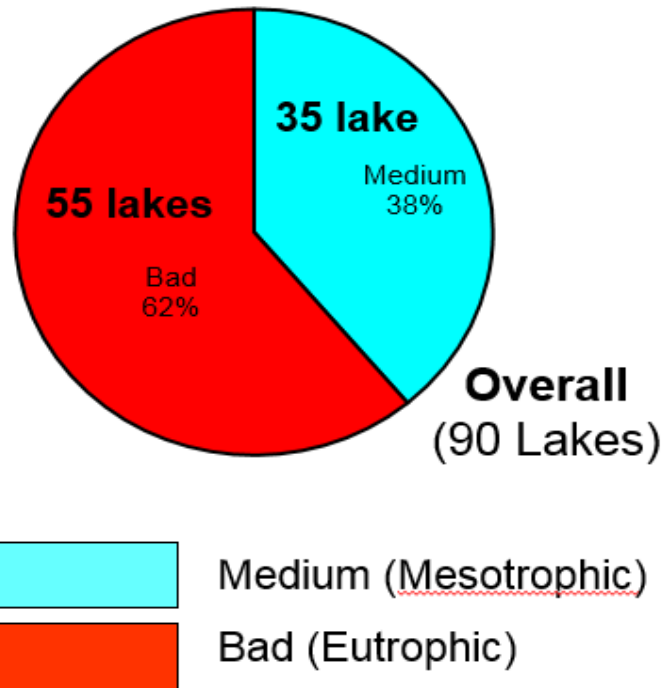
## Perubahan hujan

- Peningkatan tahap hakisan dan pengangkutan endapan dan pencemar

# ANCAMAN DAN IMPAK

## Eutrofikasi

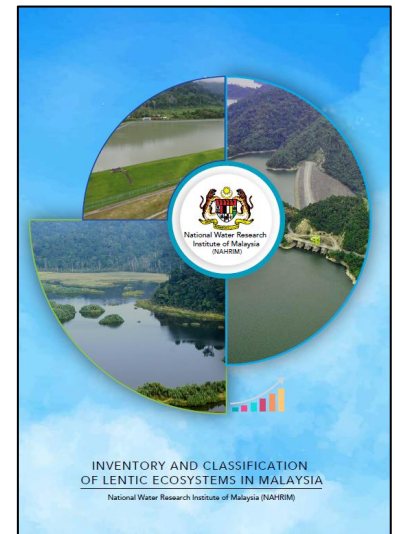
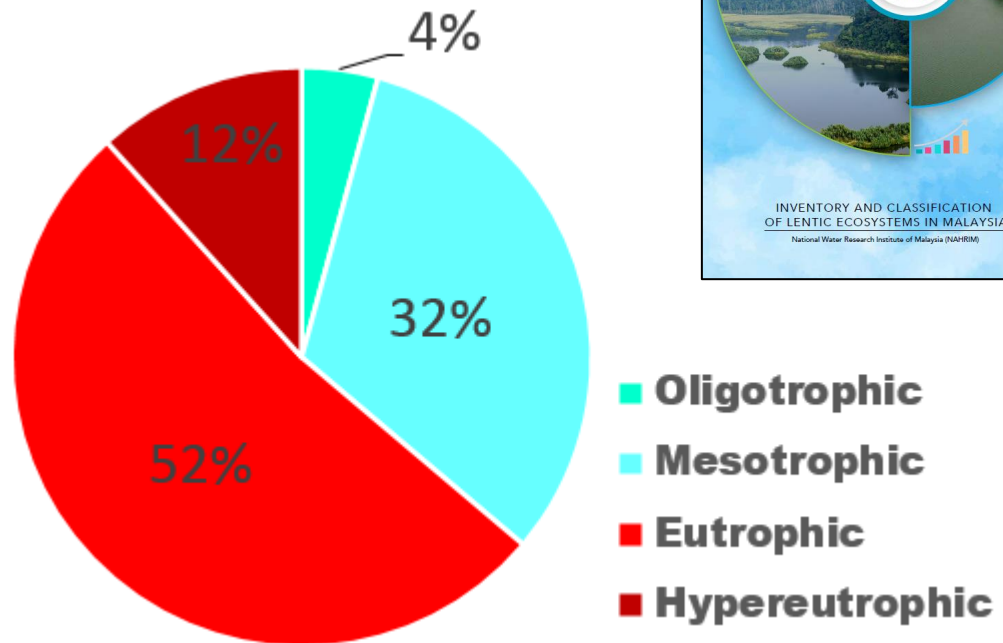
- o Kajian awal oleh NAHRIM & ASM pada 2005 melaporkan <60% dari 90 tasik utama yang dikaji berada dalam kategori eutrofik (NAHRIM 2009)



# ANCAMAN DAN IMPAK

## Eutrofikasi

- Kajian terkini pada tahun 2020 berdasar data literatur menunjukkan bahawa 64% dari 94 tasik yang telah dikaji dikategori sebagai mengalami eutrofikasi (NAHRIM 2020)





# IMPAK – PENCEMARAN NUTRIEN

## Eutrofikasi

- Pertumbuhan algal yang berlebihan menyebabkan penurunan kandungan oksigen terlarut dan kualiti air





# IMPAK - PENCEMARAN NUTRIEN

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## Eutrofikasi

- Pertumbuhan tumbuhan akuatik berlebihan
  - Native – *Hanguana malayana*, keladi bunting;
  - Non-native – *Cabomba* sp.



# IMPAK – PENCEMARAN SEDIMEN

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Sedimentasi tasik/empangan (sumber: JPS/TNB)

- ❑ Pengurangan 36% kapasiti takungan Empangan Bukit Merah
- ❑ Pengurangan 33% kapasiti takungan Empangan Anak Endau
- ❑ Pengurangan 43% kapasiti takungan Empangan Pontian
- ❑ Keperluan berterusan untuk membuang kelodak i.e. Tasik Ringlet



# IMPAK – PENCEMARAN MIKROORGANISMA

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Kajian NAHRIM ke atas beberapa kolam dan tasik di Lembah Klang berkaitan pencemar microorganisma (fecal indicator bacteria)

- Peningkatan kepekatan BOD, dan ammoniacal nitrogen berkait rapat dengan pencemaran organik
  - BOD values: 5.7 - 21.5 mg/L
  - NH<sub>3</sub>N values: 0.08 - 6.5 mg/L.
  - COD concentration: 8.1 - 131.6 mg/L
- E. coli: 0.5 - 79,133 cfu/100 ml
- *Clostridium perfringens*: 6.8 - 3,333 cfu/100 ml
- Faecal coliform: 700 - 60,900 cfu/100 ml
- Total coliform: 2,425 - 205,000 cfu/100 ml

Source: Sharip & Mohamad 2019

# IMPAK – PENCEMARAN RACUN PEROSAK

- Racun kulat (fungicides) adalah jenis pestisid yang paling banyak diguna merangkumi 53%, diikuti racun serangga (insecticides) 44% & racun rumpai (herbicides) 3%
- Residu racun perosak Organoklorin (OCPs); di dalam air permukaan Sungai Bertam dan Sungai Terla
  - methoxychlor (0.06 µg/L),
  - endrin ketone (0.63 µg/L),
  - 4,4'-DDE (0.02 µg/L)
- racun kimia di dalam air permukaan Sungai dan Tasik Sembrong
  - 4,4'-DDE (0.013 µg/L)
  - Aldrin (0.05 µg/L)
  - methoxychlor (0.23 µg/L),

## Banned but still in use

### LETTERS

Friday, 01 Feb 2013

12:00 AM MYT

It is heartening to note the recent media coverage and attention given to the current land clearing and water pollution issues affecting Cameron Highlands.

Pesticide Action Network Asia and the Pacific (PAN AP) would like to congratulate The Star for bringing the issues to the forefront as they adversely impact the lives of people in the area. Furthermore, such situations do not augur well for the reputation of our country as a tourist attraction.

Cameron Highlands over the years has acquired a reputation for its dangerous use of pesticides and of very serious concern is the evidence of the use of restricted and illegal pesticides.

Following the aftermath of the media expose on land clearing at Cameron Highlands, we wish to call to attention the underlying critical issue at hand.

# IMPAK – PENCEMARAN RACUN PEROSAK



NEW STRAITS TIMES

NEWS BUSINESS LIFE & TIMES SPORTS WORLD NST TV OPINION VOICE

EXCLUSIVE CRIME & COURTS **NATION** GOVERNMENT / PUBLIC POLICY POLITICS

## Illegal pesticide use rampant in Cameron Highlands; toxins entering water supply



By FERNANDO FONG - April 1, 2018 @ 6:04pm

BRINCHANG: The rampant use of illegal pesticides for farming continues unabated in Cameron Highlands, giving rise to health and environmental concerns.



The rampant use of illegal pesticides for farming continues unabated in Cameron Highlands, giving rise to health and environmental concerns. (NSTP file pic)

# KEPENTINGAN AIR TASIK SEBAGAI SUMBER BEKALAN AIR

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# KEPENTINGAN AIR TASIK SEBAGAI SUMBER BEKALAN AIR

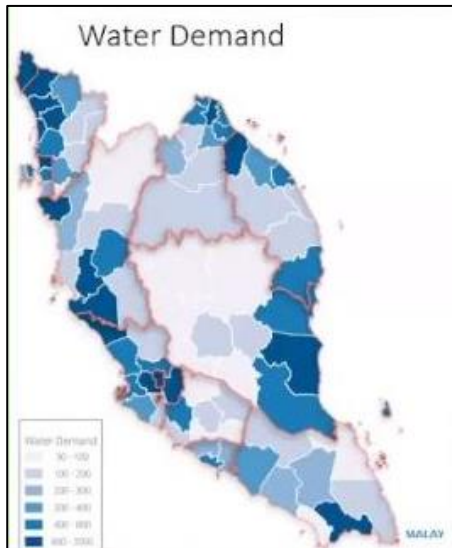
- 17.4% sumber air minuman diambil secara langsung dari empangan (*Water and Sewerage Fact Book 2019, SPAN*)
- Majoriti sumber air minuman di ambil dari sungai (81.3%) yang berkait dengan limpahan dari empangan (SPAN, 2019)





# KEPENTINGAN AIR TASIK SEBAGAI SUMBER BEKALAN AIR

## ➤ Peningkatan permintaan air



## WATER EXPLOITATION INDEX, WEI

RIVER	TOTAL ANNUAL RAINFALL (mm)	ANNUAL SURFACE RUNOFF (mm)	ANNUAL WATER VOLUME / AWA* (MCM)	ANNUAL WATER ABSTRACTION (MCM)	WATER EXPLOITATION INDEX, WEI (Index, %)	LEVEL OF WATER STRESS
Sg. Muda	2,377	619.2	2,606.80	1,962.31	75.3	Severe stress
Sg. Kelantan	2,472	1,255.80	16,451.00	1,411.02	8.6	Not-stress
Sg. Pahang	2,033	646.4	18,939.50	893.89	4.7	Not-stress
Sg. Johor	2,239	896.7	2,049.50	847.86	41.4	Severe stress
Sg. Linggi	2,046	951.1	1,234.20	227.65	18.4	Low stress
Sg. Selangor	2,659	1,277.30	2,474.00	1,134.79	45.9	Severe stress
Sg. Padas	2,259	827.2	7,593.40	249.4	3.3	Not-stress
Sg. Sadong	3,266	1,607.10	5,667.70	128.81	2.3	Not-stress

\*AWA - Annual Water Availability  
\*\*MCM - Million Cubic Meter

Water Exploitation Index (WEI)	Levels of water stress
< 10%	Not-stress
10 to <20	Low stress
20 to < 40	Stress
≥ 40%	Severe stress



# KEPENTINGAN AIR TASIK SEBAGAI SUMBER BEKALAN AIR

- Peningkatan pencemaran - Kos rawatan air semakin meningkat
- Perubahan iklim - kemarau panjang



Photo: FMT



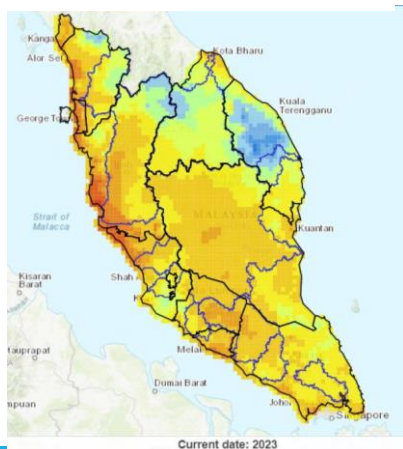
Photo: Selangor Journal/BH



Dam water level 38%

Selangor Dam (2016)

Source: N-HYDAA, NAHRIM



# KEPENTINGAN AIR TASIK SEBAGAI SUMBER BEKALAN AIR

- Peningkatan pembinaan takungan air persisiran sungai (TAPS) sebagai sumber bekalan air
- Penggunaan air tasik / kolam bekas lombong sebagai sumber air alternatif



Pengurus Besar loji Rawatan Air Sungai Selangor Fasa 1, Zulfikri Suboh, memberi penerangan kepada Menteri Alam Sekitar dan Air, Datuk Seri Tuan Ibrahim Tuan Man, di bilik kawalan operasi Loji rawatan Air Sungai Selangor Fasa (LRASSP1) ketika melakukan lawatan di sini. - Foto Fatih Asri

KUALA SELANGOR: Kerajaan bercadang memperluaskan Projek Takungan Air Pinggir Sungai (TAPS) sebagai alternatif bagi sumber air mentah jika terdapat gangguan pada saluran utama sungai.

# PEMANTAUAN DAN GOVERNAN KUALITI AIR TASIK

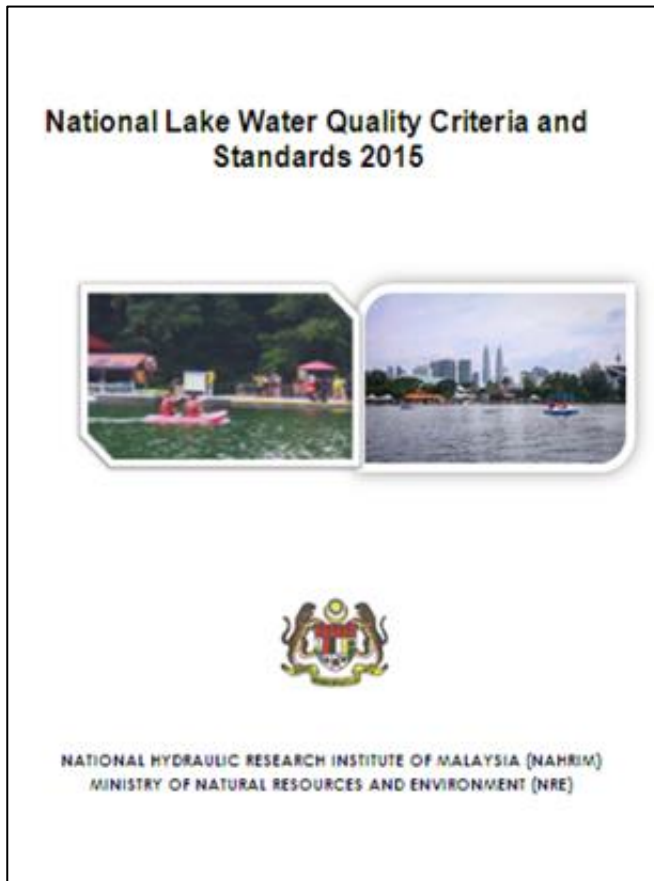
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# PEMANTAUAN & GOVERNAN KUALITI AIR TASIK

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- Pemantauan kualiti air tasik penting utk membolehkan pemahaman tentang kualiti air (tren), pengurusan dan governan
- Pemantauan kualiti air penting bagi sistem pembuat keputusan
  - Memberi amaran kepada isu semasa, masalah sedia ada dan masalah baru;
  - Menentukan pematuhan kepada piawai yang ditetapkan,
  - Melindungi penggunaan air yang bermanfaat
  - Mengukur keberkesanan polisi pengurusan
- Pemantauan adalah terhad di kebanyakan badan air bertakung / tasik

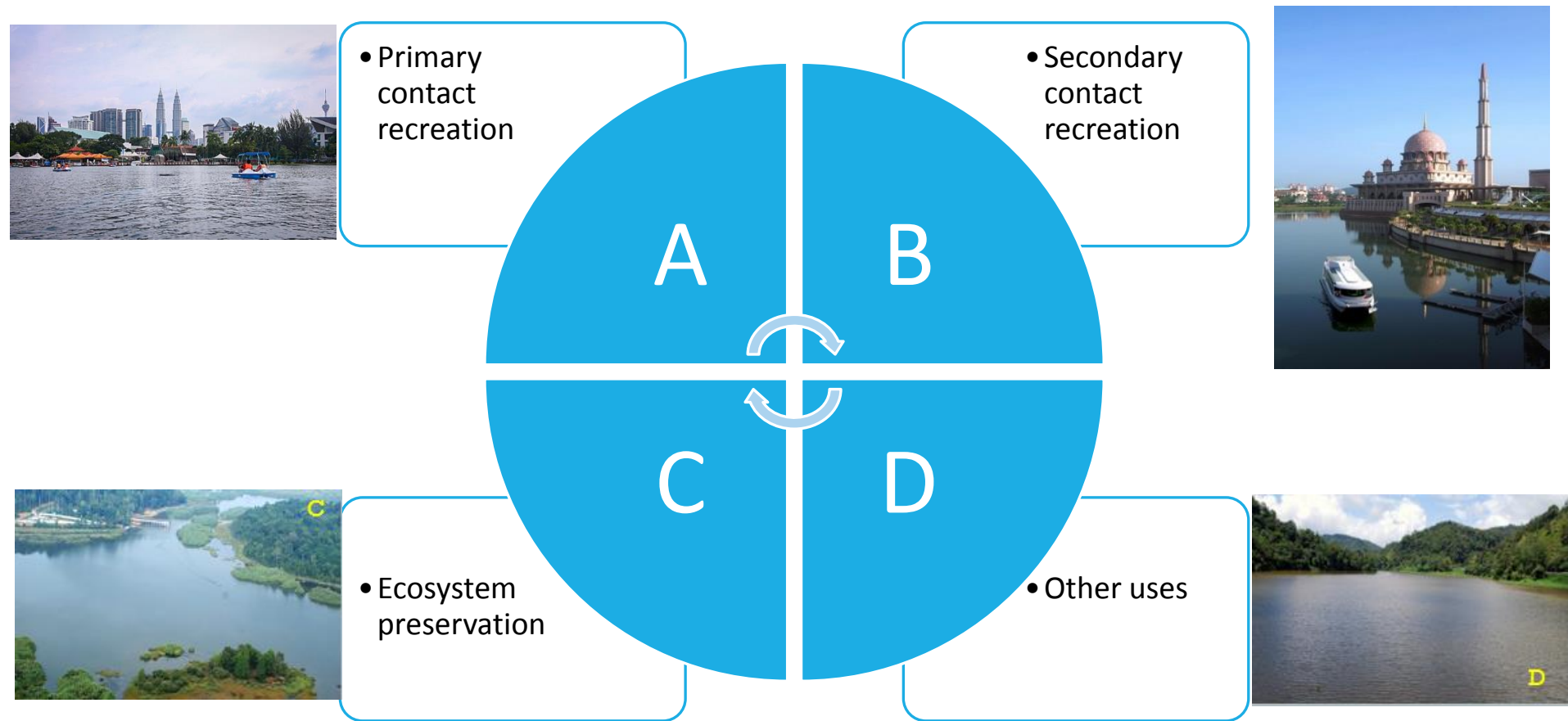
# PEMANTAUAN & GOVERNAN KUALITI AIR TASIK



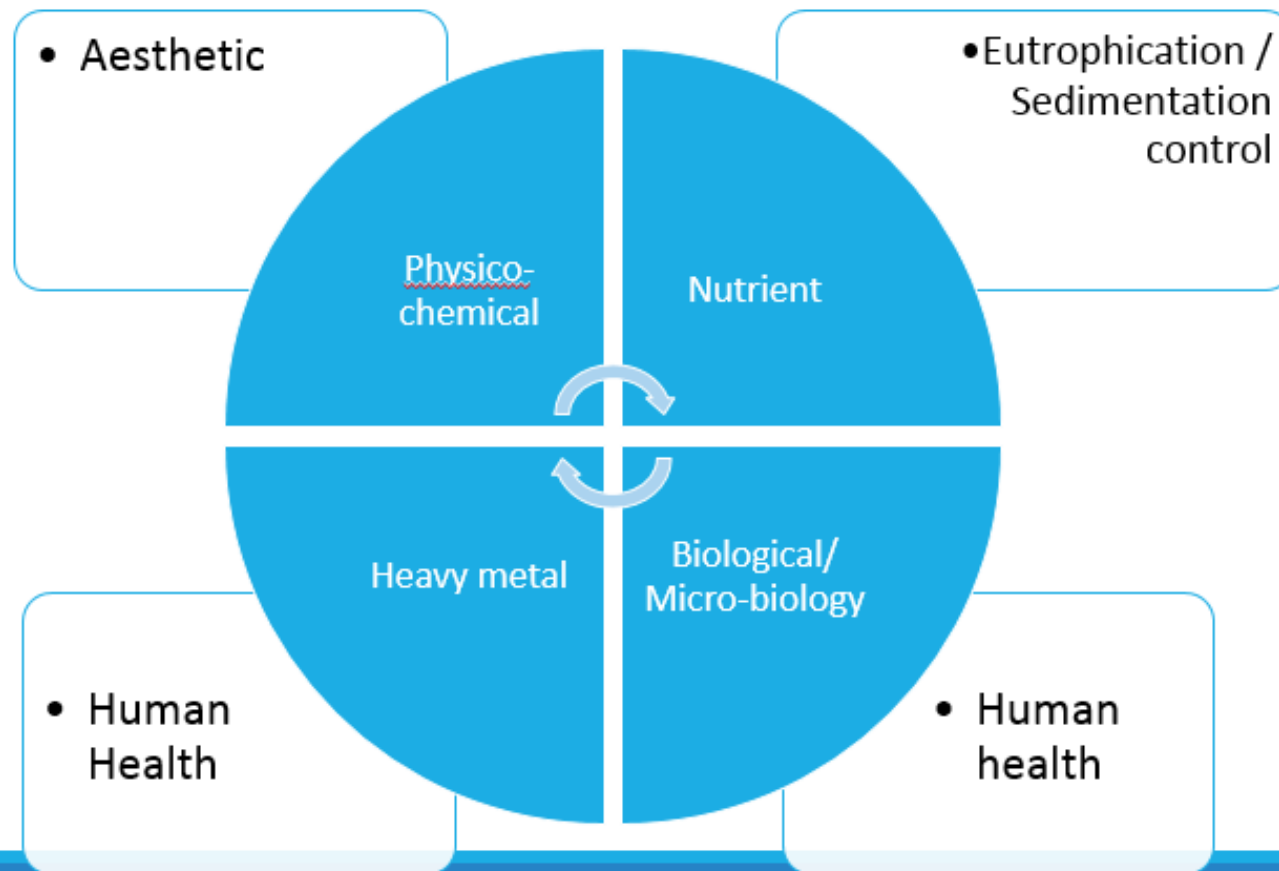
## Piawai dan Kriteria Kebangsaan Kualiti Air Tasik (NLWQCS)

- Fokus kepada 4 kategori penggunaan
- Menggalakkan pemeliharaan kesihatan manusia dan ekosistem
- Aplikasi: badan air bertakung

# PEMANTAUAN & GOVERNAN KUALITI AIR TASIK



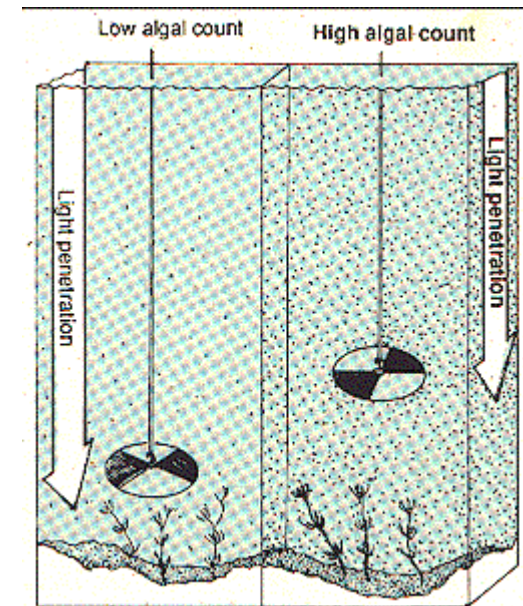
# PEMANTAUAN & GOVERNAN KUALITI AIR TASIK





# PEMANTAUAN & GOVERNAN KUALITI AIR TASIK

- Fiziko-kimia i.e., DO, pH, transparency, kekeruhan
- Nutrien i.e., total phosphorus, ammoniacal nitrogen
- Heavy metals i.e., arsenik, merkuri, plumbum, cadmium
- Biological/mikrobiologikal i.e., Chlorophyll-a, BOD, E.coli,



# PEMANTAUAN & GOVERNAN KUALITI AIR TASIK

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- Anion / Cations i.e. calcium, potassium
- Microbiological i.e. enteroviruses
- Heavy metals i.e. aluminium, copper
- Organics / pesticides i.e. aldrin/dieldrin, 2,4 – D, paraquat, parathion

# CONTOH KAJIAN KES: OLIGOTROPHIC

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## Unproductive lakes

- Nutrient levels: TP (0.035 mg/L);
- Low pH: <4
- Biological: Chlorophyll-a (<1 ug/L);
- High transparency; >6.0 m
- Heavy metals exceed detection limits



Keperluan rawatan sebelum ianya  
sesuai sebagai sumber bekalan air

# CONTOH KAJIAN KES: MESO-EUTROPHIC

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## Moderate level of productivity

- Nutrient levels: TP (<0.03 mg/L);
- Biological: Chlorophyll-a (<10 ug/L);
- High transparency; >1.0 m
- Heavy metals below detection limits



Berpotensi sebagai sumber bekalan air

# CONTOH KAJIAN KES – HYPEREUTROPHIC

Photo: Sharip



Photo: Sharip



## very nutrient-rich and productive lakes

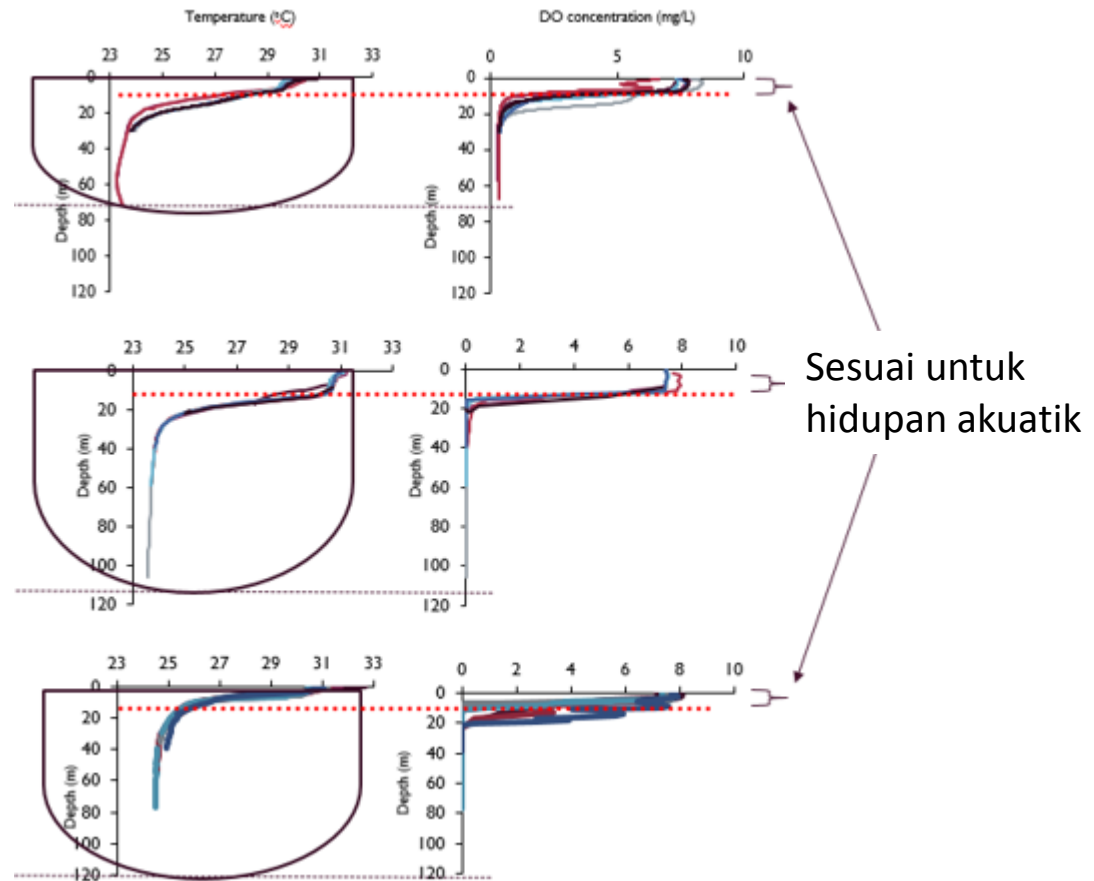
- Nutrient: TP (>0.7 mg/L);  $\text{NH}_3\text{N}$  (>1 mg/L)
- Biological: Chlorophyll-a (>50 ug/L); Cyanobacteria (>10,000 cells/ml), BOD (>20 mg/L), COD (>100 mg/L); E.coli (>2000 CFU/100 ml)
- Low transparency: <0.3 m
- Nutrient: TP (>0.2 mg/L);
- Biological: Chlorophyll-a (>100 ug/L); Cyanobacteria (>40,000 cells/ml), BOD (>6 mg/L), COD (>50 mg/L)
- Low transparency: <0.5 m



Keperluan rawatan intensif sebelum ianya boleh digunakan sebagai sumber bekalan air

# CONTOH KAJIAN KES – EMPANGAN

- Stratifikasi tasik -  
Kualiti air tasik  
yang boleh  
digunakan terhad  
kepada kedalaman  
tertentu



Sharip (2020). JICA-ILEC

# PEMANTAUAN & GOVERNAN KUALITI AIR TASIK

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NLWQS sebagai sumber rujukan

- Pemantauan kualiti air dan ekosistem badan air bertakung
- Pembangunan pelan pengurusan kualiti air dan lembangan tasik

# Sustainable Development Goals



**6.1** By 2030, achieve universal and equitable access to safe and affordable drinking water for all

**6.4** By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

**6.6** By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes





# Water Security

Ketersediaan sumber air dalam kuantiti dan kualiti yang boleh diterima untuk kesihatan, kehidupan, ekosistem, dengan tahap risiko yang boleh diterima kepada manusia, alam sekitar dan ekonomi.

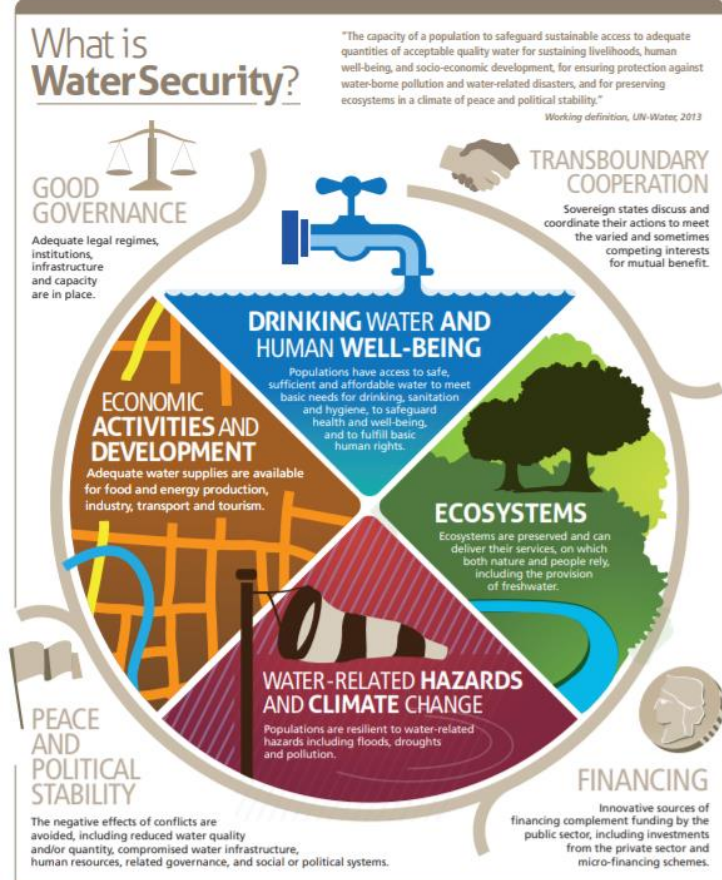


Kepentingan kualiti air tasik sebagai sumber bekalan air

**What is Water Security?**

"The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."

*Working definition, UN-Water, 2013*



**GOOD GOVERNANCE**  
Adequate legal regimes, institutions, infrastructure and capacity are in place.

**TRANSBOUNDARY COOPERATION**  
Sovereign states discuss and coordinate their actions to meet the varied and sometimes competing interests for mutual benefit.

**DRINKING WATER AND HUMAN WELL-BEING**  
Populations have access to safe, sufficient and affordable water to meet basic needs for drinking, sanitation and hygiene, to safeguard health and well-being, and to fulfill basic human rights.

**ECONOMIC ACTIVITIES AND DEVELOPMENT**  
Adequate water supplies are available for food and energy production, industry, transport and tourism.

**ECOSYSTEMS**  
Ecosystems are preserved and can deliver their services, on which both nature and people rely, including the provision of freshwater.

**WATER-RELATED HAZARDS AND CLIMATE CHANGE**  
Populations are resilient to water-related hazards including floods, droughts and pollution.

**PEACE AND POLITICAL STABILITY**  
The negative effects of conflicts are avoided, including reduced water quality and/or quantity, compromised water infrastructure, human resources, related governance, and social or political systems.

**FINANCING**  
Innovative sources of financing complement funding by the public sector, including investments from the private sector and micro-financing schemes.

Water is central to achieving a larger sense of security, sustainability, development and human well-being. UN-Water supports the inclusion of water security in the post-2015 development agenda as part of the Sustainable Development Goals.

Achieving water security requires collaboration across sectors, communities, disciplines and political borders, to reduce the risk of potential conflicts over water resources, between sectors and between water users or states.

www.watercooperation2013.org

www.unwater.org



# Terima kasih

Further Contact:

Dr. Zati Sharip

Water Quality and Environment Division

National Water Research Institute of Malaysia (NAHRIM)

Lot 5377, Jalan Putera Permai

43300 Seri Kembangan, Selangor

Email: [zati@nahrim.gov.my](mailto:zati@nahrim.gov.my)