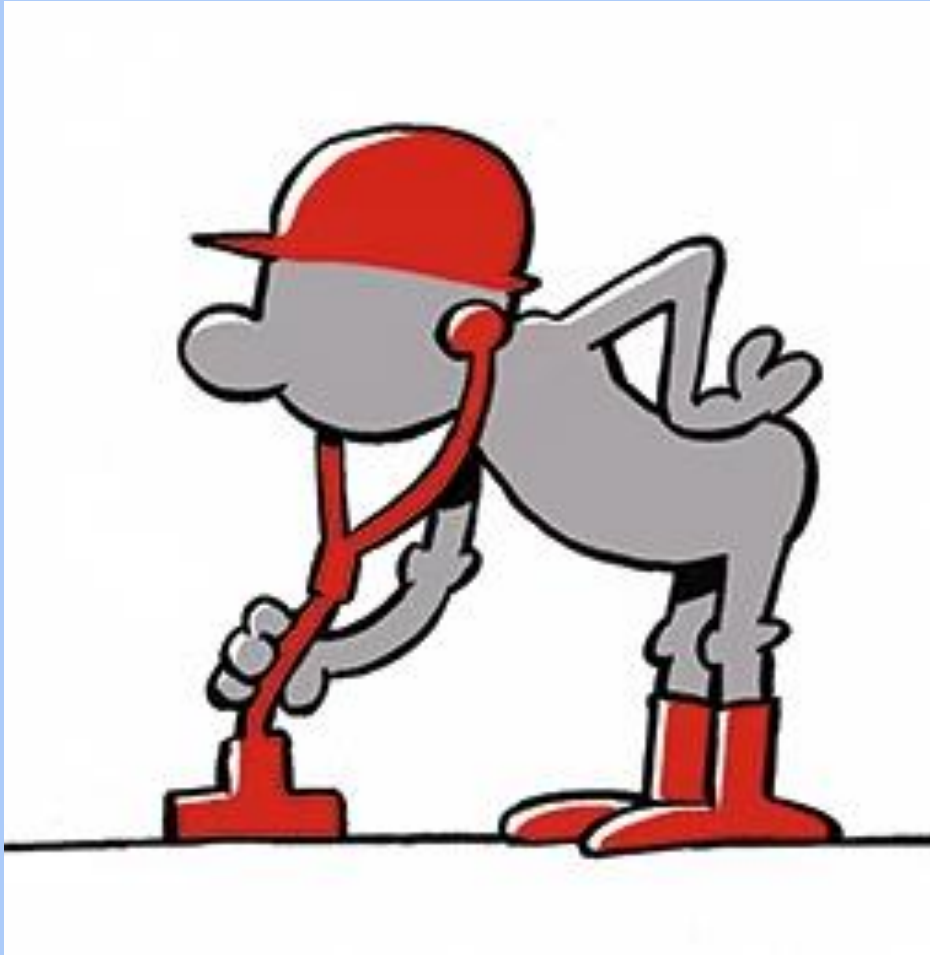
A large white sculpture of a toilet is the central focus, with a rainbow arching over its bowl. The sculpture is situated on a grassy area overlooking a body of water and a distant town. Several people are visible in the background, some standing near the water's edge. The sky is overcast.

# **GROUNDWATER AS A SUPPLEMENTARY NATIONAL WATER SUPPLY**

**by:  
SAIM SURATMAN**

**Presented at:  
APMREC  
PWTC KUALA LUMPUR  
11 NOVEMBER 2016**



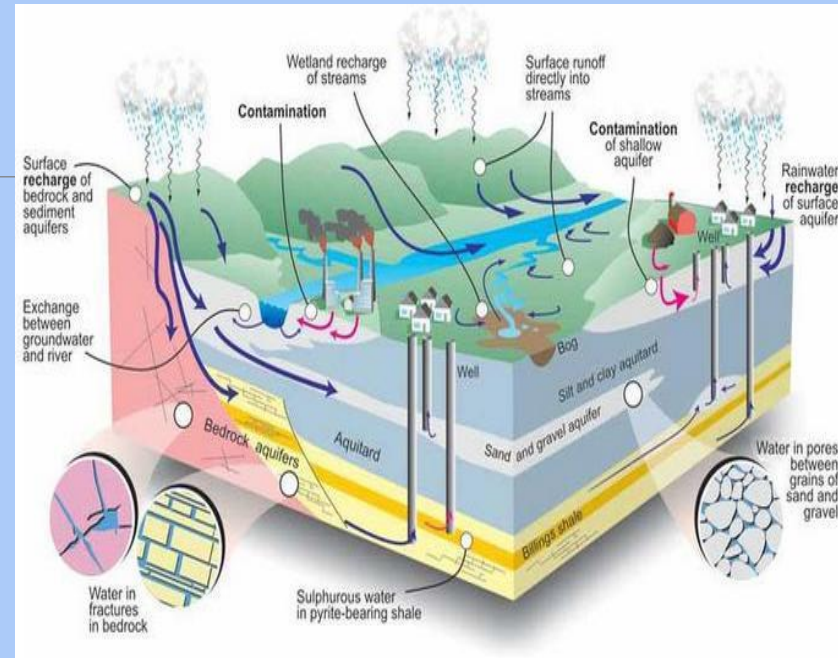
## Outline

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1. Groundwater – Overview
2. Groundwater Utilisation
3. Future in Groundwater Development
4. The Way Forward

# OVERVIEW

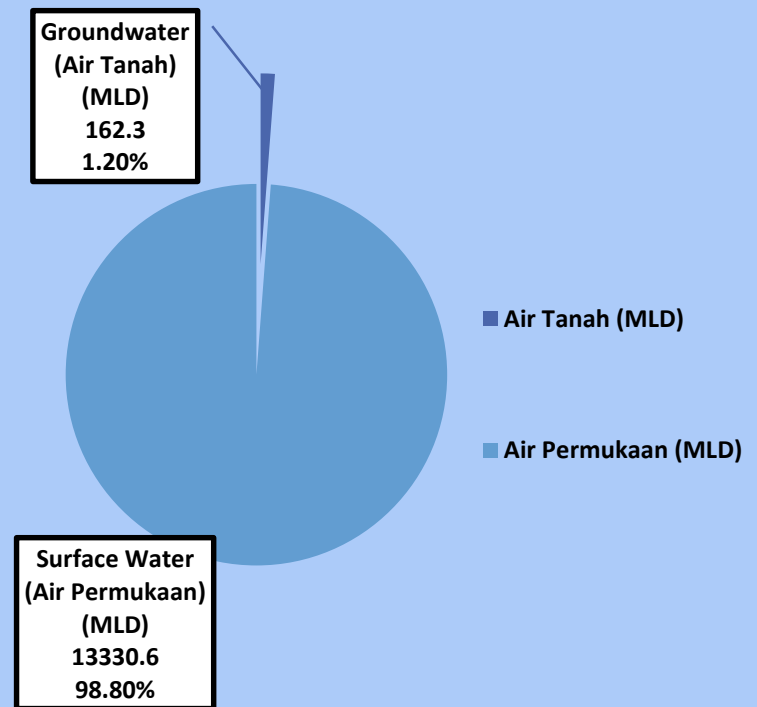
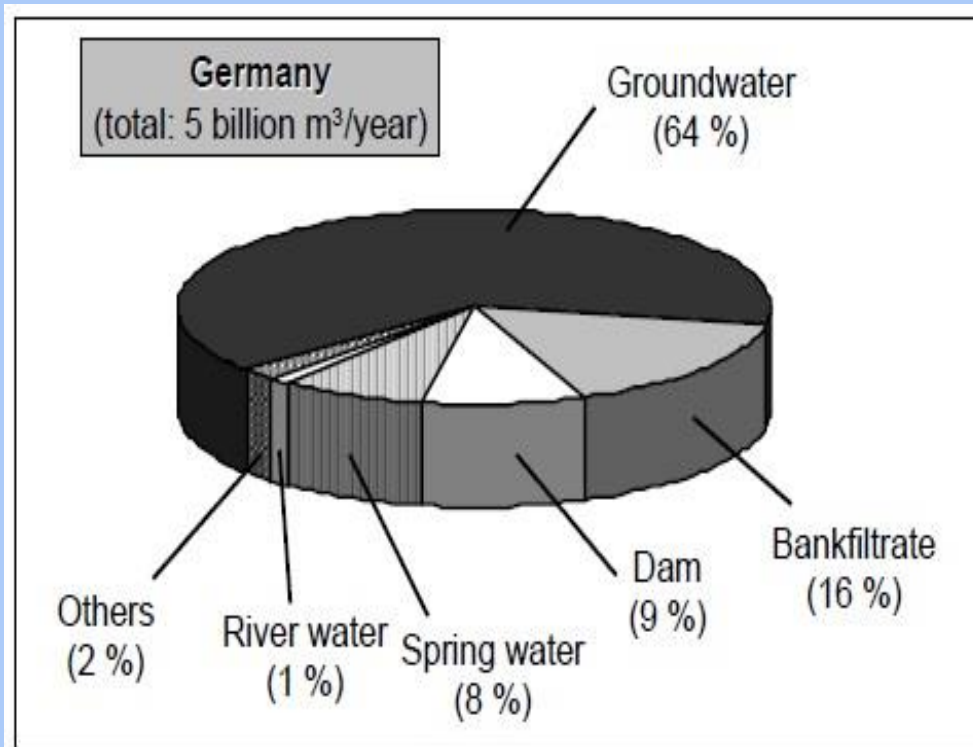
- **GROUNDWATER** resources **supply fresh drinking water to nearly half the world's population** and support streams, lakes, wetlands, aquatic communities, economic development and growth, and agriculture worldwide
- The use of groundwater is particularly relevant for many potable-water, industrial and agricultural supplies because:
  - groundwater has the capacity to balance large swings in precipitation and
  - associated increased demands during drought;
- it is also helpful when surface-water resources reach the limits of sustainability.



# COMPARISON – ENERGY VS WATER IN MALAYSIA

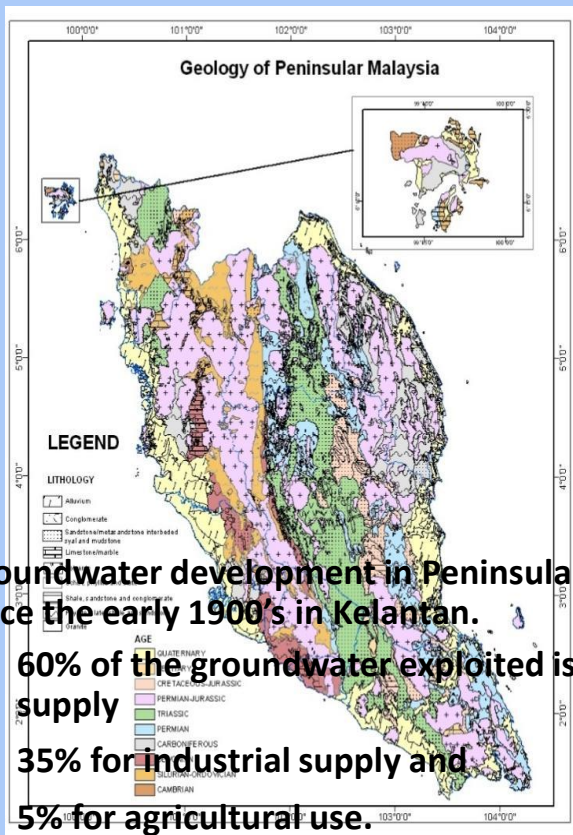
## ENERGY: Fuel Mix In Generation

## WATER: Source of Public Water Supply Malaysia



**MALAYSIA: Very dependent on ONLY 1 source of water**

# HYDROGEOLOGICAL DIVERSITY

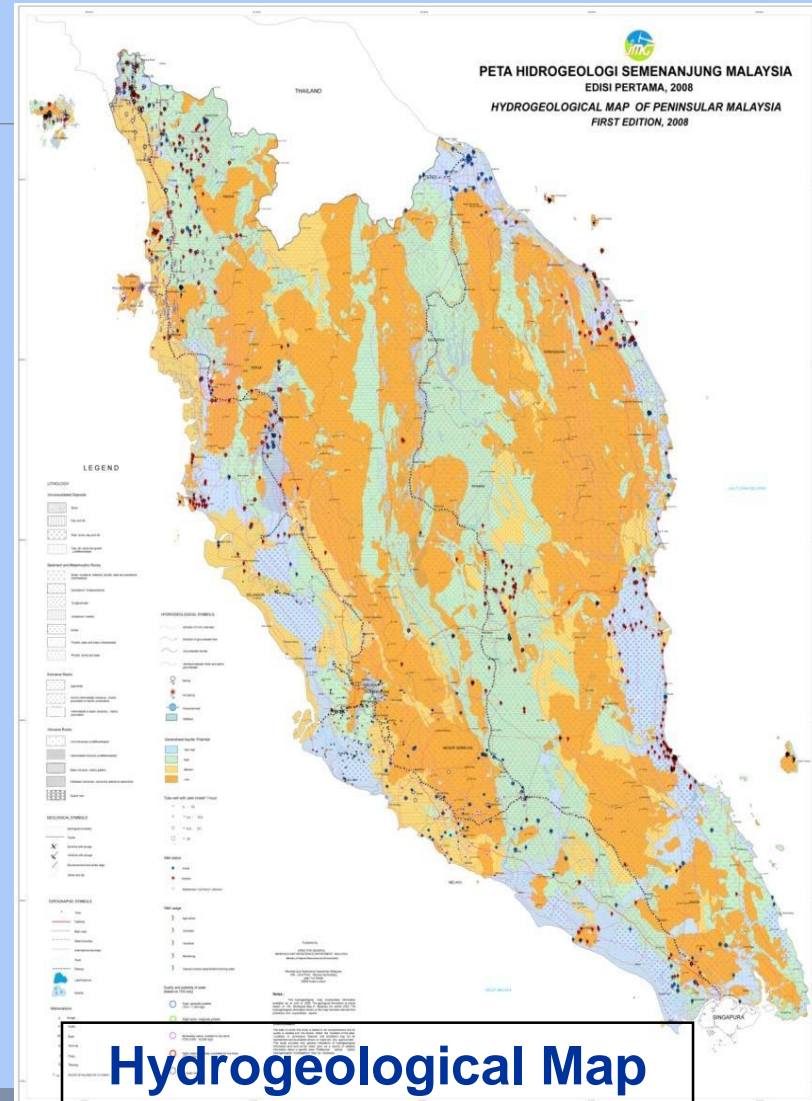


Groundwater development in Peninsular Malaysia started since the early 1900's in Kelantan.

- 60% of the groundwater exploited is for domestic supply
- 35% for industrial supply and
- 5% for agricultural use.

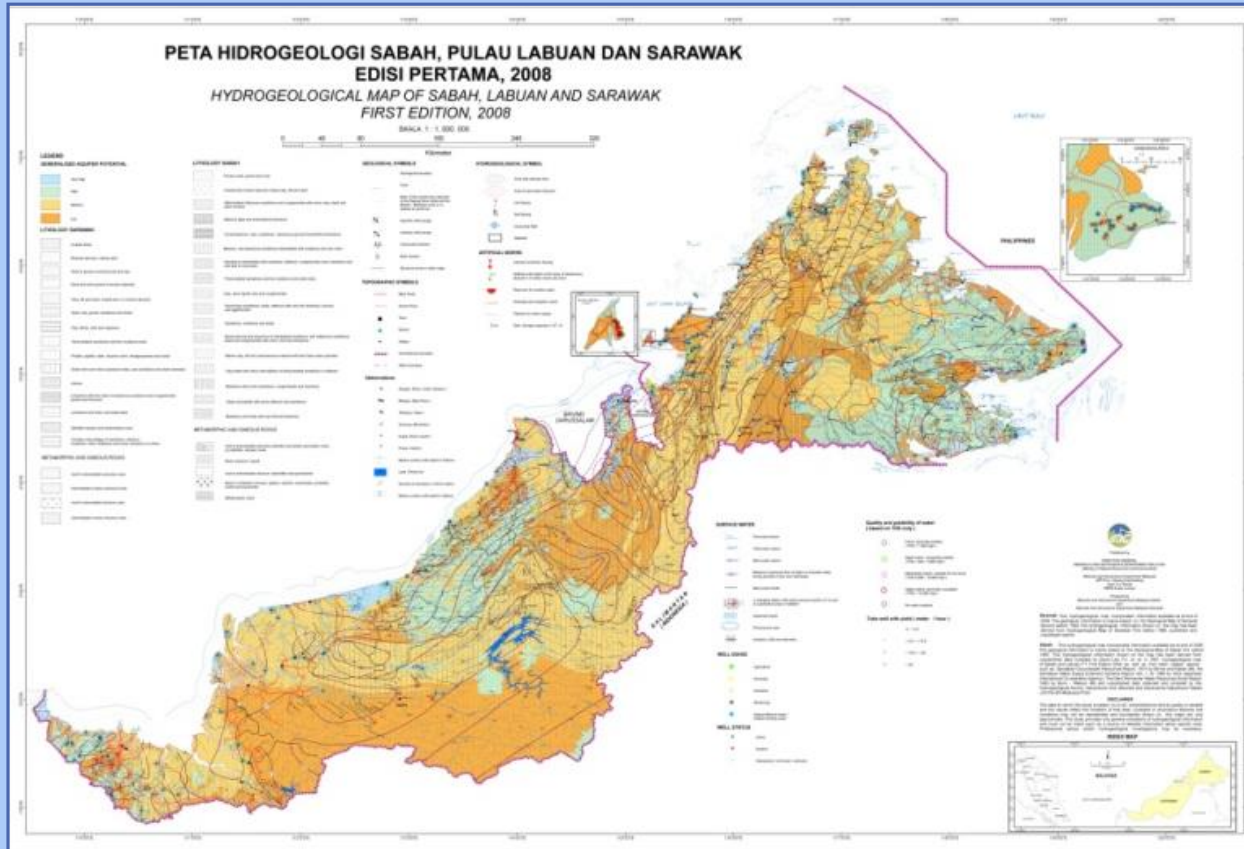
In Peninsular Malaysia, 4 categories of potential groundwater resources:

- The most productive aquifers are the alluvium (sand and gravel), which can yield from 50 to 100 m<sup>3</sup>/h/well.
- The most productive aquifer in hard rock is in limestone, which can produce up to 50 m<sup>3</sup>/h/well. But most within the developed areas and extraction may develop sinkhole.
- Fractured sandstone, their metamorphic equivalent and volcanic rock aquifers can yield up to 30 m<sup>3</sup>/h/well.
- The least productive type of aquifer is made up of fractured igneous rocks, which can give 20 m<sup>3</sup>/h/well.



**Hydrogeological Map of Malaysia**

# HYDROGEOLOGICAL DIVERSITY



Hydrogeological Map  
of Malaysia

## Sarawak

The first recorded abstraction of groundwater by tube wells in Sarawak was in 1954 in Sarikei followed by similar schemes in Bintangor and Sri Aman.

Groundwater is presently the main source of water supply in several coastal villages such as Belawai, Igan, Oya, Kabong, Pulau Bruit, Tatau, Limbang and several other new schemes under development.

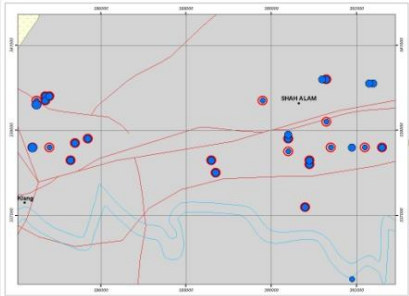
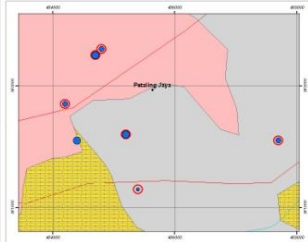
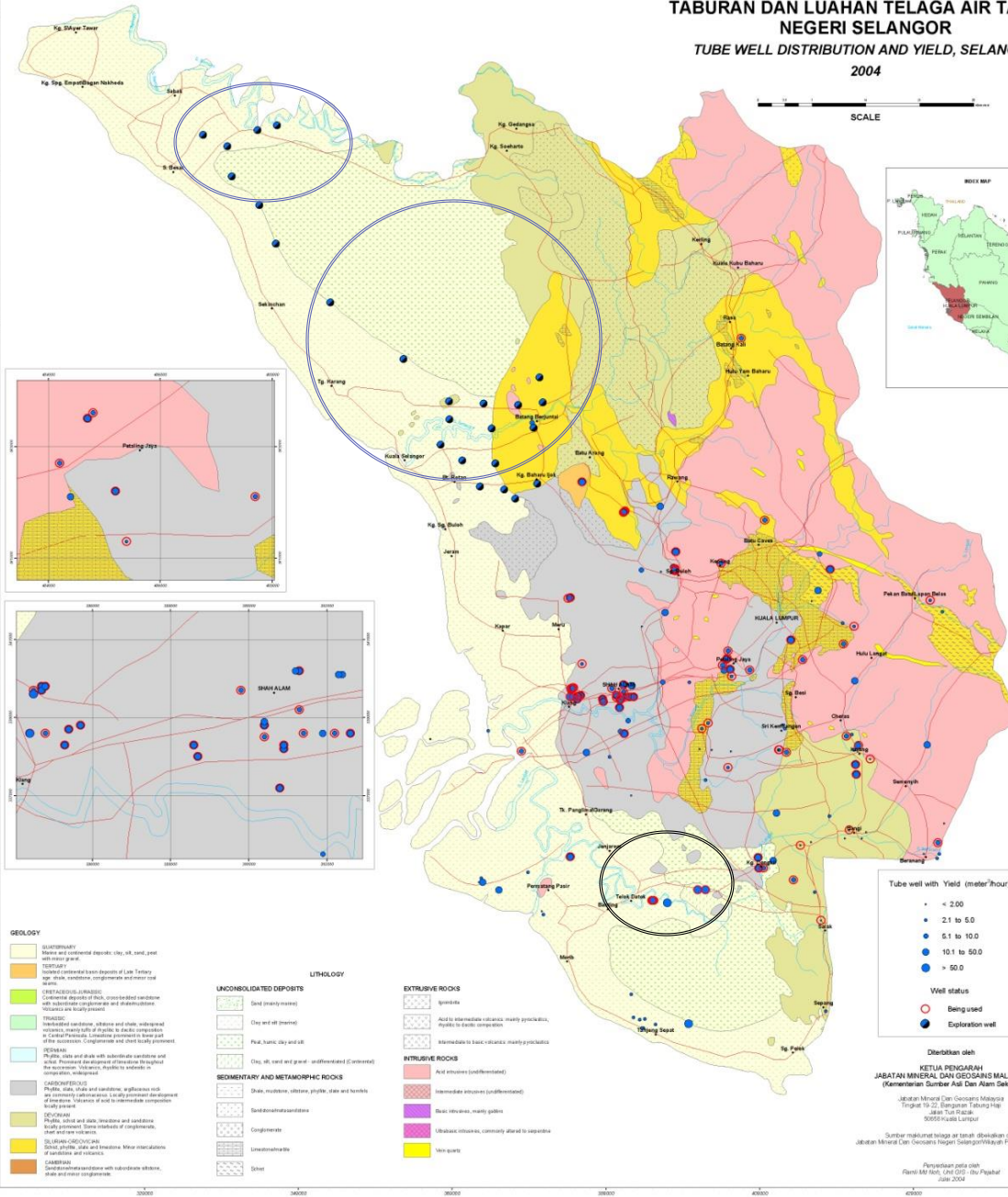
## Sabah

The only form of exploitation has been by coastal villagers who have been digging shallow wells for domestic supplies for years and the small-scale tube well abstraction in Sandakan, Kota Belud and Kuala Penyu.

In Labuan, groundwater is being used conjunctively with surface water to supply the water needs on the island.



**TABURAN DAN LUAHAN TELAGA AIR TANAH, NEGERI SELANGOR**  
**TUBE WELL DISTRIBUTION AND YIELD, SELANGOR**  
 2004



**GEOLOGY**

- QUATERNARY**  
 Recent and recent deposits: clay, silt, sand, peat and organic soil
- TERTIARY**  
 Tertiary continental basin deposits of Late Tertiary age, with moderate compression and minor sea level rise
- CRETACEOUS-DYBASIC**  
 Continental deposits of thick, cross-bedded sandstone with associated conglomerate and interstratified shales and mudstones
- TRIASSIC**  
 Interstratified sandstone, siltstone and shale, unconsolidated to moderately consolidated, mostly yellow to red-brown, composed of coarse to medium sandstone, siltstone and shale and of the succession. Conglomerate and their local placement
- PERMIAN**  
 Purple, olive and drab with subordinate sandstone and shale. Moderate to moderate to intensive diagenetic consolidation. Thinly bedded. Siltstone, siltstone to siltstone in composition, unconsolidated
- DEVONIAN**  
 Purple, olive and drab and sandstone, argillaceous siltstone and shale. Moderate to moderate to intensive diagenetic consolidation. Thinly bedded. Siltstone, siltstone to siltstone in composition. Volcanic of acid to intermediate composition locally present
- PERMIAN**  
 Purple, olive and drab, sandstone and sandstone, locally present. Some beds of conglomerate, sand and gravel rocks
- TRIASSIC-DYBASIC**  
 Drab, purple, olive and sandstone. Minor interstratification of sandstone and siltstone
- CAMBRIAN**  
 Sandstone and sandstone with subordinate siltstone, shale and minor conglomerate

**LITHOLOGY**

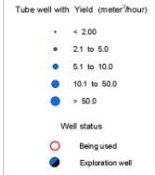
- UNCONSOLIDATED DEPOSITS**
  - Sand (medium to coarse)
  - Clay and silt (brown)
  - Peat, humic, clay and silt
- PERMIAN**
  - Clay, silt, sand and gravel (unconsolidated) (Continental)
- SEDIMENTARY AND METAMORPHIC ROCKS**
  - Sandstone, siltstone, siltstone, siltstone, clay and siltstone
  - Sandstone and siltstone
  - Conglomerate
  - Unconsolidated
  - Siltstone

**EXTRUSIVE ROCKS**

- Basalts
- Acid intermediate volcanics: mainly pyroclastics, rhyolite to basalt composition
- Intermediate to basic volcanics: mainly pyroclastics

**INTRUSIVE ROCKS**

- Acid intrusives (undifferentiated)
- Intermediate intrusives (undifferentiated)
- Basic intrusives: mainly gabbro
- Ultrabasic intrusives, commonly altered to soapstone
- Mafic dykes



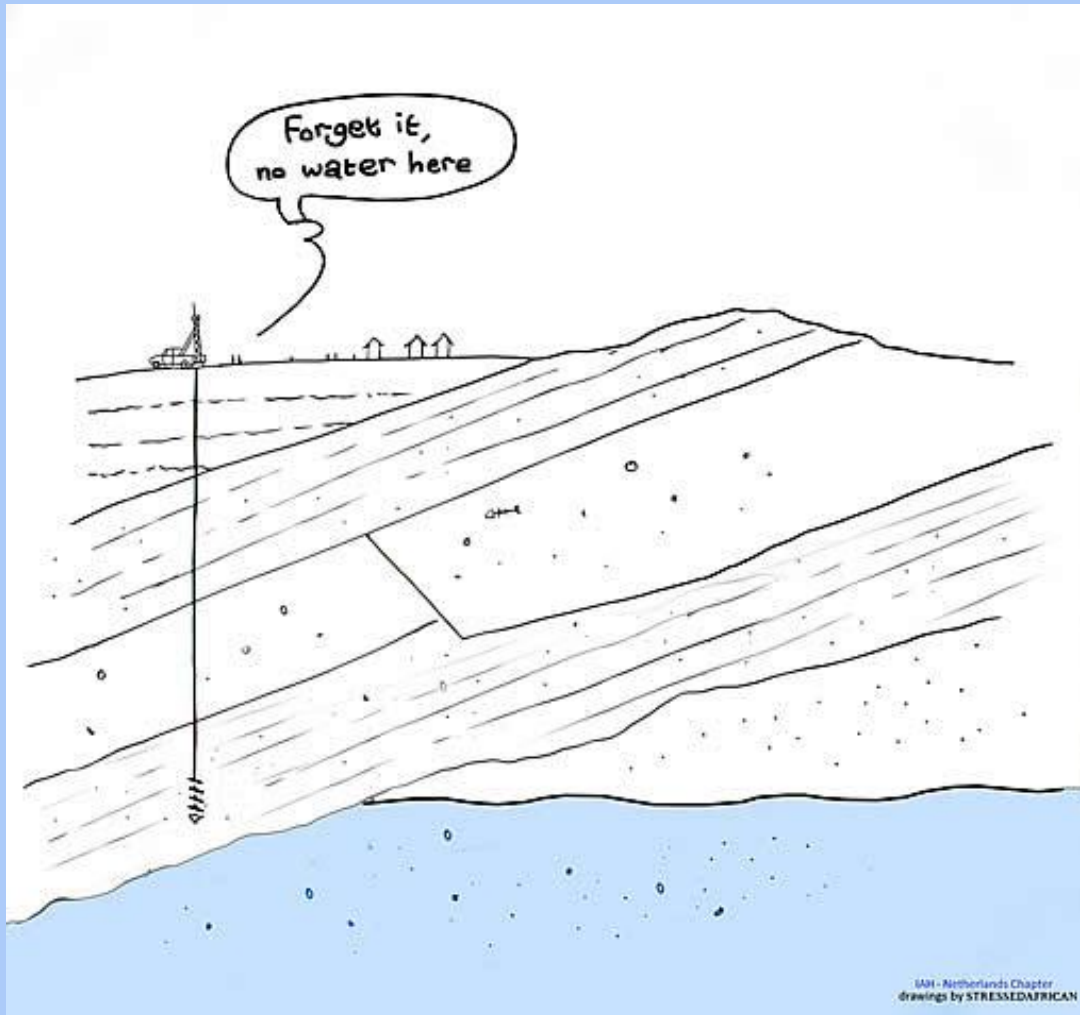
Dibuatkan oleh  
**KETUA PANGKALAN**  
**JABATAN MINERAL DAN GEOSAINS MALAYSIA**  
 (Kementerian Sumber Asli Dan Alam Sekitar)

Jabatan Mineral Dan Geosains Malaysia  
 Tingkat 19-22, Surau Muzium Selangor  
 Jalan Tok Hachib  
 00550 Kuala Lumpur

Sumber maklumat tenaga air tanah dibekalkan oleh  
 Jabatan Mineral Dan Geosains Halaju Selangor/Majlis Persekutuan M.L.

Persekitaran peta oleh  
 Ramli M. Noh, LHD GIS (Ibu Pejabat)  
 04/04/2004

# GROUNDWATER POTENTIAL IN SELANGOR



## Outline

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1. Groundwater – Overview
2. **Groundwater Utilisation**
3. Future in Groundwater Development
4. The Way Forward



# PREJUDICE

Published: Tuesday July 27, 2010 MYT 2:52:00 PM

Updated: Tuesday July 27, 2010 MYT 4:12:16 PM

## S'gor's plan to use alternate water sources not sustainable: Chin

By DHARMENDER SINGH

PUTRAJAYA: The Selangor government's plan to use alternative water sources like lakes and underground water does not make sense because they are not sustainable and cannot provide supply all year round, said Energy, Green Technology and Water Minister Datuk Seri Peter Chin.

He added that it took time for lakes and underground sources to build their water volume and, therefore, might not be able to replace quickly the amount siphoned out to water treatment plants.

STAR ONLINE, Wednesday May 19, 2010

## Preserve underground water, says lecturer

UNDERGROUND water should be left for future generations, a university professor recently said. Universiti Sains Malaysia School of Humanities lecturer Prof Dr Chan Ngai Weng said surface water was still adequate if measures were taken to minimise water wastage.

UM ARKIB : 30/09/2009

### Lindungi sumber air bawah tanah semula jadi kita

PERSATUAN Air Selangor, Kuala Lumpur dan Putrajaya (SWAn) bersetuju dengan pandangan Presiden FOMCA, Datuk N. Marimuthu yang membantah projek pembangunan sumber air bawah tanah di Batang Padang, Perak yang dicadangkan oleh Sime Darby Berhad.

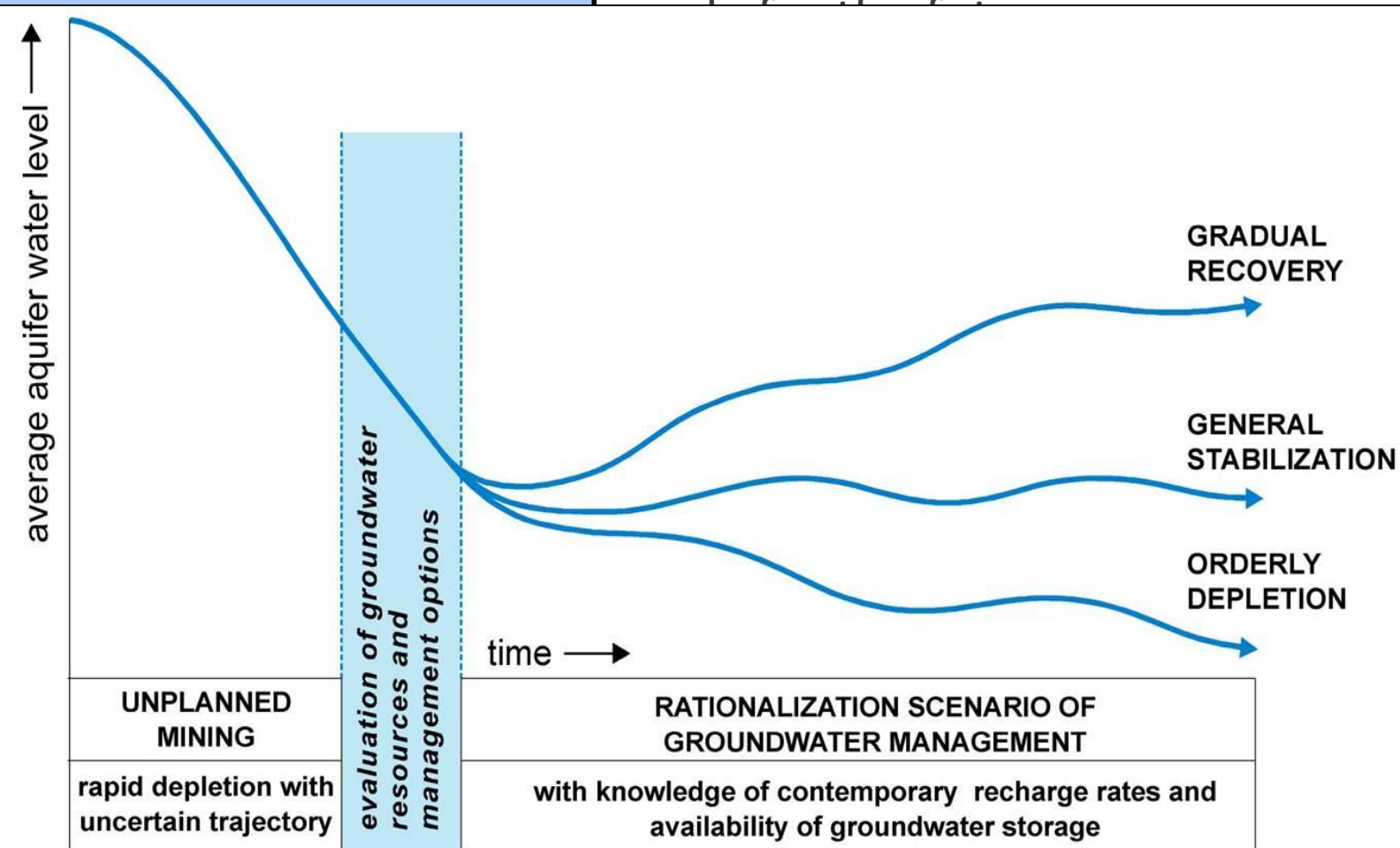
**Eksplotasi** sumber air mentah telah diketahui akan memberi **kesan buruk** terhadap ekosistem dan juga alam sekitar di Malaysia. Antara impak negatifnya ialah ia akan mengakibatkan penenggelaman tanah, berlakunya penyusupan air laut ke dalam sumber air bawah tanah atau sumber air permukaan serta penurunan paras air atau kadar aliran masuk. Terbukti pengekstrakan air bawah tanah secara berleluasa juga akan menurunkan dasar sungai-sungai dan tasik-tasik yang menjurus kepada lenyapnya sumber-sumber semula jadi kawasan tadahan air Malaysia. Bahkan landskap pertanian Malaysia iaitu tanam-tanaman juga akan terjejas kerana perubahan mendadak di dalam sistem sumber air bawah tanah semula jadi ini.

# FACTS

By REGINA LEE  
[regina@thestar.com.my](mailto:regina@thestar.com.my) | Apr 13, 2012

## Groundwater to be tapped for sustainable supply

### KUALA LUMPUR: Groundwater will be tapped in order to have a more sustainable water

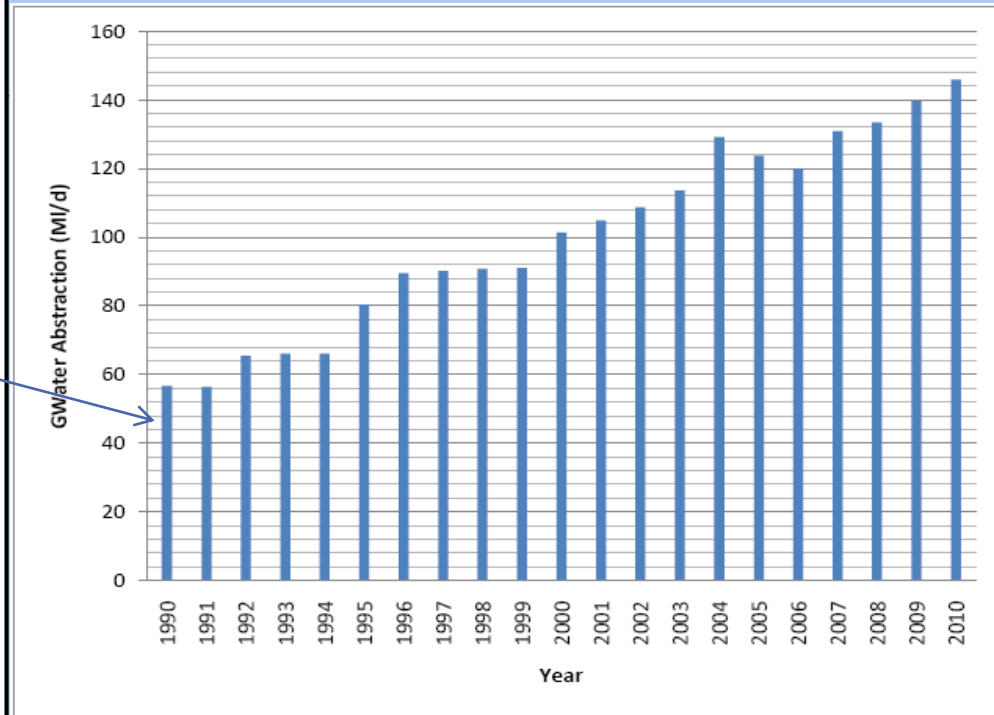


las Uggah Embas  
to water

affect the water  
are studying if  
the Malaysian  
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nal rainwater  
resources Policy  
ddin Yassin.

# MAJOR GROUNDWATER USERS

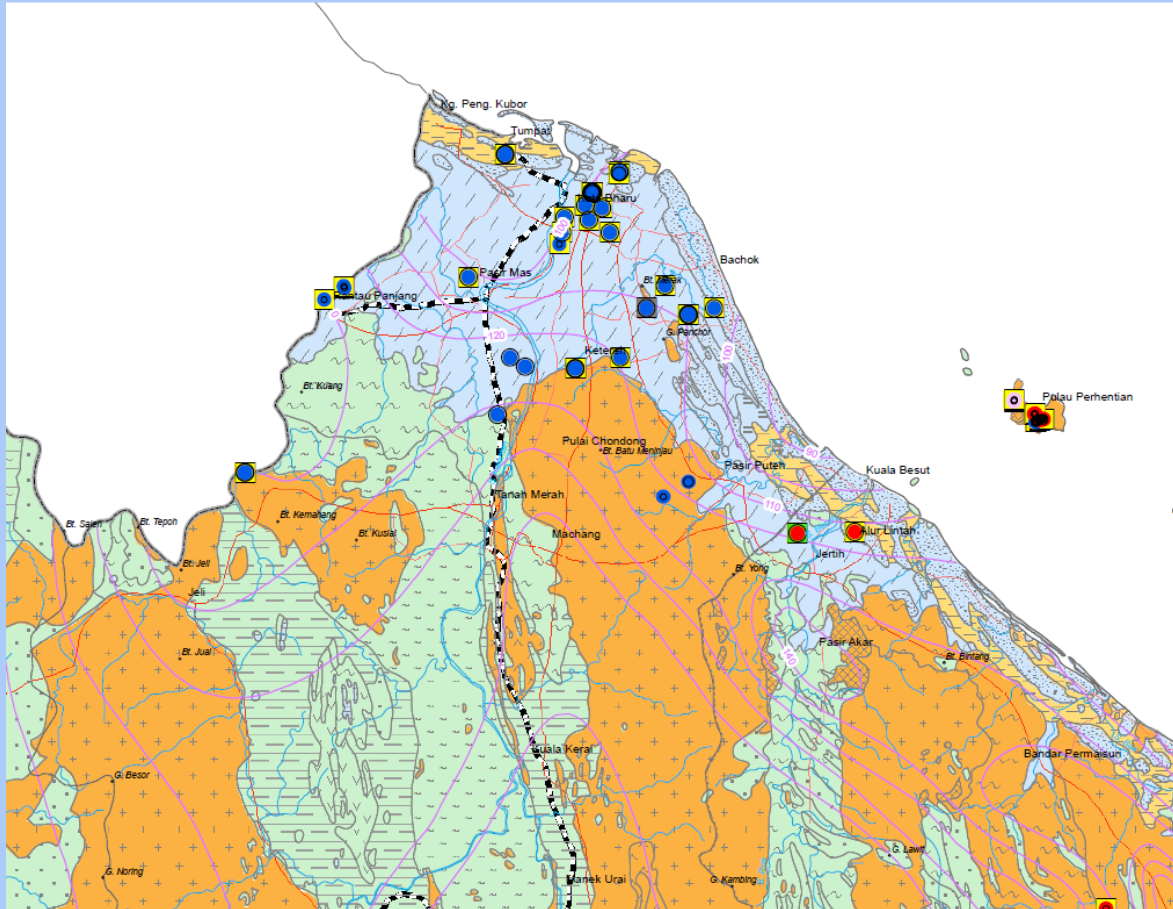


2 states:

- Kelantan - public water supply system
- Selangor - industrial

Total groundwater production in Kelantan (1990-2010)

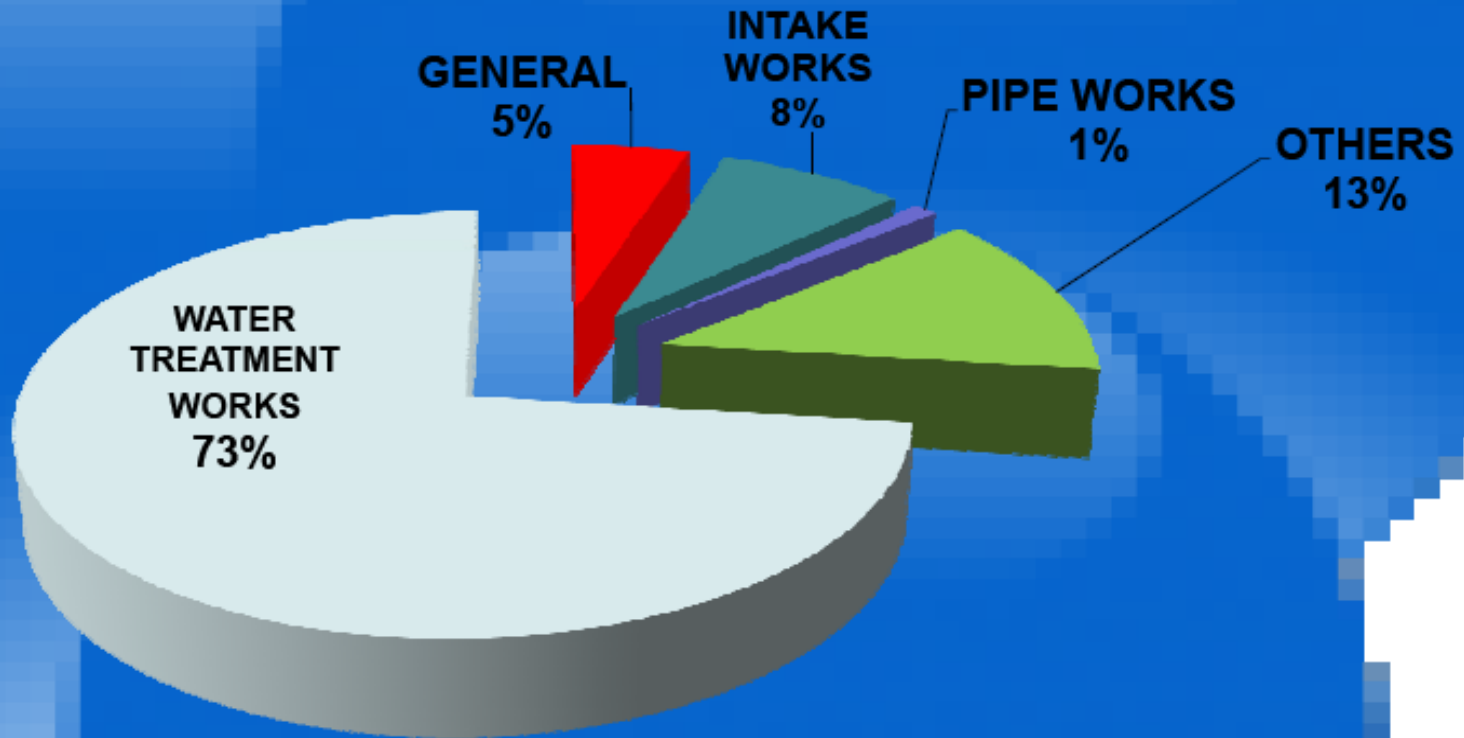
# Tubewell Distribution in KOTA BHARU



- The production of groundwater is 134 mld - 41% of total potable water supply (327 mld)
- The districts which are groundwater-dependant in potable water supply are:
  - Kota Bharu (95%)
  - Bachok (100%)
  - Tumpat (30%)

# LARGE SCALE – Public Water Supply

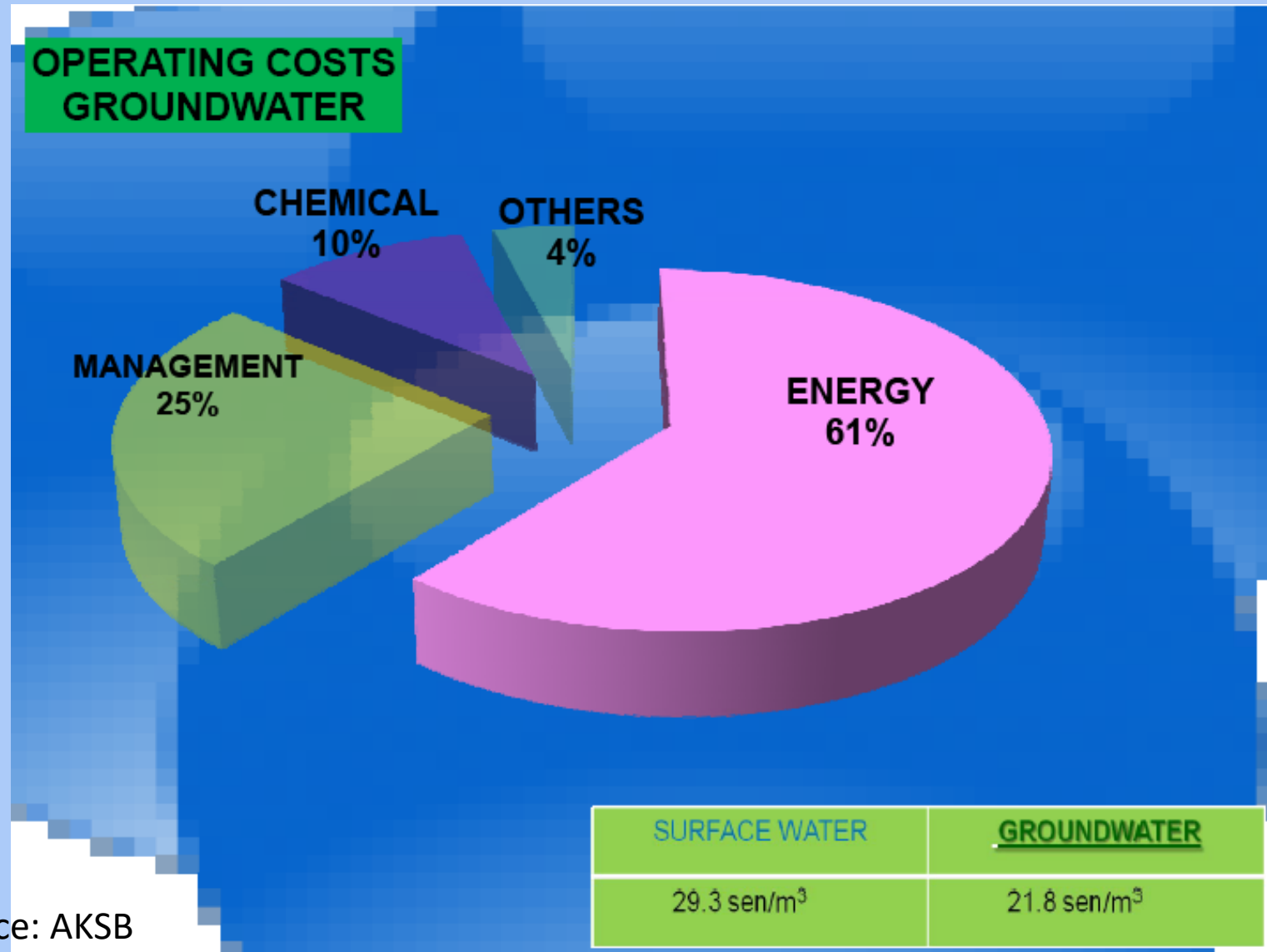
**CAPITAL COSTS  
GROUNDWATER**



<u>SURFACE WATER</u>	<u>GROUNDWATER</u>
2.73 RM/LD	2.65 RM/LD

Source: AKSB

# LARGE SCALE – Public Water Supply



Source: AKSB

# LARGE CAPACITY WELLS

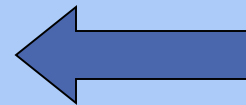


Opening ceremony by The Honourable Minister at the Dengkil groundwater scheme in Selangor

16 MLD well (Banting)



14 MLD well (Olak Lempit)



# TAPPING GROUNDWATER – Plenty of high quality water



LANGAT GROUNDWATER STUDY



PUTRAJAYA GROUNDWATER STUDY



# Groundwater Development for Agricultural Use

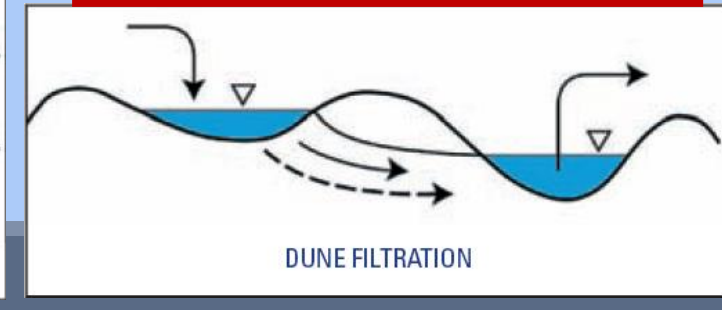
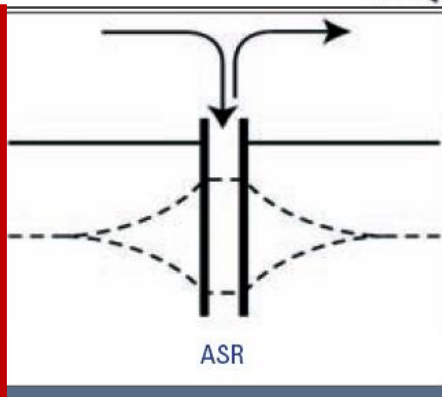
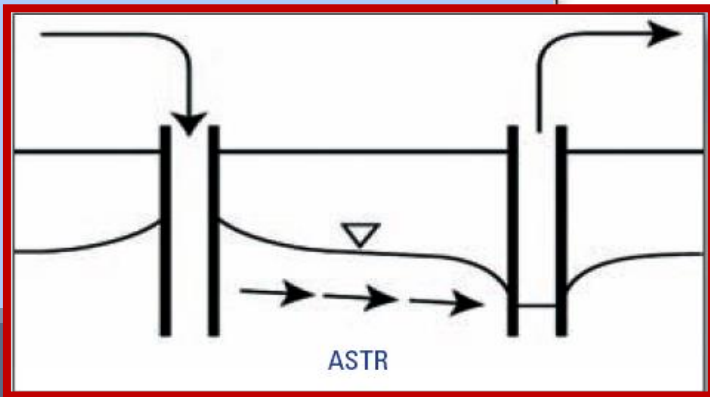
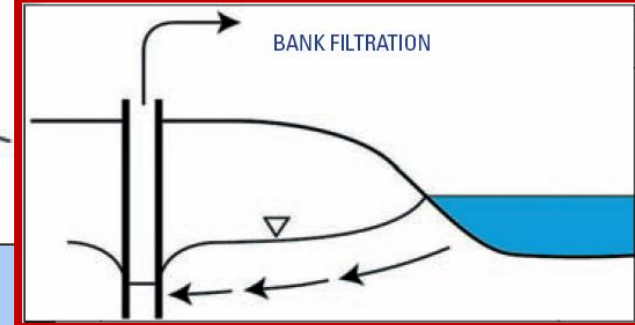
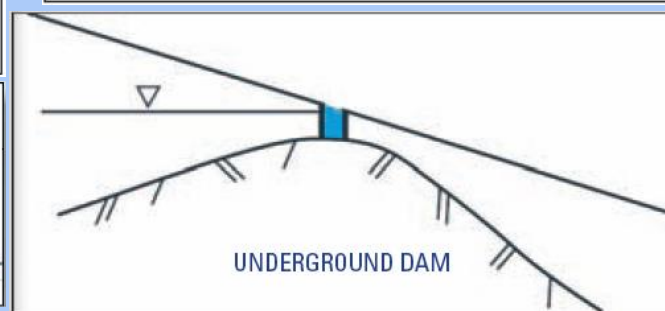
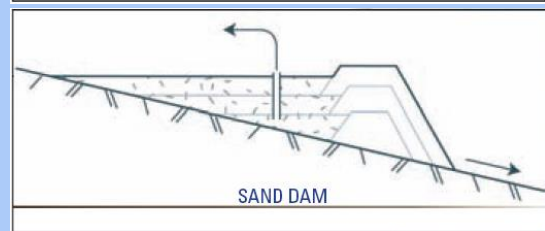
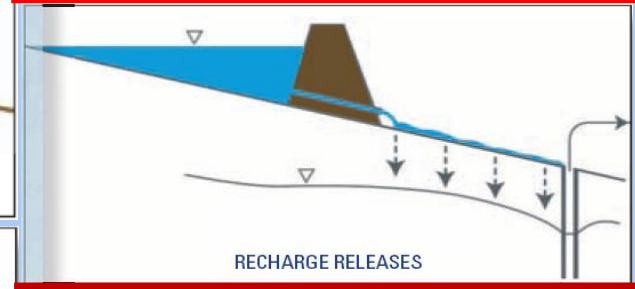
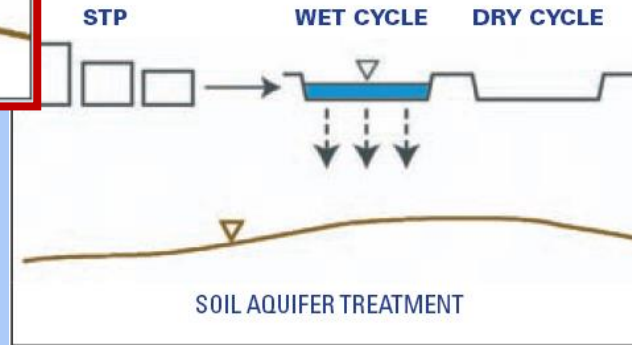
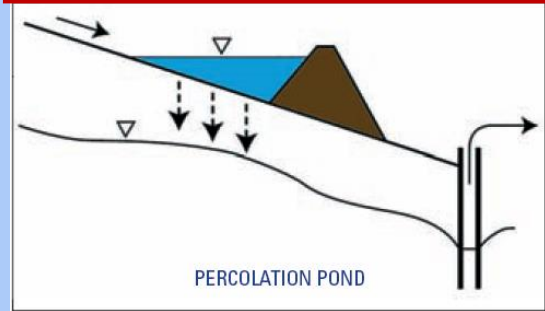
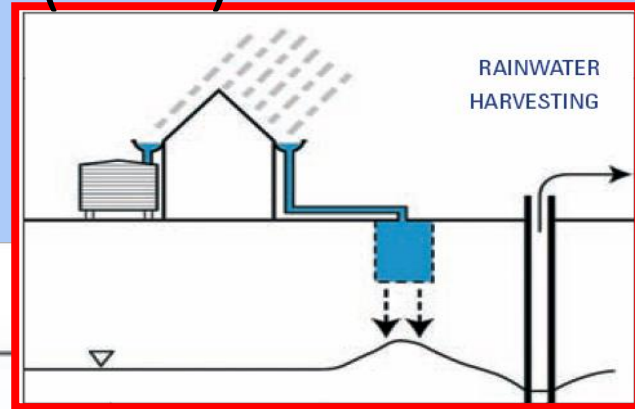
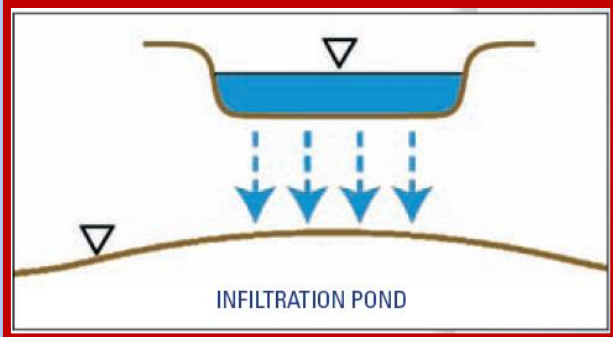


# TECHNOLOGY - Management of Aquifer Recharge (MAR)

## ***Making Better Use of Our Largest Reservoir***

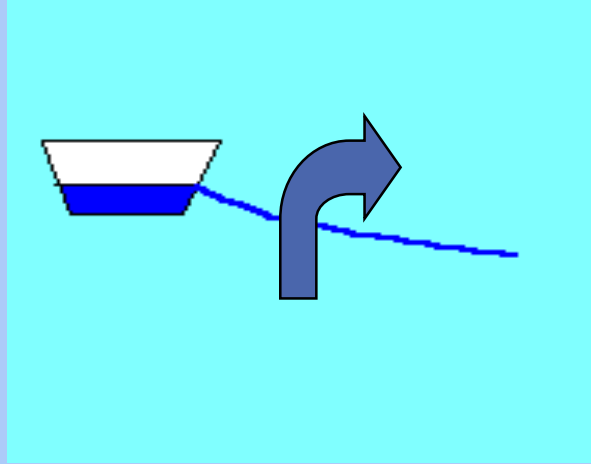
- ❑ Management of Aquifer Recharge (MAR) describes ***intentional storage and treatment of water in aquifers.***
- ❑ ‘Natural’ recharge to aquifers occurs through infiltration of precipitation, either directly to land or through the beds of streams and rivers.
- ❑ **Unintentional or incidental recharge** due to man’s activities also occurs as a result of the effects of land clearing, excess irrigation and leakage from water mains, sewers and storm drains. This water can form a major component of aquifer recharge and should be managed, both from the quantity and quality perspectives, and treated as a resource rather than a disposal problem.
- ❑ MAR has also been called **enhanced or augmented recharge**, water banking and sustainable underground storage.

# MANAGED AQUIFER RECHARGE (MAR)

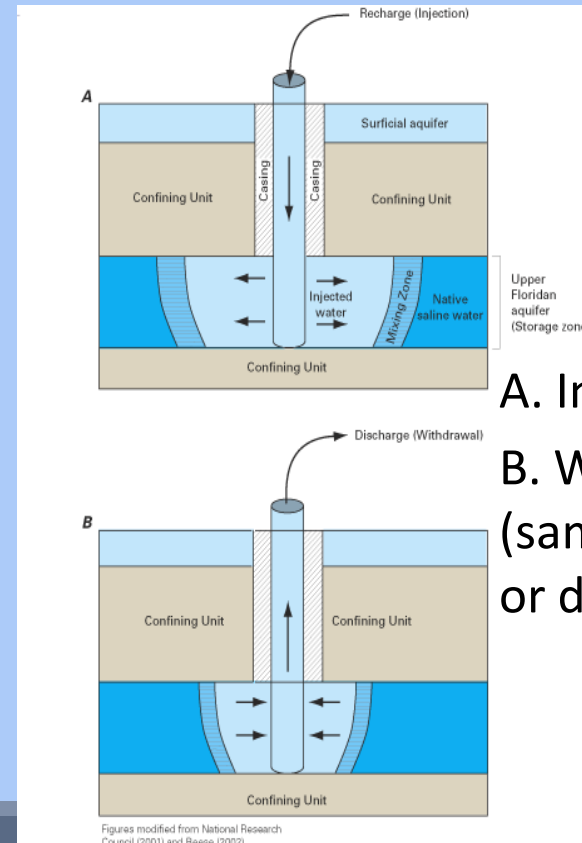
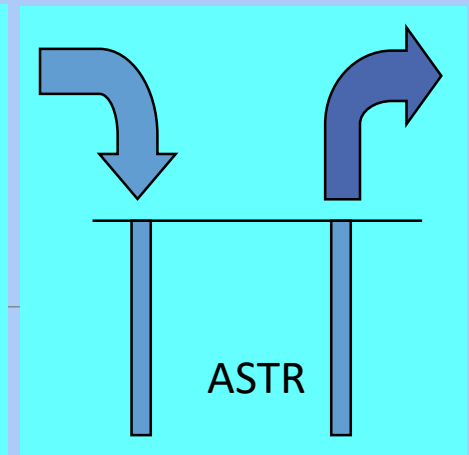
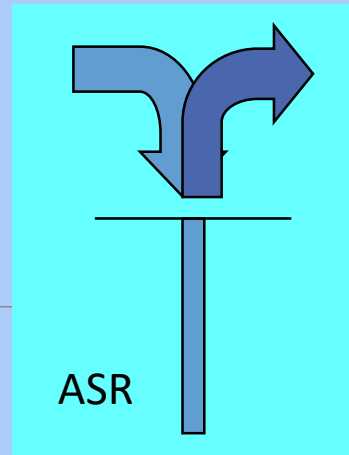
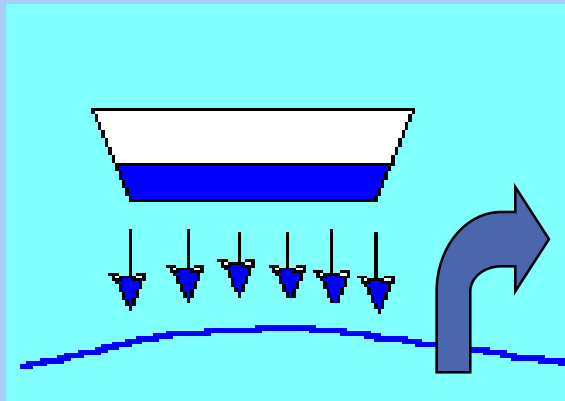


# MAR METHODS:

induced infiltration,  
bank filtration & river releases



pond infiltration,  
percolation tanks,  
soil aquifer treatment



A. Injection  
B. Withdrawal  
(same location or downstream)

# BANK INFILTRATION



Perak muncul negeri perintis di Malaysia memperkenalkan teknologi baru dikenali Sistem Penapisan Tebing Sungai (RBF)



River infiltration system at Water Intake Loji Air Jeli



Large Diameter Collector with radial well

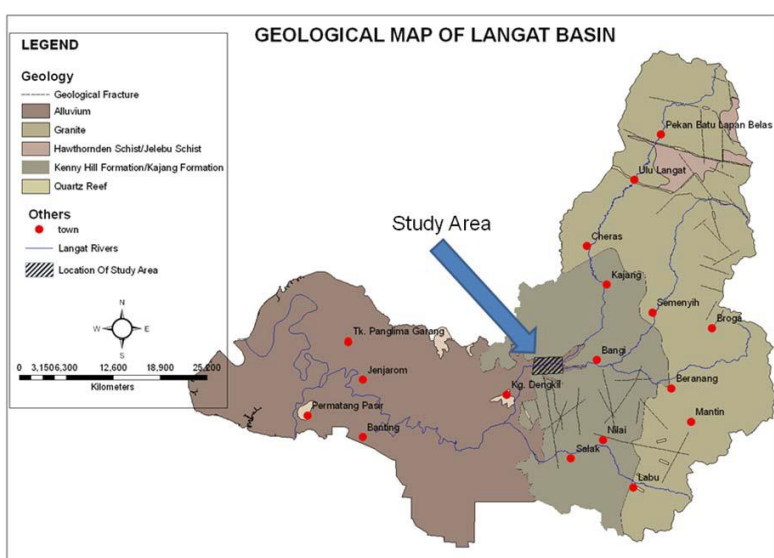
Courtesy: MajuPerak



Courtesy: AKSB

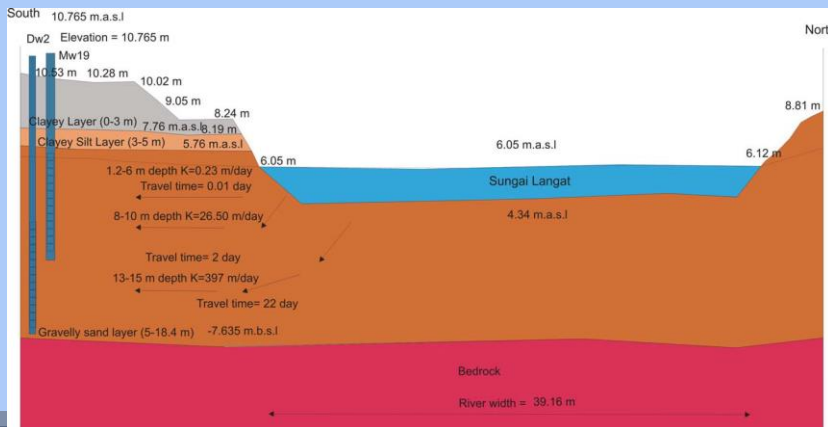
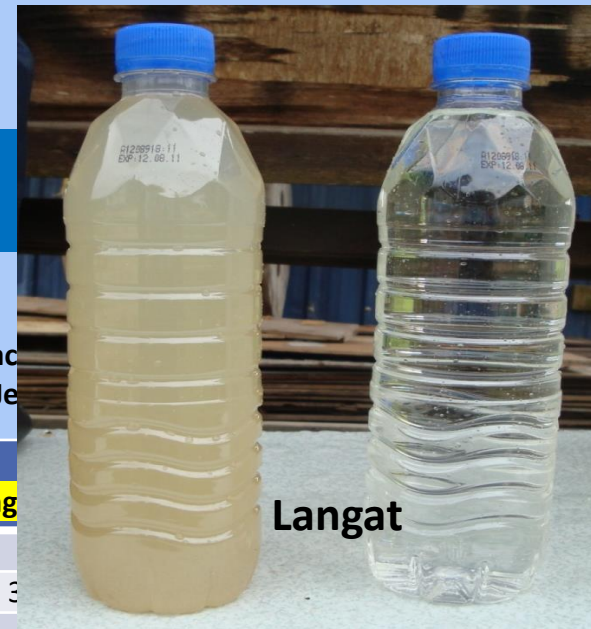
# R&D IN BANK INFILTRATION

## STUDY ON GROUNDWATER OPTIMISATION IN JENDERAM HILIR, DENGKIL, SELANGOR



Groundwater and surface

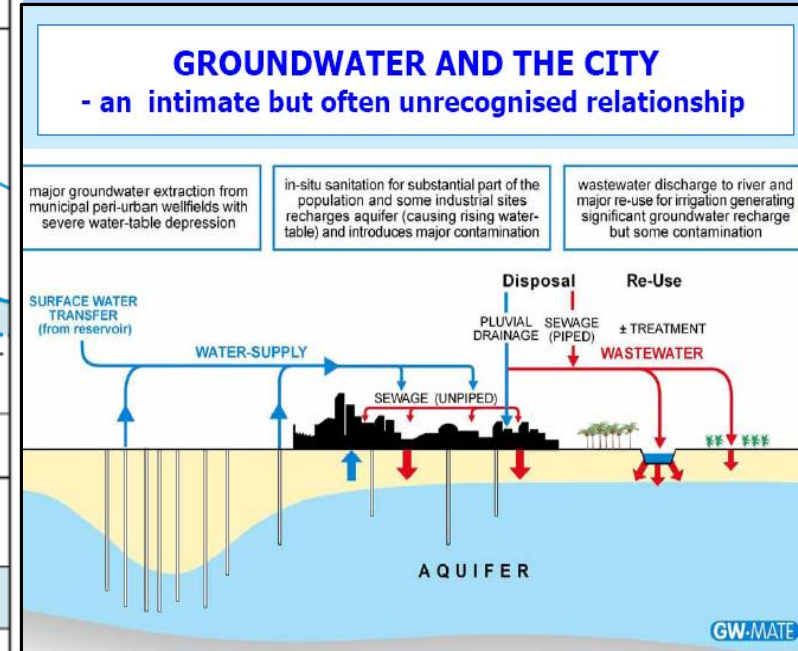
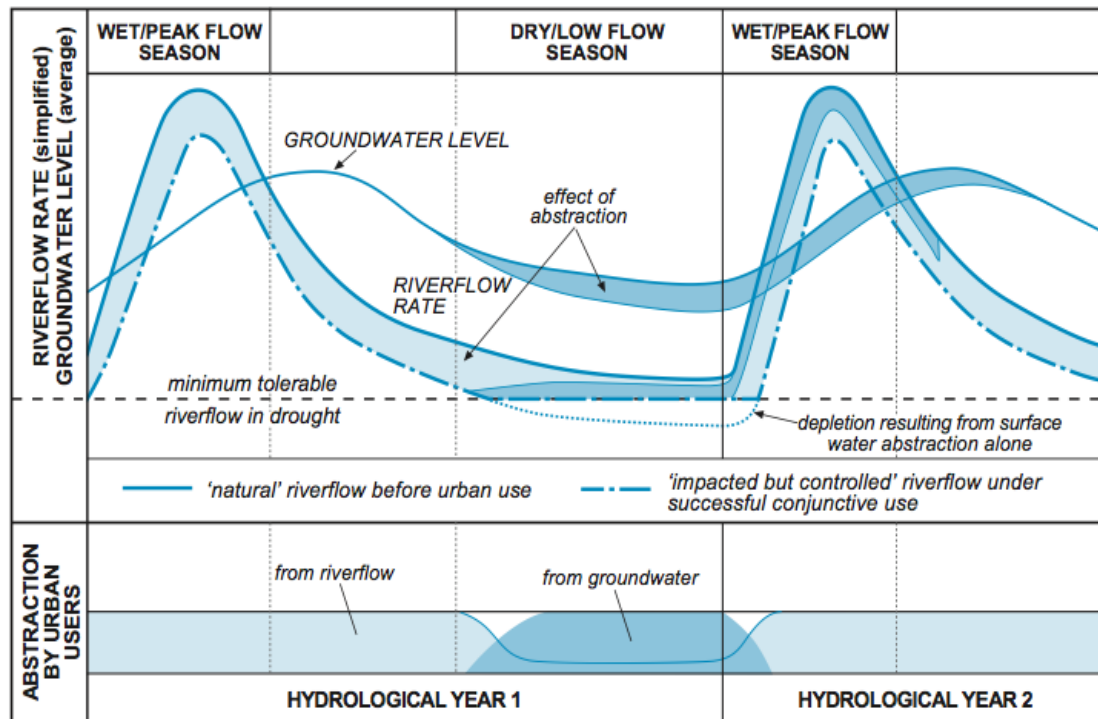
Parameter	Sungai	Langat
pH		
Turbidity (NTU)	3	
Total Solid, mg/l	370	140
Conductivity $\mu\text{S}/\text{cm}$	211	04
$\text{SO}_4$ , mg/l		
Cl, mg/l		
$\text{NO}_3$ , mg/l		
Ca, mg/l		
Total Coliform MPN/100ml		
E, coli MPN/100ml		



1. Based on pumping much as  $128 \text{ m}^3/\text{hr}$  m
2. The study has show sulphate and nitrate filtration systems o



# CONJUNCTIVE USE OF SURFACE AND GROUNDWATER



- Conjunctive use is the **coordinated management** of surface and groundwater resources, taking advantage of their complementary properties.
- Both surface and groundwater storage are used to **redistribute water in time to match supply and demands**.

# Policies

**Policy 1: Holistic Approach**

**Policy 2: Sustainable Development**

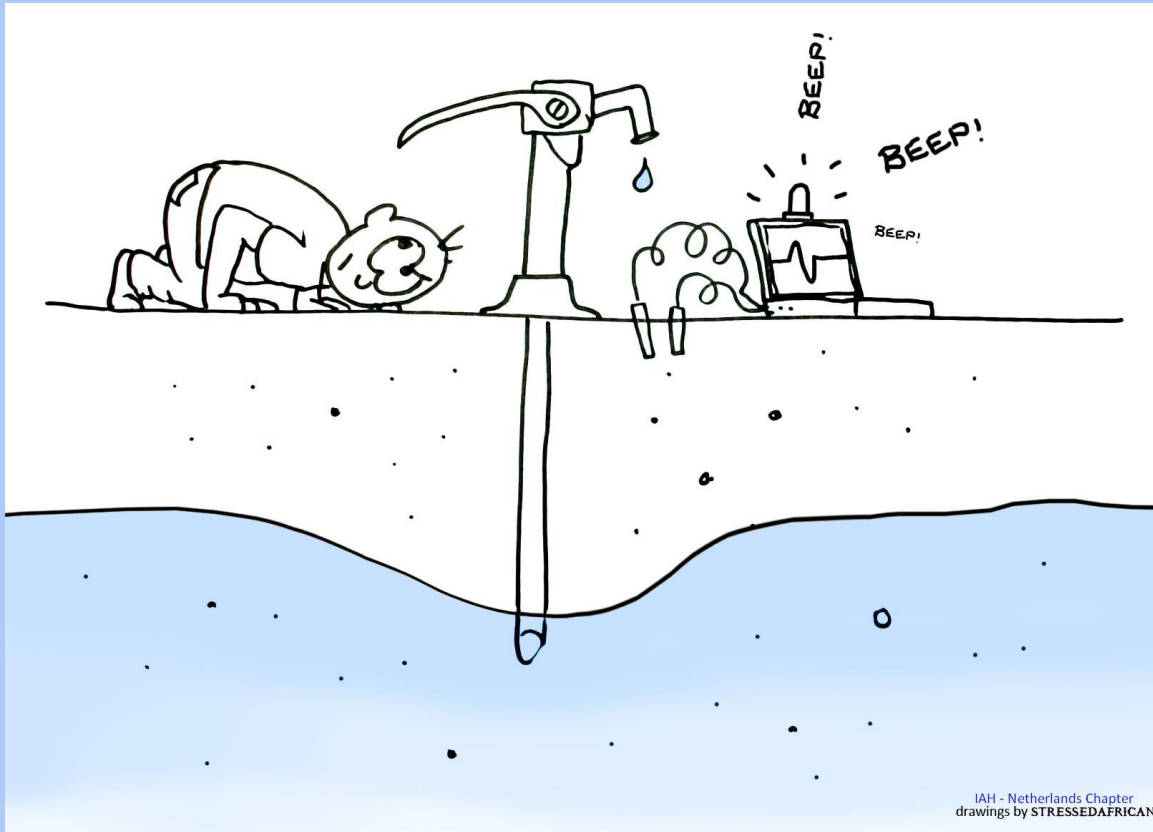
**Policy 3: Legislation on protection and over-abstraction of groundwater**

**Policy 4: Jurisdictional streamlining**

**Policy 5: Promote investment**







## Outline

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1. Groundwater – Overview
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3. **Future in Groundwater Development**
4. The Way Forward

# FUTURE OF GROUNDWATER IN MALAYSIA

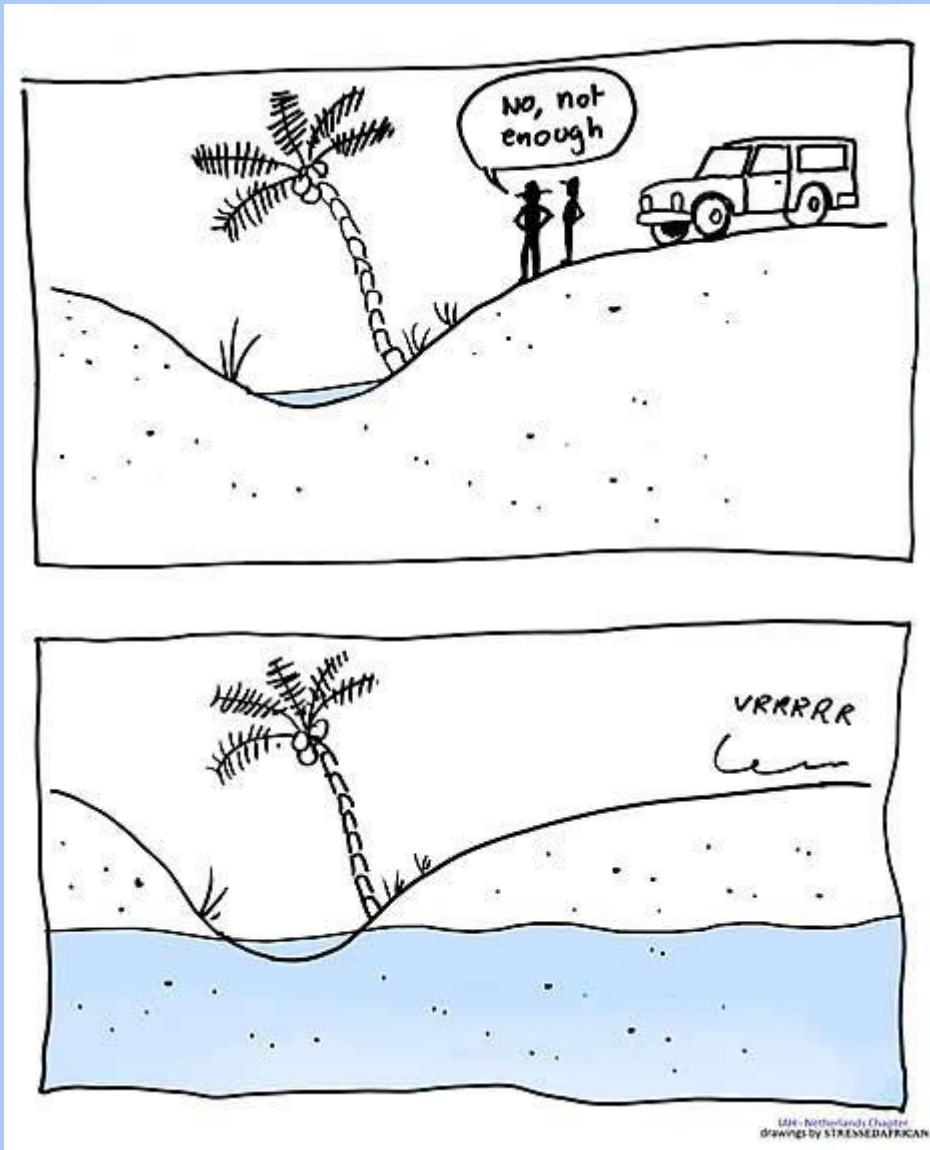
## Time for a Paradigm Shift?



- Groundwater first - *paradigm shift* from utilising man-made water storages to **utilising natural water storages**
- Focus on viable **decentralised projects** – *paradigm shift* from spending million RM on one project to spending million RM on many projects

# FUTURE OF GROUNDWATER IN MALAYSIA

1. **Groundwater as the only option** - alternative to surface water
  - ✓ Technically feasible,
  - ✓ Economically viable – less capital-intensive to develop and run,
  - ✓ Quality is good
  - ✓ Environmentally sustainable
  - ✓ Accessible to a large number of users, and
  - ✓ Provide individual supplies
2. **Conjunctive use** - as collective source to increase **water security**
3. *Avoid crisis driven* – developed only during emergency or period of drought
4. Offers better insurance against drought – as a tool for **climate change adaptation**
  - ✓ To improve water management in changing climate
  - ✓ Use of management of aquifer recharge (MAR)



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## Outline

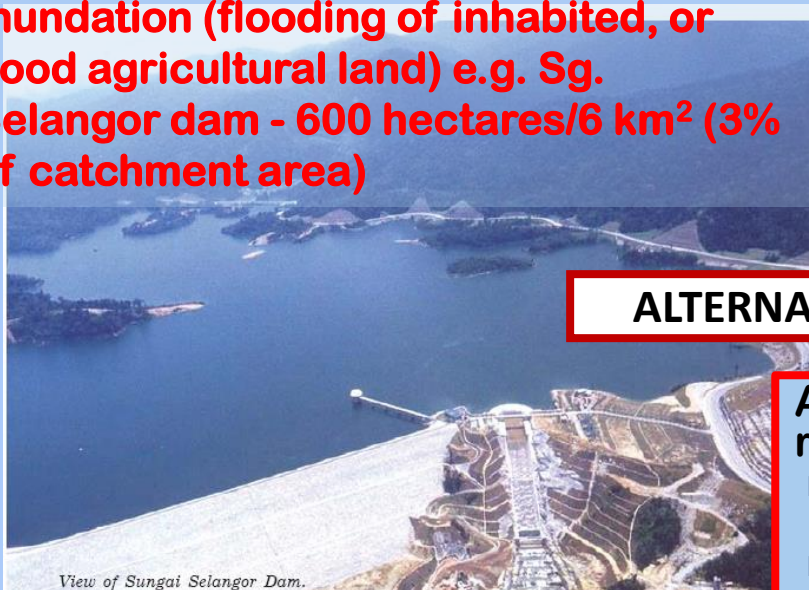
1. Groundwater – Overview
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# Averting water crisis in densely populated Malaysian states

There is a water crisis looming in the developed west coast states of Malaysia. Among the solutions put forward are water-transfer through tunnel and tapping of groundwater.

Corporate conglomerate Sime Darby Berhad and government linked entity Khazanah Berhad are said to be working on the plan to drill 3.5km underground in the Batang Padang

**Inundation (flooding of inhabited, or good agricultural land) e.g. Sg. Selangor dam - 600 hectares/6 km<sup>2</sup> (3% of catchment area)**



View of Sungai Selangor Dam.

- Dams are extremely **expensive** to build
- The **flooding** of large areas of land means that the natural environment is destroyed
- **Displaced people** living in villages and towns that are in the valley to be flooded.

ALTERNATIVELY



**Small foot print; better water quality; local**

**Advantages of groundwater over surface water resource:**

- ❑ Its supplies are not subjected to abrupt change as a result of abnormal weather
- ❑ Cheaper to develop: unpolluted, no or less treatment before use and developed stage by stage
- ❑ Can often be tapped near to where it is needed,
- ❑ Does not require large impounding area, and
- ❑ **Increase water security – as supplementary/only source or conjunctive use**

**SOMETIMES YOU ARE STANDING ON A SOLUTION WITHOUT KNOWING IT**

**Avoid Crisis Driven Groundwater Development**



**THANK YOU**