RAINWATER HARVESTING (RWH) AS A GREEN BUILDING DESIGN IN ADDRESSING CLIMATE CHANGE IN TERMS OF TEMPERATURE, FLOOD AND DROUGHT CONTROL

By

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NATURAL RESOURCES:

WATER EFFICIENCY FOR SUSTAINABLE LIVING

GBI, MBOT, LAM, BEM CPD POINTS APPLIED

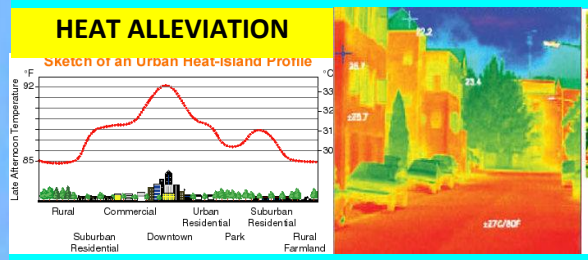
HRDF CLAIMABLE

POND RAINFALL HARVESTING SYSTEM IN SUSTAINABLE URBAN DRAINAGE SYSTEM

WETLANDS AS A NATURAL SYSTEM FOR FLOOD CONTROL

WETLANDS AS GREENLUNGS FOR TEMPERATURE CONTROL

HEAT ALLEVIATION



RAIN HARVESTING PONDS FOR DROUGHT ALLEVIATION

Outline of Talk

1. Introduction to Climate Change:
(i) Global (ii) Malaysia
2. Objectives of Rainwater Harvesting
3. Methodology
4. Results & Discussion:
(i) Flood Alleviation
(ii) Drought Control
(iii) Reduction of Urban Heat Island
5. Conclusion

1. Introduction to Climate Change (Global)

CLIMATE CHANGE IS REAL & HAPPENING NOW!!!

UNIVERSITI SAINS MALAYSIA

CLIMATE CHANGE IS NO LONGER SOMETHING IN THE DISTANT FUTURE. IT IS UPON US NOW & THERE IS NO ESCAPE.

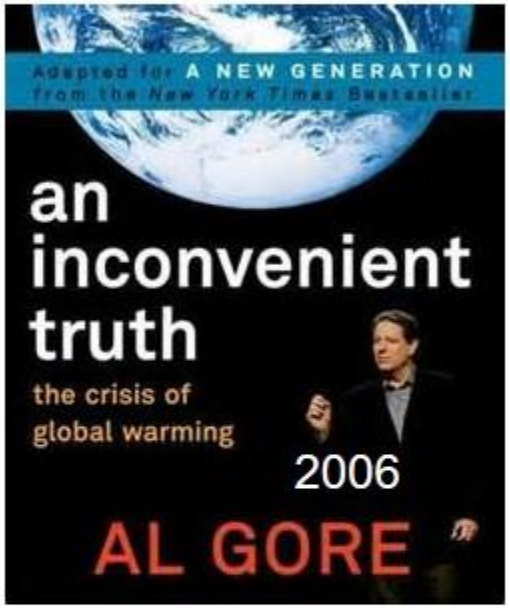
WARNINGS FROM THE NOT TOO DISTANT PAST

I want to testify today about what I believe is a **planetary emergency - a crisis that threatens the survival of our civilization** and the habitability of the Earth.

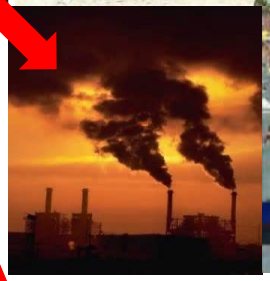
Al Gore

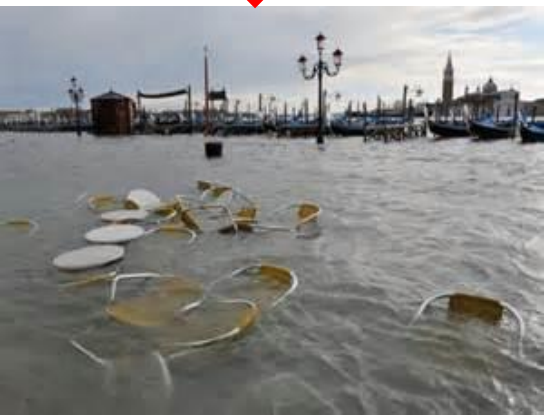
Testifying on impact of global warming before US congress.

Jan 27, 2009



WARNINGS FROM THE NOT TOO DISTANT PAST



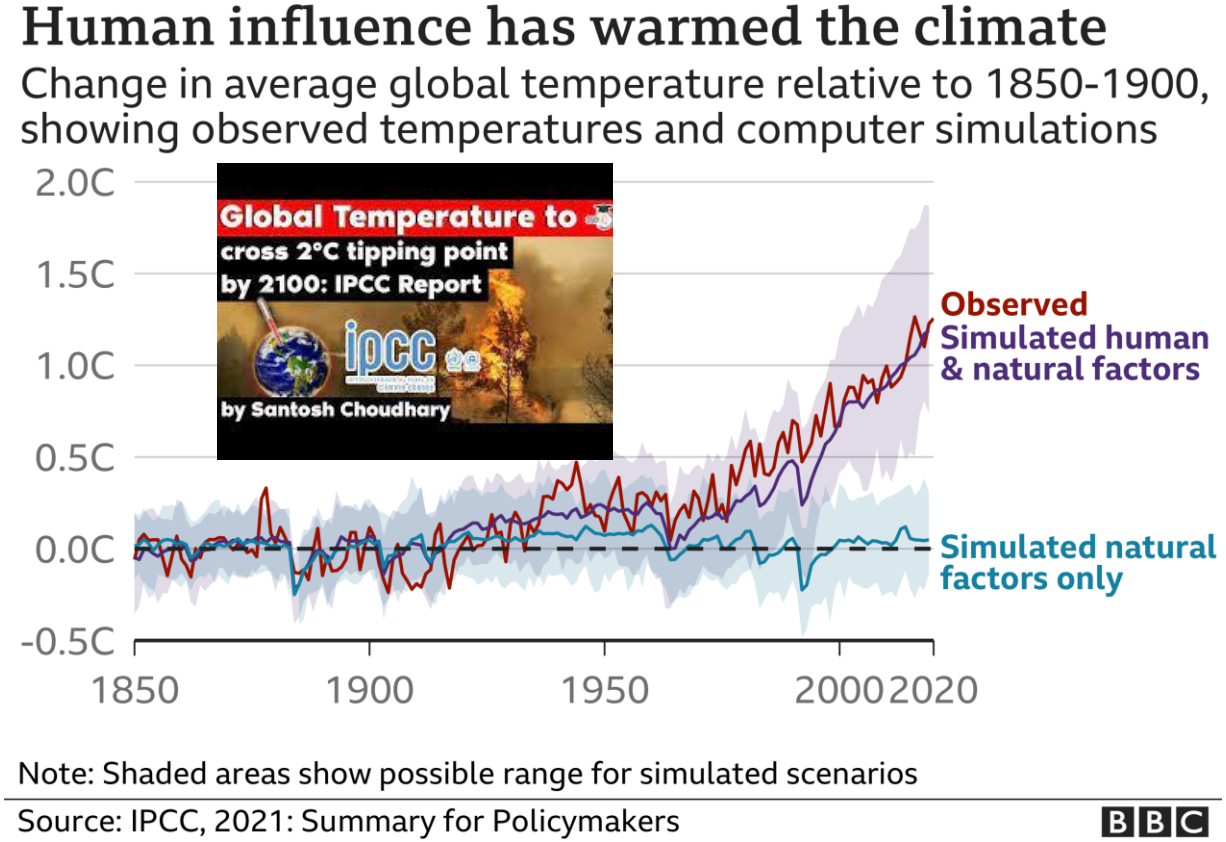


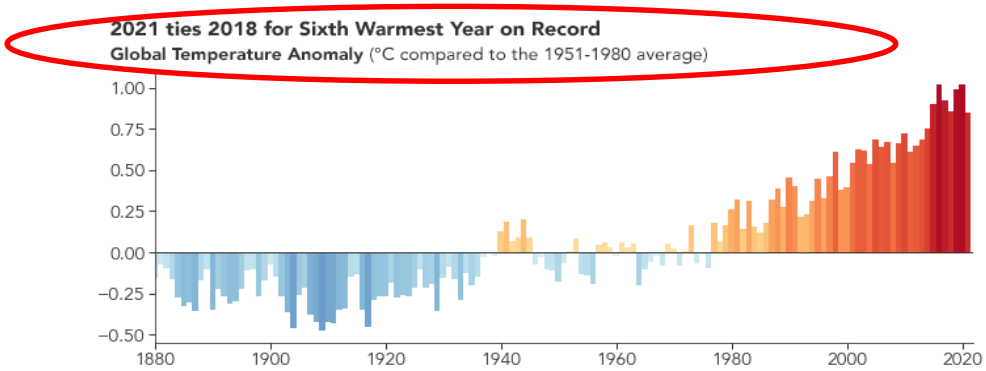
The danger posed by war to all of humanity - and to our planet - is at least matched by **the climate crisis and global warming**. I believe that the world has reached a critical stage in its efforts to exercise responsible environmental stewardship. **UN Secretary General Ban Ki-moon** (Mar 1, 2007)

WARNINGS FROM THE CLIMATE SYSTEM

Warming of the climate system

- Increasing in global average air and ocean temperatures
- Rising global average sea level
- Reductions of snow and ice





Malaysia Climate Change Scenarios

MALAYSIA SCENARIO

Authors:
Yap Kok Seng[1], Wan Azli Wan Hassan[1], Fredolin Tangang[2], Liew Juneng[2], Mohan Kumar Sammathuria[1] & Kumarenthiran Subramaniam[1]

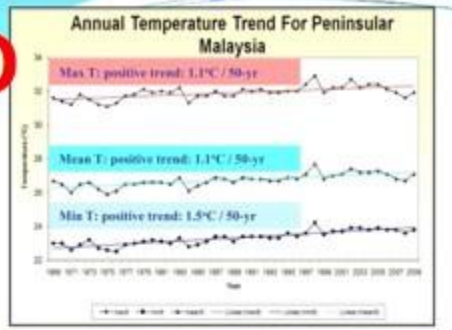
[1] Malaysian Meteorological Department
[2] Research Centre for Tropical Climate Change System (IKLIM), Faculty of Science and Technology, Universiti Kebangsaan Malaysia

2. Observed Trend of Climate Change & Climate Variability over Malaysia

2.1 Long Term Climate Change Over Malaysia

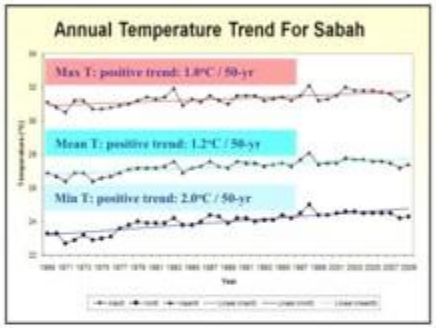
Both Observed & Modelled (Projected) temperatures are increasing.

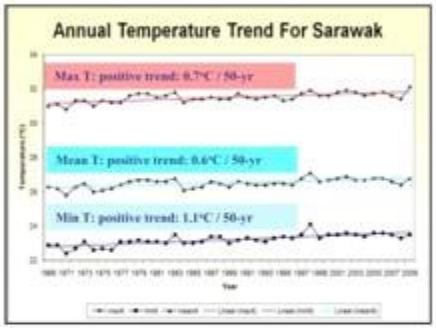
Monitoring Climate Change: Temperature trends



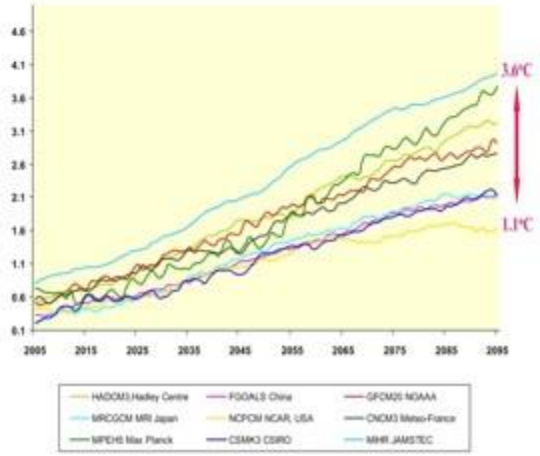
- 31 out of 36 Meteorological Stations recorded highest maximum temperature during 1990s and after
- Maximum temp. increased: 0.7 – 1.1°C
- Mean temp. increased: 0.6 – 1.2°C
- Minimum temp. increased: 1.1 – 2.0°C

per half century

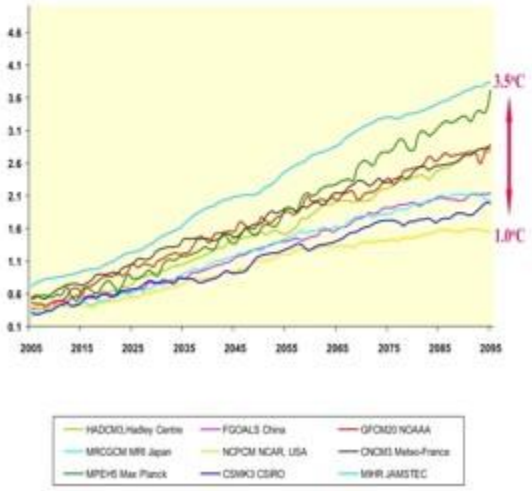




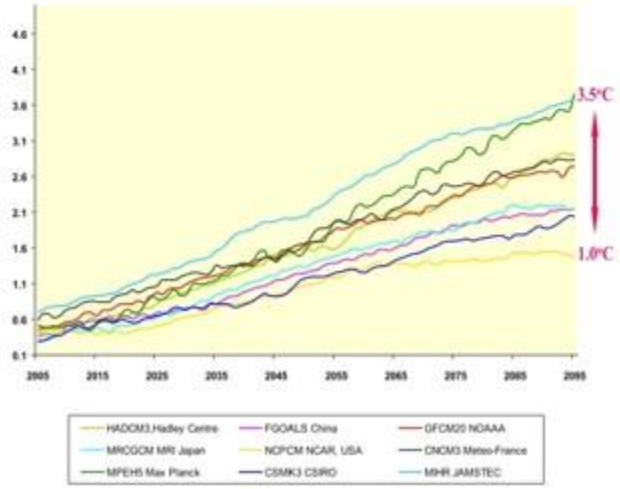
Projected Temperature Changes Relative to the Baseline (1961-1990) for **Peninsular Malaysia** from Nine GCMs, Based on SRES A1B

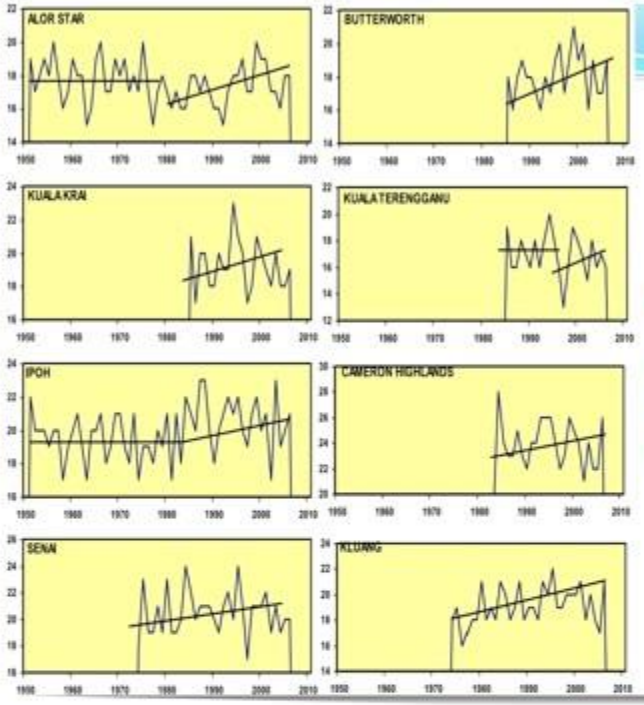


Projected Temperature Changes Relative to the Baseline (1961-1990) for **Sabah** from Nine GCMs, Based on SRES A1B



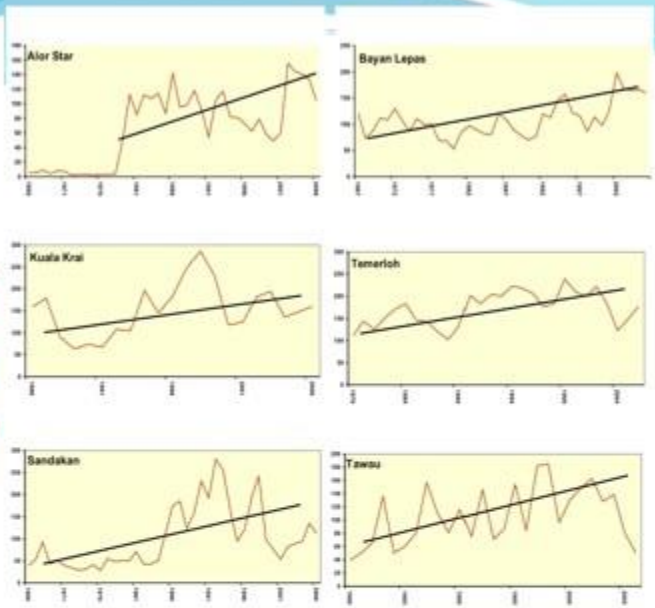
Projected Temperature Changes Relative to the Baseline (1961-1990) for **Sarawak** from Nine GCMs, Based on SRES A1B





Historical Data From MMD's Stations

Since ~1980s: Increasing number of days of extreme rainfall event (exceeding 90th percentile of total rainfall) for several stations over the Peninsular Malaysia



Increasing number of days of extreme wind events (exceeding 90th percentile of the most frequent wind speed in a year) in some parts of Malaysia

November 05, 2017

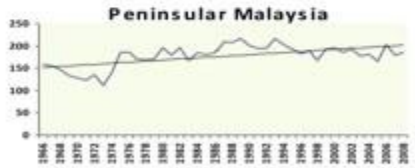
At Least 3 Dead in Malaysia as Severe Storm Forces Thousands to Evacuate

August 10, 2019

Malaysia lashed by storm, causing havoc in Penang, Kedah, Perlis

TERPORTH, ALOR SETAR (THE STAR/ASIA NEWS NETWORK) - Parts of

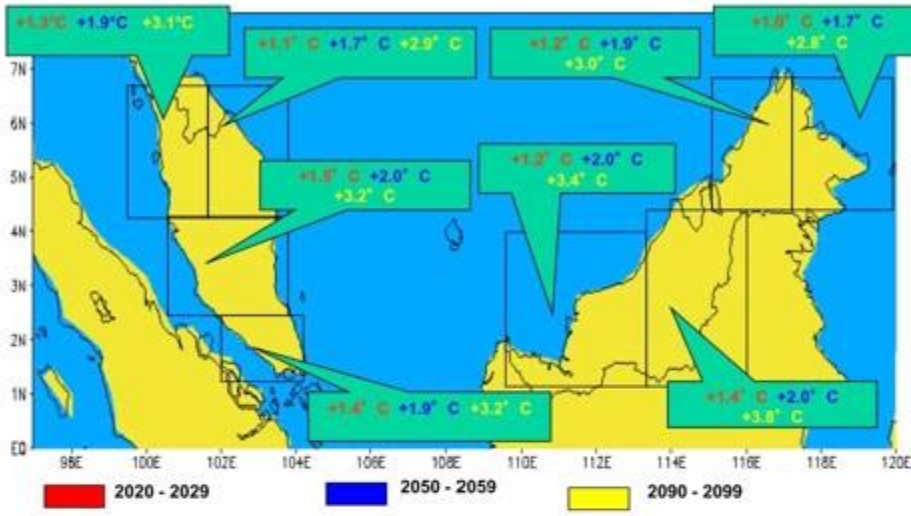
AVERAGE NUMBER OF THUNDERSTORM DAYS



OVERALL MALAYSIAN SCENARIO

- Observed increase in **minimum**, **mean** & **maximum** surface temperature trend for Malaysia,
- **Larger increase** in **minimum** surface temperature compared to mean & maximum surface temperature. Highest increase of minimum temperature at a rate of 2.0°C/50-yr for Sabah, 1.5°C/50-yr for Pen. Malaysia and 1.1°C/50-yr for Sarawak.
- Overall, no evident of increase or decrease has been observed for rainfall in Malaysia, but:
  - increase number of days of **extreme** rainfall events
  - increase number of days of **extreme** wind events
  - increase in number of thunderstorm days

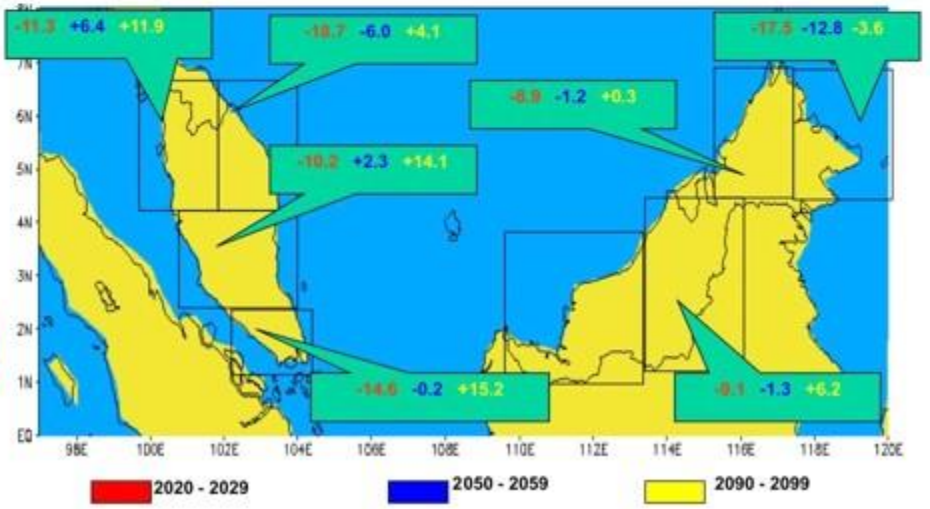
Annual Mean Temperature Anomaly Relative to 1990 - 1999



Implications (3 Things we need to Adapt to):

1. It's getting hotter and hotter (Heat Waves)
2. It's getting drier between 2020-2029 – Droughts & Water Crises)
3. Increase in Storms & Extreme Rainfall (Floods).

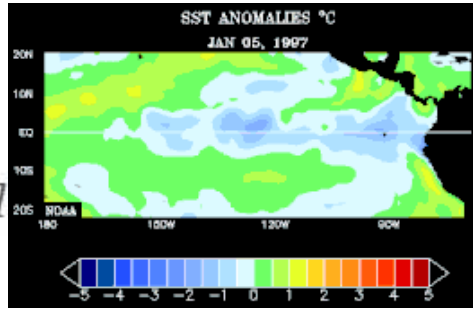
Annual Mean Rainfall Anomaly (%) Relative to 1990 – 1999

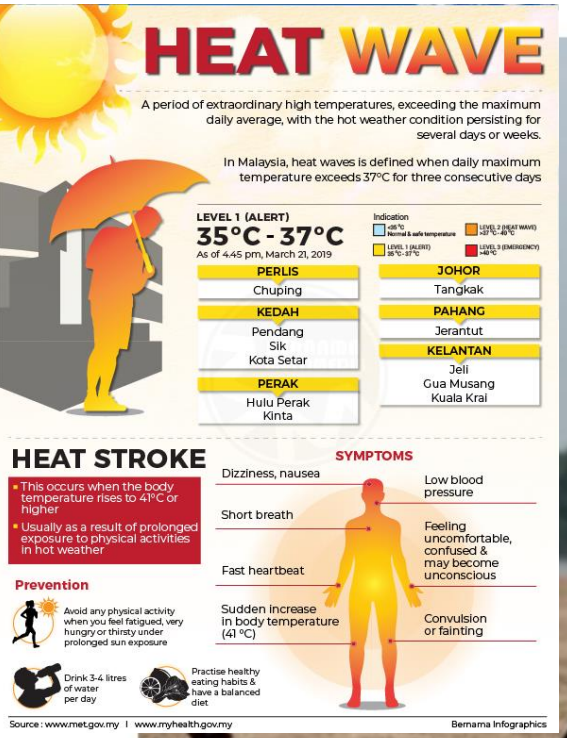


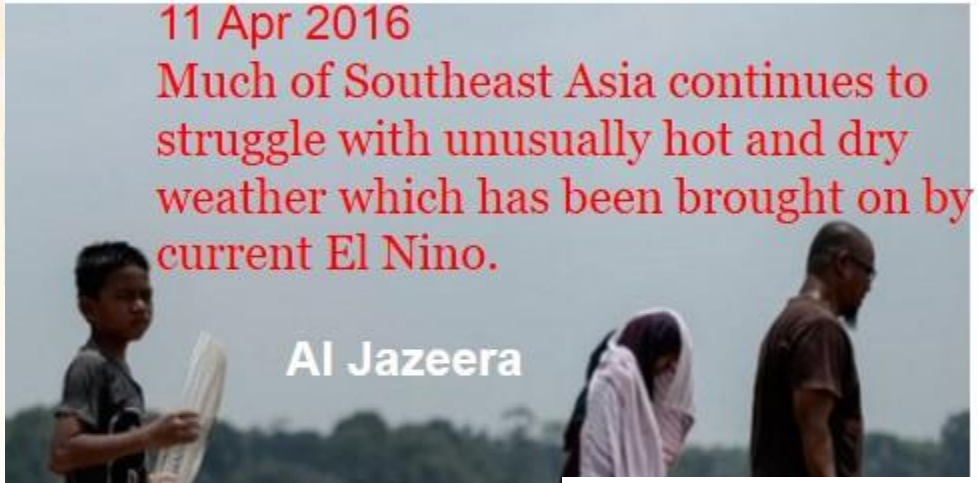
News | Climate Crisis

Severe heatwave grips Malaysia

Intense spell of hot and dry weather brought on by El Nino hits food and water supplies across parts of SE Asia.







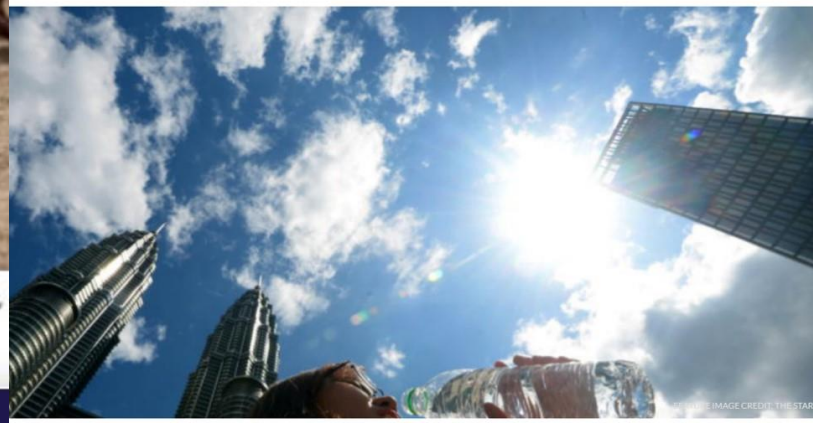
The Pahang River runs dry and schools remain closed due to the heatwave in Temerloh, /AFP]

LOCAL NEWS

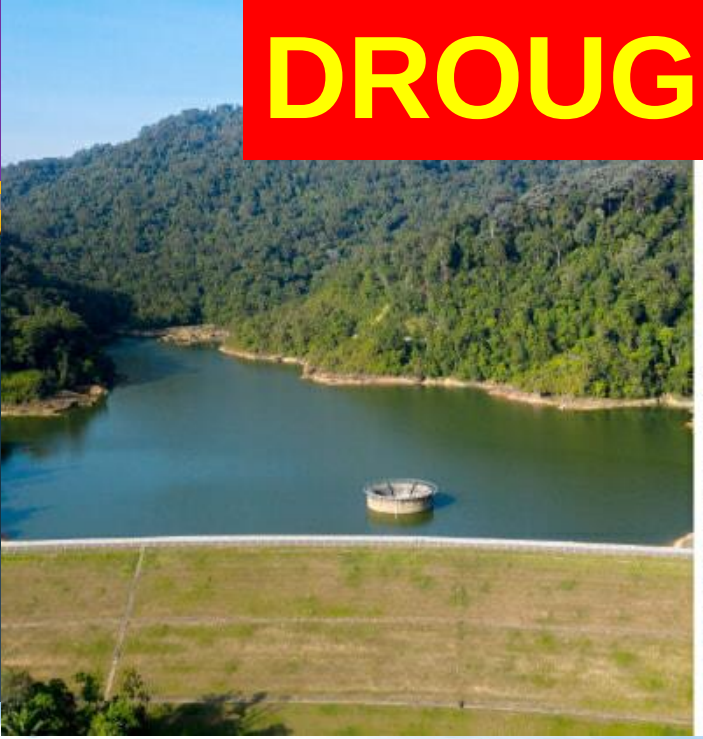
Expect Klang Valley Heat Wave to Linger Until June

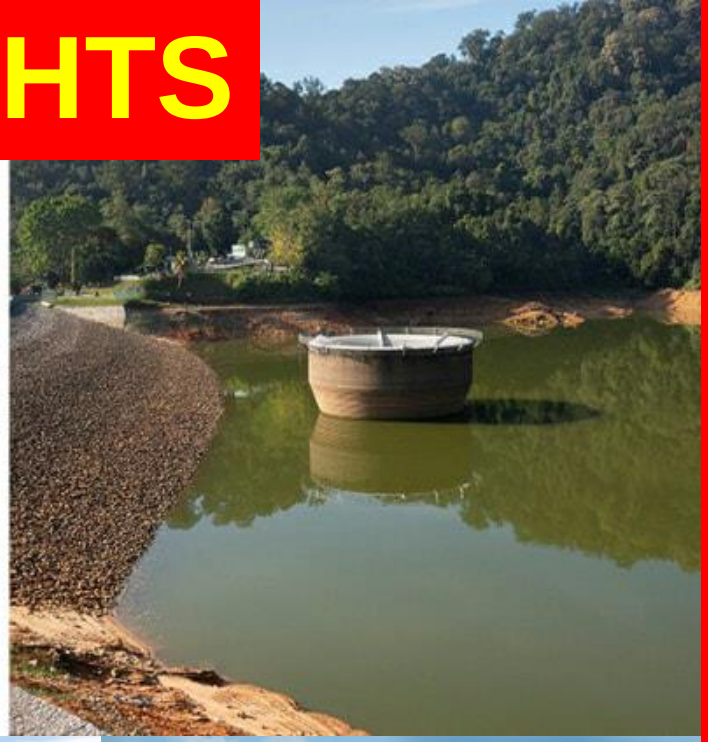
By Priscilla Emmanuel

Posted on March 31, 2022



DROUGHTS





The effective capacity of the Ayer Itam and Teluk Bahang dams yesterday dropped to 45.7% and 28.6% respectively (April 3, 2022).

Muda Lake at critical level

The Star, Saturday, 15 Feb 2020

Muda Dam's capacity was at 7.44% as of 14 Feb 2020

Penang dams in need of rainfall
The Star, 03 Mar 2020

2. Objectives of Rainwater Harvesting

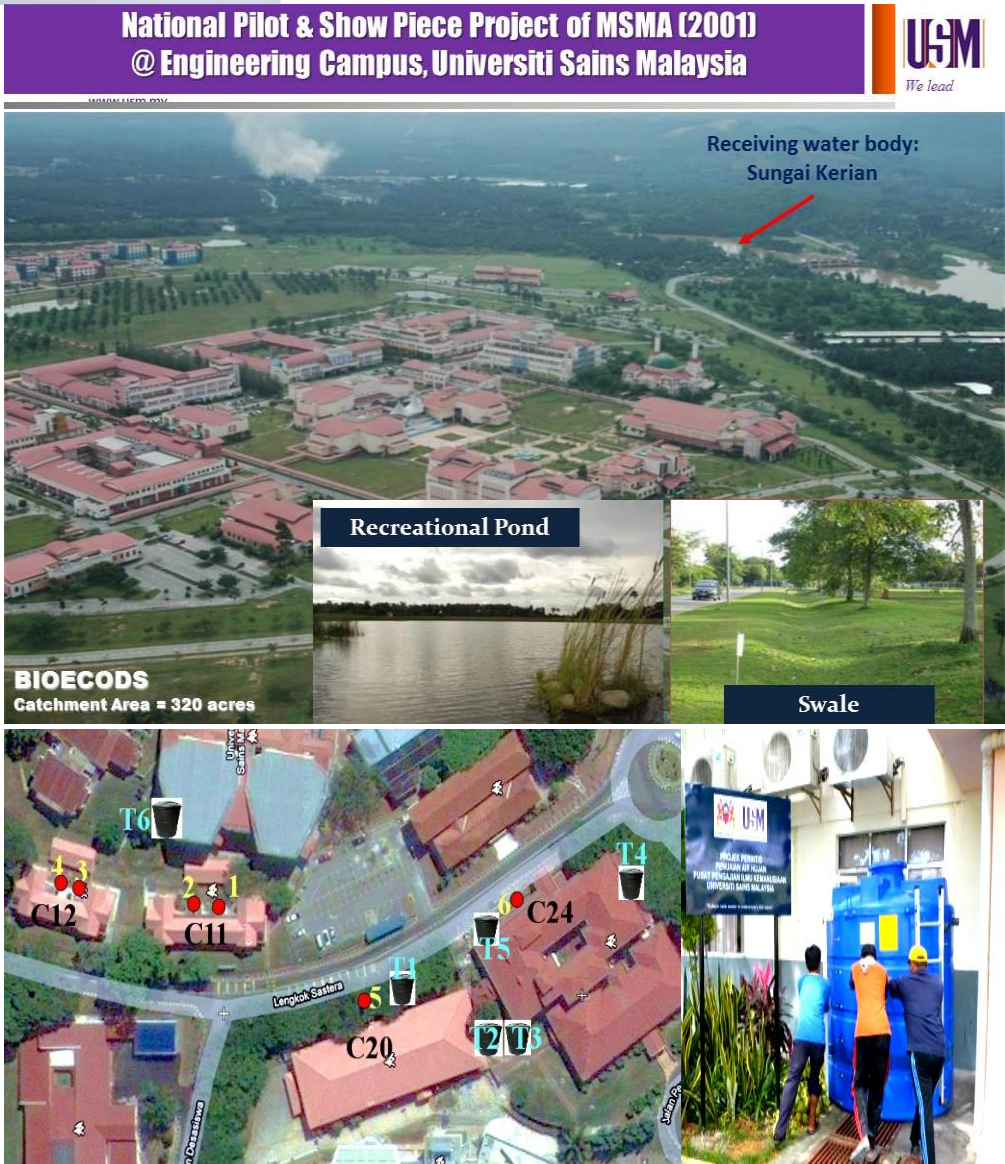
(a) TO EXAMINE THE VIABILITY OF POND RAINFALL (SUSTAINABLE URBAN DRAINAGE) AS A 3-IN-1 MEASURE OF ADAPTING TO CLIMATE CHANGE EFFECTS OF:

(i) FLOODS

(ii) DROUGHTS &

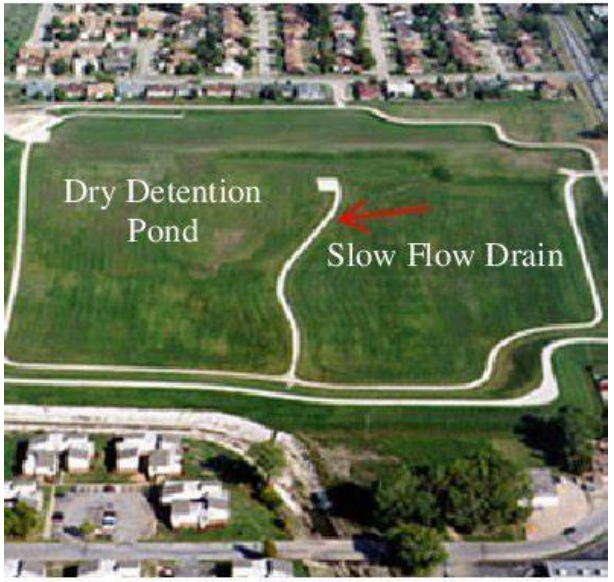
(iii) TEMPERATURE/HEAT

(b) TO EXAMINE THE VIABILITY OF ROOFTOP RAINFALL HARVESTING AS A GREEN BUILDING DESIGN FOR CLIMATE CHANGE ADAPTATION



3. Methodology

(1) Research & Consultancy results spanning >40 years in academia
(2) Literature Review on Rainwater Harvesting & Sustainable Urban Drainage
(3) Results from Best Management & Demonstration Projects
(4) Literature Review on Urban Heat Islands & Evaluation of Sustainable Urban Drainage System on Heat Reduction



RAINFALL HARVESTING SYSTEM IN SCHOOL OF HUMANITIES, UNIVERSITI SAINS MALAYSIA

Project Leader: Prof Chan Ngai Weng
nwchan@usm.my

JIMAT AIR
THE N-PARK RAINFALL HARVESTING PROJECT (Federal Government Funding)

National Pilot & Show Piece Project of MSMA (2001)
@ Engineering Campus, Universiti Sains Malaysia

4. Results & Discussion:(i) Flood Alleviation

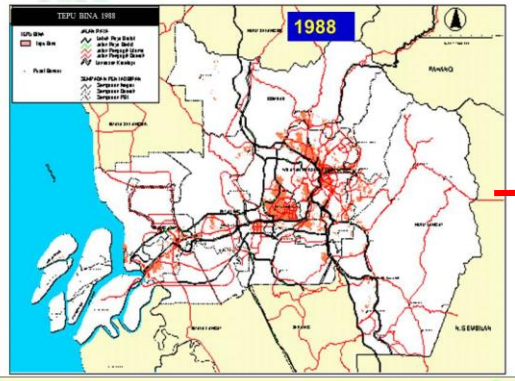
Pond Rainfall Harvesting (e.g. Universiti Sains Malaysia's Bio-ecological Drainage Systems) in Stormwater Management and Flood Control

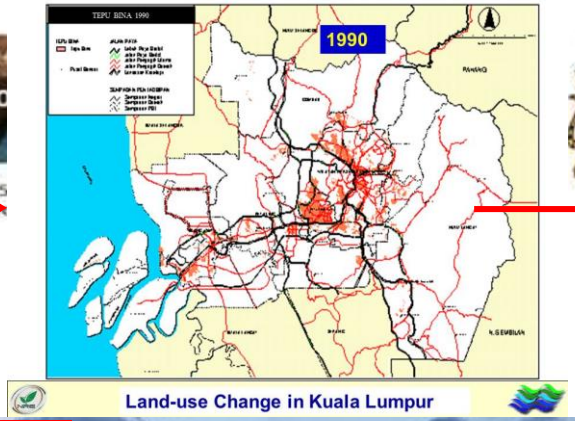

a) Before storm event - as football field

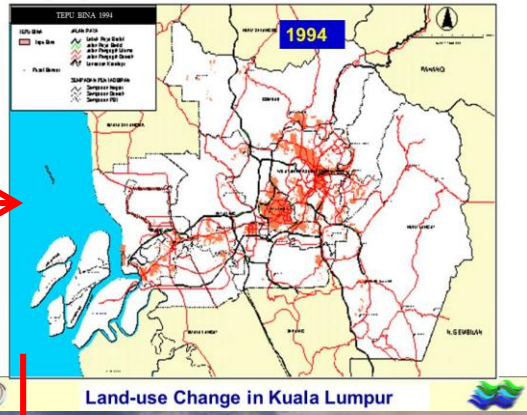

b) After storm event – as temporary water pond

COMPOSITE SWALES – GREEN, BEAUTIFUL & SAFE

Engineered Channel – Beautiful Landscape & Functional

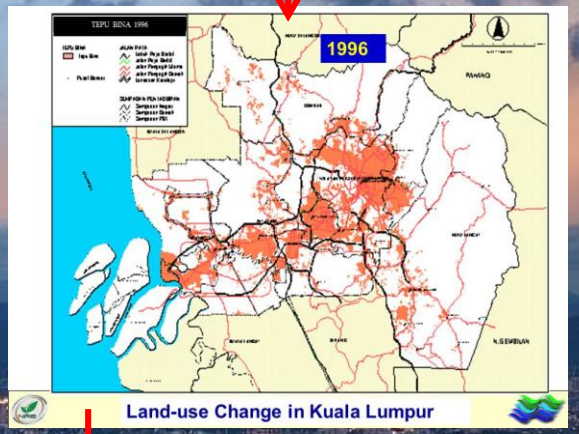


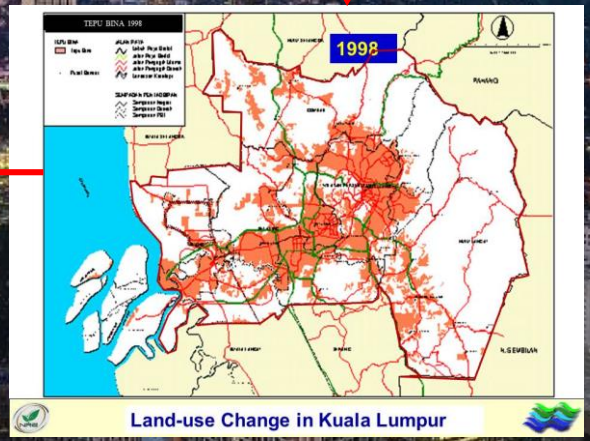


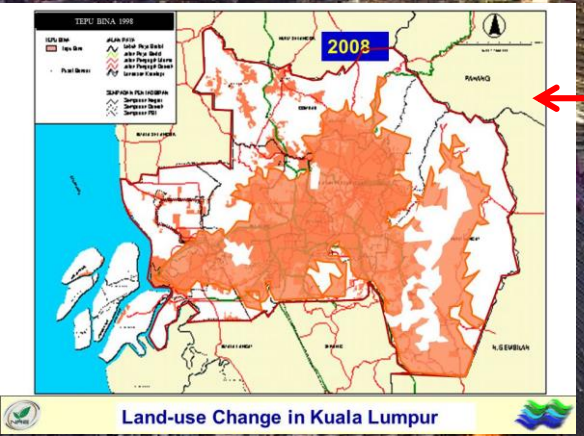


MAIN CAUSES OF FLOODS

Loss of Forests & Green Areas which absorb Rainfall is one of the main reasons for the occurrence of flash floods







Effect of Urbanisation on Storm Runoff

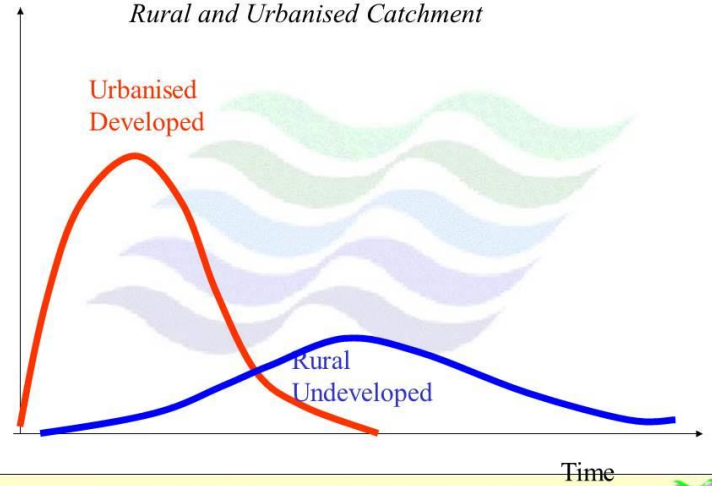
Increase In Development Area 0 - 40 %

Runoff Quantity
Q ➡ Increase 190 %

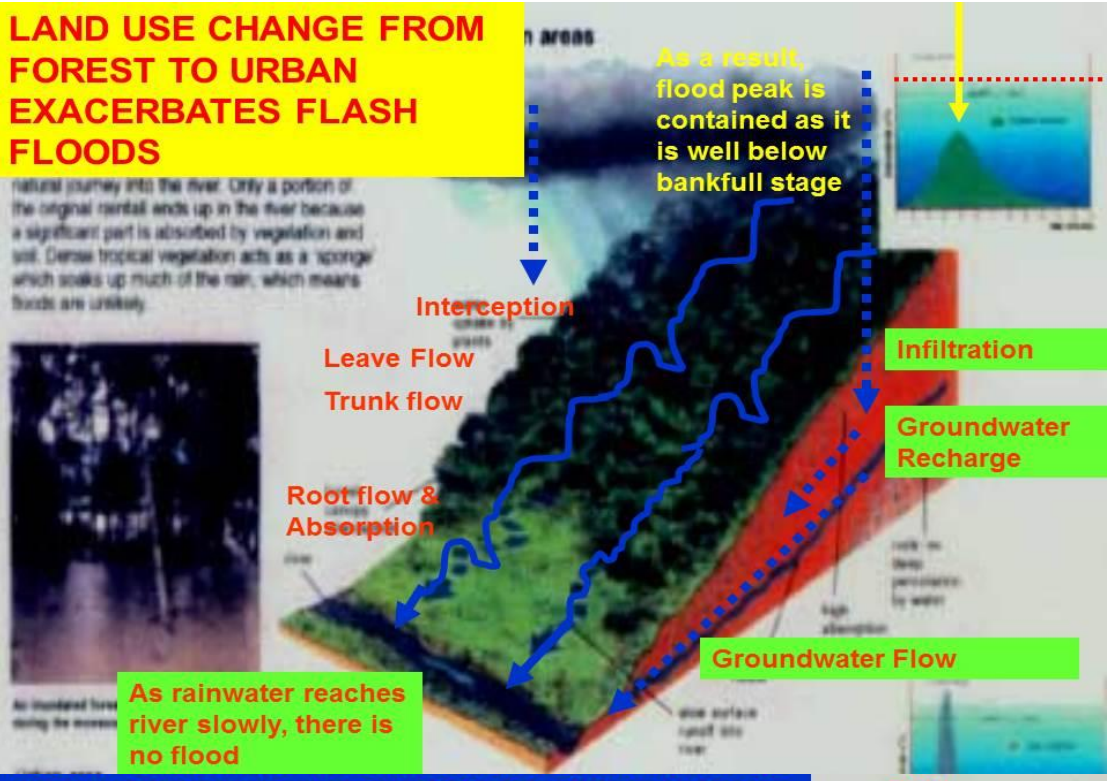
Velocity
V ➡ Increase 2x
Tc ➡ 50 % decrease

Flow

Flow Characteristics
Rural and Urbanised Catchment

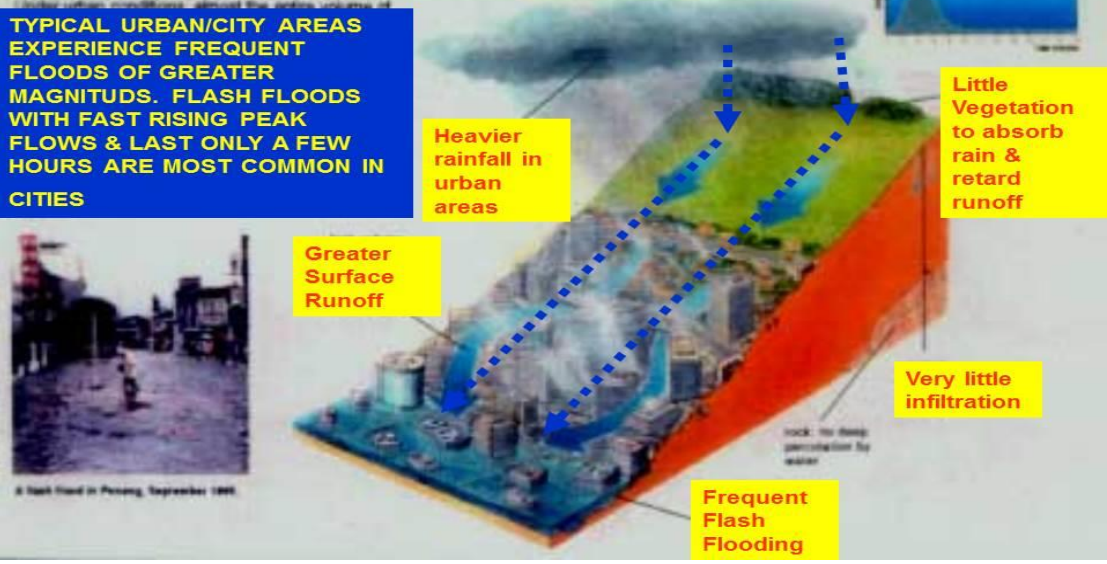


LAND USE CHANGE FROM FOREST TO URBAN EXACERBATES FLASH FLOODS



URBAN AREAS HAVE NO FORESTS TO ABSORB PART OF THE RAIN & SURFACES ARE IMPERVIOUS – INCREASING RUNOFF & SHORTENING LAG TIME

TYPICAL URBAN/CITY AREAS EXPERIENCE FREQUENT FLOODS OF GREATER MAGNITUDS. FLASH FLOODS WITH FAST RISING PEAK FLOWS & LAST ONLY A FEW HOURS ARE MOST COMMON IN CITIES



RM40bil needed to check floods

Uggah: Funds and mitigation projects lacking

By REGINA LEE
regina@thestar.com.my

PETALING JAYA: A staggering RM40bil is needed to remedy all the flood problems in the country, said Natural Resources and Environment Minister Datuk Seri Douglas Uggah Embas.

However, the Government was still short in flood mitigation projects with only RM2.4bil allocated so far

"So, we have to be creative and innovative when dealing with floods," he told reporters after opening a seminar on "Climate Change: Adaptation or Mitigation, Do We Have a Choice?" organised by Centre for Environment, Technology and Development, Malaysia (Cetdem) here yesterday.

cost is supposed to cover the 29,000 sq km flood prone areas throughout Malaysia. That size, which is based on a 2003 study, is only slightly smaller than the total land mass of Kedah and Perak put together.

"But in 2006, 2007 and even last year, we found new areas which flooded easily as the sea level rises every year," he said.

Despite that, Uggah was upbeat about receiving a fair allocation in dealing with floods.

In the second rolling plan, projects have been implemented in parts of Johor, Perak, Kedah, Kelantan, Perlis, Terengganu and Penang.

Parts of Selangor have been identified for flood mitigation projects in the next phase.

Cetdem chairman Gurmit Singh said not all floods were caused by climate change.

"Sometimes the floods are caused by non-functioning drainage system," he said.

On another matter, Uggah said Malaysia was well on the way to achieving a 40% reduction of carbon emissions by 2020 as pledged by Prime Minister Datuk Seri Najib Tun Razak at the 15th Conference of Parties in Copenhagen in 2009.

SEVERE FLOOD LOSSES!

December 2006 & January 2007	**Floods in Johor State**	**Combination**	**MYR1.5 Billion**	**18**
2008	Floods in Johor State		MYR65 Million	28
2010	Floods in Kedah and Perlis	Combination	MYR26 Million (Aid alone)	4
2011 & 2012	La Nina in 2011 and 2012 (which brought floods)	Natural	NA	-
Dec 2014	Severe Floods in East Coast States of Kelantan, Pahang, Terengganu	Combination	MYR2.9bil	200,000 people affected while 21 killed on the flood

12 JAN 2016: 1.00 USD = 4.40974 MYR

Annual Flood Damage is Massive in Malaysia

INCREASE IN FLOOD DAMAGE

12

For Malaysia:

1980's = RM 100 million / year (L.T Mean)

2000's = RM 915 million / year (L.T Mean)

Floods of Dec 2006/Jan 2007 & Jan 2011 (Johor) = RM 1.5 billion

Source: "Updating of Flood Conditions(2002) study and National Security Council

Dec 2014 Flood: RM2.84 billion

2017 Sept Flood in Penang: RM200 million

Figure 2: A typology of Flood Damage (After Parker et. al., 1987)

		Type of Flood Loss	
		Tangible	Intangible
Form of Flood Loss	Direct	Damage to Building Damage to Building Content Damage to Infrastructure Loss of Livestock Crop Damage Damage to Vehicles	Loss of life Health effects Mental/Psychological Stress Discomfort Loss of ecological goods
	Indirect	Loss of Business Loss of Production Traffic Disruption Emergency Costs Loss of Work/Working Hours	Inconvenience of post-flood recovery Increased vulnerability of survivors Cutting Off of Water Supply, Electricity, Transport, Food Supplies, Healthcare etc.

FLOOD EVENTS AND LOSSES SUFFERED IN KELANTAN STATE

YEAR	NUMBER OF DEATHS	NUMBER OF VICTIMS	LOSSES
1926	30	No Records	No Records
1967	38	537,000	RM 30 million
2004	12	11,000	RM 45 million
2014	25	500,000	RM 2.85 billion

SOURCE: Zuliskandar and Ali Baharuddin (2004); Ibrahim Komoo (2014).

How Rainwater Harvesting Via Sustainable Urban Drainage System help reduce Floods

Each Residential House can have a Storage Volume of about 1,000-3,000 m^3. Imagine Every house having RWH.

The USM Harapan Lake has an area of about 1.05 ha, storage volume of about 30,000 m^3. Imagine Every housing estate having this.

Source:

EXAMPLE OF BIOECODS PROJECT IN USM ENGINEERING CAMPUS

- This project has taken various measures to reduce stormwater runoff rates and volumes, and stormwater pollutant load by implementing control at source method.
- BIOECODS is the first project that uses control at source method in Malaysia and attempts to solve three major problems in Malaysia:

Flash Flood

River Pollution

Water Scarcity

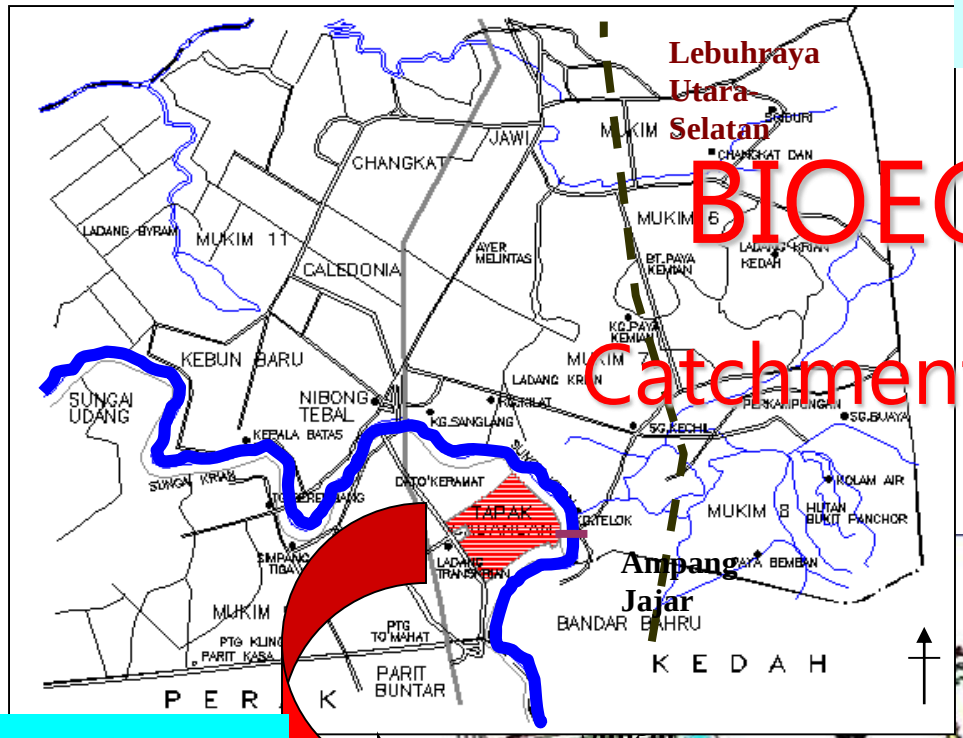
(Source: REDAC)

PROJECT LOCATION

USM Engineering Campus

BIOECODS SITE

Catchment Area: 320 acres



RESEARCH DEVELOPMENT

- Design - 1999
- Construction- Starts: 2000

Completed: 2002

- Data Collection – Starts: June 2003-Now.

(Source: REDAC)

CONSTRUCTED COMPONENTS OF BIOECODS

Constructed Swale

Constructed Wet Pond

Constructed Wading River

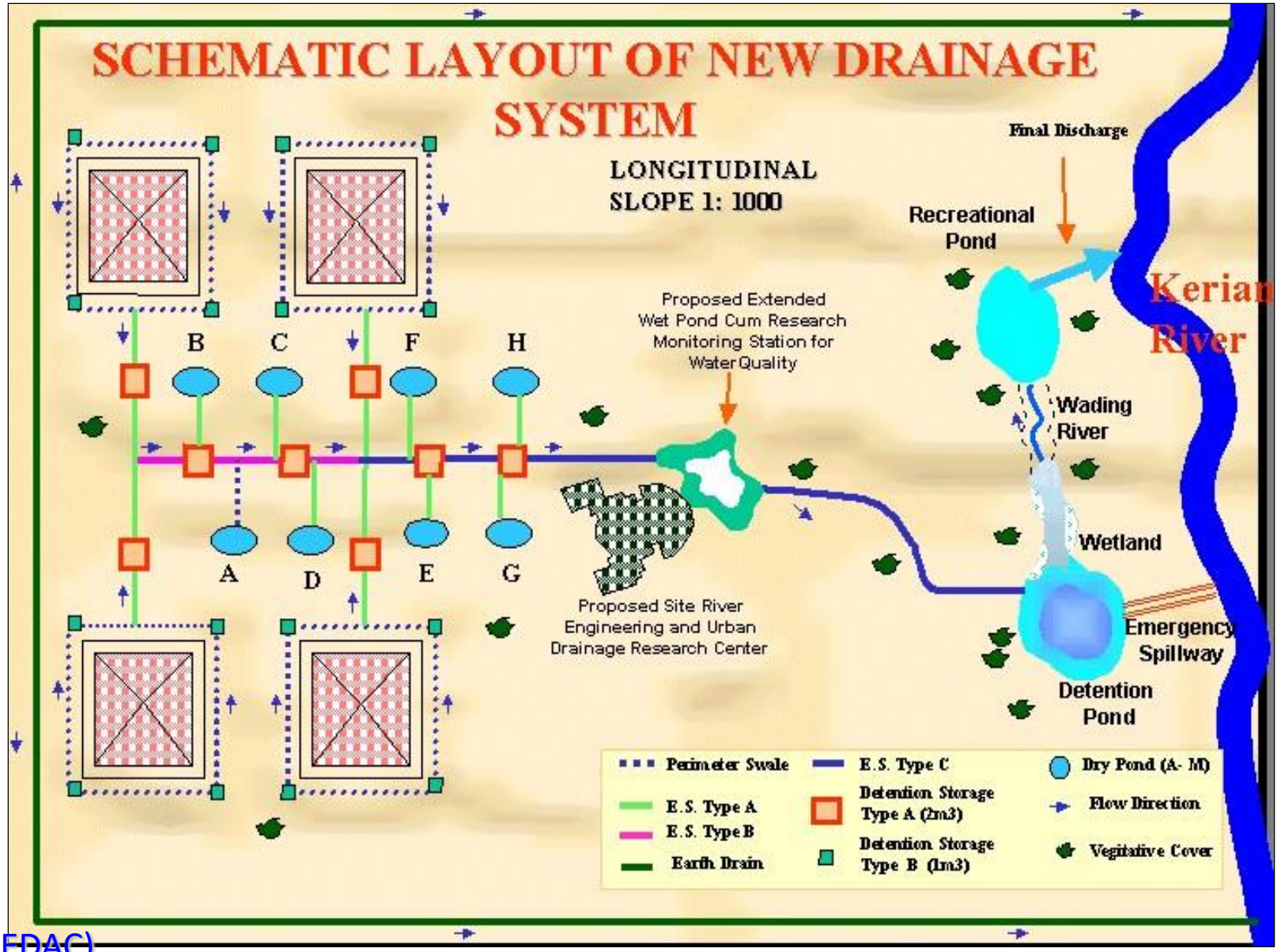
Constructed Detention Pond

Constructed Wetland

Constructed Recreational Pond

(Source: REDAC)

DESIGN CONCEPTS



(Source: REDAC)

PEAK FLOW ATTENUATION @ DETENTION POND (Beh, 2014)

Table 4.4 Rainfall and flow characteristics measured in Detention Pond (2011)

Date	Rainfall			Flow			
	Duration (mins)	Depth (mm)	Intensity (mm/hr)	Inlet (lps)	Outlet (lps)	Peak Reduction (%)	Delay time (hrs)
9/10/11	210	173.5	49.57	175.17	45.51	74%	1
19/10/11	215	125.1	34.91	168.12	46.87	72.12%	3
21/10/11	330	43.1	7.84	105.35	48.57	53.70%	4

RAINFALL EVENTS

9th October 2011 – 50 yr ARI

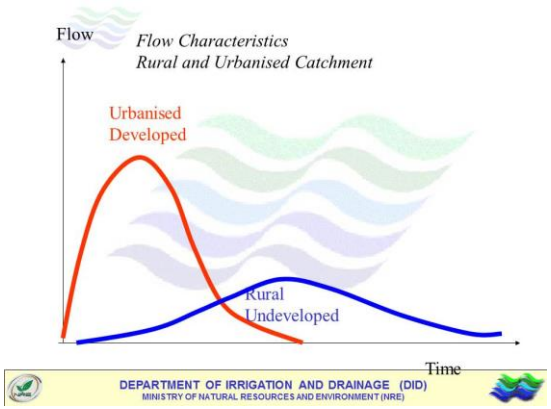
19th October 2011 – 10 yr ARI

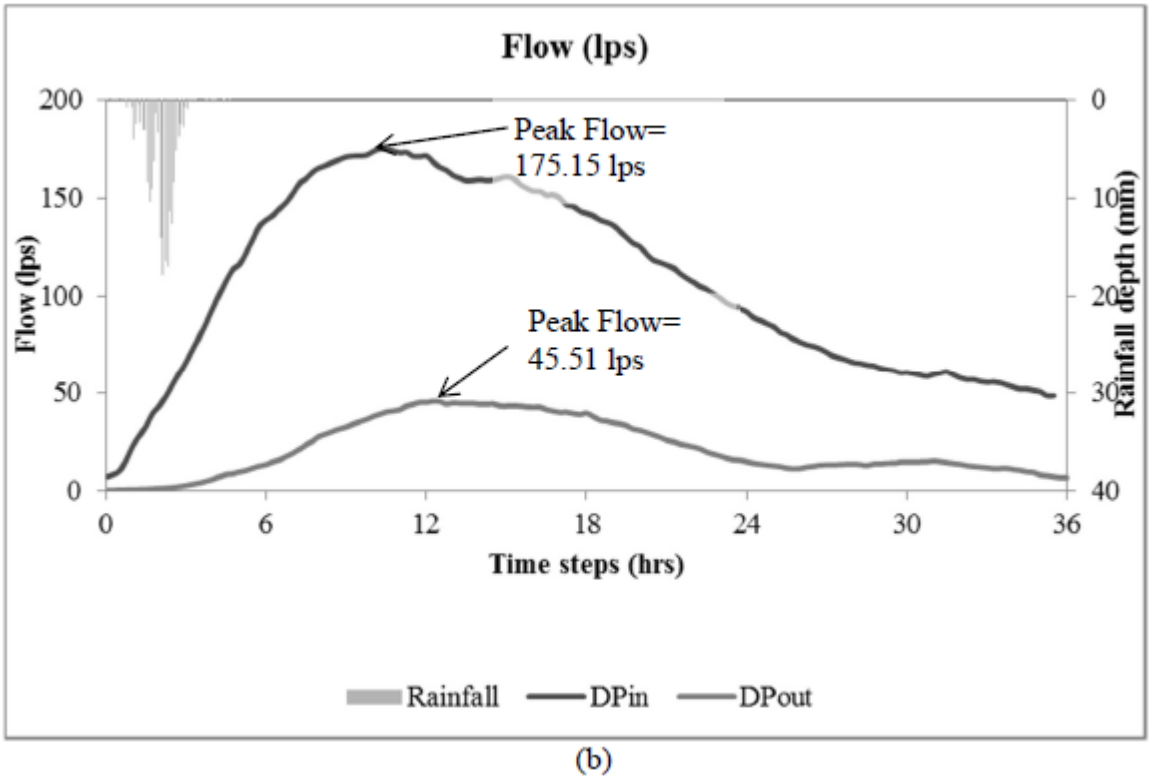
21st October 2011 – 3 month ARI

Note: 100 mm depth of rainfall is considered a possible flood event by DID Malaysia

(Source: REDAC)

PEAK FLOW ATTENUATION @ DETENTION POND (Beh, 2014)





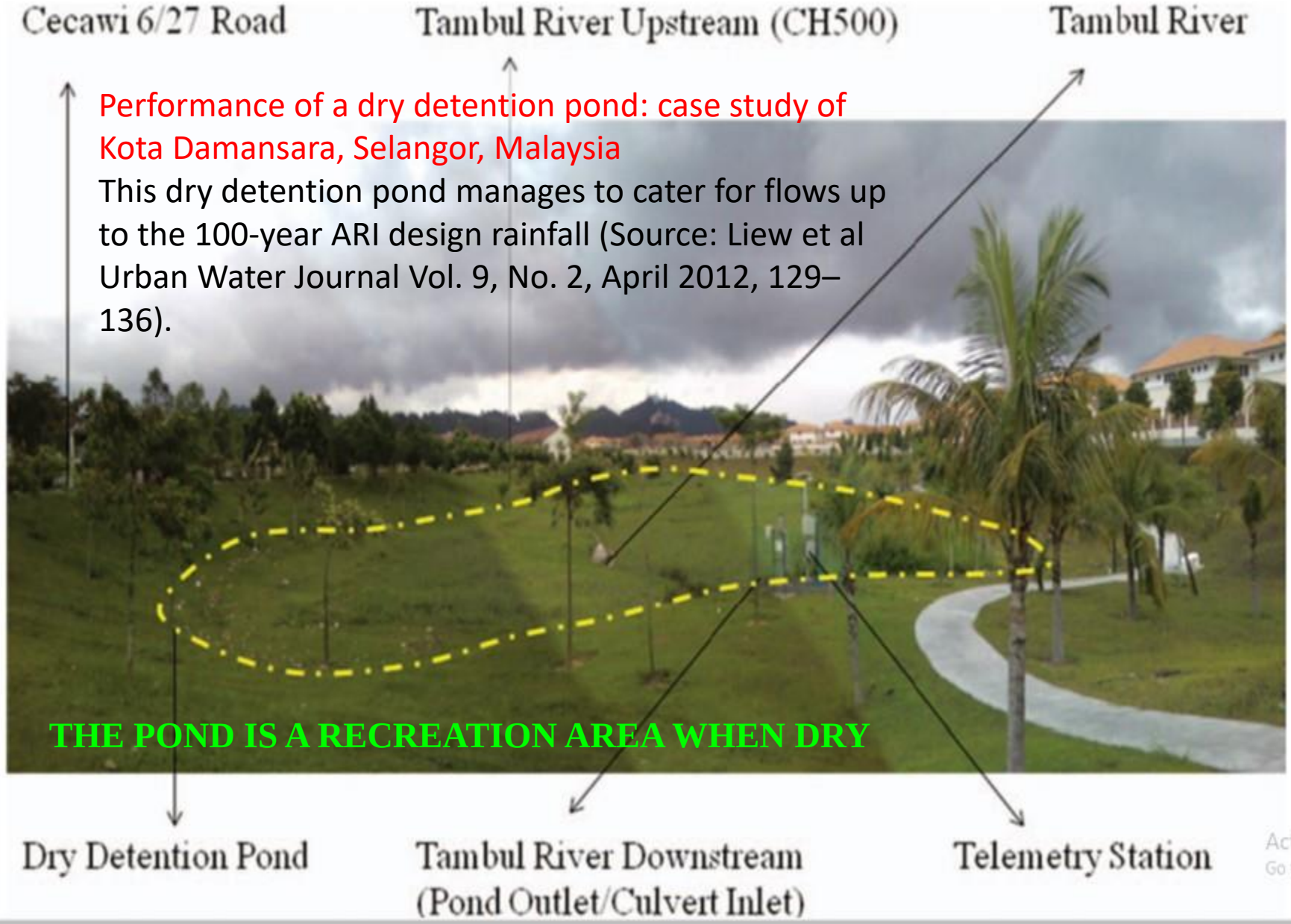
(b)

Detention Pond reduces peak flow just like natural/rural areas with high % of forests/vegetation.

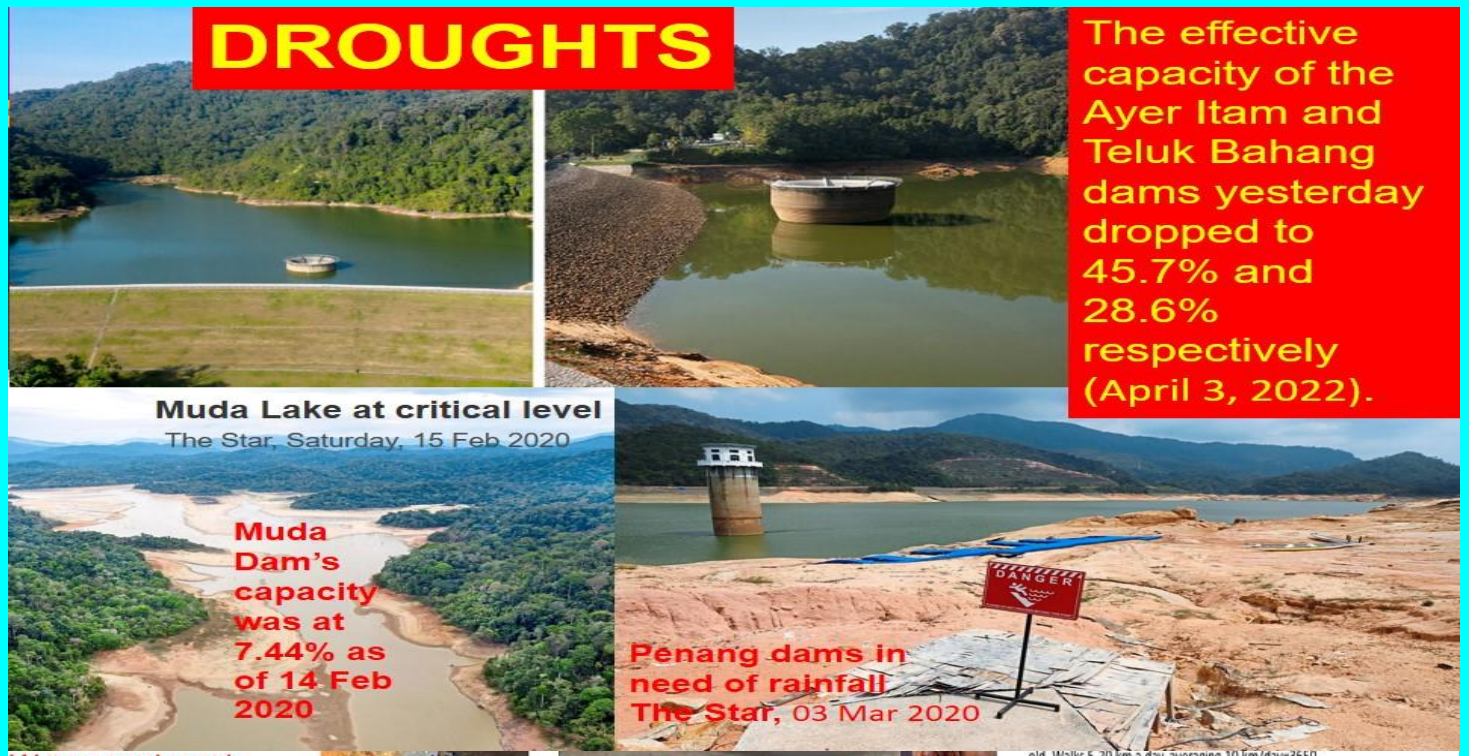
9th October 2011 – 50 yr ARI

(Source: REDAC)

ANOTHER EXAMPLE OF DETENTION POND



(ii) Results & Discussion: Drought Control



Drought is a serious Climate Change problem affecting a large part of the world, including Malaysia (Affected by El Nino, Variability of Rainfall over Time & Space).

POND RAINFALL HARVESTING SYSTEMS CAN BE USED AS ALTERNATIVE/SUPPLEMENTARY SOURCES OF WATER

(Source: REDAC)

nal Conference
vil Engineering

UNIVERSITI SAINS MALAYSIA

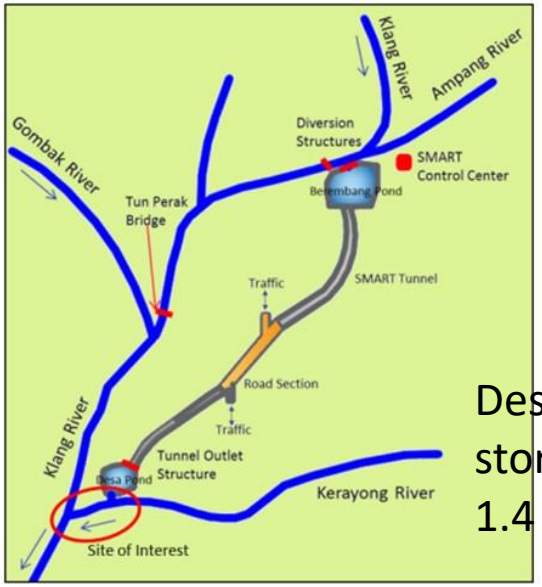


Figure 1-4 Components of SMART Tunnel

SMART TUNNEL System Berembang inlet storage pond: 0.6 million m^3

Desa outlet storage pond: 1.4 million m^3

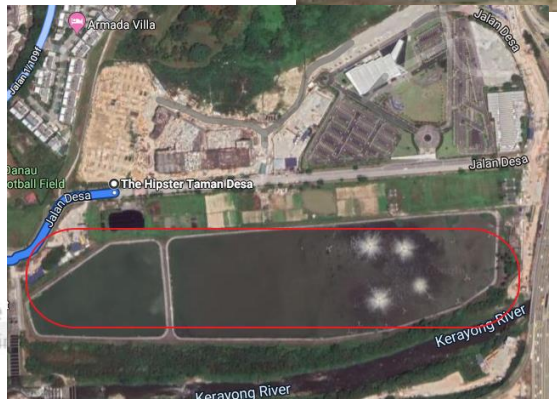


Table 8-2 CHARACTERISTICS OF DONDANG RETENTION PONDS

	Area (m2)	Ground Level (El. m)	Design High Water Level (El. m)	Design Pond Bed Level (El. m)	Water Depth (m)	Pond Depth (m)	Storage Volume (m3)	Inflow (m3/s)	Cut Q (m3/s)	Outflow (m3/s)
Pond A	30,500	21.50	20.28	17.26	3.02	4.24	79,013	40.627	9.500	31.127
Pond B	32,700	15.60	14.00	11.42	2.58	4.18	72,839	37.639	6.000	31.639
Pond C	21,200	13.50	11.47	8.73	2.74	4.77	46,410	43.399	4.500	38.899
Total	84,400						198,262		20.000	

Table 4.5 BMPs average outflow concentration and WQI class in BIOECODS

Water Quality Performance @ 2011 (Beh, 2014)

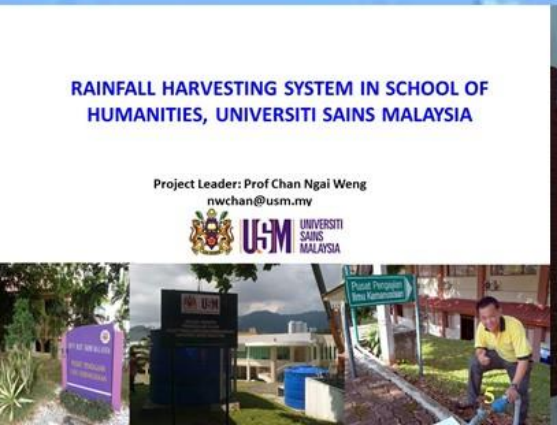
Parameters	Unit	WP	DP	WL	RP	WQI		
						I	II	III
NH_3	(mg/l)	0.34	**0.37**	0.16	0.17	<0.1	0.1 – 0.3	0.3 – 0.9
BOD	(mg/l)	**1.53**	1.33	1.10	1.00	<1	1 – 3	3 – 6
COD	(mg/l)	14.25	**16.87**	12.35	12.08	<10	10 – 25	25 – 50
DO	(mg/l)	6.56	6.94	7.47	6.91	>7	5 – 7	3 – 5
pH		6.84	6.91	7.35	7.47	>7	6.0 – 7.0	5.0 – 6.0
TSS	(mg/l)	21.18	**24.48**	6.17	6.86	<25	25 – 50	50 – 150
WQI class:		III	III	II	II			

Water quality improvement from Class III (Wet Pond) to Class II (Recreational Pond)

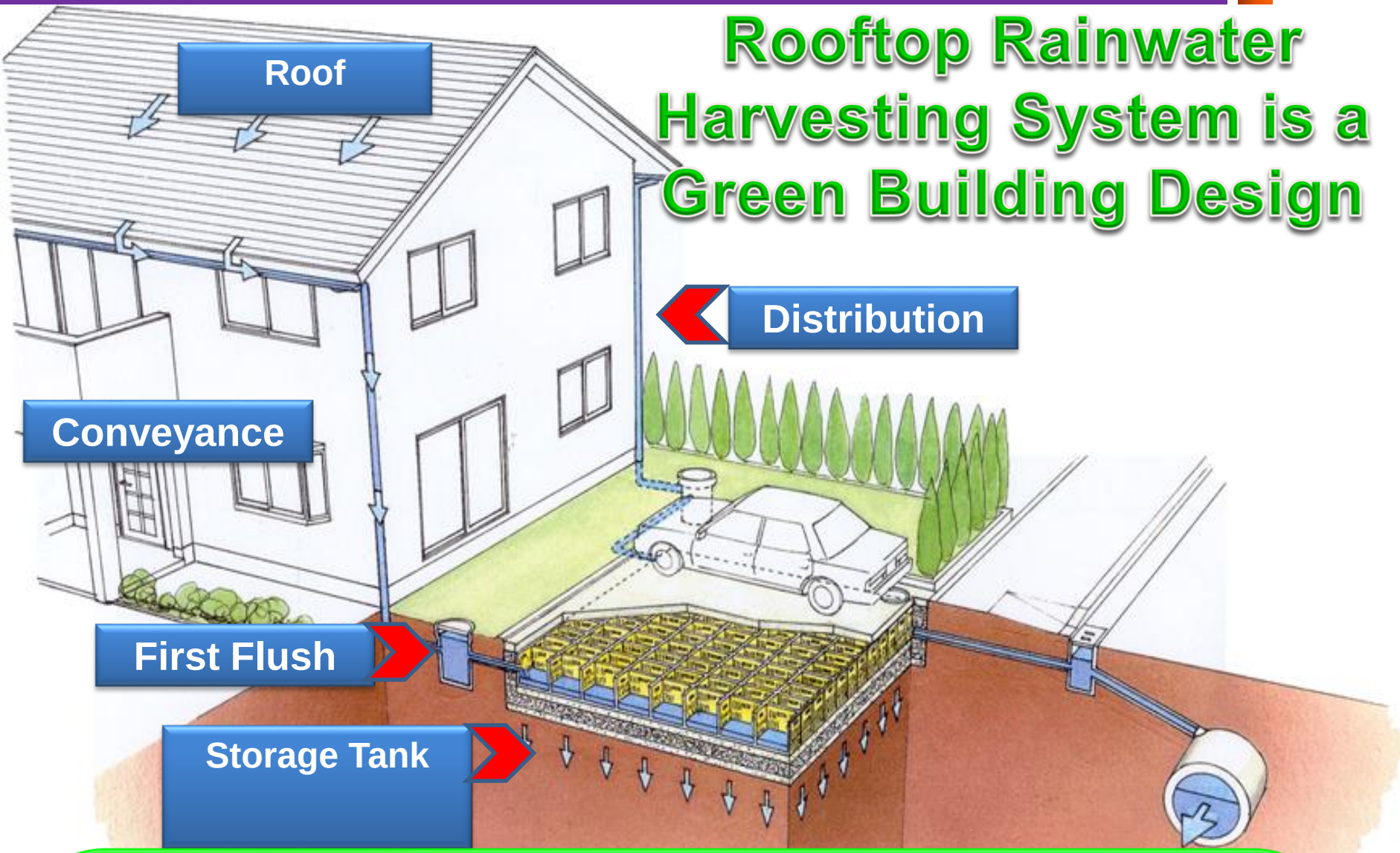
Water in Recreational Pond can be treated for drinking during drought

- **<u>Rainwater Harvesting</u>** (Rooftop Harvesting System & Pond Harvesting System) is a component of Sustainable Urban Drainage System that is used as supplementary at-source control (**quantity control**)

- Can be utilized as **water supply** for general usage e.g. toilet flushing, farming, gardening etc.



Rooftop Rainwater Harvesting System is a Green Building Design



WET SURFACE MOISTURE INCREASES EVAPO-TRANSPIRATION WHICH RELEASES HEAT FROM SURFACE UPWARDS

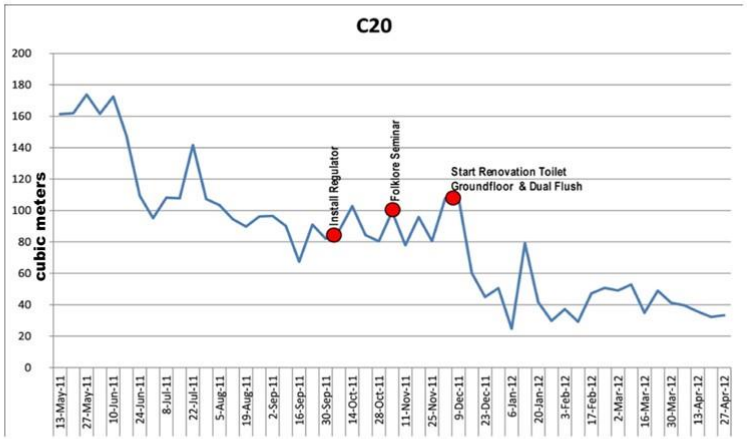
RAINFALL HARVESTING SYSTEM IN SCHOOL OF HUMANITIES, UNIVERSITI SAINS MALAYSIA

Project Leader: Prof Chan Ngai Weng
nwchan@usm.my

Installation of Rainfall Harvesting System

- Suggested locations for water tanks.
- Locations of Meters 1-6

RESULTS SHOW THAT WATER CONSUMPTION IN THE SCHOOL HAS GONE DOWN SIGNIFICANTLY FROM 170 M^3 PER WEEK TO ABOUT 80 M^3 PER WEEK (A DROP OF 52.9%) SINCE THE PROJECT STARTED



Water Watch Penang

Jabatan Pengairan dan Saliran

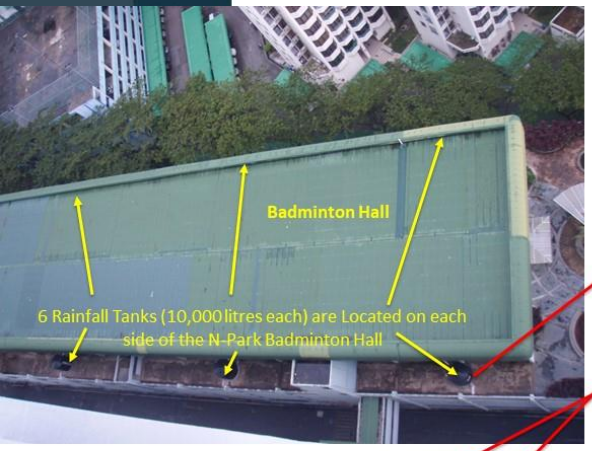
PBA HB (51119-U) PBA Holdings Bhd

N-PARK

Save Water

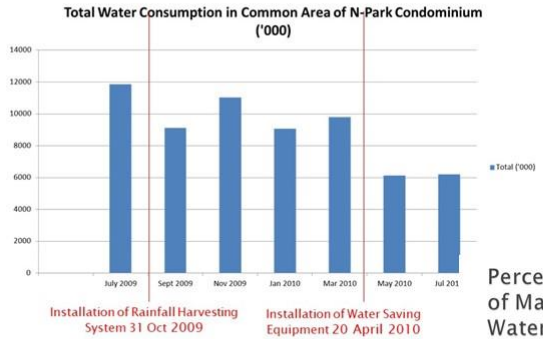
JIMAT AIR

THE N-PARK RAINFALL HARVESTING PROJECT (Federal Government Funding)



- 31st of October 2009 This rainwater harvesting project is **the first** in the nation for condominium units.
  - 6 sets of rainwater harvesting tanks (each 10,000 litres) were installed
  - Launching was officiated by Director of DID Penang, Tuan Haji Hanapi bin Mohamad Noor

Prof Dr Chan Ngai Weng, President of Water Watch Penang and Tuan Haji Hanapi bin Mohamad Noor, the (then) Director of DID Penang, showing off the rainwater harvesting unit in N-Park, 31.10.09



Percentage of Water Saved in the month of May and July after installation of Water Saving Equipment (based on the water bill from the month of March)

Month of May
- 9792-6132.1=3659.9
- 3659.9/9792 x 100 = 37.38% RM3609.1

Month of July
- 9792-6216.5=3575.5
- 3575.5/9792 x 100 = 36.51% RM3524.7

RESIDENTIAL

MKH JKR

Developer: MKH Berhad
Project: Jabatan Kerja Raya Quarters
Property Type: Bungalow, Semi-Ds & Apartments
Location: Kajang

RESIDENTIAL

GAMUDA

twentyfive.7

Property Type:
Bungalows, Semi-Ds & Standalone Buildings
Location:
Kajang, Kota Kemuning & Nusajaya

STANDALONE BUILDINGS

TENAGA NASIONAL

Developer:
Tenaga Nasional Berhad
Property Type:
Power Sub Station
Location: Various

FACTORY/ INDUSTRIAL

Model in picture:
Voda Cylinder 750L
Voda Cylinder 1500 L

mission Julie's Lovedonia

RESIDENTIAL

Homecity Group

Developer: Homecity Group
Project: Greensville
Property Type: Semi-Ds
Location: Semenyih

SCHOOL

Client: Rotary Club
Usage: 16 toilets & Irrigation
Location: SMJK Dindings, Sitiawan
Property Type: School
Model in picture: Voda Cylinder
750 L

STANDALONE BUILDINGS

LEGOLAND MALAYSIA

Project: LEGO Star Wars
Property Type: Themepark Attraction
Location: Nusajaya, Johor

I WALK THE TALK – INSTALLED 2 VODA RAINFALL HARVESTING SYSTEMS IN MY HOUSE IN PENANG

1 Unit costs RM2,226.00
(Size of tank = 300 litres)

Prof Chan's Home Rainfall Harvesting System – Front Garden

Prof Chan's Home Rainfall Harvesting System-Back Garden

Sweet Potato Leaves

Bendi & Winged Beans

Petola

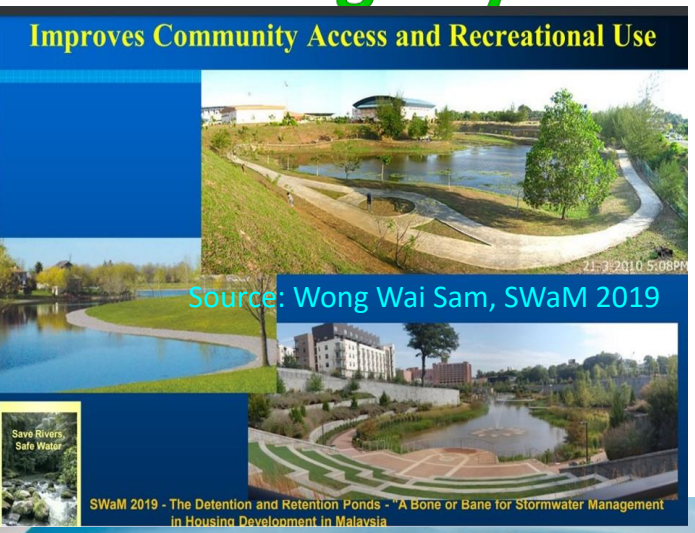
Winged Beans (Kacang Botol)

Bayam Brazil

(iii) Results & Discussion: Control of Urban Heat Islands

UNIVERSITI SAINS MALAYSIA

"Ponds & Green Surfaces under Bio-ecological Drainage Systems as a Control for the Urban Heat Island Effect"



Source: Wong Wai Sam, SWaM 2019

USM's Harapan Lake is a Popular Recreation Area for Staff & Students

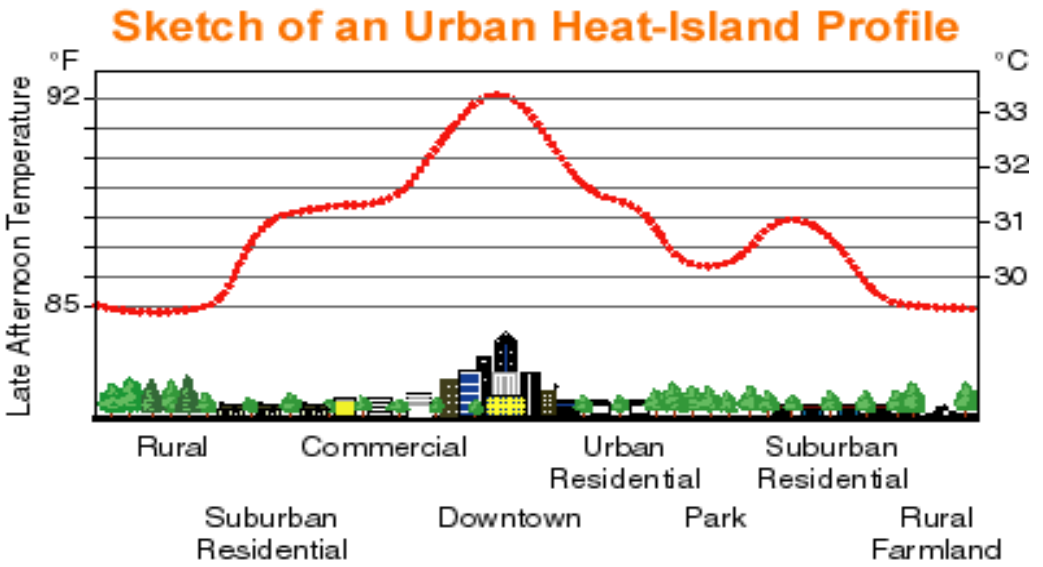
Trees and Wetland Plants are planted in pond systems

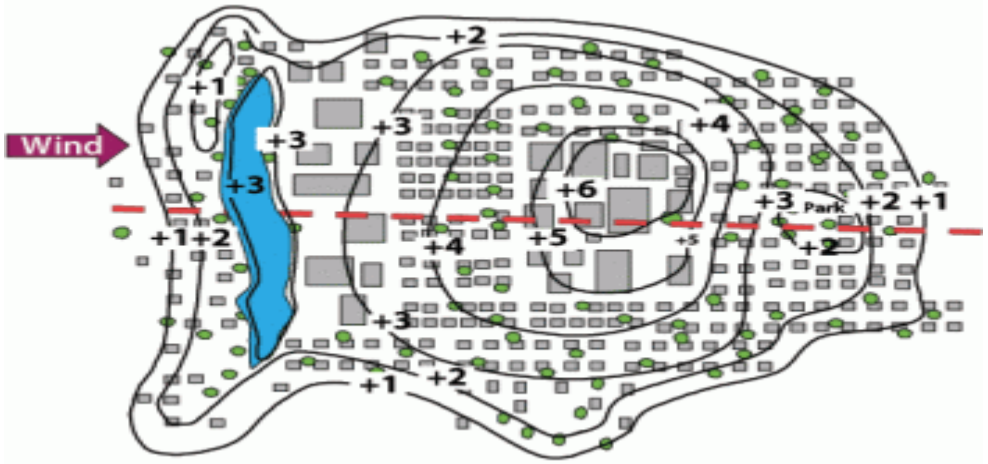
CITIES ARE "HOT SPOTS" GENERATING URBAN HEAT ISLANDS :

Cities have become awesome in size, and also greenhouse gas emissions. Larger cities have a ravenous appetite for energy, consuming ⅔ of the world's energy and creating over 70% of global CO_2 emissions.

10 Oct 2003 — At least 35,000 people **died** as a result of the record **heatwave** that scorched Europe in August **2003**. The Earth Policy Institute (EPI), warns that such **deaths** are likely to increase, as "even more extreme weather events lie ahead".

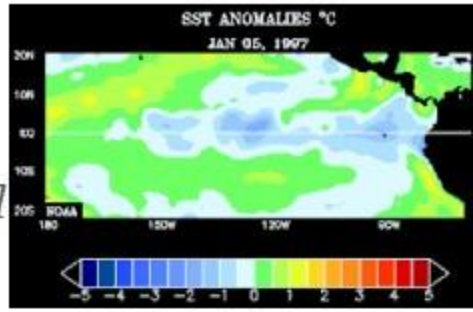
Local Urban heat islands contribute towards overall Global Warming

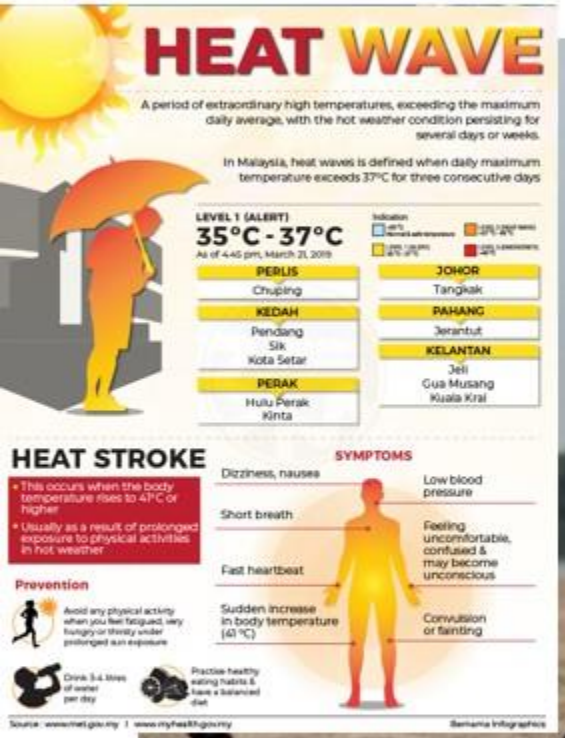




Severe heatwave grips Malaysia

Intense spell of hot and dry weather brought on by El Nino hits food and water supplies across parts of SE Asia.





The Pahang River runs dry and schools remain closed due to the heatwave in Temerloh, /AFP]

LOCAL NEWS

Expect Klang Valley Heat Wave to Linger Until June

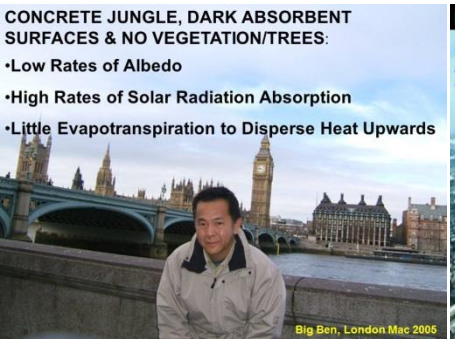
By Priscilla Emmanuel

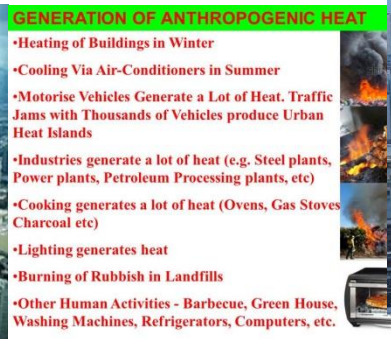
CAUSES OF URBAN HEAT ISLAND

- CONCRETE JUNGLE
- DARK ABSORBANT SURFACES
- LACK OF VEGETATION
- LOW RATES OF EVAPOTRANSPIRATION
- HIGH HEAT SOURCE POTENTIAL
- CENTRE OF AIR POLLUTION
- CONCENTRATION OF INDUSTRIES
- HIGH CONCENTRATION OF POPULATION
- ROUGH SURFACES
- HIGH CONCENTRATION OF POPULATION

Ho Chi Minh City

Kuala Lumpur





Osaka

(Source: Thinkcity)

Maps Help Back to Urban Analytics

KLCC: Land Surface Temperature (1989 & 2019)

"The presence of green spaces can enhance the health and well-being of people living and working in cities." (Leeds Ecosystem, Atmosphere and Forest (LEAF) Centre, 2015)

Slide right for 1989, left for 2019

In December 1989, the highest recorded surface temperature in Kuala Lumpur city center was **29.40°C** while the lowest **21.07°C**. In said year, not much development can be seen in areas of Mahameru and Jalan Puncak (KL Forest Eco Park), identifying them as the least warm at the time. However, hottest spots included the **City Centre, Bukit Bintang, Pudu and North KL (Chow Kit, Kampung Baru)** - localities heavily concentrated with human activities and local economies. Distinguishable brownfields observed around Jalan Ampang (now KLCC) which would eventually house many commercial and business areas also contributed to the high temperature. However, places that recorded temperatures **over 29°C were Sungei Wang Plaza in Bukit Bintang and areas surrounding Jalan Pudu.**

After three decades, in October 2019, the highest and lowest recorded temperatures were **31.04°C** and **23.34°C**, respectively. This signals an **increase of 1.64°C** between both years' hottest surface temperature*. Petronas Towers completed in 1998 is considered as the centrepiece and catalyst for KL's present modernism and has substantially increased the market values of commercial properties in the city. It is apparent from latest satellite data there has been distinguishable **increase in the city's built environment**.

Contrarily, there were few locations that have either decreased or steadied in temperature in 2019. Based on satellite data and 2019's LST map, **park reserve areas such as KL Forest Eco Park and Taman Botani Perdana, and public spaces and gardens in Mahameru and KLCC** were observed as the least warm in the city.

A study by Think City showed an increase of **1.64° C** in **Kuala Lumpur City Centre's** surface temperature between **1989 and 2019**.

Maps Help Back to Urban Analytics

Address Search

Pulau Tikus
Penang Hill St. 45
Komtar
Batu Lanchang
Jelutong
Fortune Park

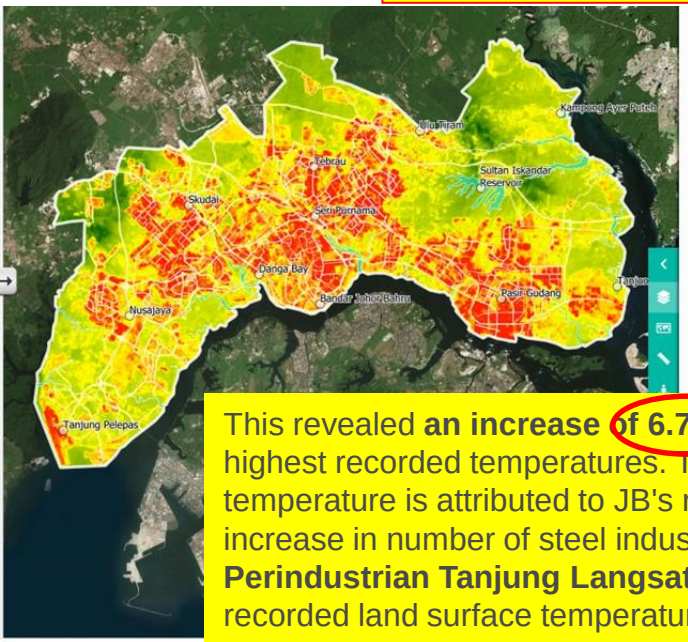
George Town: Land Surface Temperature (1988 & 2020)

"It is essential to incorporate remotely-sensed data in the study of urban climate to attain the synoptic view required in understanding the interaction between the natural and man-made processes." (Stefanov & Brazel, 2007)

Slide right for 1988, left for 2020

In February 1988, the highest recorded surface temperature in George Town was **28.36°C** while the lowest **21.07°C**. LST was particularly high in areas of **Kompleks Tun Abdul Razak (KOMTAR)** (completed two years prior) and **Jalan Dato' Keramat**. In 1988, the hottest location over 28°C was a former tin smelting plant (now Penang Times Square) in Jalan Dato' Keramat.

After over three decades, surface temperatures rose significantly. In February 2020, the highest and lowest recorded temperatures were **34.73°C** and **24.30°C**, respectively - an **increase of 6.4°C** between both years' peak records. The rise occurred across all of George Town, including areas of Penang Hill in the west. Locations reaching maximum temperature over 34°C are located in **Batu Lanchang, Jelutong, Fortune Park Industry, KOMTAR and the George Town World Heritage Site (GTWHS)**.



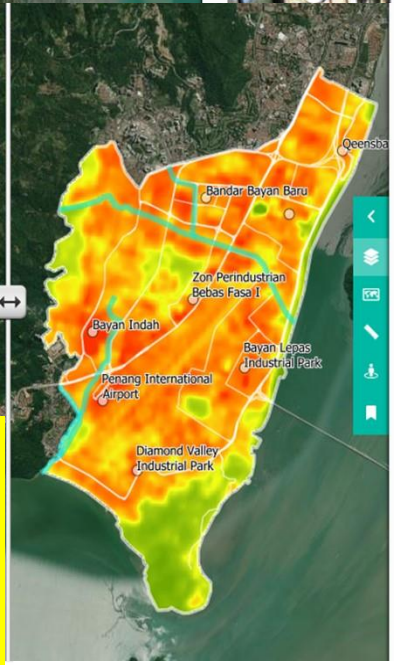
and man-made processes." (Stefanov & Brazel, 2007)

Slide right for 2005, left for 2018

In May 2005, the highest recorded surface temperature in Johor Bahru (JB) district was **27.94°C** while the lowest **17.93°C**. In said year, north of JB especially north and west of Tebrau were still greenfields - depicting them as two of the least warm areas at the time. However, hottest areas reaching over 25°C were **Skudai, Seri Purnama, Bandar Johor Bahru and Pasir Gudang**. Seri Purnama and Pasir Gudang are in fact confluences for many heavy industries of transportation and logistics, petrochemicals, electronics, plastics and many more. Meanwhile, Skudai and Bandar Johor Bahru are where many human activities and businesses concentrate.

In 2005, the east of JB (along Kampong Ayer Puteh) recorded surface temperatures between **19°C and 25°C - uncharacteristic for the forest landscapes surrounding the deltas of Sungai Johor** at the time. Vegetation index data shows in 2005, these landscapes had indeed been cleared away, indicating **deforestation activities**. This explains the high LST range in these massive patches of land (approximately up to 40 km²). However, after 13 years in 2018, the temperatures of these areas dropped by a maximum of 2°C. Close inspection on crowns of

This revealed **an increase of 6.7° C** between 2005 to 2018's highest recorded temperatures. This substantial rise in temperature is attributed to JB's rate of gentrification and increase in number of steel industries, particularly in **Kawasan Perindustrian Tanjung Langsat and Pasir Gudang** which recorded land surface temperatures over 33° C.



Slide right for 1988, left for 2020

In February 1988, the maximum surface temperature recorded while the minimum **21.51°C**. Bayan Lepas' landscape was 4 km land reclamation activities post 2008 (the dotted white line in land). In 1988, many areas of Bayan Lepas had been **clea industries and residences**. **Penang International Airport and e** of Bayan Lepas recorded temperatures in the higher range (ov with high level of human activities and thermal radiation emitte

After 32 years, surface temperature rose by **5.63°C**. In Februar recorded temperatures were **34.41°C** and **21.98°C**, respec temperature is the consequence of **increased industries and** Industrial areas (e.g. **BL Free Industrial Zones, Diamond Vall** areas (e.g. **Bandar Bayan Baru, Bayan Indah**) and commerci **Penang International Airport**) have recorded surface temperat 33°C). The least warm area pointed to an unoccupied and nor Lintang Kampung Jawa. This information proves how ther controlled and suppressed if given the opportunity.

How Green & Blue Surfaces (RWH Ponds) help reduce UHIs

They will reduce Most of the Causes of UHIs in cities

- REDUCE CONCRETE JUNGLE
- REDUCE DARK ABSORBANT SURFACES
- INCREASE VEGETATION COVER (ESPECIALLY TREES)
- INCREASE RATES OF EVAPOTRANSPIRATION
- LOWER HEAT SOURCE POTENTIAL
- REDUCE AIR POLLUTION
- REPLACE INDUSTRIES
- REDUCE CONCENTRATION OF BUILDINGS
- INCREASE GREEN-BLUE SURFACES
- REDUCE CONCENTRATION OF AUTOMOBILES

ROLE OF PONDS & TREES IN INCREASING EVAPO-TRANSPIRATION INCREASE HEAT TRANSFER FROM SURFACE (BIOSPHERE & HYDROSPHERE) UPWARDS INTO THE ATMOSPHERE

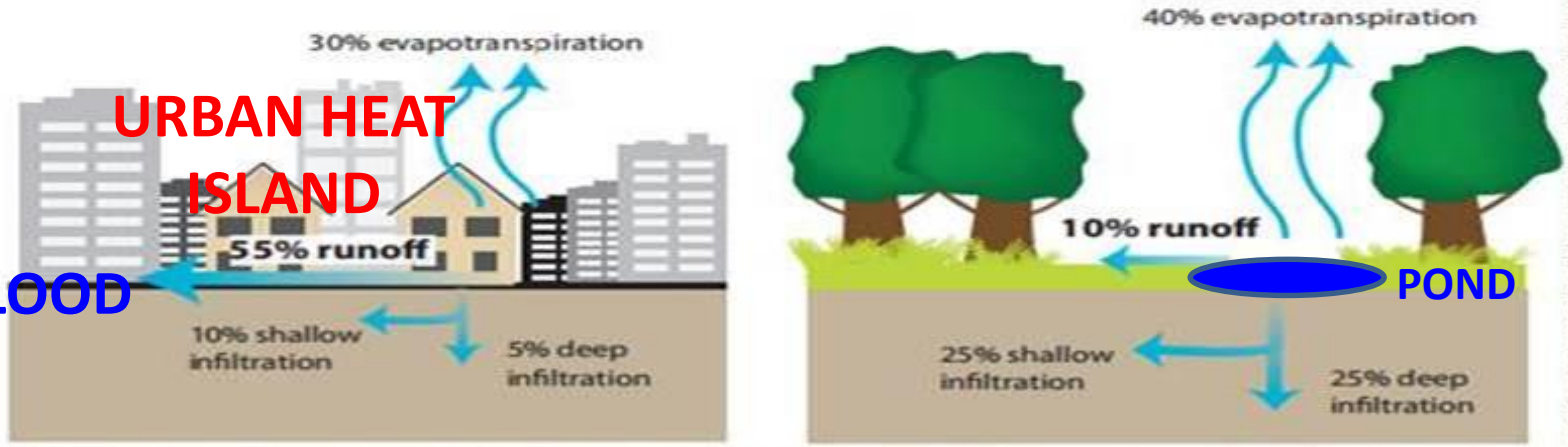
- 1 gram of water evaporated/transpirated
  = 600 Calories of Heat

URBAN HEAT ISLAND

FLASH FLOOD

POND

Figure 5: Impervious Surfaces and Reduced Evapotranspiration



Highly developed urban areas (right), which are characterized by 75%-100% impervious surfaces, have less surface moisture available for evapotranspiration than natural ground cover, which has less than 10% impervious cover (left). This characteristic contributes to higher surface and air temperatures in urban areas.

Modified from the Federal Interagency Stream Restoration Working Group (FISRWG)

GREEN SURFACES & PONDS REDUCES HEAT

Redfern Park, Sydney. Amphitheatre and on-site detention basin.

Above ground OSD system for a townhouse in Holroyd, Australia.

USM'S HARAPAN LAKE

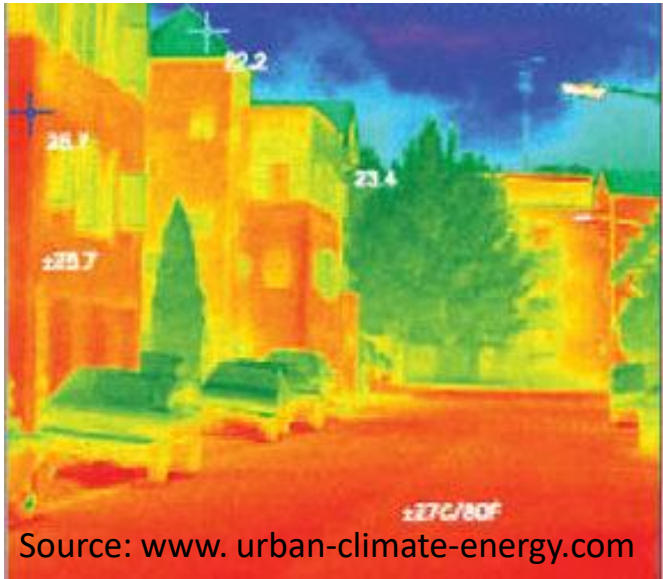
OSD Landscape Tank in public area.

Trees and vegetation lower surface and air temperatures by providing (i) shade and (ii) evapotranspiration.

Shaded surfaces, for example, may be 11–25° C cooler than the peak temperatures of unshaded materials (Akbari, H., D. Kurn, et al. 1997)

Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 1–5° C (Huang, et al. 1990; Kurn, et al, 1994).

Infra-red thermal image of heat being emmited in Tokyo. Concrete buildings & roads due to their thermal capacity store and emit greater heat than vegetation.



Source: www. urban-climate-energy.com

- Results of the study show that water bodies (ponds, wetlands, streams) and green areas have a significant cooling effect on the micro-climate, especially at higher ambient air temperatures. Such areas experience an average reduction of 1° C during temperatures higher than 20° C.

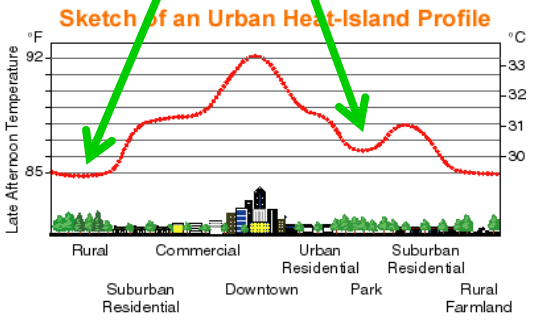
- Cooling only occurred during the daytime and ranged from 0.5 to 2.0° C. The cooling effect was found to be greater when temperatures are higher.

- It was also found that the cooling effect did not extend beyond 50 metres from the water body/green area.

- Cooling was significantly affected by urban form. Streets which were open to lakes/ponds/rivers, areas with more vegetation, areas with reflective surfaces, led to more effective cooling.

- City cooling effects can be greatly enhanced by careful consideration of urban design incorporating Sustainable Stormwater Management Systems.

Green & Blue Areas lower temperatures



Sustainable Urban Drainage System including Green River Corridors can significantly reduce Urban Heat Islands effect & create the possibility for a better quality of life and a lower carbon footprint through River Management.

RESULTS FROM CHEONGGYECHEON RIVER, SEOUL: 2003 AND 2005

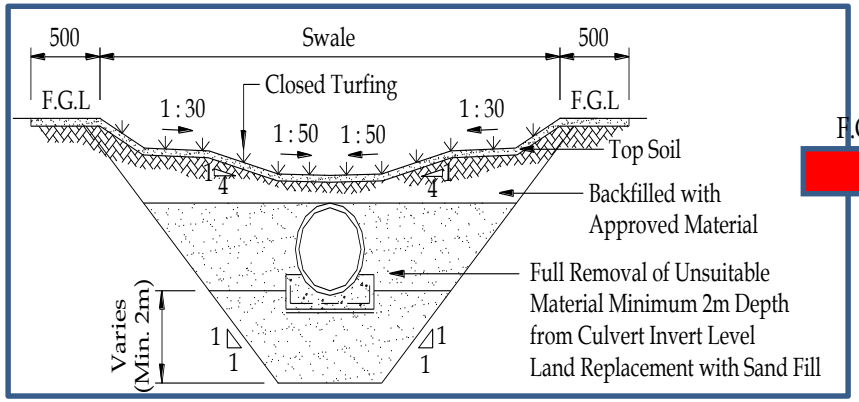
Lee Myung-bak, **Seoul's mayor**

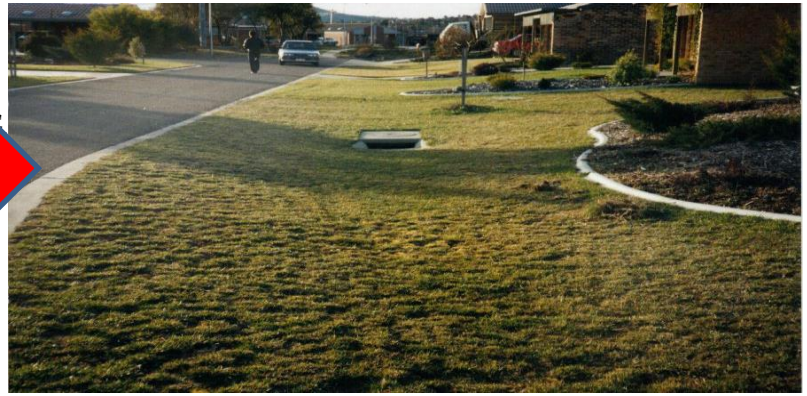
This river was paved-over by elevated highway creating congestion, pollution & Heat in the city. The river was then revived and restored, replacing the highway above it with open space and replanting of a vegetation park which now attracts 64,000 visitors a day. **The area now experiences lower ambient temperatures 3°C lower than city average, land prices have soared and biodiversity increased by 639 % along this new blue-green corridor**.

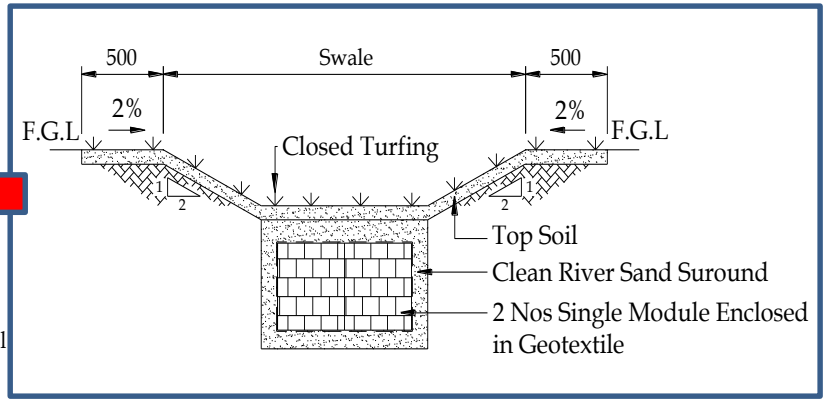
Before July 2003

Restoration completed in October 2005.

GREEN, REFLECTIVE SURFACES OF COMPOSITE SWALES REDUCES SOLAR HEAT ABSORPTION



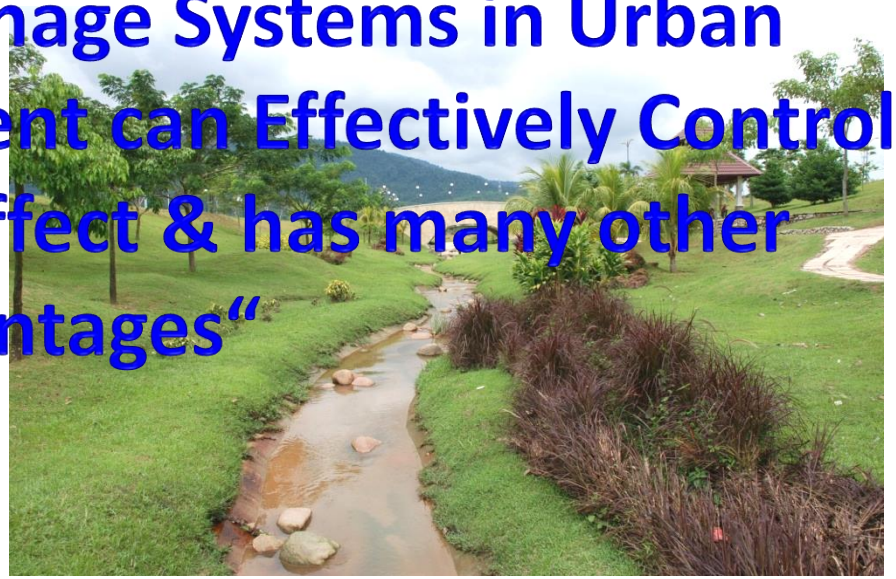




Universiti Sains Malaysia Engineering Campus is built on a Model Bio-Ecological Drainage System

Engineered Channel & Recreational Ponds – Beautiful Landscape & Functional

"Bio-ecological Drainage Systems in Urban Stormwater Management can Effectively Control Urban Heat Island Effect & has many other Advantages“



RWH Systems in Sustainable Urban Drainage System including Green Roofs are Green Building Designs that create the possibility for a better quality of life and a lower carbon footprint through more efficient infrastructure and planning.

Another Example of RWH System – Chulalongkorn Park, Bangkok

<u>Bangkok:</u> This Green park can significantly reduce Urban Heat Islands, Store & Regulate Water, Prevent Flooding & Create a better quality of life and a lower carbon footprint to Combat Global Warming.

The park addresses major environmental issues facing Bangkok as a rapidly developed, hard-paved city: water management and the urban heat island effect. The Increase in Evapotranspiration also increases Upward Heat Transfers, reducing Urban heat Islands.

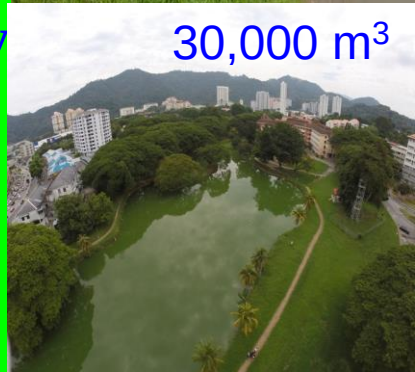
OTHER METHODS TO REDUCE URBAN HEAT ISLANDS

5. CONCLUSION

- **Research Results show that Rainwater Harvesting & Sustainable Urban Drainage System (SUDS) can be the way forward for addressing urban floods, droughts & heat in cities**

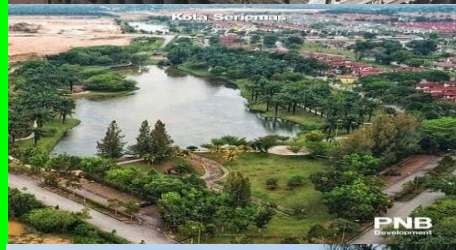
- **RWH Systems can control Floods - By minimizing the surface runoff at source through the provision of on-site facilities & peak runoff can be reduced in downstream area**

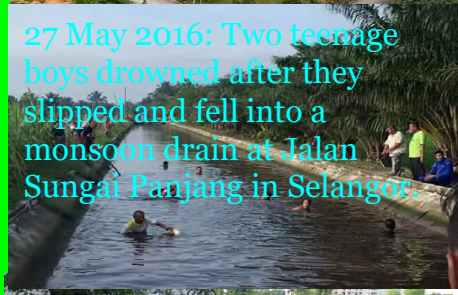
- **RWH Systems can control Droughts - Stormwater Quality improves to Water Quality Class IIB if Pond Harvesting System is used. Detention Pond water can be used as an emergency water source. Every housing estate will have an emergency water source if each has a detention pond.**



Conclusion (cont…)

- **RWH Systems can control Heat – Rooftop Rainwater Harvesting incorporating Green Roofs Help Reduce Urban Heat islands Significantly.**
- **RWH Ponds produce a Green, Productive (Urban Farms) and Healthy Urban Environment, improving Quality of Life and Livability of Cities.**
- **RWH Ponds/SUDS is a Holistic Tool to Combat Global Warming in terms of Flood, Drought & Heat Alleviation.**
- **RWH Pond Systems are Aesthetically Pleasing & Safe – Scenic, has Recreational Value and not a Public Hazard (Compared to Open Drains!).**
- **Considering all the Benefits, RWH Systems should be made Mandatory in building designs.**





Open Drains become convenient "Garbage Dumps"

Lamborghini Crashes Into Drain, Ugly Malaysians Mock Driver Saying 'You Deserved It' (https://worldofbuzz.com/)

THANK YOU

Water Watch Penang

Jabatan Pengairan dan Saliran

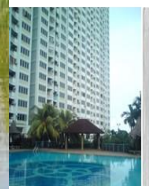
PBA HB PBA Holdings Bhd

N-PARK

Save Water

JIMAT AIR

THE N-PARK RAINFALL HARVESTING PROJECT (Federal Government Funding)



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