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Research on Water Utilization & Treatment Technology Towards Zero Water Discharge at TNB Thermal Power Plants

By Ahmad Rosly Abbas
TNB Research Sdn. Bhd.
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Introduction

Two most important natural resources for TNB: Fossil Fuel and Water.

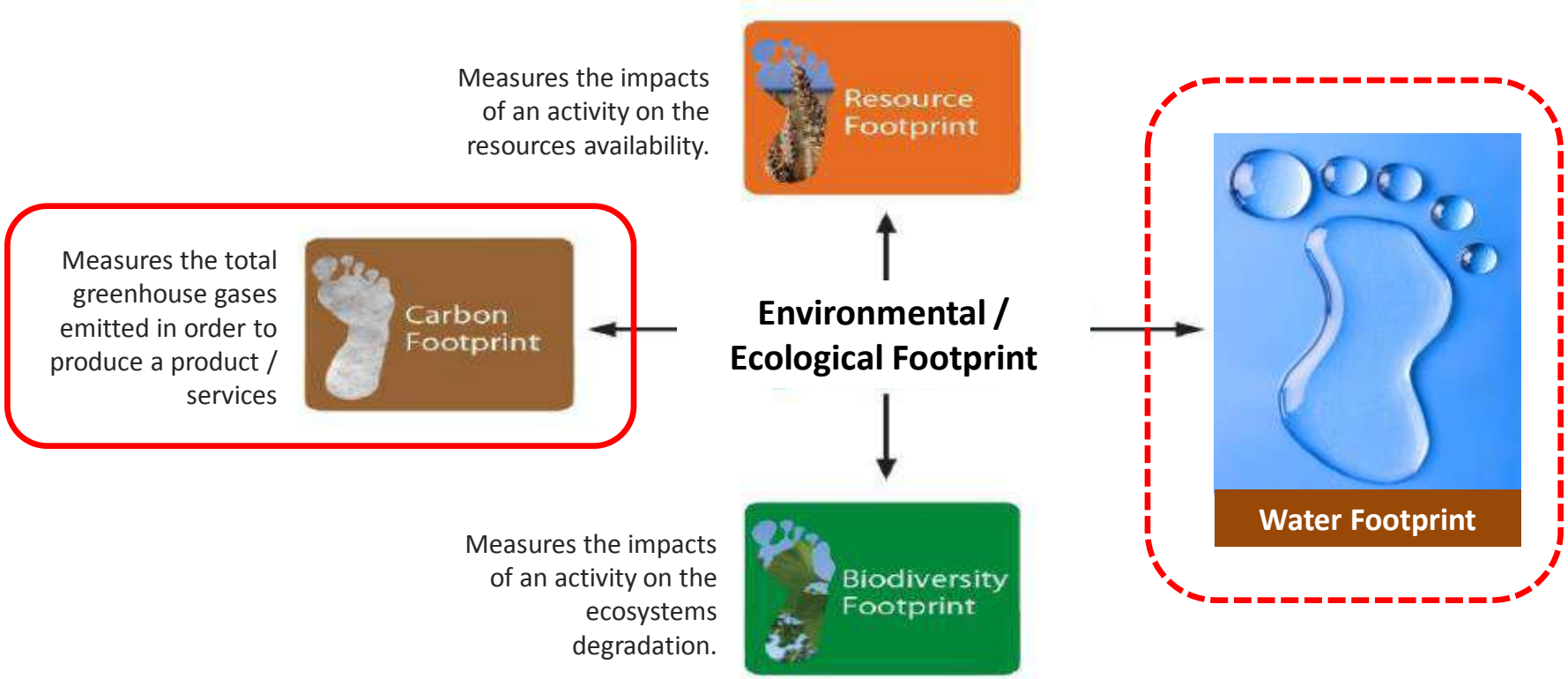
We have done various studies on fossil fuel i.e. carbon footprint, dust and gas emissions etc.

We now need to assess our water resources to understand how much we are consuming this precious earth's resources and make improvements towards achieving zero water discharge.

Water: Most Important Natural Resources

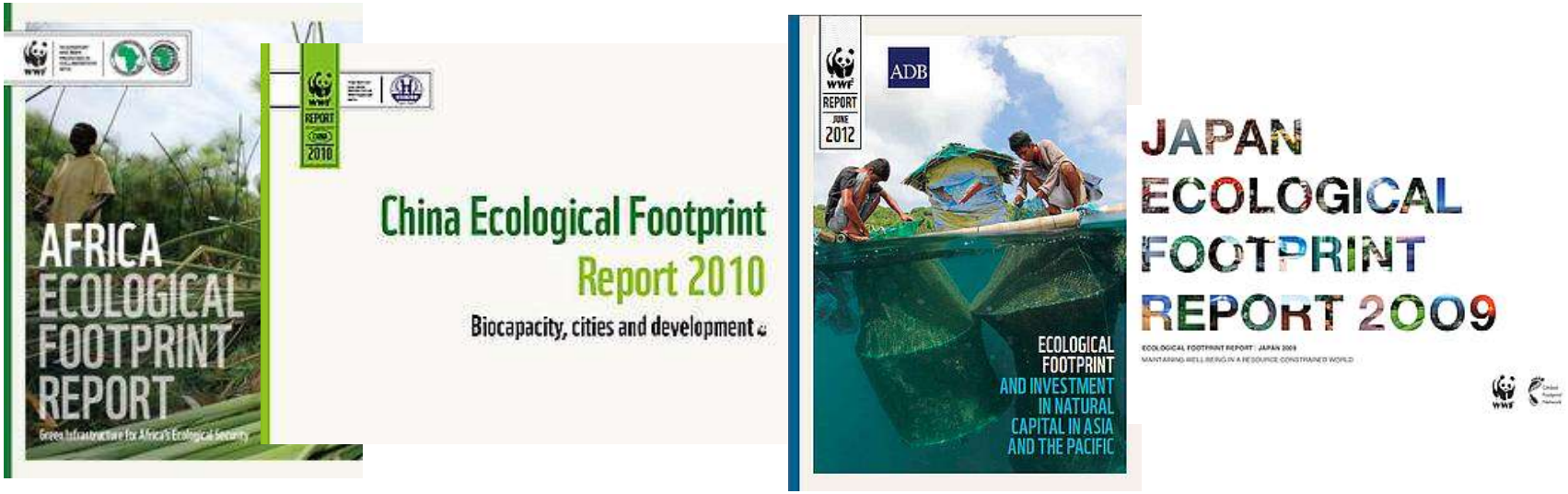
Introduction

Water Footprint is part of the overall Ecological Footprint, which is a comprehensive quantitative assessment of the immediate and indirect environmental impact of a product, process or service, through the following 4 categories (Veolia, 2011):



Introduction

Worries about global warming, contaminated air and water etc. have encouraged many countries / organizations to evaluate how much of the earth's resources they are using. Many have voluntarily embarked on assessment of their ecological footprint to understand how much they're consuming the earth's resources so that they can plan and make improvements and responsible decisions.



Why Water Footprint

A 2007 study by NAHRIM concluded that Peninsular Malaysia will be potentially exposed to vulnerability of global warming effects due to decrease of annual rain in several states and projected dry years in 2020, 2029, 2034 and 2044.

River flow in several states is expected to decrease by between 3% to 93% in 2050.

Why Water Footprint

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The Star 19th February, 2014

Negri Sembilan Declares State of Crisis over Water Shortage

BY Sarban Singh

SEREMBAN: The Negri Sembilan government has declared a state of crisis after taps ran dry in several thousand households on Wednesday. This follows an unusually long dry spell, which has resulted in several water catchment areas drying up.
Mentri Besar Datuk Seri Mohamad Hasan said the state Natural Disaster Operations room has also been activated to coordinate efforts to supply treated water to consumers in the affected areas.

"In fact we have also been unable to draw water from Sg Batang Benar and Sg Ulu Muar which provide raw water to the Talang, Kelinchi and Sg Terip dams as both have dried up," he said adding that up to 8,000 households have been affected.

He said the authorities used to draw up to 13 million litres of raw water from Sg Batang Benar and another 45 million litres from Sg Ulu Muar, which were used to supply consumers in Seremban alone.
About 200,000 households consume some 340 million litres of water daily.
Mohamad said Sendayan, Rasah and Mambau were among the affected areas.

Why Water Footprint

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The Malay Mail 19th February, 2014

Deputy Minister: Cloud Seeding this Week as Selangor Water Levels Plunge

By Faizal Nor Izham

PETALING JAYA, Feb 19 — The water reserve continues to drop, causing concern that rationing could take place soon if the hot spell continues. Syarikat Bekalan Air Selangor (Syabas) confirmed the reserve at the Sungai Selangor dam was at 53% yesterday while the reserve at Klang Gates was at 56 per cent. "The water levels at both dams have decreased compared to the reserves recorded on Thursday," Syabas communications and public affairs deputy general manager Priscilla Alfred said.

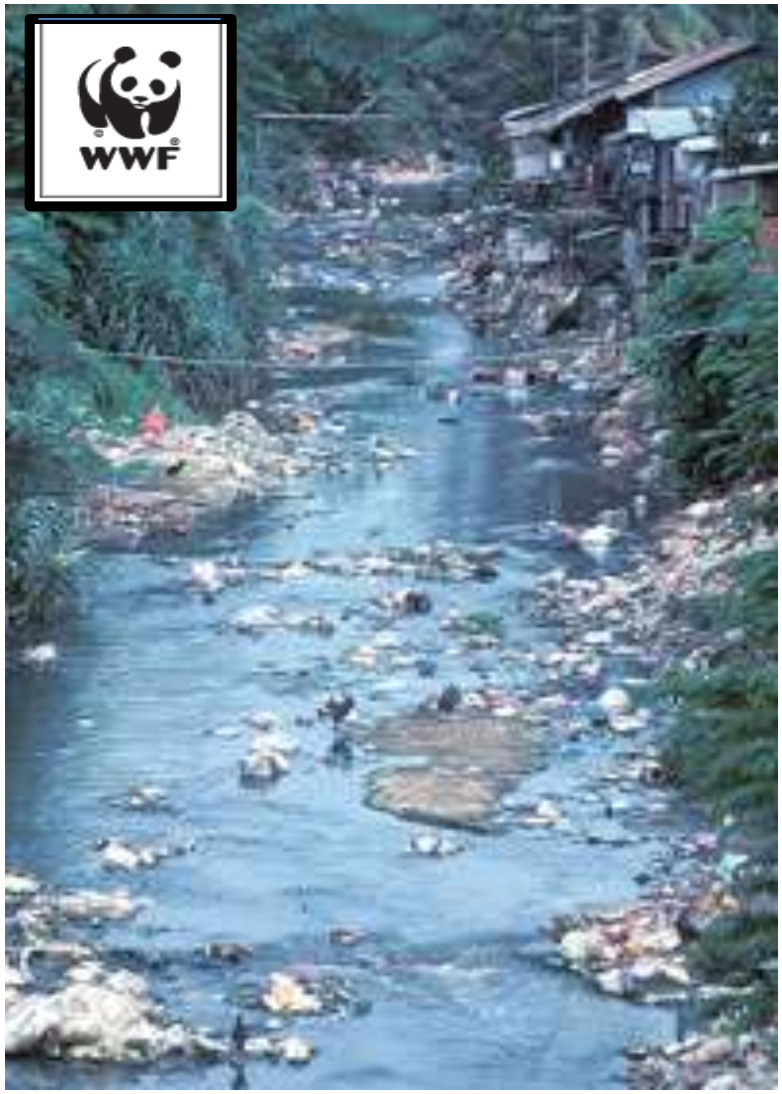
"We have seen a five per cent decrease of reserve at the Sungai Selangor dam and a one per cent decrease at Klang Gates within five days." Energy, Green Technology and Water Deputy Minister Datuk Seri Mahdzir Khalid said cloud seeding exercise will be carried out in water catchment areas this week to prevent a water crisis in the Klang Valley.

"It has been almost a week since my last visit to the dams, yet there's still no rain," he said, adding that the reserves could fall to critical levels if the hot weather continues. He warned that reserves at the Sungai Selangor dam could fall between 40 and 45 per cent if there is no rain for the next 20 days.

Why Water Footprint

Based on a study undertaken by WWF Malaysia, *Managing Water Resources well for Sustainability*, there are eleven major issues that must be addressed to ensure sustainability of our water resources for now and in the future:

- Over-emphasis on water supply management
- Institutional issues
- **High rates of water wastage**
- Changing weather patterns
- High rates of Non-revenue Water (NRW)
- Privatization of the water sector
- Destruction and degradation of water catchments
- Legislation
- Water pollution
- Low water rates
- Inefficient agricultural water use



Polluted river in squatter area Kampung Ara, Selangor. Photo Credit: WWF Malaysia, Undated

Introduction

Power plant water consumption requirement is governed by factors such as quality of raw water, cooling system, waste water management etc. Below are examples of water consumption at power plants:

Power Plant	Average town water for service water and demineralized water production.	Sea water discharge to remove surplus heat.
SJSAS, Manjung (Coal, 2,100MW)	213 m^3/hr	317,520 m^3/hr
SJTJ, Port Dickson (Gas, 1,500MW)	98m^3/hr	121,000 m^3/hr
SJSM, Kenyir (Hydro, 400MW)	1,300,000m^3/hr of water flowing through its main dam	
Typical Nuclear Power Plant @ 1,000MW	115 m^3/hr	182,000 m^3/hr

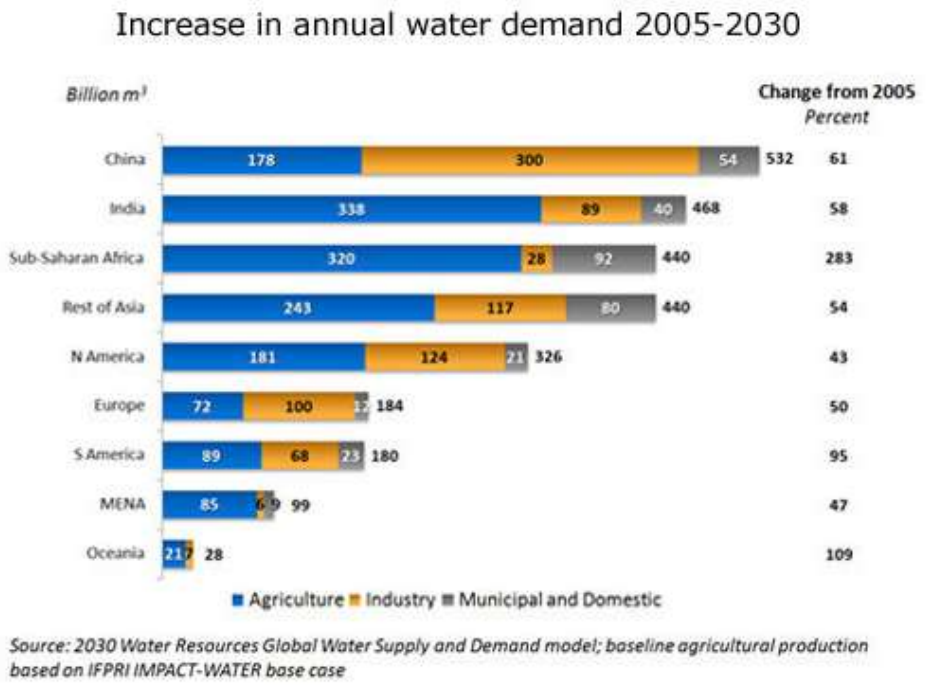
Why Water Footprint

Reducing usage and increase the quality of one of nature's most important resources, water, is also one of the initiatives that we can take to become Domestic Dominance Regional Champion (DDRC) in environmental sustainability under the Electricity Supply Industry. It is also part of our Gemilang 2015 green initiatives.

"TNB is committed to support the national green agenda and minimise the environmental impact of our business by applying sustainable, efficient operations and delivering green energy through the application of appropriate technologies and investments".

Why Water Footprint

40% of world's largest companies are experiencing water problems, 90% have developed water policies and plans. Water demand is projected to outstrip supply by 40% in 2030. Water, like fossil fuels, is a key challenge to businesses long-term sustainability. However, unlike fossil fuels, water has no sustainable alternatives.



Source: 2030 Water Resources Global Water Supply and Demand model; baseline agricultural production based on IFPRI IMPACT-WATER base case

Water Footprint

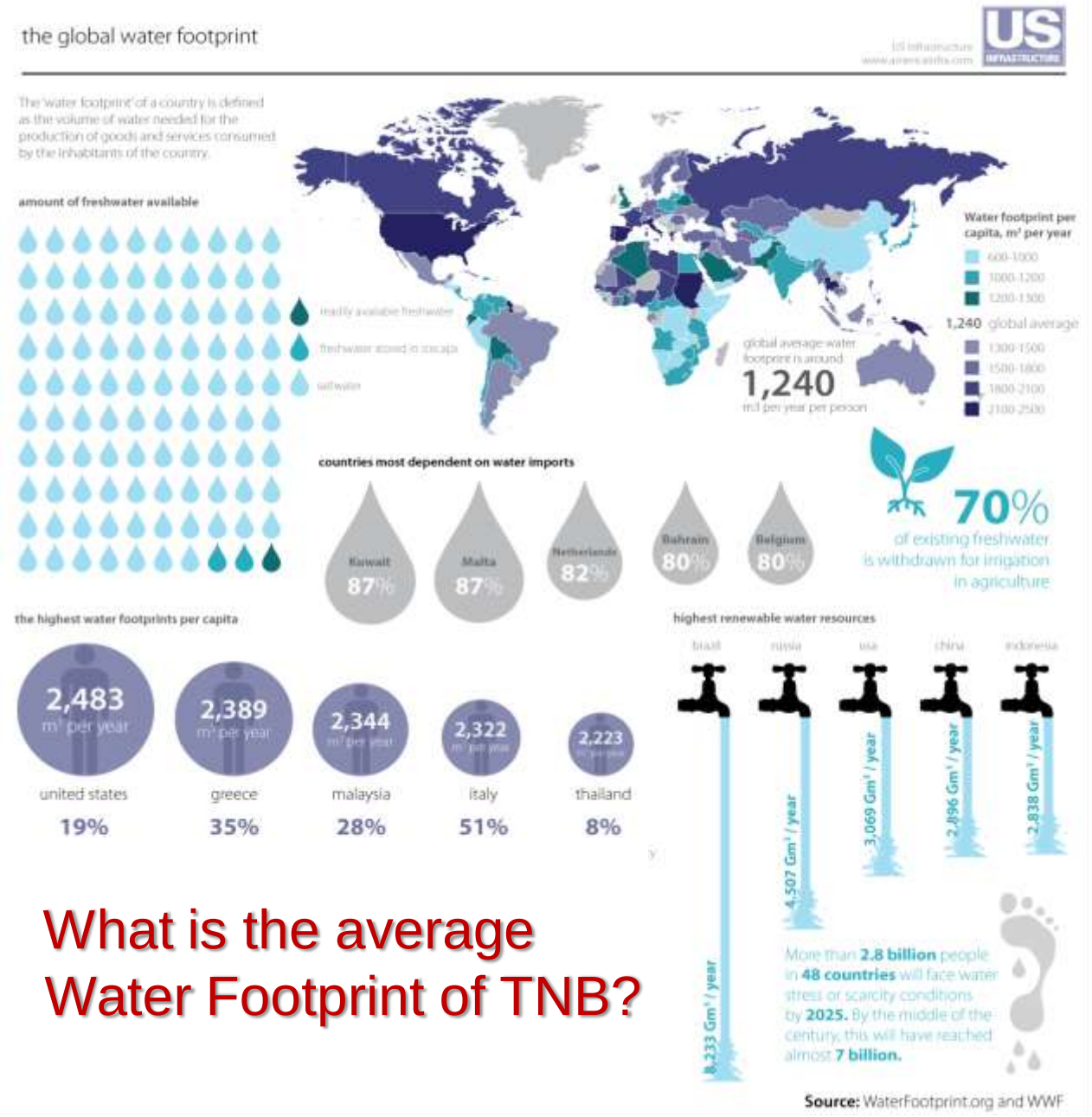
- Average consumer water footprint in Malaysia (1996-2005): 2,103 m^3/yr per capita

  Part of footprint falling outside of the country: 32.2 %

- Global average consumer water footprint (1996-2005): 1,385 m^3/yr per capita.

- Average consumer water footprint in the US (1996 – 2005): 2,842 m^3/yr per capita

Source: UNESCO, 2011



What is the average Water Footprint of TNB?

Water Footprint

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Beef (0.5 kg)
7,030 Litres

Jeans (1 pair)
11,000 Litres

Milk (3.8 L)
3,330 Litres

Coffee cup
140 Litres

Pork (0.5 kg)
2,860 Litres

Orange (0.5 kg)
208 Litres

Corn (0.5 kg)
408 Litres

1 Hamburger
2,400 Litres

Chicken (0.5 kg)
1,775
Litres

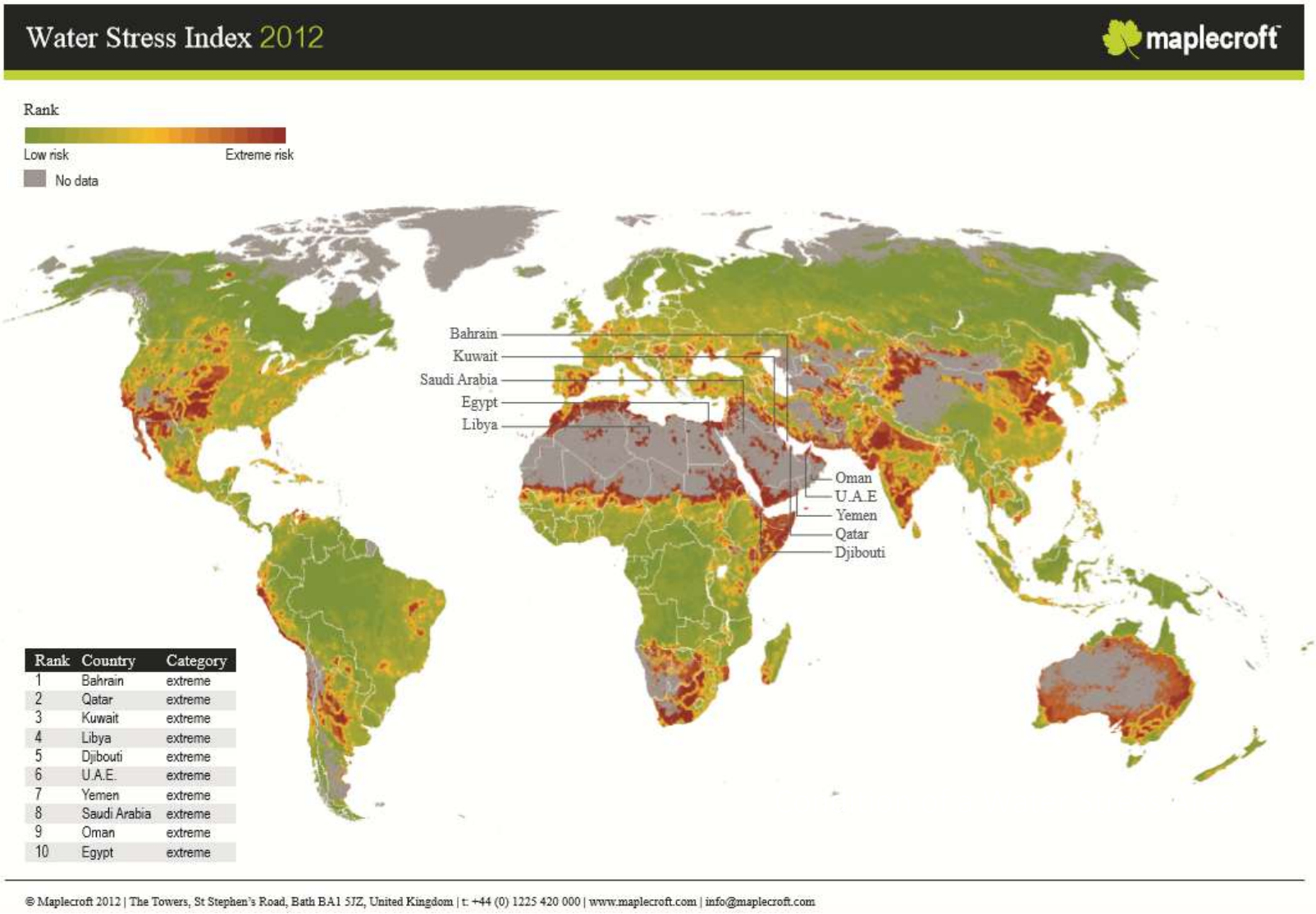
Water Stress Index

Water Stress Index (WSI) is a logarithmic value that describes the condition where an imbalance occurs between water demand and water availability of a particular area (UNESCO, 2009).

There are various WSI methodologies developed by organizations / countries. WSI varies mainly in function of:

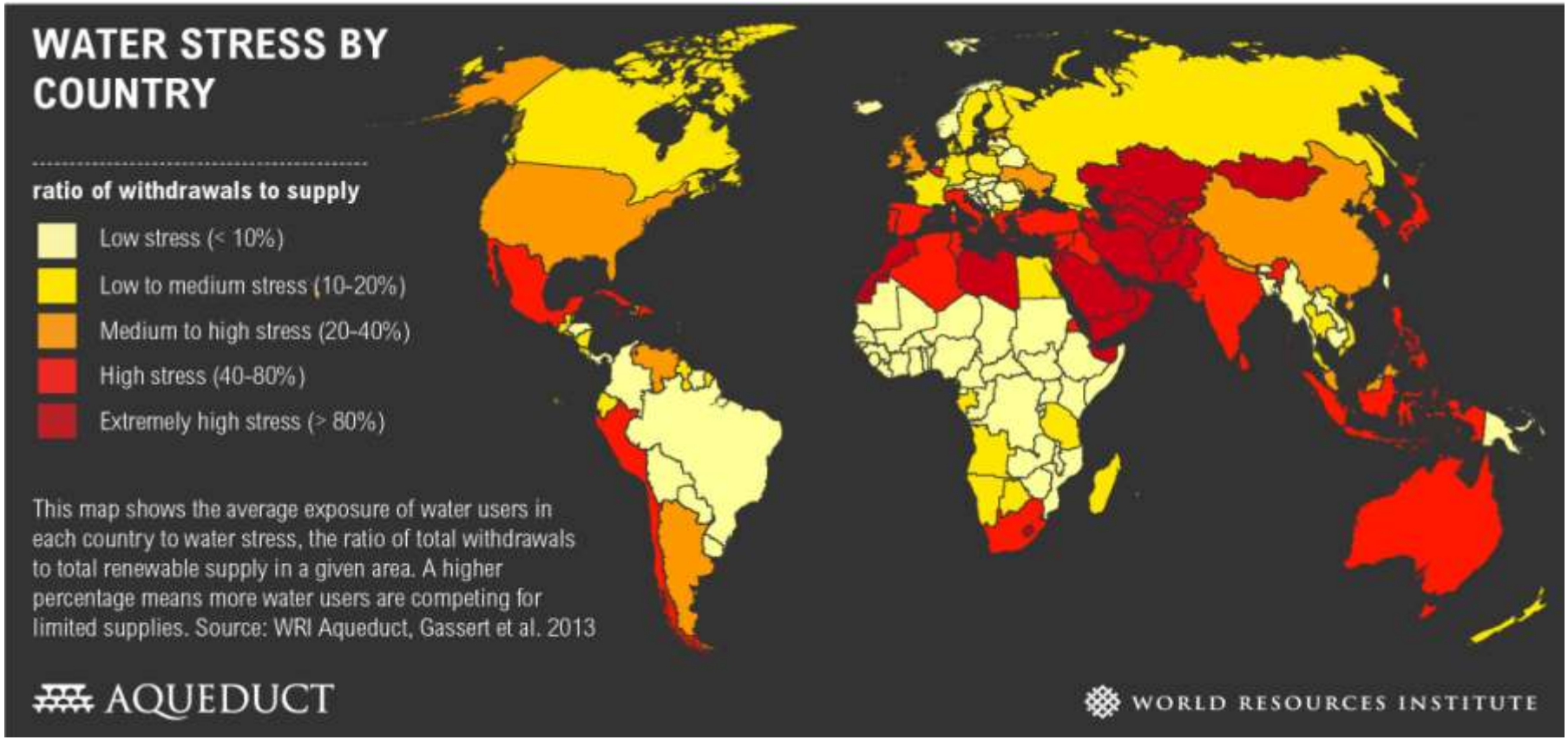
- Water use to availability ratio;
- Seasonality of freshwater availability;
- Storage capacity

Water Stress Index Map

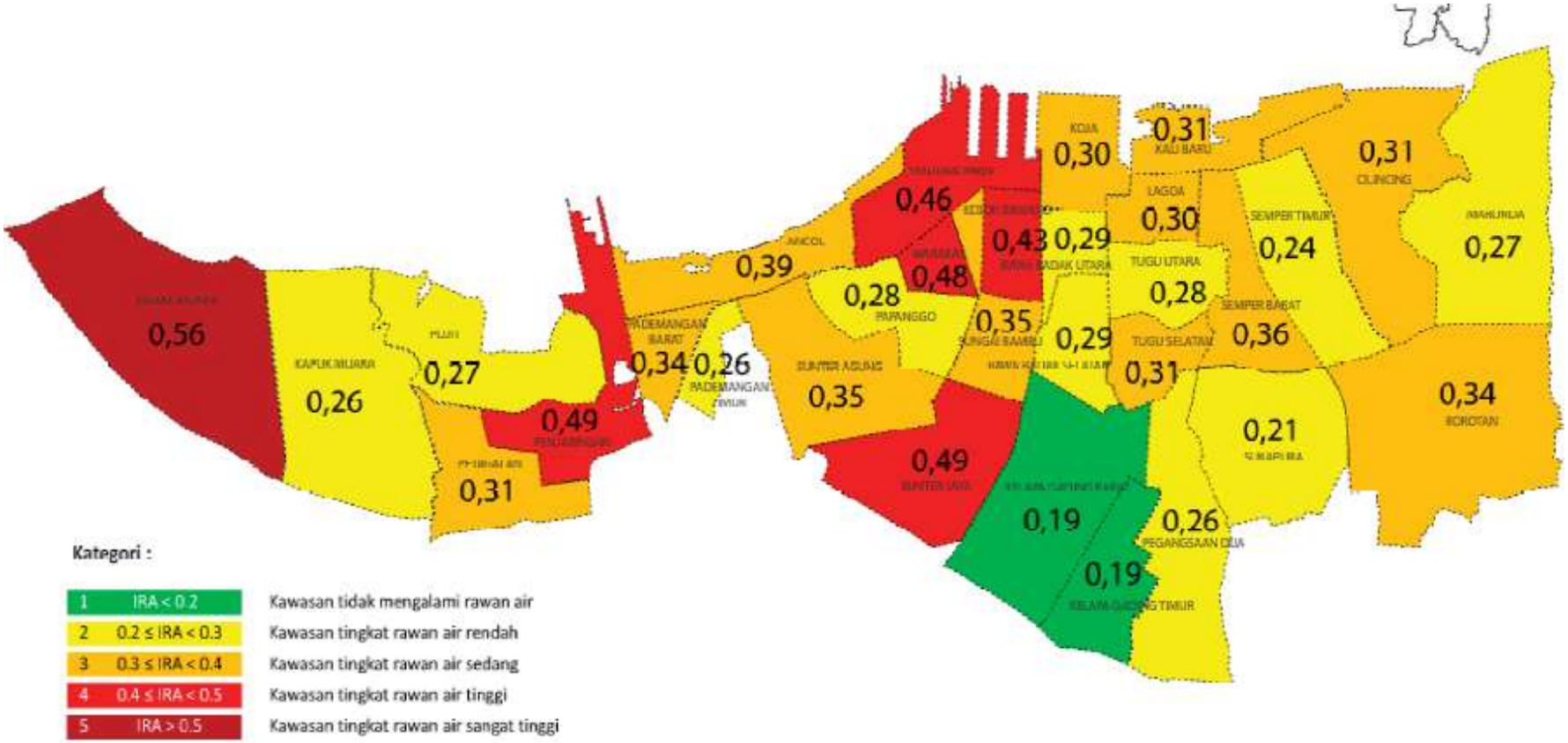


Rank	Country	Category
1	Bahrain	extreme
2	Qatar	extreme
3	Kuwait	extreme
4	Libya	extreme
5	Djibouti	extreme
6	U.A.E.	extreme
7	Yemen	extreme
8	Saudi Arabia	extreme
9	Oman	extreme
10	Egypt	extreme

Water Stress Index Map

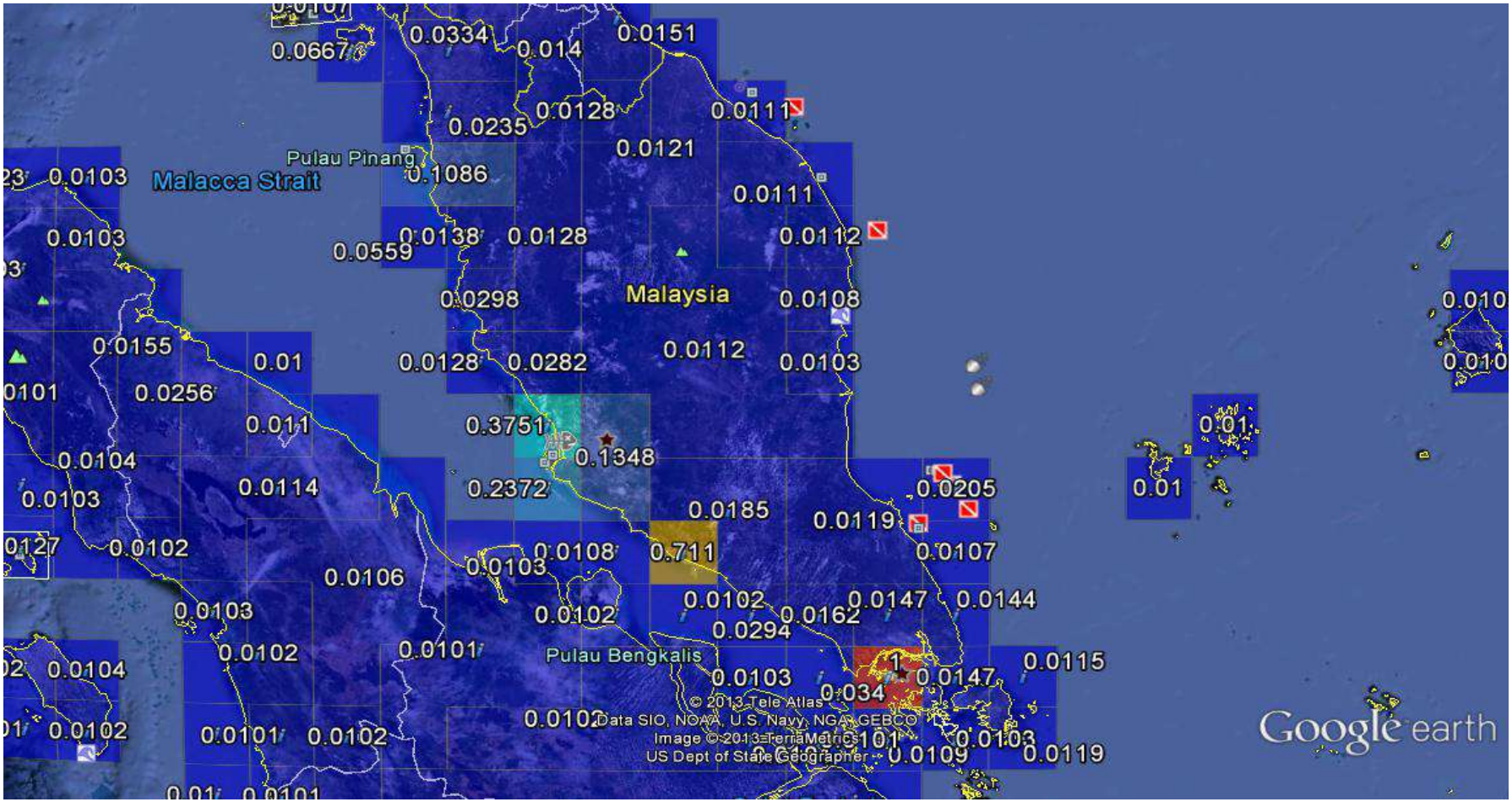


Water Stress Index Map



Water Stress Index (WSI) Map of North Jakarta
(Jakarta Water Supply Regulatory Body 2007)

Water Stress Index Map



WSI Map over the Coastal Areas of Peninsular Malaysia (Pfister et al, 2009)

Water Impact Index

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A metric indicator enabling a comprehensive assessment of the impact of human activity on surrounding water resources

WATER IMPACT = INDEX

VOLUME
- Water Quantity
- Net Water Extracted - Released

x

QUALITY
- Water Quality extracted and released

x

STRESS
- Water Stress Index
- Local Hydrology: Freshwater Scarcity

$$WII = \sum_{j} \left(W_j \times Q_j \times WSI_j \right) - \sum_{k} \left(R_k \times Q_k \times WSI_k \right)$$

Volume — **Water abstracted** — **Quality** — **Stress** — **Water released** — **Quality**

Water Impact Index Highlights Major Challenges and Prioritize Actions

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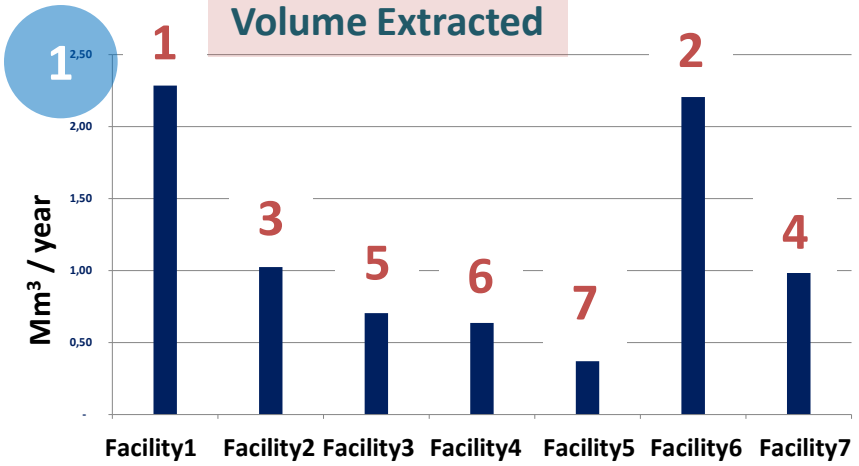
1

Volume Extracted



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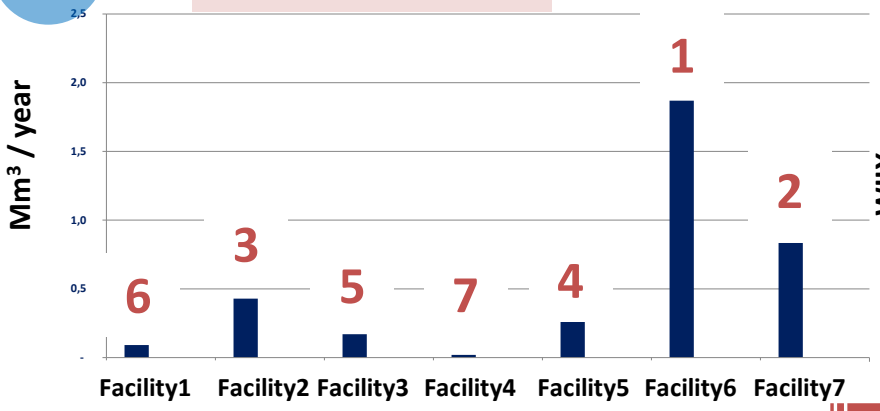
Net Consumption



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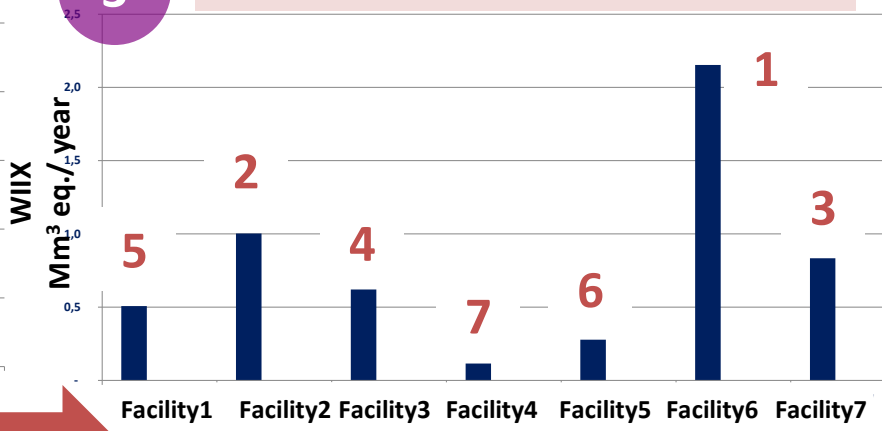
Integrating Water Quality Index



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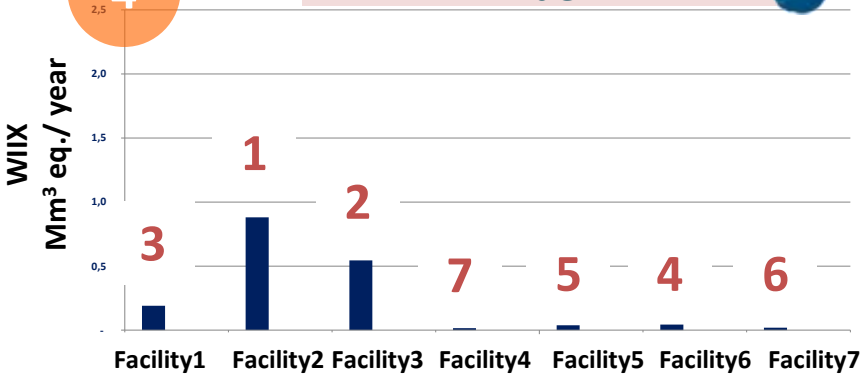
Water Impact Index: Integrating Water Stress Index



Better. Brighter.

Project Objectives

- Develop Water Footprint assessment tool to measure the Water Footprint for TNB power plants. The assessment tool will ultimately be used as an annual reporting tool for TNB power plants.

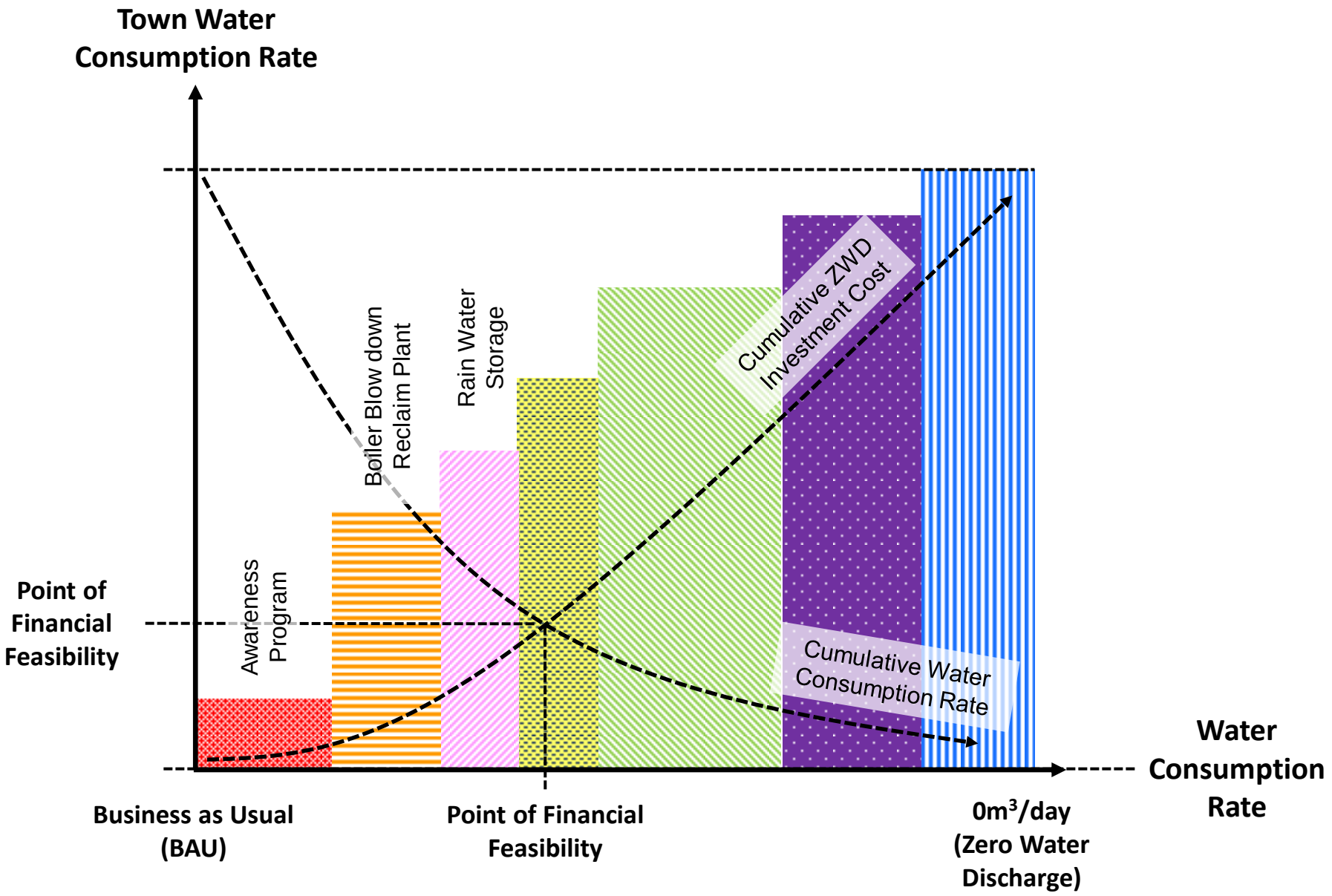
- Identify processes within TNB power plants that can potentially reduce usage of water resources.

- Identify the most appropriate water recycling technology and construct a small – scale pilot water reclamation (treatment) plant based on that technology to study its effectiveness and feasibility for future full scale implementation at TNB power plants.

- Evaluate the implementation of 3R concept towards zero water discharge principal at TNB thermal power stations.

- Identify sites within Peninsular Malaysia that are likely exposed to current and future water stress issues.

Project Objectives



Scope of Works

A pilot-scale water reclamation plant is proposed to be built and evaluated to treat 25 m^3/hr of wastewater from plant operation for feed back to raw water supply to minimize environmental impact of discharged water to the environment.

Example of a small Water Reclamation Plant

Cost to reclaim waste water are:

Item	Description	Cost (RM)
1	CAPEX	900,000
2	OPEX P.A. (@ AVE 10 YRS):	
	Electricity	60,000
	Chemicals & Consumables	340,000

Note: The above cost is based on water quality data provided by SJSAS, on steel flocculation – clarifier – filter tanks system, excluding sludge handling and long distance pumping.

Scope of Works

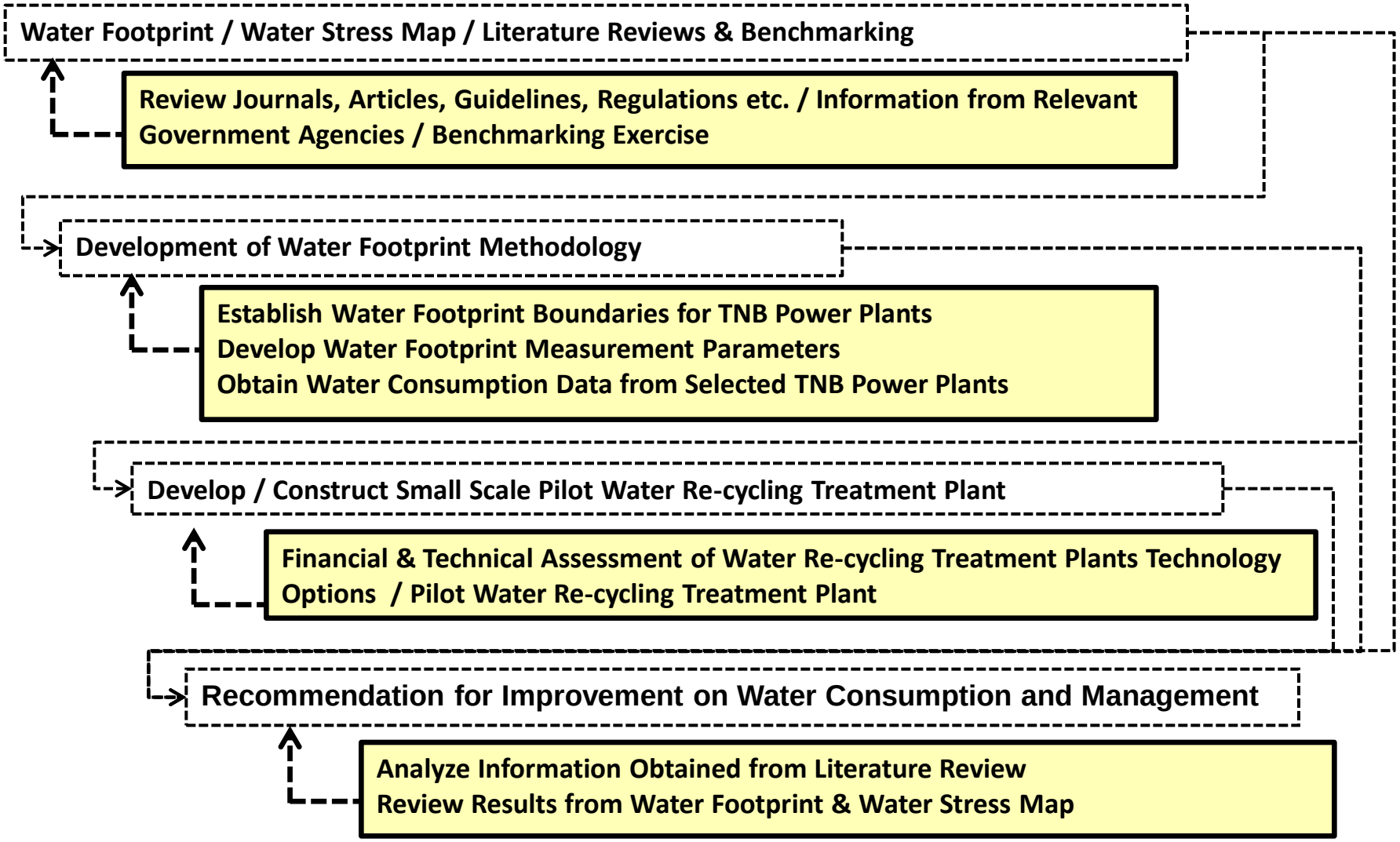
Assuming the Reclaim Plant is to be operated for a period of 10 years, total cost for producing a 1 m^3/hr of water from the Reclaim Plant (including transmission loss etc.) is RM 2.21 m^3/hr.

Determining economic viability of a reclaim plant is site-specific i.e. price of treated water in Perak for industry use is RM 1.60/m^3 whereas in Johor is RM 2.96/m^3. On the onset, principle difference between the 2 tariffs would have formulated that the Reclaim Project would currently be viable for a Power Plant located in Johor (a more detailed study is required).

The non-financial benefit in undertaking Reclaim Plant is that the reduced town water consumption as a result of substitute from the recycled water would ensure less risk in the future of external disruption.

Secondly, TNB will be able to demonstrate its commitment in sustainability to the Malaysian Government as the reclaim project will reduce the flow of waste water to the local environment by 600m^3/d.

Research Methodologies



Project Impacts

- Develop expertise within TNB / TNBR on a differentiating decision making tool for water footprint analysis.
- Assessment of future water vulnerability to TNB's power plants.
- Identification of the actions that can be undertaken to reduce TNB's impact on the precious water resource and develop a better management of its power plants water management.
- Demonstrate TNB's seriousness in environmental preservation and sustainability.
- Reducing usage and increase the quality of one of nature's most important resources, water, is also one of the initiatives that we can take to become Domestic Dominance Regional Champion (DDRC) in environmental sustainability under the Electricity Supply Industry.
- Anticipation of emerging water credit markets (similar to carbon credit markets).

THANK YOU

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