



**National Hydraulic Research Institute of Malaysia (NAHRIM)  
Ministry of Natural Resources and Environment (NRE)**

## **Expert Group Meeting on Sustainable Application of Waste-to-Energy in Asian Region**

**Waste-biomass Based Biogas Production and Energy  
Utilization to Cope With Climate Change Issue in Malaysia**

**APPLICATION OF BIODIGESTER TOWARDS THE  
SUSTAINABILITY AND SECURITY OF WATER RESOURCES**

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**22-23 FEBRUARY 2018  
BUSAN, REPUBLIC OF KOREA**

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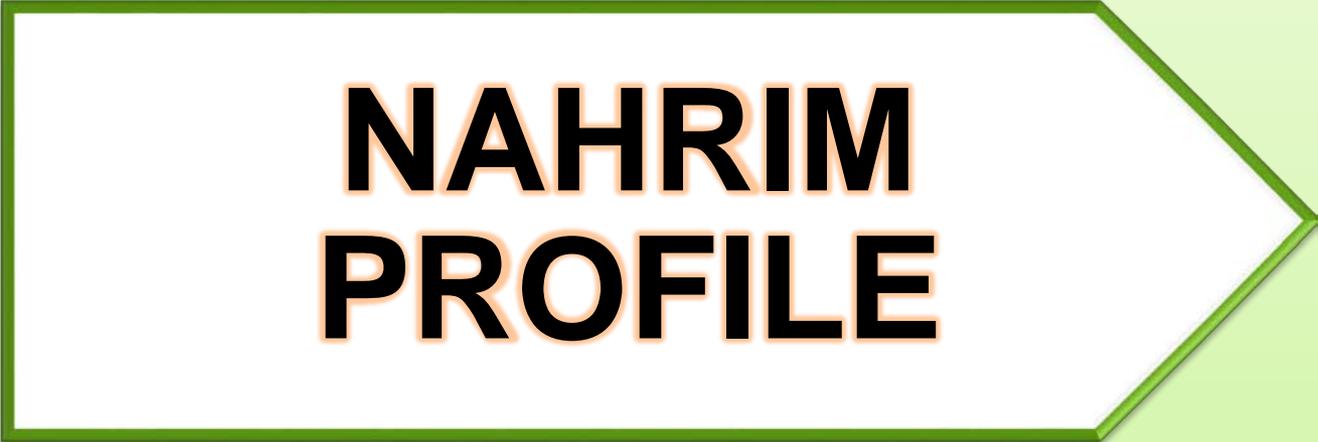
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**NAHRIM  
PROFILE**

## VISION

- To be the premier hydraulic research center for water and its environment in the world by 2030.

## MISSION

- To provide excellent services as an expert center on water and its environment management to ensure sustainable growth in order to improve the quality of life and well being.



# FUNCTIONS OF NAHRIM

1. Conducting basic and applied research within water sector such as river basin, water resources and climate change, coastal and oceanography, hydrogeology and water quality and environment;

2. Providing expert consultancy services pertaining to water and its environment for the public and private sector;

3. Providing advisory role in the water related fields and

4. As a referral centre for water and environment related research at the national level as well as participating actively in bilateral or multilateral research at international level.

# NAHRIM RESEARCH CENTRE AND DIVISION

**MANAGEMENT SERVICES DIVISION**

**CORPORATE AND PLANNING DIVISION**

**INFORMATION MANAGEMENT DIVISION**

**HYDROGEOLOGY RESEARCH CENTRE**

**COASTAL MANAGEMENT AND OCEANOGRAPHY RESEARCH CENTRE**

**RIVER BASIN RESEARCH CENTRE**

**WATER QUALITY AND ENVIRONMENT RESEARCH CENTRE**

**WATER RESOURCES AND CLIMATE CHANGE RESEARCH CENTRE**

**HYDRAULIC AND INSTRUMENTATION LABORATORY**

**WATER QUALITY LABORATORY**

# COMPLEX OF NAHRIM





**WASTE AND  
ISSUES RELATED  
IN MALAYSIA**

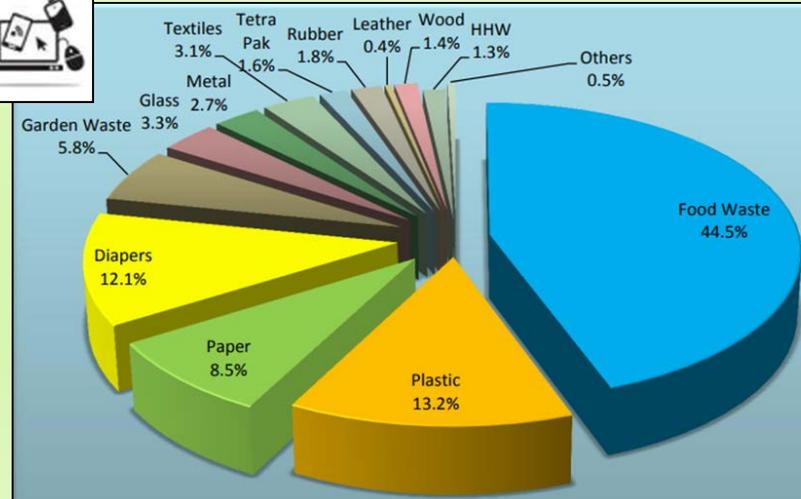
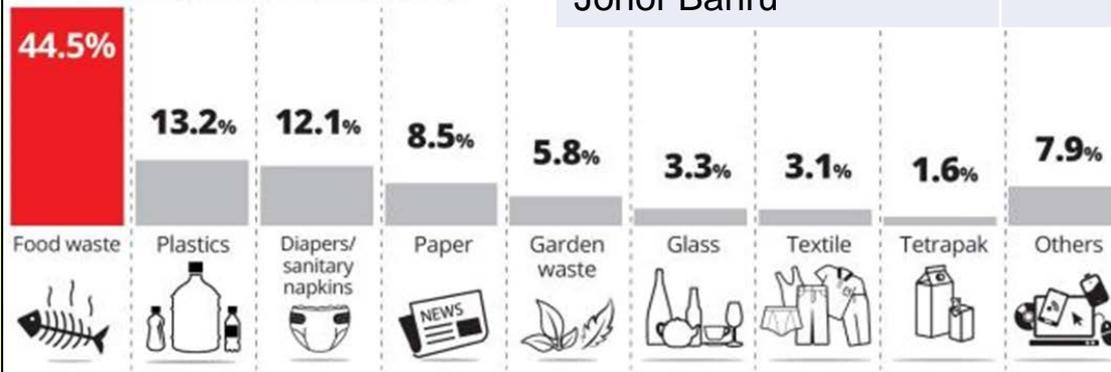
# MUNICIPAL SOLID WASTE COMPOSITION FOR MALAYSIA

Solid waste generated in major urban areas is increasing rapidly due to increase of urban population. The municipal solid waste is mainly comprised of domestic and industrial waste.

State	Solid Waste (tonne/day)	
	Year 1998	Year 2000
Kuala Lumpur	2350	2800
Penang	1220	1400
Johor Bahru	450	500

Shahida Begum and A.H. Nazri, 2013

Waste composition in Malaysia



HHW – Household Hazardous waste  
Wood – Wood + Peel / Husk

**Waste generation:**  
**0.85 kg/person/day (average)**  
**1.5 kg/person/day (major city)**

Source: Survey on Solid Waste Composition, Characteristics & Existing Practice of Solid Waste Recycling in Malaysia, Jabatan Pengurusan Sisa Pepejal Negara (JPSPN 2013)



Kira-kira 3,000 tan metrik (3 juta kilogram) sisa makanan yang pada dasarnya tidak disentuh dan masih boleh dimakan telah dibuang oleh isi rumah dan jumlah itu adalah mencukupi untuk memberi makan dua juta orang yang kelaparan.

Kosmo, 28 Nov 2016

# FOOD WASTE

## Pembaziran Makanan Di Malaysia Sangat Tinggi

Diterbitkan: Isnin, 30 Mei 2016 11:46 AM



mStar, 30 May 2016

(Ubah saiz teks)

KUALA LUMPUR: Statistik menunjukkan bahawa jumlah sisa makanan yang dibuang di Malaysia amatlah mengejutkan: setiap hari, kira-kira 3,000 tan metrik sisa makanan yang



The Star, 3 June 2013

## 930 tonnes of food being thrown away every day

BY P. ARUNA  
ARUNA@THESTAR.COM.MY

Email Share Facebook Tweet

KUALA LUMPUR: Malaysians can afford to eat less because they are either overeating or wasting food, throwing away up to 930 tonnes of unconsumed food daily, say experts.

This is equivalent to us throwing away 93,000 10kg bags of rice each day.

The experts warn that people must change or adapt their eating habits in the light of rising rice prices and a looming food shortage, adding that the country was already facing a food crisis.

Universiti Malaya Prof Dr P. Agamuthu said wastage was a growing trend, adding that almost 50% of the 31,000 tonnes of waste produced daily by Malaysians comprised organic kitchen waste such as leftover food.

"Malaysians discard about 930 tonnes of unconsumed food daily. Wastage of unconsumed food alone in Malaysia has doubled over the past three years. This does not even include leftover food," he said, adding that the unconsumed food mostly consisted of expired bread, eggs and old or rotten fruit.



News Straits Times, 27 May 2012

## Kuching is being Swamped by Waste

Share this:



Clean Malaysia, 7 February 2018

ENVIRONMENT



# SOLID WASTE



Utusan, 13 October 2009



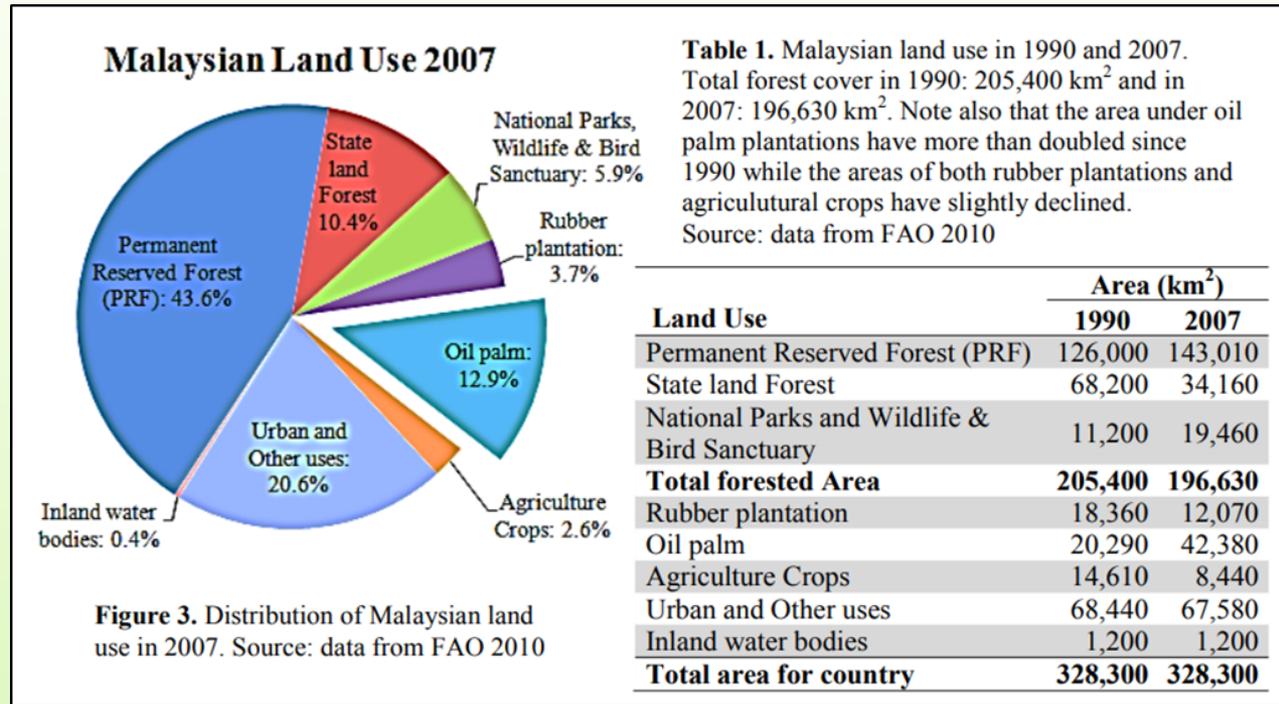
Borneo Post Online, 4 August 2015

➤ Malaysia is currently the world's second largest producer and exporter of palm oil which is 47%.

➤ Oil palm is the most important agricultural product in Malaysia.

➤ However, the growth of oil palm industry has created a major disposal problem.

➤ Breakdown of wastes from palm oil production in 2007:



Wastes	Quantity (million tonnes)
Fronds	4.681
Empty fruit bunches (EFB)	1.801
Palm pressed fibres	1.105
Oil palm trunks (OPT)	1.082
Shell	0.450

Palm Oil Mill Effluent (POME) 66.8 million tonnes (2005)

Source: Variappan and Yen, 2008

# PALM OIL WASTE



Empty Fruit Bunch (EFB)



Palm Oil Mill Effluent (POME)



Shell



Palm pressed fibres



FronDs



Trunks



**WASTE-TO-ENERGY,  
CLIMATE CHANGE AND  
WATER RESOURCES**

# WASTE-TO-ENERGY

- Biomass can be used to produce biogas in order to reduce dependence on fossil fuels and to achieve environmental benefits.
- The two most potential sources of biomass for Malaysia are **palm oil residues** and **municipal solid wastes** (MSW).
- The biogas produced can be used for heating, electricity production or as transportation fuel.

Shahida Begum and A H Nazri, 2013.

# WASTE-TO-ENERGY

- Palm Oil Mill Effluent (POME) is a by-product of a processed Fresh Fruit Bunch (FFB) of palm oil. POME is the most expensive and difficult waste to manage by mill operators. However digestion of POME can produce biogas as a by-product and change POME from waste to resources.

Yahaya S. Madaki and Lau Seng, 2013.

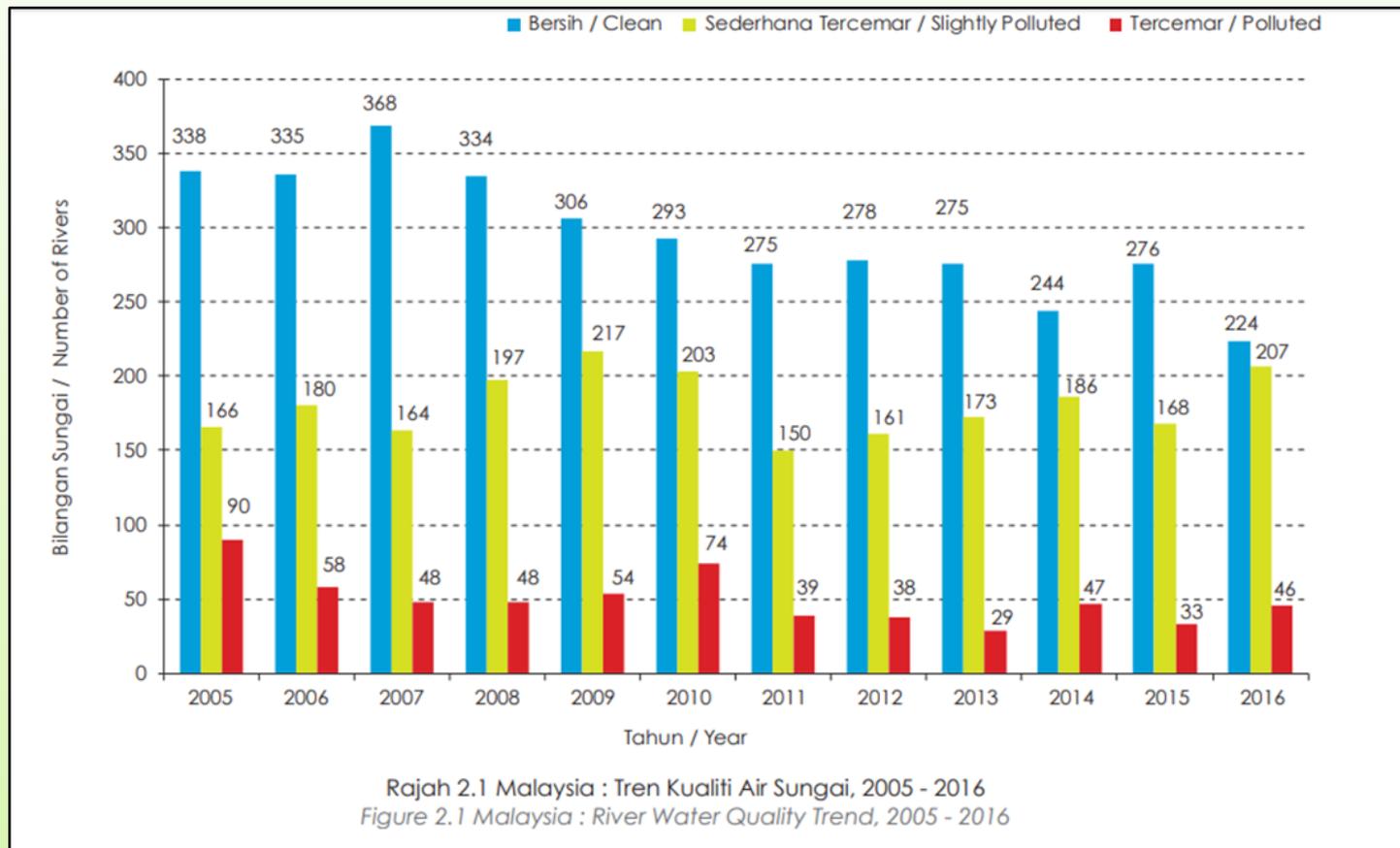
- Ahmad et al. (2011), reported that the most potential anaerobic degradation method application in waste sectors (for energy source) are on the municipal landfills and POME ponds.

# IMPACT ON THE CLIMATE CHANGE

- MSW contains organic materials as its largest portion, which produce gaseous emissions called landfill gas (LFG), such as methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>), and other gas elements through the decomposition process [Abushammala MFM. et al., 2010].
- CH<sub>4</sub> can become a major contributor to the greenhouse gaseous GHG that consequently cause the phenomena of global warming [WEILAND P., 2010].
- Harvesting biogas from landfill gas generated from the anaerobic digestion of organic fraction municipal solid waste may have potential as a substitute alternative transport fuel and as a significant means of treating organic fractions of municipal solid waste. In the meantime, Malaysia has focused on sanitary landfills equipped with gas recovery systems [MUNSTER M. and LUND H., 2010].
- EFB and POME are two major oil palm wastes that a viable renewable energy source for production of energy. Utilisation of this renewable source can reduce GHG emissions to the atmosphere [Shahida Begum and A H Nazri, 2013].



# Malaysia River Water Quality Trend: 2005-2016



- Out of 477 rivers monitored, 224 (47%) were found to be clean, 207 (43%) slightly polluted and 46 (10%) polluted.
- The major pollutants detected were sewage and effluent from agro-based and manufacturing industries. Also from animal farming and domestic sewage and land clearing activities.

# River pollution

STAR Online, 27 June 2017

Home / TSOL - Environment

## Excess food waste during Hari Raya can harm our rivers

JUNE 28, 2017 ENVIRONMENT, LIVING, TSOL - ENVIRONMENT  
BY STAR2.COM



### RELATED ARTICLES

Malaysians generate about 38,000 tonnes of waste daily. Around 15,000 tonnes of this is food waste – this can increase by up to 50% during festive periods!

These are the findings of SWCorp Malaysia, a government agency dealing with solid waste.

"The escalating amount of food waste is indeed a worrying trend, especially during festive seasons," said Ir Azmi Ibrahim, director of the Selangor Drainage and Irrigation Department (DID Selangor).

"It is a wake-up call for all of us. Improper handling of food waste is a serious threat to our rivers."

He explained that Malaysians love their food, but usually tend to order more than they can eat (note: this also leads to overspending and obesity).

JULY 4, 2016

## Penang's Rivers are as Polluted as Ever

Share this:



ENVIRONMENT



Clean Malaysia, 4 July 2016

## Eateries dump food waste into rivers, polluting eight rivers in Kuala Lumpur and Selangor

Star Online, 25 August 2016

FOCUS

Thursday, 25 Aug 2016

Breaking all the rules: The health department prohibits direct pipes into drains as well as washing plates or preparing food restaurants with fat, oil and grease (FOG) traps will be issued like Taman Megah, Cheras, however, is still operating as a result of GRACE CHEN/The Star

Breaking all drains as we grease (FOG) operating a

### Leachate polluting river

COMMUNITY

Wednesday, 20 Aug 2014



By Lim Chia Ying



STAR Online, 20 August 2014

Sinar Online, 2016



# River pollution

By **DEBBIE INJAN ANAK ANDREW JUMAT** - July 23, 2016 @ 12:00pm

PALM oil from the oil palm (*elaeis guianensis*) has, in recent years, become the world's most important vegetable oil when it comes to production quantity (USDA 2011). Used in various products from margarine to biofuel, palm oil has found a role in the West, as well as in the developing markets of China and India. The palm oil industry in Malaysia has been one of the biggest industries since 1960s.

A high demand for palm oil worldwide has made oil palm an important plantation crop, which contributes to our high national gross export (Azman et al., 2004). We know that palm oil plays an important role in economic development of the country but those involved in the industry often forget their responsibility in managing the water pollution.

According to the Department of Environment, the total water pollution sources (both point sources and non-point sources) in 2006 is 19.7 per cent in Johor and this region has a high oil palm density.

Recently, there were water disruptions in Johor due to Sungai Johor being polluted with high ammonia content. This was detected on July 12 by the state authorities. It rendered the water unfit for human consumption.

The pollution forced the temporary shutdown of three water treatment plants: Sungai Johor, Semanggar and Tai Hong.

The temporary shutdown of these plants affected 120,000 accounts in the southern part of Johor, not to mention the impact on the river ecosystem.

Time and again, we have been reminded that water is the basic need of life. Lack of clean water for a week can affect our health. Don't forget that water is not only for drinking but also for hygiene and sanitation.

**New Straits Times, 23 July 2016**

It was reported that Ulu Remis, had been

This is the second ca



Monitor palm oil mills to ensure that they do not discharge waste into rivers.

## Stop closing the stable door after the horse has bolted

November 21, 2017

It is time to punish regulators and enforcement agencies which fail to detect pollution right under their nose as it can only mean they are inefficient or corrupt.

### COMMENT



**Bernama, 21 November 2017**

By TK Chua

I refer to the news reports "River pollution: Johor palm oil mill suspended for 3 months".

Are we supposed to feel happy that a palm oil mill in Johore was ordered to suspend operations for three months after causing massive pollution to the water treatment plant?

True, the environment is the responsibility of all. Rightly, all must do their part to ensure that our water catchment areas remain free from contamination.

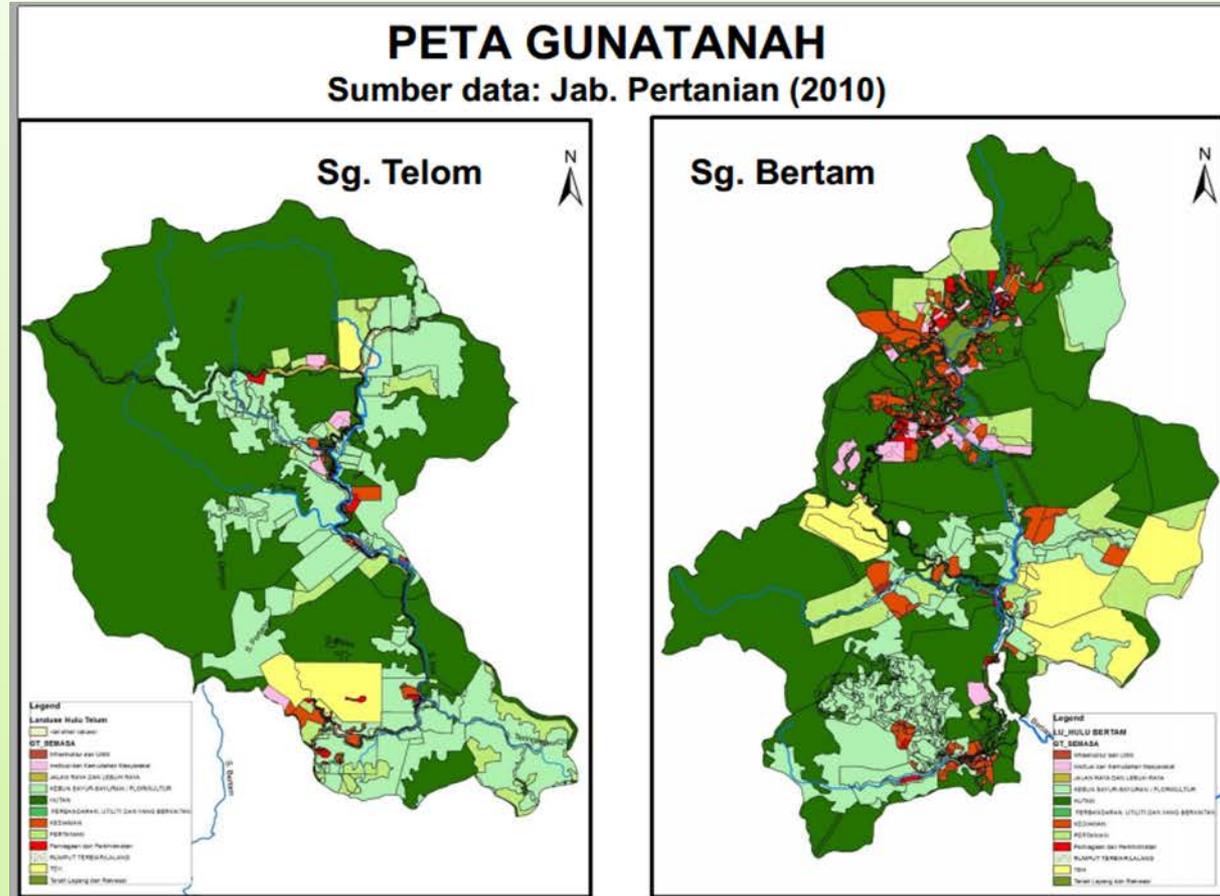
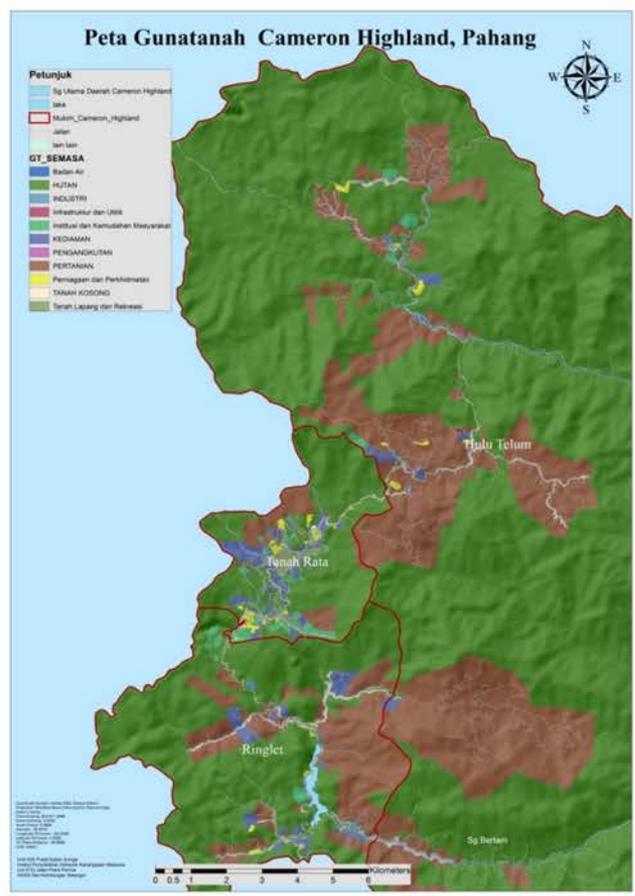
But I disagree that the public should not point their accusing finger at the authorities each time a massive contamination has taken place. On the contrary, I think the public has every right to do so.

It is the job of the regulators to ensure continuous compliance of all industrial players in the state.

**NAHRIM BIODIGESTER CASE STUDY  
- MANAGEMENT AND DEVELOPMENT  
PLAN TOWARDS THE SUSTAINABILITY  
AND SECURITY OF WATER RESOURCES  
IN CAMERON HIGHLANDS, PAHANG,  
MALAYSIA**



# LAND USE



Landuse Map in Cameron Highland, Pahang, Malaysia

Land use Map in Telom and Bertam River, Pahang, Malaysia

# ISSUES

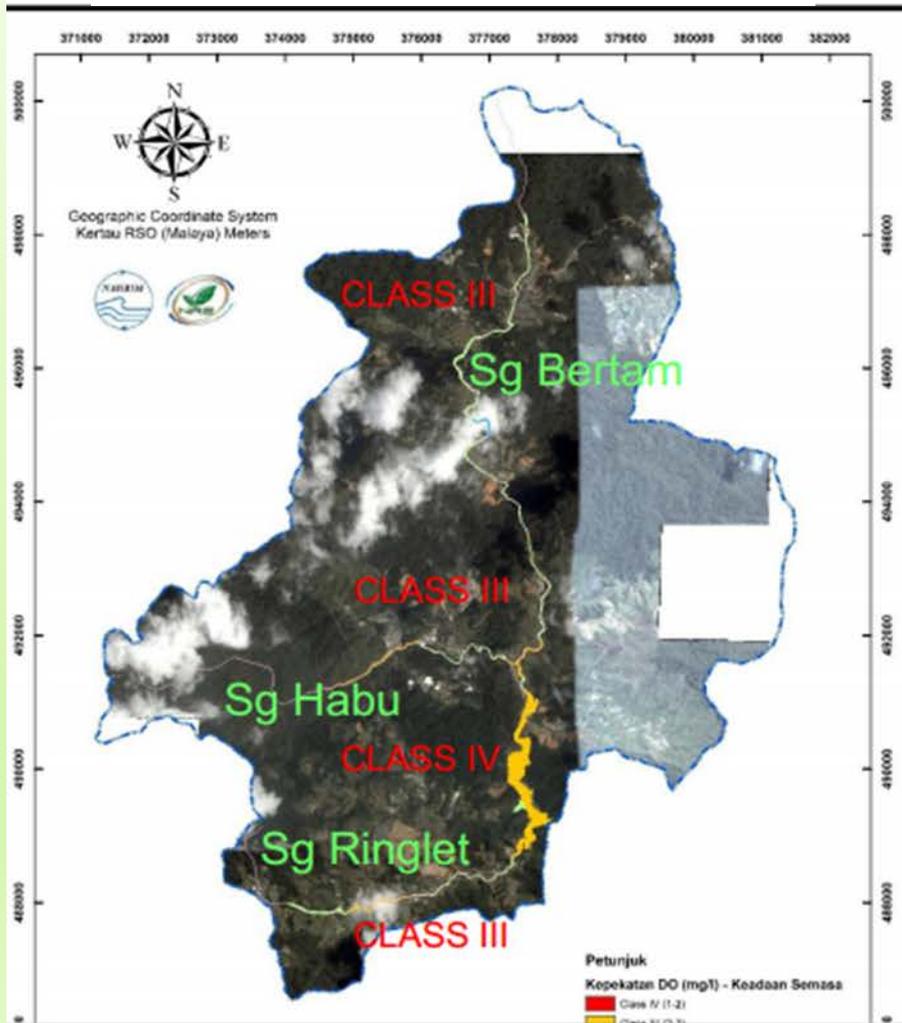
- Solid waste from agricultural activities such as plastic bag, polybag and mulching materials.
- River pollution by fertilizers and pesticides from the agricultural activities.
- River pollution from organic waste such as agriculture waste, food waste and sewage.

# OBJECTIVES OF STUDY

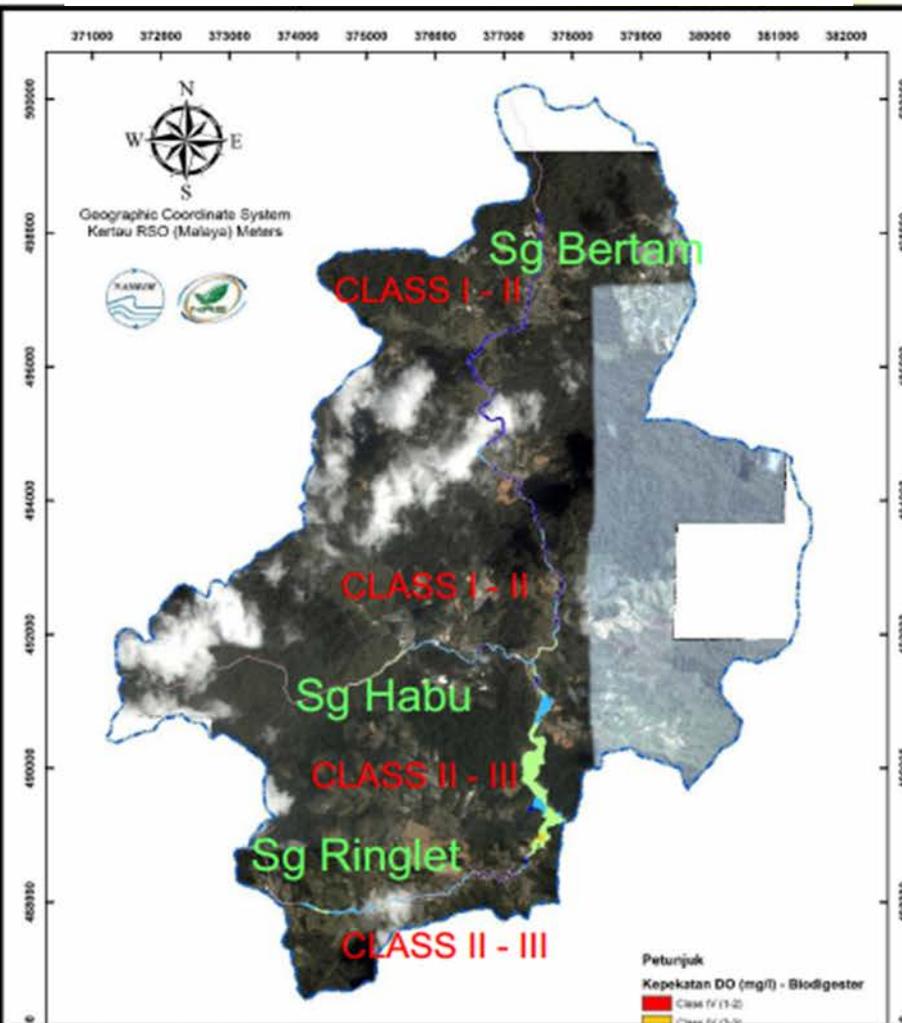
- To identify issues and problems of the study area including water quantity and quality aspect.
- To develop hydrodynamic and water quality model for Sg. Bertam and Sg. Telom.
- To develop a catchment management plan to address related issues.

# RIVER WATER QUALITY MODEL ANALYSIS AT CAMERON HIGHLANDS

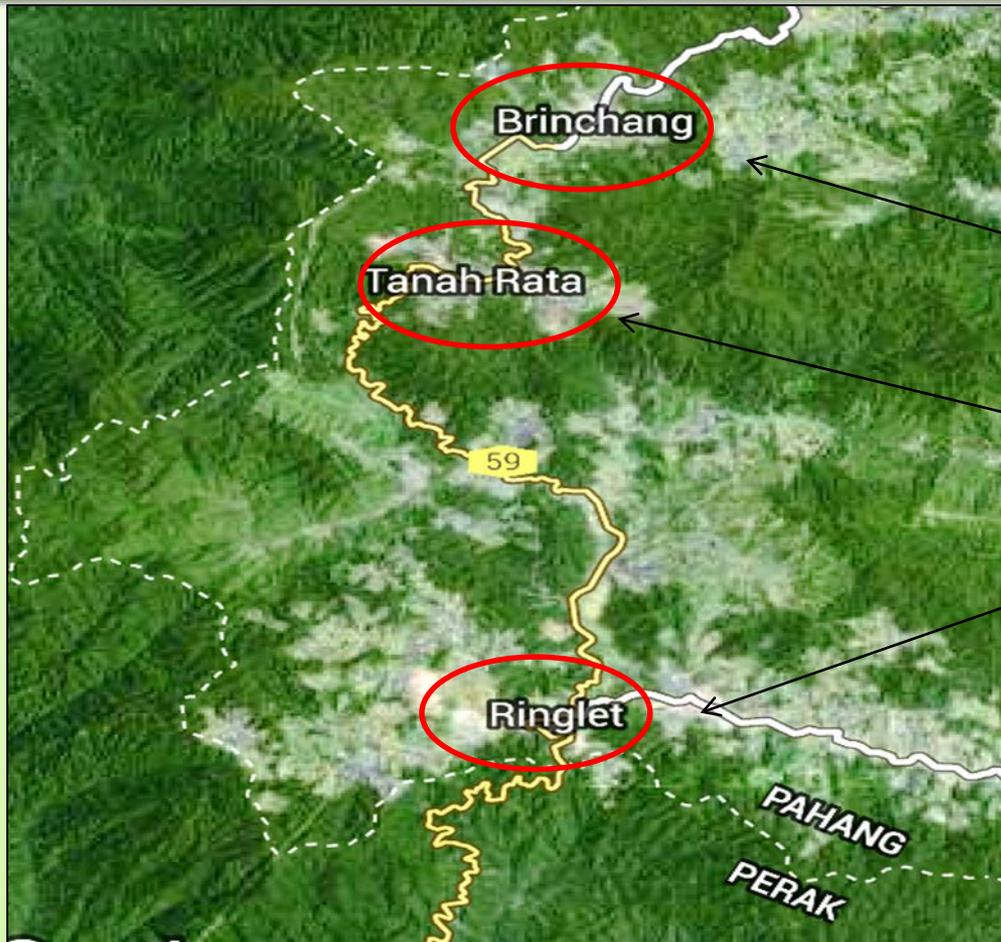
## Existing Condition



## Condition after Biodigester and NIDS treatment (including STP)



# PROPOSED LOCATION TO INSTALL NAHRIM BIODIGESTER (NIBS)



10 TPD

10 TPD

10 TPD

Estimated population = 50,000  
Waste generation = 1 kg/ca/d  
Total MSW wastes = 50 tpd  
Food and organics = 50% = 25 tpd  
Farm wastes = 5 tpd  
Total wastes = 25 + 5 = 30 tpd

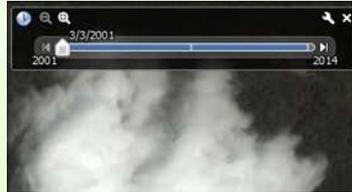
DISTANCE:

Ringlet – Tanah Rata : 11 km

Tanah Rata – Brinchang : 5 km

It is recommended to provide smaller Biodigester at 3 locations due to land availability, and minimize wastes movement on winding roads.

# PROPOSED LOCATION TO INSTALL NAHRIM BIODIGESTER (NIBS)



10 TPD BIODIGESTER	
Revenue (FIT & Fertilizer) per annum	RM 628,320
Savings on Waste disposal costs (collect + landfill)	RM 365,000
<b>Total Income</b>	<b>RM 993,320</b>
<b>Cost of 10 TPD Biodigester</b>	<b>RM 7.043 million</b>
<b>Operating Cost: per annum</b>	
Utilities cost (5% revenue)	RM 31,416
Operator costs (2 personnel)	RM 43,200
Transportation costs (10% of revenue)	RM99,332
Administration expenses (5% revenue)	RM 31,416
Maintenance (3% capex pa)	RM 117,000
<b>Total expenses</b>	<b>RM 322,364</b>
<b>Net Income per annum</b>	<b>RM 670,956</b>

Payback on capital = 10 years

Image © 2015 DigitalGlobe

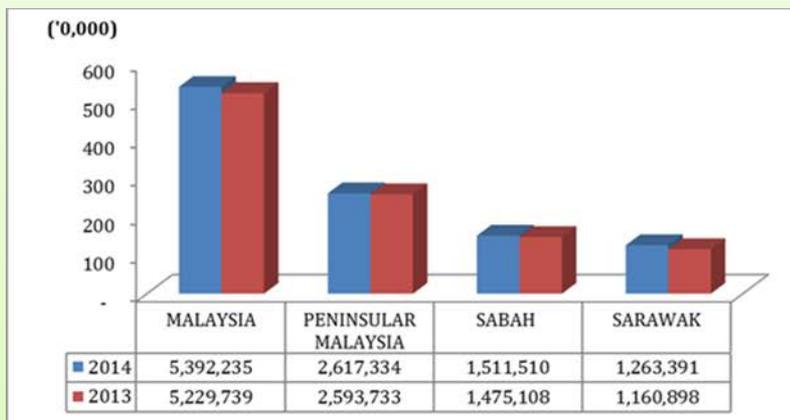
★ NIBS

Google earth

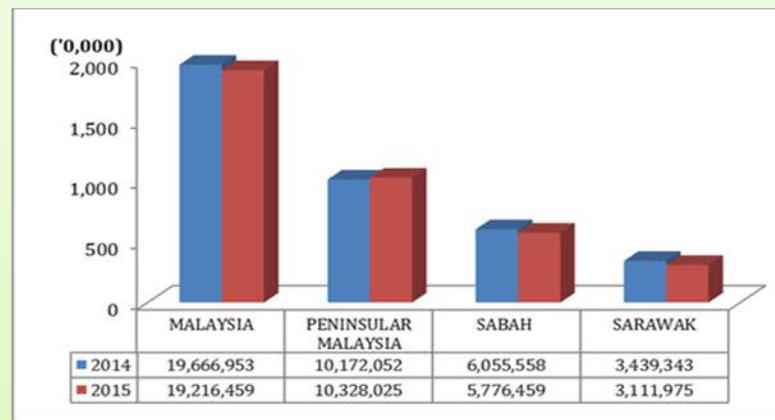
Imagery Date: 3/3/2001 lat 4.414628° lon 101.370702° elev 1272 m eye alt 5.81 km

# BUSINESS OPPORTUNITY OF BIODIGESTER IN MALAYSIA

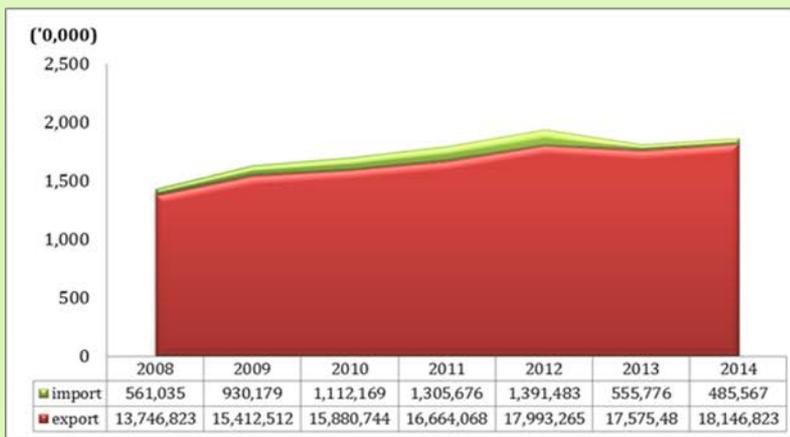
## Palm Oil Plantation (Ha)



## Crude Palm Oil (CPO) Production (Tonne)



## Palm Oil Import and Export (Tonne)



## Palm Oil Export from Malaysia in 2014 (%)



Source: Malaysia Palm Oil Board (MPOB)

# BUSINESS OPPORTUNITY OF BIODIGESTER IN MALAYSIA

- Based on research conducted, total biodigester to be installed in Malaysia: 2,628 units; Estimated cost: RM52Billion.
- The investment of 20 units biodigester/ year over the next 15 years will require a cost of RM400 million/year.
- The impact on the economy can be projected using a multiplier of output for government purchases. Economic benefits contribute to the growth of Gross Domestic Product (GDP).

Biodigester/ Year	Required Investment / Year	Fiscal Output Multiplier	Impact on GDP/ Year	The impact of an increase in GDP/ Year
20	RM400 million	2.35	RM940 million	RM540 million

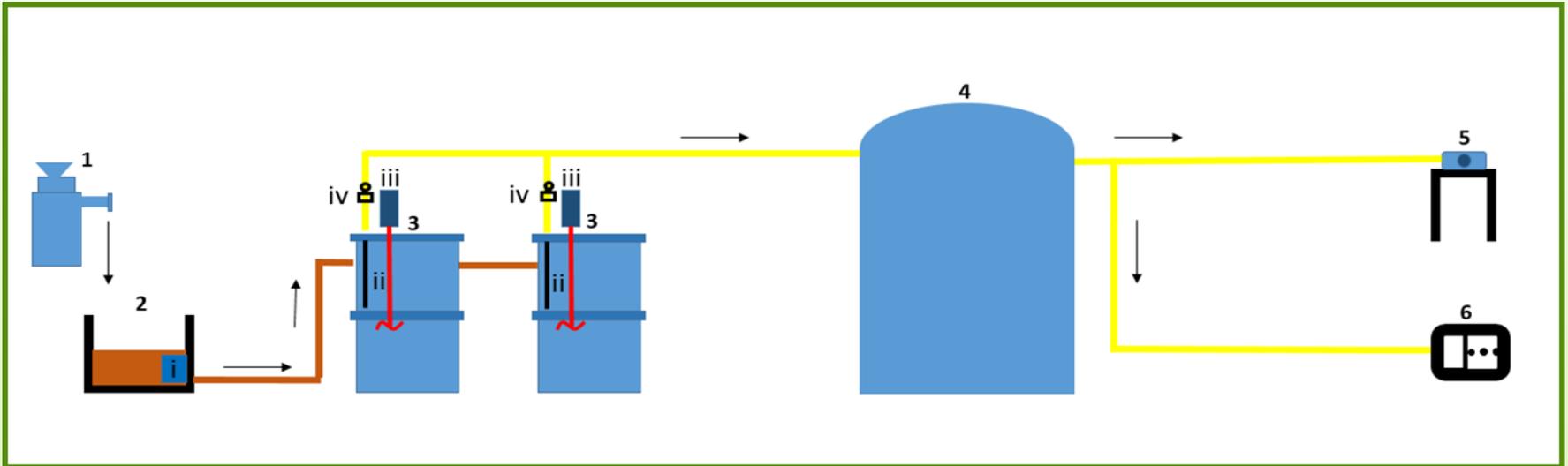
# BUSINESS OPPORTUNITY OF BIODIGESTER IN MALAYSIA

- Within a year, these biodigesters will generate many benefits to the economy in terms the usage of water supply industry, hydropower generation, eco-tourism and job opportunity.
- Providing 13,140 job opportunity for technical and non technical field.
- Technology transfer on relevant knowledge and skills.
- Collaboration and sharing information between both parties.

# NAHRIM BIODIGESTER SYSTEM (NIBS)



# NIBS PROCESS FLOW



- 1 - All collected food waste will be grinded.
- 2 - Grinded food waste will come out to leachate tank and pump to Anaerobic tank by submersible pump.
- 3 - Anaerobic digestion will be occur in AD tank. (temperature maintain 30-35 degree Celsius)
- 4 - Methane gases produced will flow to gas tank (biogas balloon)
- 5 - From the gas tank, output come out are for cooking stove or biogas generator.

# NAHRIM BIODIGESTER SYSTEM (NIBS)

Biogas balloon tank – biogas storage

Leachate tank – all grind food waste will put into this tank and mix with effluent from ad tank and pump back into ad tank.



Grinder to grind the food waste – faster the digestion process

Anaerobic Digestion tank



**CONCLUSION**

## PROJECT

**Research on Development and Management Plan for River Basin towards the Security, Quality and Sustainability of Water Resources.**

## ADVANTAGES

- Preserved the environment by reducing waste.
- Sustained the renewable energy by change waste to resources.
- Reduced GHG emissions to the atmosphere and avoid the global warming.
- Sufficient and safe water resources for the balance of people's quality of life and national development.
- The river basin and lakes is preserved towards the economic, social and environmental improvement.



**OUTCOME**

**Healthy River Basin**

# **THANK YOU**

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