Value Creation in Environmental Sustainability: The Case of Urban Rivers

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Presentation menu

- Kumarasivam in memory
- Framework and scholarly inquiry
- Value creation
- Future, strategy, roadmap

Professor, Environmental Bioengineering and Water Sustainability
Chairman, Environmental Quality Council, Malaysia
Member, National Water Services Commission, Malaysia (2007-2011)
Vice-Chancellor/President, Universiti Teknologi Malaysia

INSPIRING INNOVATION AND CREATIVE MINDS
From imperial technical school to national entrepreneurial research university

- The oldest university in Malaysia (1904)
- Alumni more than 200,000
- More than 43% enrolment at postgraduate levels in engineering and technology in Malaysia
- 10 engineering schools
- 2000 tenured academics
- 2500 PhD students
- 5000 students Global Outreach Program
- 3000 foreign students

<table>
<thead>
<tr>
<th>Year</th>
<th>Bachelor</th>
<th>Graduate</th>
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<tbody>
<tr>
<td>1984</td>
<td>3,886</td>
<td>2</td>
</tr>
<tr>
<td>1990</td>
<td>5,348</td>
<td>175</td>
</tr>
<tr>
<td>2004</td>
<td>17,897</td>
<td>3,291</td>
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<tr>
<td>2007</td>
<td>14,792</td>
<td>3,942</td>
</tr>
<tr>
<td>2008</td>
<td>14,456</td>
<td>4,850</td>
</tr>
<tr>
<td>2009</td>
<td>14,245</td>
<td>6,432</td>
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<tr>
<td>2010</td>
<td>13,000</td>
<td>9,100</td>
</tr>
<tr>
<td>2011</td>
<td>11,500</td>
<td>9,500</td>
</tr>
<tr>
<td>2012</td>
<td>10,000</td>
<td>10,000</td>
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</table>
Kumarasivam

Inquiry

Value

Future

Environmental Management and Research Association of Malaysia (ENSEARCH)
# R&D in water sustainability: Summary

<table>
<thead>
<tr>
<th>Water resources</th>
<th>Nanotech</th>
<th>Biotech</th>
<th>Automation</th>
<th>Materials</th>
<th>Process</th>
<th>Energy</th>
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<tbody>
<tr>
<td>Quality monitoring</td>
<td>In-sewer biorector</td>
<td>Modeling, pollution loading</td>
<td>Nutrient uptake</td>
<td>Reuse, recycle; Small system</td>
<td>Close to users</td>
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<tr>
<td>Treatment technologies</td>
<td>Microbial techniques, surrogates</td>
<td>Image processing</td>
<td>Sludge reuse, PHA</td>
<td>Process integration; Decentralised system</td>
<td>Carbon neutral</td>
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<tr>
<td>Governance</td>
<td>Water and wastewater treatment; osmosis, biomimetic</td>
<td>Respirometry</td>
<td>Industrial ecology</td>
<td>WASDA, RISKAS</td>
<td>Low carbon; Photosynthetic microbial system</td>
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<tr>
<td>Policy</td>
<td>Integration</td>
<td>Integration</td>
<td>Performance monitoring</td>
<td>Value creation</td>
<td>Compact; Asset light system</td>
<td>Sustainable tax</td>
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<tr>
<td></td>
<td>Value creation</td>
<td>Value creation</td>
<td>Value creation</td>
<td>Value creation</td>
<td>Environ. Performance Index</td>
<td></td>
</tr>
</tbody>
</table>
Empat tokoh diiktiraf dapat Anugerah Merdeka
Technology and financing

Water resources

Governance & Implementation

Water War

Intellectual property & human capital
Global water business

- **US$400 billion** global market (source: Goldman Sachs)
- Global market for pumps, pipes, filters, and other purification and sanitation equipment at
- United States share of the industry amounts to roughly $100 billion in yearly sales, and growing three to four percent a year (source: Pacific Institute: *World’s Water*).
- Japanese government will help the private sector tap into the water business in other countries, aiming to **garner 6% of global** markets in 2025 i.e. total of ¥31 trillion by 2025 (source: *Japan Times*, 13 April 2010)
South East Asia

Population: 600 m
Average GDP: >5%
Free economic zone: 2015?
Major environmental issues

- Rapid urbanization
- Flash flooding
- Water supply due to water pollution
Innovation: Smart tunnel Kuala Lumpur

- **Mode I**: No storms
- **Mode II**: Most storms - 7 to 10 times
- **Mode III**: Major storms - annual events

By passing major bottlenecks, convenient, faster & better via SMART MOTORWAY.
Innovation: Newater Singapore

**Where our water comes from**

<table>
<thead>
<tr>
<th>Now</th>
<th>Up to 30%</th>
<th>Up to 10%</th>
<th>Rest of demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>2060</td>
<td>Up to 50%</td>
<td>Up to 30%</td>
<td>Rest of demand</td>
</tr>
</tbody>
</table>

*Water catchment area* From 67% now, it will grow to 90% of land area by 2060.

**PROCESS SCHEMATIC**

- **CMF-S Microfiltration** 6 x 4485 T 53,000 m³/day
- **Equalisation Tank**
- **Strainers**
- **Backwash to head of WRP**
- **Microfiltered Storage**
- **Reverse Osmosis System** 5 x 8MLD (2 Stage, 75% Recovery)
- **Product Water Tank**
- **Reject to head of WRP**
- **Anti-Scalant**

40,000 m³/day to wafer fabrication plants and other industries for non-potable reuse.
Approaches in environmental management

- Conventional model
- Induced model
- Sustainability model
3 approaches in environmental management

Conventional model

- **Framework**: Environment vs Development?
- Environmental pollution control
- Public health
- Sanitary engineering
  - Water supply
  - Wastewater
  - Solid and hazardous waste
  - Air pollution
  - Environmental management and policy
3 approaches in environmental management

**Induced-model**

- Environmental components in development programs
- Pollution control
  - Less NOx, SOx engines
  - Green incinerators
  - Low energy lighting system
  - Urban green
  - Environmental management & policy
3 approaches in environmental management

**Sustainability model**

- Involve all aspects
- The whole business model and engineering paradigm into sustainability, not merely pollution control
  - Renewal energy
  - Low carbon technology
  - Clean production
  - Green city
  - Green buildings
3 approaches in environmental management

Sustainability measurement?

- Cost-benefit analysis 1970s
- Matrix of selection components 1980s
- Sustainability index 1990s
- Life cycle analysis 1990s
- Ecological footprint 1990s
- Quantitative sustainability assessment 2000s

Criteria based on:
- Health
- Environment
- Economy
- Socio culture
- Technical functions
Innovation-led economy

Value creation
High-income structure

Kumarasivam Inquiry Value Future
Why innovation matters?

INSPIRING INNOVATION AND CREATIVE MINDS
Innovation-led economy

Adapted from Prof. Deschamps (2009)
Menjana Minda
Kreatif & Inovatif

Zaini Ujang

INSPIRING INNOVATION AND CREATIVE MINDS
Zaini’s 7 Pillars of Innovation

- **Area of concerns**
- **Do it! Do it!**
- **Benefits**
- **Empowerment**
- **Green**
- **Champions**
- **Feedback**
Biggest public health enemy?

*Aedes aegypti*
Do it the innovative ways!

- **Principle**: All God’s creatures have roles and benefits to human being.
- **Question 1**: Can we **find benefits** from Aedes mosquito?
- **Question 2**: Can we **create new values** from the mosquito?
Accumulation of PHA in Phosphorus Accumulating Organisms (PAO) from wastewater

<table>
<thead>
<tr>
<th>Aerobic</th>
<th>Anaerobic</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHA minimum</td>
<td>PHA maximum</td>
</tr>
</tbody>
</table>

Working with MIT’s Tony Sinskey
**Innovation**

**Value matrix from waste to wealth**

<table>
<thead>
<tr>
<th>Waste</th>
<th>Conversion</th>
<th>Wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dangerous</td>
<td>Technology</td>
<td>Desirable</td>
</tr>
<tr>
<td>Toxic</td>
<td>Risk assessment</td>
<td>Safe to health</td>
</tr>
<tr>
<td>“Waste”</td>
<td>Value management</td>
<td>Resource</td>
</tr>
<tr>
<td>Pollutants</td>
<td>Technology</td>
<td>Commodity</td>
</tr>
<tr>
<td>Costly to treat</td>
<td>Technology</td>
<td>Cheap raw materials</td>
</tr>
<tr>
<td>Legally “Toxic”</td>
<td>Regulation</td>
<td>Legally “commodity”</td>
</tr>
<tr>
<td>Taboo</td>
<td>Marketing</td>
<td>High demand by-product</td>
</tr>
<tr>
<td>Haram</td>
<td>Branding</td>
<td>Halal</td>
</tr>
</tbody>
</table>

INSPIRING INNOVATION AND CREATIVE MINDS
Can we create value in urban river?
INSPIRING INNOVATION AND CREATIVE MINDS
Can we create value in urban river?

- Principle: River is a civilizational landmark
- Question 1: Can we **find benefits** from river pollution prevention?
- Question 2: Can we **create new values** from the urban rivers?
Klang River rehabilitation

Before

Klang bus stand

Masjid Jamek

City Hall

After
Thames, London
Newcastle Riverside, UK
INSPIRING INNOVATION AND CREATIVE MINDS
INSPIRING INNOVATION AND CREATIVE MINDS
- 1985 with a 25-year lifespan, the Mersey Basin Campaign was charged with facilitating the clean up of the River Mersey and its tributaries in the Northwest of England.

- River Mersey, 70 miles from its start, at the confluence of the Rivers Tame and Goyt in Stockport, to where it meets the Irish Sea at New Brighton. On its journey west, through south Manchester and Warrington towards Liverpool’s famous Pier Head, it passes through 29 local authority areas.

- Five million people live within its catchment.

- A successful clean up required the engagement and participation of myriad different organisations, authorities and communities. What was needed was an organisation that could bring everyone together.

- The Campaign grew out of the then Secretary of State for the Environment, Michael Heseltine’s visits to Liverpool in 1981.
The relationship between water quality and economic regeneration in the Mersey Basin

Abstract A report to Northwest Water, the Environment Agency and the Mersey Basin Campaign. The report explores the role, both actual and potential, of investment in improved water quality in the stimulation of economic activity, particularly in traditionally rundown inner-city areas adjacent to rivers and canals. This is part of the recasting of the region's image, with good water quality central to the vision of a 'green and pleasant region', and the creation of a credible setting for growth and investment. The study covers the economy, environment and policy setting in the Mersey Basin, economic regeneration and property development.

Permanent link http://merseybasin.org.uk/archive/items/MBC151.html
Theme Strategic
Progress in environmental management

- **Pollution control** (phase 1: 1970s-1980s)
  - Law, regulation, agency
  - Pollutant-target

- **Pollution prevention** (phase 2: 1990s-2000s)
  - Market-driven
  - Green technology

- **Low carbon economy** (phase 3: 2010s-2020s)
  - Ecological footprint
  - Sustainability
  - New paradigm
Two Separate Systems
Two Separate Tasks

Pollution control (phase 1: 1970s-1980s)
Pollution loads of municipal wastewater (sewage)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Black water or Urine+faeces (%)</th>
<th>Grey water (%)</th>
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</thead>
<tbody>
<tr>
<td>BOD$_5$</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td>COD$_{mn}$</td>
<td>36</td>
<td>64</td>
</tr>
<tr>
<td>SS</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>75</td>
<td>25</td>
</tr>
</tbody>
</table>

Grey water = bathing, washing, kitchen, etc.

Activated Sludge Model 2

\[
\text{COD Total} = S_A + S_F + S_I + X_I + X_S + X_H + X_{PAO} + X_{PHA} + X_{AUT}
\]

Fermentation products (acetate), $S_A$; Readily biodegradable substrate, $S_F$; Inert soluble non-biodegradable matter, $S_I$; Inert suspended non-biodegradable matter, $X_I$; $S_S = S_F + S_A$; Heterotrophic biomass, $X_H$; Phosphorus-accumulating organisms, $X_{PAO}$; Organic storage products of PAO, $X_{PHA}$; Autotrophic, nitrifying biomass, $X_{AUT}$
Action needed

“Carbon neutral economy”

<table>
<thead>
<tr>
<th>Countries</th>
<th>Reduction target by 2020</th>
<th>CO₂ Basis</th>
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<tbody>
<tr>
<td>United States</td>
<td>17%</td>
<td>2005</td>
</tr>
<tr>
<td>European Union</td>
<td>20%</td>
<td>1990</td>
</tr>
<tr>
<td>China</td>
<td>40%</td>
<td>2005</td>
</tr>
<tr>
<td>India</td>
<td>24%</td>
<td>2005</td>
</tr>
<tr>
<td>Japan</td>
<td>25%</td>
<td>1990</td>
</tr>
<tr>
<td>Russia</td>
<td>20%</td>
<td>1990</td>
</tr>
<tr>
<td>Canada</td>
<td>25%</td>
<td>1990</td>
</tr>
<tr>
<td>Australia</td>
<td>25%</td>
<td>2000</td>
</tr>
<tr>
<td>Norway</td>
<td>30%</td>
<td>1990</td>
</tr>
<tr>
<td>MALAYSIA</td>
<td>40%</td>
<td>2005</td>
</tr>
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</table>

Low carbon economy (phase 3: 2010s-2020s)

INHIBITING INNOVATION AND CREATIVE MINDS
Sustainable water system?
*(Small, decentralised, close-loop, low energy, low eco-footprint)*

**Water resources:** Stream, groundwater etc

**Water treatment plant**
- Bottled water
- Rainwater

**Distribution system**

**Wastewater treatment plant**
- Sludge treatment, reuse
- Effluent discharge, reuse

**Water users, industries**
- e.g. sewer bioreactor

**Individual on-site WW & SW treatment**
- Reuse of sludge, Treated wastewater

**KEY POINT**

- Low carbon economy (phase 3: 2010s-2020s)

- Kumarasivam
- Inquiry
- Value
- Future
Sewer technology

Present Collection
- From generation
- Convey to wastewater treatment plants
- Catchment enlarged
- Combined: sewage, industrial, sullage etc.

Future Treatment
- Long and big diameter of sewer
- Sewer reactor for organic transformation
- Pretreatment for nutrient removal plants
- Sewer biotransformation

Activated Sludge Model 2

\[ \text{COD Total} = S_A + S_F + S_I + X_I + X_S + X_H + X_{PAO} + X_{PHA} + X_{AUT} \]

Fermentation products (acetate), \( S_A \); Readily biodegradable substrate, \( S_F \); Inert soluble non-biodegradable matter, \( S_I \); Inert suspended non-biodegradable matter, \( X_I \); \( S_S = S_F + S_A \); Heterotrophic biomass, \( X_H \); Phosphorus-accumulating organisms, \( X_{PAO} \); Organic storage products of PAO, \( X_{PHA} \); Autotrophic, nitrifying biomass, \( X_{AUT} \)
How “small” is a small system?

Pollution sources
- Industrial effluent
- Sewage plant
Framework for water sustainability

- Policy, regulatory framework
- Education, training, professionalism
- R&D, Innovation
- Value chain

Water business model
Efficient and integrated water services
Global water player

INSPRING INNOVATION AND CREATIVE MINDS
Thank you!
I am grateful to take questions now ...

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MIEM, PEng (M), CEng (UK), CSci (UK), MICWEM, (UK) MIWA (UK)