Small and Decentralized Water System

Lecture 4: Small & decentralized water management system

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Lecture outline

- Philosophy - Small is Beautiful
- Chronological development
- Why small and decentralized?
- Methods and schemes
- Options

Question 1

- What is the most important aspect/issue in water management?

Philosophy: Small is Beautiful

- Schumacher's
- Why small is realistic?

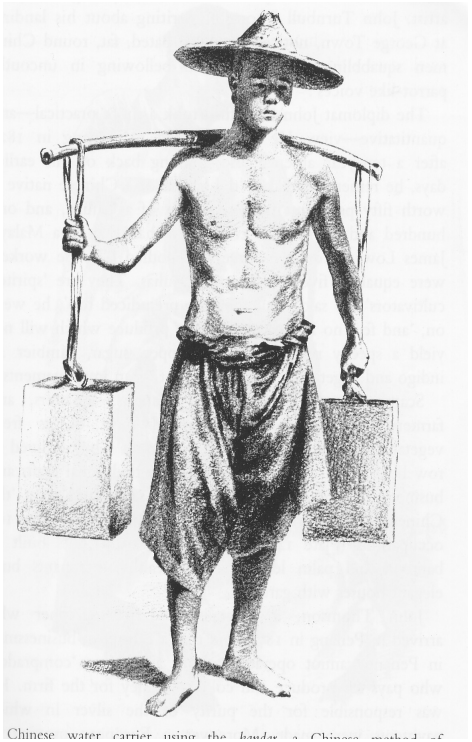
- "Yet complex answer seldom solve complex problems. **We can best deal with the process of change by taking simple steps**, **one at a time**, and doing so with thoughtfulness and patience"

Dr Arthur Calianrdo (2002) Simple Steps, McGraw-Hill

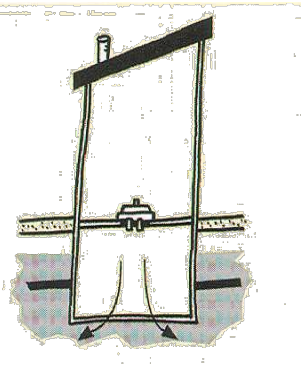
Chronological development

- Start with ZERO
- Start small
- Grow slowly, fast or exponentially
- Or not growing at all

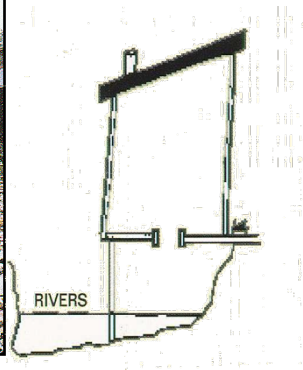
Chronological development



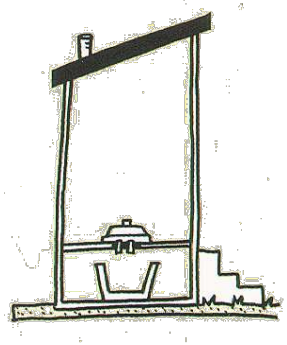
Chinese water carrier using the *bawdar*, a Chinese method of



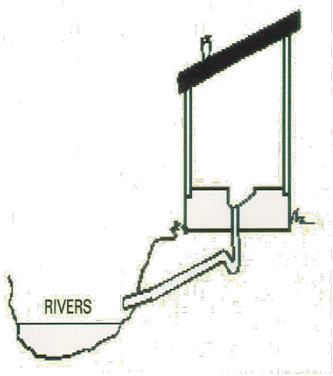
Pit Latrine



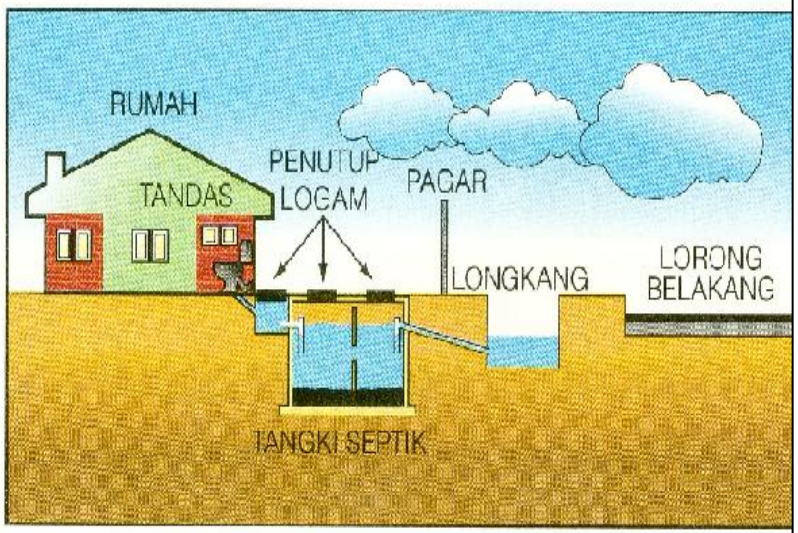
Enclosure Over Water



Bucket System



Chronological development



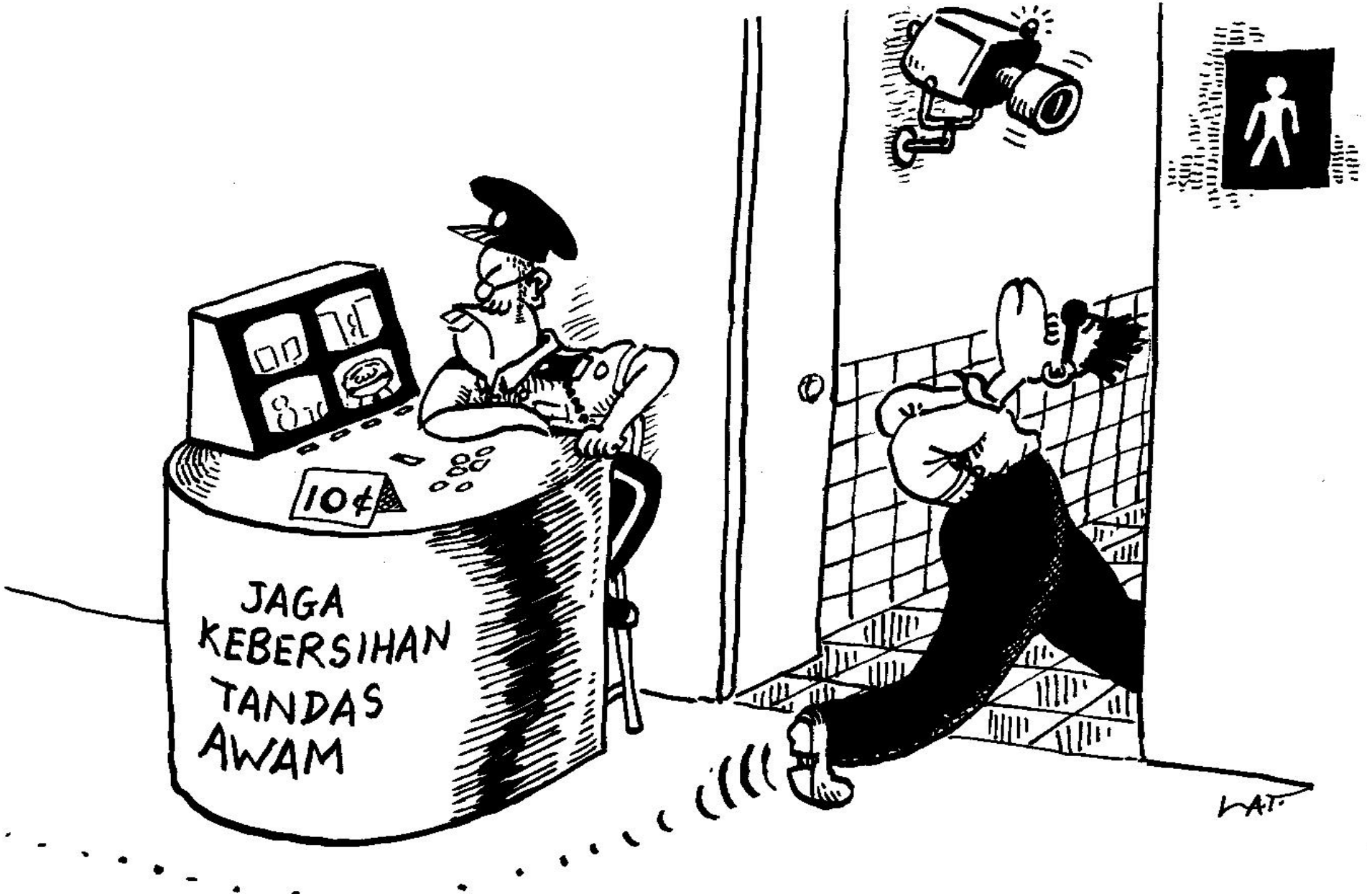
Jika kumbahan dari premis anda mengalir ke dalam sebuah tangki septik sebelum menga ir ke dalam longkar g, anda adalah seorang pelanggan perkhidmatan tangki septik.

Tangki Imhof tersebut setelah dibaik pulih oleh Indah Water.

Chronological development

Aerated Lagoon

Activated sludge plant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JAGA
KEBERSIHAN
TANDAS
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Question 2

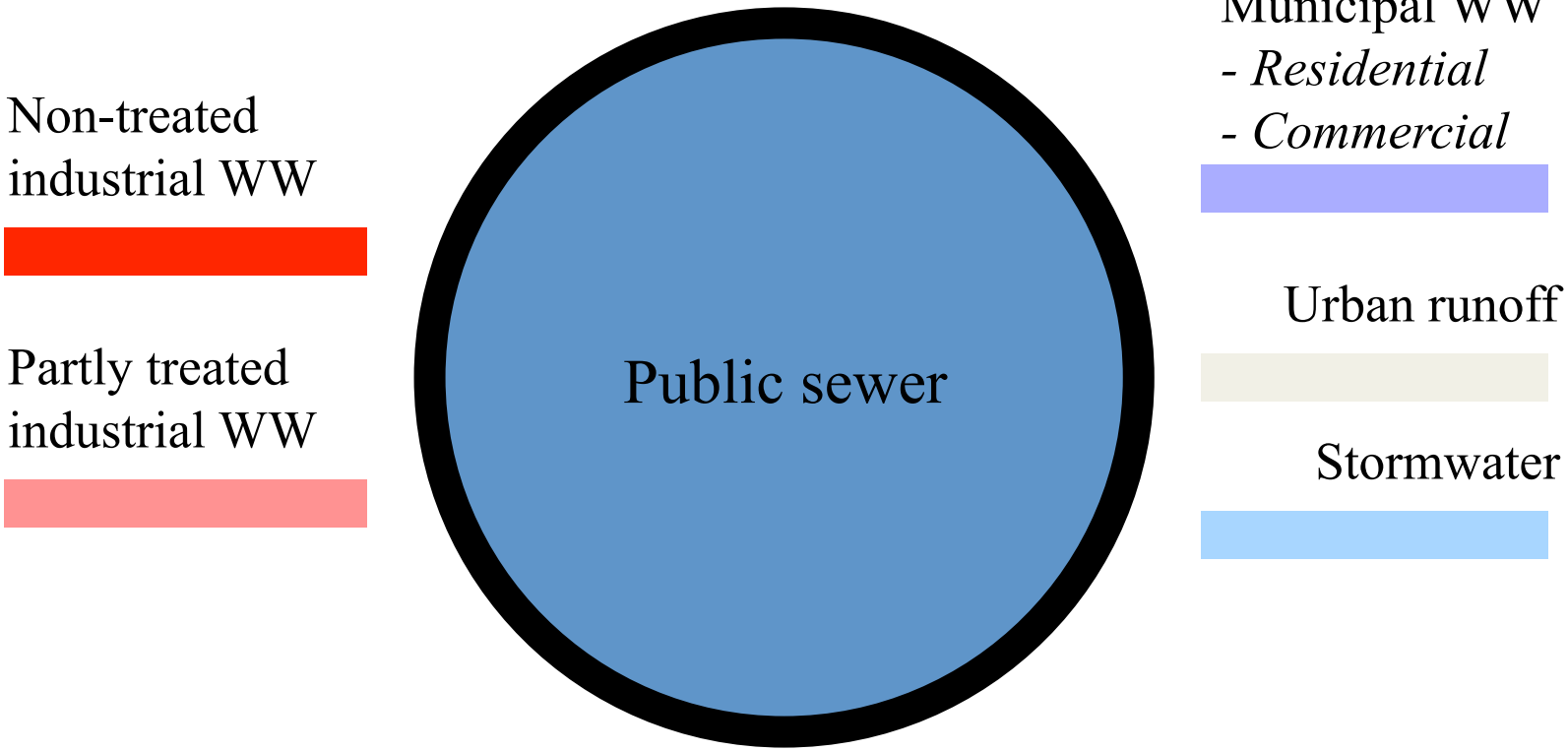
- Chronological development is still relevant for the future development, despite progress in technology and management system?

Sewerage system and facilities

- Sewage = municipal wastewater
- Sewerage = the system of sewage management (includes collection, treatment, disposal)
- Sewer = the collection pipe of sewage
- Sewerage facilities (US, Japan, Sweden) includes sewage, industrial wastewater and stormwater

Sewerage system and facilities

(Combined system)



Why small and decentralized?

- Financial
- Technical
- Political

Why small and decentralized?

- Small?
- Decentralized?

- Sustainability?
- Sustainable sanitation?
- Eco-sanitation?

Terminology

Malaysian perspective

- Small: Treatment capacity is limited to PE equivalent of less than 15,000 (1 Mgal/d)
- Decentralized system: Could be ranging from individual houses, residential areas or industries to a cluster of them.

Terminology

- Decentralized wastewater management is a system for collection, treatment and disposal/ reuse of wastewater from individual homes, clusters of homes, isolated communities, industries or institutional facilities, as well as portions of existing communities at, or near the point of waste generation.

Tchobanoglous, 1995

Sustainable sanitation

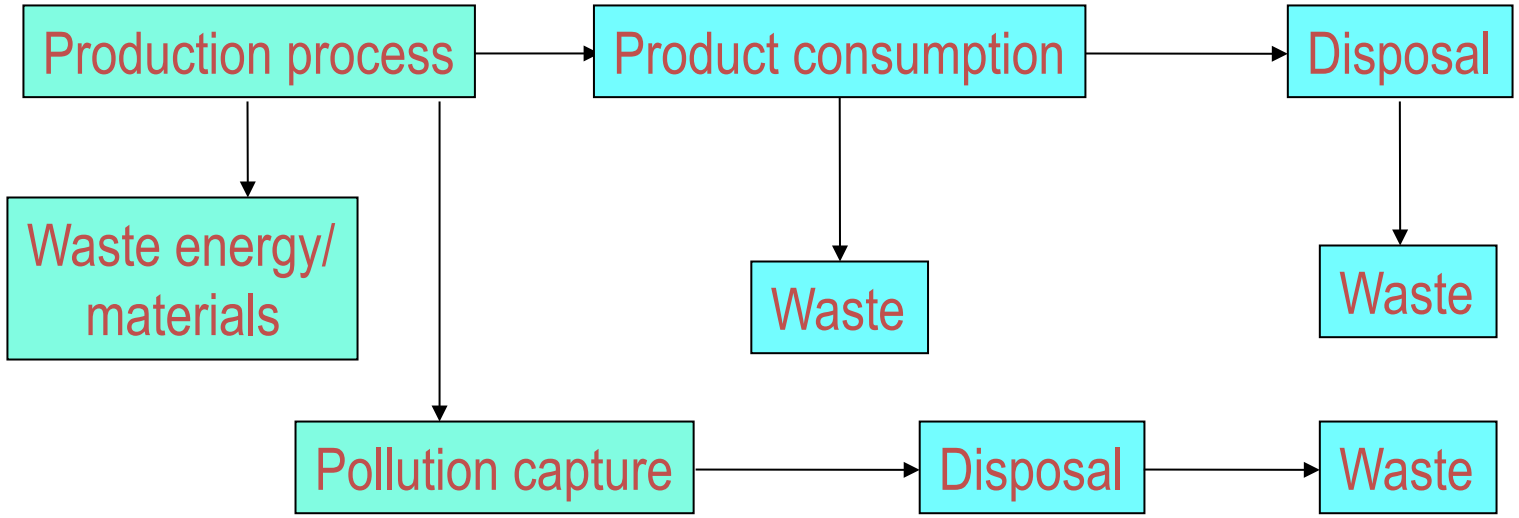
"Sustainable sanitation" means "sanitation technically manageable, socio-politically appropriate, systematically reliable and economically affordable that utilize minimal amount of energy and resources with the least negative impacts, recovery of useable matters"

Unfinished questions

- Index for sustainable sanitation
- Matrix for selection of components
- Life cycle analysis
- Cost-benefit analysis

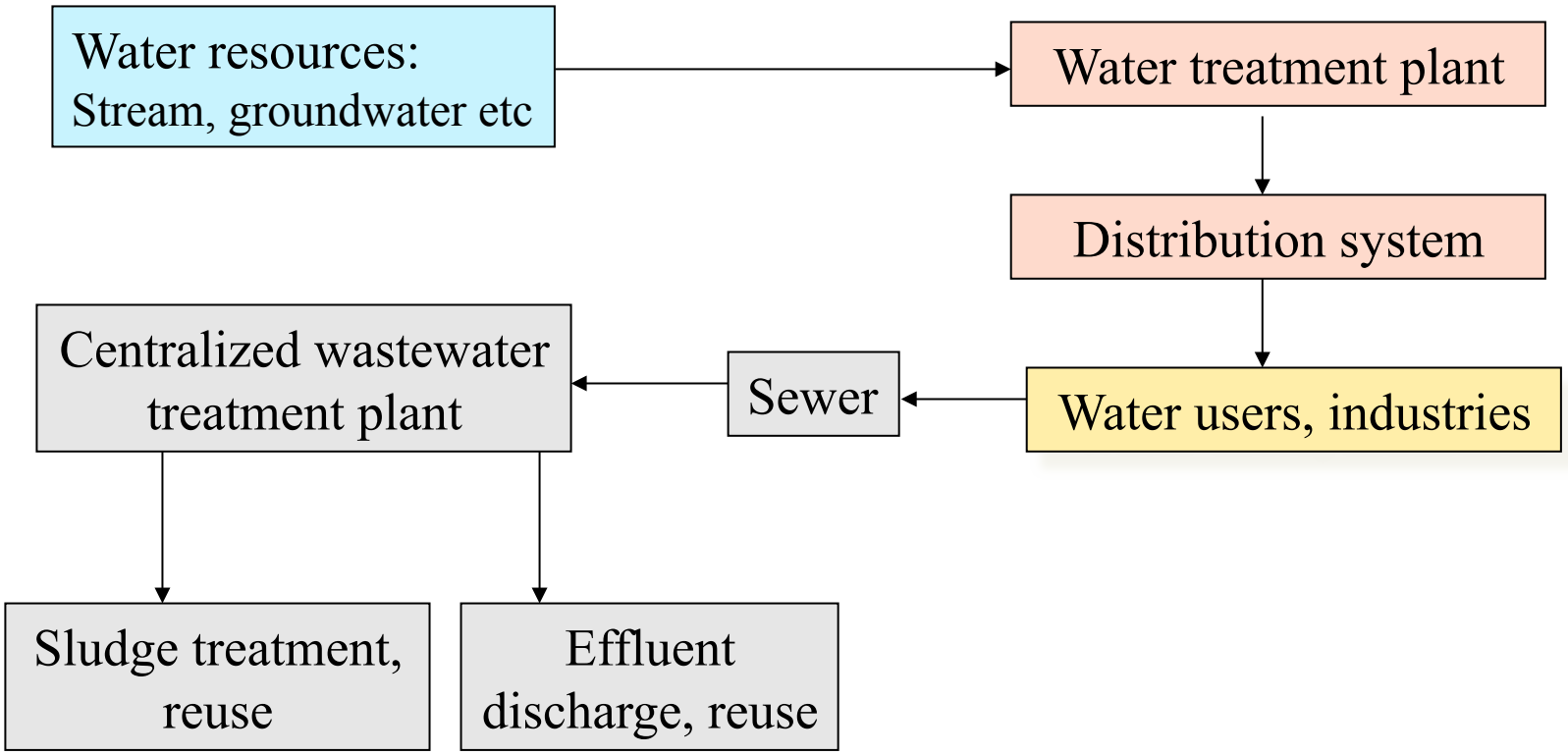
End-of-pipe approach

(Conventional water management system)



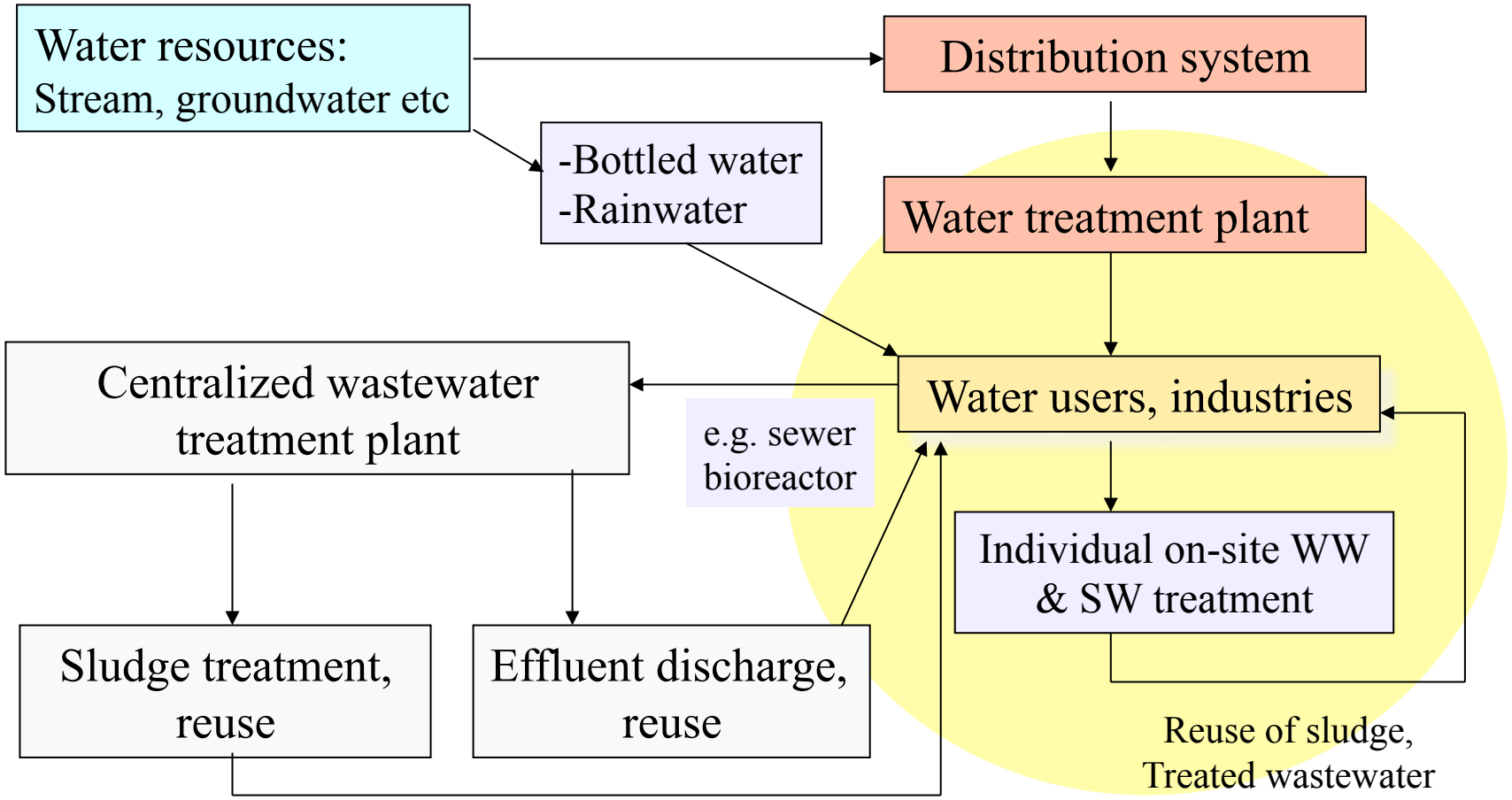
End-of-pipe approach

(Conventional water management system)



Sustainable sanitation approach

(Small and decentralized water management system)



Sewage treatment plants in Malaysia

(Total number 6,693; DOE 2002)

Types of technologies	2002	2007
Waste stabilization ponds	>600	>500
Various types of activated sludge plants	>500	>2000
Trickling filters	>1000	<1000
Rotating biological contactors	>100	<100
Imhoff tanks	>1000	>1000
Communal septic tanks	>1000	>1000
Other systems	>1000	>1000

Question 4

Main objectives of small & decentralized system?

Why small & decentralized system?

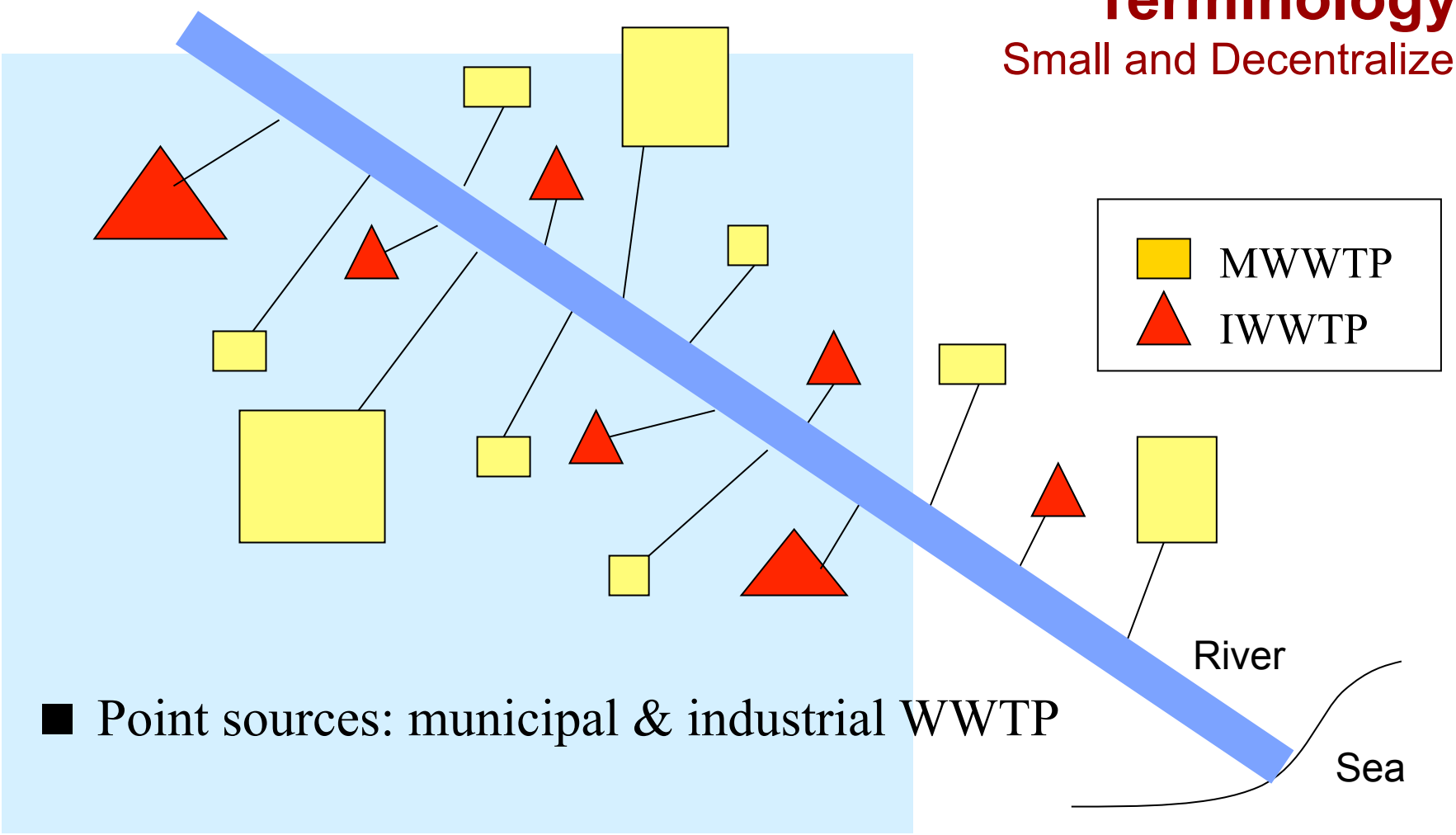
- To protect public health
- To protect receiving environment from degradation or contamination
- To reduce costs of treatment by retaining water and solids near their point of origin through reuse

Rational for small & decentralized system?

- Community or facility is remote from municipal sewer
- Localized water reuse opportunities are available
- Existing centralized WWTP capacity is limited and financing is not available for expansion
- Residential or industrial density is sparse
- Centralization / regionalization would require political annexation
- Specific wastewater constituents are treated more appropriately at the point of generation

Terminology:

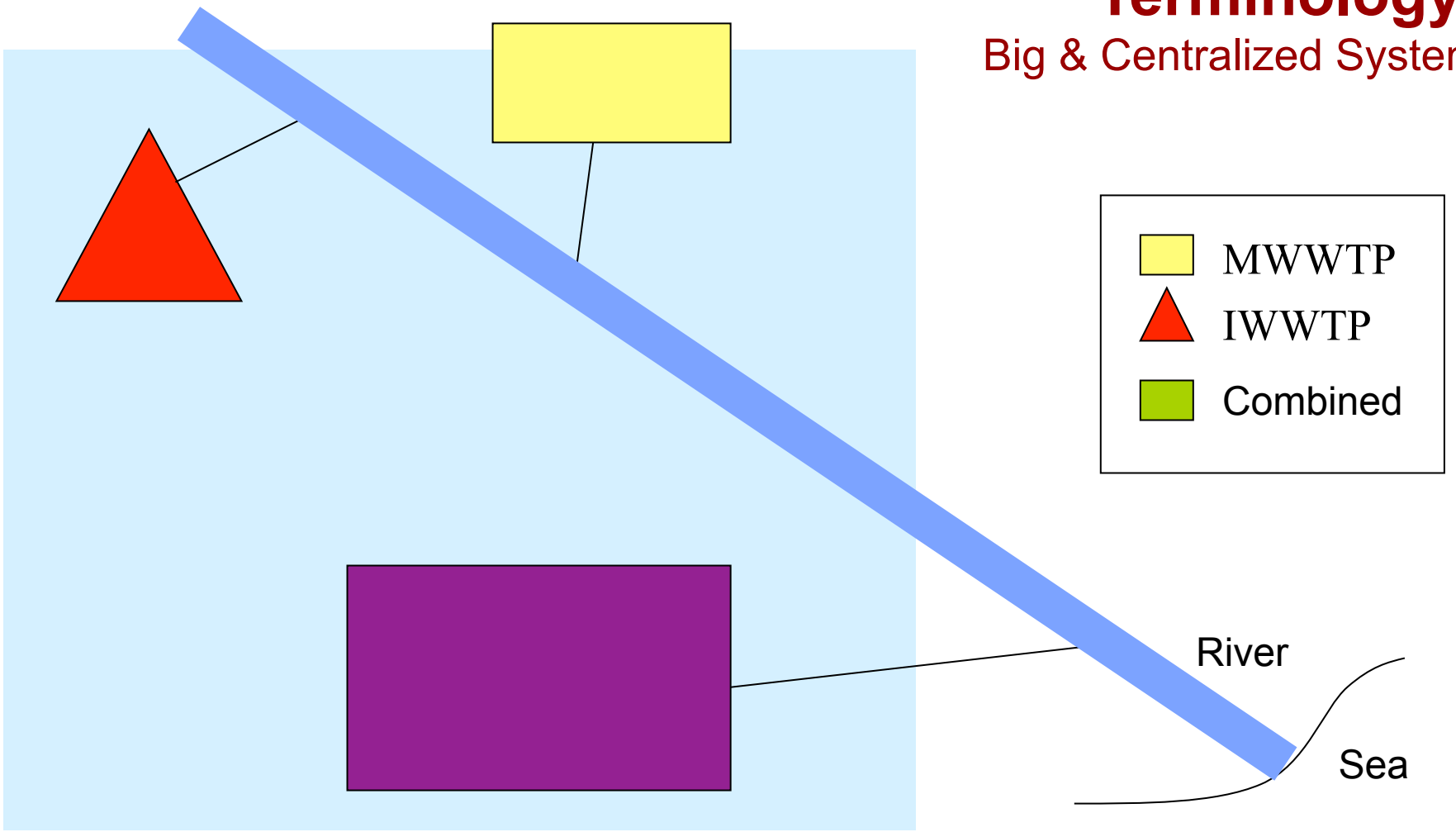
Small and Decentralized



- Point sources: municipal & industrial WWTP

Terminology:

Big & Centralized System



Elements of Small and Decentralization Wastewater Management

- Wastewater pretreatment
- Wastewater collection
- Wastewater treatment
- Effluent reuse or disposal
- Biosolids and septage management

Small and Decentralized WWTP

Criteria, Scenario, Advantages, Disadvantages

Criteria	Advantages	Disadvantages
Collection system	Short, easy to maintain	Coverage is limited
Sewer network	Cheap investment	Difficult maintenance
Treatment options	Variety, depends on investment and know-how	Limited for treatment approved by authority
Treatment level	Possible for closed loop	Economic of scale?
Effluent reuse	Possible & easy to achieve	Marketing
Effluent disposal	Possible	Often not able to meeting higher standards

Typical wastewater reuse and disposal options

Options	Examples
Constructed wetlands	- Free water surface - Subsurface flow
Discharge to water bodies	- Streams, ponds, lakes, rivers, oceans
Evaporation systems	- Evaporation beds - Evaporation ponds
Land applications	- Surface or spray application
Reuse applications	- Agricultural or landscape irrigation - Groundwater recharge - Industrial supply - Recreational lake
Subsurface soil disposal	- Soil absorption systems - Seepage beds

Decentralized WWTP

Waste Stabilization Ponds (UTM Skudai)

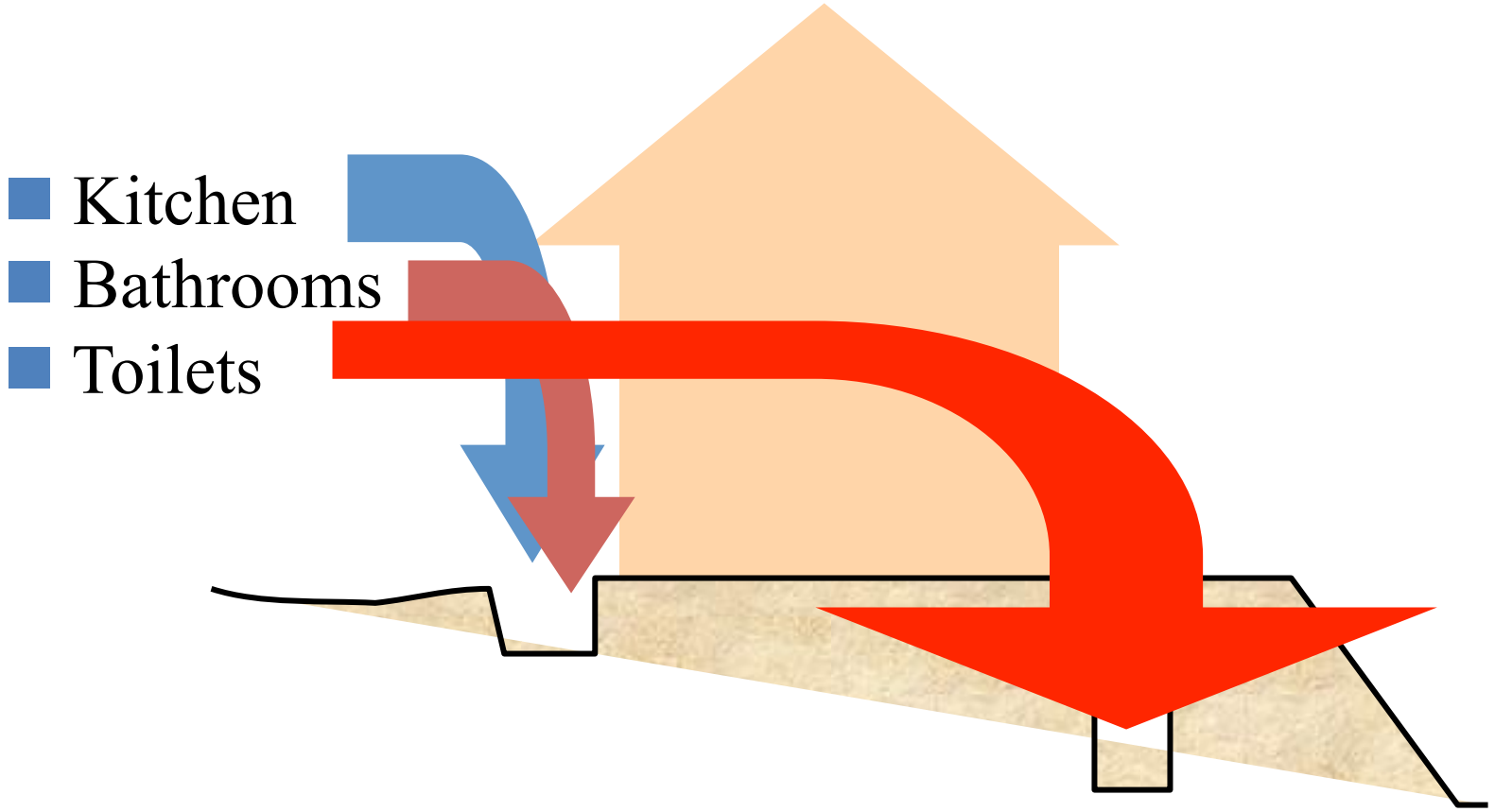
Decentralized WWTP

Rotating Biological Contactors (Hospital Sultanah Aminah, JB)

Decentralized WWTP

Activated sludge - IDEA

Septic tanks system – Rural & peri-urban areas



Why small and decentralized?

Financial reasons

- Financial models?
  - Capital expenditure (CAPEX)
  - Operating expenditure (OPEX)
- Planning
- Willingness to pay by consumers
  - Affordability?
  - Subsidy?
- Per unit cost

Why small and decentralized?

Technical reasons

- Availability of technology
  - Indigenous or import?
  - Sustainability of operation
- Upgrading options
- Local expertise
  - Design, construct
  - Operation and maintenance

Why small and decentralized?

Political reasons

- Planning and policy instruments
  - Long term planning
  - Medium and annual budget
- Geo-political borders
- Environment is a political concern?
  - Pollution issues
  - Public utilities
  - Major outbreak?

Applications of Small and Decentralization Wastewater Management

- Individual residences
- Clusters of homes
- Public facilities
- Commercial establishments
- Industrial parks
- Small communities
- Small portion of large communities

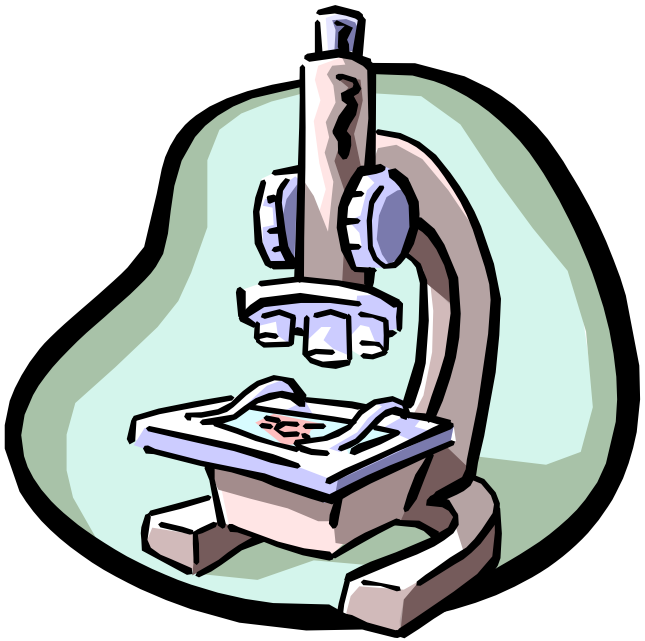
Issues and constraints of small & decentralized system?

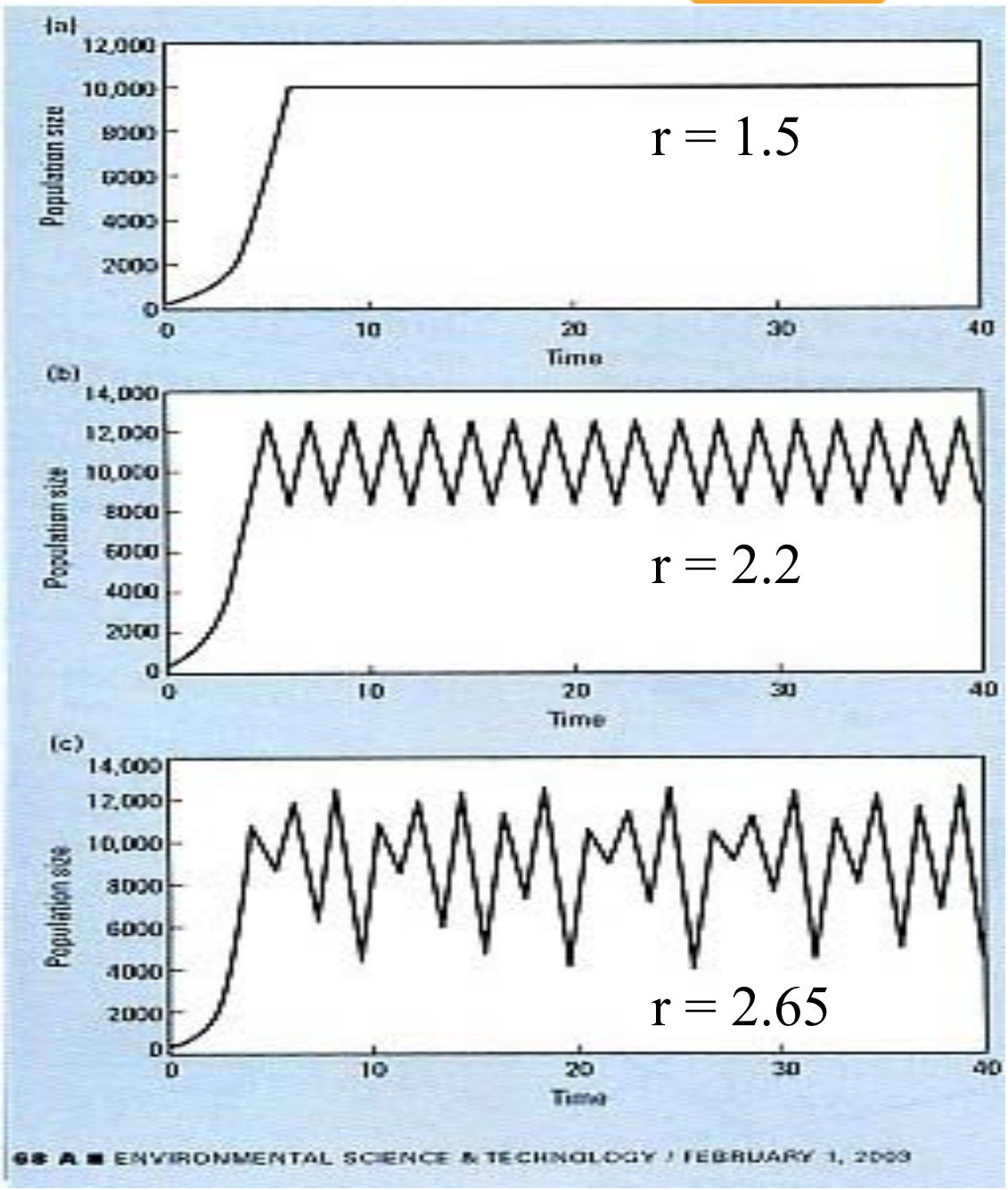
- Scientific theory on the microbial dynamics
- Financial
- Management & operation

Theory and Process

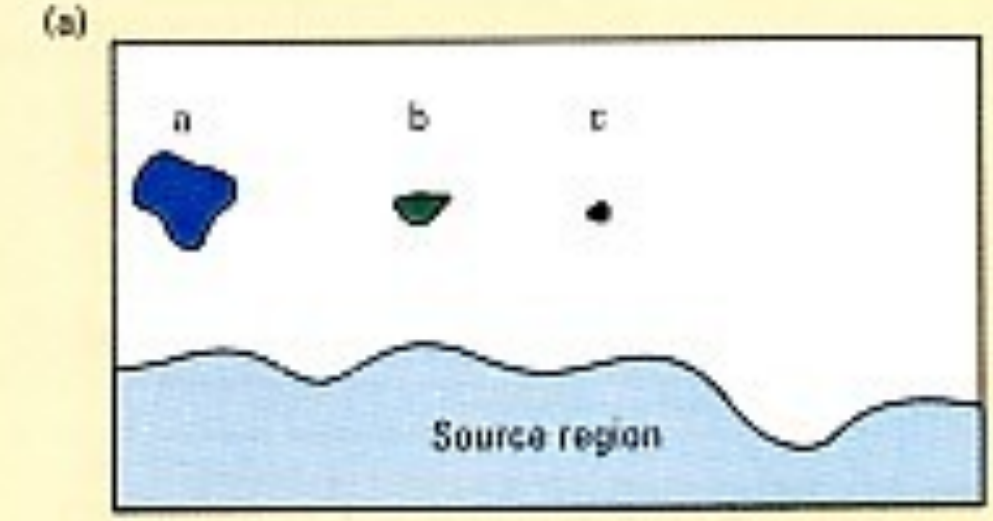
Microbial Community – New findings

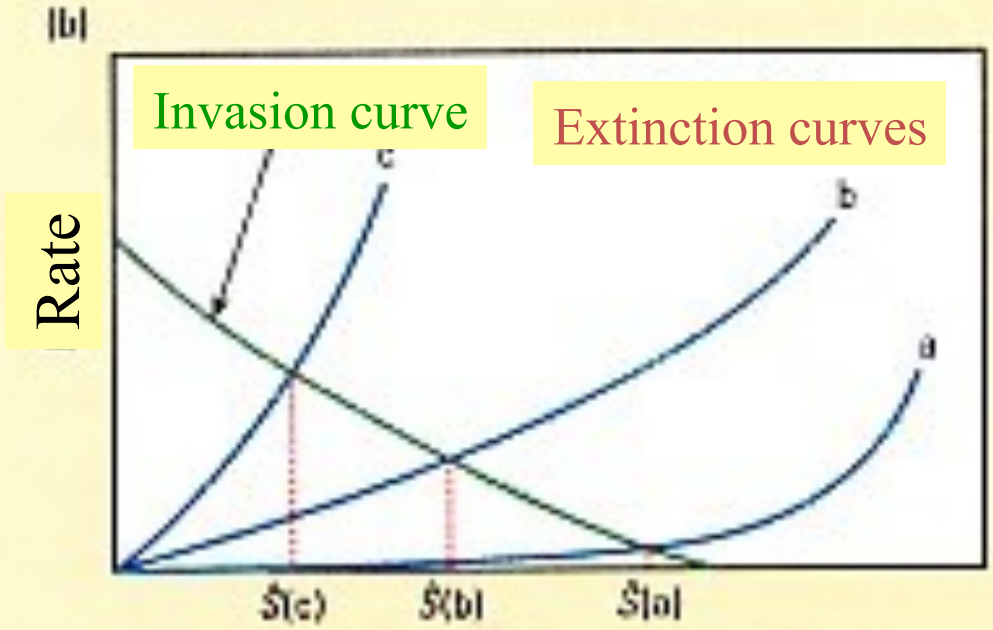
- Findings: Microbial population dynamics in large plant is not similar to small plant
- Analogy: Tropical rain forest in Endau-Rompin Malaysia and London Botanical Garden





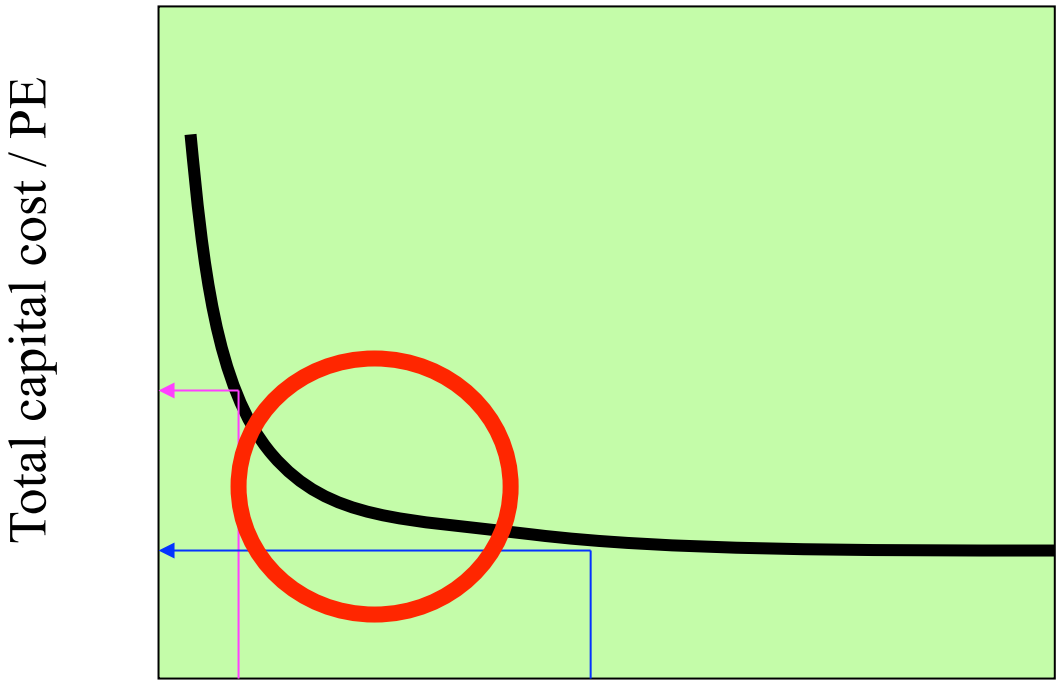
Theoretical biological temporal dynamics of population with different growth rate





Equilibrium model of island biogeography for (c) small, (b) medium and (a) large islands

Financial issues



Typical cost of small sewage treatment system in Malaysia

- Treatment plant – 40%
- Sludge plant/facilities – 20%
- Sewer/collection network – 40%

Total cost = USD250 / PE

Management issues of small & decentralized system

- Regulatory agency for industrial wastewater facilities
  - National Commission of Water Services
  - Department of Environment
- Regulatory agency for sewerage facilities, including public sewer
  - National Commission for Water Services
  - Department of Sewerage Services
- Maintenance and operation by individual operators
  - IWK for sewerage (for most local authorities)
  - Industry
  - Private contractors

Management issues of small & decentralized system

- System with low M&O cost
- Since failure is common, it is a need to have
  - Inventory
  - Educational programs for users
  - Inspections
  - Notification
  - Reporting
  - Certification
  - Water quality monitoring

Centralized & Combined WWTP

General Scenario & Advantages?

- Industrial discharge is not directly to the rivers
- Control effluent at point sources
- Combined sewer network
- Sewer process become significant
- Easier to treat the whole PS pollutants
- Industry pays
- Practice in most developed, temperate climate countries

Centralized & Combined WWTP
Constraints & issues?

- Not allowed under the present law in Malaysia to combined industrial and municipal wastewaters
- Control effluent at source to meet the requirement of the WWTP operators, esp. inhibitors to bioprocess e.g. heavy metals
- Tariff for industry to pay?
- Functions of national sewerage company, IWK?