

EN4105- Integrated Environmental Management
Semester 1 2016-2017, Nov/Dec 2016

1a) What are the benefits of water demand management? What are the common economic, socio-political and structural-operational measures for water demand management?

Benefits

Reduces water demands with no deterioration in lifestyle or service level

Reduces capital requirements for expansion of water supply and lowers operating costs

Reduces generation of pollutants, and therefore the requirements for new or expanded wastewater treatment systems

Facilitates expansion of the coverage of available fund

Enhances the development and adoption of new technologies

Leads to financially sustainable water systems

Economic

Incentives: rebates, tax credits

Disincentives: real cost, penalties, fines

Example: Realistic Water Pricing is a direct means of controlling water demand and generating revenues to cover costs

Socio-Political Measures

Policies and Laws

Economic policies, government regulations, standards on appliance redesign and marketing:

 Policies to promote water saving devices

 Encouraging water savings in industries

Effective public/stakeholder education and awareness measures

Wise use of water; direct restrictions on use

Structural and Operational Measures

Metering, retrofitting, controlling flow (rationing) and recycling

Reduction of UFW (Unaccounted-For Water), leakage detection and repair

Use of water efficient devices

Water use restrictions during periods of water shortages

1b) What is non-revenue water (NRW) and how is it different from unaccounted-for-water (UFW)?

Non-Revenue Water (NRW) refers to the difference between the volume of water delivered into a network and billed authorized consumption

Unaccounted-for water (UFW) represents the difference between "net production" (the volume of water delivered into a network) and "consumption" (the volume of water that can be accounted for by legitimate consumption, whether metered or not)

UFW = Net Production - Legitimate Consumption

NRW = Net Production - Revenue Water = UFW + Water which is accounted for, but no revenue is collected (unbilled authorized consumption)

(if you have time you can also talk about the causes of UFW, and how it is controlled in Singapore)

1c) Briefly discuss some of the measures taken by Singapore in preventing pollution of its water resources

Stringent legislation to enforce the following policies and regulations:

Industrial wastewater treated to trade effluent standard before discharge to sewers – stringent requirements

100% modern sanitation

Separate sewerage and drainage systems to prevent cross contamination

Local reservoirs are protected

Solid waste collected, incinerated and transported to offshore landfill. Proper treatment of solid waste to prevent water contamination

1d) Briefly explain what is meant by NEWater being currently used for direct non-potable use and indirect potable use. What are some potential challenges in future direct potable use of NEWater?

Direct non-potable use: NEWater being used as it is for non-drinking purposes. This includes industrial usage such as for air-conditioning for commercial buildings, wafer fabrication plants, cooling agent for industrial processes

Indirect potable use: NEWater being used for drinking purposes by blending it into local reservoirs

Potential Problems:

Psychological effect

Higher treatment cost (material, chemical and energy cost for membrane operations)

Separate water reticulation system

Corrosion of pipes and fittings (NEWater has fewer ions and encourages corrosion)

Potential long-term adverse health effects (unknown since no studies done on this before. For example, if there are emerging contaminants that the used water treatment process and NEWater process is unable to remove, it could be concentrated after water reuse)

2a) Singapore launched the ABC Waters Programme in 2006. What does “ABC” stand for? What are some of the measures undertaken to achieve the “ABC” objectives?

Active (dynamic, full of life and activities), Beautiful (aesthetically pleasing), Clean (good water quality)

Opening up reservoirs for water activities like kayaking and dragon-boating (e.g. Bedok and Marina reservoir)

To reverse man-made canals and drains into a more natural state (e.g. Bishan-Ang Mo Kio Park, also functions as a community space)

To introduce more natural elements in reservoirs for aesthetic and water quality purposes (e.g. Sengkang Wetlands in Punggol Reservoir)

To create new community spaces for lifestyle activities and attraction by integrating streams, rivers and lakes with parks and gardens

Design features to improve water quality, increase rainwater harvesting, reduce surface runoff (water recirculation, rain gardens, infiltration trench, bio-retention systems, wetlands, rainwater harvesting, rain garden at Balam Estate, cleansing biotopes at Bishan Park)

2c) Discuss briefly the potential impacts on the physical environment, ecology, human use values and quality of life, as may be caused by forest clearance through burning in Indonesia for agricultural activities.

Physical

Increase in temperature
Visibility problems

Human use values

Poor air quality

Ecology

Loss of wild life and habitat (e.g. orang gutans)

Quality of life

Loss of tourist income due to poor air quality
Airports affected due to visibility problems
Health hazard especially to the young, elderly and those with associated illness

2d) Propose the relevant environmental components you feel should be included in the baseline survey for the Environmental Impact Assessment (EIA) of the Cross Island MRT line which could include an underground section through the Central Catchment Nature Reserve.

Topography; Geology (whether it is suitable for tunnelling); Surface or ground water; Ecology – Flora, fauna, endangered species that could be affected; Air, water, land and noise pollution

2e) List three examples of social and environmental costs and three benefits which could constitute part of the total project costs and benefits

Costs

Depletion of natural resources
Social dislocation
Traffic congestion
Threat to wild life
Air, water land pollution
Threat to cultural heritage and conservation areas

Benefits

Sustainable development
Economic growth
Reduced travel time
Protection of wild life habitats
Preservation of cultural assets
Contribution to infrastructure

3a) List the possible information sources for determining environmental aspects and environmental impacts

Environmental Aspect: Element of an organization's activities, products or services than can interact with the environment

Environmental Impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services.

List of chemicals, materials and processes used

Records of past environmental aspects and impacts discovered

Observations, interviews and feedback on environmental related matters

Any relevant EIAs, reports or records

Supplier's safety data sheets to ensure that waste chemicals are properly disposed of

Relevant legislation and Codes of Practice

Writing in to the relevant public agencies to request/ purchase the required information

3b) Describe the basic steps involved in hazard identification in the Total Workplace Safety and Health (TWSH) approach)

Determine ways to identify hazards: Brainstorming, Process Review, Process Hazard Analysis, Job Safety Analysis

Determine source of hazards: Physical, Mechanical, Electrical, Chemical, Biological, Others

Consider if the hazards could cause harm beyond their immediate area of work

4ai) Briefly explain Pareto optimality

Pareto optimality refers to an allocation of resources such that no further reallocation is possible which would provide gains in production or consumer satisfaction to some firms or individuals without simultaneously imposing losses on others. It can be expressed simply on attainment of; economic efficiency in production of goods and services; economic efficiency in distribution of goods and services; and resource allocation consistent with consumer preferences.

4aii) Briefly explain Hedonic pricing

The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides. If non-environmental factors that usually determine the price are controlled for, then any remaining differences in price can be attributed to differences in environmental quality. It is most often used to estimate economic values for ecosystem or environmental services that directly affect market prices.

4b) Discuss the reasons why government intervention is needed to address environmental issues and give examples to support your argument.

Government intervention is required because leaving environmental issues to the free market will result in market failure. Below are some sources of market failure

Public good (non-excludable, non-rival): E.g. clean air, flood prevention measures

Common property resources: E.g. overfishing in the ocean, dumping waste effluents into rivers

Externalities: E.g. using environmentally friendly methods/materials will result in positive results for more people than just the user (such as resource conservation, sustainability to ensure survival of the next generation). Similarly, using environmentally unfriendly methods will cause the opposite

Ignorance and uncertainty: E.g. long term benefits from switching to environmentally friendly methods/materials not taken into account

4c) What are the major sources of pollutants for indoor air pollution? What are the indoor air quality control strategies for our city's tropical climate?

Source of pollutants

Aerosols from cooking

VOCs for paint, furniture, walls, carpet (e.g. formaldehyde)

Indoor radon

Mold growing in centralized air conditioning systems

Household chemicals like pesticide spray

Pollutants brought in from outdoors

Indoor air quality control strategies

Source control: Do not use materials that contribute to indoor air pollution

Tail-end control: Air purifiers, increase ventilation using devices like fans

d) Use the PSI Sub-Index Breakpoints to calculate the 24 hrs PSI concentration. Briefly state the PSI health-effect rating and its health implication

<p><u>9 mg/m³ CO</u></p> $\frac{PSI_{CO} - 100}{9 - 10.0} = \frac{51 - 100}{5.1 - 10.0}$ <p>PSI_{CO} = 90</p> <p><u>535 µg/m³ PM₁₀</u></p> $\frac{PSI_{PM10} - 500}{535 - 600} = \frac{401 - 500}{501 - 600}$ <p>PSI_{PM10} = 435</p> <p><u>148 µg/m³ O₃</u></p> $\frac{PSI_{O3} - 100}{148 - 157} = \frac{51 - 100}{119 - 157}$ <p>PSI_{O3} = 88.4</p>	<p><u>101 µg/m³ PM_{2.5}</u></p> $\frac{PSI_{PM2.5} - 200}{101 - 150} = \frac{101 - 200}{56 - 150}$ <p>PSI_{PM2.5} = 148.4</p> <p><u>586 µg/m³ SO₂</u></p> $\frac{PSI_{SO2} - 200}{586 - 800} = \frac{101 - 200}{366 - 800}$ <p>SO₂ = 151.2</p> <p>PSI Concentration = 435 Corresponding pollutant = PM₁₀</p> <p>(If you are running out of time, you can check the category for each pollutant, then calculate the PSI only for the pollutants at the highest category.)</p>
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Index Category	PSI	Health
Good	0-50	Air quality is considered satisfactory, and poses little or no risk.
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy	101-200	(101 – 150): Members of sensitive groups may experience health effects. The general public is not likely to be affected. (151 – 200): Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
Very Unhealthy	201-300	Health alert: Everyone may experience more serious health effects.
Hazardous	301-500	Health warnings of emergency conditions.

PSI 151 is an important threshold because it is the point when everyone may begin to experience health effects.

5ai) Briefly describe what is “Industrial Ecology”

Industrial ecology refers to the study of flows of materials and energy in industrial and consumer activities

5a ii) Within the framework of industrial ecology, elaborate on “industrial symbiosis”, “synergetic advantage” and “sustainability”. Provide relevant industry examples.

Industrial symbiosis: A mutually beneficial relationship between industries. This could be through the optimization of collective resources. For example, through the sharing of resources or reusing of by-products.

Synergetic advantage: Opportunities to gain synergy between related industries due to close geographical proximity

Sustainability: Waste reduction as the by-products of a process could be used as feed material for another material. This ensures that the full potential of a material to be exploited before it is disposed.

An example would be Eco-industrial parks (EIPs). EIPs are networks of firms and organizations, working together to improve their economic and environmental performance through symbiotic relationships. (You can elaborate using the specific examples given in the lecture notes)

Another example will be the NEWater treatment plant and used water treatment plants in Singapore. Since the NEWater treatment process uses the effluent from used water treatment plants, they are usually located in close proximity to reduce the energy required to transfer the water.

5b i) One of the important parameters in industrial ecology is the flow of the resources. What are the two main resources? Why is water not included as one of the main resources?

The two main resources are energy and limited resources (materials). Water is already included under limited resources/ materials.

5b ii) What are the main differences between mass balance analysis and life cycle assessment?

Material Flow Analysis (MFA) refers to a systematic assessment of the flows and stocks of materials within a system in space and time.

Life Cycle Assessment (LCA) is a comparison at the products or process level. It evaluates the impact of a product/ material over its entire life cycle (cradle to grave). It is objective, quantifies energy and material usage, quantifies releases into the environment and evaluates opportunities to improve environmental outcomes.

5c) What is land contamination and what is the role of hazardous waste management in the context of land remediation? Name 6 broad categories of hazardous wastes.

Land contamination refers to the inappropriate handling of hazardous waste that leads to land that contains sufficient quantities or concentrations of substances in or under the land that are actually or potentially hazardous to direct or indirect receptors.

Hazardous wastes refer to waste (solids, sludge, liquids, and containerized gases) that pose a substantial present or potential hazard to humans or other living organisms because such wastes are non - degradable or persistent in nature; they can be biologically magnified; they can be lethal; they may otherwise cause or tend to cause detrimental cumulative effects. Hazardous waste management

refers to the management of currently generated solid and hazardous waste; and the remediation or treatment of sites impacted by solid or liquid hazardous waste.

Six broad categories: Nuclear waste, Industrial waste, Universal waste, Medical waste, Construction waste, E - waste

5d) What is the Environmental Protection and Management Act (EPMA) in Singapore? Under the Act, what do industries need to comply with in storing and transporting toxic substances in Singapore?

The EPMA was implemented in January 2008, updating and replacing previous legislation. The legislation is to control environmental pollution and to provide for the protection and management of the environment and resource conservation.

EPMA requires industries that store/transport toxic substances:

1. Use a method of storage, operation or process to prevent water pollution
2. Install and operate pollution monitoring equipment to prevent and detect any leakage or discharge
3. Carry out specific tests on equipment, tanks or any other related facilities and to submit the results of these tests
4. Prepare and submit contingency plan for events of accidental discharge
5. Conduct studies on pollution control
6. Self - monitor
7. Take mandatory insurance
8. NEA can arrest offenders, enter any premise for investigation, search or seize any records if they believe discharges are being made without license

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As you can see this module requires a lot of memorization. Try to take note of what the lecturers says is important. Go for tutorials.