

Workplace Environmental Management

WEEK 11 – The control of Environmental Pollution

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Objectives

At the end of this topic students will be able to:

- Analyse the case study
 - Understand various ways to control the environmental pollution
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11.1 Case study A

- This section will present some cases for pollution control towards sustainable development for better management of the environment.
 - In Kigali, Rwanda, **air pollution** poses significant challenges. Only 1% of the urban population in low and middle-income countries breathe air that meets WHO air quality guidelines.
 - Transport is a central cause of declining air quality, but it's also essential for economic development. Research investigated air quality exposure for different modes of transport and found that regular walking and cycling population faces the highest pollution exposure. However, a well-functioning public transport system can reduce exposure. (The Case for Clean Air in Kigali: An Assessment of Sources and Solutions, Economic Impacts, and Implications for Policy, Egide Kalisa, Andrew Sudmant, Remy Ruberambuga, Yves Ujeneza, Jonathan Bower, and Shuyu Li, University of Leeds, 2022.)
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11.1 Case study A cont'd

- Another study investigates air pollution in Rwanda, focusing on Kigali City and vehicular emission to improve air quality. It combines city-level transport and economic modelling with air quality testing and monitoring.
 - The research explores the impact of urbanization, sources of air pollution, and associated health risks to provide a valuable contribution to the policy development with proper environmental management.
 - The study shows how temperature has increased tremendously between the year 2000 and 2010 while precipitation has reduced, the warming was observed in Kigali which was attributed to global warming, because rising temperatures could be recognized all over Rwanda during few last decades.
 - But it could also be related to the ongoing urbanization because the temperature trend of Kigali is much higher and faster than in other parts of the country. (A Study on Air Pollution in Rwanda with Reference to Kigali City and Vehicular Emissions, Dr. Hermogene N., Jean Pierre B., Yves S., Rwanda Environment Management Authority, 2011.)
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11.2 Case study B

- This case study investigates the implementation process behind Rwanda's **plastic bag ban**, which was introduced in 2008.
 - The study describes the policy instruments applied, including information campaigns, promotion of eco-friendly alternatives, and penalties (such as fines and imprisonment). Additionally, it explores other policy alternatives considered but not chosen.
 - Rwanda like other non-developed countries faced wide-spread problems of plastic bag pollution. In 2004, Rwanda started to raise awareness about this issue, partially through a nation-wide campaign in the media and 2008, a total ban of non-biodegradable plastic bags became reality.
 - The government developed an ambitious plan to become middle-income economy but also considering environmental protection as one of its priorities.
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11.2 Case study B cont'd

- A statement in Rwandan Constitution: 'Everyone has the right to live in a clean and healthy environment' has transformed the mindset of the population who in return understood and made the country a clean and beautiful place with high motivation of the ban on plastic bags.
 - Rwanda's plastic bag ban could be understood as a unique empirical example in terms of being an ambitious, comprehensive environmental policy.
 - Moreover, plastic waste management is on the agenda in both low-income and high-income countries as most cities grow and with that comes increasing amounts of waste and garbage. (The Plastic Bag Ban in Rwanda: Local Procedures and Successful Outcomes - A Case Study on how Rwanda Implemented a Nation-wide Ban on Plastic Bags, Michaela Danielsson, Uppsala University, 2017.)
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11.3 Case study C cont'd

The following pictures are taken from an article with title “Kigali **Waste Management System**”, to report how the country is working hard to settle the ever-rapid increasing of solid waste among residential places.

Proper waste collection services, challenges with landfill management, and the need to transition from a linear waste system to a circular economy would contribute to protection of the environment while advancing in economic development. (Kigali Waste Management System, C-38435-RWA-1, 2019.)



11.4 Ways to control

- Urban air pollution control policies and strategies (**Air pollution control strategies**).
 - Water pollution control involving a combination of physical, chemical, and biological treatments (**Water pollution control strategies**).
 - Noise pollution can significantly impact our well-being, it needs effective ways to mitigate (**Noise pollution control strategies**).
 - Thermal pollution originating from rapid and unnatural changes in ambient temperature in natural water bodies have an impact on aquatic ecosystem, it requires good and sustainable control strategies (**Thermal pollution control strategies**)
 - Exploring practical solutions to prevent and address soil contamination originating from industrial activities and agriculture (**Soil or land pollution control strategies**)
 - Controlling radioactive pollution is crucial for public health and environmental safety (**Radioactive pollution control strategies**)
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11.4.1 Air pollution control strategies

- General strategies and policies: These cover a wide range of actions such as promoting renewable energy, clean fuels, and low-pollution vehicles.
 - Transportation sector measures: Implementing free public transportation programs to reduce private car usage.
 - Energy sector measures: Eliminating or limiting the use of solid fuels.
 - Industry sector measures: Implementing emission reduction policies.
 - Governments also use incentive, supportive, and punitive policies to address air pollution. (Urban air pollution control policies and strategies: a systematic review, Ahmad Jonidi Jafari, Esmail Charkhloo, and Hasan Pasalari, Journal of Environmental Health Science and Engineering, 2021.)
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11.4.1 Air pollution control strategies cont'd

- **The preventive approach** emphasizes on the use of non-conventional source of energy in industries to upgrade to the emission minimization stage.
 - It stresses on continuous maintenance of vehicles and roads as well as efficient transportation system enhancement, this is in relation with the green transportation for eco-friendly modes like free public transport and reduction of private cars.
 - It also eradicate the reduction of garbage burning and shifting cultivation areas making sure the practice of afforestation is put in place.
 - **The dispersal approach** informs about the raising of heights of smokestacks in industries to release pollutants into high atmosphere.
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11.4.1 Air pollution control strategies cont'd

- **Collection approach** reveals the design of equipment and machine able to trap pollutants before they escape into atmosphere but also practicing re-designing by including converters which change pollutants into harmless substances.
 - **Legislative approach** involves governments to set laws, policies, standards and norms to be followed by all individuals worldwide to control air pollution ensuring good air quality.
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11.4.2 Water pollution control strategies

- Physical treatments by clarification: Removes suspended particles through sedimentation.
 - Physical treatments by filtration: Passes water through porous media to trap impurities.
 - Physical treatments by sedimentation: Allows heavier particles to settle out.
 - Physical treatments by distillation: Separates contaminants by vaporizing and condensing water.
 - Chemical treatment by flocculation/coagulation: Aggregates fine particles for easier removal.
 - Chemical treatment by disinfection: Uses chlorine or other chemicals to kill pathogens.
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11.4.2 Water pollution control strategies cont'd

- Chemical treatment by adsorption: Binds pollutants to surfaces (e.g., activated carbon).
 - Chemical treatment by oxidation: Converts pollutants into less harmful forms.
 - Biological treatment by microbial treatment: Uses bacteria or algae to break down organic matter.
 - Biological treatment by constructed wetlands: Natural systems that filter pollutants.
 - Biological treatment by bioremediation: Enhances microbial activity to degrade contaminants. (Water Pollution and Advanced Water Treatment Technologies, Manasi R. Mulay & Natalia Martsinovich, The Palgrave Encyclopedia of Urban and Regional Futures, 2022.)
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11.4.2 Water pollution control strategies cont'd

- **Educational approach** requires population in all categories (from local household to global contributors) to be educated about clean water and water quality in general as well as its impact on economy, society and ecology.
 - **Sewage treatment approach** informs household to ensure that contaminated water doesn't get mixed up with freshwater bodies.
 - **Accountability of industry approach** reminds the industries to set up proper way to treat waste materials and water for its safe drainage, the effluents control should be enhanced for regular preventive maintenance and performance monitoring of pollution control systems.
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11.4.2 Water pollution control strategies cont'd

- **Afforestation approach** reveals that planting trees is very important as trees check surface soil runoff by running water.
 - **Soil conservation approach** is regarded with the fact if many inorganic substances are added in surface and underground water have great importance. Thus, conservation of soil is a good technique to utilize for controlling water pollution.
 - **Reduced use of chemical fertilizers approach** informs to avoid the use of fertilizers as they add nitrates in water bodies. So, using compost manures can help to reduce the problem of eutrophication in water bodies.
 - **Financial support and legislation approaches** are related to the address of fighting much demand of clean water due to global population growth through laws, policies, standards and fund release to control pollution.
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11.4.3 Noise pollution control strategies

- Sound barrier like solid garden fence or wall around outdoor space are important for noise reduction or cancellation. Materials like brick, concrete, or dense timber effectively block sound waves.
 - The use of sound-absorbing materials like acoustic foam panels to absorb sound when placed strategically in rooms or workspaces, cork, carpets, and rugs also help dampen noise, wallpaper reduce indoor noise effectively, plants such as ferns, fiddle-leaf figs, and palms, absorb sound and contribute to a quieter environment.
 - Silencers and equipment modification to air exhausts, blowing nozzles, and other noisy equipment.
 - Soundproof windows to minimize external noise and doors that close quietly to prevent slamming noises.
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11.4.3 Noise pollution control strategies cont'd

- From the reference of the previous slide, though some may be repeated by the short summary is effective ways to soundproof your garden and create a more tranquil outdoor space.
 - The summary stresses on sound plants usage to absorb sound and create a natural buffer as well as artificial sound-absorbing materials. (How to soundproof a garden - 7 ways to block out the noise, Richard Jones, Ideal Home, 2024.)
 - Noise control at home as well as at the workplace is essential but also very easy to control compared to other types of pollutions, in the following slides a list is provided for home to global or mass approaches which can be used to control noise pollution in general.
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11.4.3 Noise pollution control strategies cont'd

- Turning off sound-making appliances when they are not in use.
 - Shutting the door when noisy machines are being used.
 - Lowering the volume of appliances such as television to a desirable level.
 - Using earplugs while listening to music.
 - By planting trees in large number to create vegetation buffer zones, which absorbs noise.
 - Public awareness about the need of control of noise pollution.
 - Application of engineering control techniques.
 - Construction of institutions and hospitals away from airports, railways, and highways.
 - Improved building design may also reduce the impact of noise pollution.
 - Stringent legislations at central and state levels to check all sort of pollution.
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11.4.4 Thermal pollution control strategies

- Cooling ponds described as large, shallow bodies of water used for heat dissipation where warm water from industrial processes (e.g. power plants) is pumped into one end of the pond, and cooler water is extracted from the other end. Its benefits include promoting heat exchange and while reducing the temperature of discharged water.
 - Cooling towers described as mechanical draft cooling towers (MDCCTs) and are widely used for heat removal where hot water from industrial processes enters the tower, and it evaporates then cools therefore the cooled water is recirculated. Its benefits include heat dissipation in an efficient way and minimizes thermal impact on natural water bodies.
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11.4.4 Thermal pollution control strategies cont'd

- Spray ponds described as spray nozzles to disperse water into the air, enhancing evaporation and cooling where water droplets drag air into the spray region, reducing local wet-bulb temperature and promoting heat transfer. It is advantageous by its simplicity, lower power requirements and cost effectiveness.
 - Artificial lakes described as constructed lakes or reservoirs designed for cooling purposes where industrial facilities release heated water into these lakes, allowing natural cooling through evaporation and conduction. Its benefits include controlled environment for heat dissipation. (Thermal pollution, Gary R. Brenniman, Encyclopedia of Earth Science (EESS).)
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11.4.4 Thermal pollution control strategies cont'd

- Shrock, et al investigate the thermal performance of a spray pond designed for nuclear power plant cooling and found that unlike conventional spray ponds, an innovative design called the oriented spray cooling system (OSCS) outperforms existing systems.
 - In the OSCS, nozzles are mounted on spray trees arranged in a circle and tilted toward the center which enhances air flow through the spray region, reducing local wet-bulb temperature and promoting efficient cooling. (Performance of a Spray Pond for Nuclear Power Plant Ultimate Heat Sink” by Shrock, Trezek, and Keilman, 1975.)
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11.4.5 Land pollution control strategies

- Preventing or reducing waste generation through source reduction that encourages practices to minimize waste production such as buying only what is needed, avoiding single-use items, and supporting products with minimal packaging.
 - Preventing or reducing waste generation through circular economy that promotes reuse and repair to extend the lifespan of products by repairing or reusing them for different other purposes.
 - Preventing or reducing waste generation through education and awareness to the communities about waste reduction and responsible consumption.
 - Recycling for material recovery by implementing efficient recycling programs for paper, plastics, glass, and metals with much motivation for citizens and businesses to participate.
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11.4.5 Land pollution control strategies cont'd

- E-waste recycling with proper management of electronic waste (e-waste) by recycling old electrical and electronics apparatus.
 - Recycling by composting to convert organic waste (such as food scraps and yard trimmings) into nutrient-rich compost for soil enrichment which in turn promote the control of water pollution.
 - Incineration with Waste-to-Energy (WtE) to recover energy by generating electricity or heat from waste combustion.
 - Incineration with advanced technologies involves the use of modern incinerators with pollution control systems to minimize emissions.
 - Incineration with proper ash disposal for safely management during ash incineration to prevent contamination.
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11.4.5 Land pollution control strategies cont'd

- Sanitary landfills through engineered landfills to design and operate landfills with liners, leachate collection systems, and gas capture.
 - Sanitary landfills through leachate treatment by treating liquid produced from decomposing waste to prevent groundwater contamination.
 - Sanitary landfills through landfill gas recovery by collecting and utilizing methane (a strong greenhouse gas) from landfills for energy. (Solutions for Soil Pollution, Meg Schader, Sciencing, 2021.)
 - Plasma gasification uses extremely high temperatures to turn waste into gas in an oxygen-free environment to reduce waste volume, minimize emissions, and produce syngas (a mixture of hydrogen and carbon monoxide) that can be used for energy generation.
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11.4.5 Land pollution control strategies cont'd

- Landfills, often out of sight and out of mind, play a crucial role as the final resting place for household, medical, and industrial waste. Despite increased recycling efforts in the UK, close to 50M tonnes of rubbish still end up underground each year due to limited landfill capacity. To address this challenge, engineers are exploring innovative solutions such as landfill mining. In this process, existing or closed landfills are excavated, and valuable materials are extracted for recycling.

○ Three R's (reduce, reuse, and recycle) play a crucial role in mitigating soil pollution.

(Taking out the trash – how engineers could tackle the landfill problem, Len Williams, Institution of Mechanical Engineers (IMechE), 2018.)



11.4.5 Land pollution control strategies cont'd (the approaches)

- Adoption of soil-friendly agricultural practices.
 - Use of compost manures in place of chemical fertilizers; Use of bio-fertilizers and natural pesticides help in minimizing the usage of chemical fertilizers and pesticides.
 - Scientific rotation of crop to increase soil fertility.
 - Proper disposal of industrial and urban solid and liquid wastes.
 - Planting of trees to check soil erosion in slopes and mountainous regions
 - Controlled grazing.
 - Reduction in the heaps of garbage and refuse.
 - The principles of three R's – Recycle, Reuse, and Reduce – help in minimizing generation of solid waste.
 - Formulation and effective implementation of stringent pollution control legislation.
 - Improved sewage and sanitation system in urban areas.
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11.4.6 Radioactive pollution control strategies

- Justification, Optimization, and Limitation minimize radiation exposure, they are the three underlying principles of good radiation protection.
 - Some crucial situations include risk-based application of the principles results in control methods comprising control over areas, control over people, and control over radiation sources.
 - These are implemented through judgements based on the use of dose limits, dose constraints, and application of the ALARA principle.
 - Potential dose levels and possible control measures appropriate to each situation are key consideration in various categories.
 - Proper disposal and labelling dispose of radioactive waste safely.
 - Controlled areas and protective gear use protective clothing and indicators.
(Principles and control methods, Karen E Goldstone, Oxford Academic, 2014.)
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Thank you for your good attention
Q&A

References

- The Case for Clean Air in Kigali: An Assessment of Sources and Solutions, Economic Impacts, and Implications for Policy, Egide Kalisa, Andrew Sudmant, Remy Ruberambuga, Yves Ujeneza, Jonathan Bower, and Shuyu Li, University of Leeds, 2022.
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