Problem Based Learning: Teaching engineers to tackle the SDGs
Educating for the end-of-engineered life: waste, risk and circular economy
Plastics pollution and circular economy research group
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Waste flows modelled on land, before they reach the aquatic environment

Plastic Waste generation: 316,878 t/y
- Collected: 42%
- Recycled: 7%
- Retained at landfill: 34%
- Openly burnt: 22%
- Retained on land: 24%
- Enters waterways: 13%
- Mismanaged: 58%
Plastic pollution and circular economy research group

Environmental

Economic

Social

Technical

Complex value optimisation for resource recovery

Systems approach to after-use materials
State of global waste and resources management
'Waste' concept

- Material with negative financial value to owner
- Material with no utility to owner
- Matter at wrong place
- Potential hazardousness (current or future)
- All things mixed up (heterogeneity)

‘WASTE’
‘Leakage’: open dumping, burning, marine litter and plastics pollution

Source: C Velis
SDGs and waste management
UN Environment: 2-3 billion people without basic waste services
How SDGs relate to waste management?

W.1 Access for all to adequate, safe and affordable solid waste collection services

W.2 Stop uncontrolled dumping, open burning

W.3 Achieve sustainable and environmentally sound management of all waste, particularly hazardous waste

Global Waste Management Outlook Goals 2020
How SDGs relate to waste management?

W.3 Sustainable & environmentally sound mgm’t of all waste, particularly haz. waste

W.4 Reduce waste gen. through prevention & the 3Rs (reduce, reuse, recycle) & thereby create green jobs

W.5 Halve per capita global food waste at the retail and consumer levels and reduce food losses in the supply chain

Global Waste Management Outlook
Goals 2030
SDG 12 targets and indicators
By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

**Target 12.3**

12.3.1 (a) Food loss index

12.3.1 (b) Food waste index

**12.3:** Halve per capita food waste and reduce food loss
By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

Target 12.4

12.4: Environmentally sound management of hazardous waste

12.4.1: Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement

12.4.2: Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment
12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

12.5.1: National recycling rate, tonnes of material recycled (no data available)
Recycling rate and systems
Recycling rates around the World

Source: Velis et al., in preparation
SoCo tool: Solidary selective collection

https://soco.leeds.ac.uk/
Plastics sorted in 2016

SoCo project: Cooperative in Brazil – Effective plastics sorting
Waste picking challenges
Supporting inclusion/ formalisation IRS for plastics pollution prevention

Source: CSIRO and UoL – under preparation
Recycling and pollution?
Global recycling systems rely on exports
Uncontrolled residues management for plastics in China
Global review on the safer end of engineered life
The global review on Safer End of Engineered Life

**Objectives**

- Global material flow
- Systematic literature review (n = 15,000 papers)
- Identify practical approaches to enhance safety & best practice
- Provide foresights into future health & safety challenges
- Recommendations for evidence-based action
- Provide foresights into future health & safety challenges

- Plastic waste
- Medical waste
- Construction and demolition waste
- E-Waste
- Disposal sites

~15,000 articles reviewed
The global review on Safer End of Engineered Life

Sources
- MSW formal collection
- MSW informal collection
- E-waste

Pathways
- MSW sorting
- Careful sorting reduces risk of contamination
- Despite rigorous standards, legacy substances
- Thermal release of potentially hazardous substances
- Transformation during incomplete combustion

Receptors
- Legacy substances may find their way into undesirable places
- Children are susceptible because they chew toys...... and eat mud!
- Inhalation of gaseous, liquid and solid substances of concern

Example of potential hazards and pathways toward sensitive receptors for plastics
Engineering solutions: YES!

But need maths and quantification put in socioeconomic context

Inter- and cross-disciplinarity
Integrated sustainable waste management framework
Modelling plastic pollution complexity

Human - engineering – environment complex systems
Effect of improving collection infrastructure / service

**Before:**
- **2,632** Plastic waste generated
- **1,870** Retained in the collection system
- **917** Openly burnt
- **613** Retained on land
- **340** Waterways

**After:**
- **1,795** Plastic waste generated
- **762** Retained in the collection system
- **837** Environment
- **409** Retained on land
- **131** Openly burnt
- **340** Waterways

**Improvement:**
- **Marginal change inRetained in the collection system:**
  - **917** to **762**
- **Reduction in Retained on land:**
  - **613** to **409**
- **Openly burnt:**
  - **917** to **131**
- **Waterways:**
  - **340**

**Efficiency Change:**
- **30% to 90%**
Solid waste management laboratory: sample preparation

State-of-the-art laboratory facilities for waste characterisation
Scope: Major solid waste and recourse recovery challenges

Laboratory (characterisation – processing – sampling – uncertainty)

Modelling material flows in systems (plant – city – country – economy level)

New analytical tools (assessment methodologies – indicators)

Global assessment and benchmarking (city – country level)

Approach: With multiple tools – core in environmental engineering – supported by cross-disciplinary collaborations