

Waste Research

Research Beyond the Lab: Open Science and Research Methods
for a Global Engineer

Prof. Elizabeth Tilley

2024-04-18

Week 8: Solid Waste Management



Photo: E. Tilley

Course overview

12:15-13:00: Introduction to Waste Management

13:15-14:00: Presentation and Brainstorming with S. Kahlert, ETH
Sustainability

14:15-15:00: Research Questions

Introduction to Waste Management

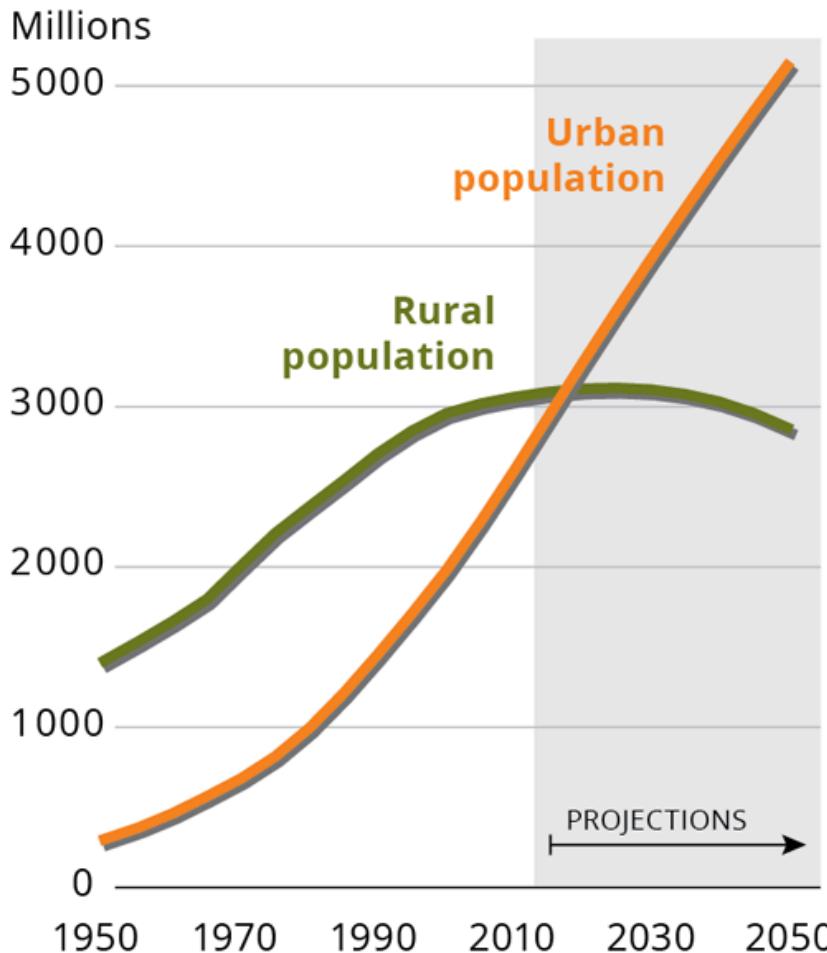
Learning Objectives

- Learners can articulate the scale and drivers of the challenges in solid waste management
- Learners understand the flow of waste from Generation to Recovery
- Learners can identify waste management challenges at ETH and/or Zurich
- Learners can develop their own research questions using either the PICOT or FINER method

World challenges in solid waste are urban

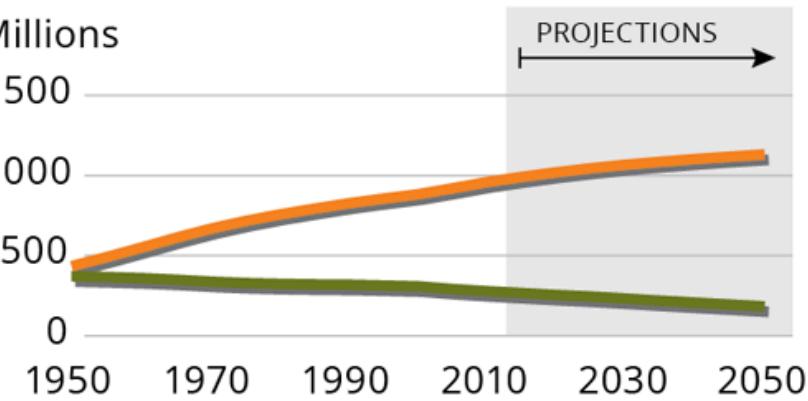
Less developed regions

Africa, Asia (excluding Japan), Latin America and the Caribbean, Melanesia, Micronesia and Polynesia.



More developed regions

Europe, Northern America, Australia, New Zealand and Japan.



Source: European Environment Agency (EEA)

Challenges of SWM

- Public health
- Environmental health – Local and Global
- Resource value

Special concern when ecological carrying capacity is overburdened

1. Population density = risk of exposure
2. Waste materials properties = severity of exposure

Health Threats

- Exposure to pollutants: formal and informal workers (collectors, sorters) exposed to waste (also by flooding)
- Proliferation of pests: waste attract insects and rodents that carry diseases
- Respiratory problems due to open burning of garbage
- Physical risks: occupational related risk of injuries



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26 dead in the Philippines, 2011

@ rbt-fs24.github.io/website/

Environmental Threats

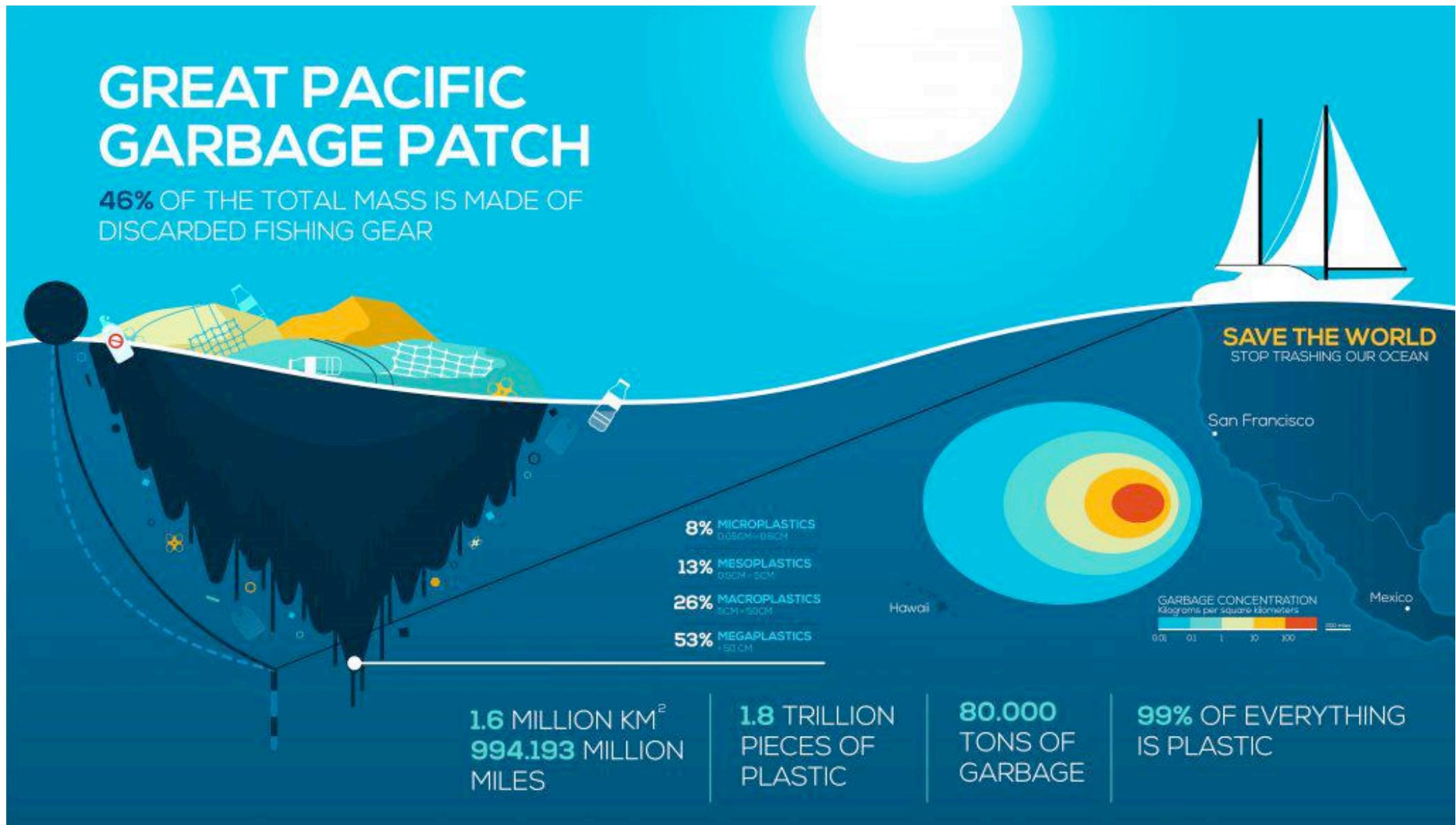
- Contamination of water, soil, air...(plastics, metals, toxins, nutrients)
- Blockage of drains -> flooding -> erosion
- Deterioration of aesthetic value of landscapes (tourism)



Source: World Bank Water

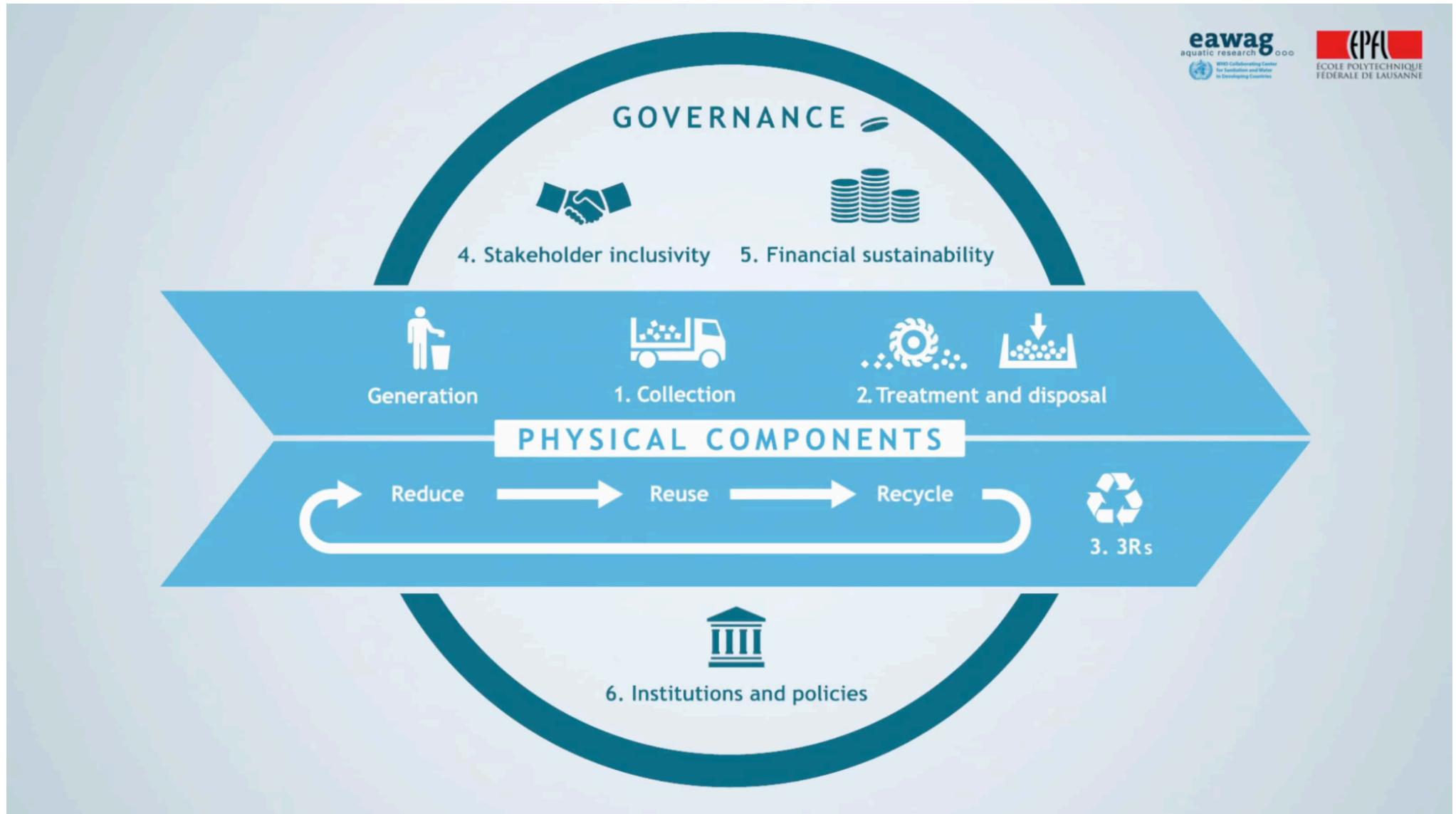
Unknown impacts

- Great Pacific Garbage Patch: 0.41 – 8.1% of Pacific Ocean
- Plastic facts: take > 400 years to degrade, bioaccumulation
- More than 80 % from land-based human activities



Source: Haultail

ISWM Framework



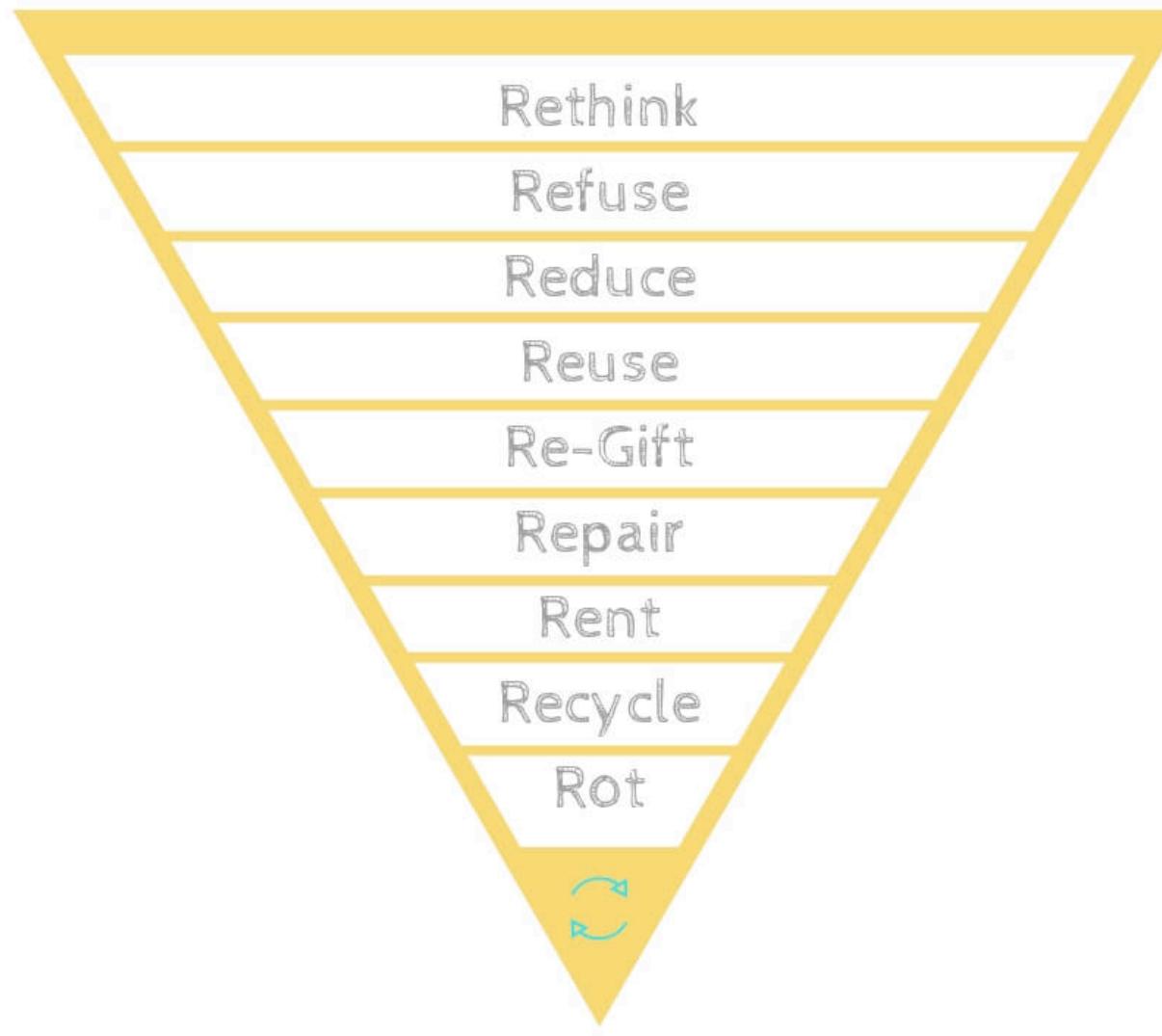
Source: samim

3Rs...



Source: LAHS ECO Engineering

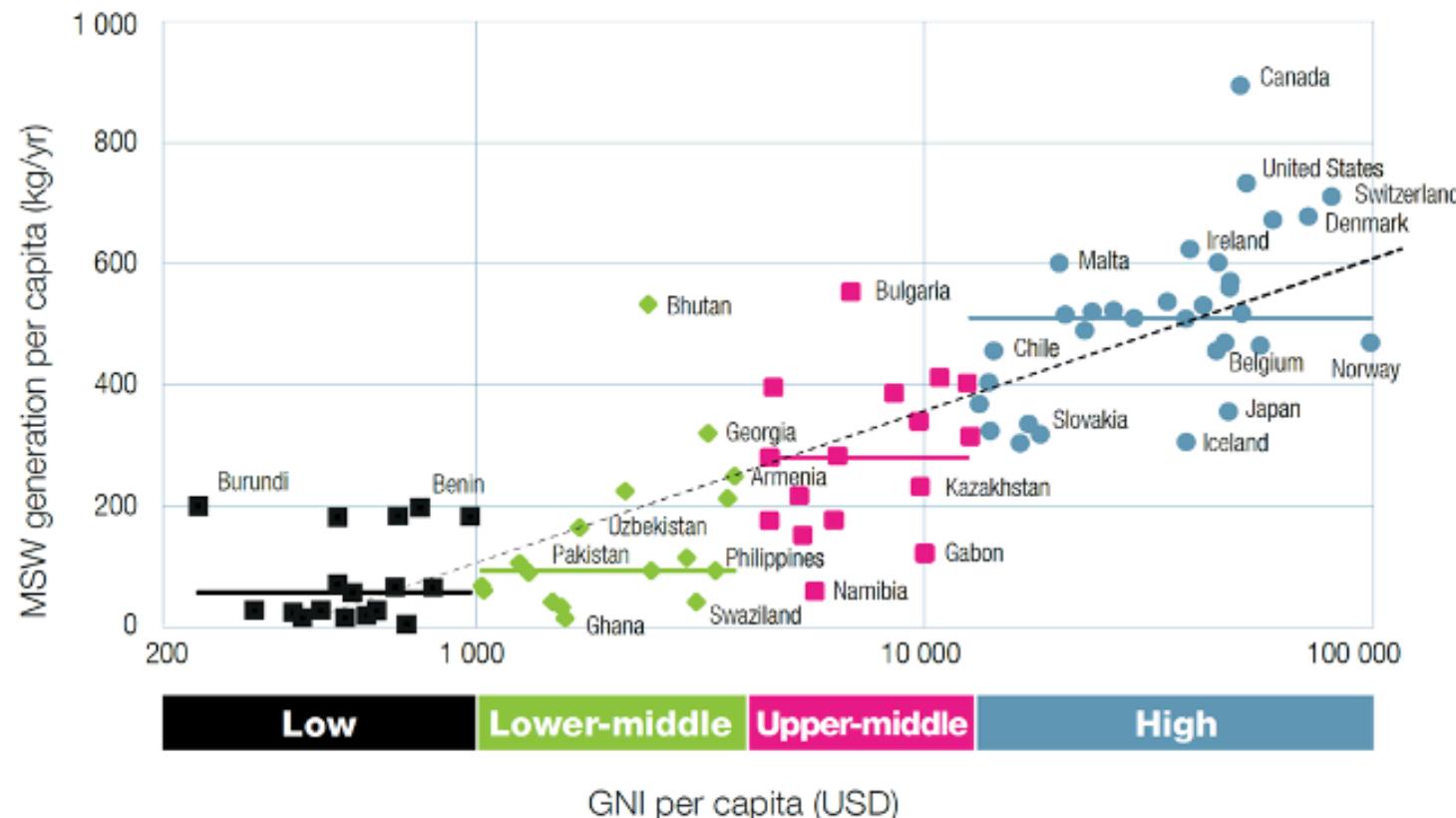
...9Rs



Source: Gypsy Soul

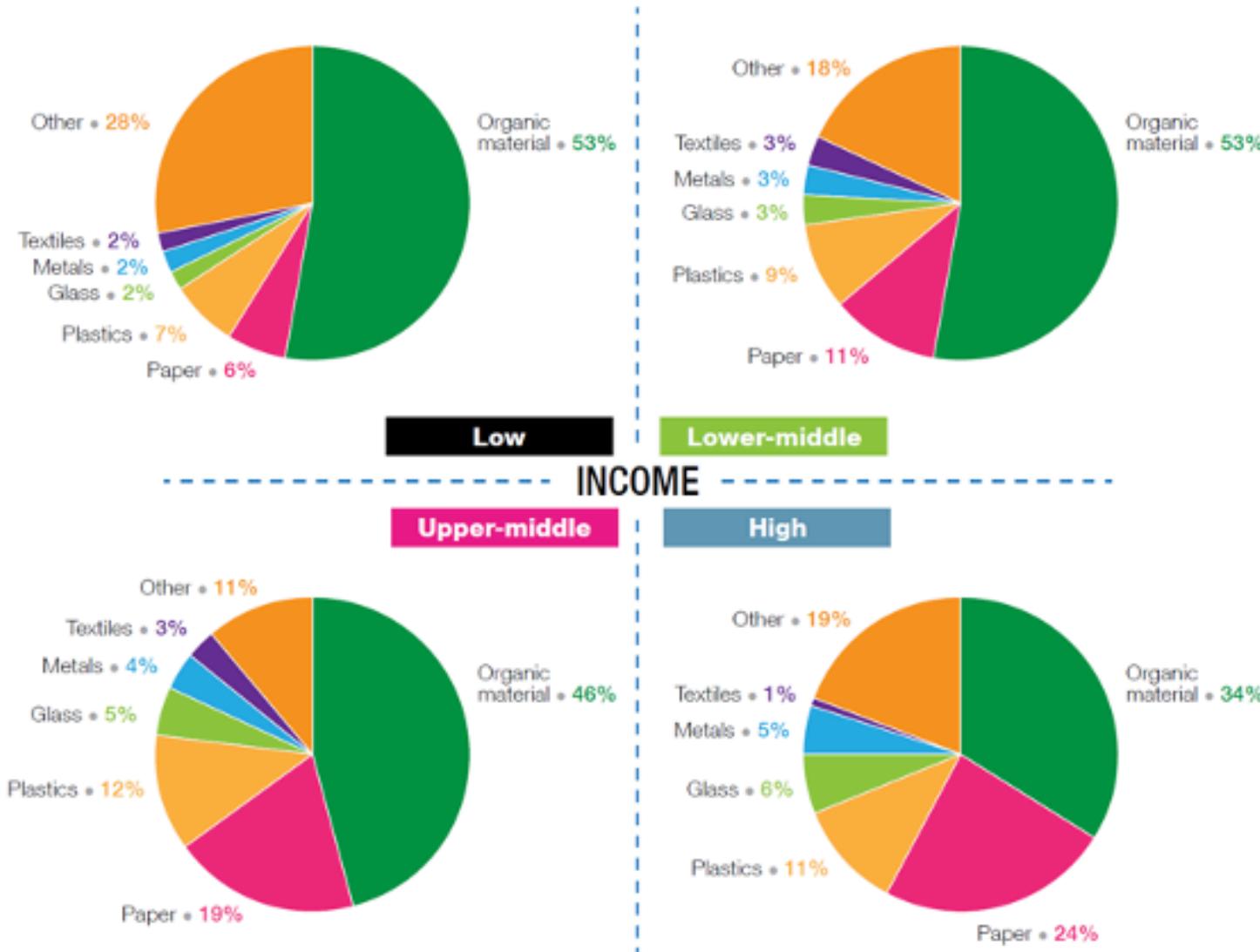
Generation

Switzerland has one of the highest municipal solid waste volumes in the world, at 716 kg of waste per person and year. *Nearly 53% of it is recycled.*



Waste generation versus income level by country, UNEP/ISWA (2015)

Generation



Waste generation versus income level by country, UNEP/ISWA (2015)

Collection and Transport



Source: TMA

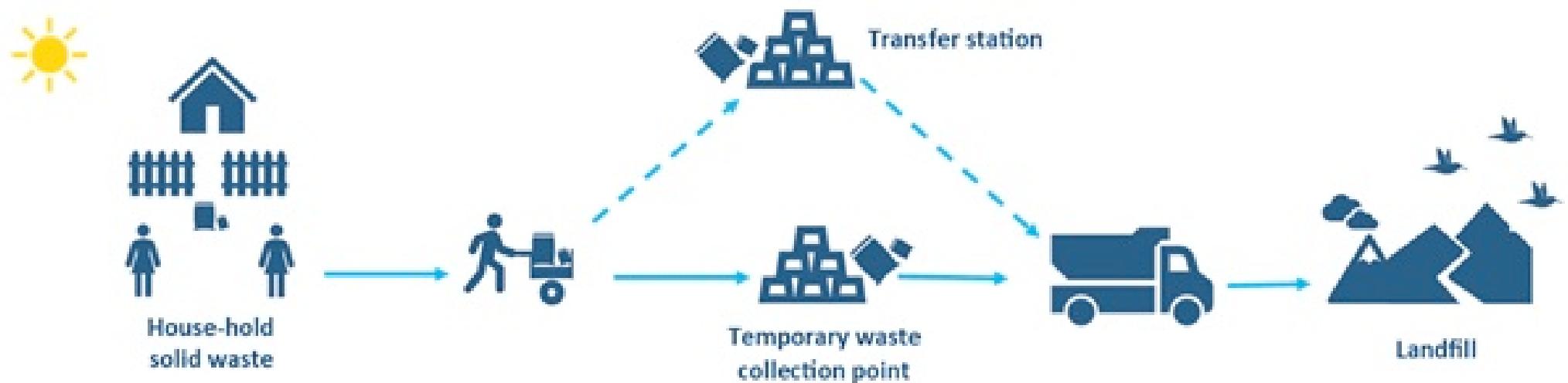
Collection and Transport



Source: UNDP

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Collection and Transport



Source: UNDP

Treatment



Photo: E. Tilley

Treatment



Photo: E. Tilley

Recovery



Source: ETH Zürich

Recycling

RECYCLING

The Swiss are world champions.



of glass



of steel



of tin cans



PET
bottles



of batteries



128,000 t
of electronic
appliances



60,000 t
of textiles
and shoes

**160 kg of wastepaper
is collected per person
per year.**



COMPOST

**1.3m tonnes of organic
waste is produced annually;
approx. 300,000 tonnes
is composted by
private individuals.**

Source: LivingIn

Stakeholders

1. Waste generators – *Need to interface with the system (waste segregation?)*
2. Central/provincial government – *Determine strategy, policy, regulation, commitments*
3. Municipality – *Service provider and regulator*
4. NGOs & CBOs – *Awareness and self-help initiatives*
5. Private formal sector – *Provide service*
6. Private informal sector – *Play an integral and important part in most low and middle income countries*
7. Internal & external support agencies – *Support and steer through funding and international conventions*

Policies

- Regulation and Enforcement
- Social Mobilization
 - Inform, education, communicate
- Economic Instruments
 - Incentives, fines

Take home messages

Research Questions

Finding the right research question early will save you a lot of headaches later

The research question will influence

- Who or what you sample
- The research design you use (we will discuss Week 9)
- The type of analysis you use

As Dr. Fandino states:

“...up to one third of the time spent in the whole process...
[should] be invested in finding the right primary study question”

Compare the examples

1. Do supraglottic devices provide similar conditions for the visualization of the glottis aperture in a German hospital?

versus

2. Among children younger than 1 year of age undergoing elective minor procedures, to what extent the insertion times are different, comparing the Supreme laryngeal mask airway (LMA) to Proseal LMA, when placed after reaching a BIS index <60?

Let's examine the first question

Do supraglottic devices provide similar conditions for the visualization of the glottis aperture in a German hospital?

1. “Do these devices...provide similar conditions...” implies a YES or NO answer 

NEVER ask a yes or no question!

- ✗ Is the city of Zurich able to recycle all of its plastic?
- ✗ Does the city of Zurich recycle all of its plastic?
- ✗ Do people recycle plastic?
- ✓ What percentage of waste is the city of Zurich able to recycle?
- ✓ How much does it cost to recycle all of the plastic in Zurich?
- ✓ Who are the residents most likely to recycle plastic?

To help us define the key components of a Research Question we use the PICOT Framework

- Population
- Intervention
- Comparator
- Outcome
- Timeframe

With many clarifying questions spelled out in the paper. Even when we don't really understand the research topic, we should be able to identify the components of PICOT

Among children younger than 1 year of age undergoing elective minor procedures, to what extent the insertion times are different, comparing the Supreme laryngeal mask airway (LMA) to Proseal LMA, when placed after reaching a BIS index <60?

- Population: children <1 undergoing elective minor procedures
- Intervention:
- Comparator:
- Outcome:
- Timeframe:

Among children younger than 1 year of age undergoing elective minor procedures, to what extent the insertion times are different, comparing the Supreme laryngeal mask airway (LMA) to Proseal LMA, when placed after reaching a BIS index <60?

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- Outcome: times of insertion
- Timeframe:

“Interventions” are common in medicine, economics, engineering

- What is the impact of extra sleep on student grades?
- What is the impact of a cash payment on the rate of mothers who vaccinate their children against polio?
- What is the impact of a natural dye on the durability of recycled PET?

Not necessary, and ideally avoided in your own project

Your turn! Write out a research question using the PICOT or PCOT method (5 minutes)

We will discuss (15 minutes)

Ok, so we have our research questions which are technically good (we can analyze the data), but is it work asking? To assess whether it's possible or useful we use the FINER framework:

- Feasible:
- Interesting:
- Novel:
- Ethical:
- Relevant:

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- Ethical: is it safe?
- Relevant: is it useful?

For your projects, you don't need to worry too much about whether it is “Novel” but it should be interesting and relevant (either for ETH, ERZ, etc.)

Your turn! Assess your research question using the FINER framework (5 minutes)

Discussion (15 minutes)