

# The Limits to Growth: Sustainability and the Circular Economy

## Lecture 2: Challenges I: Natural Resources and Environmental Pollution

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- Updated versions of these slides will be available in our [Github repository](#).

# SUSTAINABILITY

# Introduction

## Sustainability

*„Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.“*

# Introduction

## Sustainability - Origins

„Wie eine sothane [solche] Conservation und Anbau des Holzes anzustellen / daß es eine continuirliche beständige und **nachhaltende** Nutzung gebe / weiln es eine unentbehrliehe Sache ist / ohne welche das Land in seinem Esse nicht bleiben mag“ - Hans Carl von Carlowitz (1713)

# Introduction

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→ “continuously enduring and sustainable use”

# Introduction

## Sustainability - Origins

*„Sowing and planting of trees had to be regarded as a national duty of every landowner, in order to stop the destructive over-exploitation of natural resources“ - John Evelyn (1662)*

# Introduction

## Sustainability - Origins

- Carl von Carlowitz and *Sustainability*
  - Coined the term at a time when Europe was in need of vast quantities of wood (mining, ore-smelting, ship building, etc.)  
→ Fear of timber scarcity
- Growing population → Fear of food-shortage if food production cannot keep up with reproduction
  - World population in 1700 → ca. 0.6 billion people
  - World population in 1800 → ca. 1.0 billion people
- Industrial revolution (ca. 1760 – 1840) fostered environmental degradation → society chose prosperity rather than sustainability

# Biocapacity

## Definition

*Is „the locally available carrying capacity of the ecosystem for generating resources and absorbing wastes“*

# Ecological Footprint

## Definition

*„The ecological footprint for a particular population is defined as the total area of productive land and water ecosystems required to produce sufficient resources and assimilate wastes“*

- 1.) W.E. Rees (1992) – Ecological footprint and appropriated carrying capacity: what urban economics leaves out. Environmental Urbanization.
- 2.) W.E. Rees, M. Wackernagel (1994) – Ecological footprints and appropriated carrying capacity: measuring the natural capital requirements of the human economy.
- 3.) D. Yue, J. Guo, C. Hui (2013) – Scale dependency of biocapacity and the fallacy of unsustainable development - <https://doi.org/10.1016/j.jenvman.2013.04.022>

# Sustainability Implications

**Sustainability → Consume less**

## A LACK OF RESOURCES

# We only have one planet

## Resources



*"I am afraid of losing my child  
to a resource war because of a  
climate collapse"*

→ *"Our parents will die of old  
age, our children will die of  
climate change"*

# We only have one Planet

## Resource Wars

*“Resource wars are violent conflicts that are largely driven by competition for control over vital or valuable natural materials, such as oil, water, land, timber, animals (or animal products), gold, silver, gems, and other key minerals.”*

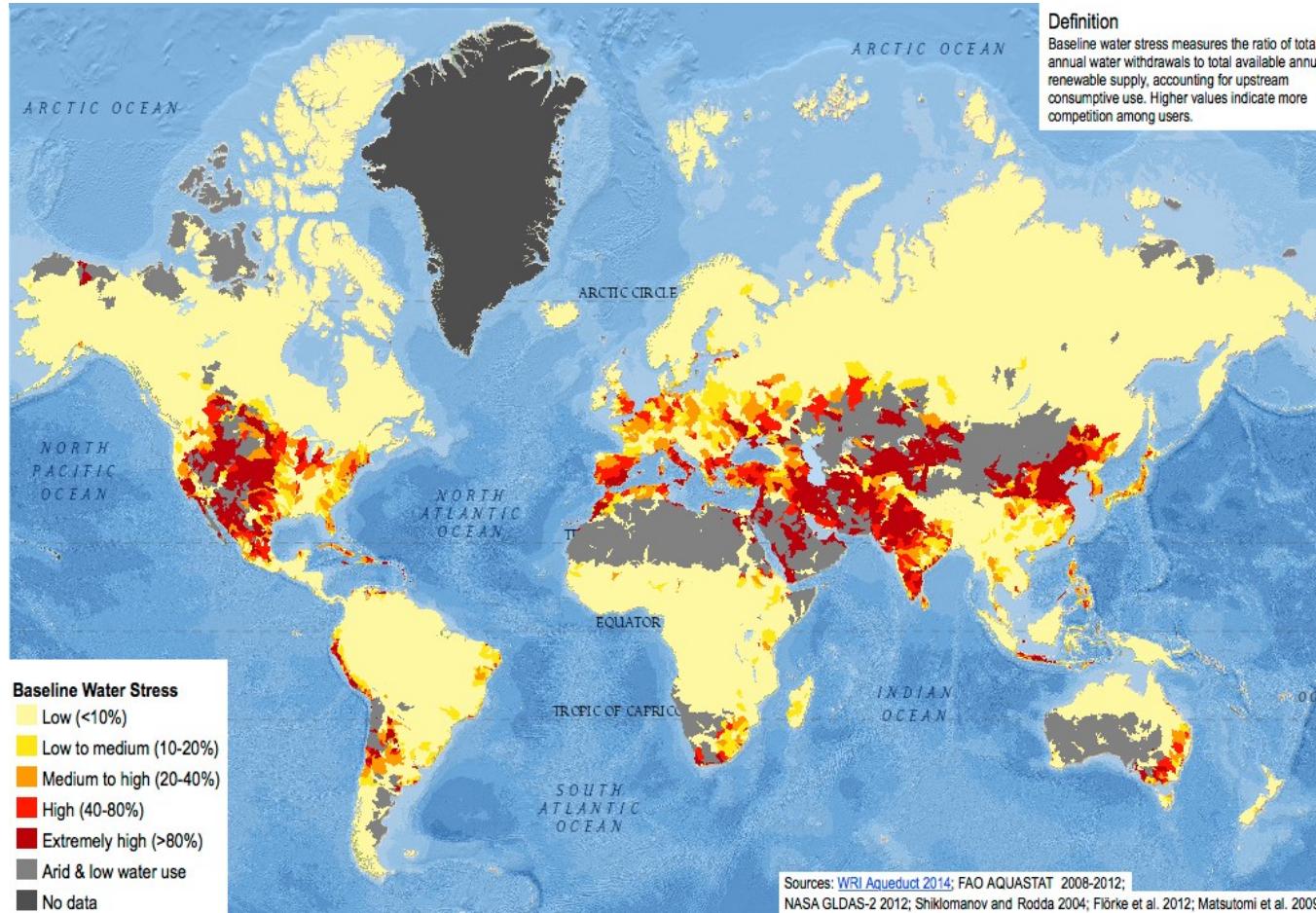
# We only have one Planet

## Resource Wars – Oil, etc.



# We only have one Planet

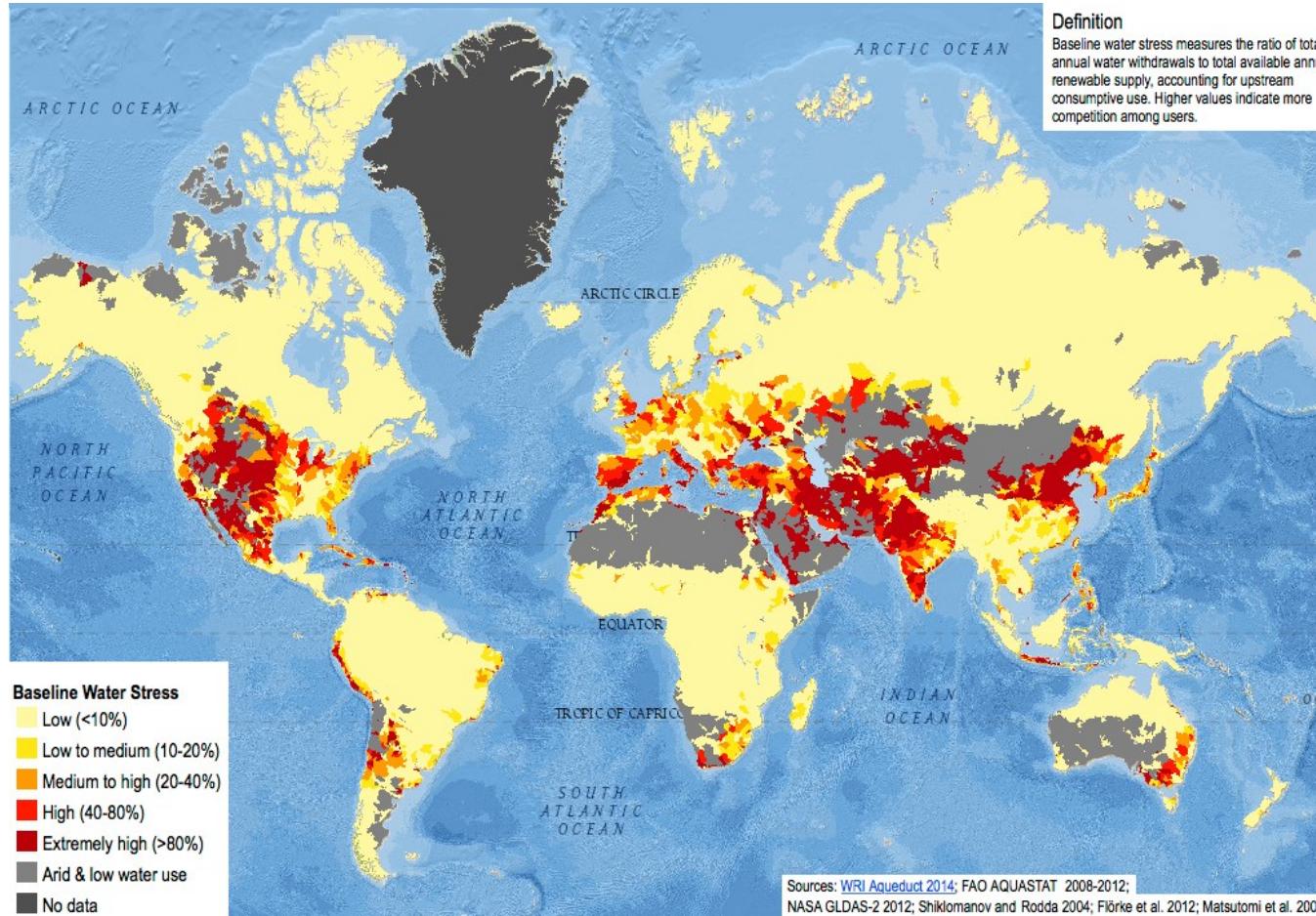
## Resource Wars – Water



1. Sampa – [https://commons.wikimedia.org/wiki/File:Baseline\\_water\\_stress.jpg](https://commons.wikimedia.org/wiki/File:Baseline_water_stress.jpg) – CC BY-SA 4.0.
2. Kgbo – [https://commons.wikimedia.org/wiki/File:Closed\\_Wivenhoe\\_Dam\\_and\\_spillway,\\_August\\_2020.jpg](https://commons.wikimedia.org/wiki/File:Closed_Wivenhoe_Dam_and_spillway,_August_2020.jpg) – CC BY-SA 4.0.
3. Arian Zwegers – <https://www.flickr.com/photos/azwegers/6226842732> – CC BY 2.0.

# We only have one Planet

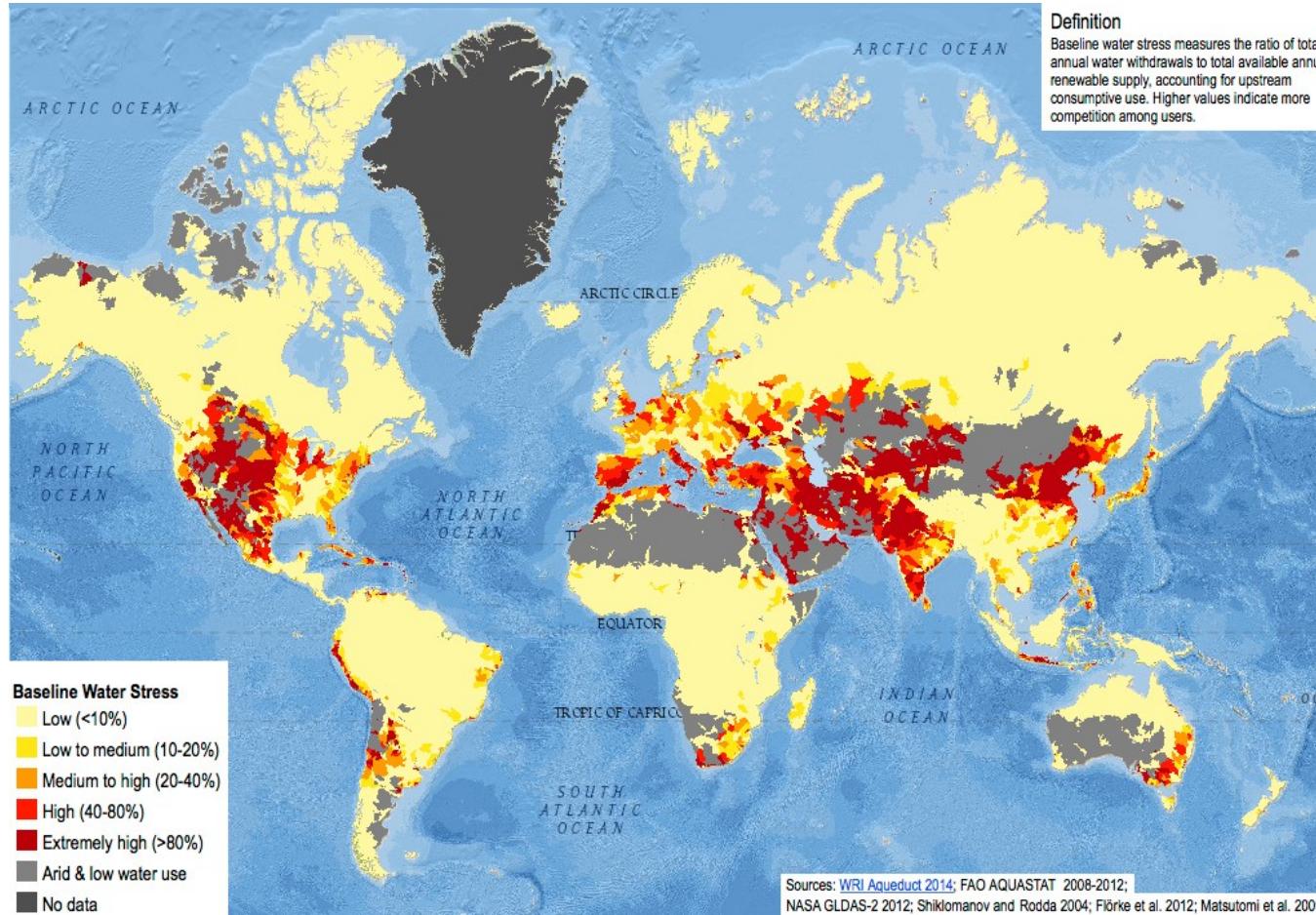
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# We only have one Planet

## Resource Wars – Water



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# ENVIRONMENTAL POLLUTION

# Environmental Pollution

## Definition

**„Pollution**, also called **environmental pollution**, the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

*The major kinds of pollution, usually classified by environment, are air pollution, water pollution, and land pollution.”*

# Environmental Pollution

## Waste



1. "Landfill at Upernivik" by ulalume - <https://www.flickr.com/photos/96649248@N00/43867280734> - CC BY-NC-ND 2.0.

2. Christian Hüpfer - <https://flic.kr/p/aKXw2F> - CC BY-SA 2.0.

# Environmental Pollution

## Fossil Fuels

- 3 of the 10 dirtiest European coal plants are located in Poland
- In which country/countries are the other 7 dirtiest coal plants located?
  - 7 of the 10 dirtiest European coal plants are located in **GERMANY**



1. <https://ember-climate.org/insights/research/top-10-emitters-in-the-eu-ets-2021/>

2. John Englart - <https://www.flickr.com/photos/takver/11308053925/> - CC BY-SA 2.0.

3. John Englart - <https://www.flickr.com/photos/takver/51658831095/> - CC BY-SA 2.0.

# Environmental Pollution

## Horrible Waste Management - Example 1



# Environmental Pollution

## Horrible Waste Management - Example 1



# Environmental Pollution

## Horrible Waste Management - Example 1

→ 2 generations profited from cheap nuclear energy

# Environmental Pollution

## Horrible Waste Management - Example 1

- 2 generations profited from cheap nuclear energy
- 40,000 generation will have to live with the waste

# Environmental Pollution

## Horrible Waste Management - Example 2



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# Environmental Pollution

## Horrible Waste Management - Example 2

- We are consuming about 2000 tiny pieces of plastic every week.



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Wijnand de Wit and Nathan Bigaud for the WWF (2019) – No Plastic in Nature: Assessing Plastic Ingestion from Nature to People.

# Environmental Pollution

## Horrible Waste Management - Example 2

- We are consuming about 2000 tiny pieces of plastic every week.
- That is a credit card every week!
- That's approximately 21 grams a month, or just over 250 grams a year.



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# Environmental Pollution

## Global Flows of Plastic Packaging Materials in 2013

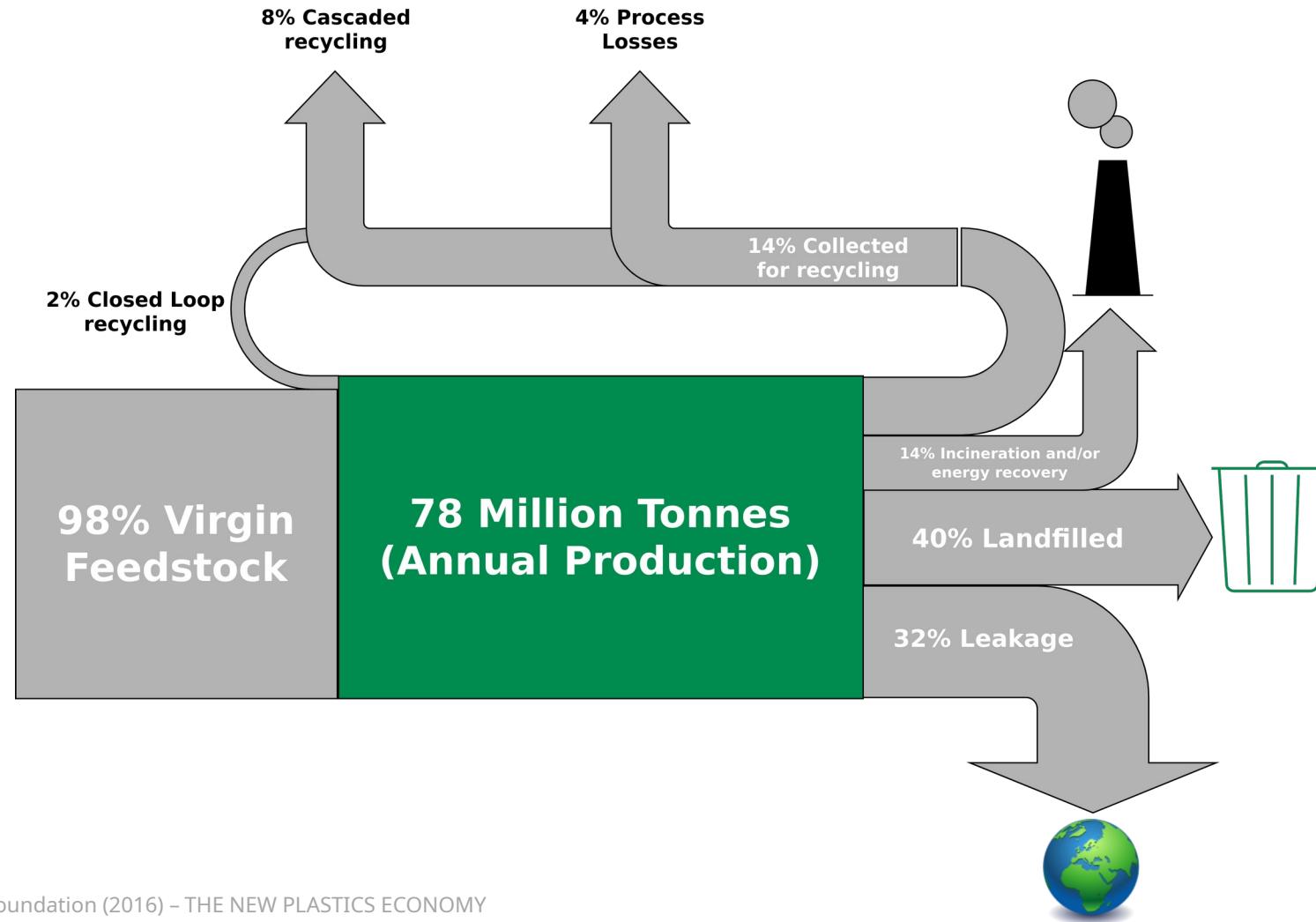


Figure adapted from: Ellen MacArthur Foundation (2016) – THE NEW PLASTICS ECONOMY

# Environmental Pollution

## Global Flows of Plastic Packaging Materials in 2013

- In 2050, there will be more plastic than fish in the ocean (by weight)

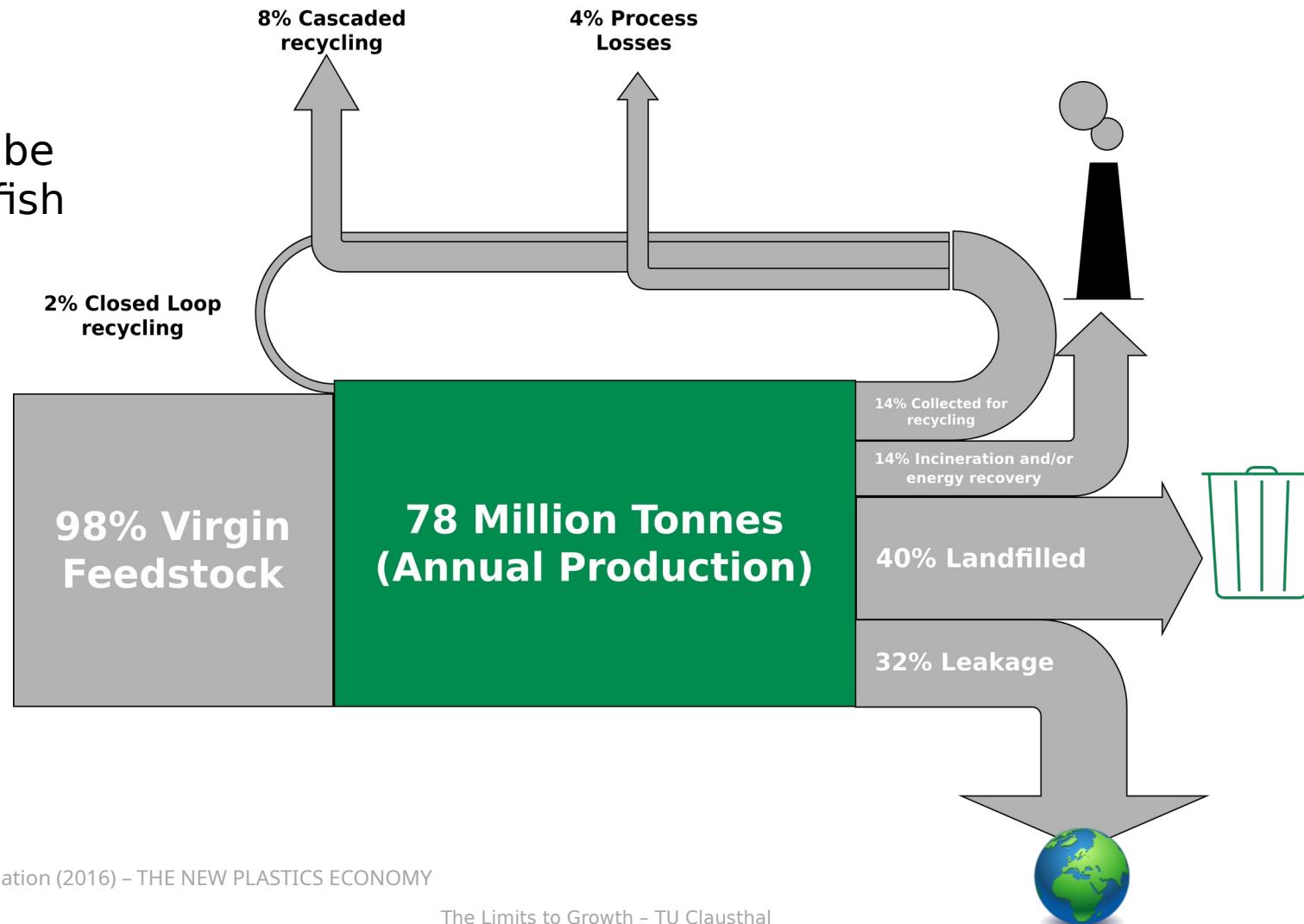


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# Environmental Pollution

## The Limits to Recycling

- Recycling often requires a lot of energy
- Some materials cannot be recycled at all (yet)
- Impurities are challenging
- Often requires a lot of manual labor
- Recycled material often with lower quality than input material
- False sense of safety!

# Environmental Pollution

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**I am not saying you should stop recycling!**

# Environmental Pollution

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- False sense of safety!

**I am not saying you should stop recycling!**

→ Recycling is great but it is better to make sure that we do not have to recycle anything.  
→ Buying less (e.g., only the essentials) is way more effective.

*"We buy things we don't need, to impress people we don't like." -  
Tyler Durden / Chuck Palahniuk*

# CONCLUSION

## Conclusion

- Basic concepts and definitions of sustainability and related to sustainability, resources, environmental pollution
- The limits to recycling

# EXERCISE E01

## Exercise E01

### Household Waste

- Get the largest jar that you can find (either at your own place, or ask your friends).
- Collect all the trash that you are producing in the upcoming week (except for bio-waste that is supposed to go into the green trash bin)
- How many days of trash can you fit into your jar?
- Submit your result according to the submission guidelines posted in the exercise sheet → [Link](#).

## Additional Resources

- Baccini et al. (2012) – Metabolism of the Anthroposphere: Analysis, Evaluation, Design
- Podcast *How to Save a Planet* – “Sacrifice Zones: ProPublica Takes Us Inside America’s Toxic Hotspots (2022) – [Link](#)

# Questions?