

# The Limits to Growth: Sustainability and the Circular Economy

## Lecture 1: Introduction

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M.A. Theresa Sommer

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

## Question 1

- How old are you?  
→ Type your response in the poll field.

## Question 2

- At which university do you study?
  - a) TU Clausthal
  - b) Ostfalia
  - c) Göttingen
  - d) other / not a student

## Question 3

- What do you study?  
→ Type your response in the poll field.

## Question 4

- Do you think that the current actions taken to address climate change and environmental pollution are sufficient and appropriate to ensure a future for you and your children?
  - Yes
  - No
  - Not sure

## Question 5

- Are you involved in any climate change or sustainability movement / organization / party / etc. – if yes, which one?
  - No? → Type “no”
  - Yes? → Type the name/abbreviation, e.g., “XR” (Extinction Rebellion), “FF” (Fridays for Future), etc.

## Question 6

- Would you like to attend the lecture and Q&A live in Goslar?
  - Yes
  - No



# AN INCONVENIENT PROBLEM



# What is the Problem?

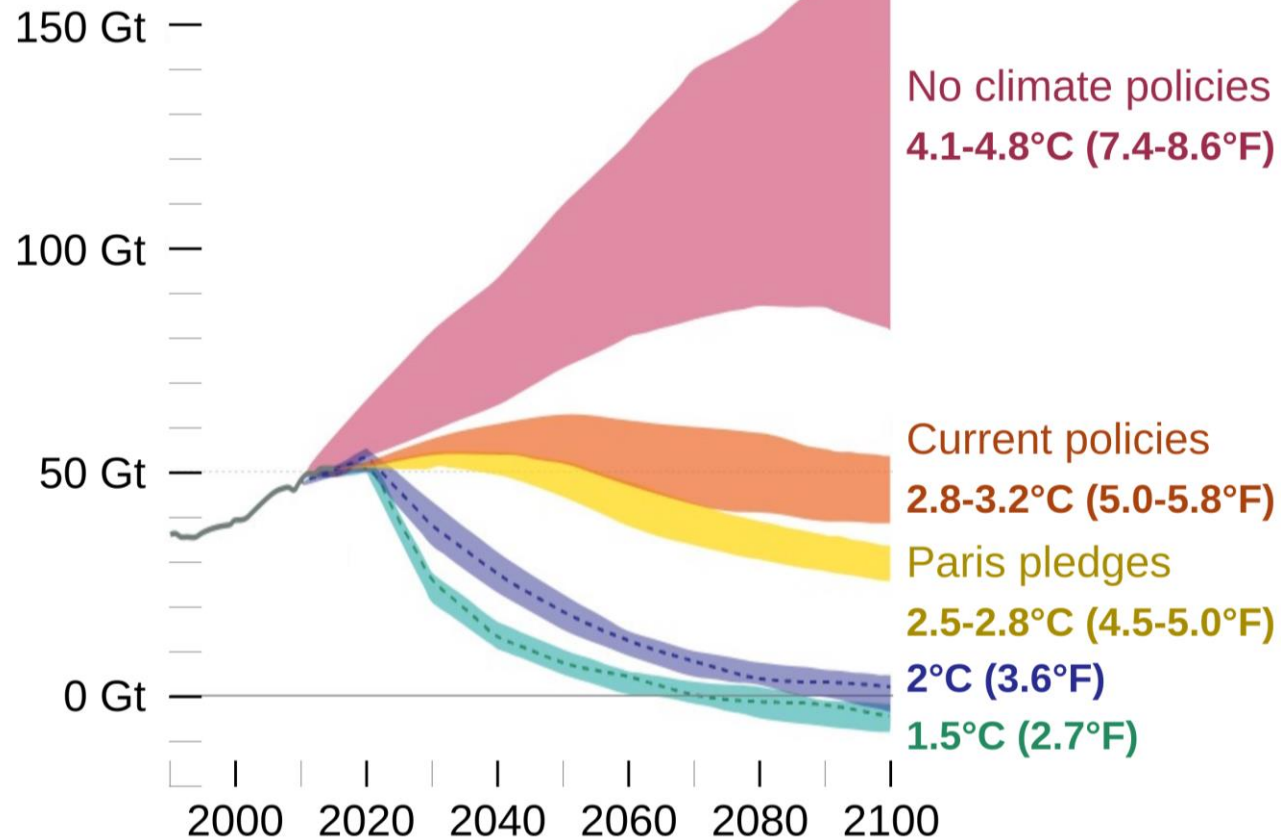
## What is the Problem?

**We only have one planet and we are ruining it.**

# We Only Have One Planet

## Climate Change – Global GHG Emission Pathways (2019)

Annual global greenhouse gas emissions  
CO<sub>2</sub>-equivalent gigatonnes



# We Only Have One Planet

## Climate Change – 1.5°C vs. 2/3/4°C

*"If we can keep warming below **3°C** we likely remain within our adaptive capacity as a civilization, but at **2.7°C** warming we would experience great hardship." - Prof. Michael Mann*

# We Only Have One Planet

## Climate Change – Floods and Droughts



1. Bettina Vier – [https://commons.wikimedia.org/wiki/File:Altenahr\\_-\\_8\\_Tage\\_nach\\_der\\_Flut\\_-\\_Volksbank.jpg](https://commons.wikimedia.org/wiki/File:Altenahr_-_8_Tage_nach_der_Flut_-_Volksbank.jpg) – [CC BY-SA 4.0](#).
2. + 3. Sören Kraft – [https://commons.wikimedia.org/wiki/File:Okerstausee\\_Niedrigwasser.jpg](https://commons.wikimedia.org/wiki/File:Okerstausee_Niedrigwasser.jpg) – [CC BY-SA 3.0](#).
4. ILRI – <https://www.flickr.com/photos/ilri/24223476605> – [CC BY-NC-ND 2.0](#).



# We Only Have One Planet

## Climate Change – Floods and Droughts



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# We Only Have One Planet

## Climate Change – Floods and Droughts



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## We Only Have One Planet Climate Change – Famine



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2. Martin Shaw – [https://commons.wikimedia.org/wiki/File:Vegetable\\_section\\_empty\\_in\\_a\\_supermarket\\_in\\_Kenmore.jpg](https://commons.wikimedia.org/wiki/File:Vegetable_section_empty_in_a_supermarket_in_Kenmore.jpg) – [CC BY 2.0](#)

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# We Only Have One Planet

## Climate Change – Wildfires



1. Bruce Detorres – <https://www.flickr.com/photos/brucedetorres/49352689768> – Public Domain.

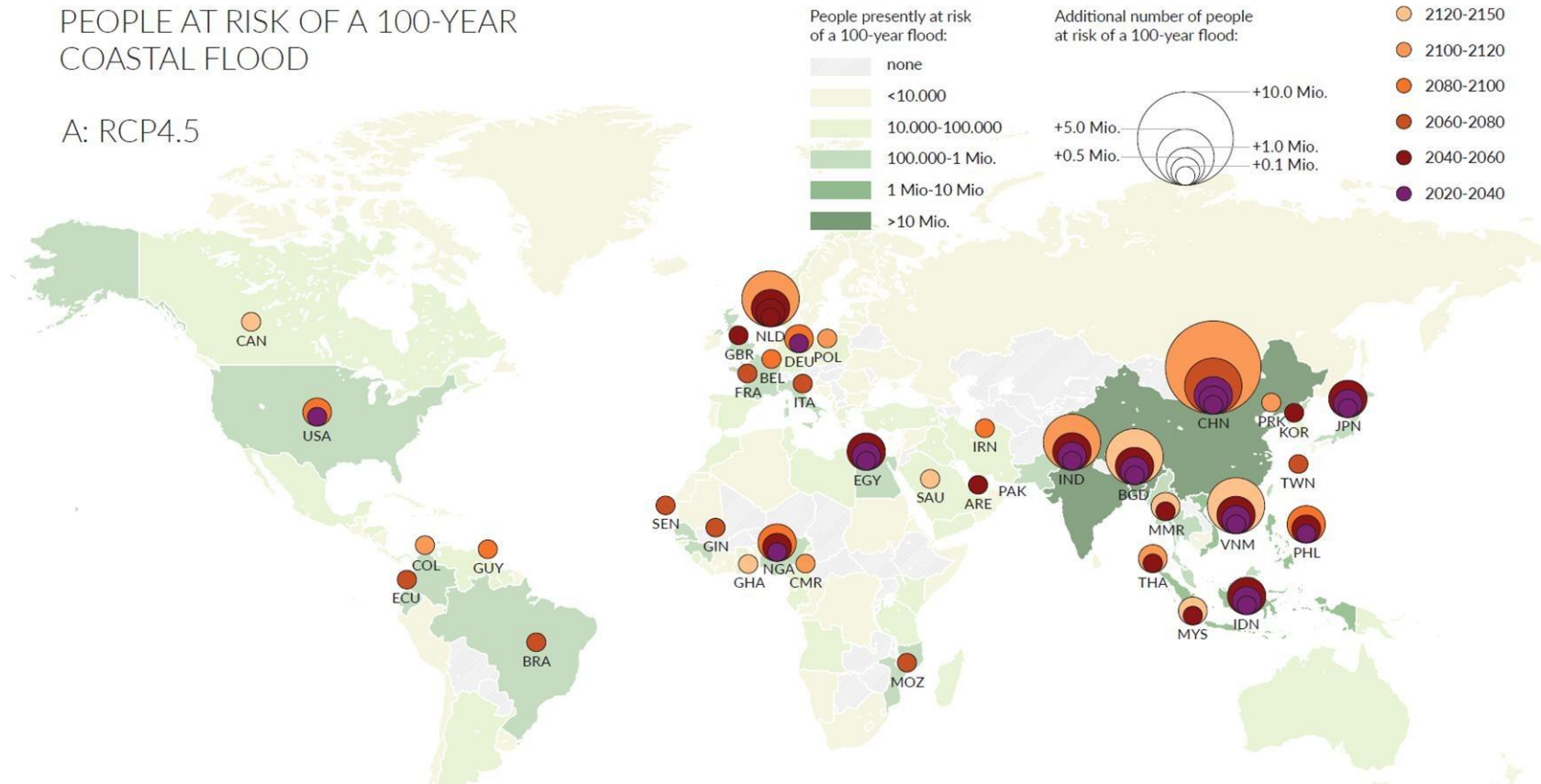
2. slworking2 – <https://www.flickr.com/photos/slworking/29034137667> – [CC BY-NC-SA 2.0](#).

# We Only Have One Planet

## Climate Change – Rising Sea Level

PEOPLE AT RISK OF A 100-YEAR COASTAL FLOOD

A: RCP4.5





# **We Only Have One Planet**

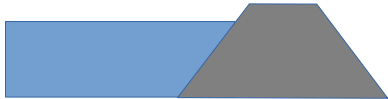
## **Climate Change – Rising Sea Level**

- What's the problem?

# **We Only Have One Planet**

## **Climate Change – Rising Sea Level**

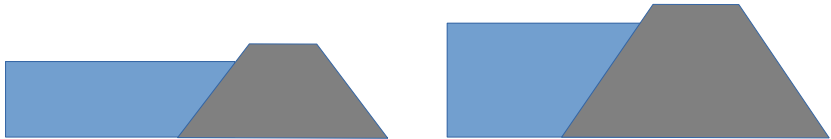
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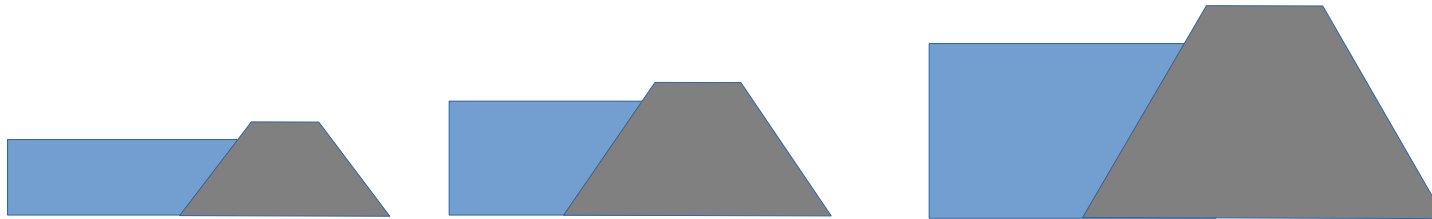
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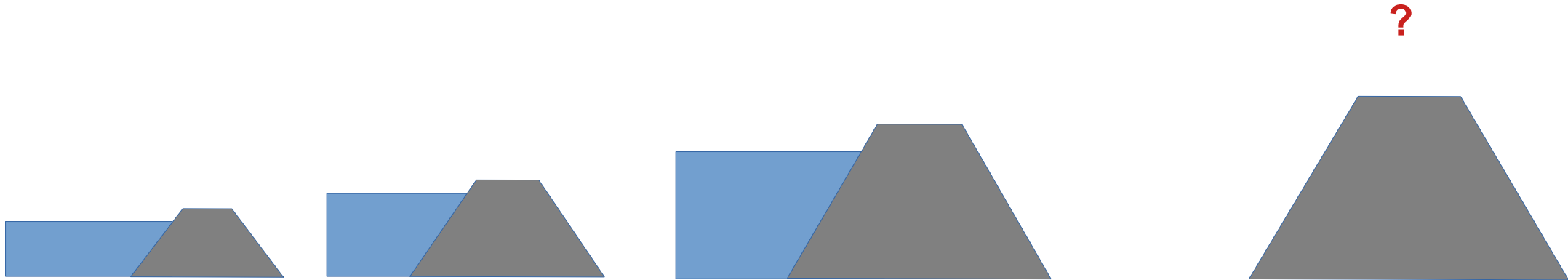




# We Only Have One Planet

## Climate Change – Rising Sea Level

- What's the problem?



# **We Only Have One Planet**

## **Climate Change – Extreme Weather Events**

- Catastrophe is the new “normal”
- Extreme weather events occur more often and with increased intensity
- 100 year floods/droughts/etc. occur every 10 years

# **We Only Have One Planet**

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→ More and more parts of the world will become uninhabitable

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## **Climate Change – Extreme Weather Events**

- Catastrophe is the new “normal”
- Extreme weather events occur more often and with increased intensity
- 100 year floods/droughts/etc. occur every 10 years
  - More and more parts of the world will become uninhabitable
  - More inhabitants per m<sup>2</sup> that need to be cared for under extreme conditions



# **We Only Have One Planet**

## **Climate Change**

*"change is coming, whether you like it or not"*

*Greta Thunberg*

[Click Me](#)

# We Only Have One Planet

## Environmental Pollution – Waste



1. "Landfill at Upernavik" 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](#).

# We Only Have One Planet

## 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?



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](#)



# We Only Have One Planet

## 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**



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# **We Only Have One Planet**

## **Environmental Pollution – Barren Land**



<https://pxhere.com/en/photo/1040531> – Public Domain



# We Only Have One Planet

## Environmental Pollution – Mass Extinction

- Roughly 8 million species on Earth (incl. 5.5 million insect species)



1. <https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/>

2. Russ Morris – <https://www.flickr.com/photos/russmorris/28320602639> – [CC BY-NC-ND 2.0](https://creativecommons.org/licenses/by-nc-nd/2.0/)

# We Only Have One Planet

## Environmental Pollution – Mass Extinction

- Roughly 8 million species on Earth (incl. 5.5 million insect species)
- Up to 1 million: species threatened with extinction, many within decades



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# We Only Have One Planet

## Environmental Pollution – Mass Extinction

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- Up to 1 million: species threatened with extinction, many within decades
- More than 40% of amphibian species threatened with extinction



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2. Russ Morris – <https://www.flickr.com/photos/russmorris/28320602639> – [CC BY-NC-ND 2.0](https://creativecommons.org/licenses/by-nc-nd/2.0/)

# We Only Have One Planet

## Resources – Overconsumption

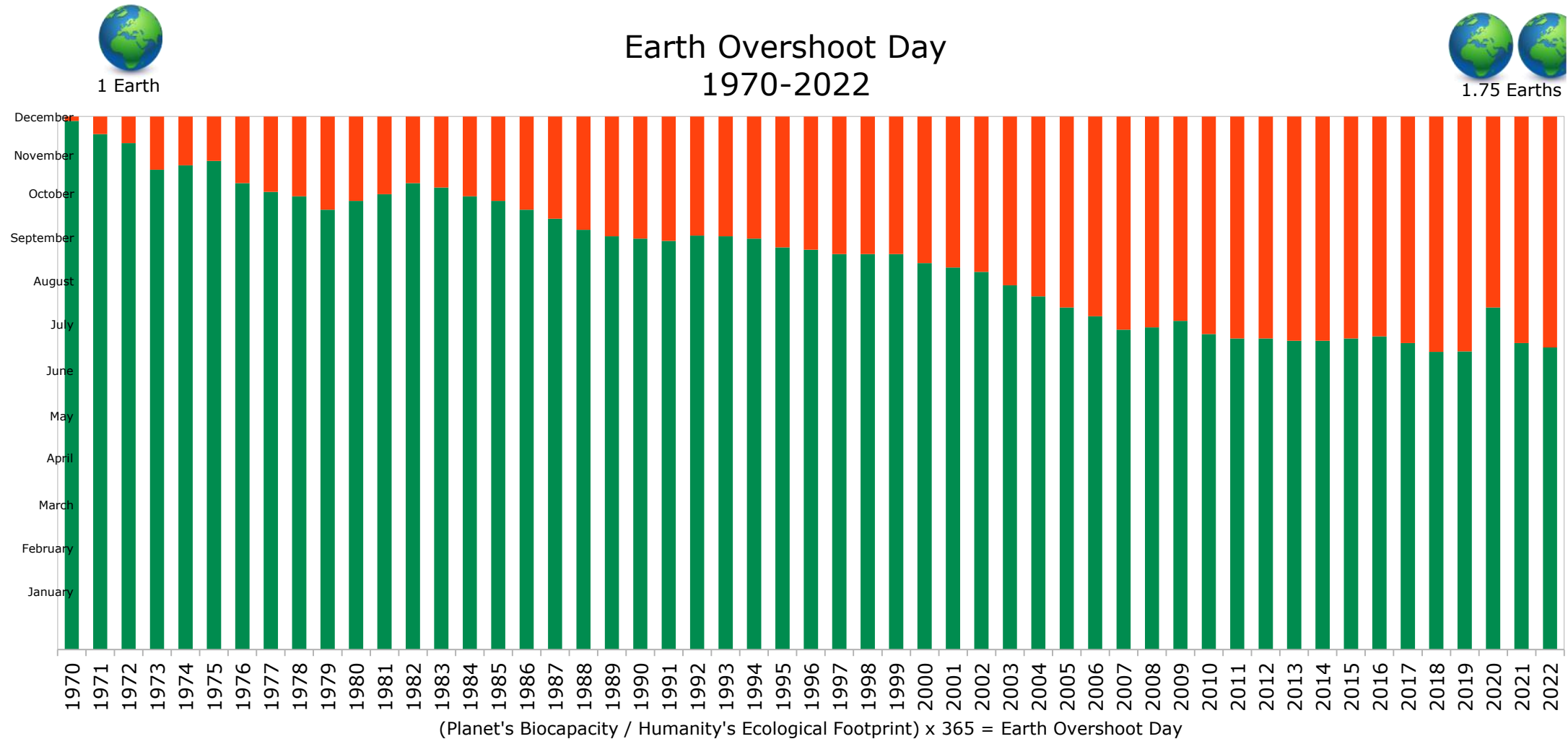


Figure adapted from <https://www.overshootday.org/newsroom/past-earth-overshoot-days/>

# We Only Have One Planet Resources



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

# 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"*





## 3 Key Challenges of the 21<sup>st</sup> Century

- 1) Climate change / adaption to climate change
- 2) Environmental pollution
- 3) Dwindling non-renewable resources



**IS THIS REALLY STILL A PROBLEM?**

## Is This Really Still a Problem?

**Yes!**

## Is This Really Still a Problem?



1. Vauxford – [https://commons.wikimedia.org/wiki/File:2018\\_Tesla\\_Model\\_S\\_75D.jpg](https://commons.wikimedia.org/wiki/File:2018_Tesla_Model_S_75D.jpg) – [CC BY-SA 4.0](#).
2. Marco Verch – <https://www.flickr.com/photos/30478819@N08/51303997289/in/photostream/> – [CC BY 2.0](#).
3. <https://pxhere.com/en/photo/1081335> – [CC0 1.0](#).
4. epSos.de – [https://commons.wikimedia.org/wiki/File:Colorful\\_Recycling\\_Containers\\_for\\_Trash.jpg](https://commons.wikimedia.org/wiki/File:Colorful_Recycling_Containers_for_Trash.jpg) – [CC BY 2.0](#).

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## There Is No Hope

*“As a climate scientist, I am often asked to talk about hope. Particularly in the current political climate, audiences want to be told that everything will be all right in the end. [...]*

*Climate change is bleak, the organizers always say. Tell us a happy story. Give us hope. The problem is, I don't have any. [...]*

*We are inevitably sending our children to live on an unfamiliar planet.”*

## We Need Courage

*“But the opposite of hope is not despair. It is grief. Even while resolving to limit the damage, we can mourn. And here, the sheer scale of the problem provides a perverse comfort: we are in this together. The swiftness of the change, its scale and inevitability, binds us into one, broken hearts trapped together under a warming atmosphere.”*

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*We need courage, not hope. Grief, after all, is the cost of being alive. [...] Courage is the resolve to do well without the assurance of a happy ending.”*

## Question 7

- What percentage of the population needs to participate in peaceful protest/civil disobedience for political change, i.e., saving our planet?

→ Type your response in the poll field.



## Question 7

- What percentage of the population needs to participate in peaceful protest/civil disobedience for political change, i.e., saving our planet?

→ Type your response in the poll field.

→ According to Prof. Erica Chenoweth 3.5%

→ Based on studying 323 violent and non-violent protests that occurred between 1900 and 2006 worldwide).

# Basic Law for the Federal Republic of Germany

## Article 20a – Protection of the natural foundations of life and animals

*"Mindful also of its responsibility towards future generations, the state shall protect the natural foundations of life and animals by legislation and, in accordance with law and justice, by executive and judicial action, all within the framework of the constitutional order."*

*German: "Der Staat schützt auch in Verantwortung für die künftigen Generationen die natürlichen Lebensgrundlagen und die Tiere im Rahmen der verfassungsmäßigen Ordnung durch die Gesetzgebung und nach Maßgabe von Gesetz und Recht durch die vollziehende Gewalt und die Rechtsprechung."*



# WHAT IS THIS COURSE ALL ABOUT?

## 3 Key Challenges of the 21<sup>st</sup> Century

- 1) Climate change / adaption to climate change
- 2) Environmental pollution
- 3) Dwindling non-renewable resources

# What Is This Course All About?

## In a Nutshell

*This course is supposed to enable **YOU** to create a sustainable future for all of us and future generations.*



## What Is This Course All About?

- Gaining an understanding of causes, dimensions, and the characterization of the 3 key challenge of the 21<sup>st</sup> century
  - Climate change / adaption to climate change
  - Environmental pollution
  - Dwindling non-renewable resources
- Critically assess available solutions
- Act before it is too late

# What Is This Course All About?

## Clausthal University of Technology – Research Profile

### About us

#### Welcome to Clausthal University of Technology

TU Clausthal is a substantial producer of research and is exceptionally well connected both nationally and internationally. This is evidenced by its high volume of third-party resources and the many successful partnerships it maintains with universities, research institutions, and businesses in the region, across the country, and throughout the world. Around 80 professors, 4,000 students, and some 1,100 employees enjoy short distances between the places they need to be, one another's personal attention, and the varied landscapes of the Upper Harz amid sites of UNESCO World Heritage.

TU Clausthal is the most significant factor in the region's economy and its largest employer. There is close collaboration between the academic and private sectors, facilitating the journey from fundamental research to real-life applications. And the overarching theme across all this work is the **circular economy**. In comprehensively pursuing the principle of a resource-efficient, regenerative economic order, TU Clausthal is taking responsibility for the future. With climate change and digitalization under way, it aims to support the establishment of a sustainable society.

TU Clausthal's degree programs can often be found in the top tier of the CHE ranking. With approximately 40% of its students from outside Germany, representing more than 100 different countries, TU Clausthal is the epitome of internationalism. Alongside this cosmopolitanism, the cornerstones of the university's vision for the future comprise a pronounced focus on practical application, outstanding levels of attentive support for students, and the involvement of broader society.

TU Clausthal is divided into three faculties, 35 institutes, and six interdisciplinary research centers. Apart from its main location in Clausthal-Zellerfeld, the university has two additional sites, namely its Energy Campus in Goslar and the Drilling Simulator Celle – German Center for High Performance Drilling Technology and Automation.

Beyond that, students and employees enjoy the international atmosphere at Clausthal University of Technology, the extensive nature of the Harz Mountains and the over 60 different sports ranging from skiing to sailing and mountain biking offered by the Sports Institute.



**Professor Dr. rer. nat. Joachim Schachtner**  
President of Clausthal University of Technology

#### ADDITIONAL INFORMATIONEN

[Our Vision at TU Clausthal](#)

[Facts](#)

### TU Clausthal's research profile

Our research, teaching, and technology transfer are all part of the interdisciplinary endeavor to tackle the great challenge facing our society: to safeguard the sustainable supply of resources and advance the transformation of our energy system under the onset of climate change. The spotlight is on systemic approaches to the creation of a circular economy.

Next to its narrow definition as an economic order that minimizes waste, the circular economy also encompasses renewable energy and digital management of the whole system. Digitalization has special significance, since it is the only means by which industrial processes designed for the linear system can be successfully transformed to suit a circular one. The problem-solving work is grounded in the academic disciplines of mathematics and computer science, natural sciences, engineering, business, and economics. Additionally, combining knowledge of materials with understanding of processes is one of TU Clausthal's key capabilities, which radiates into all its research areas. The university has organized the totality of its research activities into four areas:

1. Sustainable Energy Systems
2. Raw-Materials Supply and Resource Efficiency
3. New Materials and Processes for Competitive Products
4. Digitalization for a Sustainable Society

Under the umbrella of the circular economy, interdisciplinary and closely dovetailed study is engaged in within and across the research areas. The six research centers at TU Clausthal provide an ideal platform for this in practice. The research areas and the focused, consistent work on their continuous strategic development form the basis of our university's outstanding visibility on the national and international stage.

The holistic view inherent in the circular economy addresses not only technological but also behavioral and economic issues. The three dimensions of sustainability – environmental, social, and economic – are essential to the transition of our energy and raw-materials systems and to the necessary transformation of society. For that to succeed, public approval of the proposed technological solutions and sustainable business models is indispensable. This aspect is actively included in the processes of research and technology-transfer as well as teaching at TU Clausthal.

## What This Course Is Not

- A comforting fairy tale of:
  - “Everything will be fine”
  - “Business as usual is sufficient”
  - “Just make this minor change to your daily lifestyle and recycle plastic bags”
- A soothing high-definition TikTok video
- A place to discuss whether climate change is “*real*”

# What Is This Course All About?

## Strategy

*Strategy is "turning resources you have into the power you need to get what you want  
→ your goal. [Marshall Ganz]*

# What Is This Course All About?

## Strategy

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- Strategic Goal (what you want): The goal is a clear, measurable point that allows you to know if you've won or lost, and that meets the challenge your constituency faces.



# What Is This Course All About?

## Strategy

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- Power (what you need): tactics through which you can turn your resources into the capacity you need to achieve your goal.

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- Power (what you need): tactics through which you can turn your resources into the capacity you need to achieve your goal.
- Resources (what your constituency has): time, money, skills, relationships, etc.

## Additional Resources

- Chenoweth, E. (2013). The success of nonviolent resistance – [Link](#)



## EXERCISE E01

## Exercise E01

### Defining Sustainability

We are interested to know what you might already know about “sustainability” and what your current understanding of it is.

1. Record a short video (max. 60 seconds) in which you answer the following questions:
  - What do you understand under “sustainability”?
  - Does sustainability play a role in your personal life? If yes, please explain how.
2. Submit your result in a common video file format (e.g. mp4, avi, 3gp, mov, etc.). **Please add your full name to the filename!**

**Note:** If you are unable to record your answers in a video, instead write them down in a short essay (max. 200 words) and submit it as a pdf file.

You can find the full task sheet here. ([Link](#))

Link for Submission: <https://sync.academiccloud.de/index.php/s/MW3wY8uOVJbTrei>





# Questions?