INSTITUT FÜR NACHHALTIGKEIT
INSTITUTE FOR SUSTAINABILITY

Sustainability – Benefits for Society and Environment

Dr. Dina Barbian, Institute for Sustainability

Sustainability Conference
International DAAD-TGU Conference on Economic Dimensions of Sustainability

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Institute Director, Institute for Sustainability, Nuremberg (Germany)

Master‘s: Industrial Engineering and Management
Doctoral Degree: Sustainability Economics

Research & Business Fields:

Sustainability Reporting (GRI, DNK, UN Global Compact), Life Cycle Assessment (ISO 14.040/44), Carbon Footprint Calculations (ISO 14.064/67), FSC Audits

Lectures:

Digitalization & Sustainability,
Supply Chain Management,
Sustainable Development & National Strategies

Institut für Nachhaltigkeit – Institute for Sustainability

Agenda:
Sustainability – Benefits for Society and Environment

1. Why do we need „Sustainability“?
2. What is „Sustainability? – Concept, Classification
3. 17 UN Sustainable Development Goals
4. Planetary Boundaries
5. Solutions for more Sustainability
6. Benefits for Society and Environment

Why do we need „Sustainability“?

1. Increased share of elderly in all industrialized societies
2. Lack of qualified staff – War for talents (60 – 70 % of work is done by less qualified persons)
3. Volatile Prices for Raw Materials
4. Broken supply chains and supply shortages (because of natural disasters, epidemics/pandemics, other crisis)
5. Growing waste and pollution all over the world
6. Increased need for energy (digitalization, machine learning, increased connectivity, consumption patterns, global world population etc.)
7. Increase of global average temperature, climate change

What is „Sustainability“?

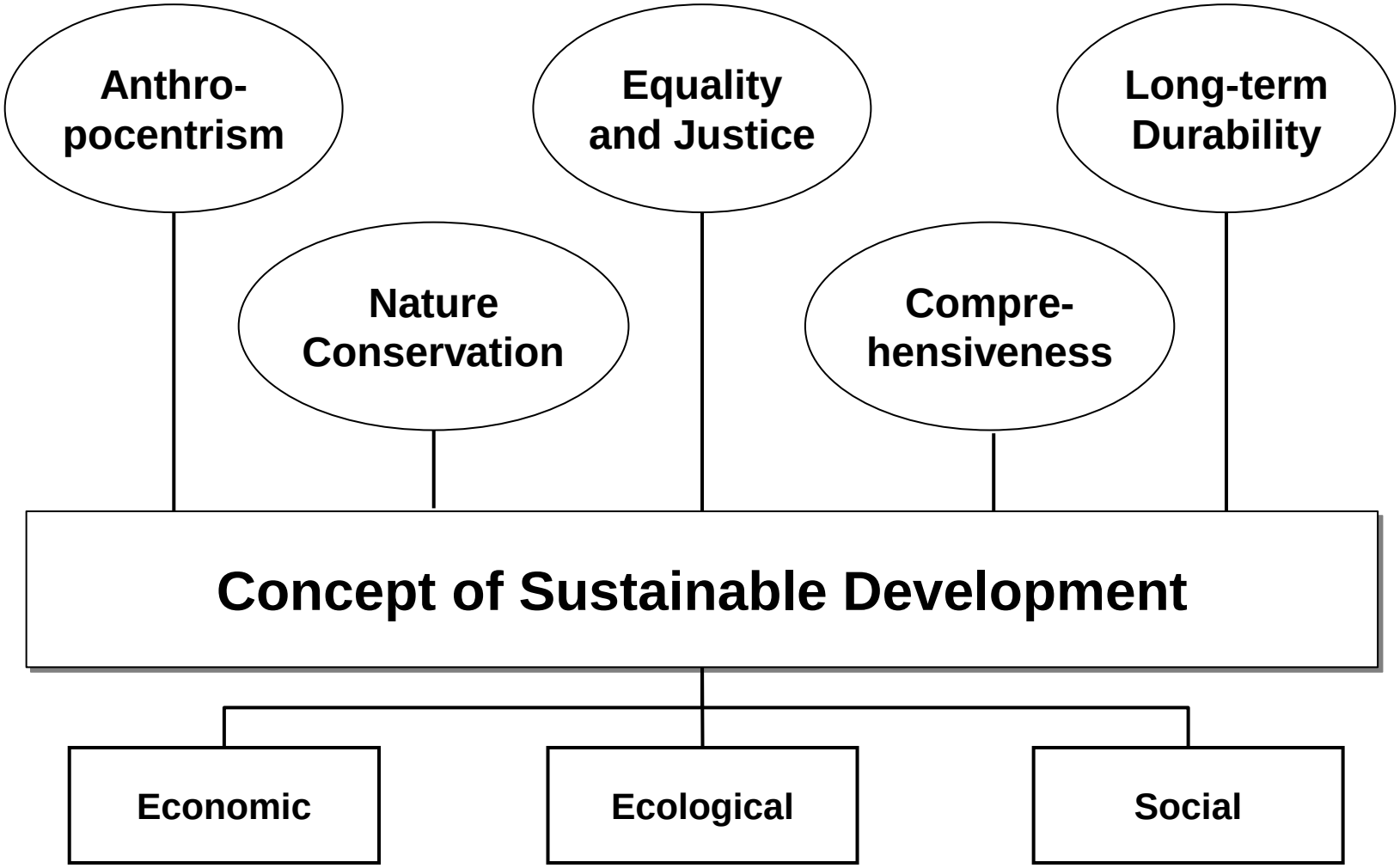
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Source: WCED (Brundtland-Report), Our Common Future, 1987

Sustainable Development – two key concepts

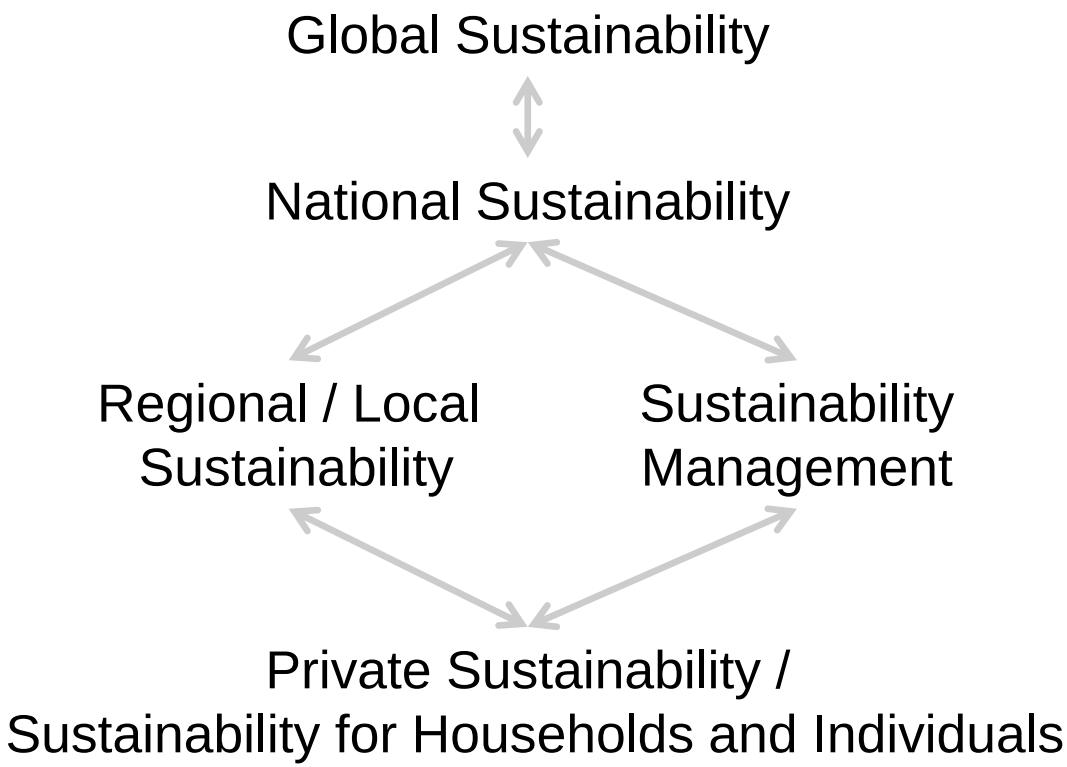
It contains within it two key concepts:

- the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of **limitations** imposed by the state of technology and social organization on the ability of the environment to meet present and future needs.



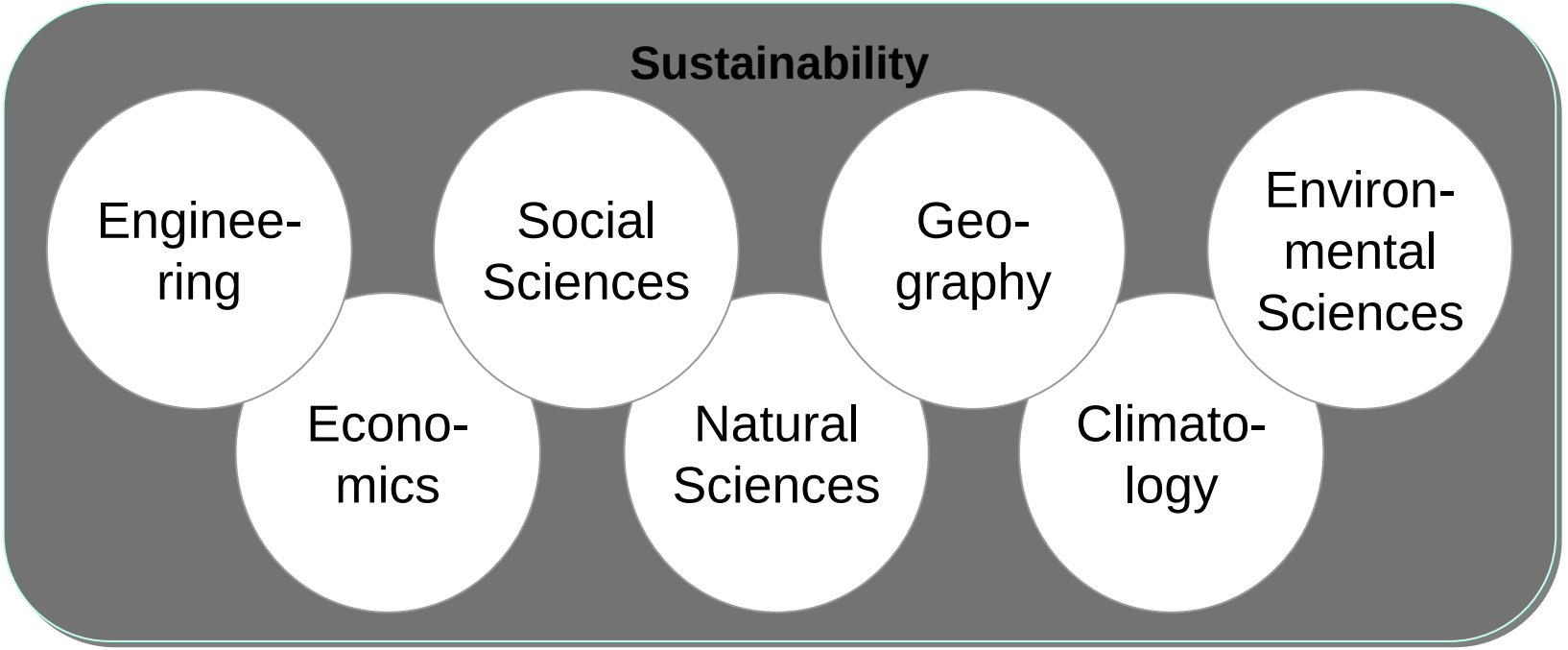
Source: Barbian, 2001

Classification



Source: Barbian, 2001

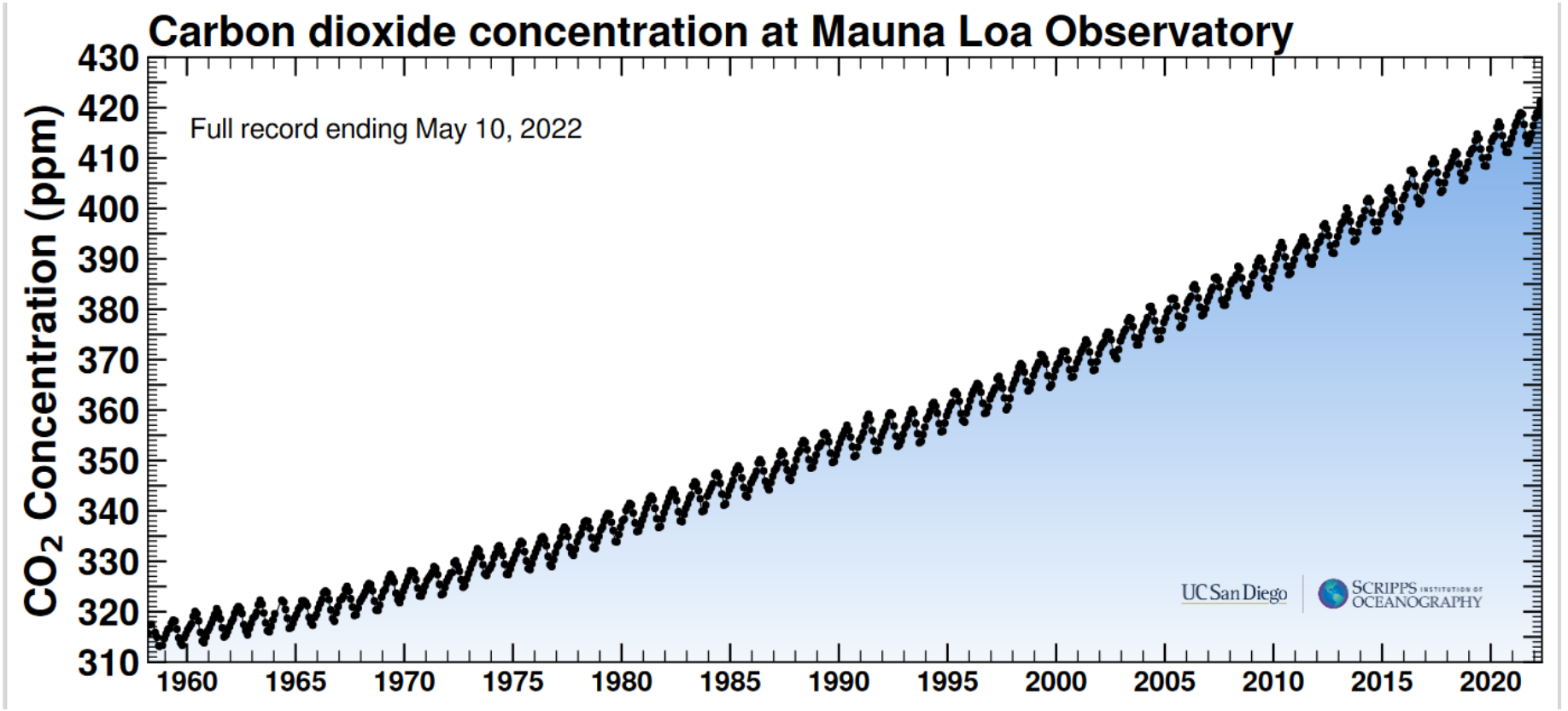
Inter- and Transdisciplinarity



Source: Barbian, 2017

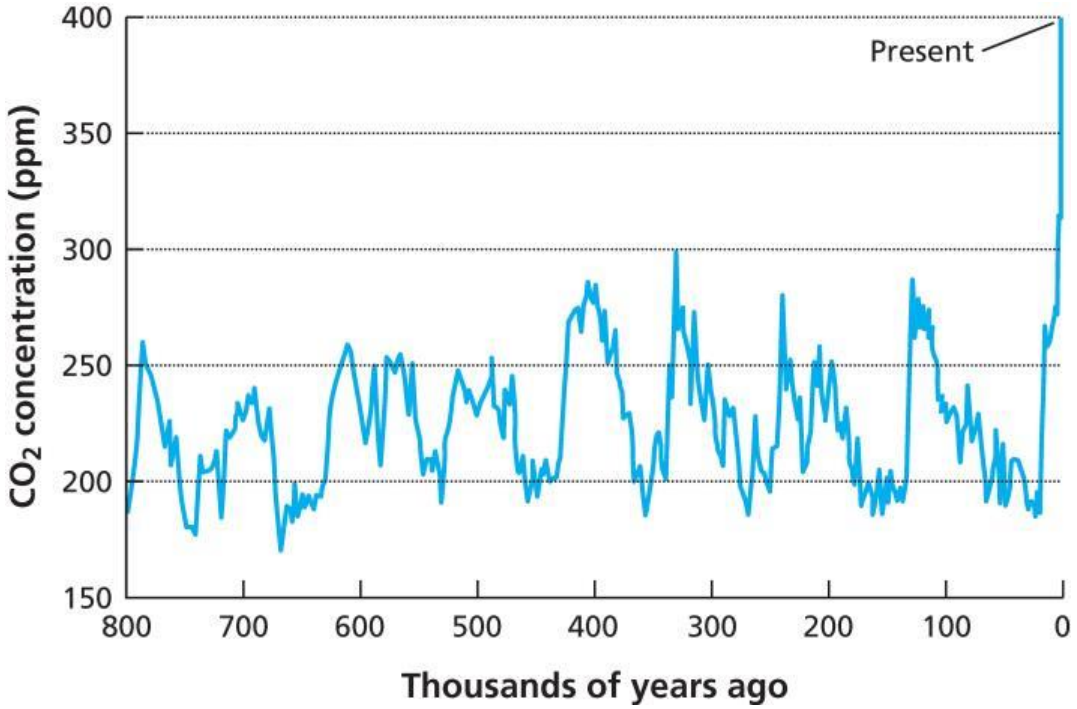

SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Keeling Curve of Atmosphere CO_2 Concentration (1958-2022)



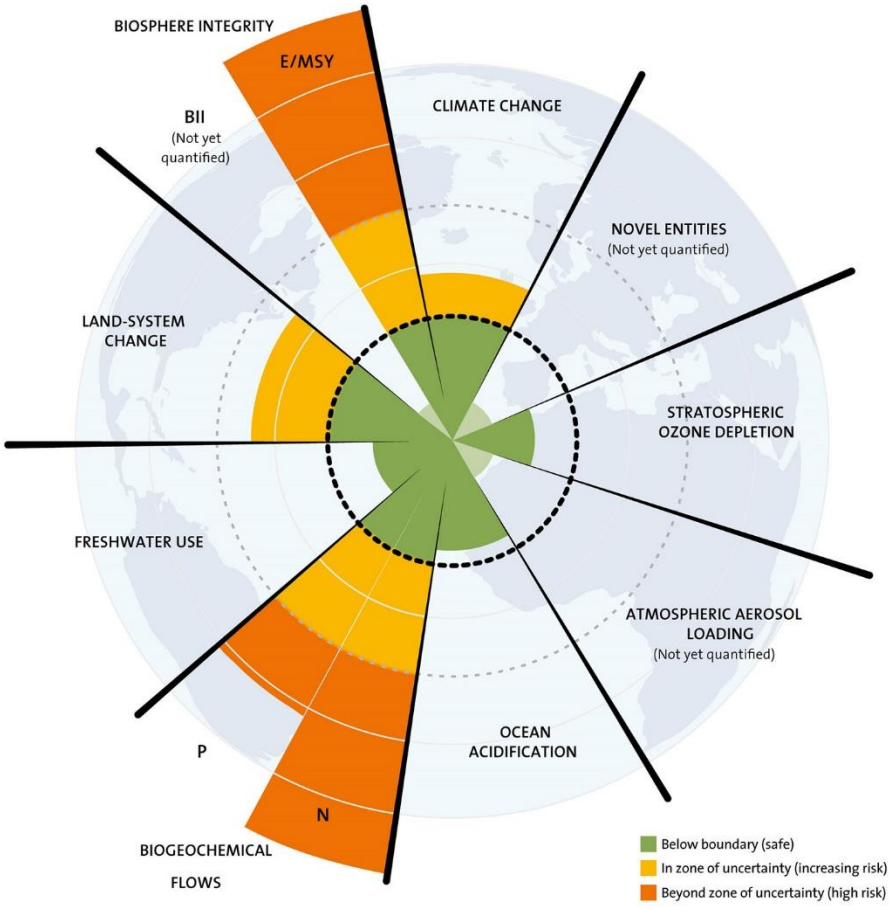
Source: Scripps Institution of Oceanography, 2022

Fluctuating levels of CO_2 in the atmosphere over the past 800,000 years



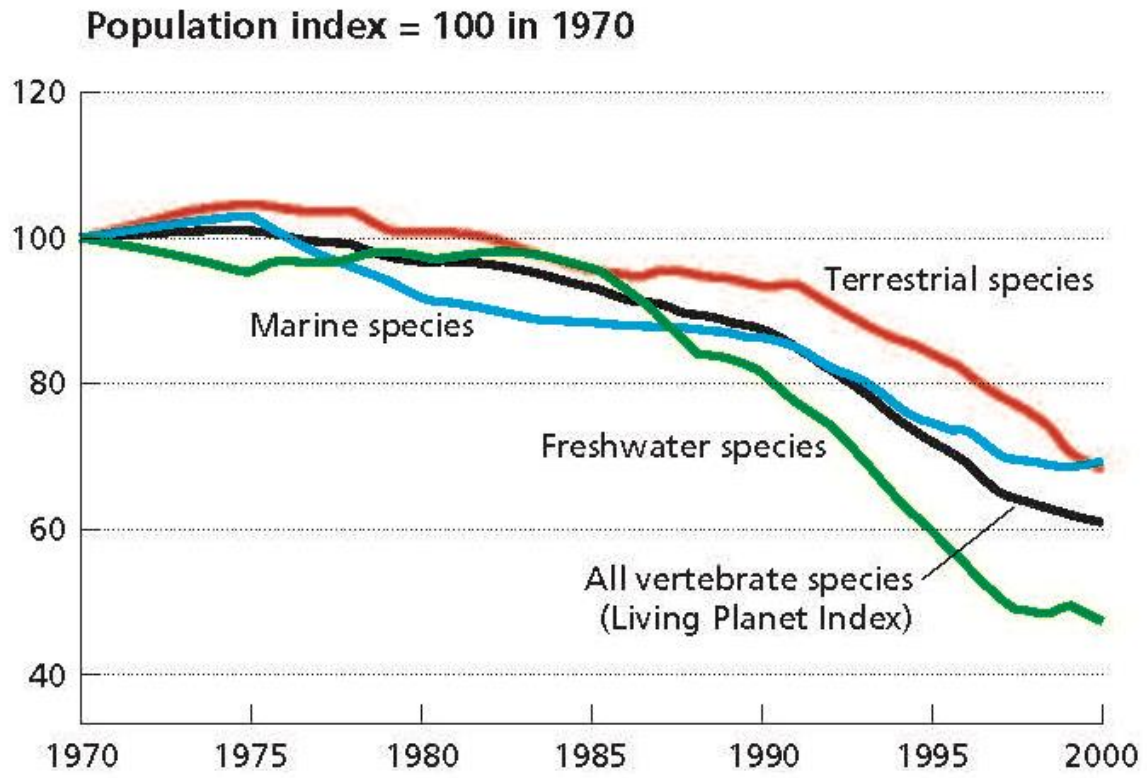
Source: Macmillan Publishers Ltd: Nature*, Lüthi, Dieter, Martine Le Floch, Bernhard Bereiter, Thomas Blunier, Jean-Marc Barnola et al. "High-resolution Carbon Dioxide Concentration Record 650,000–800,000 years Before Present," copyright 2008.*
Note: Ice core data before 1958; Mauna Loa data after 1958.

Planetary Boundaries (Stockholm Resilience Centre)



Source: J. Lokrantz/Azote based on Steffen et al. 2015, Licenced under CC BY 4.0

The Living Planet Index of Biodiversity (1970–2000)



Source: World Wildlife Fund. 2012. "Living Planet Report 2012." Gland, Switzerland: WWF International.

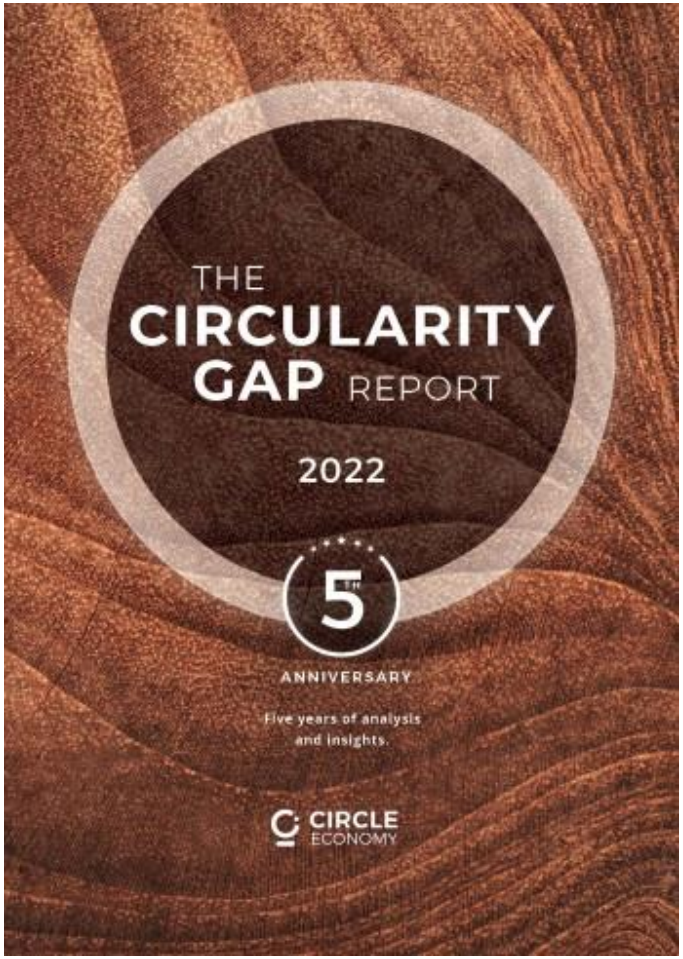
Solutions for more sustainability

1. Material efficiency: lightweight construction through additive production (3D manufacturing)
2. Modular design (products, processes, factory): Design-to-Recycle, Design-to-Repair, digital twin (continuous improvement, resource efficiency)
3. Circularity in production processes (Re-use, Recycling, Re-manufacturing)
4. Waste management system (Prevention, Re-use, Up-cycle, Recycling, Composting)
5. Energy management system: environmentally friendly generation, storage and distribution of energy (Renewable energy, decarbonization technologies)
6. Use of robots (e. g. autonomous vehicles, drones for parcel delivery, use of exoskeletons / data glasses) for assistance in bad working conditions (monotony, dangers, coldness, heavy labour)

Solutions for more sustainability

7. Smart mobility (intelligent traffic control, cargo bicycles, sharing mobility)
8. Responsible Manufacturing (recycled materials and packaging, organic fabrics, fair trade, cruelty free products, locally manufactured)
9. Sustainable water management (grey water usage, water savings)
10. Sharing Economy: Car-sharing, bike-sharing, machine-sharing, job-sharing
11. Increase of transparency in business processes (e. g. blockchain-based solutions)
12. Goods traceability in supply chains (e. g. with focus on environmental-friendly, responsible and ethical sourcing, energy-efficient sensors)
13. Use of AI technologies and forecast models (to increase resource efficiency)
14. AR/VR/XR/MR technologies to help staff (e. g. pickers or less-qualified staff)
15. On-demand and aaS price models

Circularity Gap Report 2022 by Circle Economy

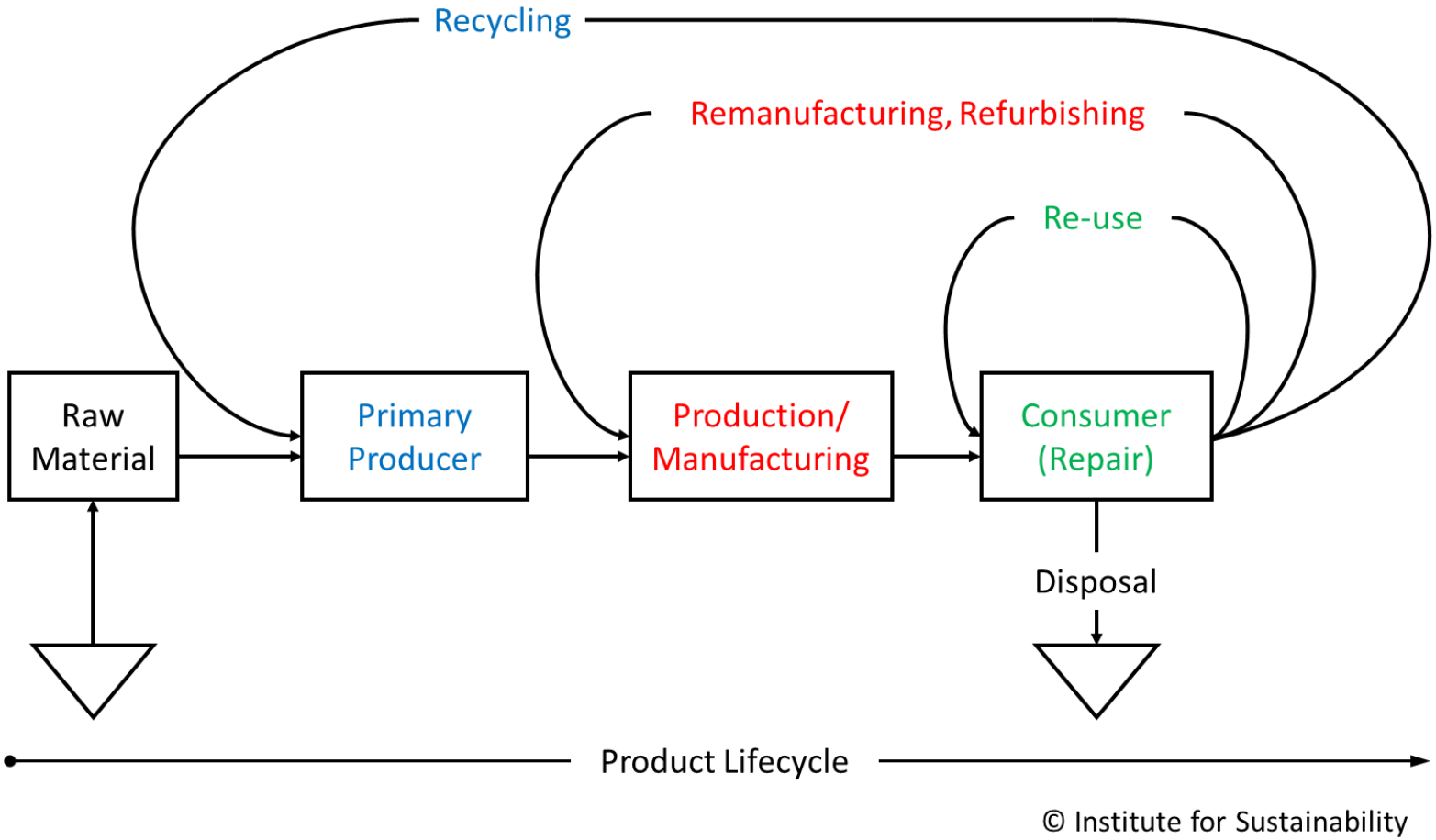


The world is consuming appr. 100 billion tonnes (Gt) of materials per year.

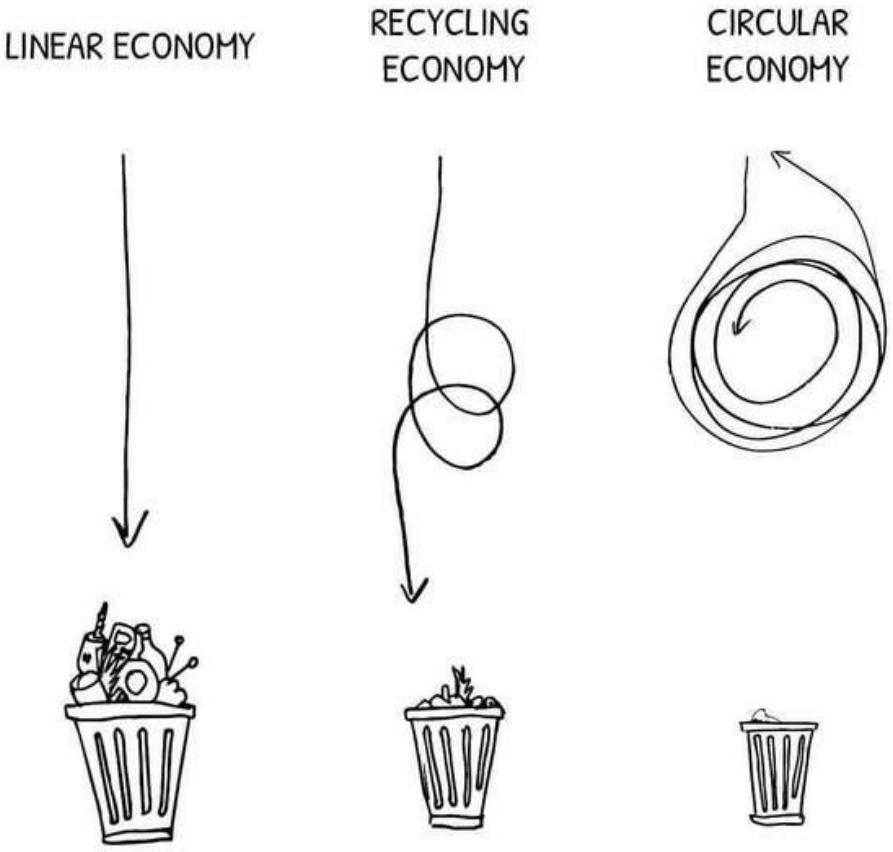
70% of all global greenhouse gas emissions are related to material handling and use. So unless we radically transform how we use materials to satisfy our needs, we cannot meaningfully cut emissions.

To keep our world liveable and thriving, we need to double global circularity from 8.6% to 17%.

From Linearity to Circularity



Ideal state of circularity = „Zero Waste“

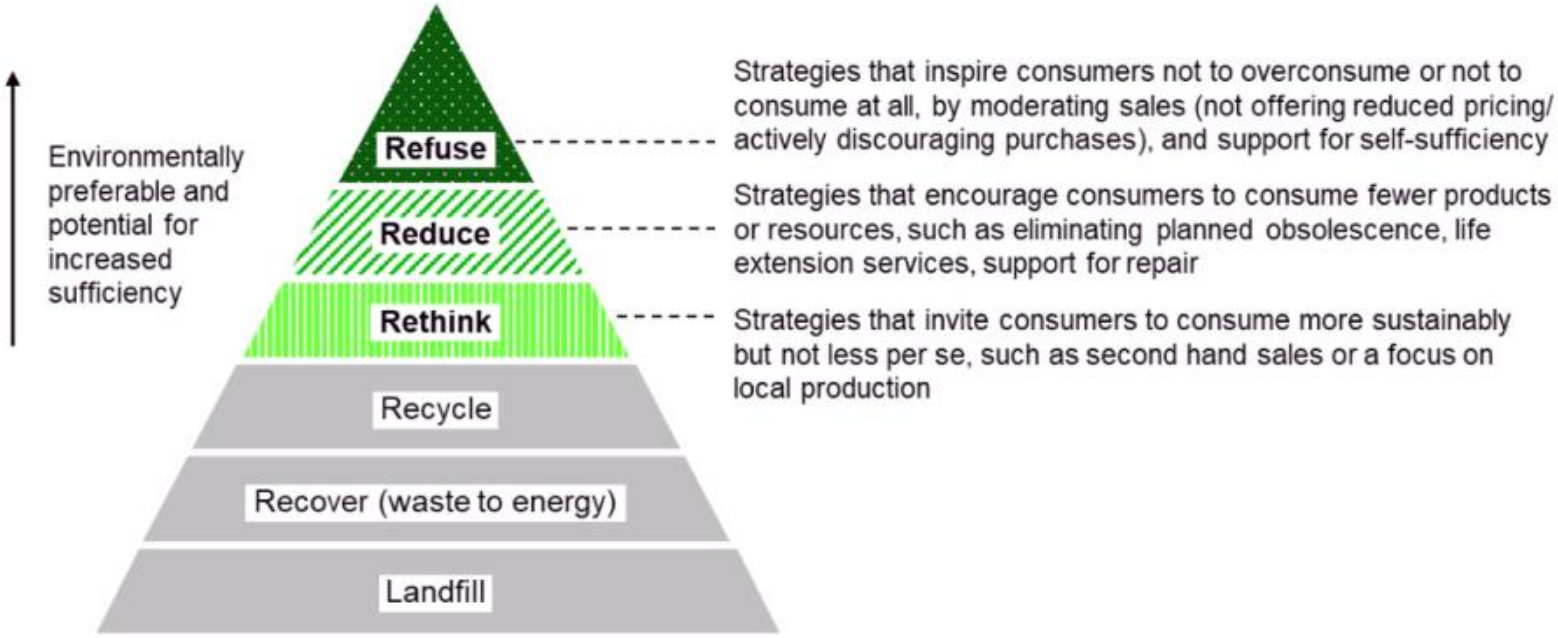


Source: https://community.materialtrader.com/the-circular-economy-more-than-just-recycling-better/

Requirements:

- Recyclable components
- Long lasting materials
- Easy to repair (modularity)
- Few different materials
- Standardised components

The sufficiency-based circular economy



Circular hierarchy depicting sufficiency strategies. *Source*: Based on Bocken and Short (2016) and Niessen and Bocken (2021).

Design-to-Repair – Modular products

Yes, you can repair it yourself

Where's my module?

1. Display Module
2. Camera Module
3. Battery
4. Core Module
5. Top Module
6. Bottom Module

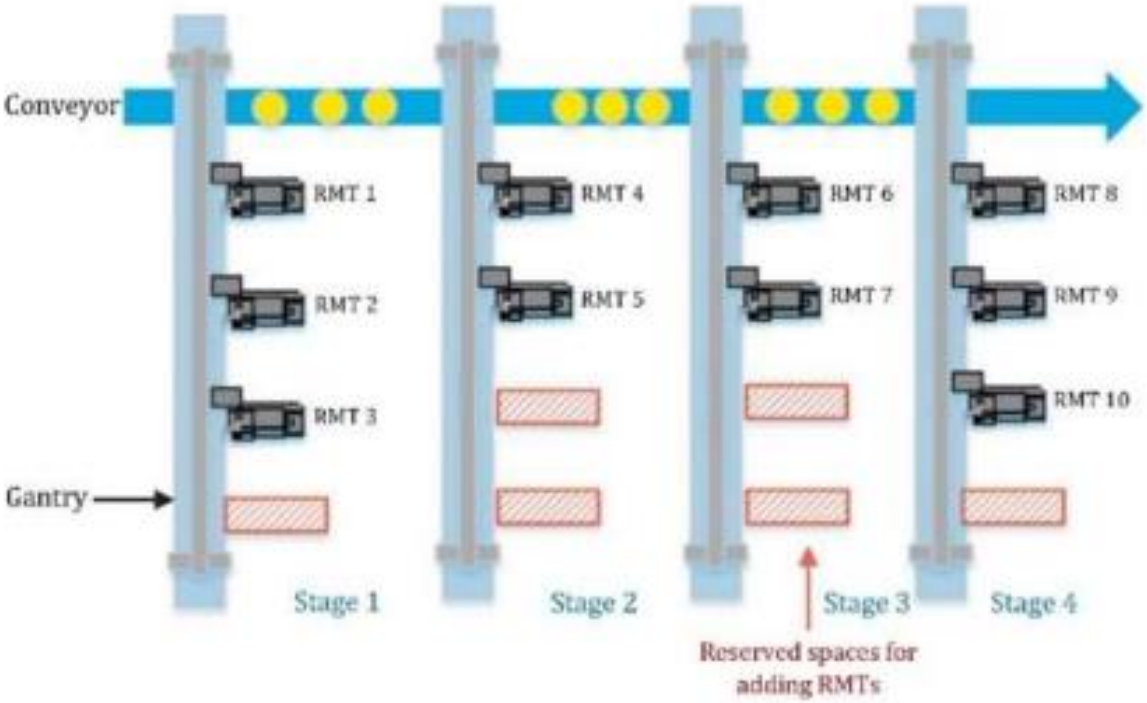
Source: https://www.fairphone.com/nl/

The #LOVEPHONE

Our SHIFT6m - the most modular smartphone in the world

Source: https://www.shiftphones.com/

Modularity– reconfigurable manufacturing Systems (RMS)



Source: Jamiri, A. et al., Developing a Bi-objective Model to Configure a Scalable Manufacturing Line Considering Energy Consumption, in: Dolgui, A. et al. (Eds.), Advances in Production Management Systems, APMS 2021, IFIP AICT 630, pp. 363–371 (revised from Koren, Y., Gu, X., Guo, W., Reconfigurable manufacturing systems: principles, design, and future trends, 2017, Front. Mech. Eng. 13(2), pp. 121-136)

aaS business model (Pay per Use)

Fa. Looxr: compressed air as a Service

With LOOXR you are always up to date on the condition of your entire compressed air system.
Our LOOXR portal combines compressed air and Industry 4.0.

Our digital technologies for the entire compressed air process make it easier for you to work and ensure production safety. Sensors and measurement technology provide you with detailed insights from your compressor station, treatment, pipelines and pneumatic components.

Save up to 50% energy costs - up to 30% less time spent - 100% control over your compressed air system.

Optimize costs

- 100% variable costs and worry-free compressed air supply through Pay per Use.
- Reduce 50% of the compressed air costs.
- Reduce life cycle costs.
- Measuring the efficiency of compressed air systems with benchmarks.

Increase process reliability

- Condition monitoring and analysis of the state of the stations.
- Predictive maintenance and less maintenance efforts.
- Identify and avoid downtimes or production stops at an early stage.
- 100% supply guarantee.

Save energy

- Save up to 50% energy.
- Transparency about energy efficiency throughout the compressed air system.
- Reduce peak loads.
- Raliable data for your energy management system.

Role of the digital twin – supply chain resiliency

Digital Product Twin (CAD, 3D modelling)
Digital Production Twin (Machines, Tools)
Digital Performance Twin (Productivity, Efficiency, Quality, Time, KPIs)

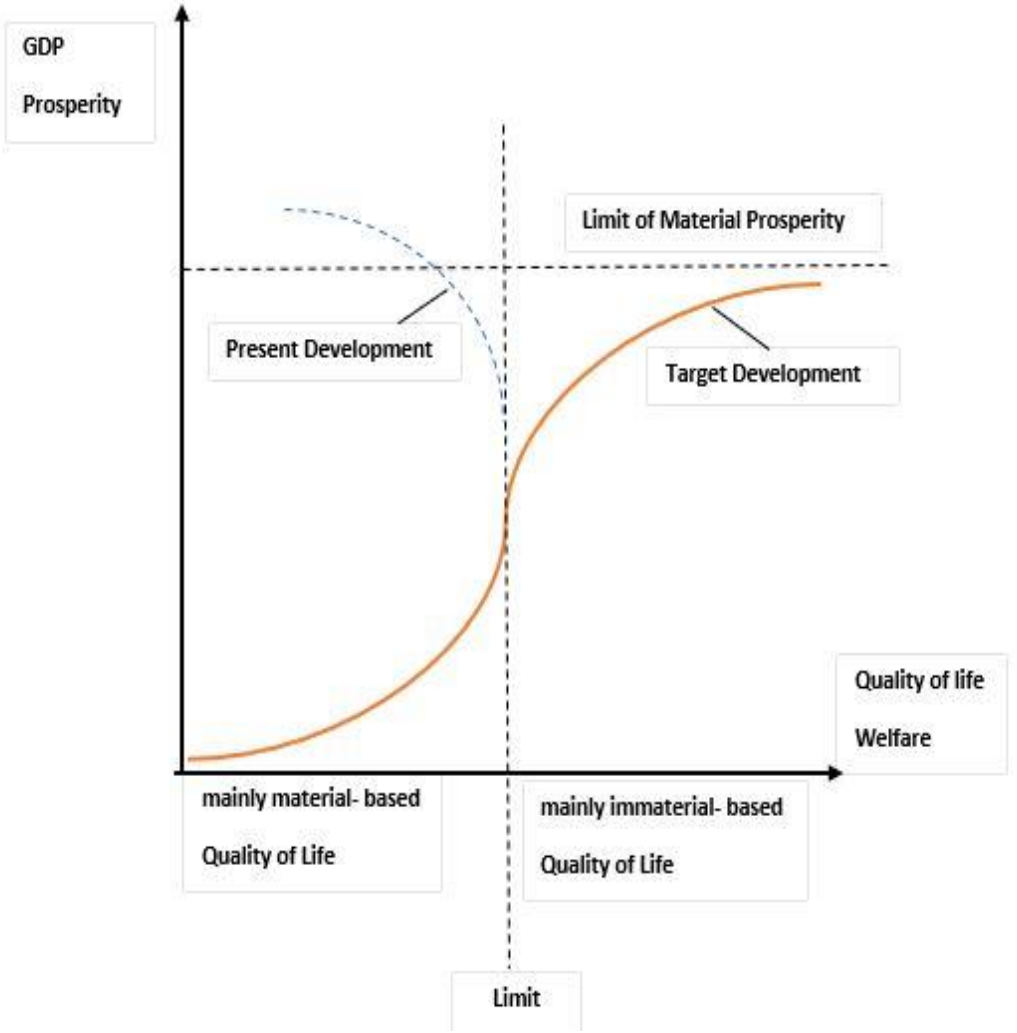
Relationship between GDP, Quality of Life and Welfare

Quality of Life:

Material-based: Income, Property and Goods

Immaterial-based:

Working Conditions, Social Integration, Living in a Safe Area, Medical Insurance, Job Security



Source: Fornallaz, 1990

Sustainability – Benefits for Society and Environment

1. Increased resource and energy efficiency (smart factory: Robots, Drones, Autonomous vehicles; Continuous Improvement through the integration of ML, Increase of Productivity; 3D Printing: Material Savings, Low Scrap Rate)
2. Assistance in bad working conditions (robots, exoskeletons, data glasses), help especially where staff is lacking
3. JIT Instruction for less qualified persons; individualized information through the help of ICT
4. Savings in labour, resources and time

Sustainability – Benefits for Society and Environment

- Earlier failure detection, lowered human failure, assistance of humans
- Reduced equipment downtime
- Order prioritization in dynamic environments
- Improvement project schedule resilience
- Optimize queueing systems
- Truck sharing management system
- Managing EOL resources: refurbish/remanufacture, reuse/redistribute, recycle
- more flexibility, maintenance could be planned in advance, the flow of goods could be optimized, or logistics and quality control could be automated
- Better and faster results, sometimes JIT decisions

Thank you for your attention!

Publications

Barbian, D.: Ökonomie und Sustainable Development – Entwicklung eines Ansatzes zur Umsetzung von Nachhaltigkeit, Dissertation, Aachen 2001.

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