„Everything is connected to everything“
Responsible Research and Innovation for the Anthropocene

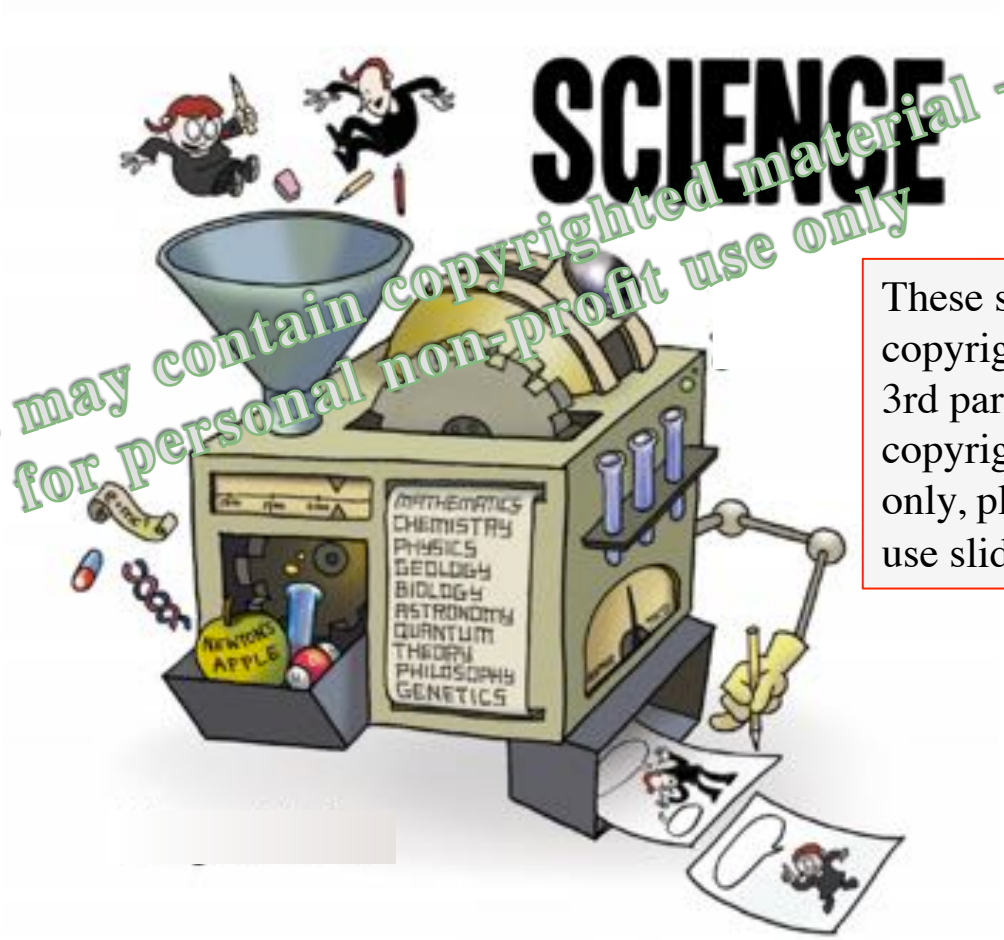


Fig. from: Margreet de Heer: Science. A discovery in comics

Prof. Dr. Reinhold Leinfelder
AG Geobiology and Anthropocene Research, FU-Berlin
Interdisciplinary Laboratory Image Knowledge Gestaltung at HU Berlin

Science, Research, Innovation: what for?

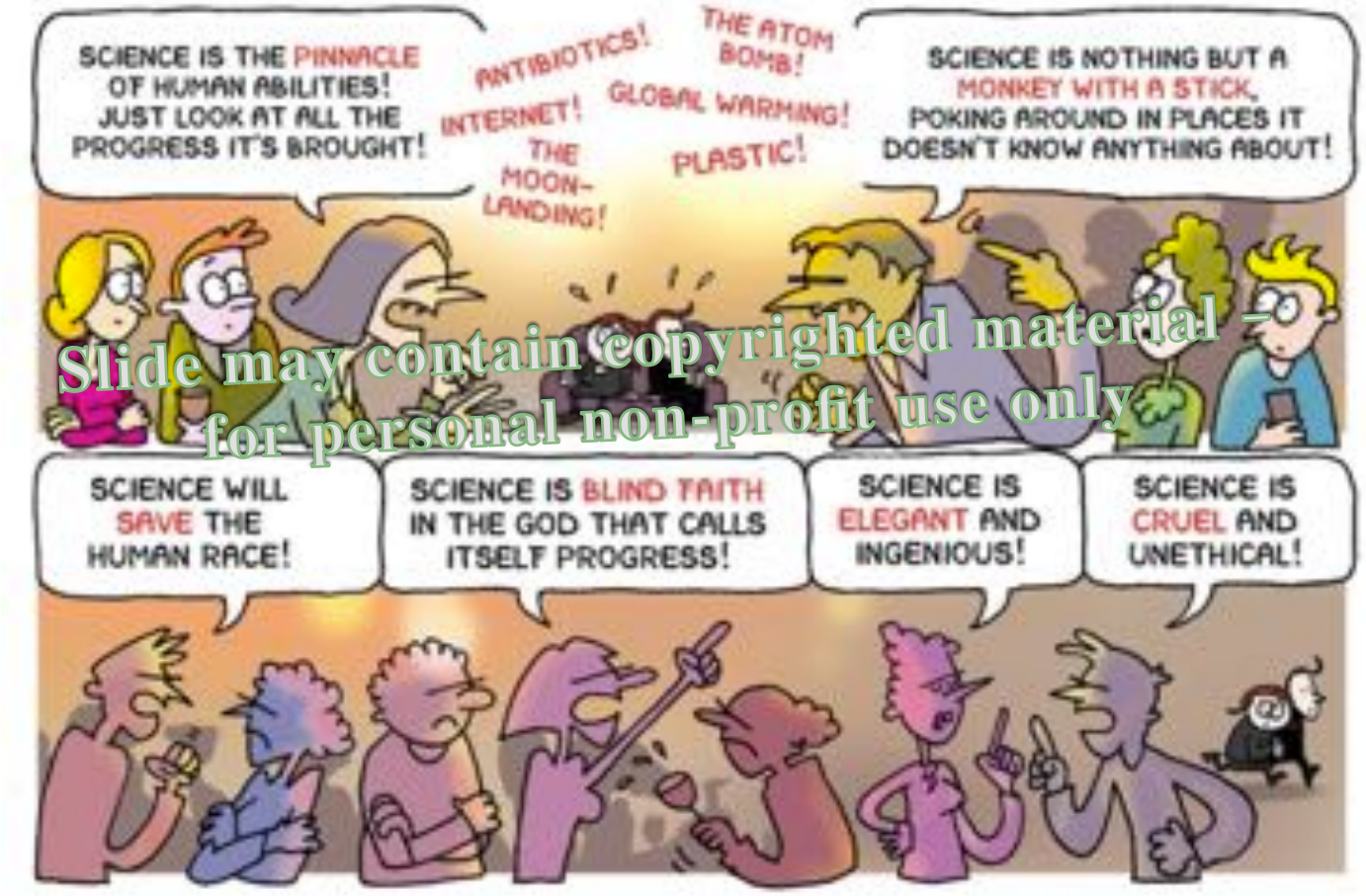
- **Understanding the World, by its Past, Present, Future.**
  - Recognise processes and interdependencies
  - Give sense to your own life
  - Societal benefits

Aus: Margreet de Heer: Science. A discovery in comics

Science, Research, Innovation: what for?

- **Context Enlightenment: Service for society and societal claim**
  Factuality as deliberation from mystics and (devine/political) power structures, *i.e.* from prefactual to factual.

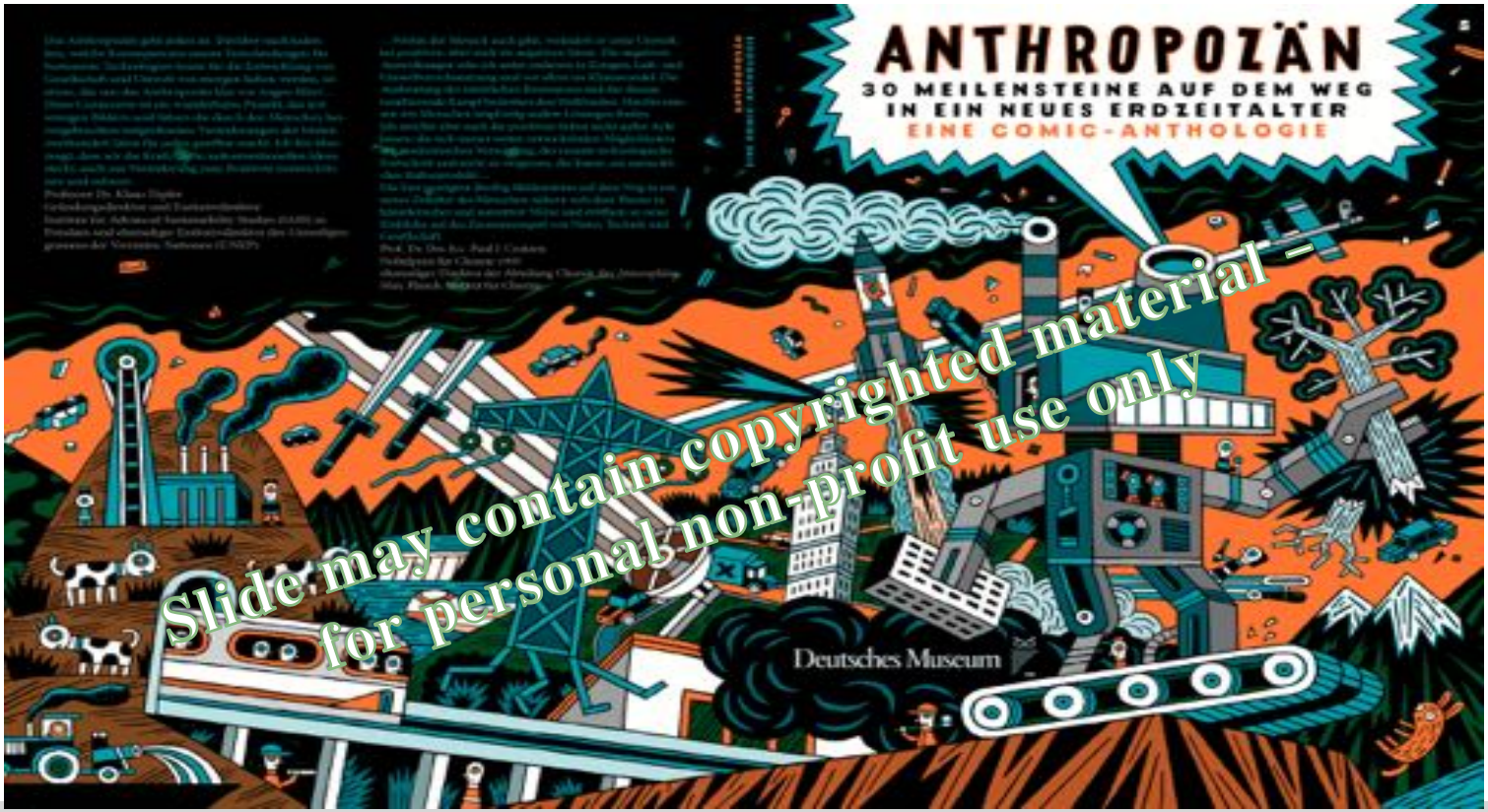
  - Currently: **postfactual**? **contrafactual**? **„alternative facts**?“



From: Margreet de Heer: Science. A discovery in comics

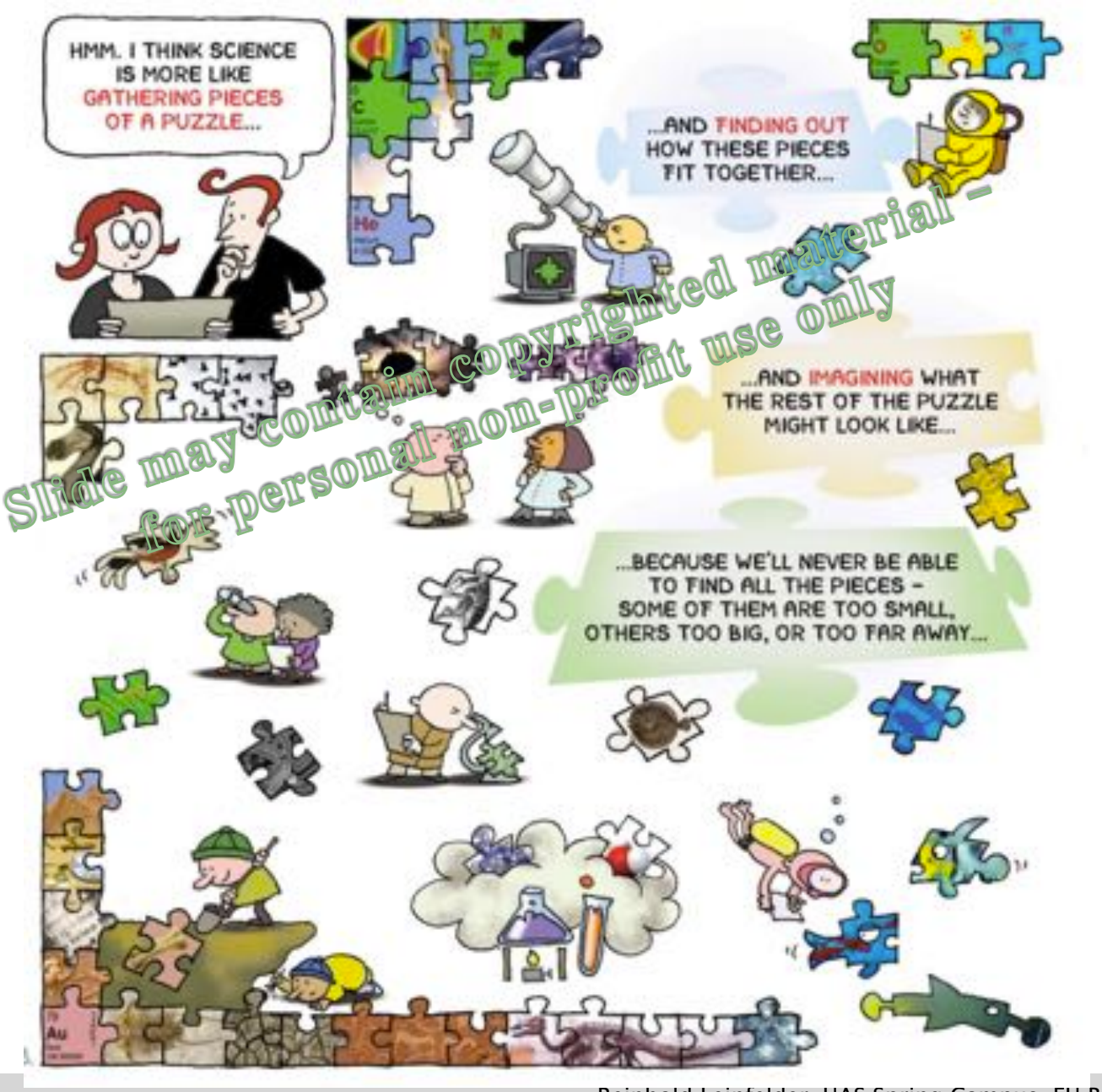
Science, Research, Innovation: what for?

- **Research as base for Technology and Innovation**
  - *Formerly*: **Technics** started as empirical tinkering, followed by scientification -> **technology**
  - *Today*: **strong dependance on technology**:
    for many **goods**: living longer, reduced child mortality, traveling and communicating worldwide. For the **bad**: environmental deterioration
  - **Human-Machine**: Machines not only need resources for constructing them, but also „fodder“ to make them work.



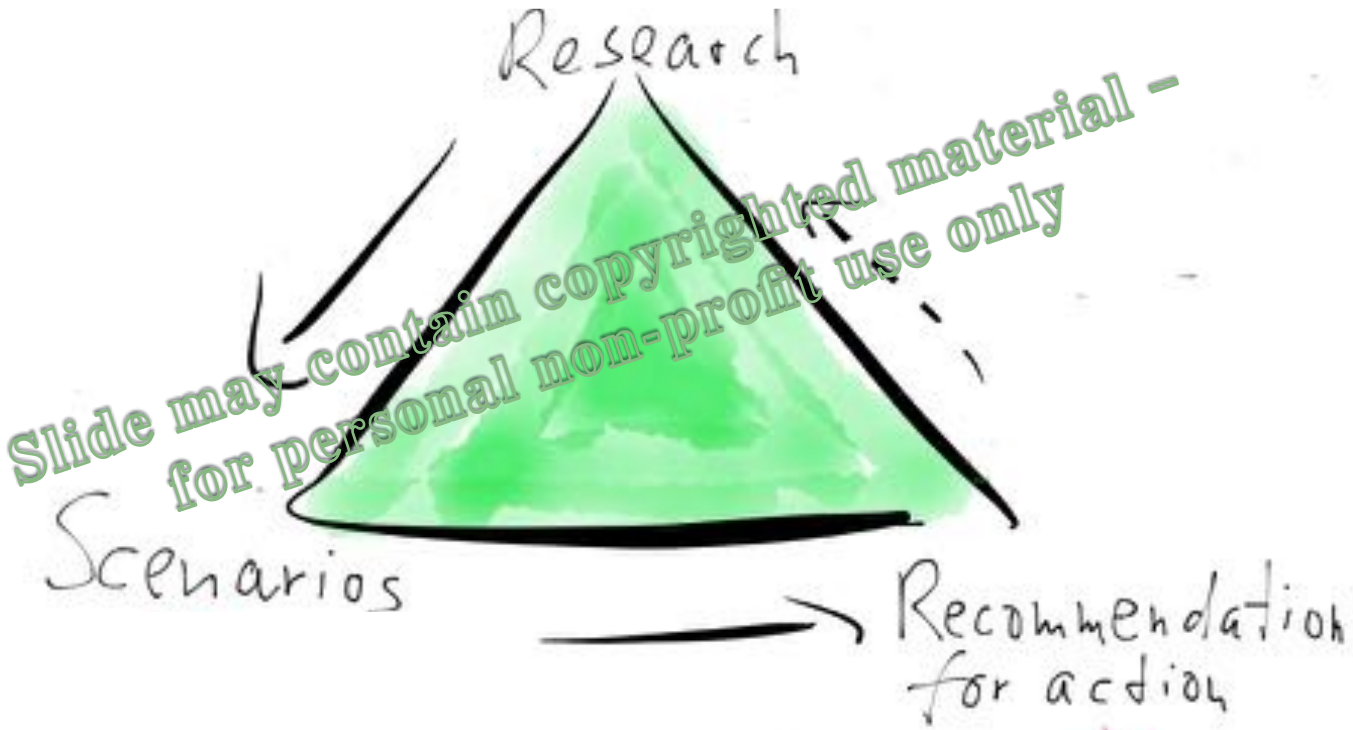
Img.: H. Wagenbreth, Cover from : A. Hamann, R. Leinfelder, H. Trischler, H. Wagenbreth (2014)

Science, Research, Innovation: what for?



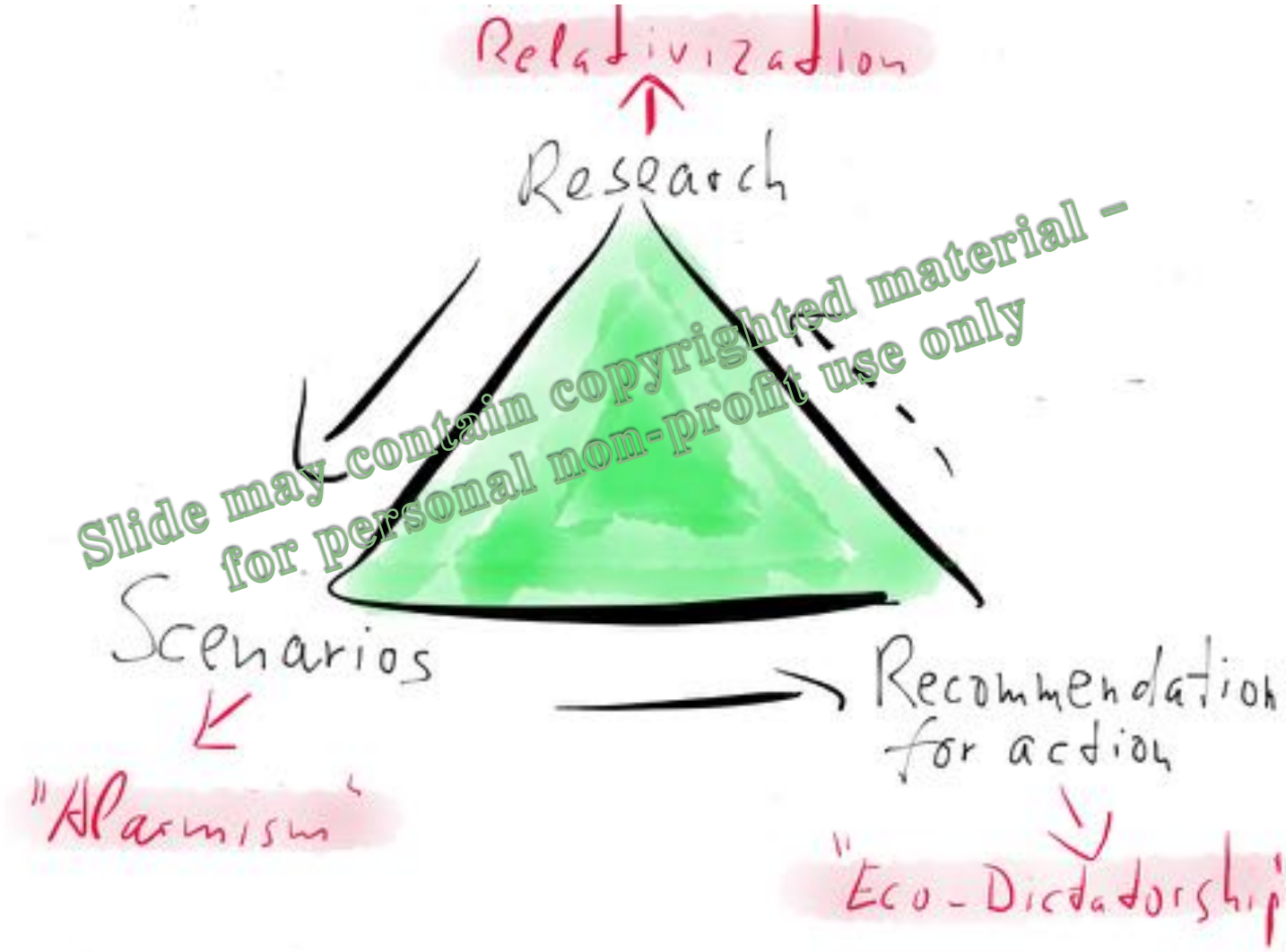
Aus: Margreet de Heer: Science. A discovery in comics

The Research Process Chain for Grand Challenges



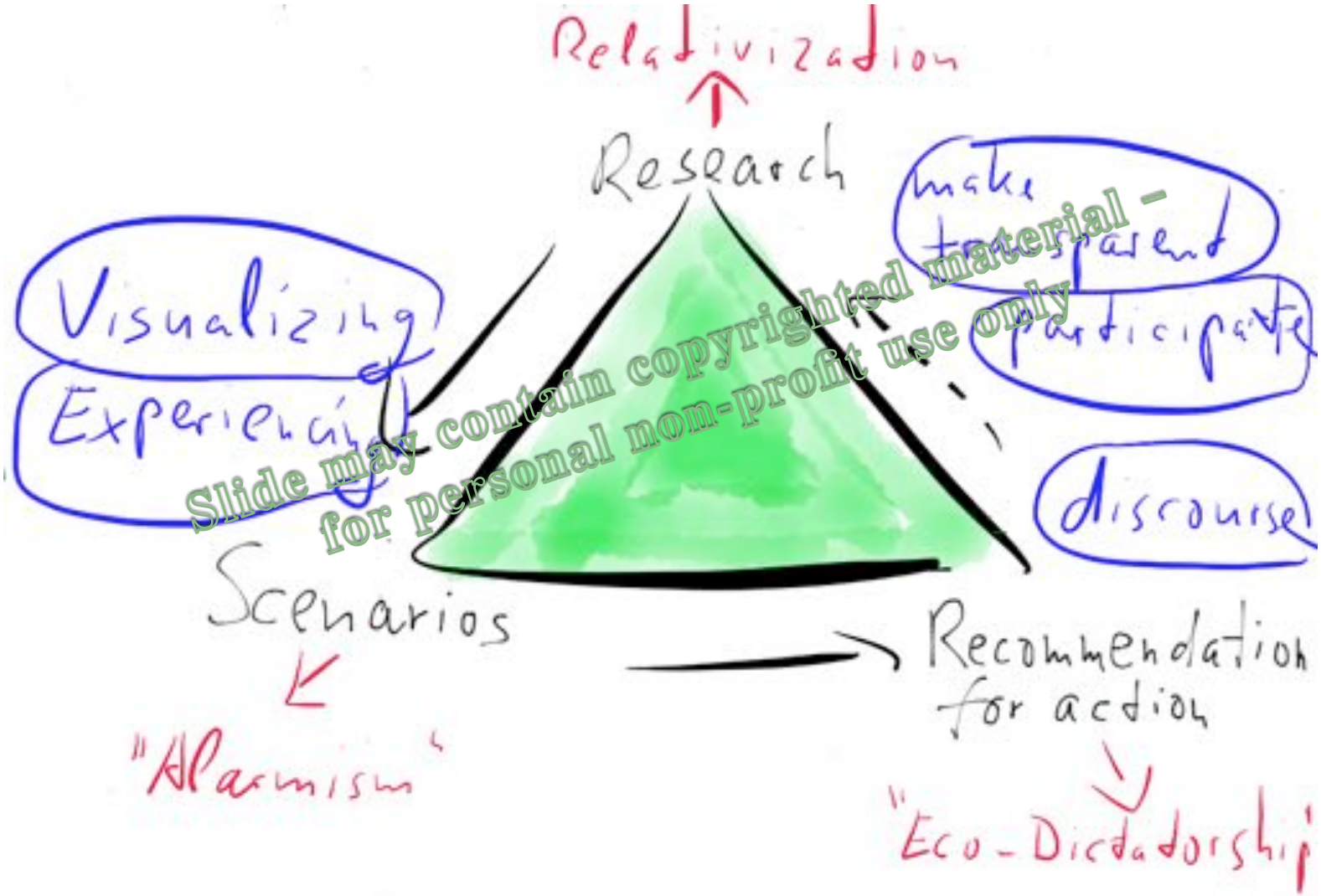
Based on Leinfelder 2010 ff

The Research Process Chain (?)



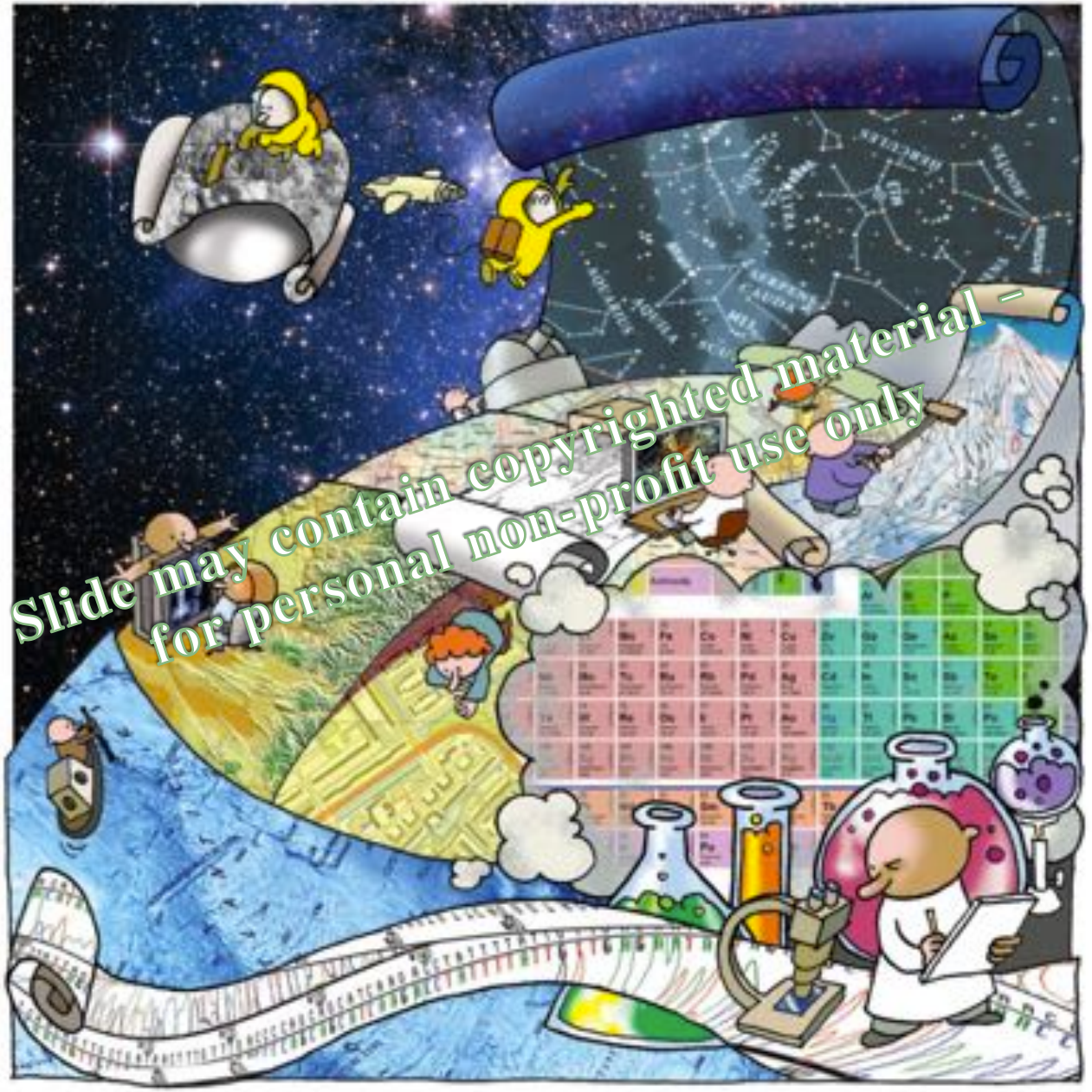
Based on Leinfelder 2010 ff

The Research Process Chain (?)



Based on Leinfelder 2010 ff

Science, Research, Innovation: what for?



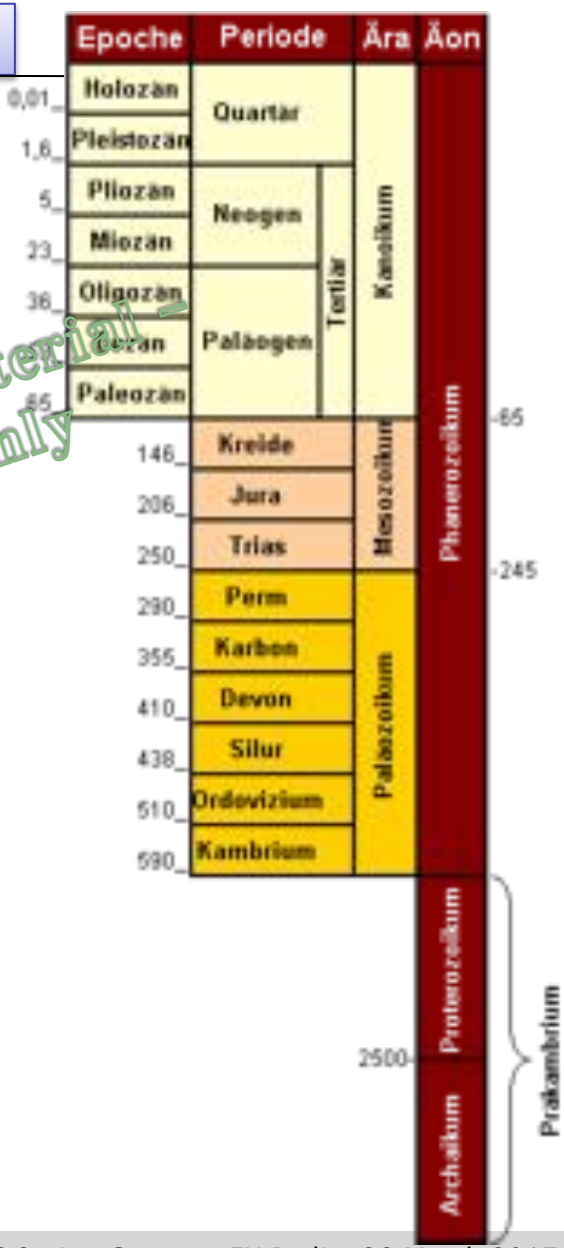
Aus: Margreet de Heer: Science. A discovery in comics

„Geology of Humanity“
The Anthropocene

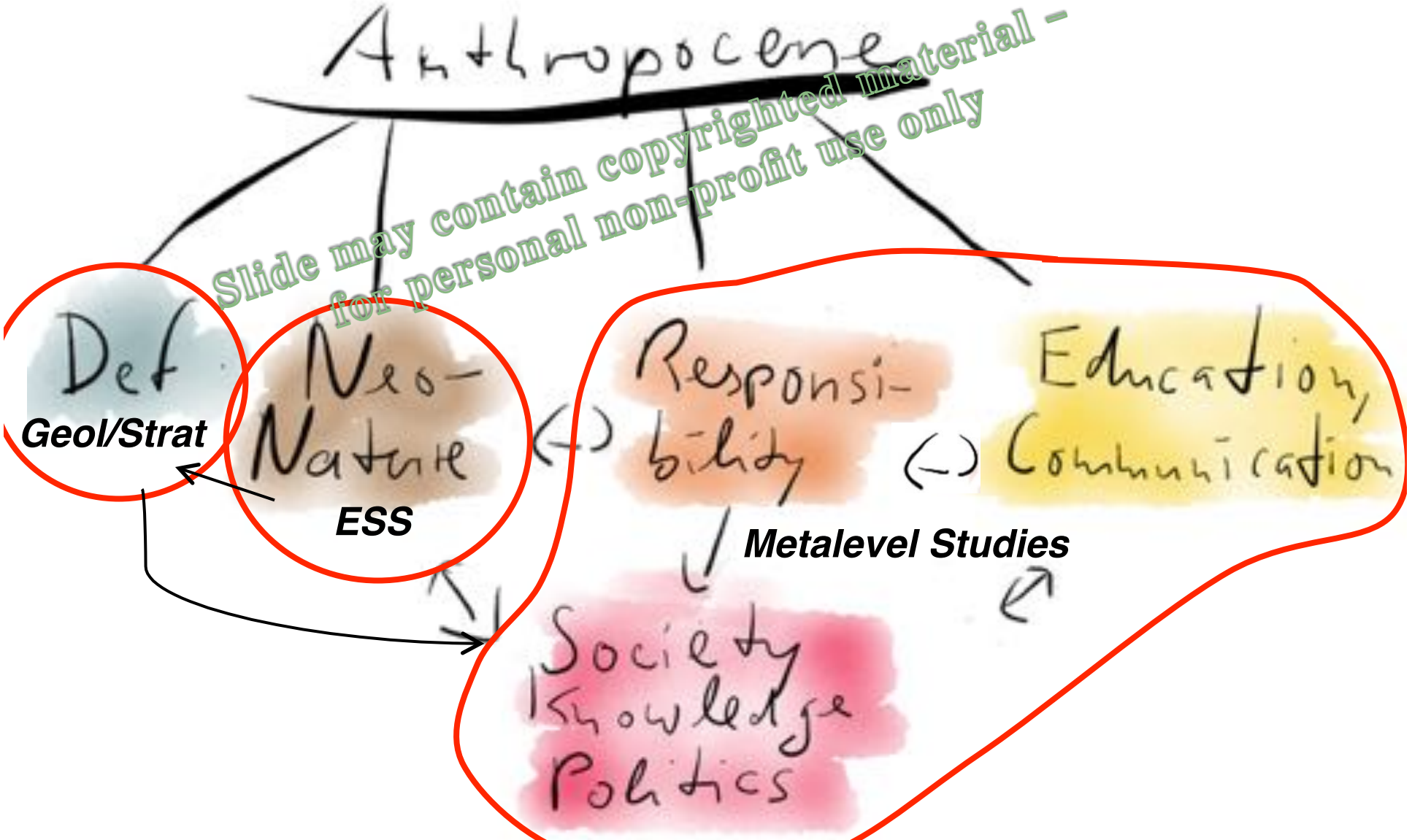
Paul Crutzen

„We live in the Anthropocene“

„Anthropozän“



The three „layers“ of the Anthropocene-concept



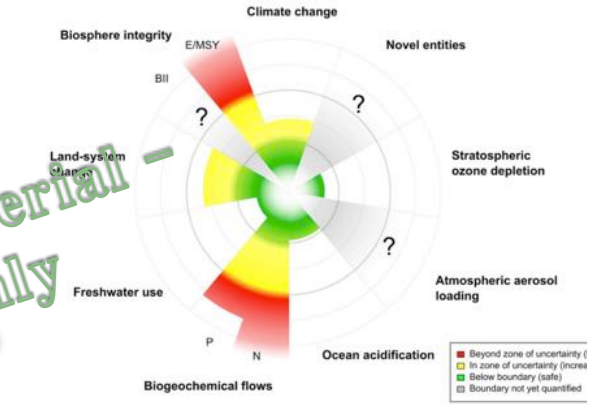
Based on Leinfelder 2014, 2016, http://scilogs.spektrum.de/der-anthropozaeniker/zukunft-teil3-zukuenfte/
http://scilogs.spektrum.de/der-anthropozaeniker/haus-zukunft-berlin/

A) ESS: The extent of change

- **77%** of (ice-free) **land surface** not pristine any longer
- >> **50%** of **freshwater** used / managed by humans
- **60-80% overfishing** world wide (FAO),
- **100 -1000 x higher extinction rate** of animals and plants than natural
- **Biomass of humans and its domestic animals** amounts to **90%** of biomass of all living mammals
- Plastic production per year equals mass of all living humans; total technosphere weights 30 trillion tons.
- Global mean temperature ca. + 0,9°C, esp. Since 50 years sea level rise ca 3,2 mm/y, severely increased
- Increase of **energy consumption** since 1900: > **x 16**
- **Highest** atmospheric **CO_2 and CH_4**-concentrations **since >>800.000 years.**
- **NO_x und SO_2-emissions now higher than natural sources**
- Mean **erosion rate 10-30x higher** than average of last 500 million years

Figs:
WBGU-Comic 2013

ESS: Interdependencies: everything connects with everything



Steffen et al. 2015

Climate change

Chem. Pollution,, not yet quantified

Ocean acidification

Atmosph. aerosoe loadig (not yet quantified)

Stratospheric ozone depletion

Nitrogen cycle

Biodiversity loss

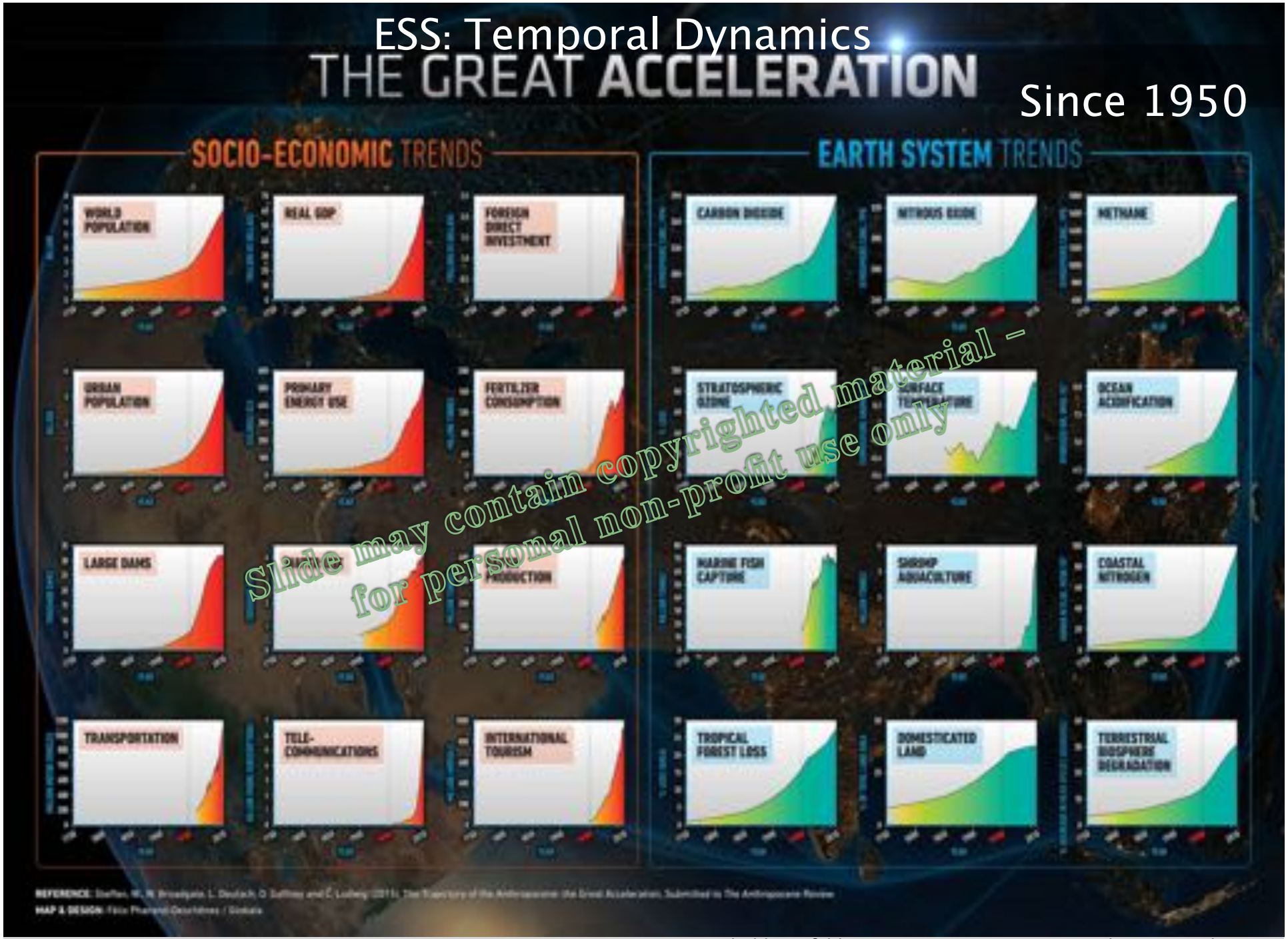
Phosphorus cycle

Change of land use

Global freshwater use

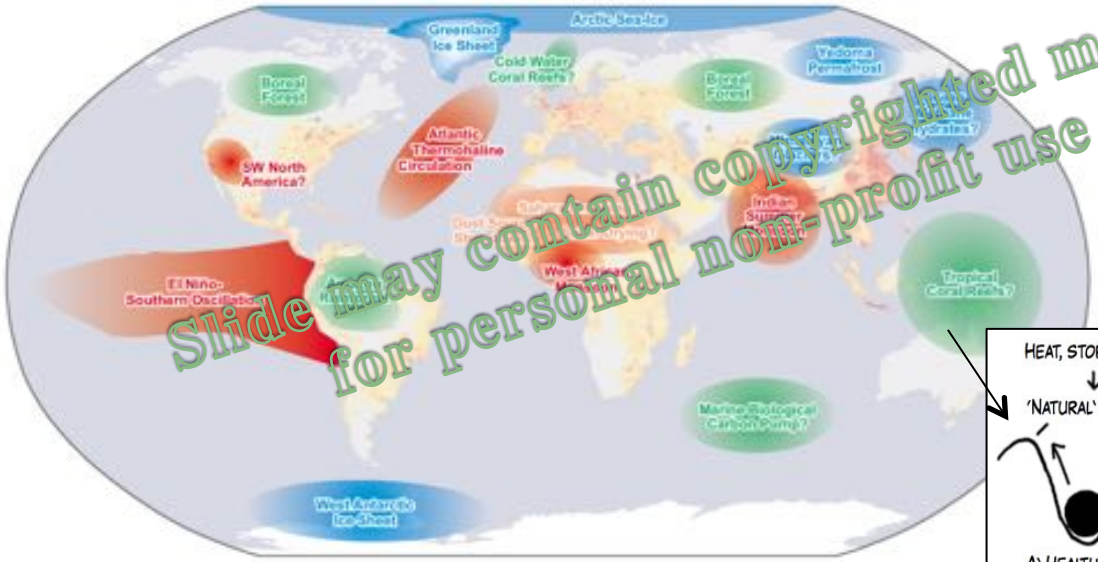
Source: Rockström et al., Nature, 24. Sept. 2009, modified

ESS: Temporal Dynamics



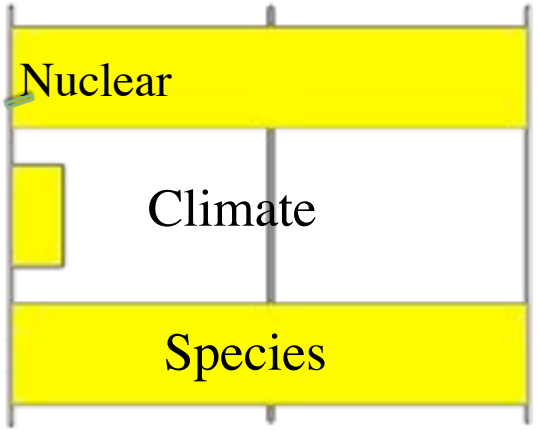
ESS: Understanding Time-Related Problems

The Tipping Point Problem



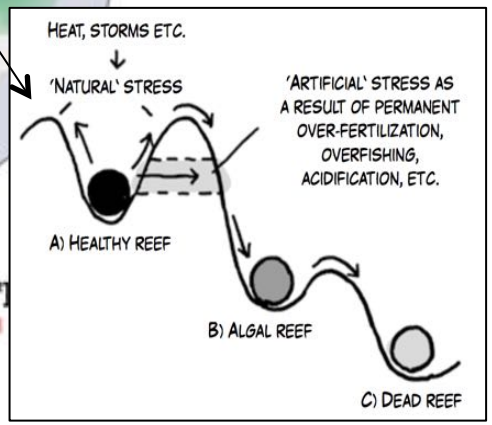
https://www.pik-potsdam.de/services/infothek/kippelemente

The „Long Now"-Effect



500.000 10^6 year

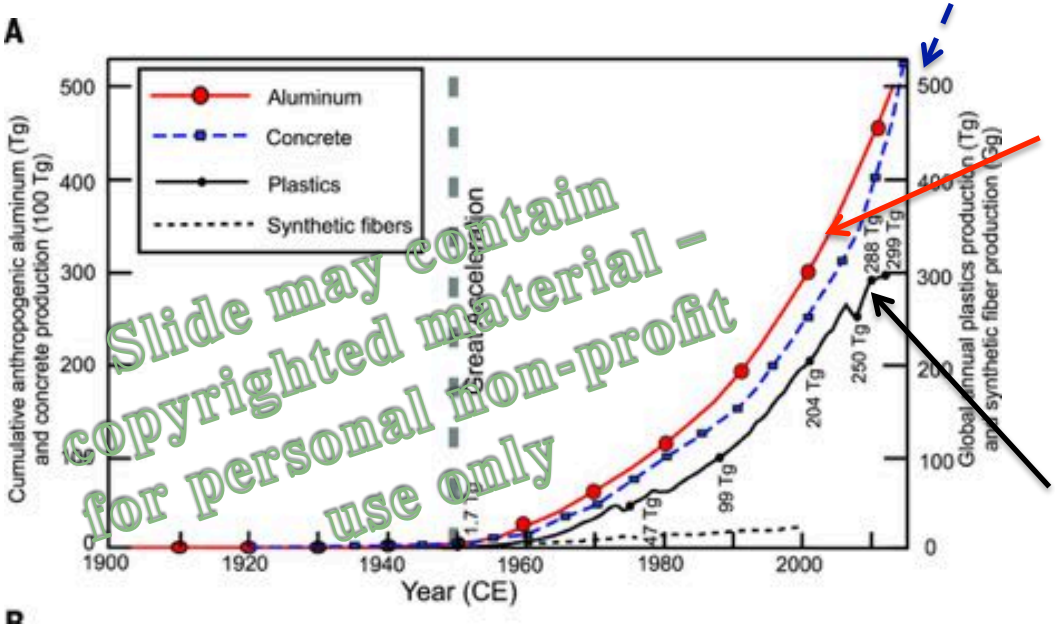
„The Dictatorship of the Now"
John Schellnhuber

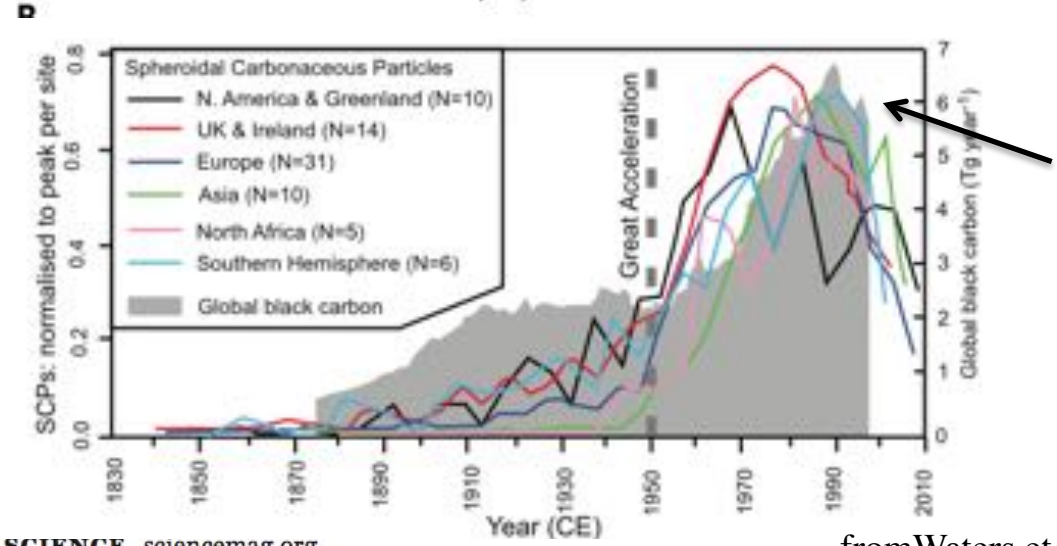


From: WBGU-Comic 2014

Living with likelihoods and risks

B) Geological Signatures





Concrete:

- Invented by romans
- 50% produced since 1995
- ca.1 kg concrete per m^2 of earth surface

Elementary aluminium:

- Al most frequent metal in nature, but not in elementary form
- elementary since19. Jhd.
- 98% seit 1950

Plastic esp. since WorldWar II and thereafter

Industrial fly ash, POPs, pesticides, „**spice metals**“, **Rare Earths, etc,**

+ radioactive Fallout (1950/60ies)

+ atmospheric anomalies

fromWaters et al. 2016

B) Geological Signatures

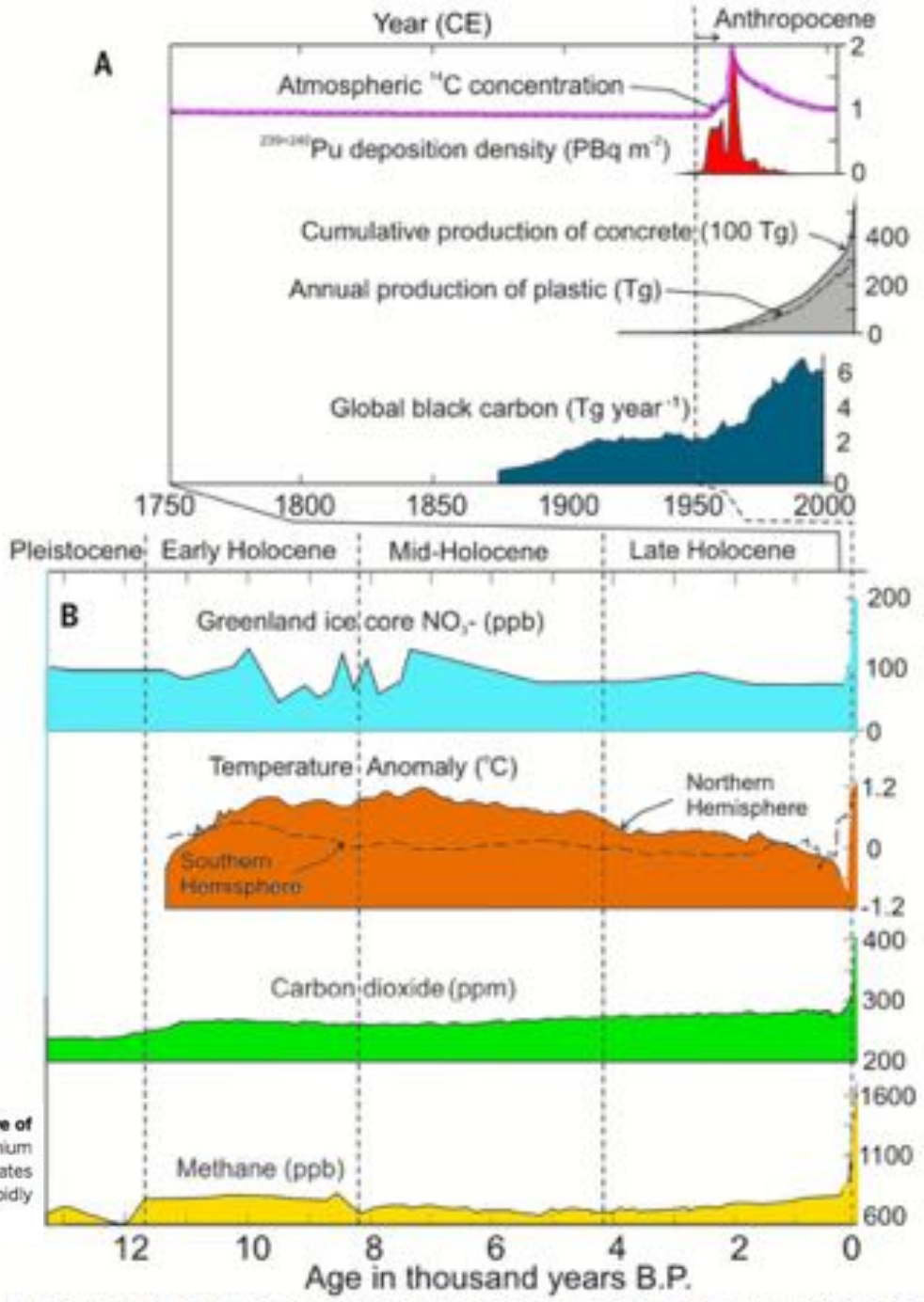


Fig. 1. Summary of the magnitude of key markers of anthropogenic change that are indicative of the Anthropocene. (**A**) Novel markers, such as concrete, plastics, global black carbon, and plutonium (Pu) fallout, shown with radiocarbon (^{14}C) concentration. (**B**) Long-ranging signals such as nitrates (NO_3^-), CO_2, CH_4, and global temperatures, which remain at relatively low values before 1950, rapidly rise during the mid-20th century and, by the late 20th century, exceed Holocene ranges.

From Waters et al. 2016

C) Responsibility:
So how to design a future Anthropocene?

„Even the future was better back then“

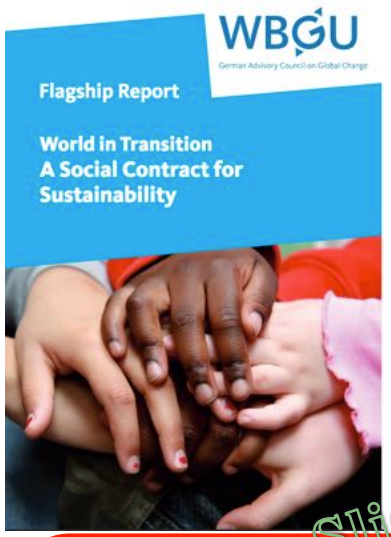
Karl Valentin

C) Responsibility:
So how to design a future Anthropocene?

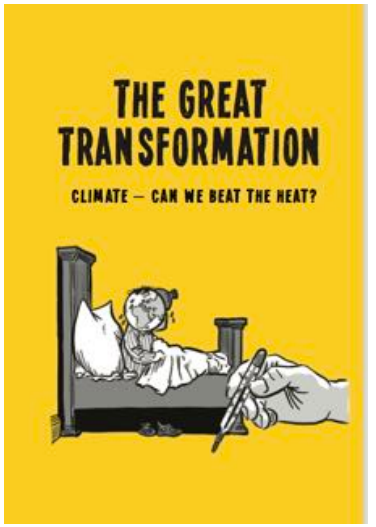
„~~Even~~ the future was not better back then“

Karl Valentin

Who is „We“? Social Contract for a Great Transformation



Top-Down: UN, G20, EU, multinational alliances, states



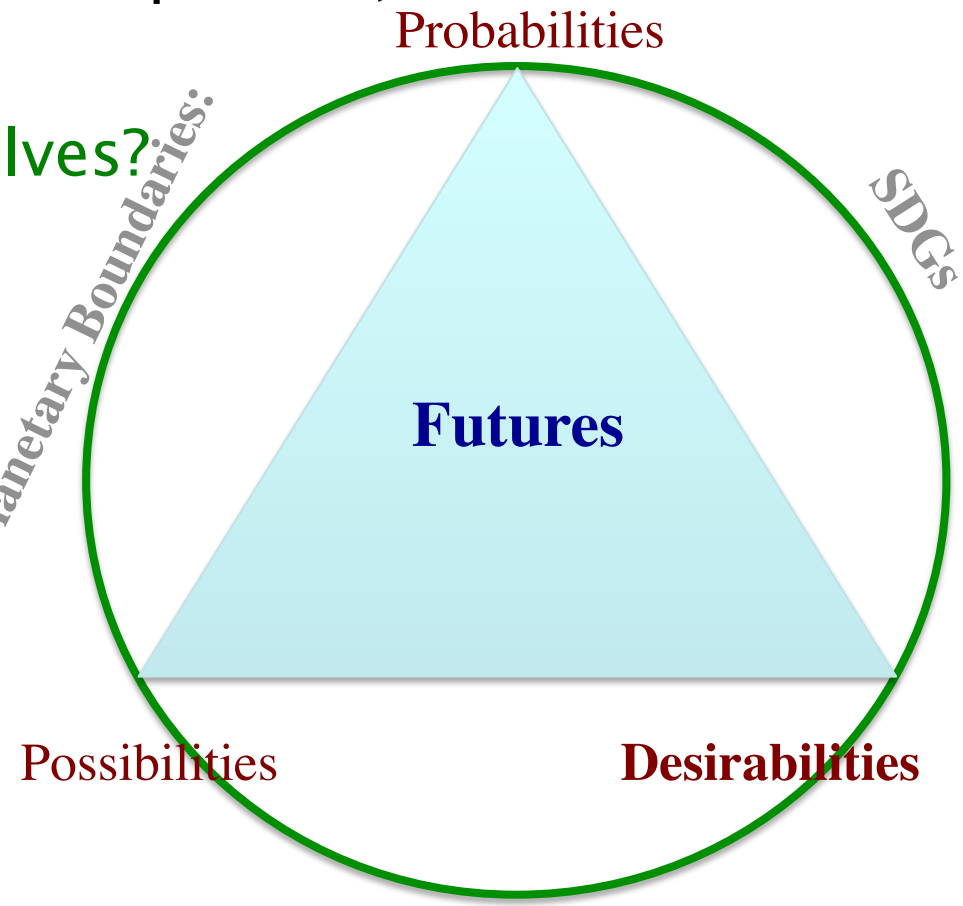
„We together“: cooperation of **science, humanities, technology and civil society,** new ways of political participation, best-practice examples, innovative companies, dedicated authorities, municipalities, foundations, other pioneers und promoters of change, etc.

Bottom-up: NGOs, initiatives, protest movements, masterminds etc.

R. Leinfelder, Based on WBGU 2011

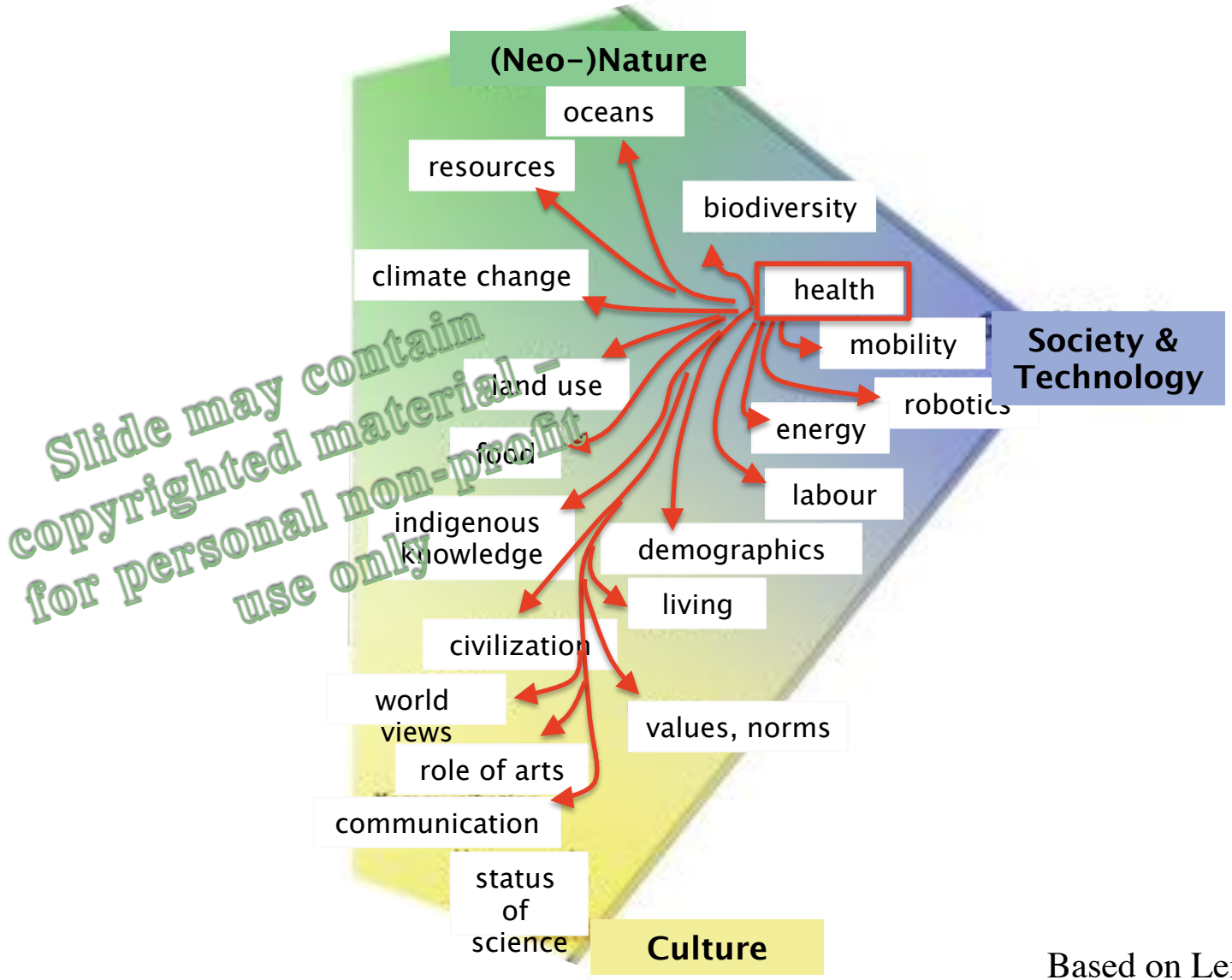
1. Ask key questions

- Is the future designable?
- How do science, industry and politics, design the future?
- How can we design ourselves?
- How do we want to live?



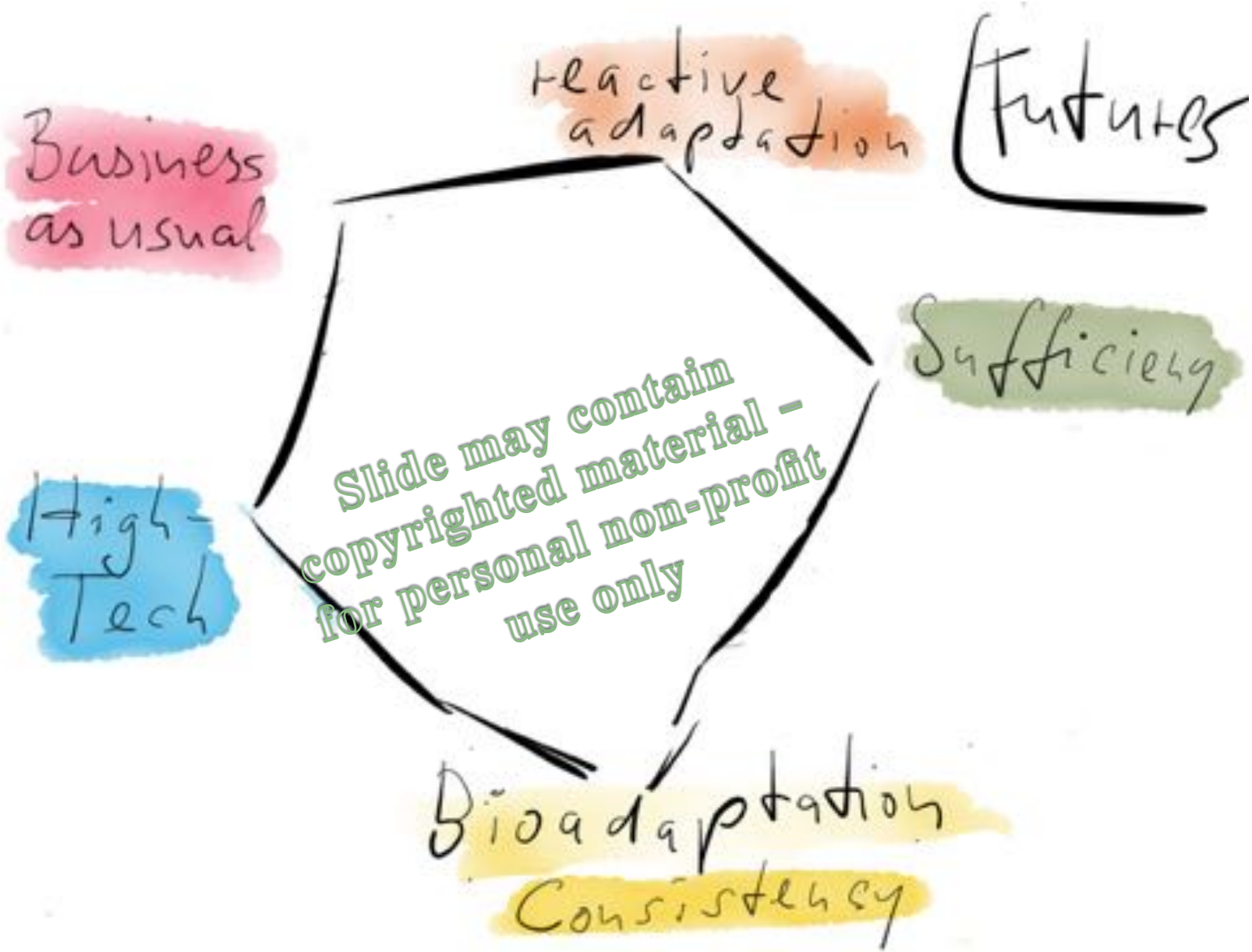
Based on Leinfelder 2014, 2016

2. Unravel and reflect connectedness in the Anthropocene



Based on Leinfelder 2014

3. Develop and „negotiate“ visions



3. Develop and „negotiate“ visions

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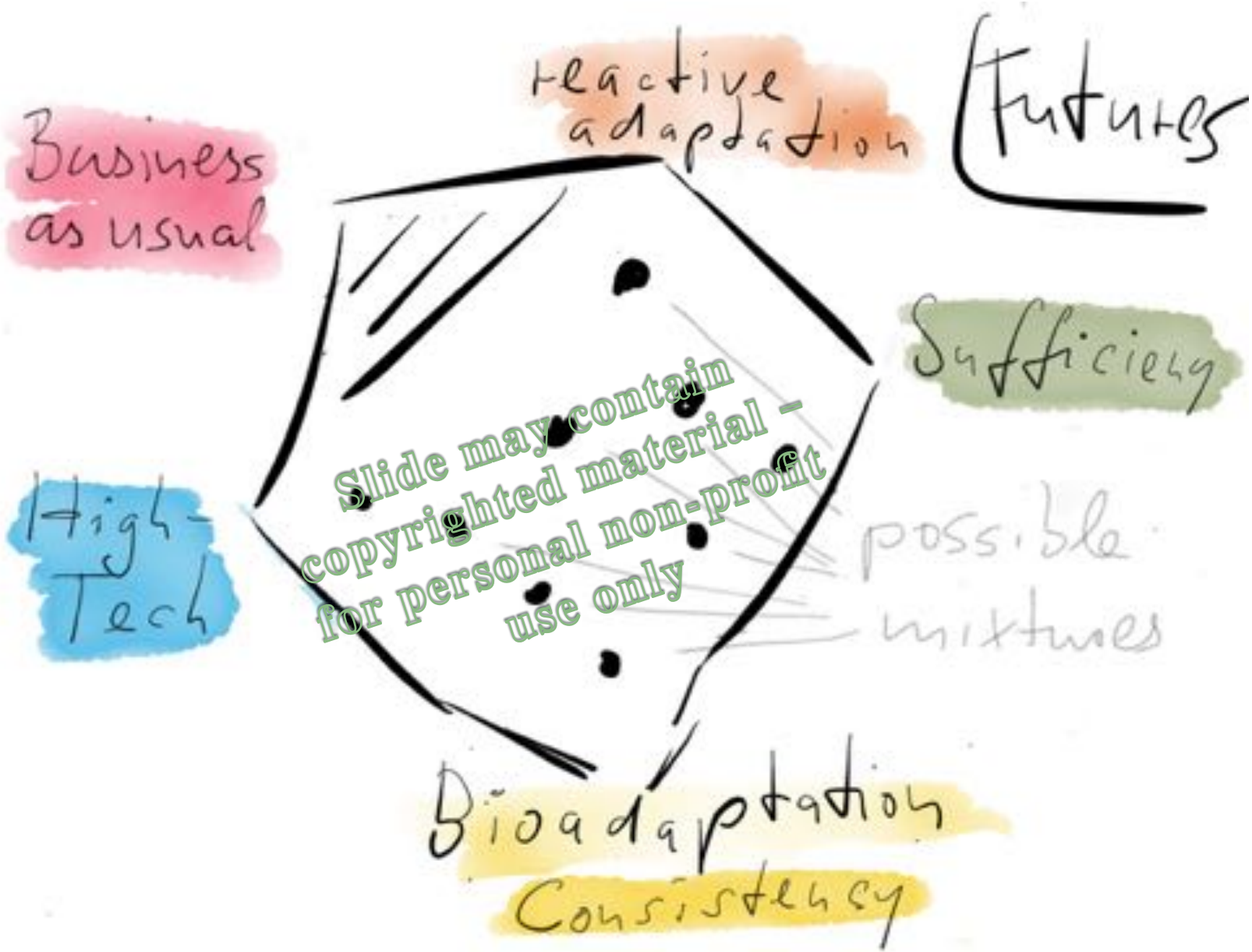
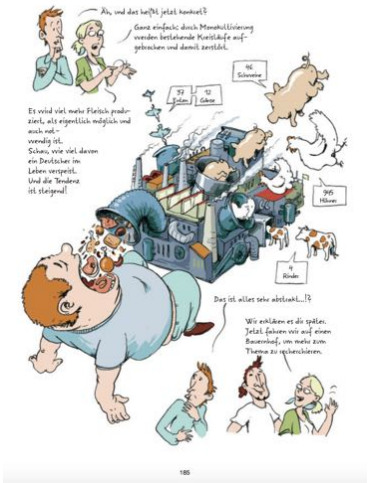
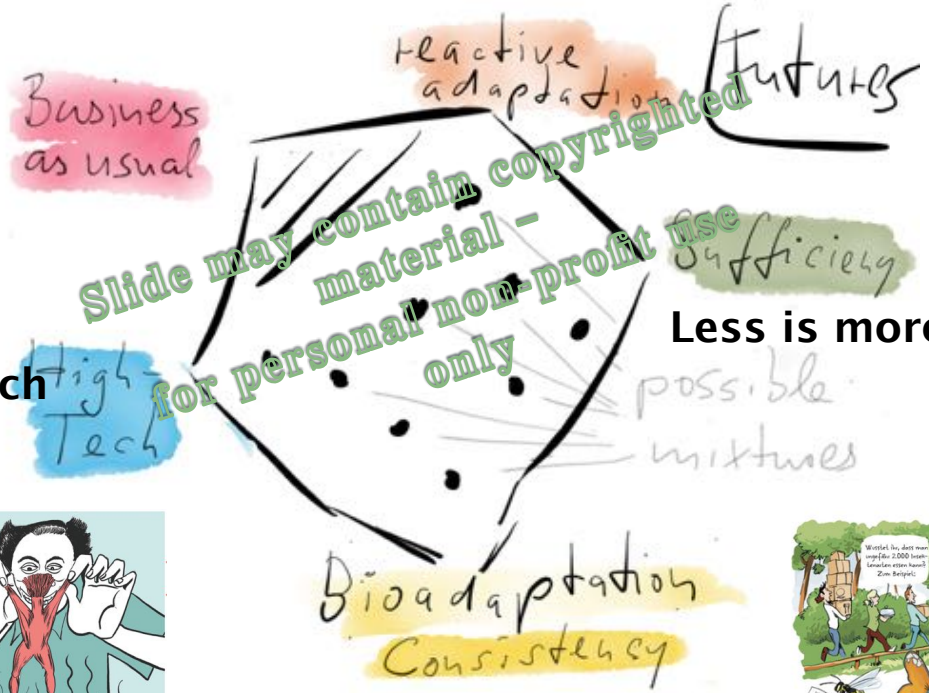


Eating Anthropocene



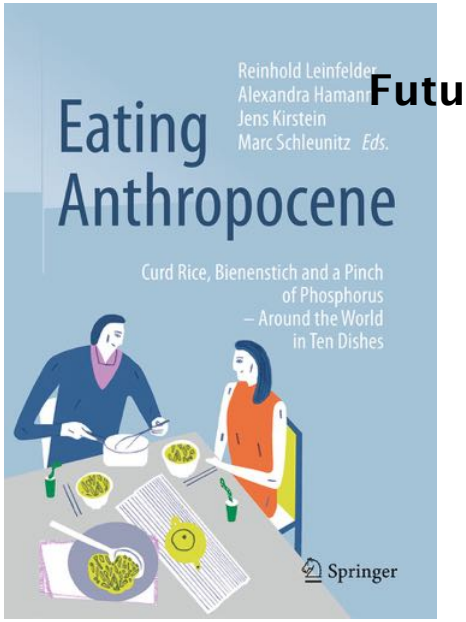
Fight Symptoms

Keep on



Future Tech

Less is more



Nature as Role Model

From Leinfelder, Hamann et al. (2016) Eating Anthropocene

3. Develop and „negotiate“ visions

Energy for the Future

CCS, Fracking??, Solar Radiation Management???

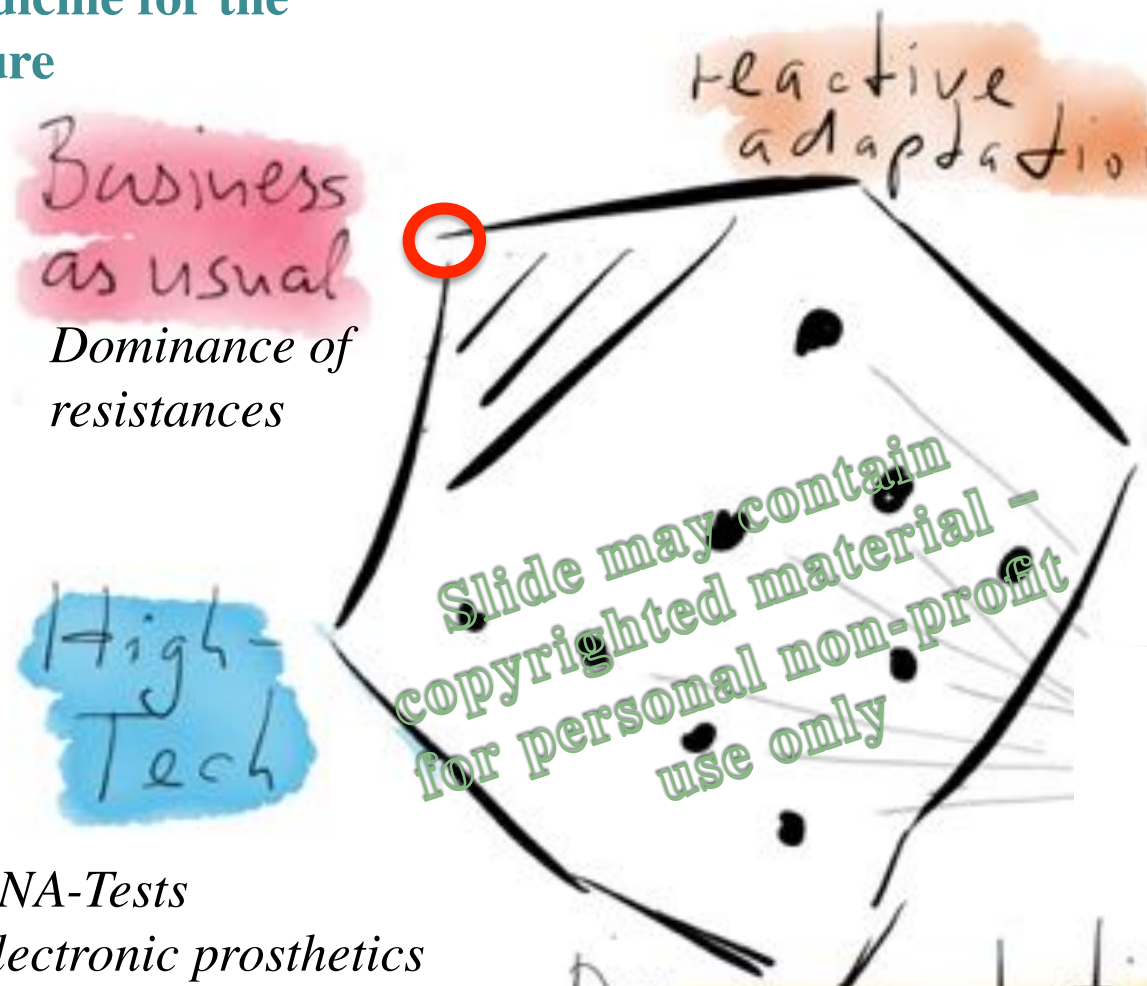
Less heating, bicycles, woolen sweater, insulation etc.

Nuclear fusion?, CCU, super smart grids, higher efficiencies

Solar, wind, geothermy, biofuels?, bioCCS

3. Develop and „negotiate“ visions

Medicine for the future



Antibiotics,
pain killers,
chemotherapy
etc.

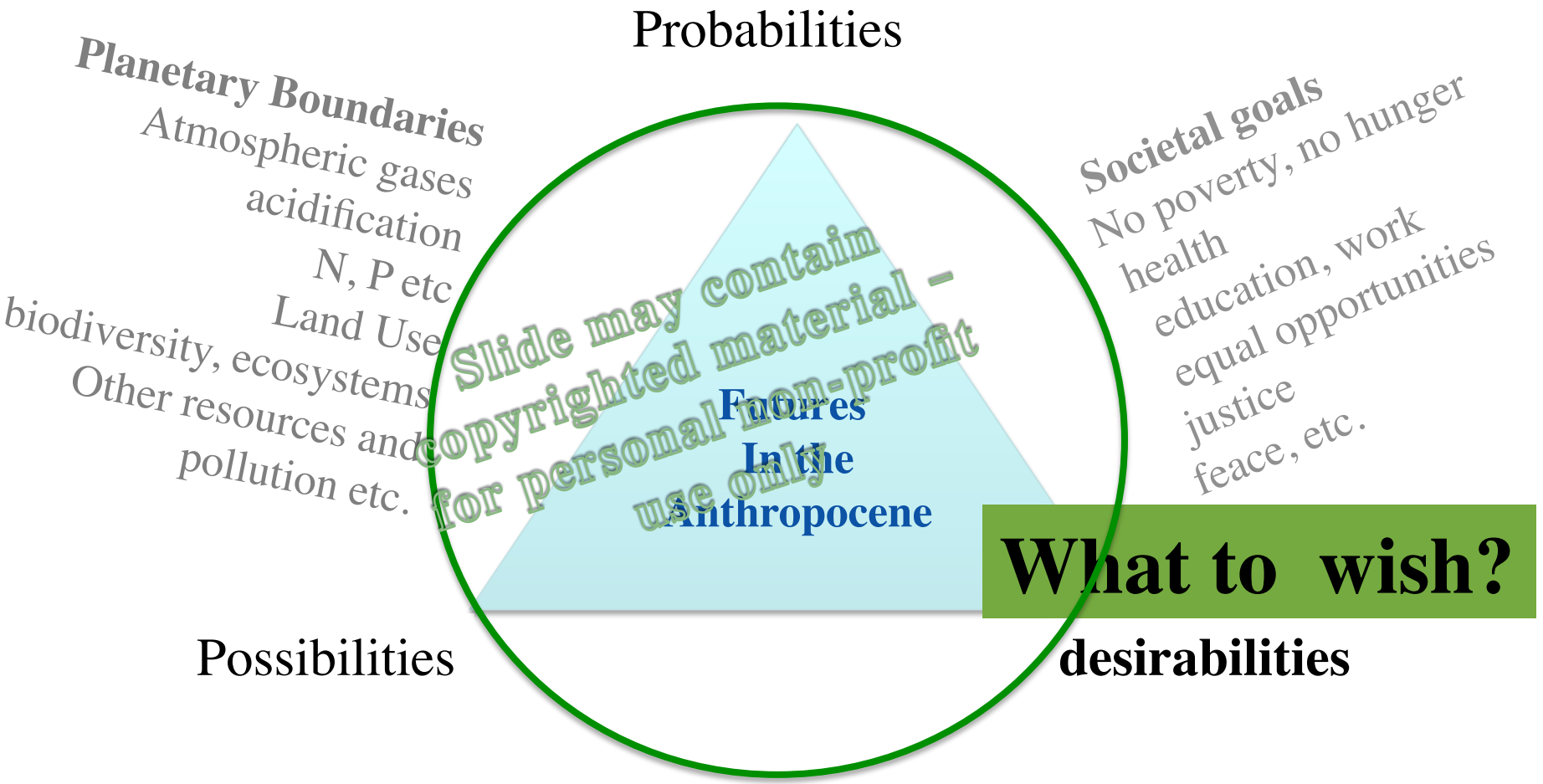
Dominance of resistances

Nature medicine,
Relaxation, meditation

DNA-Tests
Electronic prosthetics
Supporting robotics
etc.

Sports, proactive medicine,
Self-tracking Apps
Evolutionary medicine

Future as a space for desirabilities



From Leinfelder 2014

Participative formats

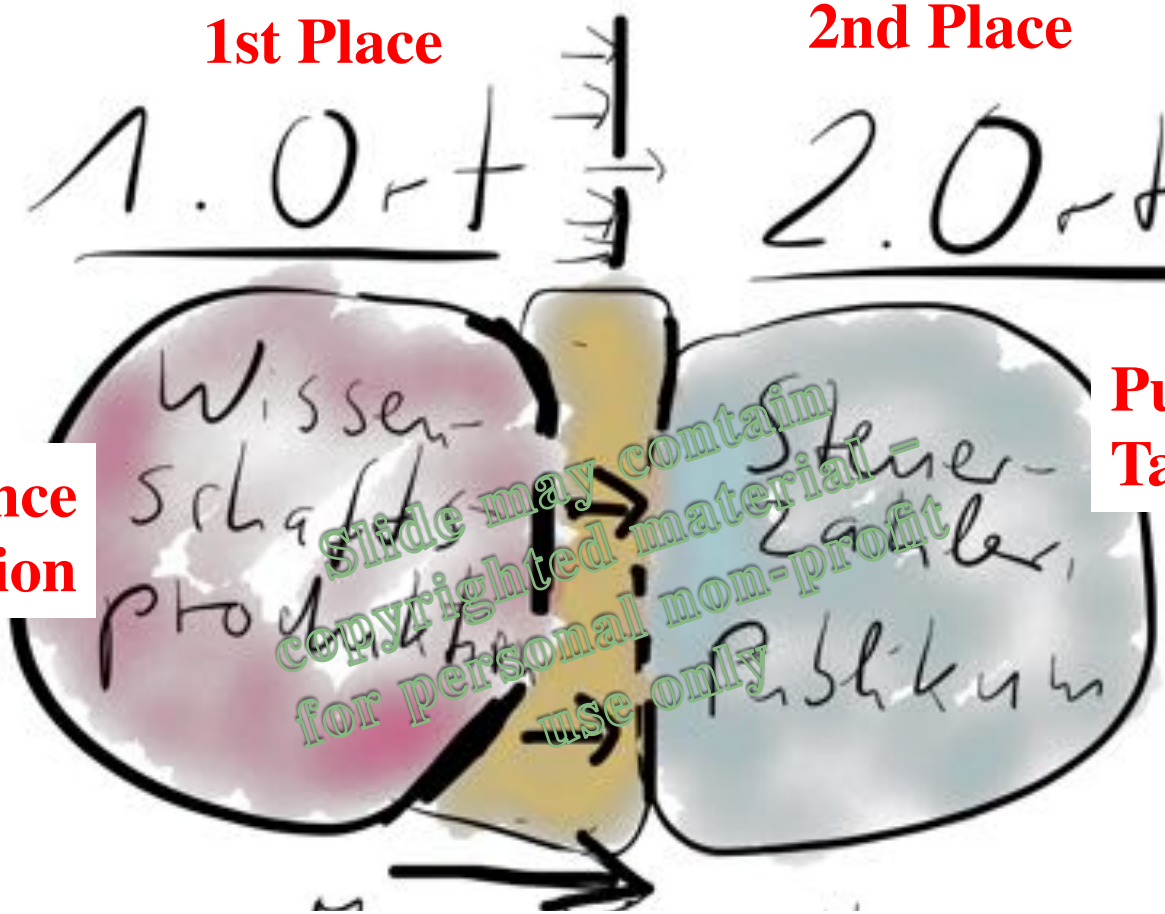
for co-science, co-design, co-government etc.

Based on D. Weigend, modified, redrawn

Responsible Science – Spaces

1st Place

2nd Place



Science Production

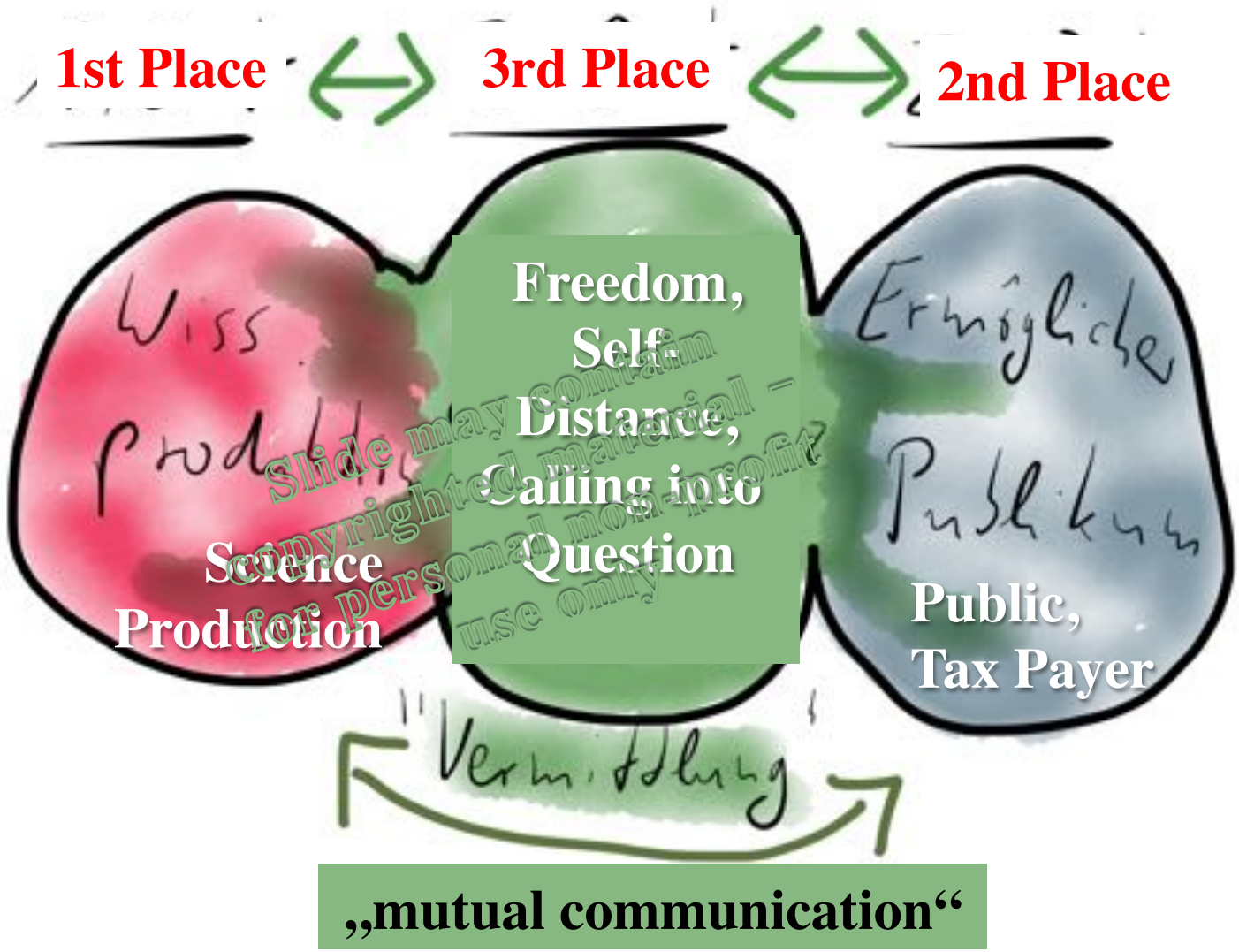
Public, Tax Payer

Pedagogics, Schools
Marketing
Journalism

Partly after Tyradellis 2014

Leinfelder 2015

Science and Innovation needs more than two spaces!



Leinfelder 2015, partly after Tyradellis 2014, based on
Oldenburg, Ray (1989). *The Great Good Place: Cafes, Coffee Shops, Community Centers, Beauty Parlors, General Stores, Bars, Hangouts, and How They Get You Through the Day*. New York: Paragon House.

Lei‘

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Web: www.reinhold-leinfelder.de

From Leinfelder, Hamann et al. (2016) Eating Anthropocene