

4 actions to align SDGs with climate goals

Climate
Biodiversity
Pollution
Health
Human Agency



**Eat mostly plants,
unprocessed, in
parts self grown**

Climate
Biodiversity
Pollution
Health
Human Agency



**Provide services for
all, connected with
walking, cycling, and
mobility services**

Climate
Biodiversity
Pollution
Health
Human Agency



**Electrify everything,
stop burning
(also biomass)**

Climate
Biodiversity
Pollution
Health
Human Agency



Align AI

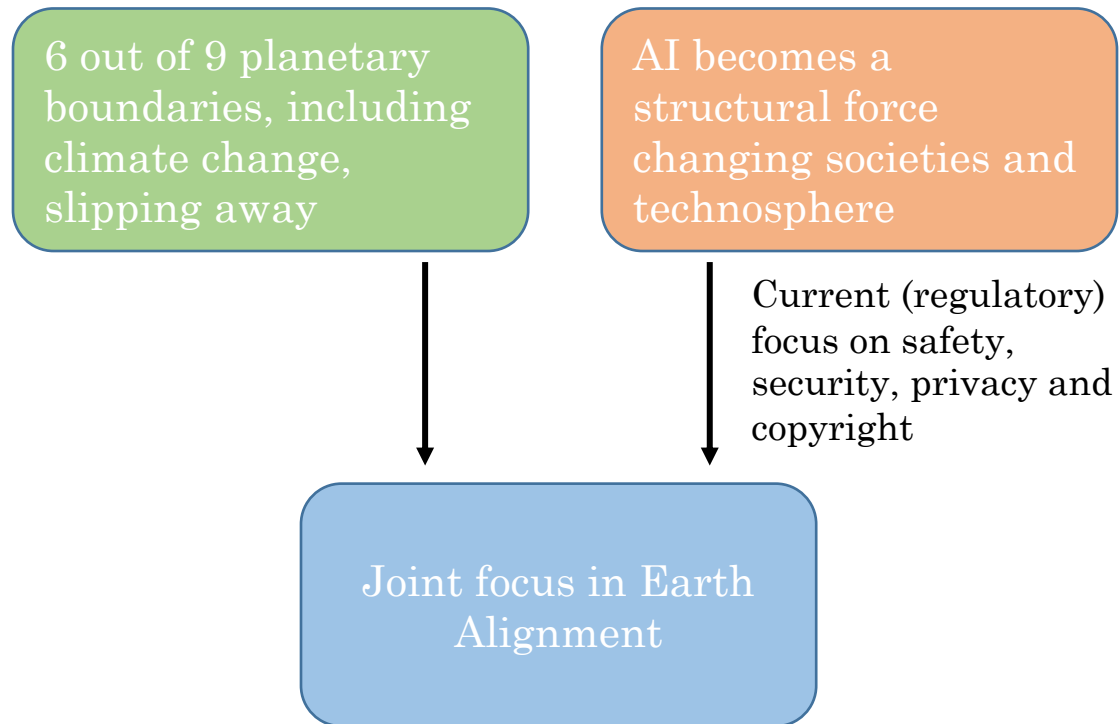
A vibrant, futuristic landscape. In the foreground, a lush green field with a winding river and several children playing. To the right, a large building with a solar panel roof. In the background, several wind turbines are visible against a sky with colorful, swirling clouds. The scene is overlaid with a semi-transparent white box containing text. The overall aesthetic is a blend of nature, technology, and digital art.

Earth Alignment: Some Considerations on Governing AI in the context of planetary boundaries and human well-being

Prof. Dr. Felix Creutzig

Why Earth Alignment?

A crucial time in human and Earth history



Defining “Earth alignment” of AI:
The principle of aligning the development, deployment and use of AI systems to *promote* planetary stability and stewardship for the benefit of humankind.

Differentiated from the principles of “do no harm” or “the precautionary principle” in that it actively seeks to leverage AI’s capabilities to drive sustainability transformations

3 Earth Alignment principles

(EA1)

Actively utilize AI for decarbonization and biodiversity protection and avoid harmful usage

(EA2)

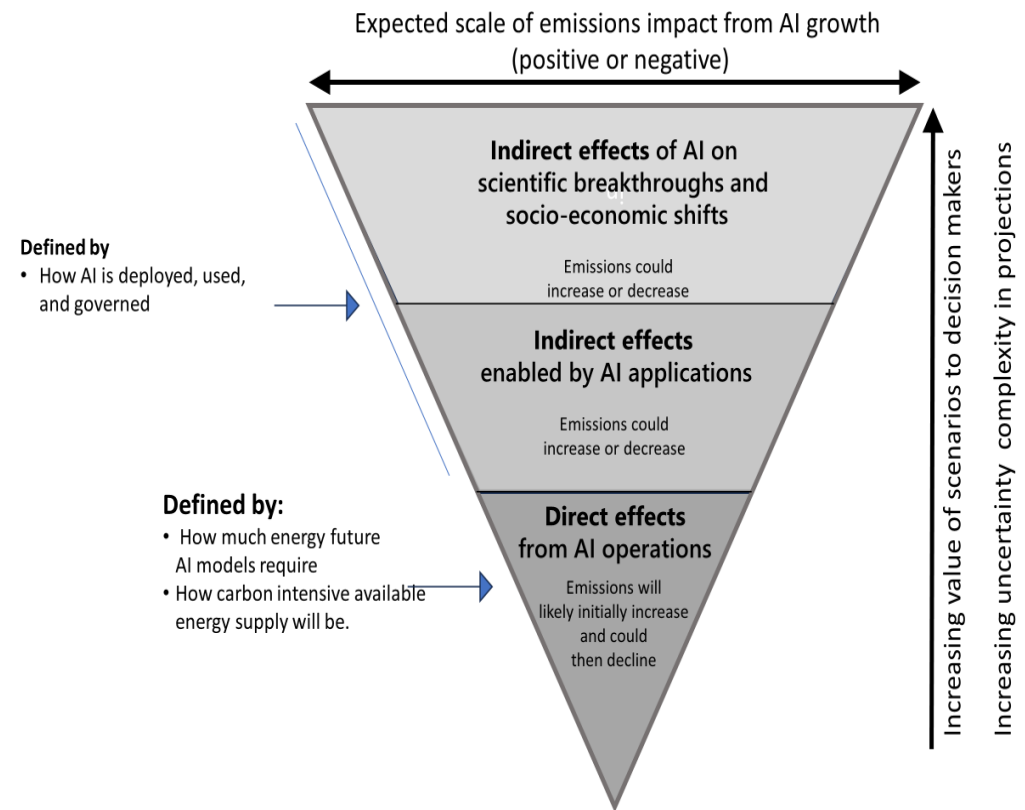
Promote fair and distributed approaches to power and control and protect human agency

(EA3)

Advance social trust, cohesion and access to reliable information

EA1: AI & decarbonization trajectories: Forget about the computing part

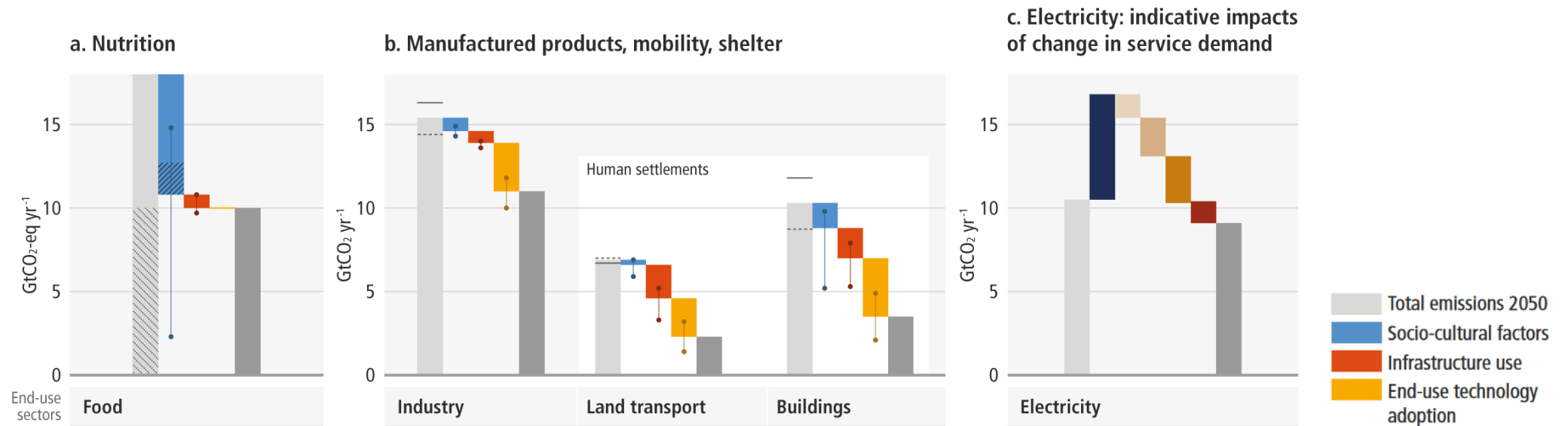
- Installed AI processors responsible for approximately 0.01% of global GHG emissions
- Energy requirements grow 10x by 2027
- Remains quite small and can be addressed by energy efficient algorithms and renewable energy
- Systemic impacts much more relevant



Luers, Creutzig et al (2024)

EA1: Refocus AI solutions on service provisioning

Demand-side mitigation can be achieved through changes in socio-cultural factors, infrastructure design and use, and end-use technology adoption by 2050.



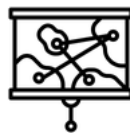
EA1: Interpretable AI models to provide sustainable urban planning insights

Create accurate data bases



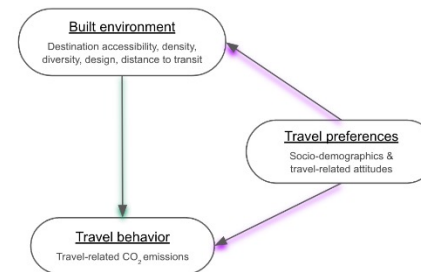
Monitoring

Map relevant features



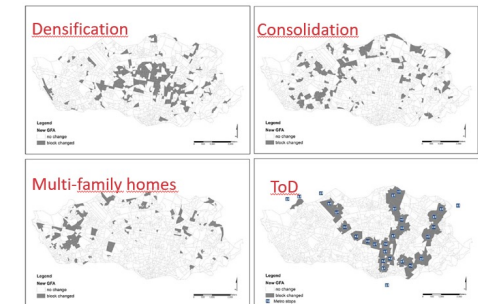
Mapping

Compute interpretable metrics (e.g., with SHAP values, causal inference, and double machine learning)



Computing

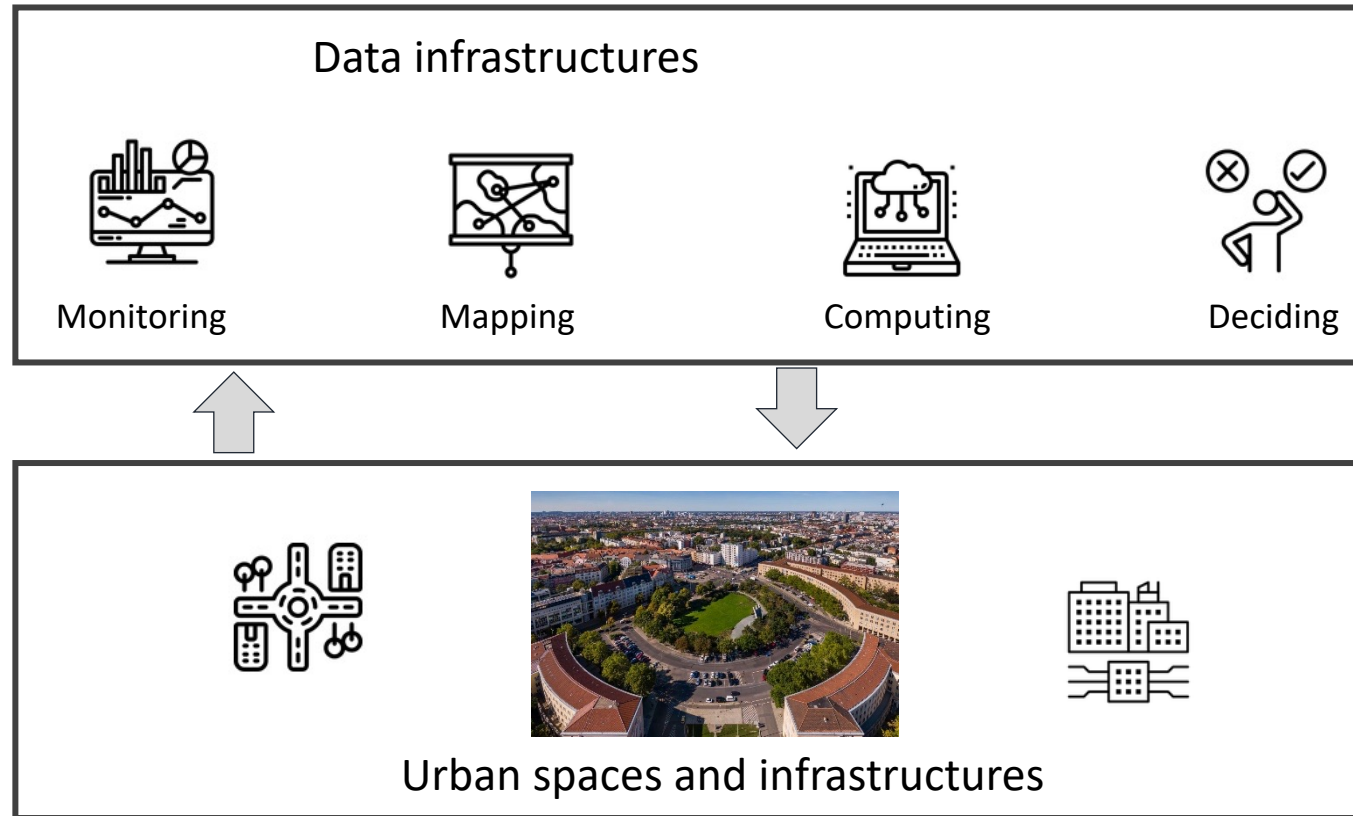
Use results to make informed decisions



Deciding

A number of data and ML publications in recent years

EA1: Joint governance of data, AI and physical infrastructure



Requires

- Substantial investments
- Trusted data governance
- Citizen engagement
- Transport and urban planning guidance.

Builds on political alignment.

Municipal ownership in contrast to big tech ownership.

Creutzig et al, ERIS (2022)

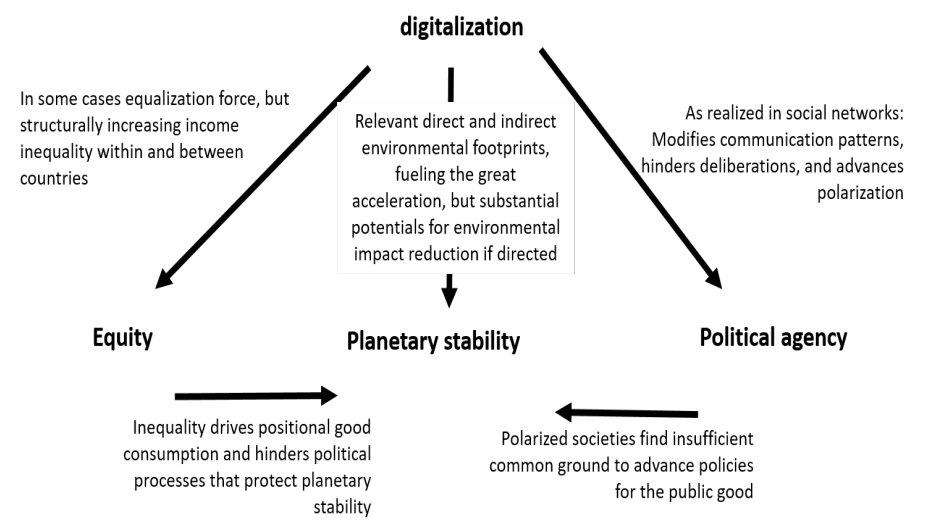
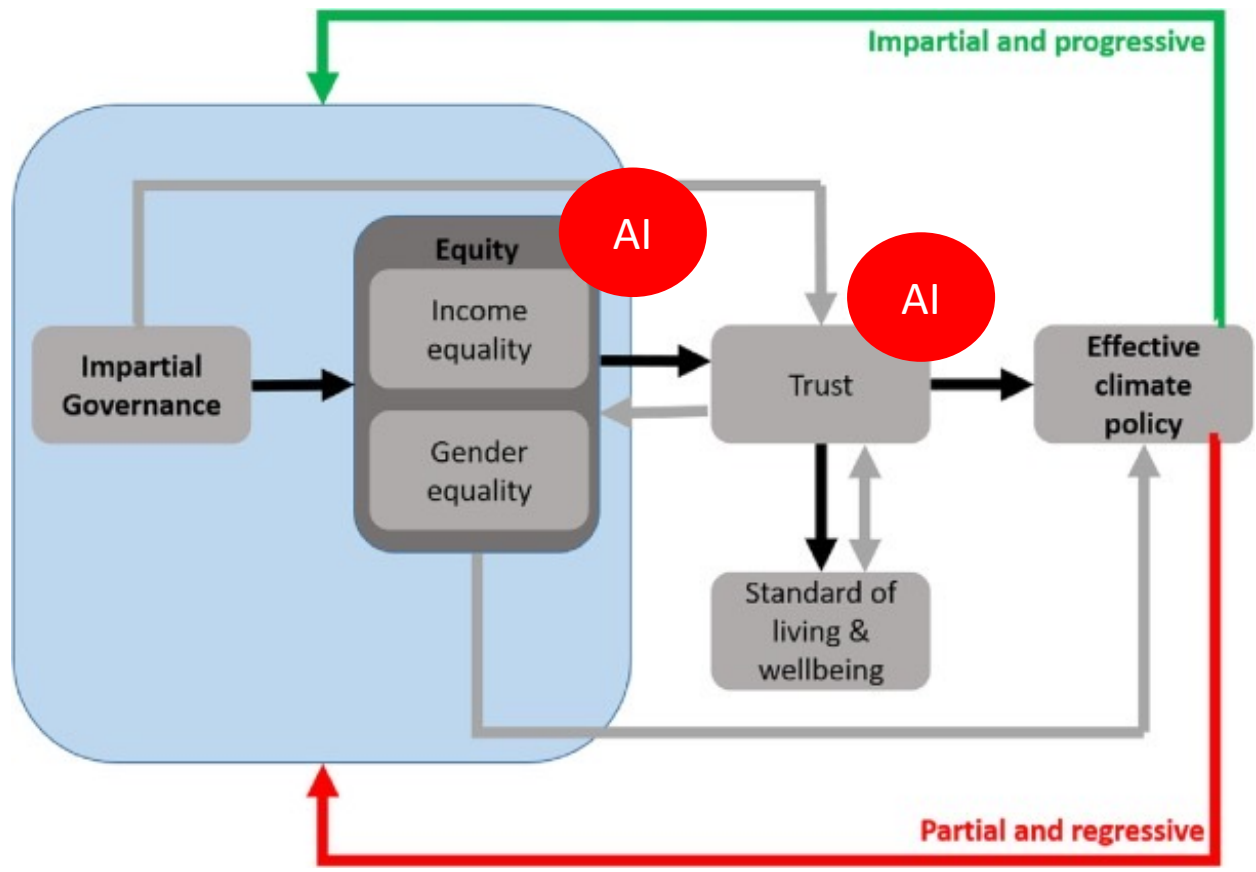
Creutzig et al, in review

Ke & Creutzig, in preparation

Hintz, Kaack & Creutzig, submitted

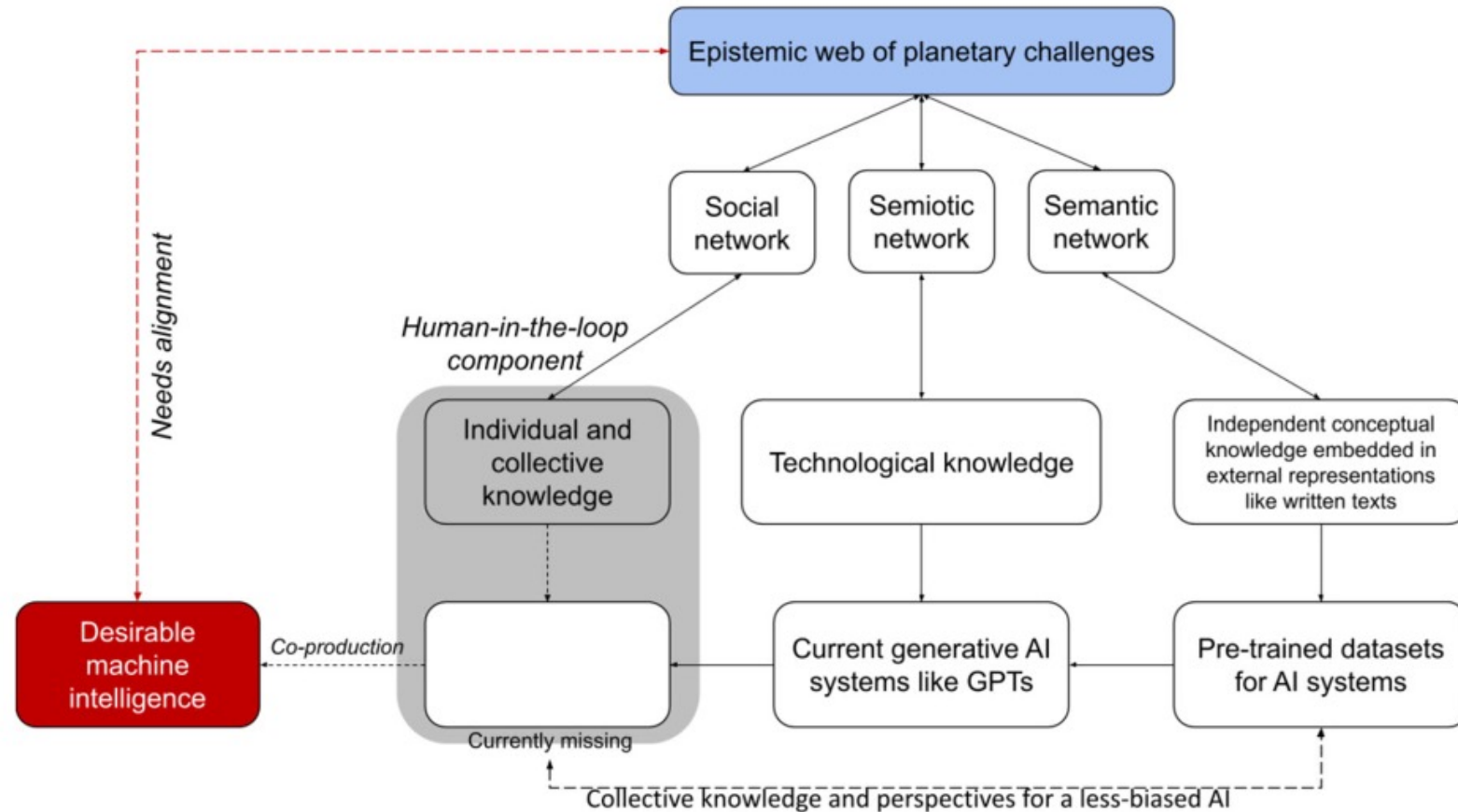
EA2:

Fair resource distribution essential for effective climate policies



See also Krishna Gummadis contributions
 Creutzig et al (2022)
 Creutzig et al (2023)

EA3: Combine new AI technology (GPTs) with (scientific) knowledge about our planetary system



Debnath, Creutzig et al (2023)

EA3: Create prospective knowledge: 6 elements for scenario design

1. Holistic:

Include direct and indirect impacts, e.g., on political stability

3. Participatory:

Elicit expertise and buy-in from relevant international bodies

5. Transparent:

Make data sharing mandatory and establish standards

2. Quantitative:

Quantify direct and indirect effects (CO₂e/yr)

4. Timely:

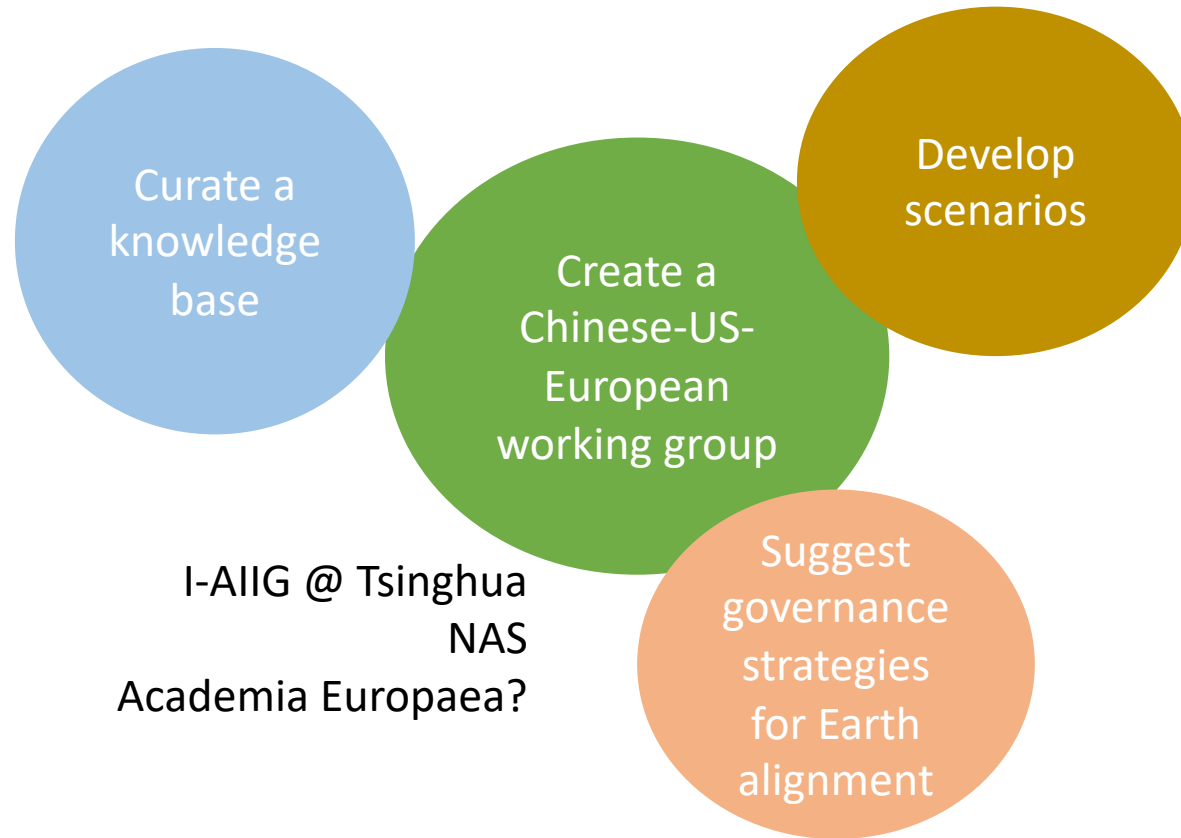
Rapidly update crucial parameters

6. Connected:

Link to other scenarios on climate change (SSP, IAM community, ...)

Luers, Creutzig et al (2024)

The way forward: Contributing to Earth Alignment



Relevant publications

Gaffney, Creutzig et al.
Earth Alignment for Artificial Intelligence Nature Sustainability (2024)

→ Outlines the 3 Earth Alignment principles

Luers, Creutzig et al.
AI's full impact on climate must be better understood – here is how. Nature (2024)

→ Calls for scenarios exploring the impact/potential of AI on climate change and solutions

ANNUAL REVIEWS
Annual Review of Environment and Resources
Digitalization and the Anthropocene

Felix Creutzig,^{1,2} Daron Acemoglu,³ Xuemei Bai,⁴ Paul N. Edwards,⁵ Marie Josefine Hintz,^{2,6,7} Lynn H. Kaack,⁸ Siir Kilikis,⁹ Stefanie Kunkel,⁹ Amy Luers,¹⁰ Nikola Mилоjević-Dupont,^{1,2} Dave Rejeski,¹¹ Jürgen Renn,¹² David Robnick,^{13,14} Christoph Ross,^{12,15} Daniela Russ,¹⁶ Thomas Turnhall,¹² Elena Verdolini,^{17,18} Felix Wagner,¹² Charlie Wilson,¹⁹ Aicha Zekar,² and Marius Zumwald²

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¹⁷Department of Law, University of Bristol, Bristol, UK
¹⁸WZL (Wissenschaftszentrum für Umwelt- und Energieforschung), Leibniz Institute of Environmental Change, Berlin, Germany
¹⁹Environmental Change Institute, University of Oxford, Oxford, United Kingdom

→ Explores the past, present and future of digitalization in the Anthropocene

npj climate action
PERSPECTIVE OPEN
Harnessing human and machine intelligence for planetary-level climate action

Ramit Debnath^{1,2}, Felix Creutzig^{3,4,5}, Benjamin K. Sovacool^{6,7} and Emily Shackburgh⁸

The ongoing global race for bigger and better artificial intelligence (AI) systems is expected to have a profound societal and environmental impact by altering job markets, disrupting business models, and enabling new governance and societal welfare structures that can direct global consensus for climate action pathways. However, the current AI systems are trained on biased datasets that could destabilize political agencies impacting climate change mitigation and adaptation decisions and compromise social stability, potentially leading to societal tipping events. Thus, the appropriate design of a less biased AI system that reflects both direct and indirect effects on societies and planetary challenges is a question of paramount importance. In this paper, we tackle the question of data-centric knowledge generation for climate action in ways that minimize biased AI. We argue for the need to co-align a less biased AI with an epistemic web on planetary health challenges for more trustworthy decision-making. A human-in-the-loop AI can be designed to align with these goals. First, it can contribute to a planetary epistemic web that supports climate action. Second, it can directly enable mitigation and adaptation interventions through knowledge of social tipping elements. Finally, it can reduce the data inequity associated with AI pretraining datasets.

npj Climate Action (2024) 2:20. <https://doi.org/10.1038/s41565-023-00905-3>

INTRODUCTION
The age of artificial intelligence (AI) has begun and is filled with opportunities and responsibilities. It is yet to be clearly understood how AI or machine intelligence can help address present global challenges, including climate change.

A digital digital transformation would need an unprecedented level of machine intelligence. Making this machine intelligence sustainable and coping with planetary health challenges is a grand challenge on its own, starting with the rapid reduction of GHG emissions associated with the internet and currently carbon-intensive data centres.^{1,2} The literature emphasizes several ways in which AI can play a crucial role in addressing climate change. It can provide innovative solutions to mitigate the negative impacts of greenhouse gas emissions, increase energy efficiency and promote sustainable development³ (discussed later in detail).

Addressing climate change through AI systems is challenging because of the enormous number of variables associated with this complex system for planetary health challenges we aim to solve a significant amount of time to collect, analyze and use to make informed decisions that can translate into climate action taking it into account for the continuously changing factors of climate change allows us to generate better informed predictions about environmental changes, allowing us to deploy mitigation strategies earlier. This remains one of the most promising applications of AI in climate action planning. However, while exploiting the potential of AI tools in physics-driven modeling of earth systems for predicting climate change, Ingers et al.,⁴ emphasize the need to rely on clear, physically meaningful scientific hypotheses, the geographical determination of process-based modeling and careful human evaluation against domain-specific knowledge to develop a meaningful AI that can address the challenges of climate change with classical earth system models.

Moreover, as the embedded impact of some of the current machine intelligence and AI systems associated with cyberspace energy mining, cloud computing, and large-scale machine learning models is just beginning to be understood, the accelerating impact of digitalization on consumption and resource extraction appears to be an increasingly troubling problem. As a result, our current trajectory of digitalization seems like a double-edged sword that may increase greenhouse gas emissions, worsening overall planetary health.⁵

Furthermore, digitalization's influence on the natural environment and social systems is substantial and may require careful public policy design in many domains.⁶ The desirable design of an accountable machine intelligence system, reflecting both direct and indirect effects on societies and planetary health, is a question of paramount importance. However, while exploiting the potential of AI tools in physics-driven modeling of earth systems for predicting climate change, Ingers et al.,⁴ emphasize the need to rely on clear, physically meaningful scientific hypotheses, the geographical determination of process-based modeling and careful human evaluation against domain-specific knowledge to develop an epistemic web of planetary health challenges for climate action.

An epistemic web of planetary health challenges for climate action
Climate action through machine intelligence must mean supporting climate mitigation and adaptation decisions at a global scale while avoiding excess emissions. However, the current generation of machine intelligence systems that drive digitalization has embedded biases and data justice issues, making them less trustworthy for transparent decision making. Thus, for effective

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Designing a virtuous cycle: Quality of governance, effective climate change mitigation, and just outcomes support each other

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ARTICLE INFO
ABSTRACT
Climate change mitigation to avoid overshoot through the use of technologies and policy instruments. However, governance and social capital are crucial factors in complex social systems and may be relevant in the formation of effective climate policies. Here, we investigate the role of quality of governance (QoG), social capital, and equity in preparations for meeting climate goals. Relying on indicators of social capital at nation state level, we investigate relationships with Sustainable Development Goals (SDG) and Environmental Progress Index (EPI). We find that quality of governance, measured as impartiality, subjective social capital and transparency and equity, are effective climate change enablers, indicated by low level of carbon pricing, impartiality and social capital are necessary conditions for climate policy. Socio-economic inequalities reduce trust and political engagement, and thus compromise the effectiveness of climate change enablers. Evidence from country-level analyses indicates that fairly implemented climate policies could foster a virtuous cycle that further increases quality of governance, and thus the capacity for implementing strong climate policies. The results demonstrate that impartial governance and resulting social capital from the underpinning of effective climate policies.

1. Introduction
Research and assessment of climate change mitigation has mostly focused on technological options and policy instruments (Creutzig et al., 2019). The drive to a higher role of social systems that is increasingly acknowledged. For example, the percentage of renewable electricity changes has been studied for years (Creutzig et al., 2011), and climate change mitigation is increasingly investigated from the perspective of the demand side and lifestyle (Creutzig et al., 2015, 2018). In addition, studies are beginning to understand the social and institutional challenges for climate change mitigation have provided valuable insights (Creutzig et al., 2013). However, the role of social systems like social capital, governance and social equity for effective climate policy remains mostly unexplored.

The Green New Deal of the European Union and the Inflation Reduction Act in the United States put new emphasis on the importance of social factors associated with climate change mitigation. The importance of such legislation argues that including QoG assessment must be more than a technical exercise, and assess that it should also address poverty, income inequality and racial discrimination. Decisions are the expansion of public funded QoG initiatives reduction in an expensive and potentially misleading add-on to decarbonization. Proposals, however, see press social policy as a strategic lever to decrease emissions while expanding the conditions for decarbonization. Indeed, systemic social mobility demonstrates that a low-carbon transition is compatible with social sustainability possible (Creutzig et al., 2023; Creutzig et al., 2018; Creutzig et al., 2013). At climate policy progress directly, and carbon pricing is kept on hold in the US at the federal level, a more comprehensive approach that also addresses equity and justice in getting non-members (Creutzig & Sauer, 2023; Sauer & Creutzig, 2013). There

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Align AI