International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

The power of Systems Analysis:

Addressing global challenges using systems analysis

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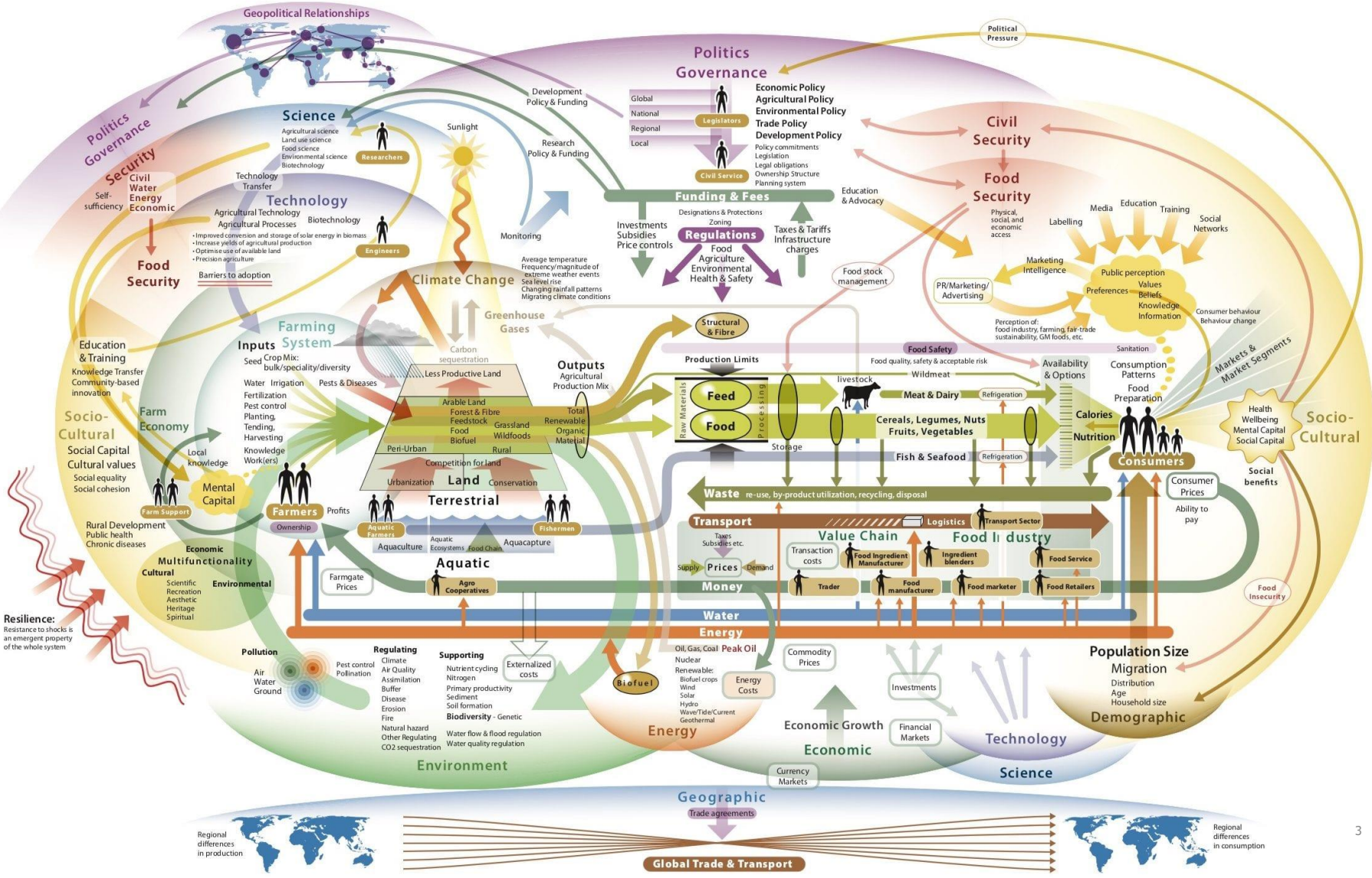
Human society: Quo vadis?

- **Wealth**
  - 71% of adults own < than $ 10 000 in wealth
- **Health**
  - life expectancy has doubled in a century – inequalities
  - one billion are obese while less go hungry
  - Acute hunger affects over 100 million (2018)
  - COVID-19 pandemic (amplified inequalities)
- **Environment**
  - 9 out of 10 people breathe air with high levels pollutants
  - 1 in 9 people use water from unsafe sources
  - 2.3 billion people lack access to a toilet
- **Happiness**
  - more die by suicide than war and violence
  - happiness inequality is on the rise

- Everyone in the world has a mobile phone but a billion people have no access to electricity
- 3 billion people suffer from land degradation, desertification and have missed out on the great acceleration

The world is complex as are the key political and scientific challenges of the day



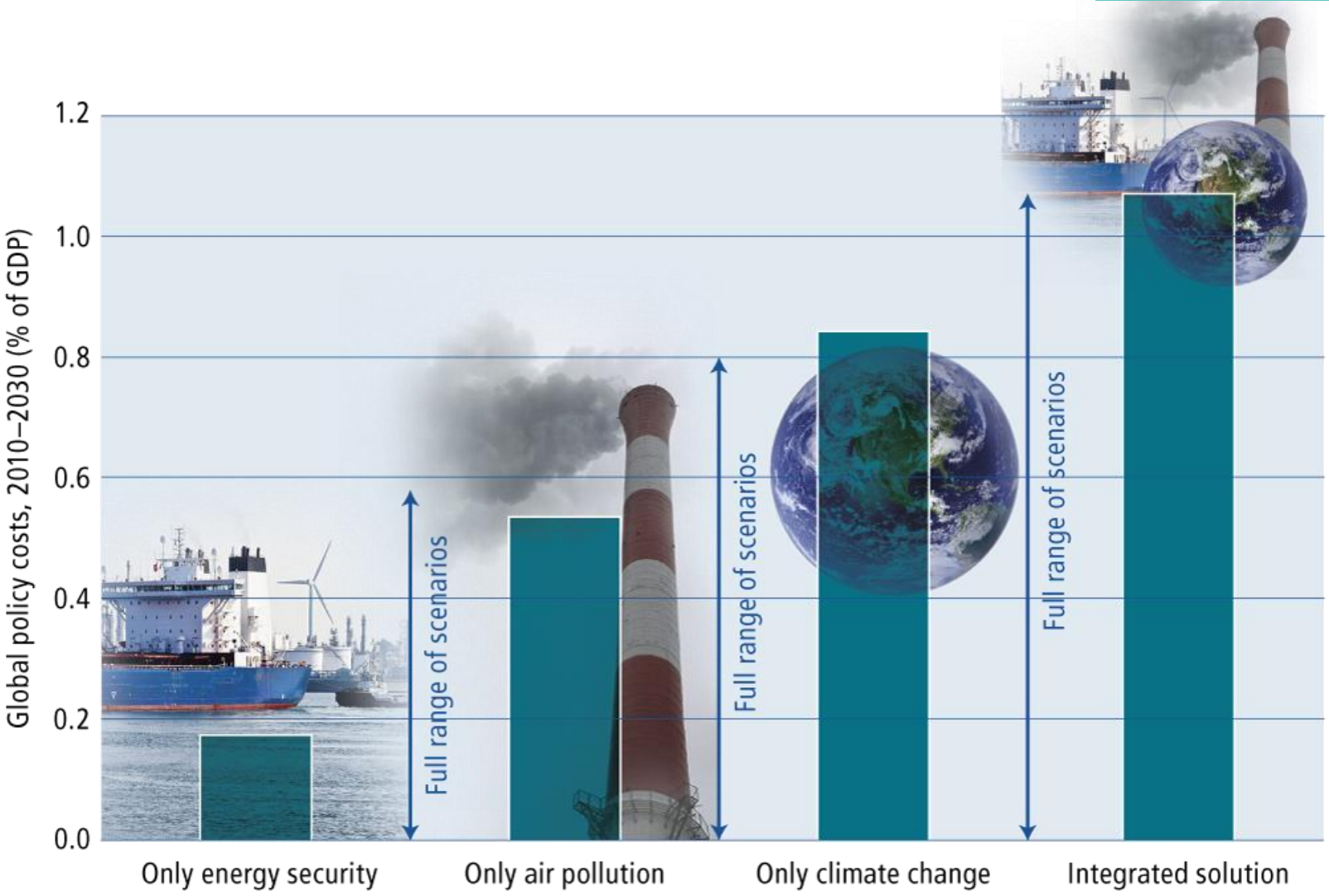
Five critical components of systems thinking

1. The notion of **externalities results from drawing narrow boundaries around a system's** economic components, **while leaving the system's environmental and social components on the outside.** It is crucial to draw system boundaries widely enough to capture the externalities as part of a sufficiently **holistic accounting of impacts (opportunity costs: potential assets viewed as costs, education, waste products)**.
2. Crucially, the various impacts occurring throughout a system may all be part of **feedback loops (positive and negative)**. Overlooking feedbacks is particularly harmful to the quality of systems analysis **(population – education - wealth, demography).**
3. When **trade-offs or synergies are not well reflected in an analysis**, either because some of their **components are left outside** the drawn **system boundaries** or because the relationships specifying the **trade-offs or synergies are poorly quantified**, major errors in predictions are inevitable **(ignoring biodiversity consequences in biofuel production forecasts).**
4. The dynamics of complex systems often leads to **emergent phenomena**. In particular, since beliefs, psychology, norms, and culture profoundly affect real-world systems, often through such **emergences**, **the human and social dimensions** of systems thinking are of fundamental importance, including for institutions and governance **(new social movements, lake eutrophication and other system tipping points etc).**
5. When a policy challenge involves many **stakeholder groups**, the **inclusive framing** of solutions, or of processes suitable for collectively identifying them, is essential for the **subsequent policy acceptance (transdisciplinarity - gaming approaches)**.

Source: Dieckmann, U. , Hager, G., Magnuszewski, P., & Lees, M. (2020). Human Capabilities for Systems Leadership: Disseminating Systems Thinking through Education and Training. In: Systemic Thinking for Policy Making: The Potential of Systems Analysis for Addressing Global Policy Challenges in the 21st Century. pp. 153-166 Paris, France: New Approaches to Economic Challenges, OECD Publishing. ISBN 978-92-64-49456-510.1787/879c4f7a-en.

Multiple benefits of integrated policies

Holistic accounting of impacts



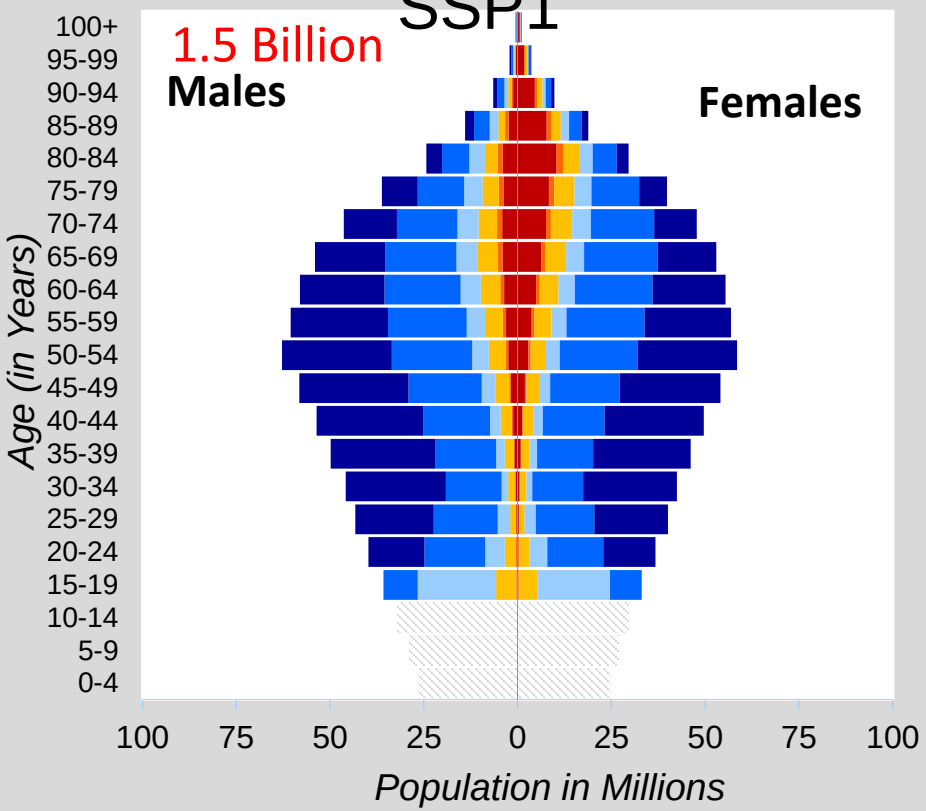
Source: McCollum, Krey, Riahi, 2012

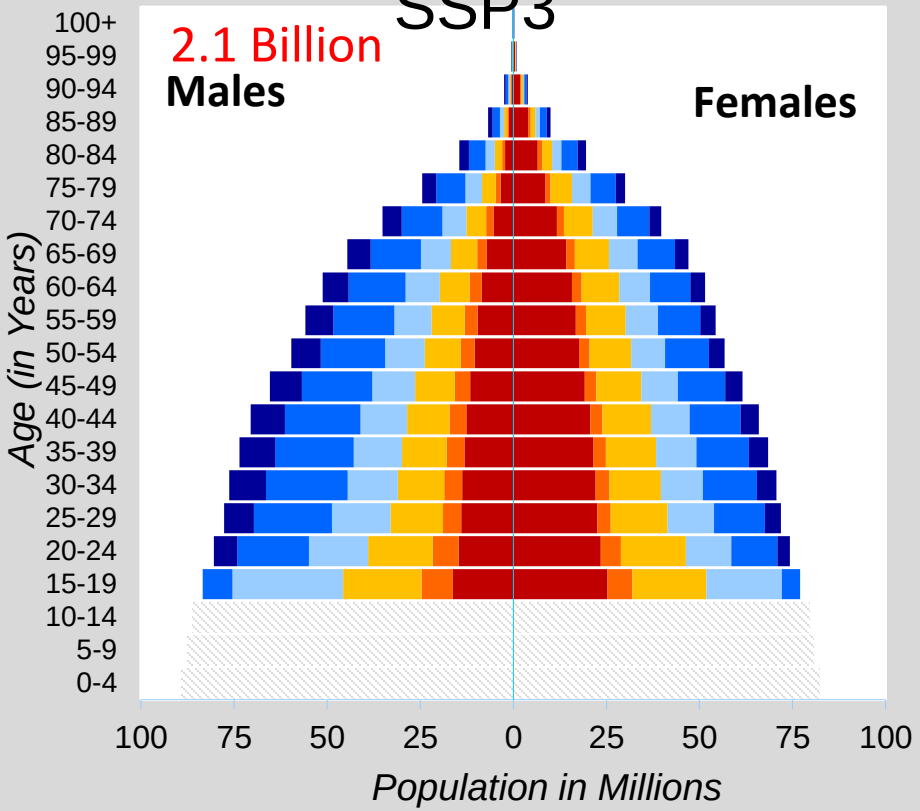
Impact of Education on Population

SUSTAINABLE DEVELOPMENT

STAL

Positive feedback loops (virtuous cycle)



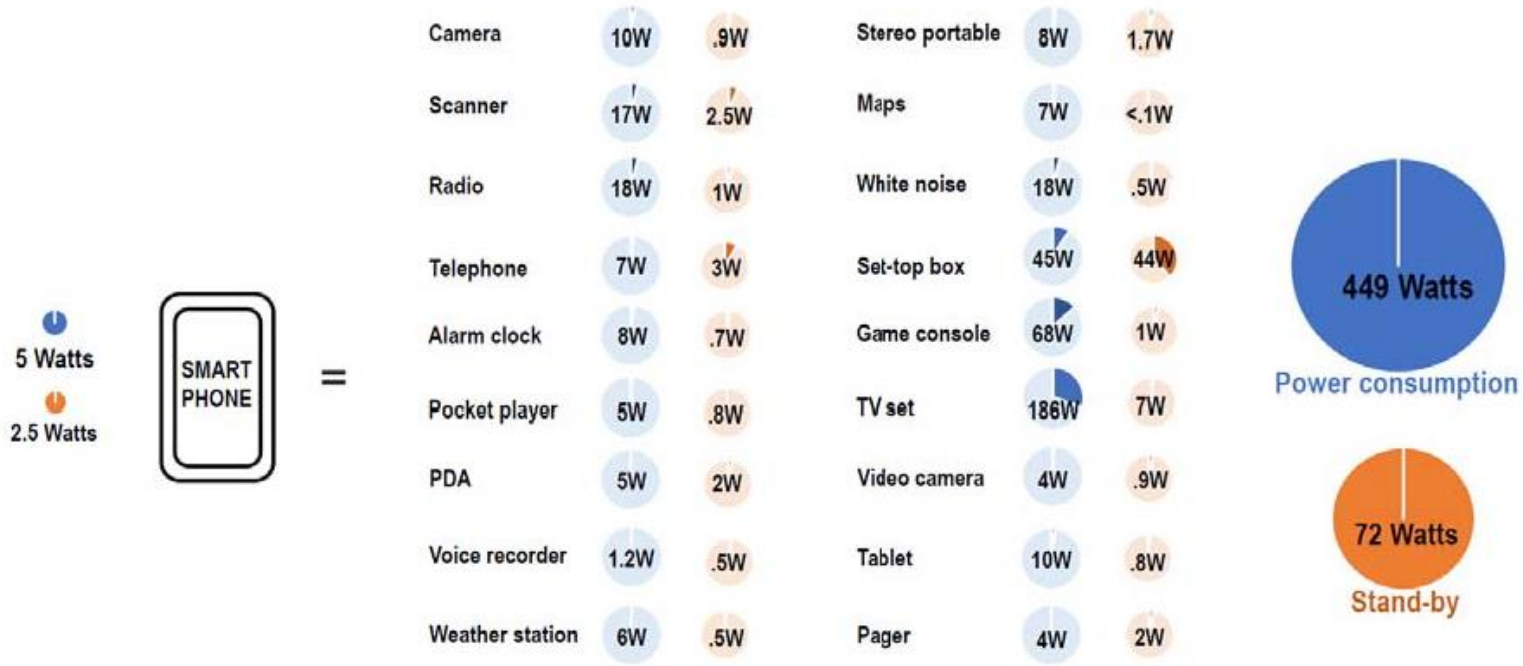


Pop < 15 yrs | No Education | Incomp. Primary | Primary | Lower Secondary | Upper Secondary | Post Secondary

Research made the case for making education a sustainable policy priority, subsequently SDG4 aims that all boys and girls receive primary and secondary education by 2030. In 2017, the German Federal Ministry for Development announced it will spend 25 percent of its entire funding on education.

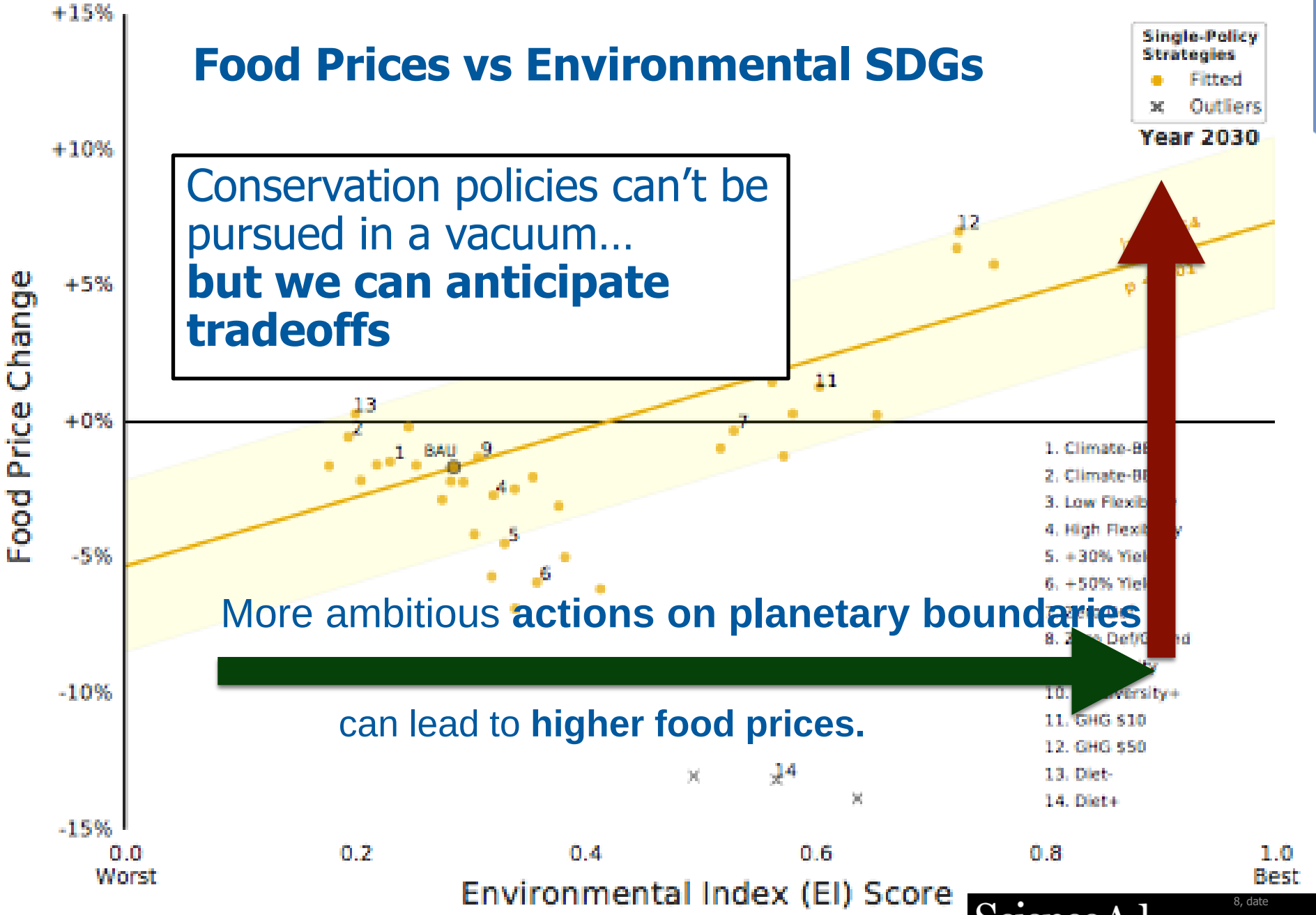
Global warming can be limited to 1.5°C by transforming how we move around, heat our homes, and use devices (supply and demand management)

Example of Reduced Energy Demand through Digitalisation and Device Convergence.



Source: Grubler A, Wilson C, Bento N, Boza-Kiss B, Krey V, McCollum D, Rao ND, Riahi K, et al (2018). "A Low Energy Demand Scenario for Meeting the 1.5°C Target and Sustainable Development Goals without Negative Emission Technologies." Nature Energy.

Food Prices vs Environmental SDGs



Conservation policies can't be pursued in a vacuum…
but we can anticipate tradeoffs

More ambitious **actions on planetary boundaries**

can lead to **higher food prices.**

Science Advances

Bouncing forward sustainably: Pathways to a post-COVID world

8 key recommendations WITH THE POTENTIAL FOR SYSTEMIC TRANSFORMATION (new recovery options emerged):

1. Strengthen knowledge base on, and preparedness for, compound and systemic risks
2. Repurpose and redesign global institutions for the complexities of the 21st century
3. Advance toward smart, evidence-based, adaptive, good governance arrangements at all levels
4. Partnerships key to sustainability solutions
5. Create a pervasive, sustainable knowledge society
6. Reset economic infrastructure and development for sustainability
7. "Sustainable and resilient" have to be the new "mantra" for development
8. Harness the new consciousness in society

Food, **A**griculture, **B**iodiversity, **L**and, **E**nergy (FABLE – SDSN-IIASA)

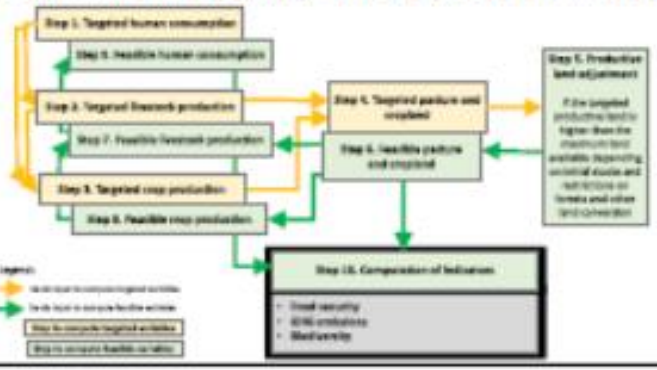
Transdisciplinarity:
Co-design, co-production and co-implementation

1. National data

Collect and harmonize national data on consumption patterns, land use, biophysical characteristics, biodiversity, population, etc.

2. National pathways

Compute the evolution of key variables of the land-use and food system by mid-century using appropriate models



4. Linker tool

Aggregates country results at the global level

5. Scenathon

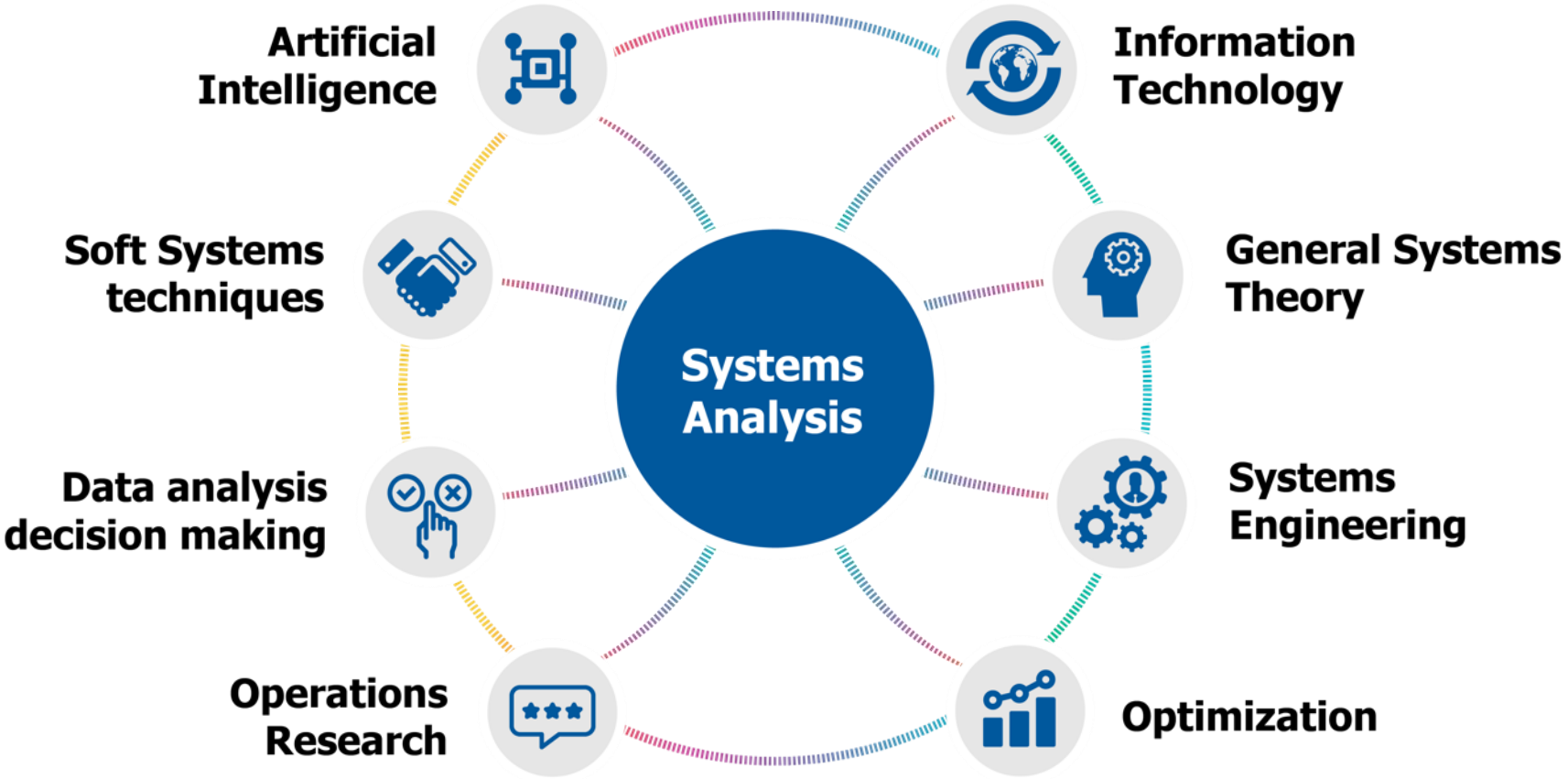
Iterative adjustment of country pathways to align ambition with global targets and balance trade flows

Share data, tools and results

3. Verification tool

Compares models parameters' values and results with relevant benchmarks

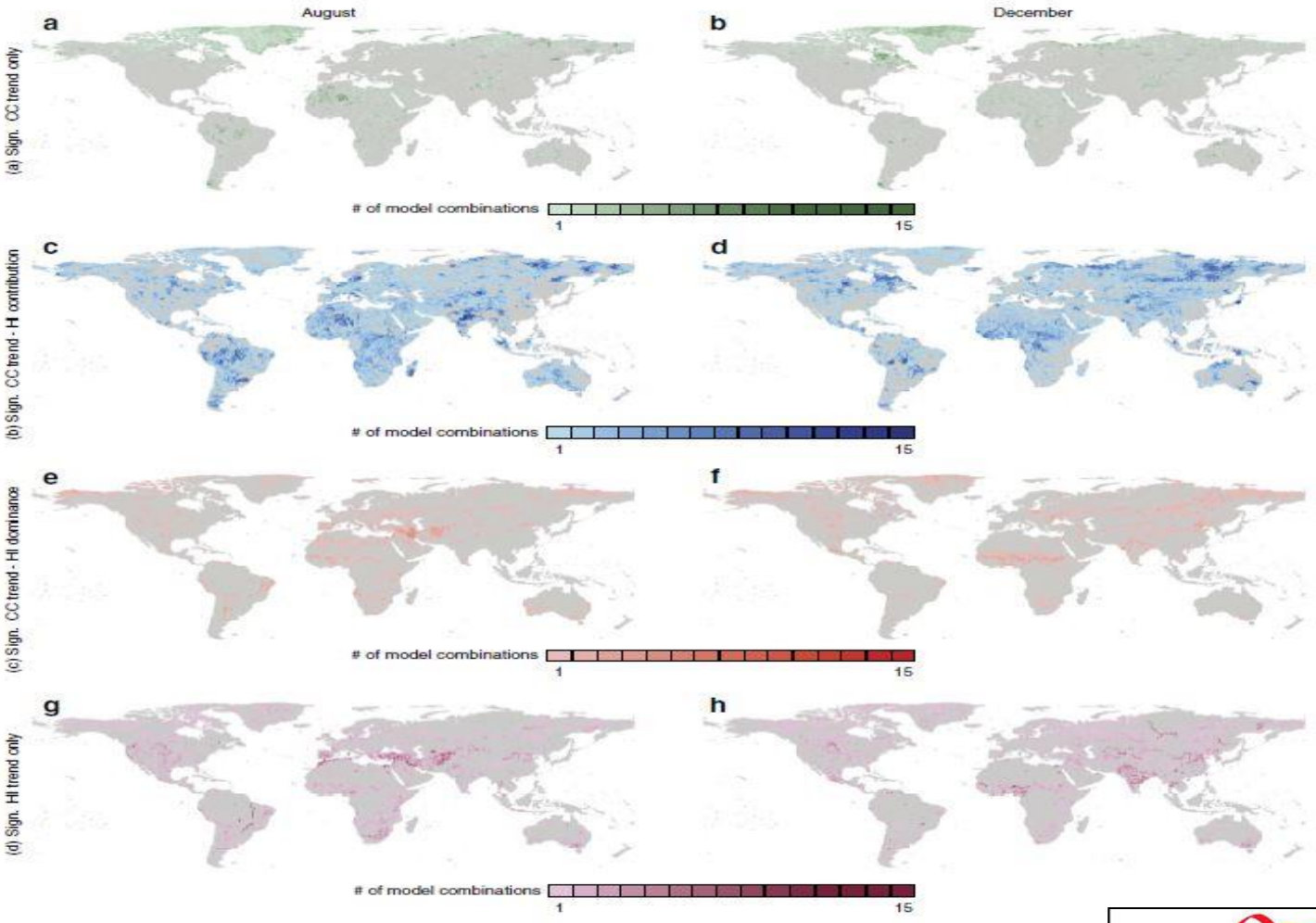
Systems Analysis: Tools of the trade



Water management interventions push scarcity downstream

International systems analysis

IIASA

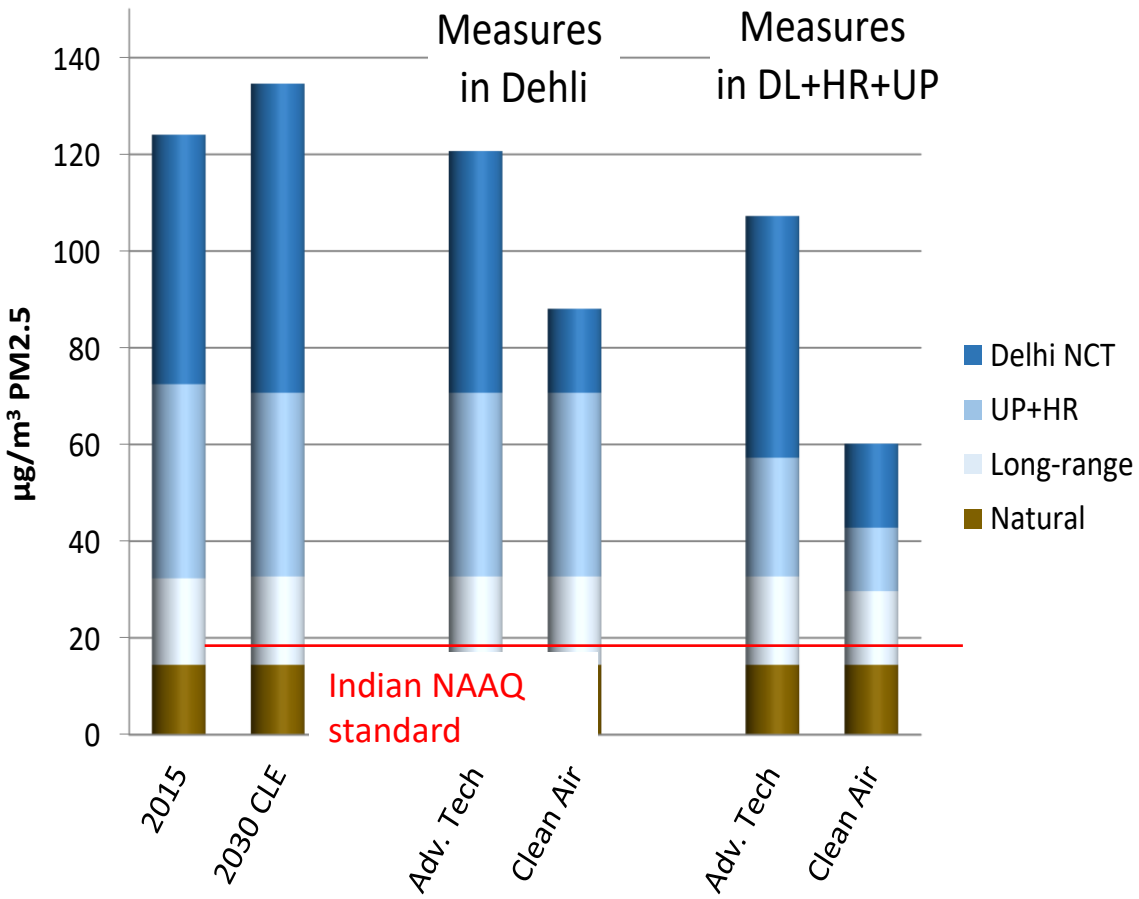


Veldkamp TIE, Wada Y, Aerts JCJH, Döll P, Sosling SN, Liu J, Masaki Y, Oki T, Ostberg S, Pokhrel Y, Satoh Y, Kim H, Ward PJ (2017). Water scarcity hotspots travel downstream due to human interventions in the 20th and 21st century.

Nature Communications, [doi: 10.1038/ncomms15697]

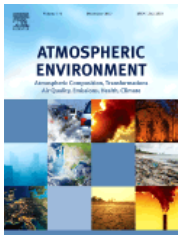
nature COMMUNICATIONS

Tackling air pollution in Delhi



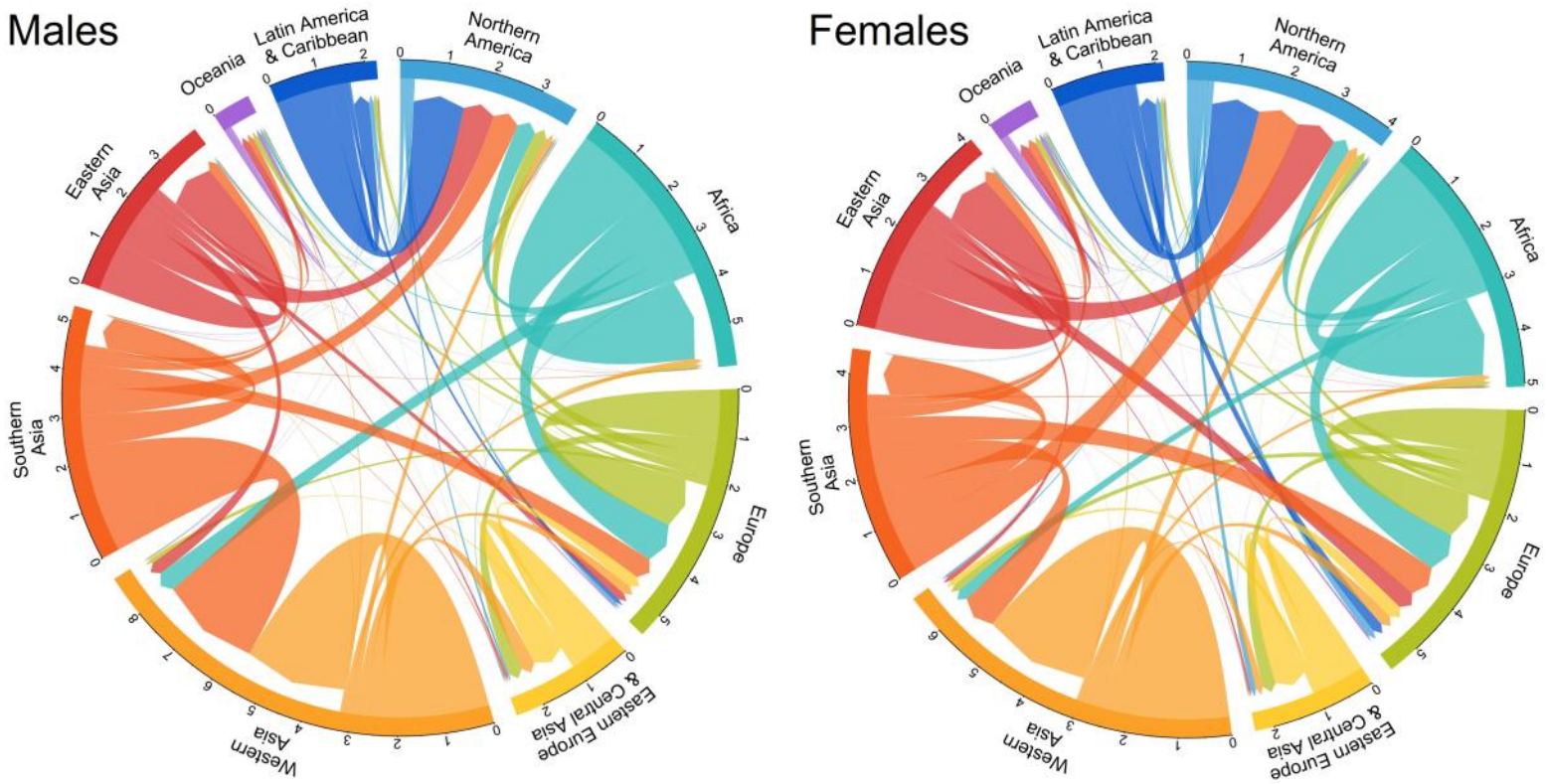
KEY FINDINGS INCLUDE:

- Effective improvement of Delhi's air quality requires collaboration with neighboring States and countries
- Effective policy interventions must involve sources that are less relevant in industrialized countries (e.g. road paving, clean cooking waste management)
- Co-benefits include: saving premature deaths in neighboring states, reduce GHG emissions, reduce water stress, improve waste management
- GAINS Delhi tool available online



Amann M, Purohit P, Bhanarkar AD, Bertok I, Borken-Kleefeld J, Cofala J, Heyes C, Kiesewetter G, et al. (2017). Managing future air quality in megacities: A case study for Delhi. Atmospheric Environment 161: 99-111. DOI:10.1016/j.atmosenv.2017.04.041.

Estimated global migration flows by gender 2010-15 (~0.65% of population since 1960's - pull and push factors)



Source: Lutz L, Goujon A, Samir KC, Stonawski M, Stilianakis N eds. (2018) Demographic and human capital scenarios for the 21st century. Luxembourg: Publications Office of the European Union

Knowledge Centre for Migration and Demography

JRC EUROPEAN COMMISSION

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Nexus research on water, energy and land: Zambezi river basin case study

Successful systems analysis goes mainstream

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Zambezi Challenges

Water-Land

- Low agricultural productivity addressed mainly through irrigation development
- Water quality deterioration linked to urbanization and mining

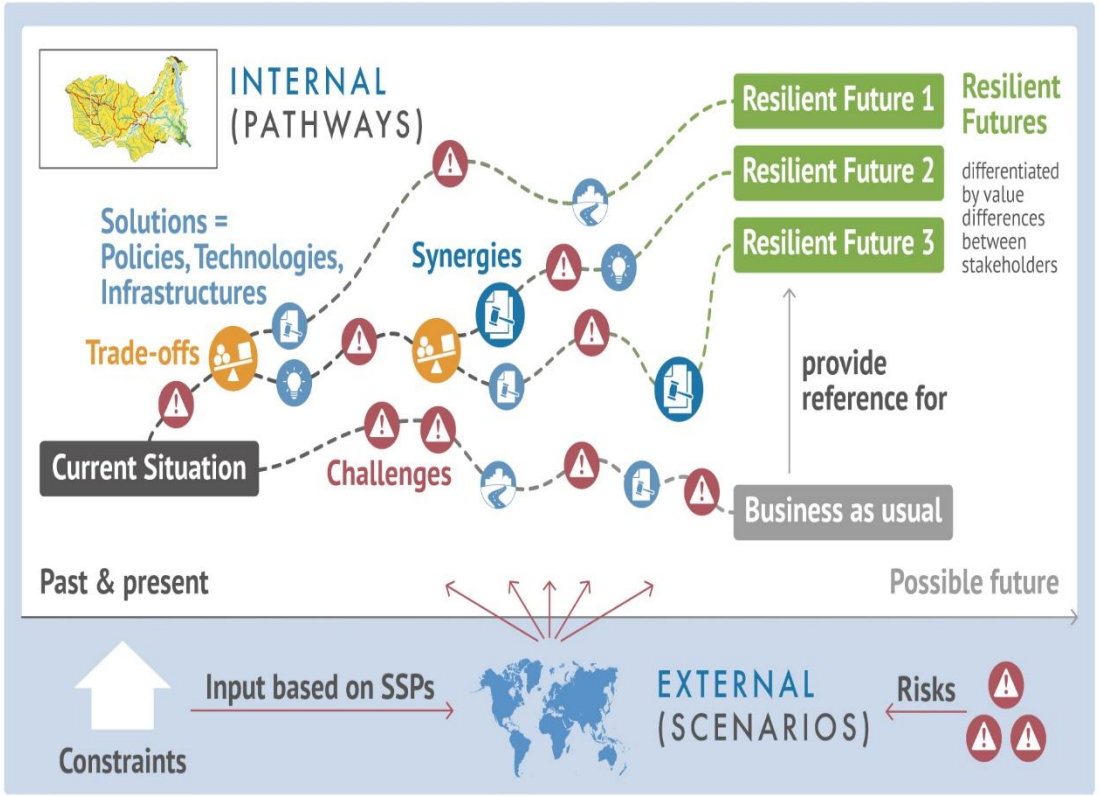
Energy-land

- High deforestation rates linked to use of charcoal
- Soil erosion is causing sedimentation and affecting hydropower potential

Water-energy

- Energy deficit addressed through the development of new hydropower without consideration of CC impacts
- Hydropower development threatening wetlands and safari tourism

Integrating disciplines, temporal and spatial scales



14 local stakeholders along Zambezi river basin and 3 funders (IIASA plus:

gef GLOBAL ENVIRONMENT FACILITY INVESTING IN OUR PLANET

UNIDO

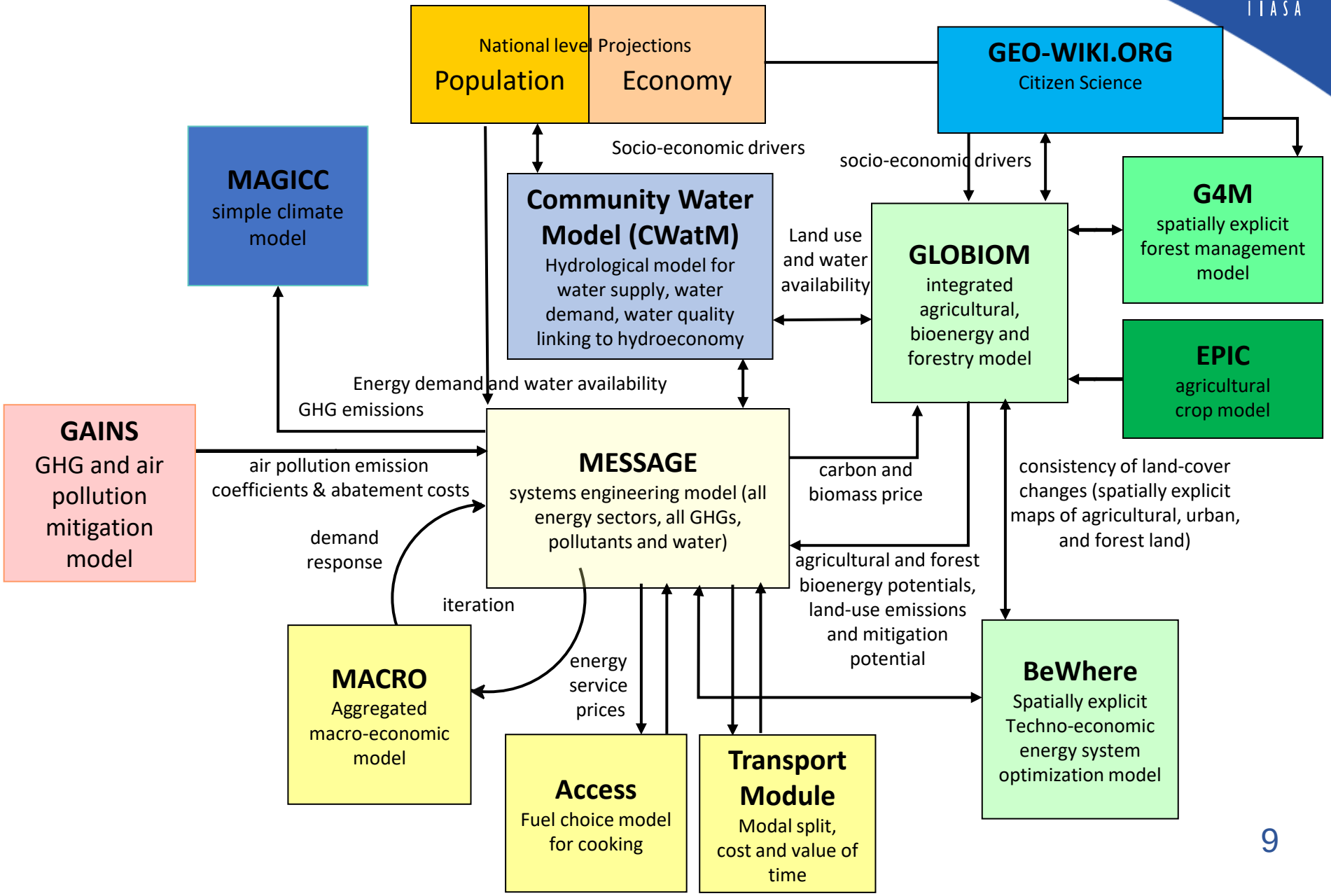
15

Successful systems analysis goes mainstream

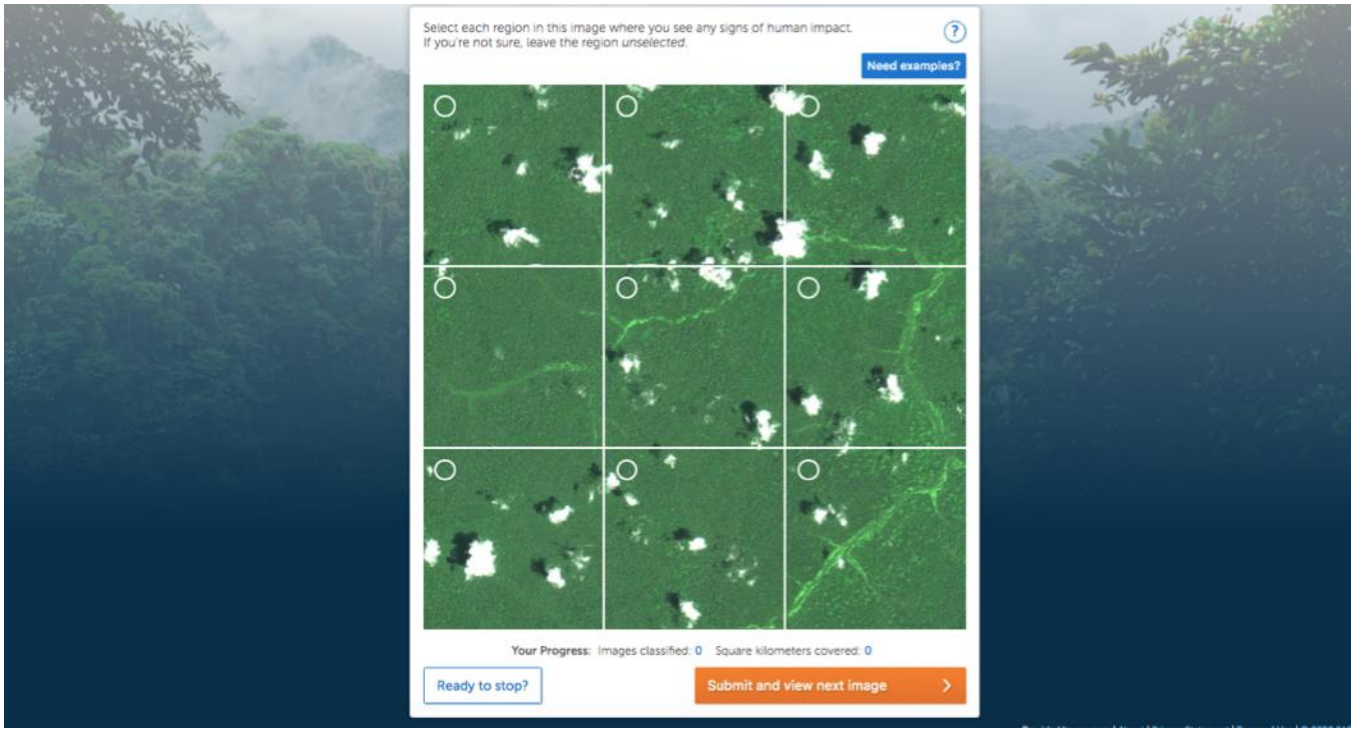
Systemic risk

To **inform national and international macroprudential policies**, IIASA studied systemic risk emerging from financial interconnections. A **"systemic risk tax"** was suggested **to reduce systemic risk by restructuring financial networks**. Furthermore, the most comprehensive assessment to date of systemic importance of nearly all firms (financial and non-financial) in a national economy was conducted for Austria.

IIASA Integrated Assessment Framework



SAS and IIASA: Crowd-driven training of artificial intelligence to help track deforestation (near real-time)



Combines the power of IIASA's environmental science research platforms, SAS' artificial intelligence (AI) and computer vision technologies, and the sheer intellectual power of concerned citizens, to develop AI models that will exponentially increase the value of human insights and strive to deliver near real-time assessment of global environmental change.

Systems science for transformations to sustainability: IIASA Research Strategy (2021-2030)

What's New?

- **Seven new interlinked research themes** and six new programs
- Brand new research foci include: **Just Societies, New Economic Frontiers. Biodiversity, Machine learning and AI**
- **Large-scale interdisciplinary research projects** collectively agreed by **NMOs and IIASA**
- **Increased capacity development** opportunities in systems analysis for NMOs (including increased open access to data and models)
- Growth in **IIASA as a facilitator for science diplomacy**

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