

How computational methods can support food chain safety decision making?

Ákos JÓZWIAK, NÉBIH

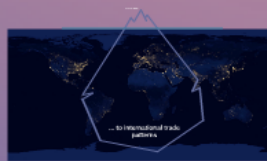


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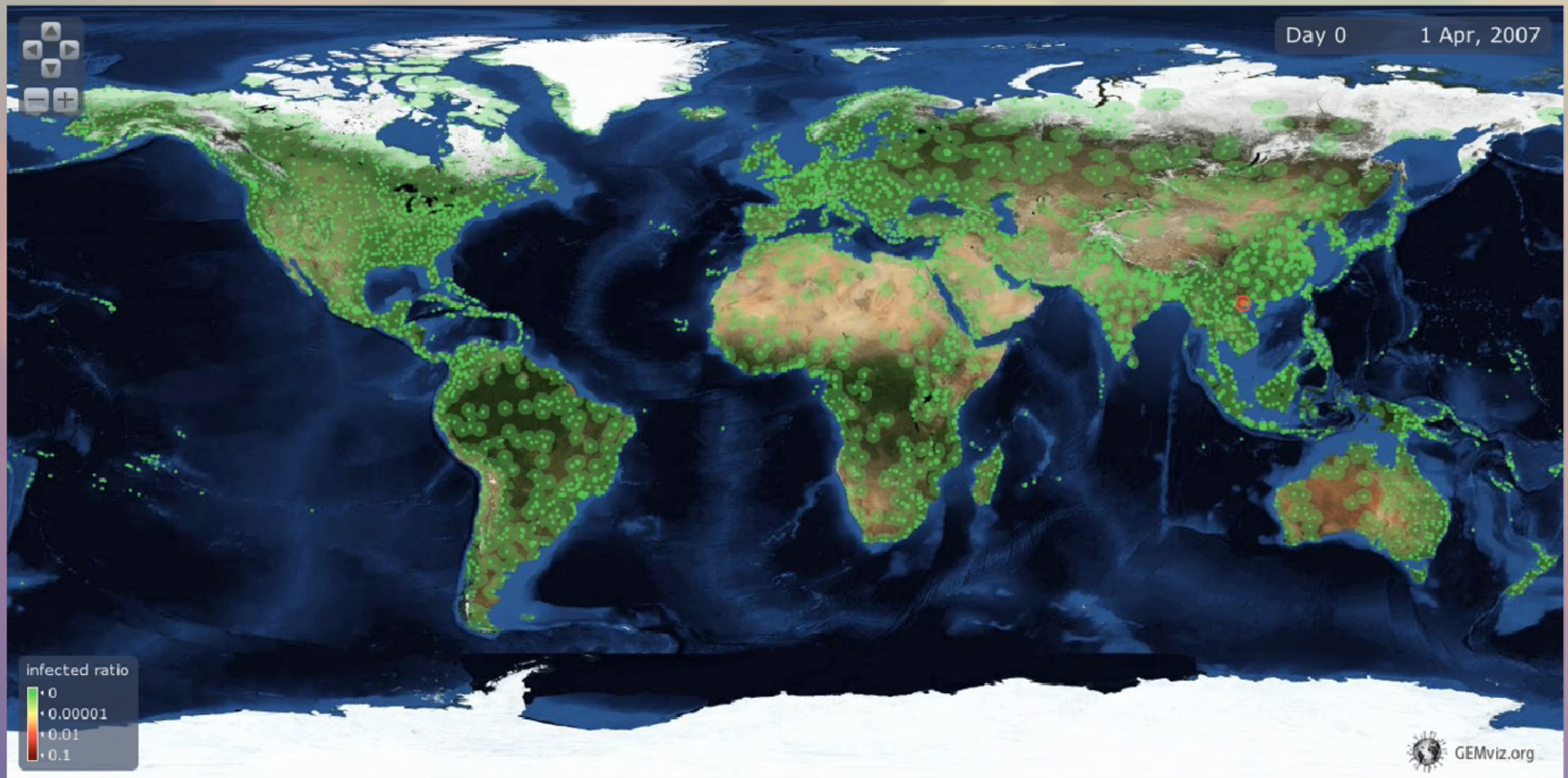
Many orders of magnitude



Data Science & Computational tools

Complex drivers

Food chain is actually complex network



gleamviz.org

Many orders of magnitude



S. Keola, M. Andersson and O. Hall: "Monitoring development from space: Using night-time light and land cover data as proxies of economic growth"
(via <http://www.economist.com/blogs/banyan/2013/09/measuring-local-economies>)

From nano particles...



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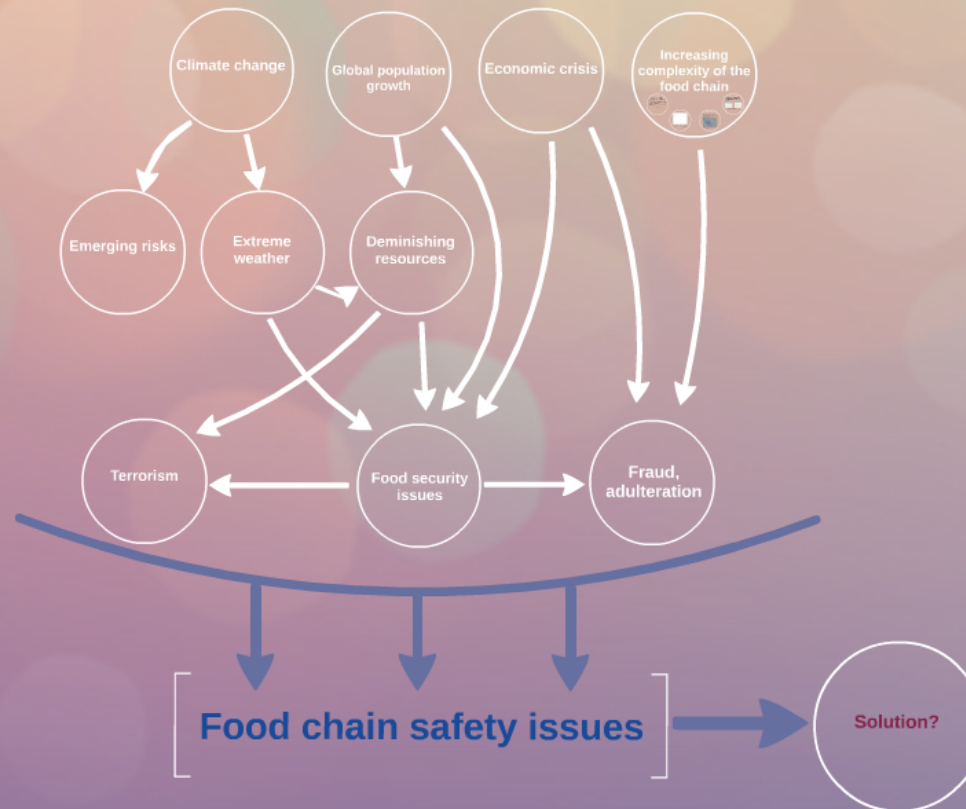
**... to international trade
patterns**

Many orders of magnitude

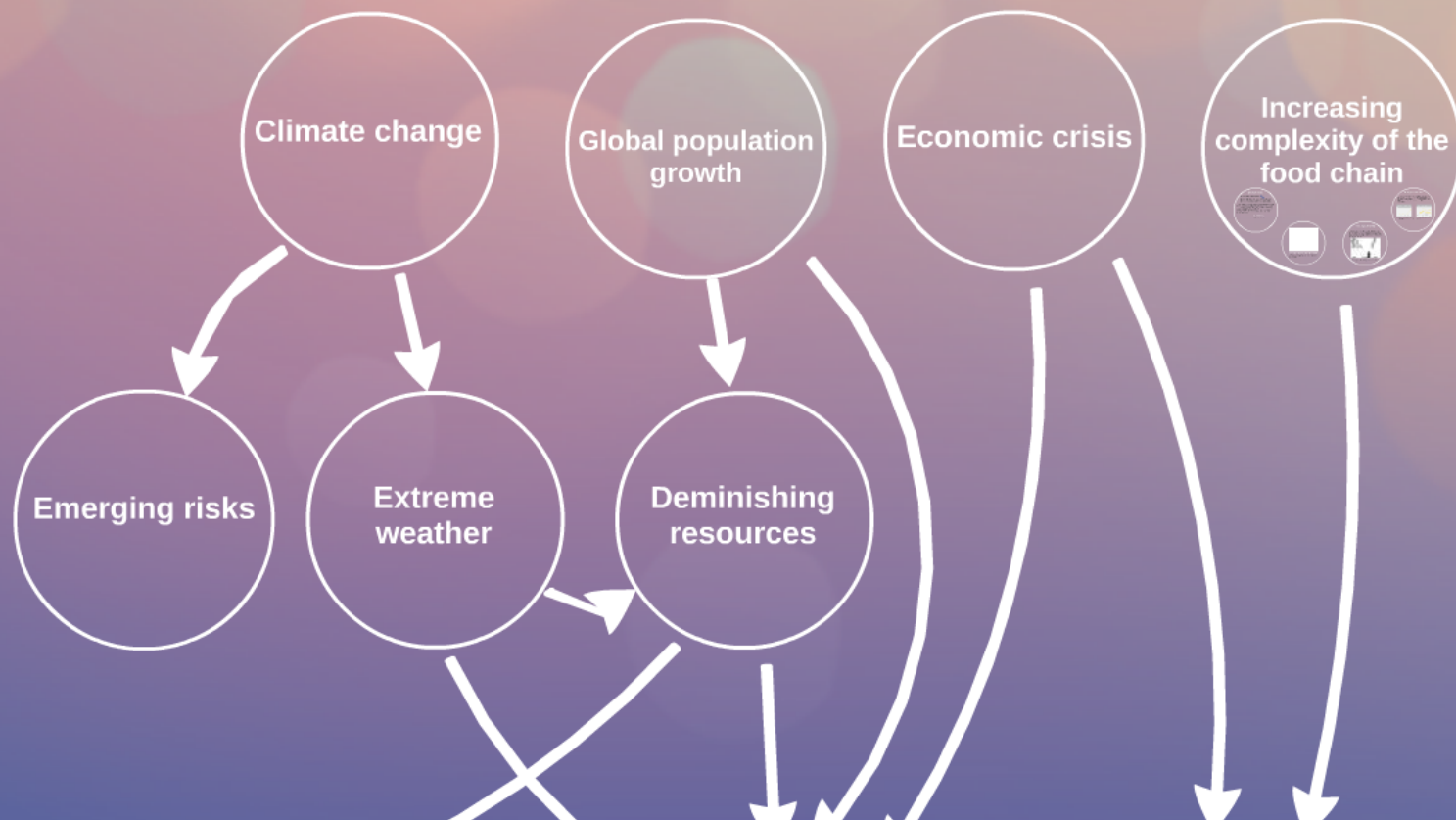


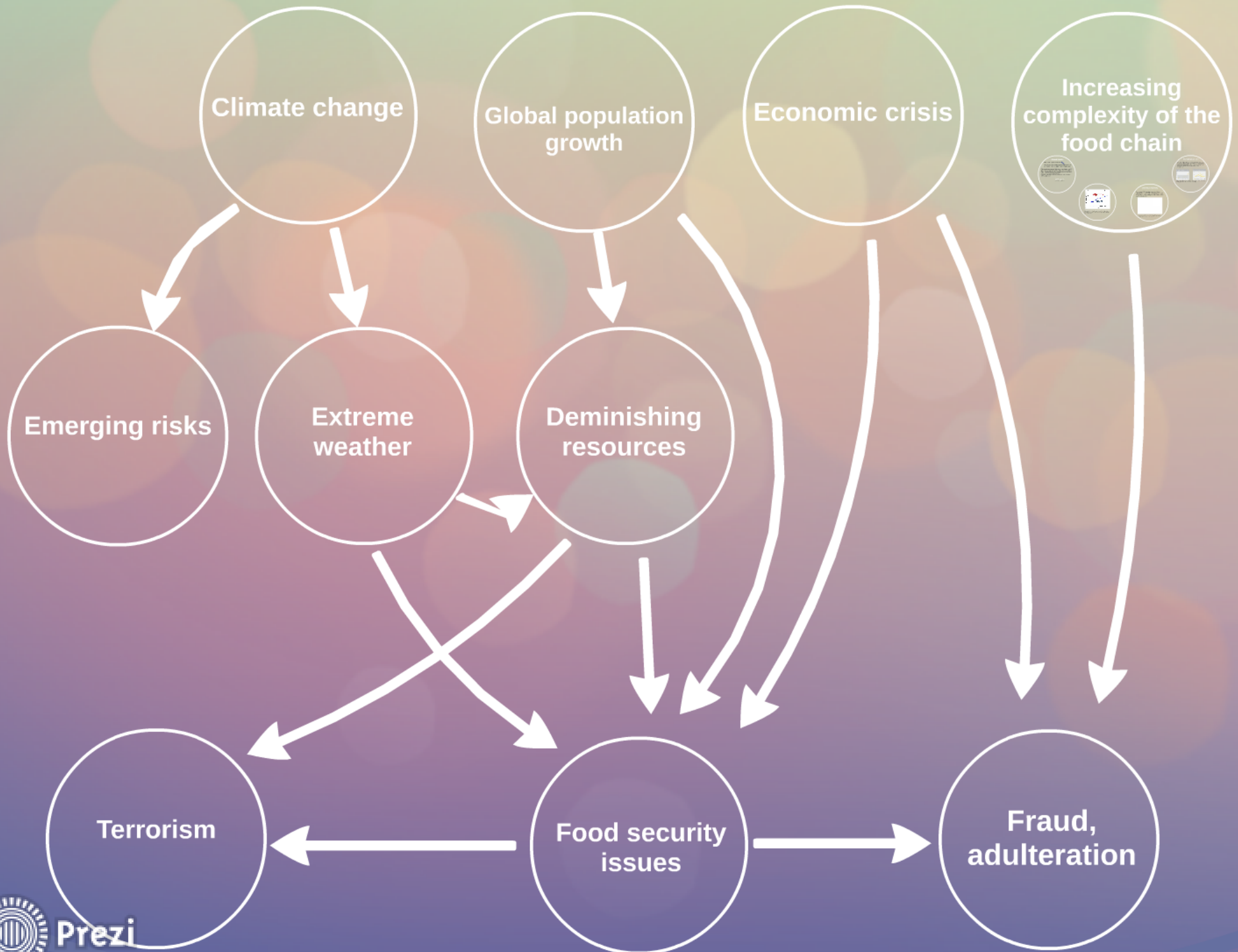
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Complex drivers



Complex drivers





Increasing complexity of the food chain

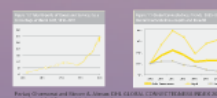
Global trends

- 2050: 9.3 billion people expected
- International trade in food and feed is expected to rise significantly in order to nourish the global population
- The global economy up to 2010 was constantly growing (3.2% per year on average during the period between 2000-2010).
- This trend changed due to the economic crisis and it is very difficult to make any predictions now.
- However, it is clear that developing countries are facing a further expansion.



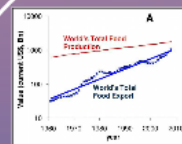
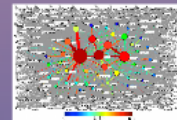
How global we are?

The current globalization is far from finished, actually this process is only the beginning and the world we know is more local than global. In our personal relations and business connections are restricted in our direct environment.



Growing complexity

7 countries (5 EU member states, the USA and China) form the core of the international agri-food trade network, each trading with over 77% of all the countries in the world.



The world's food trade system faces three risks: the food production, the food distribution, and the food consumption. The food production risk is the most significant, as it is the most difficult to manage.

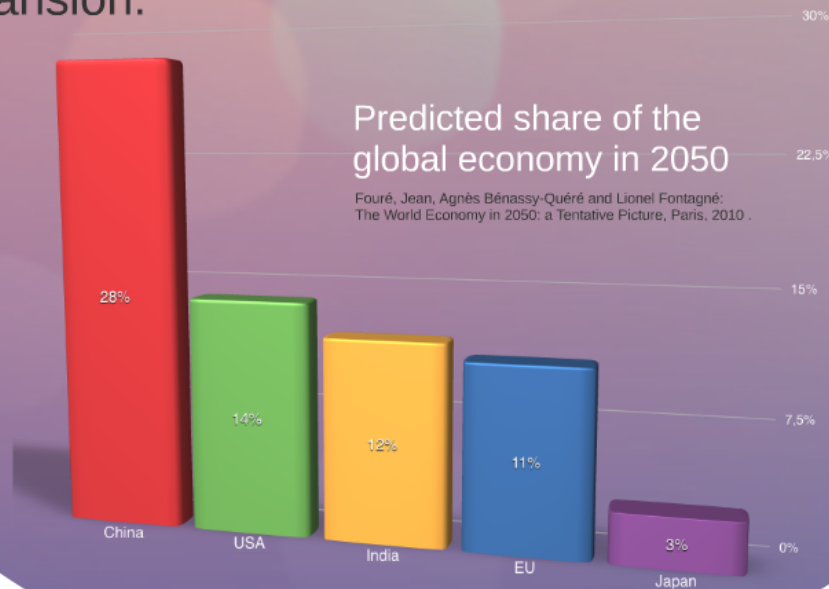
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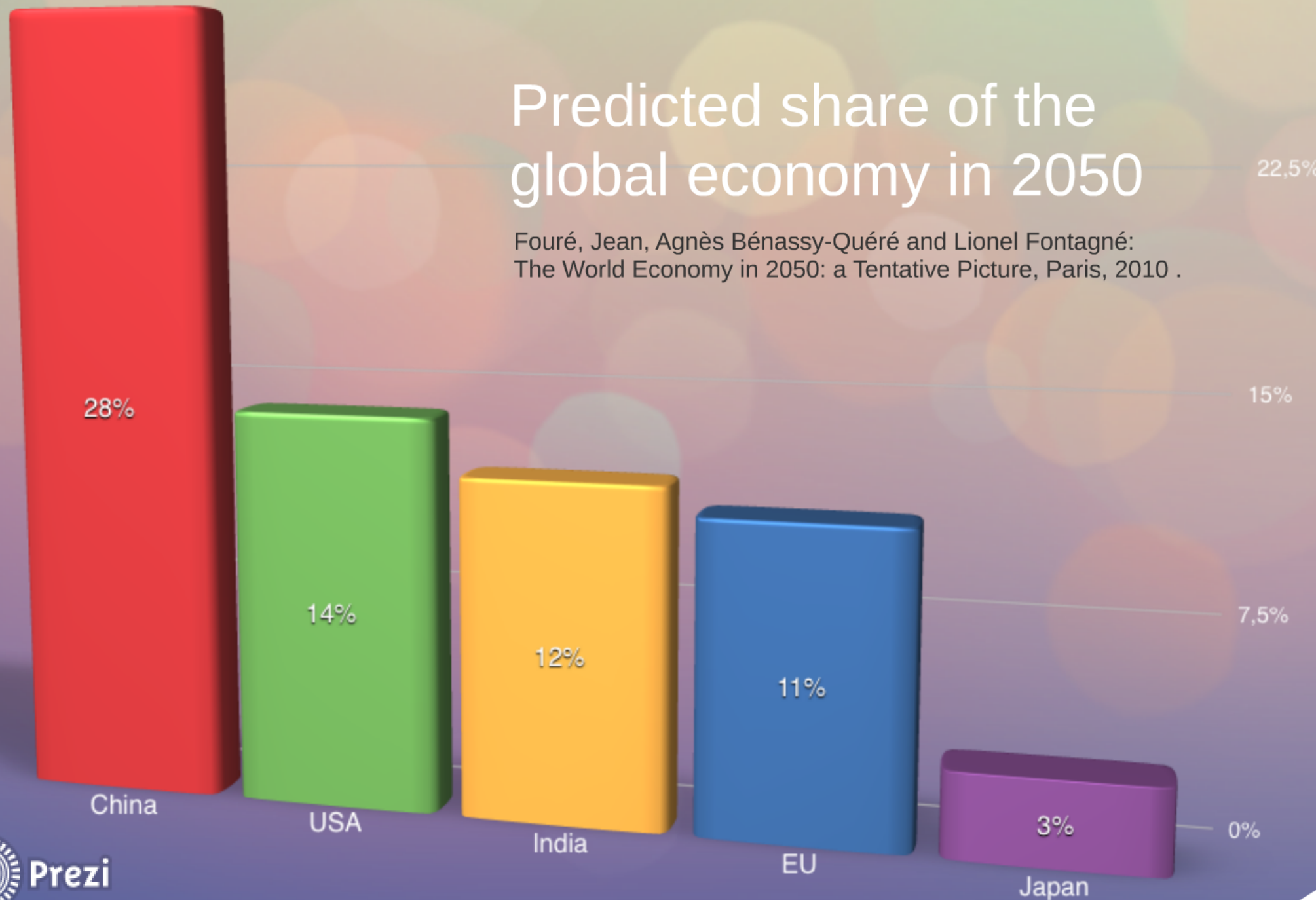
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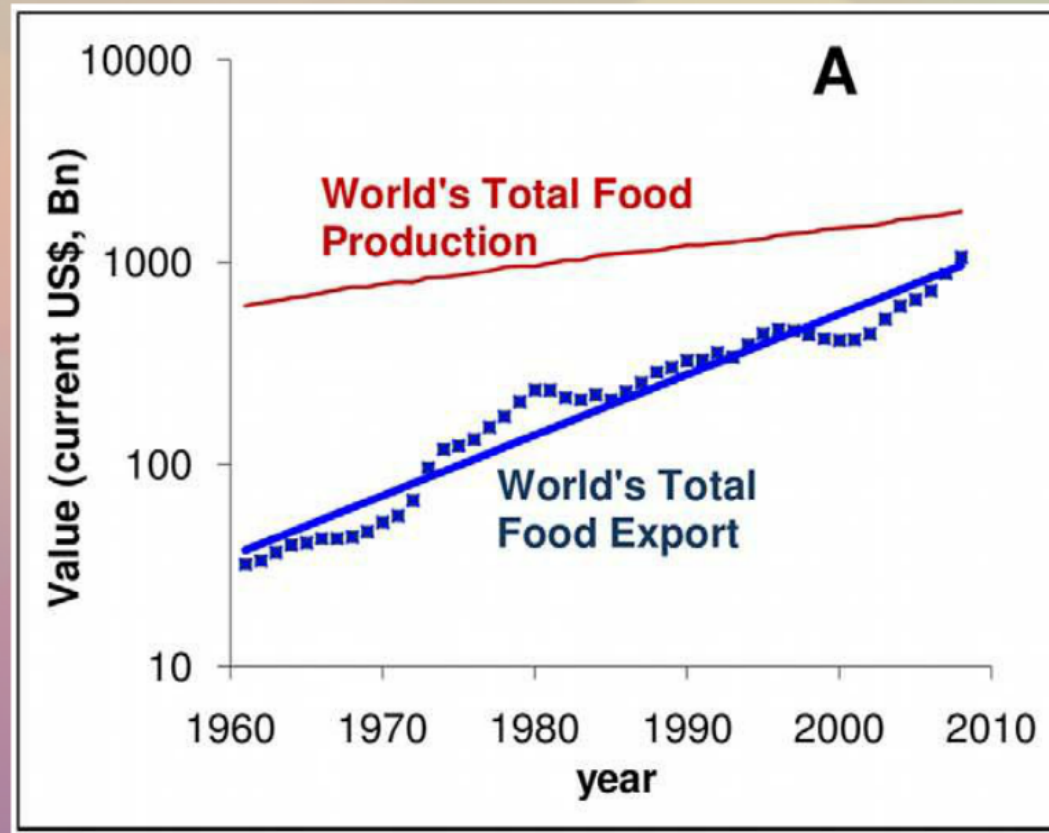


ension.

Predicted share of the global economy in 2050

Fouré, Jean, Agnès Bénassy-Quéré and Lionel Fontagné:
The World Economy in 2050: a Tentative Picture, Paris, 2010 .



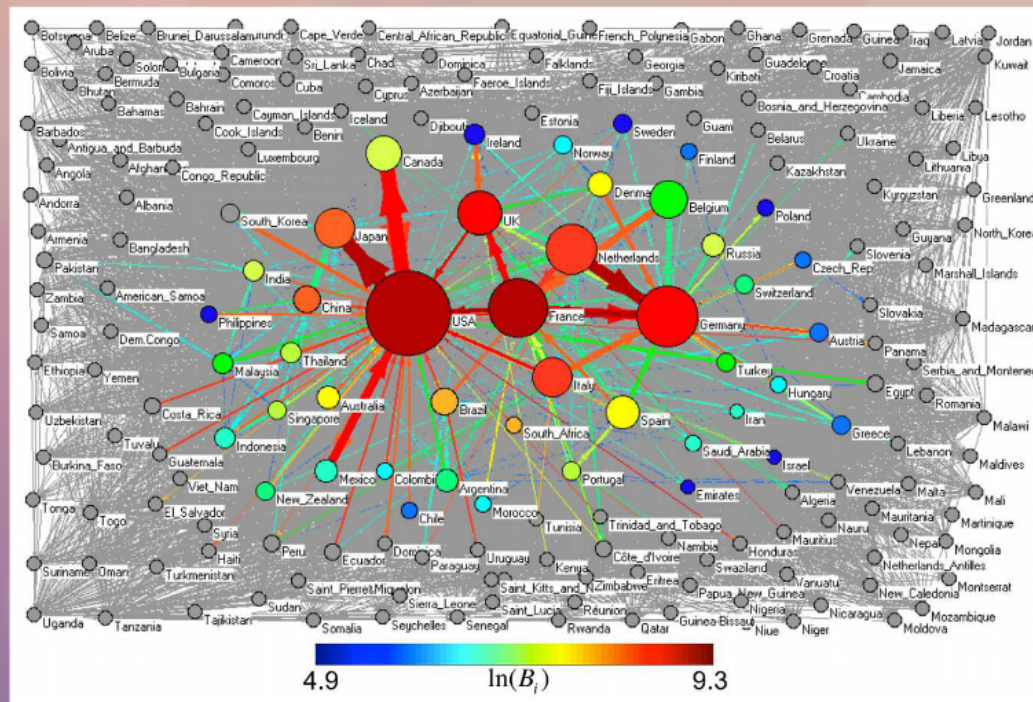


The world's food trade grows faster than the food production

Ercsey-Ravasz, M., Toroczkai, Z., Lakner, Z. & Baranyi, J. Complexity of the International Agro-Food Trade Network and Its Impact on Food Safety. PLoS ONE 7, e37810 (2012)

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The sensed globalization is far from finished, actually this process is only the beginning and **the world we know is more local than global**: both our personal relations and business connections are realised in our direct environment.

Figure 1.2 Total Exports of Goods and Services As a Percentage of World GDP, 1810–2011

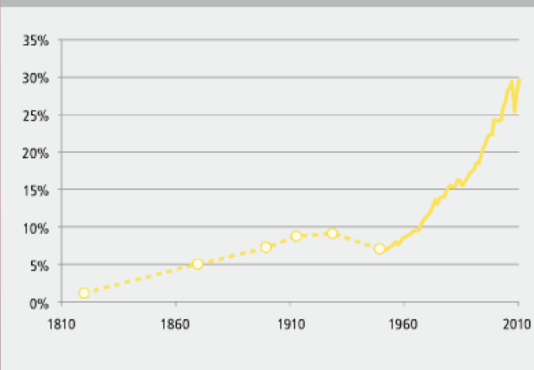
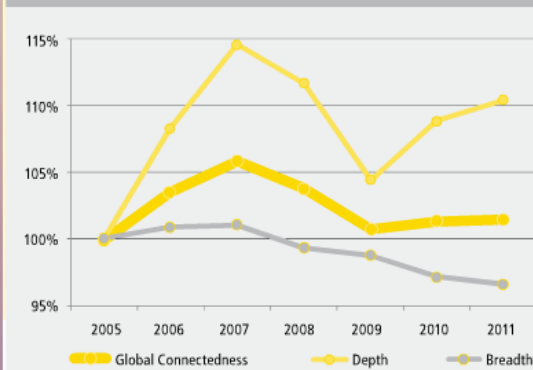


Figure 1.1 Global Connectedness Trends, 2005–2011 Overall Connectedness Depth and Breadth



Pankaj Ghemawat and Steven A. Altman: DHL GLOBAL CONNECTEDNESS INDEX 2012. Analyzing global flows and their power to increase prosperity

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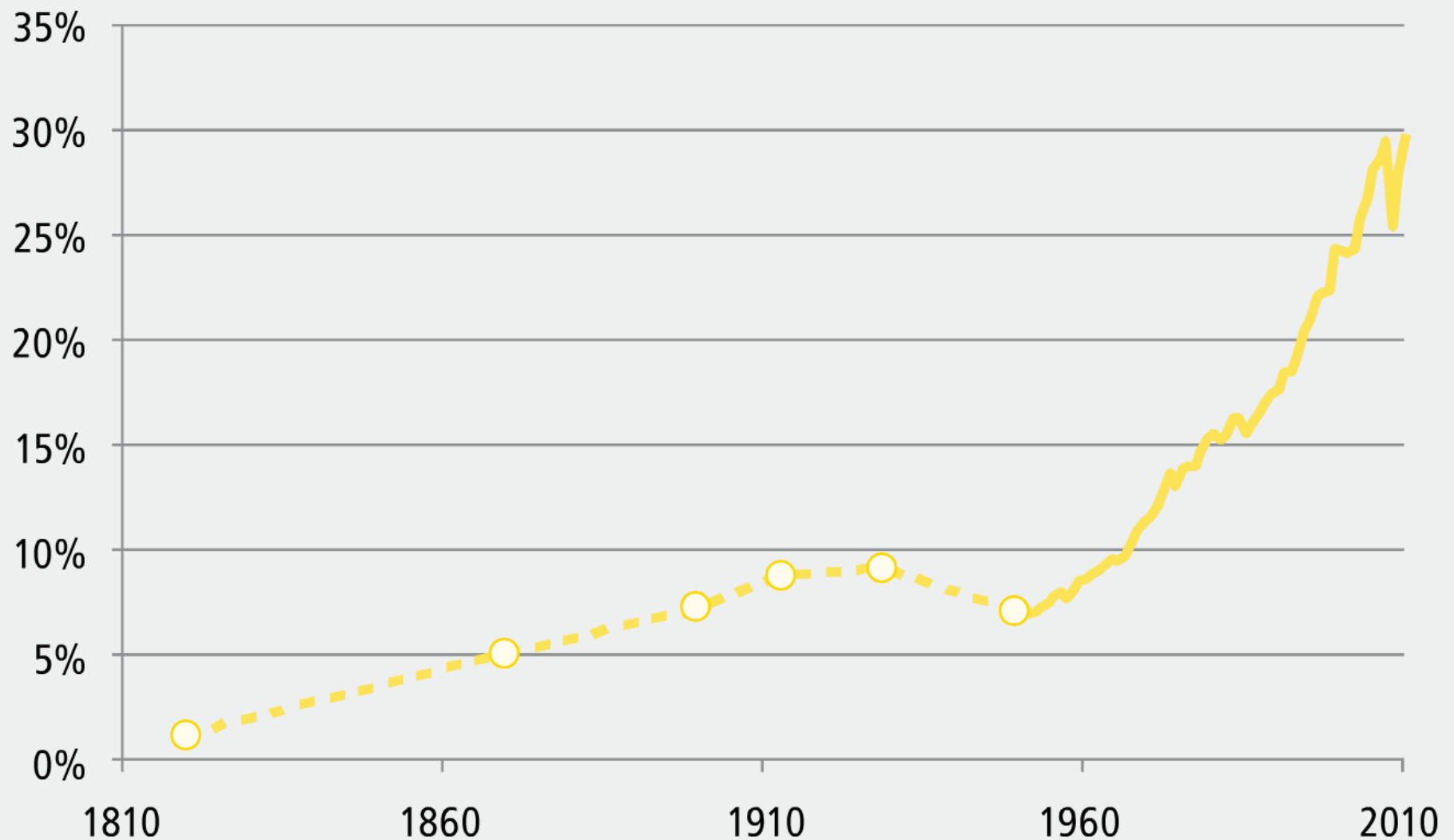
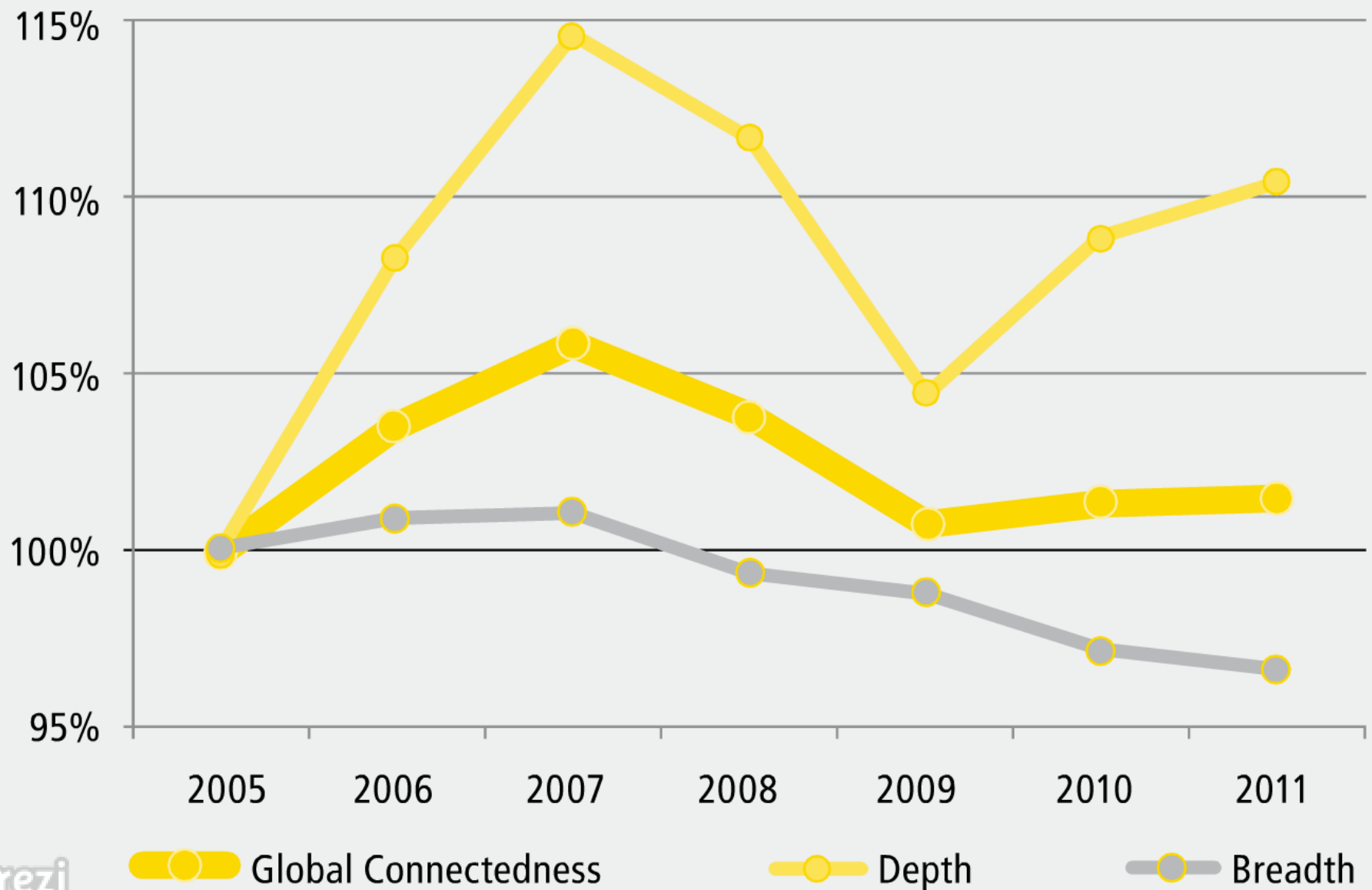


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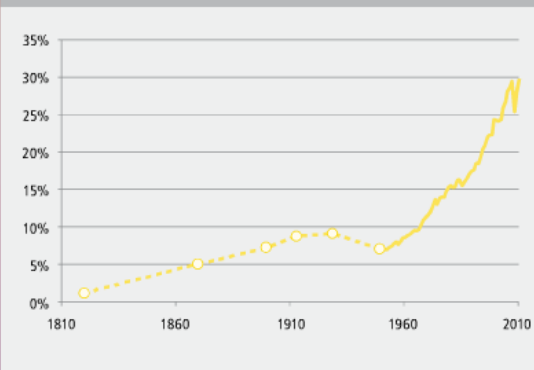
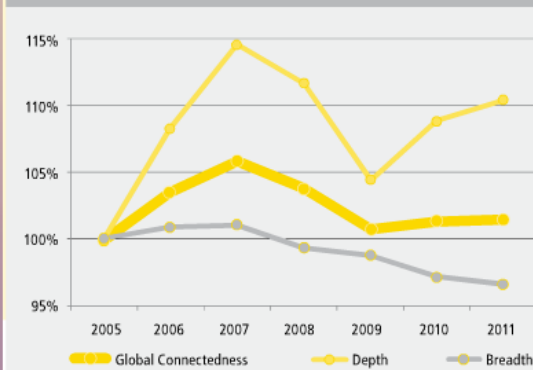


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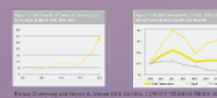
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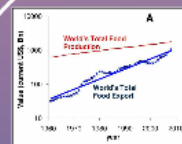
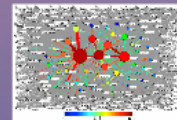
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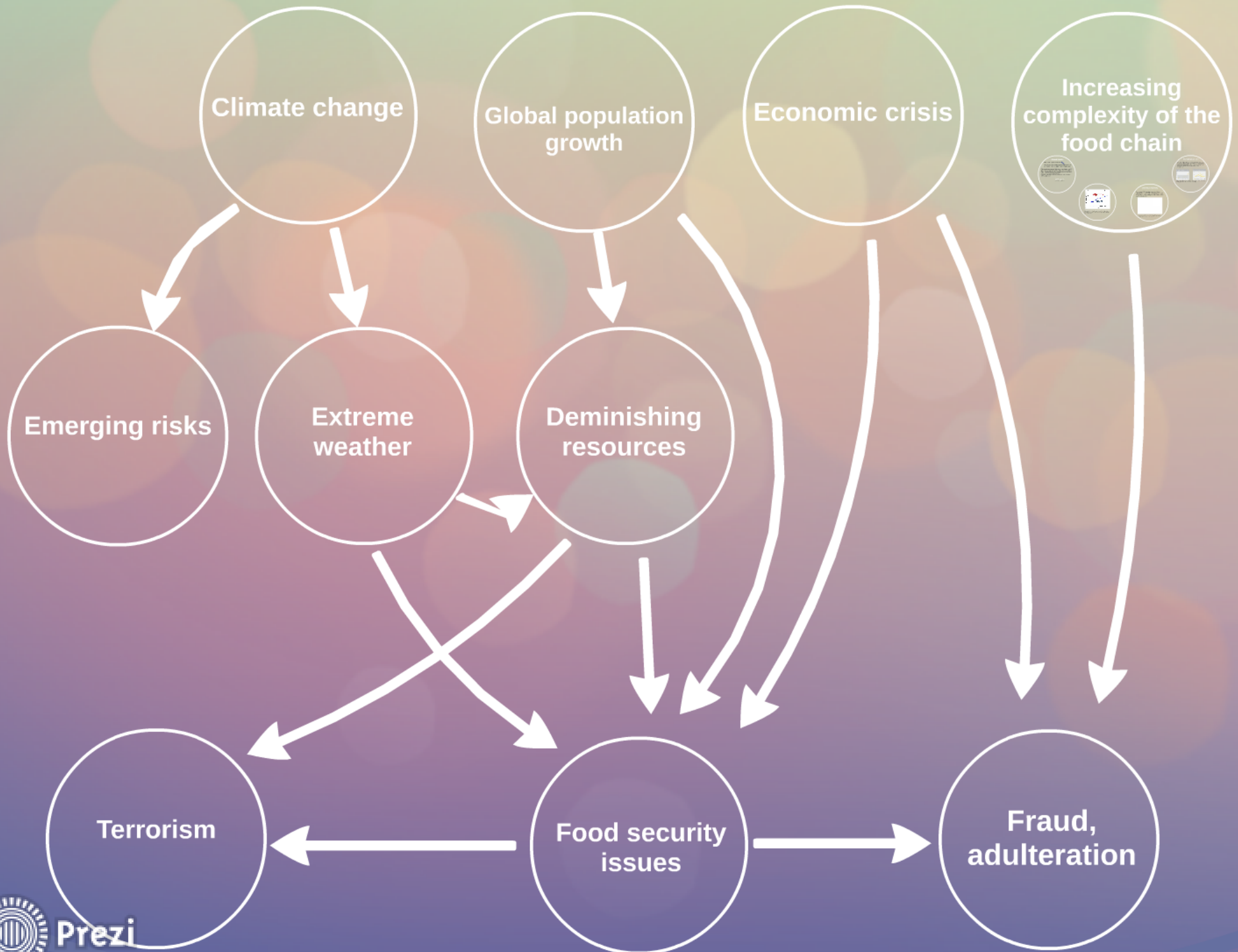


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Terrorism

Food security
issues

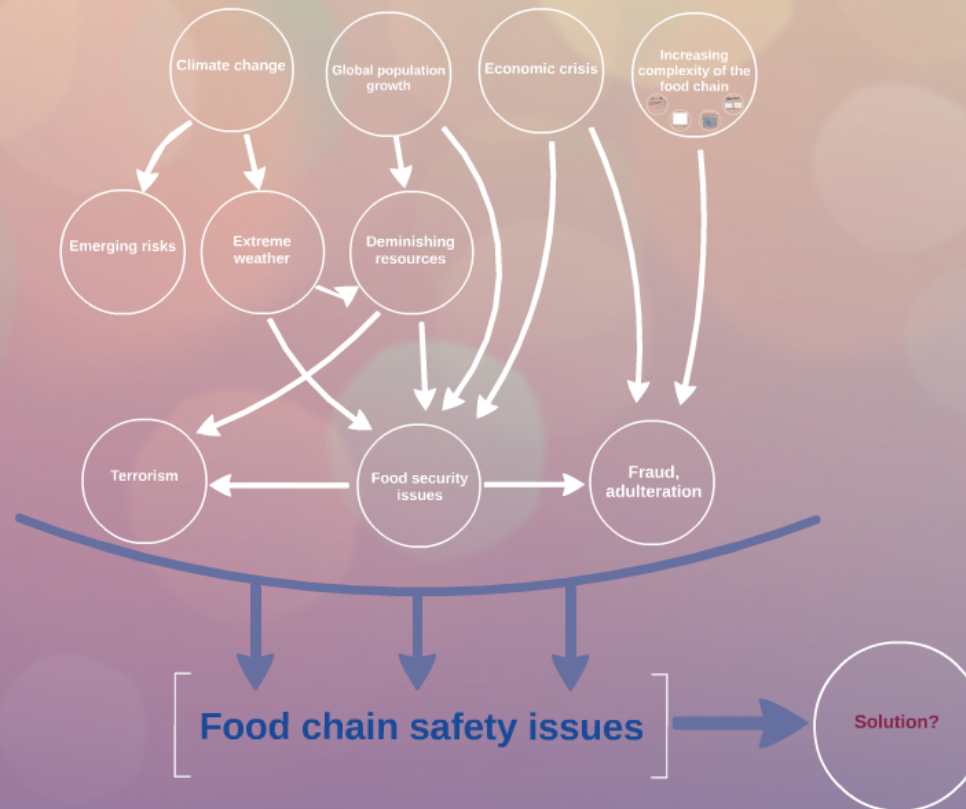
Fraud,
adulteration

Food chain safety issues



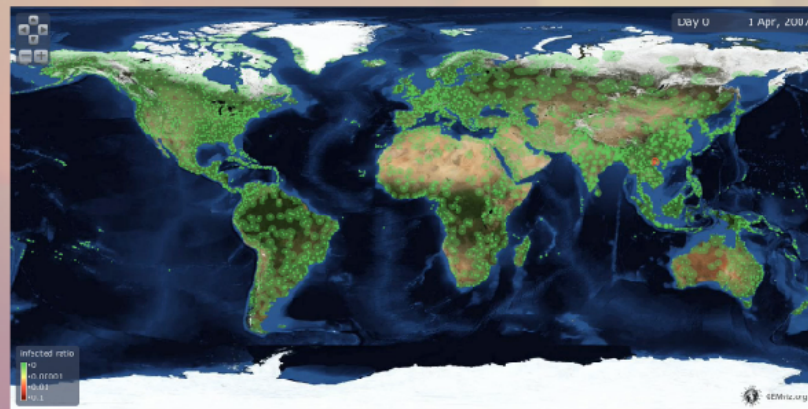
Solution?

Complex drivers

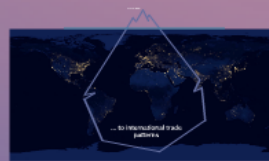


Data Science & Computational tools

Food chain is actually a complex network



Many orders of magnitude



Data Science
&
Computational tools

Complex drivers



Nature

Information boom

From the dawn of the civilization to 2003
humans produced 5 exabytes of data.

Now we produce 5 exabytes every 2 days.



Society

Science

... brought us where we are



Markets



Authority

Politics

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Markets

Business	Key technologies
1. Artificial Intelligence	Machine Learning, Deep Learning, Natural Language Processing, Computer Vision, Robotics
2. Cloud Computing	Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)
3. Big Data	Data Analytics, Data Mining, Data Science, Data Engineering
4. Cybersecurity	Cryptography, Network Security, Incident Response, Threat Intelligence
5. Blockchain	Distributed Ledger Technology, Smart Contracts, Decentralized Finance (DeFi)
6. Internet of Things (IoT)	Sensors, Actuators, Network Protocols, Data Management
7. Augmented Reality (AR)	Computer Vision, Spatial Computing, User Interface Design
8. Virtual Reality (VR)	3D Modeling, Motion Tracking, Audio Rendering
9. Quantum Computing	Quantum Algorithms, Quantum Hardware, Quantum Software
10. Biotechnology	Genetic Engineering, Synthetic Biology, Bioprinting

Authority

Politics

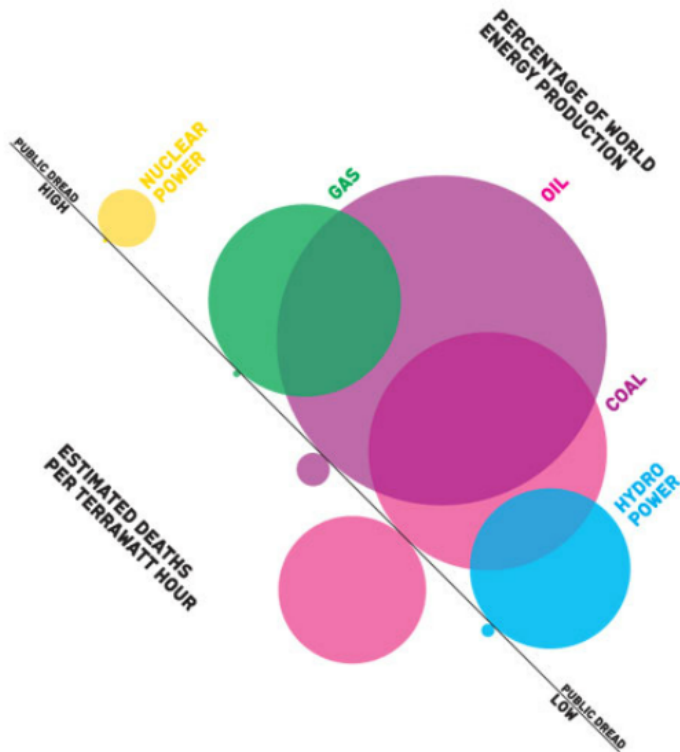
Political system

Society

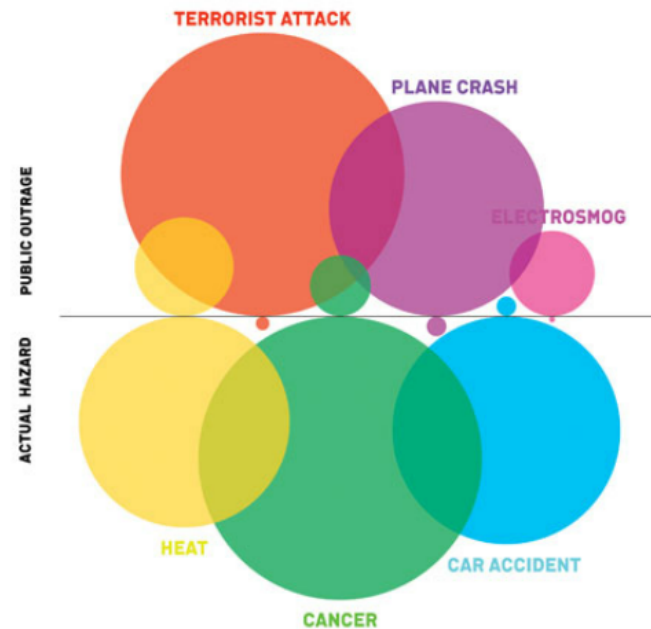
Do we need to eat?

What is the risk perception of the society?

**PUBLIC DREAD
AND ACTUAL DEATHS**
IN RELATION TO WORLD ENERGY PRODUCTION



**RISK PERCEPTION
AND ACTUAL HAZARDS**



Source: Susanne Hertirch

Society

Science

... brought us where we are



Markets

Business Key Technologies	
Artificial Intelligence	Machine Learning
Cloud Computing	Big Data
Internet of Things	Blockchain
Virtual Reality	Augmented Reality
3D Printing	Autonomous Vehicles
Robotics	Space Exploration
Biotechnology	Genetic Engineering
Renewable Energy	Smart Grids
Advanced Materials	Quantum Computing
Space Exploration	Artificial Intelligence

Authority

Politics

Political system

Markets

Business New technologies

- printing food with 3D printer
- soy and pea proteins to mimic meaty texture
- hydroponic greenhouses
- development of new adulteration technologies
- ...

THE
SIMPLE ANSWERS
TO THE QUESTIONS THAT GET ASKED
ABOUT EVERY NEW TECHNOLOGY:

Will <input type="checkbox"/> MAKE US ALL RICHER?	NO
Will <input type="checkbox"/> MAKE US ALL POORER?	NO
Will <input type="checkbox"/> DESTROY WHOLE INDUSTRIES?	YES
Will <input type="checkbox"/> MAKE US MORE EFFICIENT?	NO
Will <input type="checkbox"/> MAKE US LESS EFFICIENT?	NO
Will TEENS USE <input type="checkbox"/> FOR SEX?	YES
Will TEENIES GOING TO HAVE SEX WITHOUT	YES
Will <input type="checkbox"/> DESTROY MATH?	NO
Will <input type="checkbox"/> DESTROY ART?	NO
But ONLY WE GO BACK TO A TIME WHEN—	NO
Will <input type="checkbox"/> BRING ABOUT WORLD PEACE?	NO
Will <input type="checkbox"/> CAUSE Widespread Hunger by creating a world of empty stomachs?	WE WERE ALREADY HUNGRY



Business

New technologies

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WILL <input type="checkbox"/> MAKE US ALL MORONS?	NO
WILL <input type="checkbox"/> DESTROY WHOLE INDUSTRIES?	YES
WILL <input type="checkbox"/> MAKE US MORE EMPATHETIC?	NO
WILL <input type="checkbox"/> MAKE US LESS CARING?	NO
WILL TEENS USE <input type="checkbox"/> FOR SEX?	YES
WERE THEY GOING TO HAVE SEX ANYWAY?	YES
WILL <input type="checkbox"/> DESTROY MUSIC?	NO
WILL <input type="checkbox"/> DESTROY ART?	NO
BUT CAN'T WE GO BACK TO A TIME WHEN—	NO
WILL <input type="checkbox"/> BRING ABOUT WORLD PEACE?	NO
WILL <input type="checkbox"/> CAUSE WIDESPREAD ALIENATION BY CREATING A WORLD OF EMPTY EXPERIENCES?	WE WERE ALREADY ALIENATED

Politics

Policy-related scientific problems:

- uncertain facts
- disputes over ethics and values
- urgent decisions needed
- that may have far-reaching consequences

Policy makers are required to make difficult and firm decisions based on data characterized by high levels of uncertainty.

Post-normal science

Policy-related scientific problems:

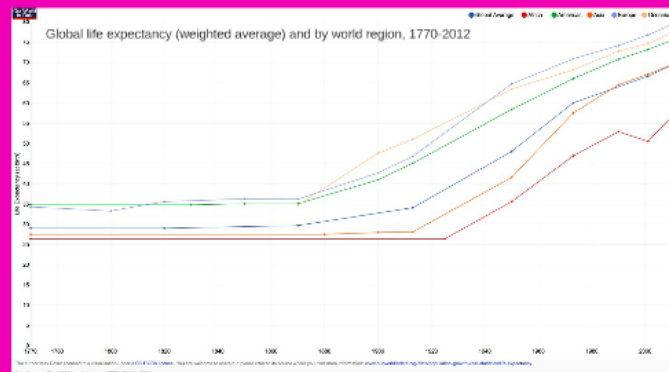
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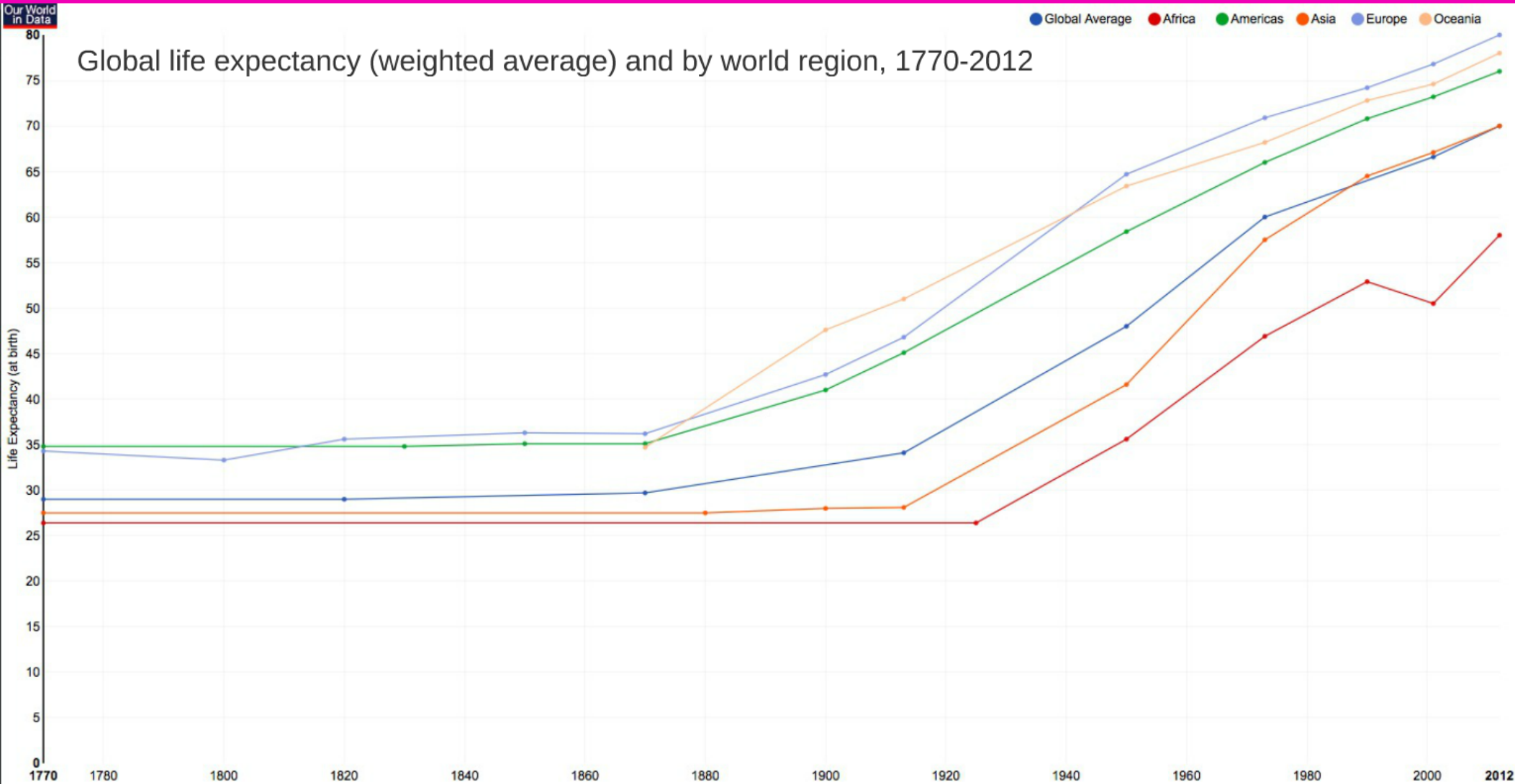
Post-normal science

Science

... brought us where we are



Assessment science: not just
What is it? Assessment science
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The author Max Roser licensed this visualisation under a [CC BY-SA license](https://creativecommons.org/licenses/by-sa/4.0/). You are welcome to share but please refer to its source where you find more information: www.ourworldindata.org/data/population-growth-vital-statistics/life-expectancy

Data Sources: Riley (2005) for all data up to 2000; WHO for 2012

Assessment science: not pure

Pure science

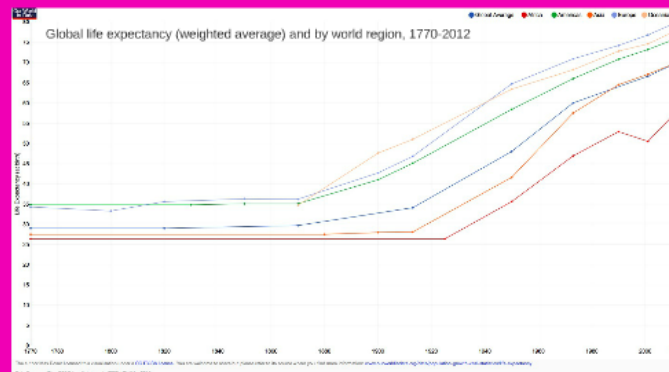
- Curiosity driven
- Disinterested
- Discipline based
- Scrutinized by peers in discipline
- Receptive environment

Assessment science

- Purpose driven
- Sponsored
- Cross-disciplinary and cross-institutional
- Publicly scrutinized
- Rejecting environment

Science

... brought us where we are



Assessment science: not just
What is it? Assessment science
Why is it? Assessment science
How is it? Assessment science
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Markets



Authority

Politics



Seek for new approaches, new analysis and control methods

Computational science as a solution

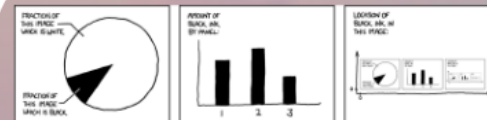
- Big data
- Network science
- Data mining
- (Business) intelligence
- Quantified self
- STEAM (science, technology, engineering, arts, mathematics)
- ...

Computational science

Computational science is a field of research that aims to develop new computational methods and algorithms for solving complex scientific problems. It involves the use of high-performance computing and data science to analyze large datasets and simulate complex systems.

Important is...

...the story behind the numbers!



Source: xkcd.com

Creation and development of (big) databases is not only an IT problem

The ability of analysis and evaluation of input data and results: high-level knowledge of food chain science is needed enabling interpretation and validation.

Computational science as a solution

- Big data
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Computational science

- able to detect patterns which can not be detected by a smaller set of data
- those **emerging patterns** can be surprising & counter-intuitive
- 'more is different'

- Meta-analysis
- Psychology
- Game-theory
- Decision theory
- Risk-benefit analysis
- Predictive modeling
- ...

Computational science as a solution

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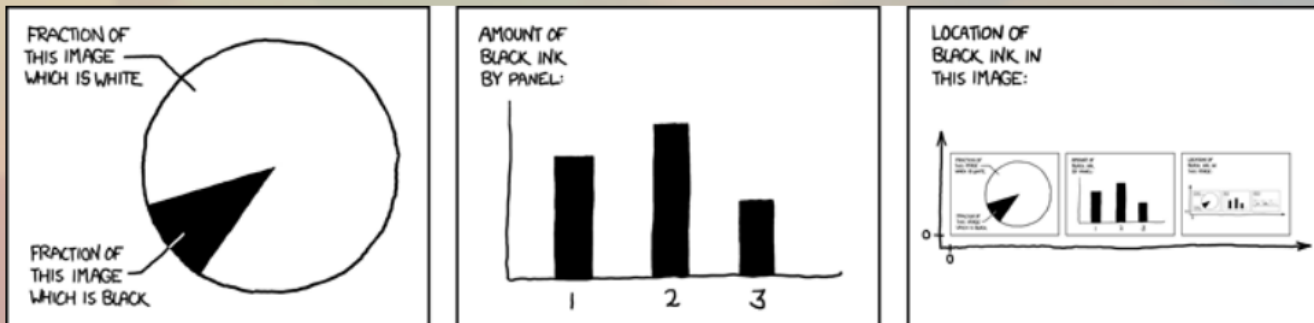
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Computational science as a solution

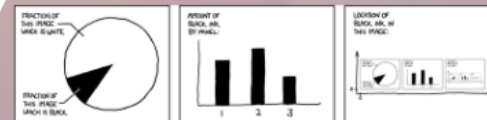
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Computational science

Computational science is the use of computers to simulate and analyze complex systems and phenomena. It involves the use of mathematical models and algorithms to represent and solve problems that are too difficult to solve analytically.

Important is...

...the story behind the numbers!



Source: xkcd.com


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Siddhartha Mukherjee: The Emperor of All Maladies



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