

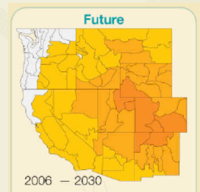



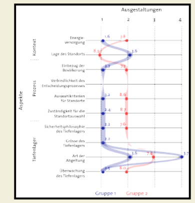


From *Analyzing* to *Forming* Agent Networks for Sustainability

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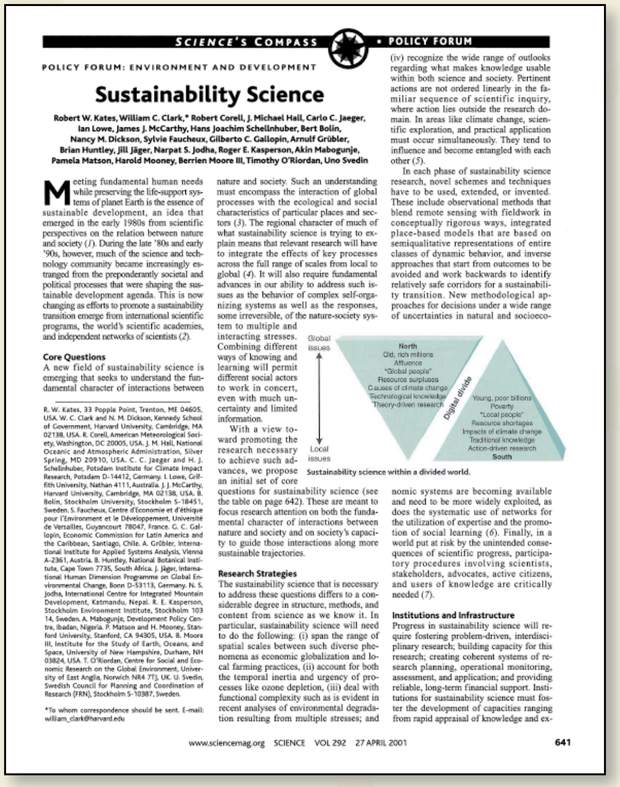
Indiana University – September 17, 2009

Understanding Complex Interactions


SCIENCE'S COMPASS • POLICY FORUM

POLICY FORUM: ENVIRONMENT AND DEVELOPMENT

Sustainability Science

Robert W. Kates, William C. Clark,* Robert Corell, J. Michael Hall, Carlo C. Jaeger, Ian Lowe, James J. McCarthy, Hans Joachim Schellnhuber, Bert Bolin, Nancy M. Dickson, Sylvie Faucheux, Gilberto C. Gallopín, Arnulf Grübler, Brian Huntley, Jill Jäger, Narpat S. Jodha, Roger E. Kasperson, Akin Mabogunje, Pamela Matson, Harold Mooney, Berrien Moore III, Timothy O'Riordan, Uno Svedin

Core Questions

Research Strategies

Institutions and Infrastructure

Sustainability science within a divided world.

www.sciencemag.org SCIENCE VOL 292 27 APRIL 2001 641

Kates et al., 2001, Science, 292, 641-642


Pushing Networks to the Limit

NEWS

Ourselves and Our Interactions: The Ultimate Physics Problem?

In the field of complex socioeconomic systems, physicists and others analyze people almost as if they were interchangeable electrons. Can that approach decipher society and what ails it?

Complexis as complex does

406 24 JULY 2009 VOL 325 SCIENCE www.sciencemag.org

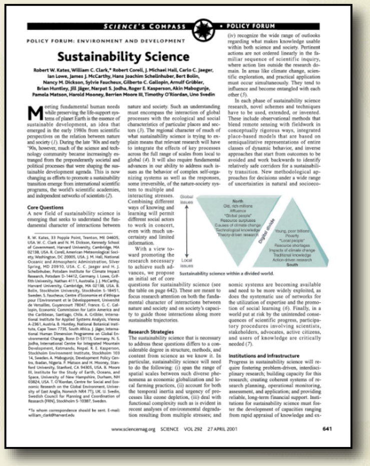
Downloaded from www.sciencemag.org on September 21, 2009

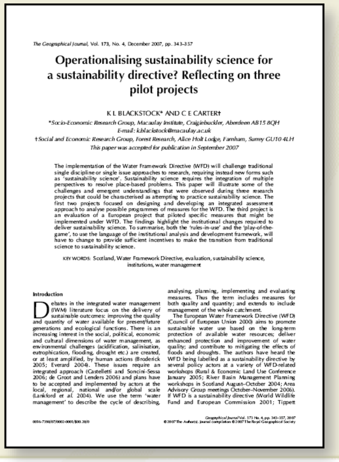
Cho, A., 2009, *Science*, 325, 406-408

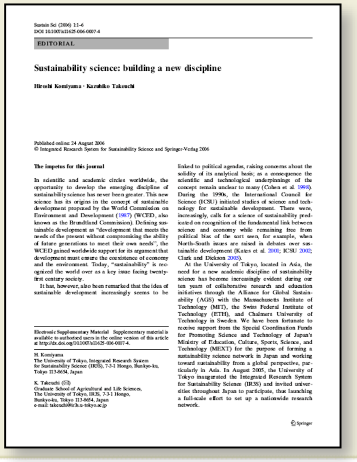
A Transformative Agenda

"Pertinent <u>actions</u> are not ordered linearly in the familiar sequence of scientific inquiry, where action lies outside the research domain. In areas like climate change, scientific exploration, and <u>practical application</u> must occur <u>simultaneously</u>. They tend to influence and become <u>entangled</u> with each other".

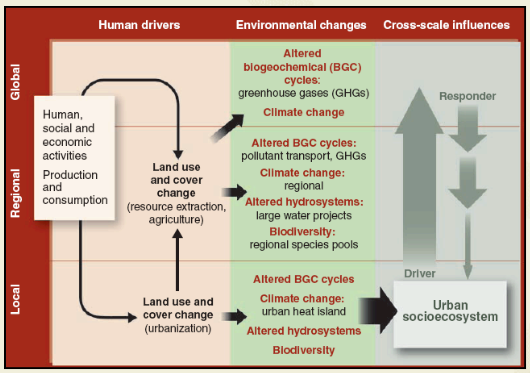
"<u>Participatory procedures</u> involving scientists, stakeholders, advocates, active citizens, and users of knowledge are critically needed".

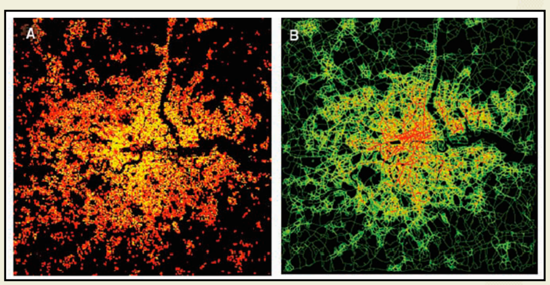


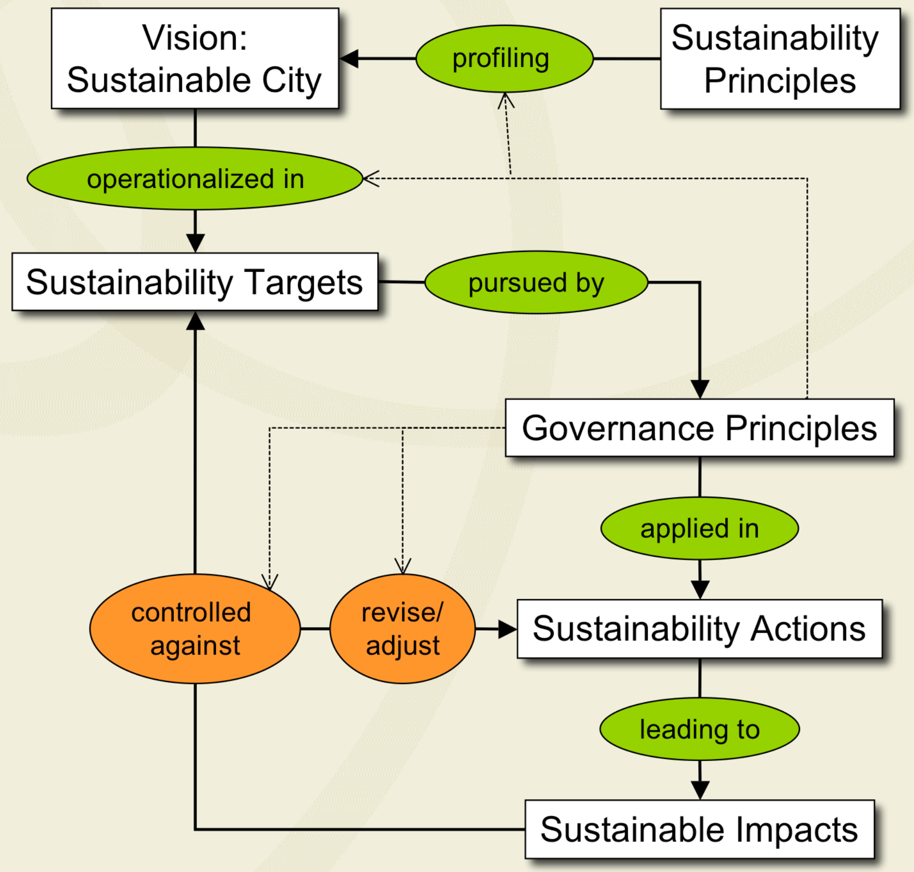




Sustainability Research & Problem-Solving







Moving Agent Network Analysis “Downstream”

From: “ How are agent networks constituted and structured?”

To: “What are critical constellations in agent networks and how should agent networks be formed to support sustainability?”

Studies

- Study on Agent Networks of Nanotechnology

1. Study on National Strategy for Sustainable Development
2. Study on Water Governance

Reference Points

Elinor Ostrom's work on failures, successes, and design principles for collective action on common resources

Brian Wynne's work on public involvement (co-construction) of technology

Not a Problem … *Yet!*

Nanotechnology

- Emerging technology
- Risk indications
- Public debate
- ‘Collingridge dilemma’

COMMENTARY

Scientists worry about some risks more than the public

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A comparison between two recent national surveys among nanoscientists and the general public in the US shows that, in general, nanoscientists are more optimistic than the public about the potential benefits of nanotechnology. However, for some issues related to the environmental and long-term health impacts of nanotechnology, nanoscientists were significantly more concerned than the public.

In previous controversies surrounding emerging technologies, such as nuclear energy and food biotechnology, scientists, in most cases, perceived lower risks associated with these new technologies than the general public or the journalists covering these stories. These findings seem to hold in both the US and Europe[1,2,3], and most recently, an exploratory comparison of a quota sample of 375 lay people and a convenience sample of 46 experts in Switzerland suggested that the same pattern is beginning to emerge for nanotechnology as well[4].

However, two large-scale systematic data collections in the US now show that the dynamics surrounding risk perceptions of nanotechnology among members of the general public and nanoscientists shape up to be much more complex than for previous issues. In particular, historical patterns of the difference between the perceptions of scientists and the general public of risks may be reversed for nanotechnology.

We collected survey data from both lay individuals and nanotechnology scientists. Both surveys used questions with identical wording, providing a unique opportunity for systematic comparisons across two large-scale, national data sets. The first data source was a general population telephone survey of 1,015 US adults; the second data source was a mail survey of 363 nanotechnology scientists and engineers. The fieldwork was conducted from May to July 2007 for the public opinion survey, and from May to June 2007 for the scientist survey (see Methods).

Not surprisingly, scientists were generally more optimistic about the benefits and less concerned about the risks of nanotechnology than the general public. For example, scientists were more optimistic about the potential for nanotechnology to lead to breakthroughs in medicine, environmental cleanup or national defence (Fig. 1a). Members of the general public, in contrast, were more concerned about potential drawbacks of nanotechnology than scientists, including the potential loss of privacy or adverse economic impacts (Fig. 1b).

However, scientists expressed more concerns than the general public about two areas of potential risks: more pollution and new health problems as a result of nanotechnology. This makes nanotechnology unusual among emerging technologies in that scientists working directly with the technology express stronger concerns about specific potential risk areas than the general public does.

These differences in risk perceptions between scientists and the general public for nanotechnology can be explained to some degree by how the issue has evolved, both in scientific circles and in the public debate. In particular, the fact that scientists are more concerned about new health problems and potential pollution than the general public should not be too surprising for at least two reasons.

First, there has been an ongoing debate in science and policy circles about a lack of systematic nano-related risk research in both academia and business[5]. Although many of these discussions were initially driven by specific toxicological concerns, similar concerns are now being voiced more broadly. In 2006, for instance, the Royal Society and the Royal Academy of Engineering in the UK recommended an expansion and standardization of research on the environmental, health and safety (EHS) impacts of nanomaterials[6]. Similarly, concerns about these have been the subject of public hearings in the US, organized by the Food and Drug Administration and, most recently, the Environmental Protection Agency.

Second, and somewhat related, interest groups in the US have pushed for specific regulations and safety procedures for new nano-enabled products. For

Scheufele et al., 2007, *Nature Nanotechnology*, 2, 732-734

Research Design

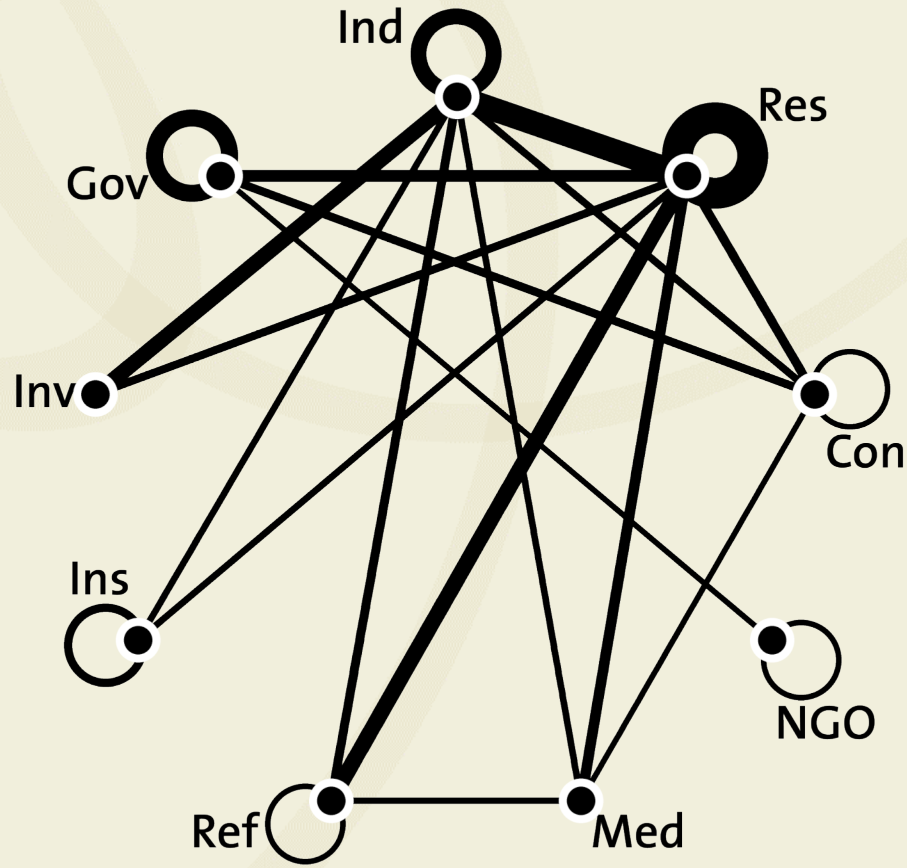
Table 5
Number of agents and key agents of nanotechnology in Switzerland (interviewees $n = 47$, multiple entries allowed)

Agent category	Number of agents		Key agents
	Mentioned	Mentioned ⩾4 times	
Industry	54	7 →	Bühler AG, Ciba Specialty Chemicals, F. Hoffmann-La Roche, IBM, Ilford, Nanosurf, Novartis
Consultants	15	3 →	The Innovation Society, Foundation Risiko-Dialog, Centre for Technology Assessment TA-SWISS
Insurers	6	1 →	*
Investors	6	0	
Public research institutes	27	10 →	Swiss Center for Electronics and Microtechnology (CSEM), Swiss Federal Laboratories for Materials Testing and Research (EMPA), Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Federal Institute of Technology (ETH Zurich), Paul Scherrer Institute (PSI), Universities of Basel, Bern, Zurich, Geneva, Neuchâtel.
Government regulatory agencies	24	3 →	Federal Office for the Environment (BAFU), Federal Office of Public Health (BAG), State Secretariat for Economic Affairs (SECO)
Government research funding agencies	6	3 →	Commission for Technology and Innovation (KTI), Swiss Academy of Engineering Sciences (SATW), Swiss National Science Foundation (SNSF)
Non-Government Organizations (NGOs)	7	2 →	Greenpeace, WWF Switzerland
Media	26	2 →	Neue Zürcher Zeitung (NZZ), Tages-Anzeiger
Others	1	0	
Total	172	31	

*Because of the small sample in this agent category (see Section 4.1.2), we do not name this key agent due to the de-personalization code.

Agent Network Relations

	Ind (N=10)	Con (N=8)	Ins (N=2)	Inv (N=2)	Res (N=8)	Gov (N=4)	Ref (N=4)	NGO (N=4)	Med (N=5)
Ind (N=10)	2.8								
Con (N=8)	1.3	1.0							
Ins (N=2)	1.2	!	1.5						
Inv (N=2)	2.7	!	!	!					
Res (N=8)	4.2	1.6	1.2	1.5	5.4				
Gov (N=4)	!	1.5	!	!	2.1	3.0			
Ref (N=4)	1.6	!	!	!	2.8	!	1.0		
NGO (N=4)	!	!	!	!	!	1.0	!	1.0	
Med (N=5)	1.2	1.0	!	!	1.9	!	1.1	!	!



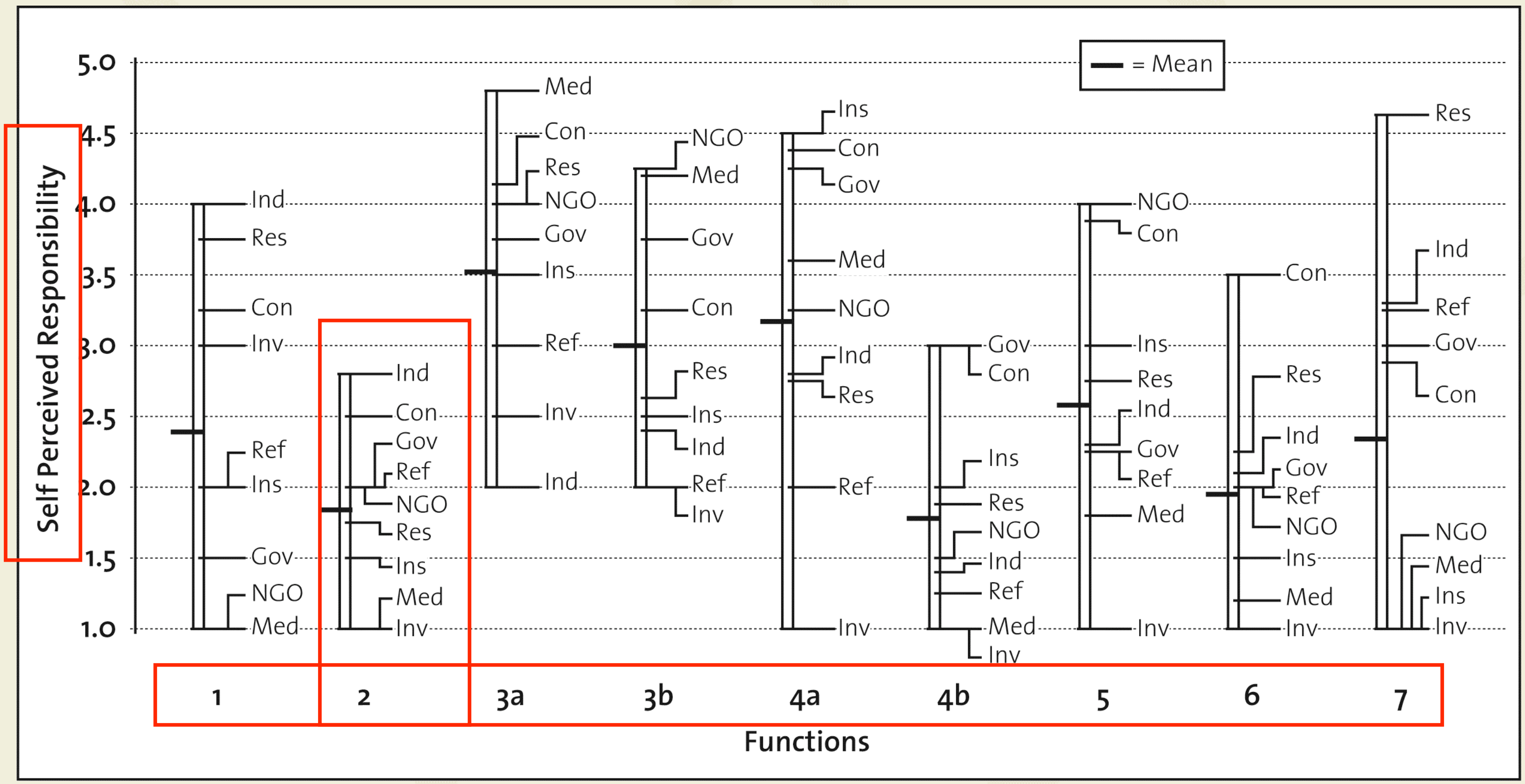
Agent Roles

Table 2
Set of agents' functions/roles in sustainable technology governance

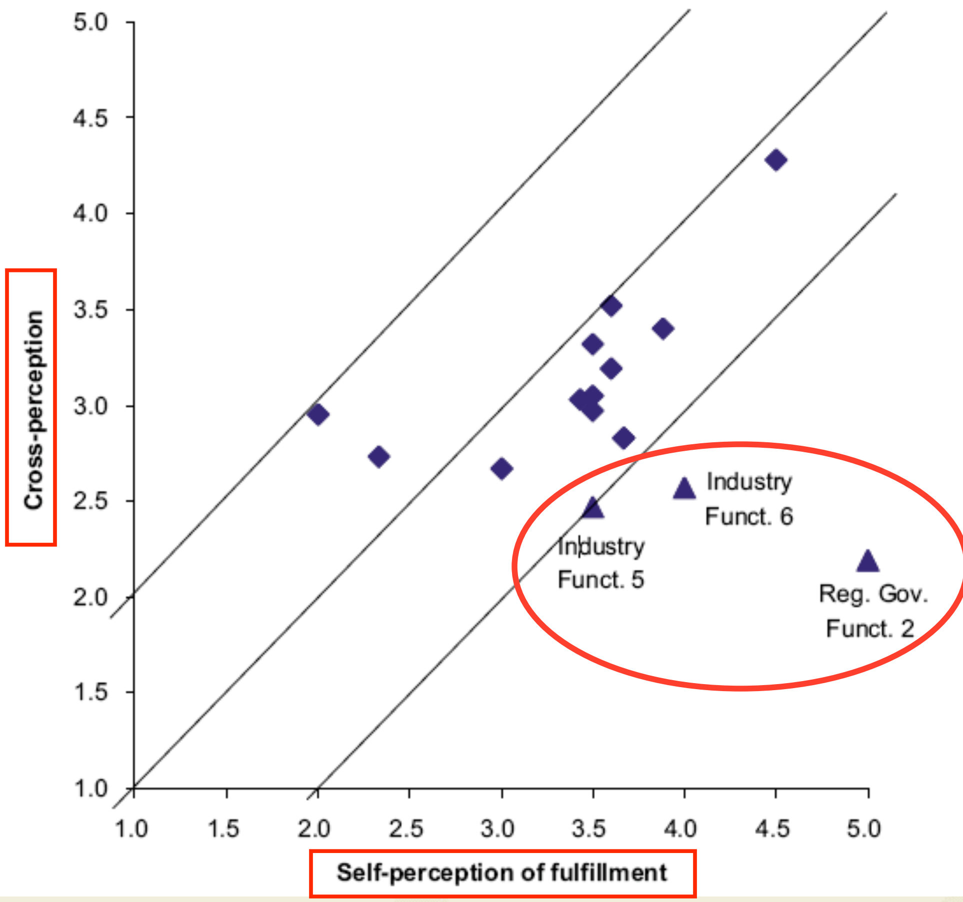
Field of sustainable governance (Fig. 1)	Function/role
1 Economic	To generate profits from applying available knowledge and realizing market potential of the emerging technology
2 Economic–social	To monitor potential hazards at workplaces
3a Social/institutional	To inform the public about research results, opportunities and risks of the emerging technology
3b Social/institutional	To ensure that opinions and concerns of the public are seriously taken into account
4a Social–environmental	To assess risks of the emerging technology for humans and the environment
4b Social–environmental	To regulate the emerging technology concerning human health (norms, instructions, thresholds)
5 Environmental	To ensure that environmental aspects are seriously taken into account in R&D, production, consumption, and regulation
6 Environmental–economic	To promote the sustainable usage of resources along the life-cycle of the emerging technology and its applications
7 Environmental–economic–social	To publicly fund, or conduct publicly funded research on integrated sustainability issues of the emerging technology

2

Agent Responsibilities



Cross-Perceptions



Function	*Agent*	*Self*	*Entries*	*Cross*	*n*
1	Ind	3.9	>50%	3.4	35
2	Gov	5.0	25%	2.2	36
3a	Res	3.4	>50%	3.0	38
3a	NGO	2.3	>50%	2.7	37
3a	Med	3.6	>50%	3.5	42
3b	Gov	3.7	>50%	2.8	29
3b	NGO	3.7	>50%	2.8	23
3b	Med	3.6	>50%	3.2	26
4a	Gov	3.5	>50%	3.0	29
4a	Ins	3.5	>50%	3.3	22
4b	Gov	3.0	50%	2.7	27
5	NGO	2.0	>50%	3.0	19
5	Ind	3.5	20%	2.4	17
6	Ind	4.0	20%	2.6	28
7	Res	4.5	>50%	4.3	39

Critical Constellations

1. Key agents missing
2. Lack of connectivity
3. Important functions not assigned (roles)
4. Divergences in assigned roles
5. Insufficient fulfillment of roles
6. Divergences in perceived fulfillment

Publications

Helland, A., Scheringer, M., Siegrist, M., Kastenholz, H., Wiek, A., & Scholz, R.W. (2008). Risk assessment of engineered nanomaterials – A survey of industrial approaches. *Environmental Science & Technology*, vol. 42, no. 2, pp. 640-646.

Siegrist, M., Wiek, A., Helland, A., Kastenholz, H. (2007). Risks and nanotechnology: the public is more concerned than experts and industry. *Nature Nanotechnology*, vol. 2, p. 67.

Siegrist, M., Keller, C., Kastenholz, H., Frey, S. & Wiek, A. (2007). Lay people's and experts' perception of nanotechnology hazards. *Risk Analysis*, vol. 27, no. 1, pp. 59-69.

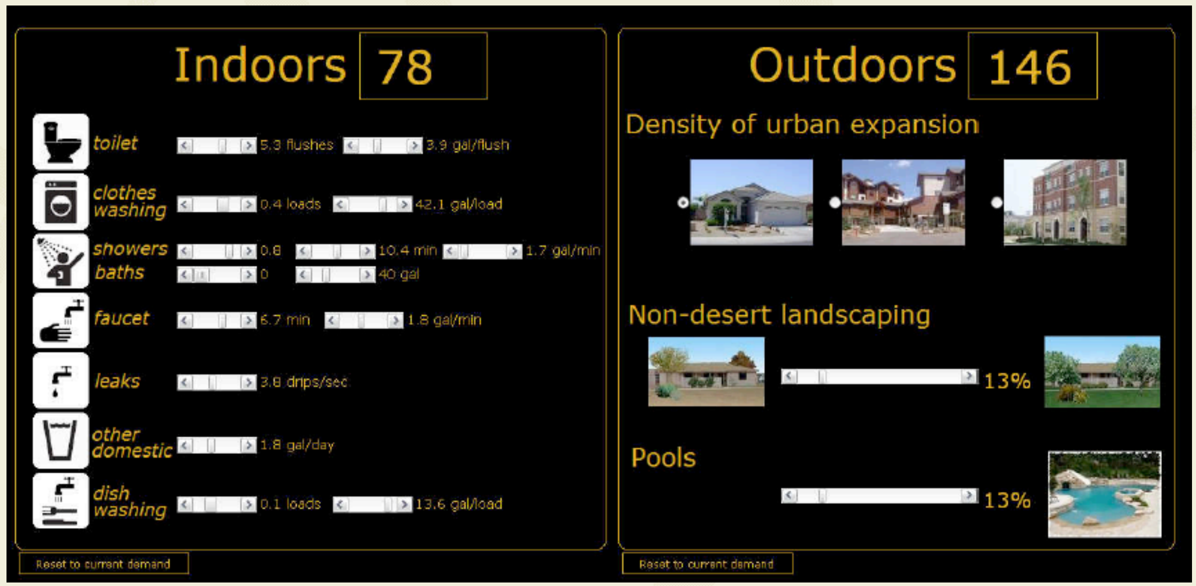
Siegrist, M., Cousin, M.E., Kastenholz, H. & Wiek, A. (2007). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite*, vol. 49, no. 2, pp. 459–466.

Wiek, A., Zemp, S., Siegrist, M., Walter, A. (2007). Sustainable governance of emerging technologies – Critical constellations in the agent network of nanotechnology. *Technology in Society*, vol. 29, no. 4, pp. 388-406.

Wiek, A., Lang, D. & Siegrist, M. (2008). Qualitative system analysis as a means for sustainable governance of emerging technologies – The case of nanotechnology. *Journal of Cleaner Production*, vol. 16, no. 8/9, pp. 988-999.

Wiek, A., Gasser, L. & Siegrist, M. (in review). Systemic scenarios of nanotechnology – Sustainable governance of emerging technologies. *Futures*.

The Next Step – Water Governance in Phoenix



Conclusions

1. Agent Network can contribute to the *transformative* agenda of sustainability science.
2. The *normative* component of this research is based on transparent criteria (societal discourse, expert opinions, meta-studies).
3. How far "moving downstream"? Constructing and *creating* networks!