Edited Volume

Applying Collective Inquiry

Author(s):
Backhaus, Julia; de Carteret, Robin; Damerius, Laura; Huang, Yuanyuan; Huppenbauer, Markus; Pöll, Constantin; Rahn, Eric; Reynolds, Martin; Wallimann-Helmer, Ivo

Publication Date:
2019

Permanent Link:

https://doi.org/10.3929/ethz-b-000315545 →

Engaging in the science-policy dialogue

8 Collective inquiry

Publisher
Zurich-Basel Plant Science Center

Editors
Melanie Paschke
Manuela Dahinden

Universität Zürich[UZH] | ETH zürich | Universität Basel

Publisher
The Zurich-Basel Plant Science Center is a competence center linking and supporting the plant science research community of the University of Zurich, ETH Zurich and the University of Basel. The center promotes plant science research and education and provides platforms for interactions with peers, policymakers, industry, stakeholders and the general public.

Zurich-Basel Plant Science Center
ETH Zürich
Tannenstrasse 1, TAN D5.2
8092 Zürich, Schweiz
+41 (0)44 632 23 33
info-plantscience@ethz.ch
www.plantsciences.ch

Editors
Melanie Paschke and Manuela Dahinden

Layout
Manuela Dahinden and Fabian Leuenberger

Illustrations
Fabian Leuenberger

Editing
Kaitlin McNally, Karina Oborune, Joseph Swann and Annina Ziltener

Version 1: 19.09.2019

Download link
DOI: 10.3929/ethz-b-000315545

Citation
Paschke, M. and A. Pfisterer (2019). Collective inquiry. With contributions of: Backhaus, J., de Carteret, R., Damerius, L., Huang, Y.-Y., Huppenbauer, M., Pöll, C., Rahn, E., Reynolds, M., Wallimann-Helmer, I. In: Paschke, M. and Dahinden, M. (eds.). Engaging in the science-policy dialogue, Workbook 8. Zurich: Zurich-Basel Plant Science Center.

We would like to thank the funding agencies and foundations supporting the PSC Science & Policy training program for graduate students, including the Swiss Science Foundation, the European Commission and the Mercator Foundation Switzerland.

Authors and chapters

THEORY
Melanie Paschke and Andrea Pfisterer
From analysis to transformation of complex situations

COMMENT
Julia Backhaus
Multi-level perspective on socio-technical transitions

TOOLS
Robin de Carteret
Systemic complexity games
Martin Reynolds
Introduction to critical systems heuristics
Ivo Wallimann-Helmer and Markus Huppenbauer
Five-step model for ethical inquiry into complex problems
Julia Backhaus
Strategic niche management

EXAMPLE
Yuanyuan Huang, Constantin Pöll, Laura Damerius and Eric Rahn
Biodiversity conservation through coffee agroforestry

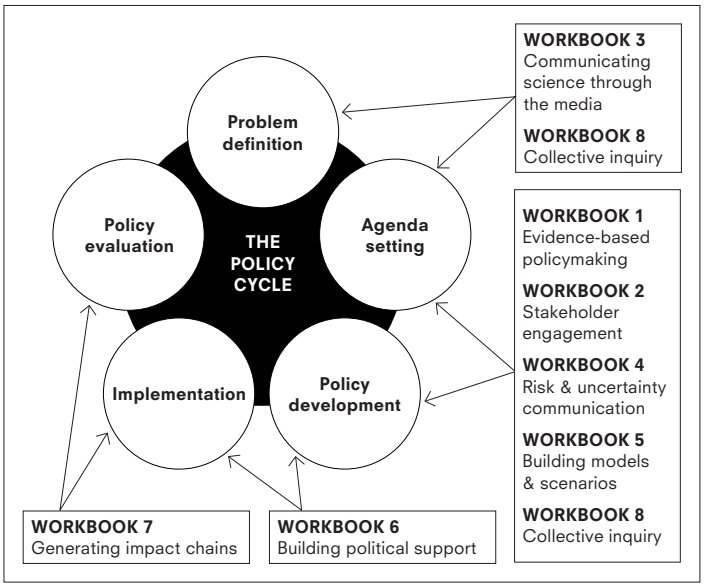
Contents

Editorial

Scientists generate knowledge that is anchored within world-views, norms, values and interests generated by themselves, by policymakers, funding organizations and other societal actors. Collective inquiry can be applied as a framework to connect participants from different social groups. They collect their specific knowledge and engage in decision-making.

This workbook is the last in a series of eight workbooks exploring the role of scientists in the science-policy dialogue. Workbook 8 explains fundamental concepts of systems thinking and boundary work. It can be used for obtaining more insights into principles at the science-policy interface. With systems thinking we can analyze the nature of relationships and dependencies between the elements of a system, we can engage with multiple world-views to understand their relations with and within the system, and we can reflect on the boundaries of our own system of interest.

FIGURE 1 — The policy cycle.



MORE READING
M. Paschke (2019). Introduction to science in policy. In: Paschke, M. and Dahinden, M. (eds.). Engaging in the science-policy dialogue. Workbook 1. Evidence-based policymaking. Zurich: Zurich-Basel Plant Science Center.

Guide to workbook 8

The aim

Workbook 8 introduces you to systems thinking and the generation of knowledge based on different world-views. Life scientists will learn how to engage in collective inquiry processes as part of social valorization of their evidence and how to carry out systems analysis to better understand the social dimensions of a problem.

Competencies

- You will be able to describe the key features of complex problems.
- You will be able to identify emergent properties, feedback and self-organization as characteristics of systems.
- You will gain reflexive skills, being able to identify, differentiate and evaluate how world-views and their characteristics influence the process of knowledge production.
- You will be able to apply collective inquiry.
- You will be able to apply the approach of critical systems heuristics.
- You will be able to conduct an ethical inquiry.

How to read this workbook

THEORY
Setting the scene
We will introduce you to the concept of systems theory and to tools carrying systems thinking. What are the differences between simple and complex problems? How can we understand their behavior? We will describe key features of systems, such as emergent properties, feedback, chaos, and self-organization.

Self-reflection
You will become aware of how complex problems are framed differently depending on the societal background of the participating stakeholders. What world-views, norms, values and interests do these boundaries involve?

Applying systems thinking
We will introduce you to systems thinking as a three-way communication. Firstly understanding the elements of a system and their interconnections; secondly engaging with the perspectives of participants in a system and exploring their world-views; and thirdly reflecting on the impact of bounding evidence and values on systems.

Collective inquiry as a framework
We will introduce you to collective inquiry as a framework to facilitate conversation about different world-views and knowledge, and to offer options for action through critical reasoning.

COMMENT

Multi-level perspective (MLP) on socio-technological transitions is used as a framework to think about and stimulate systemic change. In this framework systems thinking, collective inquiry and the three loops of learning are used to illustrate how changes can be brought about in a society.

TOOLS

Collective inquiry can be facilitated by different tools. Systemic complexity games help participants to explore how complex systems operate. Systems thinking can be carried out through critical systems heuristics. Ethical analysis using the five-step model allows you to identify and analyze ethical challenges as part of systems thinking.

EXAMPLE

We will present you with the example of biodiversity conservation through coffee agroforestry that has been analyzed under the collective inquiry and critical systems heuristic approach by former participants in the *PSC Science & Policy training program* for graduate students.

1. THEORY of collective inquiry

Melanie Paschke
Director of education at the Zurich-Basel Plant Science Center, lecturer at the ETH Zurich and University of Zurich, Switzerland

Andrea Pfisterer
Former coordinator of the PSC Science & Policy training program for graduate students, Zurich-Basel Plant Science Center, Switzerland

1.1. Complex problems and key features of systems

> A system approach begins when first you see the world through the eyes of another. — Churchman, 1968.

Society, scientists and policymakers often have to deal with wicked problems. The characteristics of these problems are (Rittel and Weber, 1973):

- No clear definition of what the problem is and what the solution should be.
- The problems are multi-causal and knowledge about them is incomplete.
- Any attempt to solve the problem will evolve it and generate some new effects and problems.
- Addressing complex problems involves transformation of societal systems: changes both in individual behavior and in societal norms and values are necessary.

A typical example of a wicked problem is climate change. While there is clear evidence that the climate is warming and it is " […] extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century" (IPCC, 2013), there is still controversy about the significance of climate change risks, and the scale and speed of its impact, as well as how to handle these problems via regulations, policies and investment on both the local and global scales.

We all know that mankind needs to react to climate change. Why is it so problematic to achieve consensus about what to do and how to do it?

Depending on the level of complexity of a problem, different forms of analysis, planning, monitoring and management need to be applied.

TABLE 1 — Characteristics of simple, complicated and complex situations.

Situation is	**Simple**	**Complicated**	**Complex**
Characteristics	One variable.	Several variables.	Many variables and many perspectives.
Type of thinking	Linear thinking.	Systematic thinking.	Systems thinking.
Knowledge about	Facts	Analysis of dependencies between variables (= facts).	Interdependencies and interrelationships of facts and perspectives.

When dealing with complex problems an understanding of the nature of systems is necessary. A system is:

> An interconnected set of elements that is coherently organized in a way that achieves something […]. A system must consist of three kinds of things: elements, interconnections and a function or purpose. — Meadows, 2008: 11.

Interconnections are the relationships between the elements of a system that together make the system's functions. Your life can be seen as the function or purpose of the individual elements of your body which are themselves combined in various subsystems (e.g., the circulatory system, the digestive system, etc.) that work together and are controlled via interconnections and feedback mechanisms.

1.1.1. About the nature of interconnections

As the number of elements in a system and / or their interconnections increases, a system's complexity increases. Changes in complex systems will produce outcomes (emergent properties) that nobody could predict or even want – as can be experienced with systemic complexity games (see 'Chapter 3. Tools'). In a complex system such as the global climate, changes in one connection will cause changes in most or all interconnections of the whole system; this is called non-linear feedback.

Feedback loops are important characteristics of a system and are sources of uncertainty when projecting change. In the climate system, one dreaded **reinforcing feedback loop** is the melting of polar and glacial ice, causing a reduction in the earth's capacity to reflect sunlight, and thus further destabilizing the system by accelerating the warming trend. On the other hand, one possible **balancing feedback loop** would be if higher temperatures intensify cloud formation by causing increased evaporation, thereby increasing the earth's capacity to reflect sunlight and enhancing system stability (IPCC, 2001).

Systems can have multiple stable states: the system can exist in one configuration for a period of time but can be knocked into a different configuration by a perturbation near the tipping point, leaving the system in a newly self-organized stable state. This is called a regime shift.

It might be unfamiliar to describe the perspective of the actors within a system as part of its interconnections. However, this is exactly what happens: perspectives and changes in perspective will generate changes in the interconnections of other systemic elements.

1.1.2. Interrelations: recognition of world-views, norms, values and interests as aspects of complex problems

We all operate within world-views, intentionally or unintentionally. These are shaped by our values and norms, beliefs and attitudes, our experiences based on our cultural background, on the historical moment and on our interests. World-views are represented within social groups as perspectives or frames, shared mental models or interpretative patterns held by members of a group. Knowledge production by scientists is also anchored within frames. See for example tables 2 and 4. Different frames affect our plans and actions and the decisions we are ready to take or accept.

FIGURE 2 — From world-views to frames.

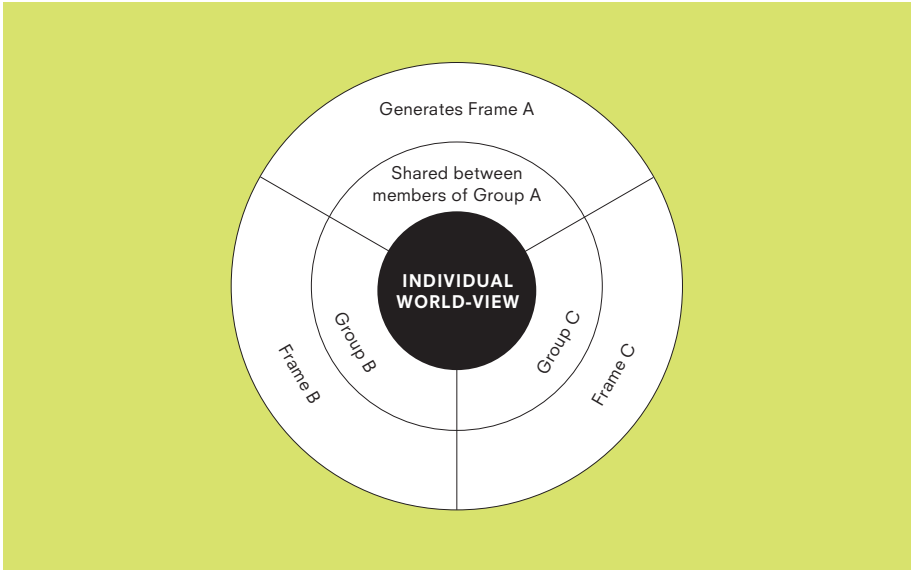


TABLE 2 — Frames and underlying beliefs create different options for climate change mitigation and adaptation. Adapted from Commonwealth of Australia, 2007; IPCC, 2014.

Belief in	Frame	Problem-solving options
Technological progress and dynamic market.	Improve global technology.	Substantial reductions in CO_2 emissions will require large changes in investment patterns for low carbon electricity supply and energy efficiency by public and private sectors.
Egalitarian structures among all members of society.	Reduce consumption, increase sufficiency.	CO_2 emissions can be decreased through changes in consumption patterns, energy saving measures, changes in dietary habits and reduction of food waste.
Hierarchical bureaucracy.	Improve global planning and governance.	Global policy needs to agree, e.g., on the extent of future emission cuts and to implement these agreements in international and national regulations. International cooperation is necessary for the creation of adaptation strategies with national governments providing frameworks and support.

World-views and frames provide the basis for our actions and reactions, however, as individuals we need to be motivated to accept them. In society different world-views and frames can arise conflicts and world-views will be challenged. For example, individualism is esteemed very highly in many western cultures, whereas in other cultures there is a much higher degree of social pressure and family loyalty. How do these different beliefs influence people in a globalized world?

What interests are generated from belief in technological progress and dynamic markets versus belief in egalitarian structures within society? Why can conflicts arise between these interests?

TABLE 3 — Examples of interests and conflicts generated from different frames.

Frame	Interest	Conflict
Improve global technology.	To secure large-scale investment of public and private sector in new technologies.	To guarantee future economic growth.
Reduce consumption, increase sufficiency.	To establish frameworks for less consumption and more egalitarian distribution of wealth.	To decrease need for future economic growth.
Improve global planning and governance.	To establish global governance structures.	To balance different needs and interests.

EXAMPLE 1
Genetically modified crops

How have different frames shaped the discussion on the unsuccessful introduction of **g**enetically **m**odified (GM) crops in Europe, resulting in bans on GM crops in many European member states? In an international context, conflicts arose between the *World Trade Organization (WTO)* and the European Commission because the dominant perspective of the WTO is that free trade can only be restricted when considerable health and environmental risks are associated with a technological innovation. In contrast, European citizens' concerns were system-oriented, long-term and linked to ethical, value-based discussion (Winter, 2011).

TABLE 4 — Frames, beliefs and interests in the GM crop debate in Europe.

Frame	Belief	Interest
Free market will decide if GM crops are successful or not.	Free trade.	Avoidance of protectionism e.g., abolish tarifs, subsidies, import quotas.
Health and environmental risks.	Precautionary principle: a new technology cannot be implemented before proof of its safety.	Increased research on risks associated with GM crops, and adaptation of regulations to avoid possible health and environmental risks.
Socio-environmental and economic risks of GM crops.	GM crops will drive industrial agriculture and monocultures to further impair biodiversity.	Regulations to protect agrobiodiversity and biodiversity.
Ethical concerns about GM crops.	Dignity of creation.	Integrity of farm organisms and protection of reproduction, i.e., natural ability to produce seeds.

EXERCISE I
An exercise to open your mind – try another hat

Some Swiss municipalities have began to switch the streetlights off between 10 pm and 5 am, which created a public debate in these towns and villages. Below you find three examples of typical beliefs. Can you complete the different, sometimes competing interests and ensuing conflicts? Can you summarize the perspective of the different individuals involved?

TABLE 5 — Some typical beliefs.

Personal background	Beliefs	Interests	Conflicts	Frame
Manuel owns a private property. The house was recently built and includes latest energy-saving technologies. He also owns a restaurant. He is active in the local trade association.	Switching off street lights at 10 pm will have negative consequences for the local bars and restaurants and will make the town unattractive for property-owners, as they will fear increased burglary rates.			
Vanessa gets her vegetables through a community-assisted agricultural initiative. She has no car. For short distances she uses her bike, for long distances, the train.	Switching off streetlights after 10 pm will have positive effects on the local fauna. But she feels insecure, even scared when she imagines being in the dark streets alone after 10 pm.			
Sarah works in the local administration and is involved in the planning group for this project together with the mayor. At the moment the only solution is to switch the streetlights either on or off. Dimming the streetlights on demand will need large investments that are not available.	Switching off the street lights will save CHF 200'000 per year, which is of great benefit for the small town. There have been complaints about safety on a busy road. Sarah needs to deal with these.			

1.2. Different knowledge cultures contribute to collective inquiry

Society is structured in different systems for example politics, economy, science, religion, art, education and justice. Within social systems social groups (for example scientists within the social system of science or more specific life scientist within the subsystem of natural sciences or even more specific ecologists in the subsystems of disciplines) share worldviews and responding frames.

FIGURE 4 — Knowledge cultures and social groups as aspects of social systems.

Brown (2010) introduced a useful model of five knowledge cultures in society to describe that knowledge and evidence can come in different dimensions. As presented in table 6 and 7, they can contribute to collective inquiry with their different knowledge and questions.
Within society these knowledge cultures act within the different social systems and social groups. For example, scientists can act as specialists but can also participate in boundary organizations engaged in policymaking, e.g., in the IPCC. In politics, for example, policymaking can be carried out through governmental and non-governmental organizations but also through grass-root community projects, e.g., food sharing initiatives or citizen of transition tows where the experiences of their members generate knowledge and is used for further up-scaling.

TABLE 6 — Knowledge cultures and their different dimensions of contributions to collective inquiry.
Adapted from Brown, 2010: 68.

		KNOWLEDGE CULTURES				
		Individual	**Community**	**Specialist**	**Organization**	**Holist**
DIMENSIONS	**Content**	Personal lived experience.	Mutual experience.	Academic disciplines.	Agendas, regulations, precedents.	Symbols, metaphors, images.
	Method of inquiry	Reflection	Dialogue	Specific tools.	Cost / benefit analysis.	Imagination
	Type of question	Introspective	Social	Empirical	Strategic	Aesthetic
	Evidence	Memory	Stories	Reproducible facts.	Will it work?	Meaning
	Role models	Personal heroes.	Eminent citizen.	Nobel prize winners.	Powerful leaders.	Writers, artists.
	Examples	Individual stories and experiences shared with friends, family members, neighbours	Globally-oriented new social movements and their contributors contribute with role models and shared spaces for experience and social learning.	Research institutes, scientific experts contribute with evidence-based and systematic knowledge.	Parties, federal agencies, non-governmental organizations, private companies implement possible solutions.	Artists inspire through new images and visions.

EXAMPLE 2
Decarbonizing society

The adoption of less energy-intensive, de-carbonized lifestyles in society would mitigate climate change. This is, however, difficult to achieve as little knowledge and experience exists. Nevertheless, different knowledge cultures and organizational structures can initiate a process of social learning.

TABLE 7 — Contribution of different knowledge cultures.

Knowledge culture	Contribution
Individual	Adapts less energy-intensive lifestyle to fulfill own needs, and generates knowledge by reflecting on individual experience.
Community	Mutual sharing of values, experiences and knowledge about living a less energy-intensive lifestyle within the community. Communities can share knowledge and experiences with other communities.
Academic specialist	Compares different types of less energy-intensive lifestyle, and systematically analyzes their efficiency.
Organization	Seeks to strategically implement less energy-intensive lifestyles in society. Asks about costs and benefits of implementation.
Holist	Inspires and motivates. May connect isolated initiatives and integrate individual experiences into books, films or other artwork that can influence large populations.

1.3. Systems thinking: when systems relate

Boundaries are the borders of a system determined by its participants. They will determine the contents (knowledge, people etc.) of the system. Boundaries are social or personal constructs that are related to the world-views and interests of the social group within the system. Where different systems and their social groups interrelate, legitimation of boundaries becomes necessary. Boundaries are negotiable and can be questioned. This process is called boundary critique and is part of systems thinking (Ison, 2008).

Systems thinking includes a triple loop of social learning:

- **First.** Understanding interconnections between elements of a system. Know the issues.
- **Second.** Engaging with multiple perspectives of members of interrelated systems. Understand their frames.
- **Third.** Making boundary judgments. Reflect on their frames and the limitations of these frames.

FIGURE 5 — Bees graffiti. London's East End.
Chow, 2015. Photo courtesy of Louis Masai and Jim Vision.

EXERCISE 2
Systems thinking on the use of neonicotinoids in agriculture

An example of a complex system and systems thinking is the use of neonicotinoids as pesticides in agriculture. Neonicotinoids are systemic pesticides that generate negative interdependencies with several elements of ecosystems. Please complete the table. Think about issues, perspectives and values, as well as frames and their limitations.

TABLE 8 — Systems thinking on the use of neonicotinoids in agriculture.

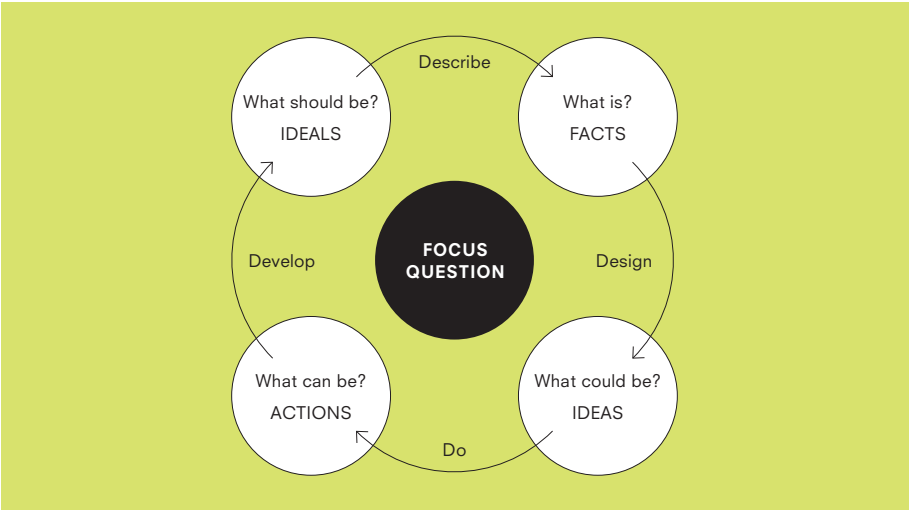
Understanding interdependencies	**Issues**
• Honey bees / pollination • Biodiversity • Pollution • Human health	
Engaging with multiple perspectives	**Perspectives and values**
• Farmers • Environmentalists • Chemical industry • Organic sector • Current and future generations	
Reflecting on boundaries	**Frames and their limitations**
• Technocratic (quick fix) *vs.* deliberative (well-reasoned decision-making). • Reflection on economic models. • Different regulatory bodies (national / international). • Production-centered perspective *vs.* agro-ecosystem perspective.	

1.4. Steps in collective inquiry

How can boundary work and boundary critique be accomplished? Collective inquiry is about asking and answering questions together, building shared knowledge and carrying out the triple loop of social learning. In their book *Tackling wicked problems through the transdisciplinary imagination*, Brown, Harris and Russell (2010) describe a framework of collective inquiry that can be applied to overcome boundaries between interrelated systems. It can be implemented as a learning cycle that moves from knowledge to action:

- **What should be?** Making the underlying world-views, values and interests of each individual and social group, as well as the normative social context, visible to generate ideas from the plurality of opinions and to enable questions about what ought to be. **Ideals**.
- **What is?** Bringing together knowledge from different social systems to make knowledge more complete. **Facts**.
- **What could be?** Brainstorming the potential; validating the ideals in combination with knowledge and reason through a social process of critical debate aiming at discussion and consensus. **Ideas**.
- **What can be?** Transforming the results into action and judging their consequences on those affected and the broader community. **Decision-making and action**.

FIGURE 4 — Steps in collective inquiry. Adapted from Brown, 2010.



EXAMPLE 3
Adopting a low-carbon lifestyle

Let us focus on just one of the contributing knowledge cultures mentioned in example 2, the individual, and run through the four stages that allow social learning. Imagine you want to adopt a low-carbon lifestyle. Some examples of questions that you could ask at the different stages:

- **What should be?** What should a low-carbon lifestyle look like? Why is it necessary? Why do I want to adopt it? **Personal world-view, values**.
- **What is?** What lowcarbon lifestyles exist? How do they work? How does my current lifestyle relate to them? What expert knowledge is available about low-carbon lifestyles and their pros and cons? **Knowledge**.
- **What could be?** What could my low-carbon lifestyle look like? What is the target I want to address through possible actions and change in my current lifestyle? What resources do I need for this? **Ideas**.
- **What can be?** How could I transform my current lifestyle into a low-carbon lifestyle? What actions must I implement? Can I still pursue my interests? Where do I see conflicts? **Actions**.

1.5. Places to intervene in a system

The 'holy grail' of managing complex systems is to identify key 'leverage points', where small changes can have big effects. This is often unintuitive, and it is historically common for business managers or policymakers to push for change in all the wrong directions. In her book *Thinking in Systems* (2008), the scientist and systems analyst Meadows describes how, while attending a *North American Free Trade Agreement (NAFTA)* meeting in the early 1990s, she got frustrated by the very few mechanisms in place for managing the effects of proposed new systems. As a consequence she eventually described 12 leverage points with their varying effectiveness for change in a system.

The least effective **leverage points** are those that target the physical aspects of an existing system, e.g., numbers, parameters (taxes, subsidies), buffer sizes, material stocks and flows (transportation networks, demographics), and the regulation of delays relative to the rate of change within the system. These low-level leverage points are obvious and common targets for managers and policymakers aiming to monitor or regulate complex systems, but they either have little effect, or are extremely difficult or impossible to implement. They are therefore considered the least powerful.

The next leverage points deal with the information and control elements of a system, e.g., negative feedback and loops through information flows (who can access information) and system rules (incentives, constraints). These leverage points are powerful for effecting change because they are strong regulatory processes that have exponential or overarching effect on the systems in which they operate.

The last and most powerful leverage points are on the meta-level. They include the power of a system structure to **self-organize and evolve**, to **change the goals of a system**, to alter the **mindset or paradigm from which a system arises** and finally the **power to transcend paradigms**.

Changing the system on a fundamental level has deeper consequences than playing around with existing parts or operational rules. It is often difficult to identify the most effective leverage points within a system, and the higher a leverage point is, the more the system will resist change.

2. COMMENT

Julia Backhaus
PhD candidate at Maastricht University, the Netherlands

2.1. Multi-level perspective on socio-technological transitions

The **m**ulti-**l**evel **p**erspective (MLP) on socio-technical transitions has developed into a popular framework to think about and stimulate system change. The MLP has a sectorial focus (e.g., food, energy, transport) and distinguishes innovative ´niche´ developments that are different from or rival to incumbent socio-technical ´regimes´ and that occur amidst large-scale, often global trends, so-called ´landscape´ developments (Geels, 2002). **S**trategic **n**iche **m**anagement (SNM) and **t**ransition **m**anagement (TM) are proposed as methods to bring about system change.

Strategic niche management (SNM) aims to develop and foster alternative configurations of (new) technologies; rules, regulation and policies; infrastructures; industries; knowledge and skills; practices and preferences; culture and meanings in ´niches´ that are shielded from the dominant ´regime´ (Kemp, Schot and Hoogma, 1998); for example, organic farming and food cooperatives as niche alternatives to intensive agriculture and large food retailers. The biggest challenge is supporting and growing niches to a mature-enough level to compete with the incumbent system. Strategies discussed in the literature to tackle this challenge are replication, up-scaling and embedding. While replication refers to the transfer of concepts and ideas from one place or context to another, up-scaling simply means the growing and maturing of a project, programme or initiative in a place where it has become established. Embedding, finally, implies better support of existing projects, programmes or initiatives to improve their foothold and, ideally, their stabilisation and maturation until the point of successful self-reliance.

Transition management (TM) is a governance strategy involving multi-actor participation in niche experiments (Rotmans, Loorbach and Kemp, 2007). It suggests bottom-up strategies to support niches and top-down measures to create windows-of-opportunity for niches to stabilise and get established. Planning and strategy tools used include vision-building (to agree on targets and seek stakeholder buy-in), scenarios (to extrapolate from current and planned developments) and backcasting (working backwards from an envisioned and ambitious target to develop implementation strategies).

To bring about system change, people from various domains (for example, policy, technology R&D, civil society, research) engage in social learning and joint knowledge production by experimenting with alternative ways of living, innovative technologies, or new forms of governance.

2.1.1. Policy-oriented social learning for strategic niche management and transition management

Social learning is part and parcel of strategic niche management and transition management, entailing acquisition of knowledge (single-loop learning) as well as examination of dominant assumptions (double-loop learning). Moreover, SNM and TM will both – if a system transition is to be achieved – challenge prevailing norms and values (triple-loop learning).

An interesting field of research that has developed in the political sciences is the study of social structures active in changing policies and policy paradigms. Salient among these are **advocacy coalitions**, consisting of "actors at various levels of government, as well as journalists, researchers and policy analysts who play important roles in the generation, dissemination, and evaluation of policy ideas" (Jenkins-Smith and Sabatier, 1994: 179; see also Sabatier, 1999). These coalitions interact within policy subsystems, and it is not unusual for a specific coalition to dominate and have the most impact on actual decision-making.
The 'glue' holding a coalition together is a shared belief system (Cairney, 2015: 486), of which three main types or levels can be distinguished: **deep core beliefs, policy core beliefs** and **secondary aspects**[1] (Sabatier, 1999). Policy change most frequently concerns secondary aspects, related to policy implementation, and seldom policy core beliefs regarding the most appropriate distribution of power and goals to pursue. Especially those core beliefs that are central to a coalition are unlikely to be questioned, let alone changed. However, internal shocks in the form of a 'crisis of confidence' (Cairney, 2015: 488), e.g., in light of fatal election outcomes, or external shocks, such as a political or environmental crisis that other coalitions can exploit and respond to much better, can trigger a revision of policy core beliefs. Policy-oriented (social) learning here refers to the **interaction** of advocacy coalitions within a policy subsystem, the **experience** and **evaluation** of events and their consequences framed by core beliefs, the **adaptation** of either secondary aspects, or even policy core beliefs, the effective mustering of **evidence** for the coalition's position (Hall, 1993) and, as a result of these **actions**, a potential impact on policy.

A different, albeit still related field of research addresses questions of power and agency in the context of norm formation and compliance. Wenger (2000) coined the notion 'communities of practice' and stressed how social learning relies on **participation**. In the course of actions and interactions, individuals gain experience and understanding of their context and, at the same time, change that context. While this classic concept of dual agency offers valuable insights, underlying mechanisms of learning remain opaque, or 'black boxed'. In an admirable attempt to reconcile rationalist and constructivist views, Checkel (2001) posits[2] that the reason why people adhere to social norms may be internalization following interac-

tion (constructivist view) rather than cost/benefit analysis in relation to existing incentive structures (rationalist view). In accordance with both views (and with Sabatier), a more malleable level of implementation or action strategy will be based on a more rigid grid of norms. Complex or double-loop learning is also credited with bringing about changes in preferences and actions. For Checkel (2001), collective **deliberation**, **argumentation** and **persuasion** provide evidence of social learning and are thus to be traced in social interaction as proof of changes in norms. In his line of reasoning, (full) participation in the process is a prerequisite for, and even bound to lead to, social learning. Given Checkel's (2001) focus on discussions in the public sphere, participation here implies verbal exchange and engagement, while Wenger refers more broadly to any form of communal participatory practice.

[1] Deep core beliefs are based on an "underlying personal philosophy" and include convictions regarding human nature as basically 'good' or 'evil', or, for example, the relative importance of freedom and security (Sabatier, 1993: 30). Policy core beliefs are "fundamental policy positions" and relate, for example, to the proper level of government interference in the market (Sabatier, 1993: 31; 1998: 110); secondary aspects comprise the funding, delivery or implementation of policy goals (Sabatier, 1993: 31). Changes in deep core beliefs are "akin to a religious conversion" (Sabatier, 1993: 31, 36) and are rarely observed.

[2] The article by Checkel (2001) focuses on adherence to international norms on the national (policy) level but includes a sweeping review of research on norm compliance across 'scale levels', from the individual to the global.

2.1.2. Collaborative governance for sustainable resource management

Building on the idea of participation as an integral aspect of social learning, Pahl-Wostl and Hare (2004) developed tools combining social involvement processes and content management to support what they call (computer model-facilitated and -mediated) integrated resource management. As key ingredients for collaborative governance in sustainable resource management (Pahl-Wostl et al., 2007), they stipulate mutual **awareness of sometimes different goals and perspectives, shared problem identification, recognition of the complexity of the problem,** and the **interdependence, trust** and formal as well as informal **interrelation of all actors in the process of learning to work together**. Referring to Folke et al. (2003) they point to the crucial role social learning plays in dealing with uncertainty and change. Moreover, in terms of institutional setting, **assured, stable and flexible networks across scale-levels and stakeholder groups** are needed for effective social learning (Pahl-Wostl et al., 2007). This requires **process-oriented approaches** (Pahl-Wostl et al., 2008).

In research related to social innovation (Moulaert et al., 2013), sustainability science (Reed et al., 2010) or resource management (Schusler et al., 2003), social learning has come to denote **multi-level and multi-actor stakeholder processes** comprising **communities of learners** committed to learning about, for example, best practices, context-specific approaches, or long-term change (Wals and van der Leij, 2007).

In a comprehensive response to several articles discussing social learning in the context of resource management, Reed et al. criticize a frequent conflation of the concept with participation, a confusion of processes and outcomes, and a lack of differentiation "between individual learning and wider social learning". They argue that to be considered social learning, a process must:

> Demonstrate (1) that a **change in understanding** has taken place **in the individual** involved; (2) that this change goes **beyond the individuals** and becomes situated within wider social units or communities of practice; and (3) that it occurs through social **interactions** and processes between actors within a social **network**. — Reed et al., 2010.

In sum, several signals signposting different levels of learning become apparent here that need to be considered separately. The following table outlines relevant preconditions and aspects of these processes. It shows how social learning processes are identical for first and second order, or single- and double-loop learning, yet the outcomes are somewhat different. The challenge for niche-level actors, as well as scientists and policy actors, who seek to bring about, shape and facilitate sectorial transitions lies in sparking, engaging in, and continuing these processes that are useful, or indeed essential, for keeping track of advancements, dealing with set-backs, and thus monitor the impact of their efforts.

TABLE 9 — Levels, processes and outcomes of social learning.

Level	Process	Outcome
Antecedents	• Commitment to working together in social relations (participation). • Observation and interaction.	• Social network with diverse participants. • Trust. • Qualitative prerequisites for social learning are present.
Single-loop learning	• Deliberation, argumentation (potentially also persuasion). • Critical thinking and discussion. • Questioning power and privileges.	• Change of strategy considered effective. • Goals unquestioned.
Double- and triple-loop learning	• Deliberation, argumentation (potentially also persuasion). • Critical thinking and discussion. • Questioning power and privileges.	• Awareness of different goals and perspectives. • Recognition of the complexity of the problem. • Revision of assumptions and deeply held beliefs.
Action	• Calls to action.	• Plans / strategies for action.

MORE READING

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research Policy, 31(8–9): 1257–1274.

Reed, M. S., A. C. Evely, G. Cundill, I. Fazey, J. Glass, A. Laing, J. Newig, B. Parrish, C. Prell, Raymond, C., Stringer L.C. (2010). What is social learning? Ecology and Society, 15(4).

3. TOOLS for collective inquiry

Robin de Carteret
Founder of systemsgames.org.uk, United Kingdom

Martin Reynolds
Lecturer at the School of Engineering & Innovation, Open University, United Kingdom

Ivo Wallimann-Helmer
Professor of Environmental Humanities, University of Fribourg, Switzerland

Markus Huppenbauer
Professor of Ethics, University of Zurich, Switzerland

3.1. Systemic complexity games

The world becomes more complex, highly networked and globalized, but we still use a linear, mechanistic understanding of the world. Reductionism and linear thinking has been hugely beneficial but when dealing with complex, 'wicked' problems. We need a different approach. We need a shift to a more systemic view of the world, where we recognize that we are part of multiple interacting systems, such as organizations, economies, societies and ecosystems.

Systemic complexity games help participants to explore how complex systems operate. The interactive nature of the games gives a live experience of dynamics such as emergence, feedback, chaos and self-organization. This can provide a deeper understanding of fundamental dynamics in any complex system and potentially throw light on solutions to complex problems in an increasingly unpredictable world.

Here we present two systemic complexity games: the complex handshake and the systems game.

3.1.1. Complex handshakes 1,2,3

Purpose
The main point of this activity is that in complex systems the interactions are key. Trying to understand the system by looking at the parts in isolation will not allow you to fully understand how it works.

Applications
Complex handshakes help participants to explore more deeply how group dynamics emerge from simple behaviors of interacting parts. Leading / following, domination / submission, competition / collaboration are some of the dynamics that emerge in groups – humans are very good at negotiating these issues, often intuitively rather than through analysis.

Time needed
10–20 minutes.

Implementation

STEP 1 — Begin by shaking hands with everyone in the room and saying your name.
STEP 2 — Everybody secretly chooses a number – either 1, 2 or 3. This will be the number of shakes you will do for each handshake.
STEP 3 — Predict what you think might happen – what might emerge from this simple rule? Now try to shake everyone's hand again using your secret number of shakes and try to observe any emergent behaviors.
STEP 4 — Discuss the outcome. What emergent behaviors did you notice? Did anyone laugh? Did anyone predict laughter? The behaviors of parts lead to some predictable and some unpredictable emergent behavior in the whole.
STEP 5 — Choose a different number. Now as well as trying to shake your number, more importantly, try to shake the number of times you think the other person wants to.
STEP 6 — Discuss the outcome. How did you decide when to stop shaking? Did you notice differences in how firmly you shook? Did you notice some participants being more dominant or submissive? This shows how great humans are at working with complex interactions.

3.1.2. Systems game

Purpose
In this game, each person follows a very simple rule and acts only according to it. The behavior that arises is fascinatingly unpredictable and is different each time the game is played. Playing this game gives a sense of how the intricate behavior of a system could emerge from the interaction of its elements.

Applications
The systems game helps participants to understand that centralized control is not the only way to create order. In some situations distributed intelligence is much more effective than top-down control. In this game participants can see a system moving from chaos to order spontaneously. They experience a system passing a tipping point where path dependence means that a system will not necessarily return to its previous stable state. They get an understanding of how scale matters in complex systems, with more connections and nodes affecting the whole system in a non-linear way.
The system will start off going into a chaotic, unpredictable movement – even though no single person is leading this movement. Then the system will usually stabilize with a group of up to 15 people. We can use this as a powerful example of many different types of system: the climate system, the economic system, an ecosystem and social change. Asking one element to move will result in destabilization, but often the system will restabilize – showing self-regulation.

Time needed
10–40 minutes.

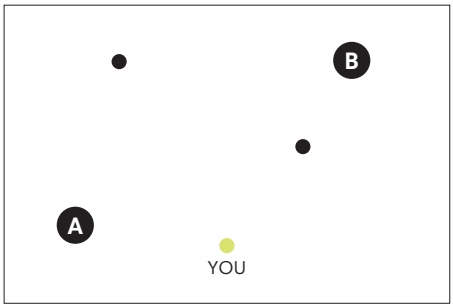
Implementation

STEP 1 — All the participants are 'elements' in a 'system'. Decide what kind of system we are representing? The climate change system? An ecosystem? An economic system?
STEP 2 — Secretly choose two other 'elements'. For the rest of the game, you must stand equidistant from the two elements you have chosen – effectively there is a line equally dividing the space between your two elements that you have to try to stand on (see diagram on p. 41).
STEP 3 — The game begins when all elements move to stand according to the equidistant rule. If the group does not stabilize, reiterate that you should move only when you have to in order to stay equidistant from your chosen two.
STEP 4 — Wait until the system has stabilized. Choose one element (representing CO_2 levels, decomposers, exchange rates, etc.) to now take a very small step in either direction that still obeys the 'equidistant' rule; the other elements should adjust. The system will be disrupted and almost always everyone in the group will need to move a small distance.

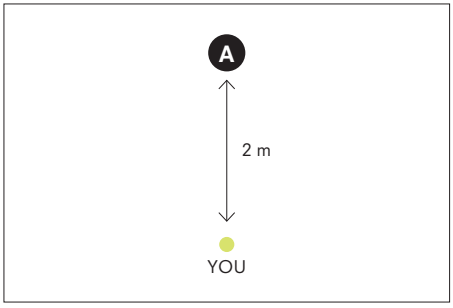
STEP 5 — With a small disruption the system often self-regulates and stabilizes again. Ask the same element to move again, but this time with a few steps, this time the whole system is usually pushed past a 'tipping point' and the following chaos will result in the elements settling into a completely new stabilized 'state'.

More options for the game:

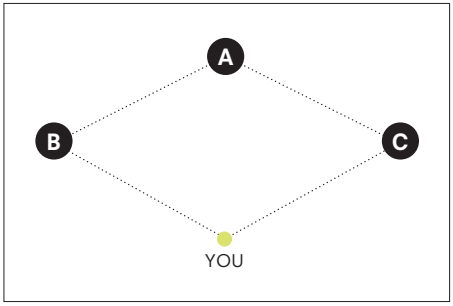
Change initial conditions
Choose two different people to follow each time (butterfly effect – small changes can cause massive effects).



Change connectivity
Follow one person – stand 2 meters away from your chosen person. This stabilizes very quickly and does not really go through a period of chaos. A system like this would be stable but not very adaptable or resilient to changes.



Following three players
Position yourself to make the 4th corner of a parallelogram (four sided shape with parallel opposite sides). This goes into chaos and never stabilizes. A system like this would not be able to function, due to lack of stability.

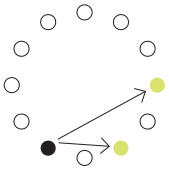


Following two players (the original game)
Usually puts the system at the edge of chaos. A system such as this has enough stability to function but can dip into chaos when it needs to in order to adapt and come up with new ways of dealing with change. Living systems operate at this balance point of chaos and stability.

Change rule
Create systems with different characteristics, which are emergent properties. A real world example of this would be the characteristic of a team where individuals respond to problems with anger and blame compared to a team that responds with compassion and understanding. Reflection: If you want to make changes to a system you are working with, such as a policy issue, what would it mean to change the rules by which that system operates?

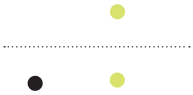
Variations
Monsters and monsters. Choose two people and stay as far away as possible from both (simply explodes to the walls).
Friends and friends. Choose two people and stay as close as you can to both (simply a big huddle!).
Monsters and friends. Choose one monster to stay as far away as possible from and choose one friend to stay as close as you can to. This tends to create lots of chasing and fun – but also interesting mini-dynamics of subgroups.

1



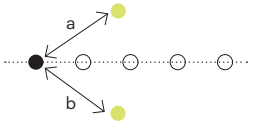
Randomly choose two other people in the group.

2



You can ignore everyone else in the group. There is an imaginary line that goes between your chosen two persons.

3



a = b

Try to always stand on this line – even as your chosen two persons move around. Anywhere on the line is fine (on the line you are equidistant from your chosen two persons).

MORE READING

Capra, F. (2002). The Hidden Connections. London: HarperCollins.

Systems games website: systemsgames.org.uk

3.2. Critical systems heuristics

Purpose
A particularly powerful systems approach is **c**ritical **s**ystems **h**euristics (CSH). Based on boundary critique – i.e., dealing explicitly with boundaries and boundary judgments – CSH introduces a simple generic framework of systems thinking in practice as 'conversation'. There are three orders of conversation: first, with reality (interpreting evidence); second, with stakeholders (exploring values); and third, involving reflection on the limitations of bounding evidence and values on developing systems.

Three complementary core ideas are outlined:

- Understanding interrelationships
- Engaging with multiple perspectives
- Reflecting on boundary judgments

CSH was developed by Werner Ulrich (2010), based on the systems thinking philosophy developed by C. West Churchman (1979).

Applications
Boundary critique with CSH does not provide solutions to complex problems but rather an approach to framing complex problems. The challenge for practicing scientists is to seek ways in which ideas of boundary critique might be adapted for their own skill-sets and institutional practices.

Time needed
1 to 2 days.

Implementation
The worksheet in table 10 provides guiding question for CSH. The four sets of CSH questions provide a reference system for examining the four sources of influence affecting any systemic design and systemic evaluation: (1) motivation and values; (2) control and decision-making; (3) knowledge and uncertainty; and (4) legitimacy and politics.

TABLE 10 — Worksheet for CSH. Boundary questions informing a system of interest (S). S may represent an intervention such as a policy, a program or a project. These questions are answered in three loops, see table 11.

Source of influence	**Stakes / Role-specific concern**	**Stakeholders / Social roles**	**Stakeholding / Key problems**
Who gets what?	(1) Key objectives of S?	(2) Intended clients or customers of S?	(3) S's measure of improvement?
Motivation and values.	**Purpose**	**Beneficiary / client**	**Measure of success**
Who owns what?	(4) Resources and other conditions of success controlled by the decision-maker to secure improvement?	(5) Those in command of resources necessary to enable S?	(6) Conditions of success outside the control of the decision-maker for S?
Control and decision-making.	**Resources**	**Decision-maker**	**Decision-environment**
Who does what?	(7) Relevant knowledge and skills supporting S?	(8) Those providing relevant knowledge and skills for enabling S.	(9) Promises or guarantee of successful implementation of S?
Knowledge and uncertainty.	**Expertise**	**Expert**	**Guarantor**
Who is affected by what some people get?	(10) Constraints on the interests of those negatively affected to have freedom of expression and independence from the world-view of S?	(11) Those representing the interests of those negatively affected by but not involved with S?	(12) Opportunities available for reconciling contrasting giving meaning to improvement in S?
Legitimacy and politics.	**Emancipation**	**Witness**	**World views**

A worked out example of a CSH analysis is presented in 'Chapter 4. Example'.

TABLE 11 — Worksheet for loop 1, 2 and 3. Loop 1 involves an analysis to establish an ideal viewpoint, the 'ought'. Loop 2 involves engaging with multiple perspectives – through contrasting normative viewpoints – different value judgments according to ideal 'ought' reference systems. Loop 3 involves generating models through boundary critique. Adapted from Ulrich, 2000; Ulrich and Reynolds 2010 Table 6.1: 244.

Source of influence		Stakes	Stakeholders	Stakeholding
Motivation and values.		**(1) Purpose**	**(2) Beneficiary**	**(3) Measure of success**
	Ought			
	Is			
	Critique			
Control and decision-making.		**(4) Resources**	**(5) Decision-maker**	**(6) Decision environment**
	Ought			
	Is			
	Critique			
Knowledge and uncertainty.		**(7) Expertise**	**(8) Expert**	**(9) Guarantor**
	Ought			
	Is			
	Critique			
Legitimacy and politics.		**(10) Emancipation**	**(11) Witness**	**(12) World-views**
	Ought			
	Is			
	Critique			

MORE READING

Churchman, C. W. (1979). The systems approach and its enemies. New York, NY: Basic Books.

Reynolds, M. (2014). Triple-loop learning and conversing with reality. Kybernetes, 43(9/10): 1381–1391.

Reynolds, M. (2015). Rigour (-mortis) in evaluation. Evaluation Connections: The European Evaluation Society Newsletter, June 2015, Special Edition: 2–4.

Ulrich, W. (2000). Reflective practice in the civil society: The contribution of critically systemic thinking. Reflective Practice, 1(2): 247–268.

Ulrich, W., Reynolds, M. (2010). Critical systems heuristics. In: Reynolds, M., Holwell, S. (eds). Systems approaches to managing change: a practical guide. London: Springer: 243–292.

3.3. Five-step model for ethical inquiry into complex problems

Purpose
Ethics reflects the moral aspects of any kind of challenge and especially of complex problems. Ethics asks, 'What should be?' given the facts, dilemmas and normative claims. It is always worth analysing complex problems through a normative-ethical lens since many, if not all, complex problems incorporate moral issues. The five-step model allows decision-making in situations in which our moral intuitions do not provide convincing guidance.
Ethical analysis is not only a means to clarify your individual moral position but also to analyze the challenge you face from a moral point of view. Using the five-step model allows you to identify the ethical challenges, acquire a more encompassing understanding of them and make a well-reflected ethical decision.

Applications
The five-step model functions as a toolbox, containing the instruments suited to processing and solving moral problems. The method can break down complex moral disputes into manageable steps and guide the decision-making process in a reliable manner.

Time needed
Depending on how familiar you are with ethical issues and depending on the complexity of the challenges you face, applying the five-step model can take from one hour up to a full working day.

Implementation
The method comprises five steps. Investigate the following questions on the worksheet whenever you face a moral problem.

TABLE 12 — Worksheet for carrying out a five-step ethical inquiry.

0 — Point of departure: What bothers or disturbs you?
1 — Who are the relevant stakeholders?
2 — What are the morally relevant question(s)?
3 — What reasons speak for, and what reasons speak against the options available?
4 — How would you evaluate the case from a moral point of view?
5 — What implementation would you suggest?

Point of departure – ethical awareness

It is not easy to locate the ethical issues involved in complex challenges. But there is one important indicator: an ethical challenge provokes feelings such as outrage, shame, guilt or bad conscience. More generally speaking, if a situation or behavior disturbs or bothers you, then there might be an ethical issue involved.

STEP 1 – Analyze the situation
Identify all relevant stakeholders from the relevant legal, economic, political or ideological contexts. In ethical decision-making, fairness dictates that all those affected by a conflict of interest should be considered.

STEP 2 – Identify the morally relevant question(s)
Clarify the moral problem by identifying and defining the moral question(s) at issue. Moral questions are normative. They ask what should be prohibited, imperative or permissible.

STEP 3 – Analyze the arguments
Make a complete list of all arguments that the various stakeholders could raise in support of their convictions, for or against certain solutions to the challenges or varying assessments of the case at issue. Since different stakeholders might raise similar arguments, focus on the structure of the arguments, disregarding their point of origin. Ensure that the arguments listed are indeed moral arguments.

STEP 4 – Evaluate and decide
Evaluate the complete list of arguments in the most unbiased and impartial manner possible, distancing yourself from your own personal convictions. To perform the evaluation and decision, it is helpful to rely on one or several of the following three classical ethical theories. Each of these theories works as a lense providing a specific view on the case:

- **Consequentialism.** The consequences of an action are relevant. Through actions, as much good should be achieved and as much bad should be avoided as possible.
- **Deontology.** Proponents of this view often maintain that persons must be treated as ends in their own right and may not be instrumentalized as means.
- **Virtue ethics.** This theory focuses on moral competencies (e.g., integrity, fairness, loyalty, courage, honesty). Actions stemming from these virtues are morally correct.

STEP 5 – Implement
In an ideal world, the involved stakeholders would implement what they have agreed upon to be morally correct. However, circumstances are not always favorable, and human beings do not always want to be moral, so some creativity may be needed. The most common ways to implement an ethical decision are: (1) making it legally codified; (2) using economic incentives to foster ethical behavior; or (3) ideally, the stakeholders themselves feel obliged to implement certain decisions, simply because they are convinced by the arguments developed in the process.

SOURCE — adapted from

Bleisch, B., Huppenbauer, M. (2014). Ethische Entscheidungsfindung, Zürich: Versus Verlag.

EXAMPLE 4
Streetlights

We will work with the model case 'Swiss municipalities switch the streetlights off between 10 pm and 5 am presented in exercise 1 (p. 17) using the three ethical lenses described above to evaluate the case from an ethical point of view.

From a **consequentialist** perspective, what are the **benefits** and **costs** of the action 'Switch off lights between 10 pm and 5 am' that must be considered? For example:

- **Benefits.** How much energy is saved? What is the expected benefit for the environment? Other?
- **Costs.** How much investment is needed to install a dimming system? How large is the risk of loss in property rates or for local trade?

From a **deontological perspective** what rights and duties are involved? For example, every citizen has a **right** to feel secure in public space; this includes anyone that may feel impaired in his or her security when they are out late at night. No evaluation is necessary if they are exposed to real danger. The following questions can be discussed based on the exemplary conduct of stakeholders or communities in this town.

- What are the **duties** for policy-makers that arise from this right?
- What are other rights and duties connected with the new light regime?

From a virtue ethics perspective, the following question can be discussed, based on the exemplary conduct of stakeholders or communities in this town:

- What are the **virtues** and **vices** that need to be considered?
- What behaviour is morally correct of the different agents involved?

Depending on the ethical lens you base your evaluation and decision, other issues come into focus and other weaknesses have to be taken into account. Consequentialism makes all benefits and costs visible; it has its limitations where benefits for the majority override the rights of single individuals, minorities, or neglected groups. Deontological analysis can put the focus on minorities or neglected groups but is weak when it comes to the overall weighting of benefits and costs. Virtue-based decisions may often work when you have a clear view of how a morally good person in the role relevant to decide the challenge would behave. If you do not have such a view you might want to rely on one of the first two lenses.

4. EXAMPLE of collective inquiry

Yuanyuan Huang
Former PhD student at the Department of Evolutionary Biology and Environmental Studies, University of Zurich, Switzerland

Constantin E. Pöll
Former PhD student at University of Basel, Switzerland

Laura Damerius
Former PhD student at the Department of Anthropology, University of Zurich, Switzerland

Eric Rahn
PhD student at the Chair of Ecosystem Management, ETH Zurich, Switzerland

As former participants in the PSC Science & Policy training program for graduate students they have worked out this example of a CSH analysis as part of the *Summer School: Tackling wicked problems* organized by the Zurich-Basel Plant Science Center in September, 2015.

4.1. Biodiversity conservation through coffee agroforestry

Question
How can livelihoods be improved / maintained while ecosystem services are increased / maintained in the Kodagu district of the Western Ghats in India?

Starting point and background
Across the globe, many coffee plantations are located within areas declared as biodiversity hotspots. In India, the 6th largest producer of coffee worldwide, highly profitable coffee plantations are located in the Western Ghats biodiversity hotspot. In the Kodagu district of the Western Ghats the most planted coffee is the Robusta variety *(Coffea canephora)*. It is grown under complex, multi-storied agroforestry systems with a diversity and density of indigenous tree varieties that is about half that of the surrounding natural forests. The figure has worsened over the past 30 years due to intensification and changes in shade tree canopy and composition (Garcia et al., 2010).

Tree-cover changes are driven mainly by three different management interventions: when farmers (1) replace forest habitats with coffee plantations; (2) remove shade trees to increase productivity; and (3) replace a rich and diverse evergreen and moist deciduous canopy cover by planting silver oak *(Grevillea robusta)*, a fast growing tree originating in Australia. Of these three practices, the slow conversion to silver oak is most prevalent because this species can be logged and traded easily, while harvesting native species is severely restricted. In this context, two broad campaigns have surfaced, providing potential solutions to these complex landscape level changes.

Certification for sustainable coffee production in the form of *Rainforest Alliance* and UTZ-certified schemes have been proposed, to encourage farmers through price premiums to switch to more ecologically acceptable farming practices. Second, independent of any formal conservation movement, farmers and their representatives have been actively demanding a policy change giving them full ownership rights over the trees on their land and lifting all restrictions concerning harvesting. One of their key arguments is that granting ownership and harvesting rights would lead to better management, including increased afforestation efforts. The underlying ideology is that 'the government trees are not desirable but we will plant trees if we have ownership over them'. Despite solutions proposed by the two campaigns, research indicates that neither proposal is likely to fully address the loss of biodiversity from coffee farms.

Certifications implemented as universal blueprints across coffee producing nations have limited impact in the Indian context. For example, the *Rainforest Alliance* requires certified farms

to maintain 12 native tree species per hectare, while a typical coffee farm in Kodagu (~2 ha) already has an average of 34 species. With regard to tree rights, an exercise on participatory scenario building has shown that restitution of tree rights, as farmers' campaigns have demanded, would speed up the removal of native trees from the landscape instead of reversing it. Previous attempts showed that most coffee farmers removed native species and replaced them with fast-growing exotics. However, the absence of existing solutions provides an opportunity for new approaches that are both democratic and effective.

The complexity of the interconnected system components and the contrasting perspectives, objectives, and needs of different stakeholders has prevented researchers from identifying solutions that maintain, let alone increase biodiversity on a landscape scale. It is a wicked problem, since interventions have always been accompanied by negative side-effects, and multiple objectives and perceptions have hindered successful implementation of suggested measures. Erratic changes in coffee and timber prices, climate variability and the unintended consequences of intervention measures have resulted in heightened uncertainty and a need for continuous adaptation.

Different perceptions, objectives and stakeholder needs result in different versions of problem definition and framing. The wicked problem needs to be addressed by combining inputs and perspectives from social science, political science, ecology and the economy, as well as from relevant stakeholders, i.e., plantation owners, farmers, local and national communities, the coffee board, coffee companies, the Forestry Ministry, the ecosystem and local NGOs such as for example the *Ashoka Trust for Research in Ecology and the Environment (ATREE)*.

Based on this background information we carried out critical system heuristic analysis (see table 13).

Table 13 — CSH analysis: 12 questions. Loop 1, the 'ought' parameter, is contrasted with loop 2 and its multiple perspectives or frames. Loop 3 generates models through boundary critique.

	Source of influence	**Stake / Role-specific concern**	**Stakeholder / Social roles**	**Stakeholding / Key problems**
Ought	**Who gets what?** *Motivation and values.*	*Purpose* Key objective How to improve farmer's livelihoods through agroforestry while maintaining/ increasing ecosystem services?	*Beneficiary / client* Intended clients or customers? **Farmers.** **Agro-Ecosystems.**	**Measure of success** Measure of improvement? **Farm** income. **Health** status and security of farmers. **Number** native tree species maintained on farm. **Area** where native tree species are grown.
Is		Double income through production of coffee and exotic timber. *Premium prices for high quality coffee.*	**Farmers.** **Coffee companies.** **Wood industry.**	**Unfolding landscape change through:** **Demand** for easy accessibility to exotic timber. **Increase** in exotic tree area. Logging of native shade trees to increase coffee production. **Demand** for quantitative / qualitative coffee production.
Critique		What are the likely damaging effects of the ongoing landscape change?		
Ought	**Who owns what?** *Control and decision-making.*	*Resources* Relevant components ('capital') to secure improvement? **Finances** (for coffee, timber and incentives). **Ownership** of native trees / licenses. **Ownership** of land. **Human** capital. **Ecosystem** services e.g., pollinator abundance / pollinator services.	*Decision-maker* Those in command of resources? **Forest** Ministry. **Coffee** companies. **Wood** industry. **Local communities** / farmers. **Local NGO**: Rainforest Alliance. **Ecosystem.**	*Decision-environment* Conditions of success outside the control of the decision-maker? **Sustainable** coffee market. **Sustainable** wood market. **Need** for autonomy of local community. **Maintenance of quality** of ecosystem services.
Is		Sell licenses. Increasing demand for coffee production. Increasing demand for timber production.	**Forest** Ministry. **Coffee** companies. **Wood** industry.	Unaccountable behavior of wood industry. Diminishing of pollinator services.
Critique		Is there an interest amongst Forestry Ministry officials to sell many licenses to log native trees?		

Ought	**Who does what?** *Knowledge and uncertainty.*	*Expertise* Relevant knowledge and skills. **Knowledge** about local agriculture, conditions, traditions. **Knowledge** about maintenance of ecosystem services. **Knowledge** about innovative and successful agroforestry examples and their implementation.	*Expert* Those providing relevant knowledge and skills. **Local** community. **NGO** and expert consultancy.	*Guarantor* Promises or guarantee of successful implementation. **Wide** stakeholder dialogue. Mediator that everyone trusts. Media communicating the process to the public.
Is		Lack of knowledge regarding impact of tree species homogenization on ecosystem services and coffee productivity. Biased incentives due to licenses for logging native trees leading to increased uncertainty.	**Local community.** **Local NGO**, ATREE. Research groups.	Local NGO ATREE.
Critique		There is a disconnection between policy, farmer needs and ecosystem resilience. Knowledge exchange, is required and should be mediated by someone everyone can trust.		
Ought	**Who gets affected by what some people get?** *Legitimacy and politics.*	*Emancipation* Constraints on the interests of those negatively affected to have freedom of expression and independence of world-view. Farmers need rights over their trees. They are more likely to preserve something that is their own. Incentives for farmers to maintain native trees and replant native trees.	*Witness / Victims* Those representing the interests of those negatively affected but not involved. **Witness**. NGOs, media, researchers documenting the cause and effects of the landscape changes and communicating to the public. **Victims**. Global community due to biodiversity loss.	*World-views* Opportunities available for reconciling contrasting world-views giving meaning to improvement. Global ideal for biodiversity conservation should allow provision of incentives for maintaining native trees > provide actual value of tree species diversity conservation.
Is		Farmers do not have rights over the native trees on their farm.	Missing link that illustrates the problems farmers are facing to the Forest Ministry.	Consumer interest for coffee with exceptionally high conservation value.
Critique		Tackle issue from a different perspective by enabling new markets that allow the preservation of native trees to be adequately valued.		

Underlying values and interests

The underlying values and resulting interests of the involved stakeholders give an impression of the complexity of this project. The main concern of the **coffee board and coffee companies** is to maintain the quality and quantity of the coffee being produced, ensuring their position on the international trade market. Therefore, they are not necessarily interested in increasing biodiversity on farmland or in the landscape unless it contributes to increasing the quality and / or quantity of coffee production.

Plantation owners and farmers want to maintain or even increase their income from coffee and timber production. It is important to them that the timber is fast-growing and easily accessible. Although the leaves of the introduced foreign tree species decompose more slowly and are not, therefore, as beneficial for coffee productivity as the native tree species, the combined profitability from coffee and exotic timber is more attractive. Safety risks from elephants, tigers and snakes in half-forest-half-coffee plantations result in conflicts, since accidents are fairly common and elephants destroy coffee plants.

The **local and national communities** are interested in keeping their autonomy in decision-making, landscape use and agricultural management, as well as maintaining their farming production and increasing their own incomes. For them there is no direct value in biodiversity.

The **local NGO, ATREE,** has a very important role for the project, as it can serve as a mediator and negotiator between the local / national community and scientists, the Forestry Ministry and other external project partners. Their continued presence succeeding the research project ensures the project's longevity. ATREE's main values lie in the social promotion of environmental conservation and sustainable development by generating rigorous interdisciplinary knowledge that engages actively with academia, policymakers, practitioners, activists, students and wider public audiences.

The **Forestry Ministry** is interested in economic growth, profit and financial support. They manage national forests, including native tree rights. The native trees are not the property of the landowners, but belong to the ministry. This is a crucial conflict for farm owners. Farmers who want to sell native timber have to pay for a permit from the ministry.

Ideas

In order to achieve a more resilient ecosystem and maintain / increase farmers' livelihoods, the focus of a new management approach could center on locally adapted sustainable agricultural practices developed together with farmers and within the institutional context. These objectives are based on the following values: (1) sustainability – biodiversity provides a resilient and stable ecosystem in the long-term; and (2) human rights – equal availability of resources, work, respect, economic welfare for everyone.

Ethical questions have been considered, such as whether the intervention risks leave farmers worse off. There is also the risk of disapproval from local stakeholders against intervention by a project with a different world-view that they feel compromises their ownership and autonomy. Evaluating the project from a moral standpoint and using systems thinking increases the likelihood of identifying appropriate measures and tools to establish conservation channels in the local community.

Negotiation and action

The critical systems heuristic (CSH) provides an iterative analysis of all relevant system components and their interrelationships, allows engagement with multiple perspectives and reflection on their respective limitations. Here it is very important to be clear about issues of value (measures of success) and their relation to issues of power, knowledge and social legitimacy.

Is there a way to improve / maintain livelihoods while increasing / maintaining ecosystem services, taking account of different stakeholders? Improved farmers' livelihoods can be measured by overall farm profitability, health status and security compared to the baseline assessment. Other important measures targeting ecosystem services are, for example, biodiversity indices, coffee production variability, carbon stocks and soil health. Higher-level measures are included which ensure that the influence of the different stakeholders are balanced and allow measures to be adapted to different constellations and/or problem frames.

Several stakeholders, such as the NGO (ATREE) and the Forestry Ministry, are in a position to make decisions about the necessary human, financial, natural and political resources. It is of great importance that the decision-makers are ideally independent of the decision environment. The process of knowledge acquisition requires multiple expertise: scientists as well as community mayors, NGOs and farmers. The knowledge of local ecology, culture, farming methods and livelihoods is of great importance and is acquired by working cooperatively with the different stakeholders. The process will be evaluated regularly and revised accordingly.

It is crucial to consider any possible risks and side-effects caused by project implementation to ensure legitimacy. This is done by considering potential victims (e.g., the current generation of farmers and their families, certain elements of the ecosystem, the government budget); negative impacts that should be avoided (e.g., increased deforestation of primary forest or human-wildlife conflict); and the different world-views of the involved actors.

References

Bleisch, B., Huppenbauer, M. (2014): Ethische Entscheidungsfindung. Zürich: Versus Verlag.

Brown, V. A., Harris, J. A., Russel, J. Y. (2010). Tackling wicked problems through the transdisciplinary imagination. London: Earthscan.

Cairney, P. (2015). What is complex government and what can we do about it? Public Money and Management, 35 (1): 3–6.

Capra, F. (2002). The hidden connections. London: HarperCollins.

Checkel, J. T. (2001). Social constructivism and European integration. In: Christiansen, T. Jorgensen, K. & Wiener, A. The social construction of Europe. California: Sage Publications.

Churchman, C. W. (1979). The systems approach and its enemies. New York: Basic Books.

Commonwealth of Australia (2007). Tackling wicked problems. A public policy perspective. Retrieved from: www.enablingchange.com.au/wickedproblems.pdf

Folke, C., Colding, J., Berkes, F. (2003). Synthesis: building resilience and adaptive capacity in social-ecological systems. In: F. Berkes, J. Colding and C. Folke (eds). Navigating social-ecological systems: building resilience for complexity and change. Cambridge: Cambridge University Press: 352–387.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. Research Policy, 31(8–9): 1257–1274.

Garcia, C., Bhagwat, S., Ghazoul, J., Nath, C. D., Nanaya, K. M., Kushalappa, C. G., Raghuramulu, Y., Nasi, R., Vaast, P. (2010). Biodiversity conservation in agricultural landscapes: challenges and opportunities of coffee agroforests in the Western Ghats, India. Conservation Biology, 24(2): 479–488.

Hall, P. (1993). Policy paradigms, social learning, and the State: The case of economic policymaking in Britain. Comparative Politics, 25(2): 275–96.

IPCC (2001). Observed climate variability and change. Folland, C. K., Karl, T. R., Christy, J. R., Clarke, R. A., Gruza, G. V., Jouzel, J., Mann, M. E., Oerlemans, J., Salinger, M. J., Wang, S.-W. In: Climate change 2001: The scientifi basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., van der Linden, P. J., Dai, X., Maskell, K., Johnson, C. A. (eds.). Cambridge: Cambridge University Press.

IPCC (2013). Summary for policymakers. In: Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Stocker, T. F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P. M. Midgley (eds.). Cambridge: Cambridge University Press.

IPCC (2014). Climate change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from: https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf

Ison, R. L. (2008). Systems thinking and practice for action research. In: Reason, Peter W. and Bradbury, Hilary (eds.). The Sage Handbook of action research participative inquiry and practice (2nd edition). London, UK: Sage Publications: 139–158.

Jenkins-Smith, H. C., Sabatier, P. (1994). Evaluating the advocacy coalition framework. Journal of Public Policy, 14(2): 175–203.

Kemp, R., Schot, J., Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. Technology Analysis & Strategic Management, 10(2): 175–198.

Masai L. M., Vision J. (2013). Bees graffity London`s East End. In: Chow, L. (2015). Buzzing artist swarms city walls to save the bees. Ecowatch, 31.03.2015. Retrieved from: www.ecowatch.com/buzzing-artist-swarms-city-walls-to-save-the-bees-1882023610.html

Meadows, D. H. (2008). Thinking in systems – A primer. In: Wright, D. (ed.). White River Junction, USA: Chelsea Green Publishing Company.

Moulaert, F., MacCallum, D., Mehmood, A., Hamdouch, A. (2013). The international handbook on social innovation; Collective action, social learning and transdisciplinary research, Cheltenham: Edward Elgar Publishing.

Pahl-Wostl, C., Hare, M. (2004). Processes of social learning in integrated resources management. Journal of Applied and Community Psychology, 14: 193–206.

Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tàbara, D., Taillieu., T. (2007). Social learning and water resources management. Ecology and Society 12 (2): 5. Retrieved from: http://www.ecologyandsociety.org/vol12/iss2/art5/

Pahl-Wostl, C., Gupta, J., Petry, D. (2008). Governance and the global water system: Towards a theoretical exploration. Global Governance, 14: 419–43.

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., Stringer, L. C. (2010). What is social learning? Ecology and Society, 15(4). Retrieved from: www.ecologyandsociety.org/vol15/iss4/resp1/

Reynolds, M. (2014). Triple-loop learning and conversing with reality. Kybernetes, 43(9/10): 1381–1391.

Reynolds, M. (2015). Rigour (-mortis) in evaluation. Evaluation Connections: 2–4.

Rittel, H. W. J., Webber, M. M. (1973). Dilemmas in a general theory of planning. Policy Sciences, 4: 155–169.

Rotmans, J., Loorbach, D., Kemp, R. (2007). Transition management: Its origin, evolution and critique. Paper presented at the Politics and Governance in Sustainable Socio-technical Transitions workshop, 19–21 Sept 2007, Schloss Blankensee, Berlin, Germany.

Sabatier, P. A. (1993). Policy change over a decade or more. In: Sabatier, P., Jenkins-Smith, H. (eds.). Policy change and learning: An advocacy coalition approach. Boulder, CO: Westview Press,13–39.

Sabatier, P. A. (1999). The need for better theories. Theories of the policy process, 2: 3–17.

Schusler, T. M. , Decker, D. J., Pfeffer, M. J. (2003). Social learning for collaborative natural resource management, Society & Natural Resources, 16 (4): 309–326.

Ulrich, W. (2000). Reflective practice in the civil society: The contribution of critically systemic thinking. Reflective Practice, 1(2): 247–268.

Ulrich, W., Reynolds, M. (2010). Critical systems heuristics. In: Reynolds, M., Holwell, S. (eds.). Systems approaches to managing change: A practical guide. London: Springer: 243–292.

Wals, A. E. J., van Leij, T. (2007). Introduction to social learning towards a sustainable world. In: Wals, A. E. J. (ed.) Social learning towards a sustainable world. Wageningen: Wageningen Academic Publishers: 17–33.

Wenger, E. (2000). Communities of practice and social learning systems. Organization, 7: 225–246.

Index