GAiA
ECOLOGICAL PERSPECTIVES FOR SCIENCE AND SOCIETY
ÖKOLOGISCHE PERSPEKTIVEN FÜR WISSENSCHAFT UND GESELLSCHAFT

9 FRAMEWORKS –
A COMPILATION

FRAMEWORKS FOR TRANSDISCIPLINARY RESEARCH

The series ***Frameworks for Transdisciplinary Research*** published open-access between mid-2017 and end-2019 highlights existing ways of approaching transdisciplinary research. Five frameworks focus on transdisciplinary research as a whole and four concentrate on significant parts of the transdisciplinary research process.

FRAMEWORKS FOR THE WHOLE PROCESS

Framework #1: Principles for designing transdisciplinary research.
By Christian Pohl and Gertrude Hirsch Hadorn.
GAIA 26/3: 232. DOI: 10.14512/gaia.26.3.3.

Framework #2: A model for the transdisciplinary research process.
By Matthias Bergmann and Thomas Jahn.
GAIA 26/4: 304. DOI: 10.14512/gaia.26.4.3.

Framework #3: Outcomes spaces: Designing for impact in transdisciplinary research.
By Cynthia Mitchell, Dena Fam and Dana Cordell.
GAIA 27/1: 112. DOI: 10.14512/gaia.27.1.3.

Framework #8: What makes a researcher transdisciplinary? A framework to identify expertise.
By Gabriele Bammer.
GAIA 28/3: 253. DOI: 10.14512/gaia.28.3.2.

Framework #9: Grounded action design – Transdisciplinary co-creation for better transformative processes.
By Thomas Bruhn, Jeremias Herberg, Giulia Molinengo, Daniel Oppold, Dorota Stasiak and Patrizia Nanz.
GAIA 28/4: 336. DOI: 10.14512/gaia.28.4.3.

FRAMEWORKS FOR PART OF PROCESS

Framework #4: Four building blocks of systems thinking.
By Derek Cabrera and Laura Cabrera.
GAIA 27/2: 200. DOI: 10.14512/gaia.27.2.3.

Framework #5: Knowledge co-production: An analytical framework.
By Andreas Muhar and Marianne Penker.
GAIA 27/3: 272. DOI: 10.14512/gaia.27.3.3.

Framework #6: Context in the interaction between research and government policy.
By Vanesa Weyrauch and Leandro Echt.
GAIA 27/4: 344. DOI: 10.14512/gaia.27.4.3.

Framework #7: Ten essentials for contributing more directly to transformational change.
By Ioan Fazey.
GAIA 28/1: 8. DOI: 10.14512/gaia.28.1.3.

Frameworks focusing on transdisciplinary research as a whole emphasise different aspects. Choosing among them is not a matter of right or wrong, but of each being more or less helpful for a particular research problem in a particular context. And of course, different frameworks can also be used in combination. One way to link the frameworks is to start with:

- ***Framework #2*** which distinguishes the scientific and societal processes and then specifically concentrates on the integration between them.
- ***Framework #3*** nicely expands this by focusing on research outcomes – both scientific and societal – specifically improving the problematic situation, generating knowledge stocks and flows, and producing mutual and transformational learning.
- ***Framework #1*** provides guiding principles for the process, including designing implementation as real world experiments and developing reflexivity through recursiveness.
- ***Framework #8*** highlights the expertise that is required for all phases of the research and implementation.
- ***Framework #9*** hones in on expertise required to help decision-makers work with relevant experts and stakeholders to understand the problem space before setting change in train.

Of the frameworks for part of the process:

- ***Framework #4*** provides guidance to key elements for taking a systems approach.
- ***Framework #5*** takes a deep dive into knowledge co-production, teasing out the complexity involved in recognising the diversity of stakeholders, the different phases of research in which their involvement is useful, the need to clarify goals and expectations, and recognising important knowledge types.
- ***Framework #6*** provides insights into one aspect of context, namely circumstances and factors which influence the uptake of research into policy. As a whole, context is often overlooked in transdisciplinary research.
- ***Framework #7*** concentrates on research that aims to lead to transformational change, highlighting ten essential processes.

Some cautions are required in using these frameworks. The descriptions, and often the accompanying diagrams, are necessarily truncated. The aim is to provide an accessible overview that invites further exploration. And, of course, there are many additional frameworks that could have been included. This compilation should be seen as a start, rather than a comprehensive collection.

The companion compilation – the ***Toolkits for Transdisciplinarity*** series published in ***GAIA*** between mid-2015 and mid-2017 – provides useful concepts and methods for applying the frameworks in practice in research projects and programs: ***www.oekom.de/publikationen/zeitschriften/gaia/toolkit/c-168***.

Commissioning Editor: Gabriele Bammer, Australian National University

Principles for Designing Transdisciplinary Research

This framework consists of a set of principles from the ***td-net (Network for Transdisciplinary Research)*** of Swiss Academies of Arts and Sciences. A series of case studies in the *Handbook of Transdisciplinary Research* (Hirsch Hadorn et al. 2008) shows how these principles can be implemented. The principles are general guidelines for addressing key challenges of transdisciplinary research. The aim is to help transdisciplinary researchers plan and implement their investigations.

The principles are structured along the three phases of transdisciplinary research (see figure 1):

1. problem identification and structuring;
2. problem analysis;
3. "Bringing results to fruition", in other words, implementing research in practice-oriented solutions for the common good.

Problem Identification and Structuring

The main principles for phase 1 are to reduce complexity by specifying the need for knowledge and identifying those involved. The latter requires involving all those concerned in developing the research question; including participants from the research world *and* the "life-world", the latter encompassing public agencies, the private sector and civil society.

Specifying the need for knowledge means clarifying which of three interdependent forms of knowledge – systems, target, transformation knowledge – are required to reach the project's goals. These are described in more detail in table 1.

TABLE 1: Overview of interdependent forms of knowledge.

SYSTEMS KNOWLEDGE	How the problem is structured and could develop and how it is perceived by those concerned.
TARGET KNOWLEDGE	Norms and values in relation to desired goals, both making them clear and deliberating about conflicting values, using the common good (e. g., sustainable development) as a regulatory principle.
TRANSFORMATION KNOWLEDGE	Technical, cultural, social, legal and other ways of achieving the desired change.

Problem Analysis

This covers the approach to the research question, collaboration and integration. Approaching the research question generally involves dividing it into sub-questions, keeping these sub-questions interrelated while addressing them and integrating the sub-answers. A key principle concerns integration. The research team has to decide what form of collaboration (common group learning, negotiation among experts, integration by leader) and what method of integration (e. g., boundary object, developing a glossary, mutually adapting concepts) will be used. A further key principle for integration is recognizing the value of other perspectives.

Bringing Results to Fruition

Key principles of this phase are to design implementation as real-world experiments, to clarify and test the project's underlying impact model, and to recognize that impacts are numerous and can occur at many levels, as well as being intended or unintended. A further principle is to achieve effectiveness through contextualization, i. e. understanding needs, interests, practices, power relations and related issues for those who are key to changing the life world, as well as ensuring the research results are relevant for these groups. Finally, the results need to be embedded in the research environment, contributing to the store of research knowledge and linking to research policy goals.

Recursiveness or Iteration

Cutting across these three phases of transdisciplinary research is the principle of developing reflexivity through recursiveness. This means that the three phases above are not a linear set of steps to be followed sequentially. Instead the complexity and interdependence of the phases means that what is learnt and decided in one phase affects the process of the other phases, so that the research process also involves revisiting earlier decisions and reshaping them in light of additional knowledge and insights. Iteration allows targeted learning and helps avoid stalling in the face of complexity.

References

Hirsch Hadorn, G. et al. (Eds.). 2008. *Handbook of transdisciplinary research.* Dordrecht: Springer.

Pohl, C., G. Hirsch Hadorn. 2007. *Principles for designing transdisciplinary research. Proposed by the Swiss Academies of Arts and Sciences.* Munich: oekom.

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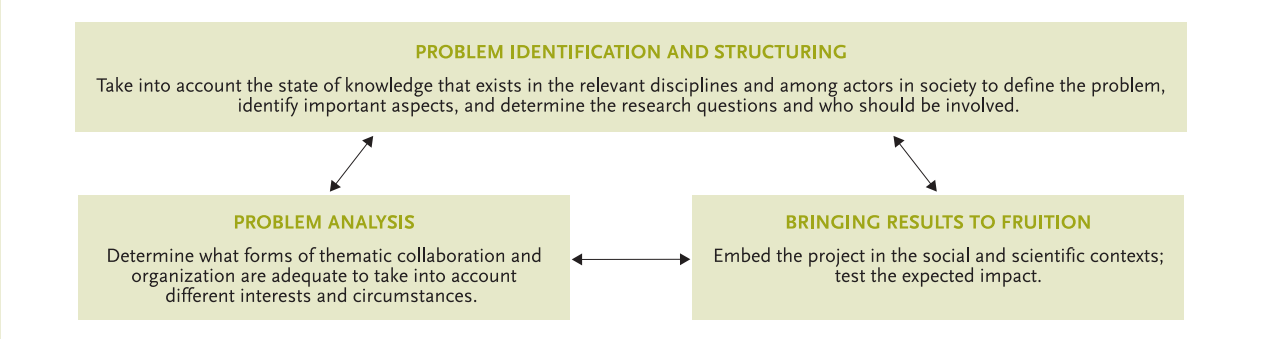
FIGURE 1: Phases of transdisciplinary research (from Pohl and Hirsch Hadorn 2007, p. 42).



This is the first column in a series that aims to alert GAIA *readers to useful frameworks for conducting transdisciplinary research. If you would like to contribute a framework description, please contact* ***gaia@oekom.de****.*

A Model for the Transdisciplinary Research Process

This model aims to guide researchers through the challenging tasks of ***problem constitution, knowledge integration,*** and the ***participation of societal actors.*** It was developed at the Institute for Social-Ecological Research (ISOE) in 2004 and subsequently refined. The model (see figure 1) builds upon a basic proposition: developing solutions for complex societal problems requires linking these problems to gaps in the existing bodies of knowledge, that is, to scientific problems. This proposition allows one to conceptualize the contributions of research to societal and scientific progress as the two epistemic ends of a single integrative process. This consists of three tasks (problem constitution, knowledge integration, participation of societal actors) across three consecutive phases (A to C).

Problem Constitution (Phase A)

Starting with the identification of a societal problem (figure 1, upper left), the process of problem constitution comprises several important conceptual steps (not shown in the figure):

- identifying the required scientific and societal expertise and knowledge;
- building a research team of scientists and experts from the problem field (societal actors) who can provide the required knowledge;
- developing a common understanding of the societal problem and related scientific problems;
- translating the societal problem into an epistemic object;
- formulating research questions that are problem-oriented (and not discipline-oriented).

Decisions taken here substantially influence the quality, efficiency, and impact of the research results. They often cannot be revised during the research process and thus have to be made carefully.

Knowledge Integration (Phases A to C)

Knowledge integration is a task in all three phases of the research process, and its products are described in the middle column of figure 1. This requires methods of knowledge, social and communicative integration to be applied (or developed if relevant methods do not exist).

In ***Phase A*** the knowledge integration aim is to formulate problem-oriented research questions as the prerequisites for producing socially robust results. Problem-specific knowledge requirements have to be identified before integration can be attempted. It is therefore critical to distinguish who owns which expertise in science and society, respectively, and to develop a concept for how and when to integrate it. This is often accomplished by establishing sub-teams, which represent the relevant disciplines and societal expertise.

In ***Phase B*** the knowledge integration aim is to produce new connectable and solution-oriented knowledge. This can involve disciplinary, interdisciplinary and transdisciplinary research processes, depending on which knowledge is needed and has to be connected with other knowledge elements. In this phase knowledge from very diverse epistemic cultures has to be merged, specifically specialist knowledge arising from application of the scientific method and the situated knowledge of those who have day-to-day experiences related to the societal problem under investigation. This requires specific methods for knowledge integration.

In ***Phase C*** transdisciplinary knowledge re-integration takes place. The new knowledge generated in Phase B is evaluated for how efficiently it contributes both to the solution of the initial societal problem and to scientific progress. This evaluation involves all project partners.

Participation of Societal Actors (Phases A to C)

Participation allows the societal experts to contribute to the problem constitution, to gain access to the generation of new, socially robust knowledge, and to support its implementation. Participation provides direction to the processes and results of transdisciplinary research and, therefore, is an important precondition for its efficiency and impact. The societal experts expect an added value for their living and/or working environment. The scientists gain access to practical knowledge and appreciate the desirability of solutions in the field of action. Moreover, they may receive momentum for new research questions.

Reference

Jahn, T., M. Bergmann, F. Keil. 2012. Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics* 79: 1–10.

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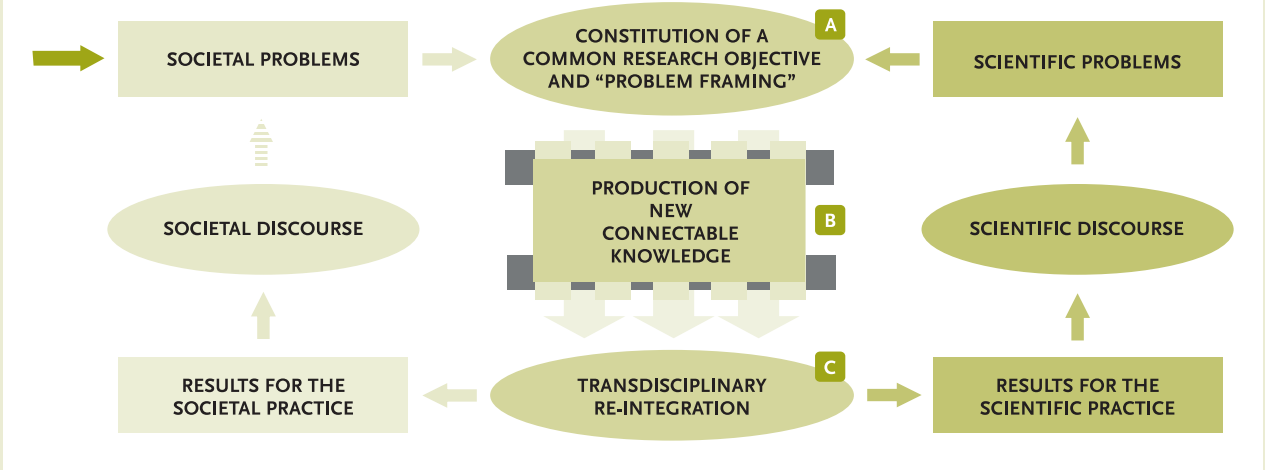
FIGURE 1: Model of the transdisciplinary research process (modified from Jahn et al. 2012; detailed version: *www.isoe.de/en/research/transdisciplinarity*).



Outcome Spaces: Designing for Impact in Transdisciplinary Research

Starting with a richly articulated picture of where we would like to be at some defined point in the future has powerful consequences for any human endeavour, and especially for transdisciplinary research. Over the last two decades at the Institute for Sustainable Futures (ISF) at the University of Technology Sydney, Australia, we devised, then used and evolved, a simple framework – the ***Outcome Spaces Framework*** (Mitchell et al. 2015, see figure 1) – to guide the conception, design, implementation, and evaluation of our transdisciplinary research.

We discern three essential outcome spaces as:

- improving the situation,
- generating relevant stocks and flows of knowledge, and
- mutual and transformational learning by the researcher(s) and involved participants.

We see these outcome spaces as distinct but overlapping, which can lead to tensions, especially about where to focus efforts when resources such as time and budgets are constrained. On the plus side, the overlaps can also be mutually reinforcing.

Improving the Situation

Language matters, and our choice of the term "situation" is deliberate because it helps us and our partners recognise and engage systemically with mess and complexity whilst avoiding implicit notions of one-shot solutions to problems. Instead, we are seeking a discernible difference – a tangible and articulable improvement in institutional or physical conditions at whatever level (such as strategic, tactical, or operational levels) is appropriate.

Generating Stocks and Flows of Knowledge

Flows of knowledge are as important as stocks of knowledge when the goal is to create change. Stocks include tangible and accessible knowledge artefacts, from peer-reviewed publications and reports to blogs, apps, and social media. Flows relates to how knowledge moves, for example, between disciplines, between academic and professional practice, from within the project to outside – it is about designing in mechanisms by which memes of transdisciplinary research insights are transported and transferred between people of shared and different worldviews. That means paying attention to the form and placement of knowledge artefacts, matching them with audiences in accessible ways at the right points. All of this raises questions about what and whose knowledges are valid.

Mutual and Transformational Learning

In the best of all transdisciplinary research worlds, everybody learns – researchers and participants learn from and with each other in an environment that enables the depth of reflection necessary to achieve deeper conceptual change associated with transition and transformation, allowing the goals that govern decision-making to be redefined. This level and quality of learning leave a legacy on the strategies and actions of the individuals, project participants and organisations involved.

Conclusions

Collaboratively identifying the preferred outcomes in these distinct spaces ahead of time can provide discernable benefits. A significant contribution is the potential to reveal, categorise, articulate, and evaluate the impact of research.

For the research team, articulating the project-specific outcome spaces provides a set of guiding principles for process decisions throughout the project life-cycle: defining the purpose of improving the situation at conception influences who is involved and how they are engaged, for example. For research clients, collaborators and participants, the framework can help to ameliorate assumptions about the rarefied nature of research, potentially changing stakeholders' perceptions about what research is, and assumptions about how to fund and manage research.

Reference

Mitchell, C., D. Cordell, D. Fam. 2015. Beginning at the end: The outcome spaces framework to guide purposive transdisciplinary research. *Futures* 65: 86–96.

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This series aims to alert readers to useful frameworks for conducting transdisciplinary research. If you would like to contribute a framework description, please contact ***mickler@oekom.de****.*

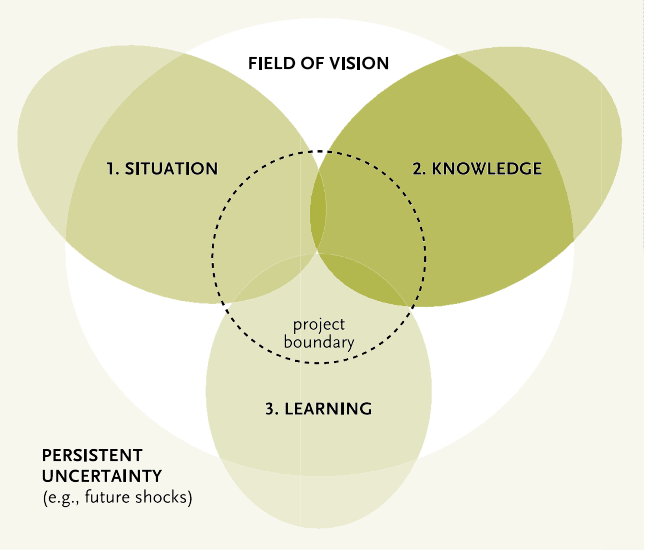


FIGURE 1: Conceptual map of the three outcome spaces *situation, knowledge,* and *learning*. The transdisciplinary project is embedded within a field of vision, which is limited by the experiences, knowledge and worldviews of the research team. Beyond the field of vision is the unknown, which can also be thought of as future persistent uncertainty. An example is future shocks (Mitchell et al. 2015).

Four Building Blocks of Systems Thinking

Transdisciplinary research generally treats problems as systems, but has few ways of making that systems approach explicit. ***Derek and Laura Cabrera*** at Cornell University in Ithaca, NY, describe four building blocks of systems thinking, along with ways in which these building blocks can be effectively combined.

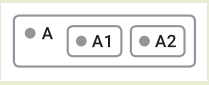
The Building Blocks

Distinctions (Identity-Other)

An essential element of systems thinking is making *distinctions* (identity-other) between and among things and ideas. How we draw or define the boundaries of an idea or a system of ideas is an essential aspect of understanding. Whenever we draw a boundary to define a thing, that same boundary defines what is not the thing (the "other"). Systems thinkers consciously use distinctions to challenge existing norms, labels, and definitions and to identify biases in the way information is structured.

Systems (Part-Whole)

Systems thinkers organize things and ideas into part-whole *systems* to make meaning. They know that changing the way ideas are organized changes meaning itself. The act of thinking is defined by splitting things up or lumping them together. Systems thinkers constantly consider context by asking "What is this a part of?" in order to see how things fit into larger wholes than is the norm.



Relationships (Action-Reaction)

Systems thinkers identify *relationships* (action-reaction) between and among things and ideas. We cannot understand much about anything, including a system, without understanding how parts and wholes are related. Relationships come in all types: causal, correlation, direct/indirect, etc. Systems thinkers use relationships to show dynamical interactions between things and ideas, including feedback loops to show reciprocal relations.

Perspectives (Point-View)

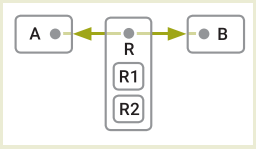
Systems thinkers look at ideas from different *perspectives* (point-view) and understand that every time we make a distinction (including identifying relationships and systems), we are always doing so from a particular perspective. Systems thinkers use perspectives to rethink distinctions, relationships, and/or systems. They move beyond human or animal perspectives (i.e., "perspectives with eyes") by taking conceptual perspectives (i.e., seeing a phenomenon from the perspective of an idea or thing).

Mixing and Matching the Building Blocks

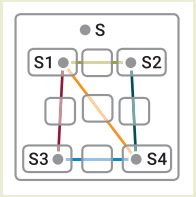
Even though the four patterns *distinctions (D), systems (S), relationships (R),* and *perspectives (P)* are very simple, the brain is very complex so it can do these four things simultaneously and in combinations that create amazing patterns of thought. Systems thinkers mix and match as follows:

- ***Mix R and D:*** make a relationship a distinction, which means to define relationships as ideas or things rather than just noting connections between objects;

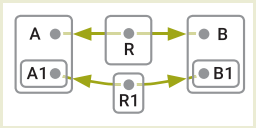
- ***Mix R, D, and S:*** after identifying relationships, "zoom into them" by deconstructing them into part-whole systems;



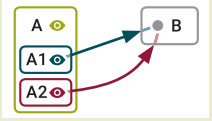
- ***Mix S and R:*** see the organization of parts and the relationships between them in novel ways;



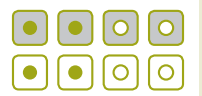
- ***Mix S and R:*** compare the relationship between two wholes by comparing the relationships between their parts (i.e., a "Relationship Channel" or "R-channel");



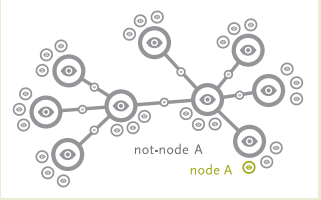
- ***Mix P and S:*** Break down perspectives into sub-perspectives in order to avoid the homogenous perspective thinking error (i.e., assuming any group is characterized by a single perspective);



- ***Mix P, S, R, and D:*** see that distinct objects and ideas can be grouped/related in various ways according to a perspective, thereby avoiding thinking errors brought about by categorizing;



- ***Mix P, S, R, and D:*** realize every complex topic or phenomenon is a massively relational, perspectival network where
  1. every relationship can be made a distinction, and
  2. where every element must be made a distinction, could be a system in and of itself, could be a perspective (point or view), and could be related to or the relationship between other elements.



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Cabrera, D., L. Cabrera. 2015. *Systems thinking made simple: New hope for solving wicked problems.* Ithaca, NY: Odyssean.

Derek and Laura Cabrera developed a visual modeling language and software called *Plectica*.

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This series aims to alert GAIA readers to useful frameworks for conducting transdisciplinary research. If you would like to contribute a framework description, please contact ***mickler@oekom.de****.*

Knowledge Co-Production: An Analytical Framework

This framework addresses the question: *Who can contribute what kind of knowledge in which phase of a transdisciplinary project and why?* It can be implemented ex-ante to design future projects and ex-post, as originally developed by Enengel and colleagues (2012), for analysis of knowledge co-production in transdisciplinary research processes.

Four main elements form the core of the framework; the internal differentiation within each element will depend on the organisational and thematic context of an individual research project.

WHO (Actors and Roles): A simple distinction between researchers and stakeholders is not sufficient to describe the complex reality of a transdisciplinary research project. In particular, the diversity of stakeholders needs to be considered. It can be helpful to consider stakeholders at three levels, as they will have different roles and resources. First, practice experts often work in public agencies or non-government organisations and are very familiar with the practical and political aspects of the issues investigated, but not necessarily with the specific local case. Second, on the case level, strategic case actors hold formal or informal responsibilities (local politicians, local leaders, regional managers). Third, local case actors represent all the other actors either affected by, or involved in, the local case.

WHEN (Research Phases): Knowledge co-production and other communication among participants have different intensities in the various phases of a project. Practice experts and strategic case actors are typically involved in the definition of the research questions and in the discussion of results, sometimes also in the data collection, but rarely in data analysis and in publications. An often neglected aspect is the problem history, that means the interaction among stakeholders that had occurred before a research project starts.

WHY (Objectives): The goals of stakeholder involvement can vary for the actor groups and in the different research phases. For example, while strategic case actors are often involved in co-defining the research question, local case actors are usually informed about the question afterwards. Methods selection tends to be the researchers' task, with or without consultation with relevant stakeholder groups. The different goals of stakeholder involvement need to be clarified in order to avoid unrealistic expectations, in particular when it comes to decision-making for implementation, which in many cases is outside the scope of a research project.

WHAT (Knowledge Types): Complementary to the differentiation between systems, target and transformation knowledge (see Pohl and Hirsch Hadorn 2017), the knowledge contributions of different actor groups at various stages of the project can be described by using the following three dimensions:

Scale: *Context-specific* knowledge refers to the concrete setting of the individual case. *Generalised* knowledge claims to be universally valid and is expressed in a systematic way, free from context-specific conditions and constraints.

Function: *Phenomenological* knowledge addresses (local) social and environmental phenomena and their description, for example, local fauna and flora. *Strategic* knowledge focuses on connections and interrelations of system elements. It often addresses organisational, functional and network issues for changing the system, and is essential for implementation phases.

Epistemology (Cognition): *Experiential* knowledge is derived from one's own life experience or from traditional knowledge, and is often tacit or implicit and therefore usually not formalised or systemised. *Scientific* knowledge is based on empirical evidence or scientifically acknowledged theories; it is systematic, formalised and explicit. There is no hierarchy between these types of knowledge in the sense of superiority or inferiority, instead they need to be negotiated and integrated.

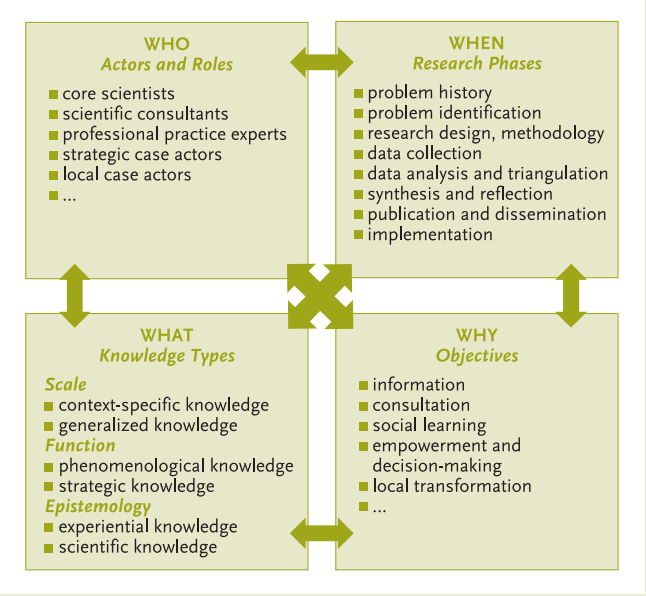

FIGURE 1: Framework for designing and analysing transdisciplinary research projects (adapted from Enengel et al. 2012, p. 108).

References

Enengel, B., A. Muhar, M. Penker, B. Freyer, S. Drlik, F. Ritter. 2012. Co-production of knowledge in transdisciplinary doctoral theses on landscape development: An analysis of actor roles and knowledge types in different research phases. *Landscape and Urban Planning* 105/1–2: 106–117.

Pohl, C., G. Hirsch Hadorn. 2017. Frameworks for transdisciplinary research: Framework #1 – Principles for designing transdisciplinary research. *GAIA* 26/3: 232.

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Context in the Interaction between Research and Government Policy

This framework can inform transdisciplinary research on how best to influence change in government policy. The framework:

- strategically identifies potential areas of change for different types of interventions,
- focuses specifically at the institutional level, and
- embraces the importance of politics in achieving change.

Drawing on extensive academic literature, as well as interviews with more than 50 policy makers in Africa, Asia and Latin America, the framework illustrated in figure 1 uses a systemic approach and embraces the complexity of the policy-making process, rather than using linear recipes.

Six main dimensions allow users to identify entry points to make strategic decisions about knowledge use at governmental institutions:

1. ***macro context:*** the overarching forces (structural and circumstantial) at the national level that establish the "bigger picture" in which policy is made.
2. ***intra- and inter-relationships with state and non-state agents:*** although part of macro context, these warrant special mention. They are the internal relationships between the public institution and other related government agencies and the interaction with relevant users and producers of knowledge who can affect or be affected by policy design and implementation.
3. ***culture:*** the set of values and assumptions accepted as "the norm".
4. ***organizational capacity:*** the ability of an organization to use its resources to perform.
5. ***management and processes:*** ongoing processes and policies, and how routine decisions are made.
6. ***core resources:*** include budget, time, infrastructure and technology.

Each dimension breaks down into several critical sub-dimensions which can be interactively explored at *www.politicsandideas.org/contextmatters*.

For example, item 3, ***culture,*** is explained in detail and divided into four components which are also expanded upon. These are:

- beliefs and values (of both the policy makers and the organizations),
- incentives (the external rewards for achieving policy change),
- openness to change (what are the facilitators and barriers to introducing policy change), and
- motivations (the personal drivers of the policy makers involved).

The links among the dimensions can change as circumstances change.

The framework allows users to systematically and comprehensively assess where the potential for change in government policy is greatest, as well as where the most significant barriers are.

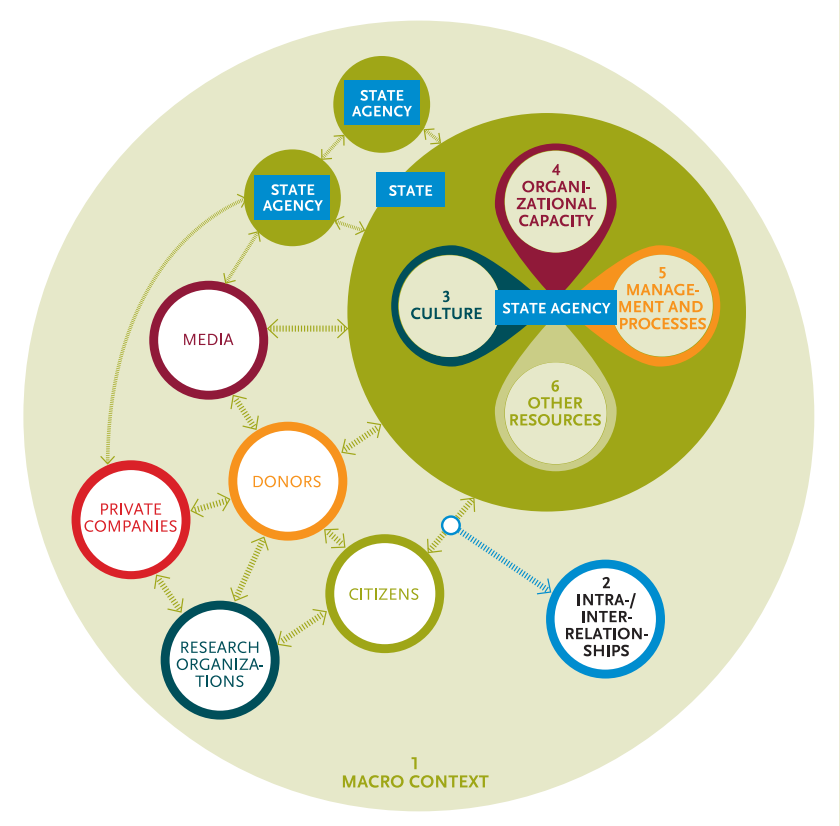

FIGURE 1: The six main dimensions of context defining the interaction between knowledge and policy.

The framework was developed by a collaboration between the think net *Politics & Ideas* and the *International Network for the Availability of Scientific Publications (INASP)*.

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Ten essentials for contributing more directly to transformational change

Frameworks for transdisciplinary research #7

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This framework presents ten essentials needed for transdisciplinary research to achieve a greater action and solution orientation in relation to complex and urgent problems (figure 1). It emerged over a two-year period from individual and collective reflection (Fazey et al. 2018).

The framework is underpinned by rejection of the assumption that researchers can or should be independent from what they observe. This opens up possibilities for other kinds of research (especially transdisciplinary research) and places greater responsibility on researchers to be more explicit about personal, social and cultural influences on the nature and way knowledge is produced.

The first three of the essentials relate to the focus of the research, while the rest are concerned with research practice.

1. ***Focus on transformations:*** Research needs to directly focus on transformative rather than incremental or marginal forms of change. This includes addressing underlying structures and systems, such as governance, power, values, cultures and technology.
2. ***Focus on solution processes:*** Greater focus is needed on solutions and processes for change, expanding beyond simply understanding the problem. This includes focus on aspired outcomes and how these are expected to be achieved.
3. ***Focus on "how to" practical knowledge:*** Research must engage more with practical knowledge as well as epistemic knowledge and practice must play a more direct role in informing research. Practical knowledge includes "know how" as well as morally defensible outcomes and paths towards achieving them.
4. ***Approach research as occurring from within:*** Research needs to be approached as occurring from within the system being intervened in. This assists researchers to recognise they are influenced by and part of the problems they seek to address or understand. Researching from within encourages approaches where action and learning are more closely intertwined, enhancing innovation, learning and change.
5. ***Work with normative aspects:*** Research needs to find ways to work in the messy real world of politics, values and change and to incorporate ethical and aesthetic considerations as part of the process of knowledge production.
6. ***Seek to transcend current thinking and approaches:*** Many contemporary problems cannot be addressed by the same kinds of thinking that created them. New forms of thinking are required that open up space for new questions, insights and solutions that can transcend current paradigms and disciplines.
7. ***Take a multi-faceted approach to change:*** Different paradigms, methodologies and methods affect the interpretation of phenomena and the way in which subsequent actions are prescribed. Multiple perspectives, knowledge and ways of knowing therefore need to be taken into account.
8. ***Acknowledge the value of alternative roles of researchers:*** Enhancing learning about how to foster change often requires greater flexibility in the roles undertaken by the researchers involved. Researcher roles may include facilitating interactions, mediating between different frames, acting as knowledge brokers or guiding action.
9. ***Encourage second-order experimentation and change:*** Developing action-oriented knowledge requires experimenting with change processes, such as through local and context-specific actions, projects and initiatives. It also requires as much focus on learning from the action as generating tangible and actionable outcomes.
10. ***Be reflexive:*** Reflexivity is the critical exploration of how perceptual, cognitive, theoretical, linguistic, political and cultural circumstances influence interpretations, approaches and learning. This includes engendering scepticism concerning one's knowledge and value stances as well as the views of others and making explicit underlying values and assumptions. Actively incorporating reflexivity into research and action processes is critical for supporting the other essentials.

FIGURE 1: Ten essentials for transdisciplinary research to have greater impact (Fazey et al. 2018).

Each of these essentials is effective on its own, but the greatest impacts will be achieved when the essentials are applied together. This will create a much more adaptive, reflexive, collaborative and impact-oriented form of research, as well as intellectual depth that enables integration of knowledge with normative considerations of what is considered to be good.

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Fazey, I. et al. 2018. Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. *Energy Research and Social Science* 40: 54–70. www.sciencedirect.com/science/article/pii/S2214629617304413 (accessed January 24, 2019).

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What makes a researcher transdisciplinary? A framework to identify expertise

Frameworks for transdisciplinary research #8

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Integration and Implementation Sciences (i2S) provides a framework to identify the core elements of expertise required for research to be transdisciplinary in addressing complex societal or environmental problems. Expertise is required in three foundational domains (figure 1):

- ***Synthesizing knowledge:*** Identifying and synthesizing relevant knowledge from various disciplines and stakeholders to develop a more comprehensive understanding of the problem.
  Knowledge includes not only "facts", but also epistemologies, values, interests and world views. It can be formally defined in disciplines or gleaned from stakeholders, who can be usefully thought of as those affected by the problem and those in a position to do something about it.
- ***Managing unknowns:*** Comprehensively reviewing unknowns and developing strategies for dealing with them to reduce the risk of adverse unintended consequences.
  Unknowns include known unknowns, unknown knowns and unknown unknowns. Manifestations include error, incompleteness, vagueness, distortion, uncertainty, deception, taboo, suppression, and undecidability.
- ***Supporting improvement:*** Providing the best possible evidence-based support to those in a position to address the problem to maximize the chances of effective action.
  The evidence base integrates the results of the knowledge synthesis and the strategies for dealing with unknowns. Those acting on the problem may be in government, business and/or civil society and may seek to change policy and/or practice.

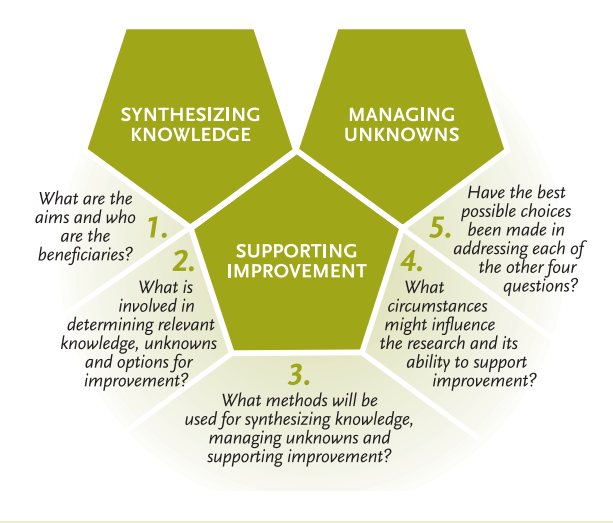

FIGURE 1: Identifying transdisciplinary expertise: the *Integration and Implementation Sciences (i2S)* framework.

The framework also provides five questions, plus prompts, to stimulate systematic consideration of specific expertise in each of the three domains, in particular for how each question will be addressed.

1. ***What are the aims and who are the beneficiaries?***
2. ***What is involved in determining relevant knowledge, unknowns and options for improvement?***
   - Systems-based approaches to adequately understand the problem and possible improvements;
   - scoping to identify all relevant disciplines and stakeholders, relevant unknowns, and possibilities for action;
   - boundary setting to establish the most important priorities from the options identified by the scoping process;
   - framing decisions to define the problem and articulate courses for improvement;
   - identification of value differences, especially value conflicts;
   - effective harnessing of different expertise in the research team, plus management of differences that cause irritation and conflict.
3. ***What methods will be used for synthesizing knowledge, managing unknowns and supporting improvement?***
   - Knowledge synthesis methods include dialogue, modelling and building a product;
   - managing unknowns includes established methods to reduce unknowns (such as experiments, surveys, focus groups), processes for accepting inevitable unknowns (such as hedging and building in resilience), techniques to counter suppression and deception, and means to exploit the benefits of unknowns;
   - supporting improvement includes methods for communication, co-production and activism.
4. ***What circumstances might influence the research or its ability to support improvement?***
   - "Big picture" context includes political, economic, historical, and cultural circumstances;
   - whether and what authorization is necessary;
   - facilitators and barriers imposed by the research and other organizations involved.
5. ***Have the best possible choices been made in addressing each of the four questions above?***

Transdisciplinary research teams need an expert with an overall appreciation of the knowledge, skills and dispositional attributes identified above. Different team members can also contribute specific elements of that expertise such as skills in building models or understanding elements of context.

Reference

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Grounded action design – Transdisciplinary co-creation for better transformative processes

Frameworks for transdisciplinary research #9

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A government or other political institution wanting to enact change often approaches the problem being addressed with specific perceptions and understandings. However, their approach is usually insufficient to capture the complexity of the "problem space". Grounded action design is a framework for a reflexive and co-creative process where stakeholders, relevant experts and decision makers – guided by researchers from a scientific advisory organization – explore, map and expand their understanding of the complex problem space before the political institution or decision making body sets transformative change in train (figure 1). This framework is suitable for research organizations acting in a scientific advisory function (Bruhn et al. 2019).

Grounded action design, summarized in the figure, has four phases, each of which has specific aims and processes. The four phases are described sequentially, but in practice there will be iterations among them.

1. ***Problem scoping:*** An iterative process where all the stakeholders affected by the problem and the decision makers engage in dialogue to ensure that all aspects of the problem are considered. Potential conflicts are identified and commitment of the stakeholders is established.
2. ***Transformative mapping:*** A participatory exploration to develop an overview of stakeholders, their positions, functions, and experiences, and how they are connected.
3. ***Identifying stakeholder capacities, useful ideas, and possibilities for change:*** Detailed inquiry to identify the potential for positive outcomes for the field of affected stakeholders through transformative change.
4. ***Developing transformation strategy:*** Creating a plan to address the complex challenge with relevant stakeholders based on the insights of phases 1 to 3.

Reference

Bruhn, T., J. Herberg, G. Molinengo, D. Oppold, D. Stasiak, P. Nanz. 2019. *Grounded action design: A model of scientific support for processes to address complex challenges.* IASS discussion paper. Potsdam: Institute for Advanced Sustainability Studies (IASS). DOI: 10.2312/iass.2019.054.

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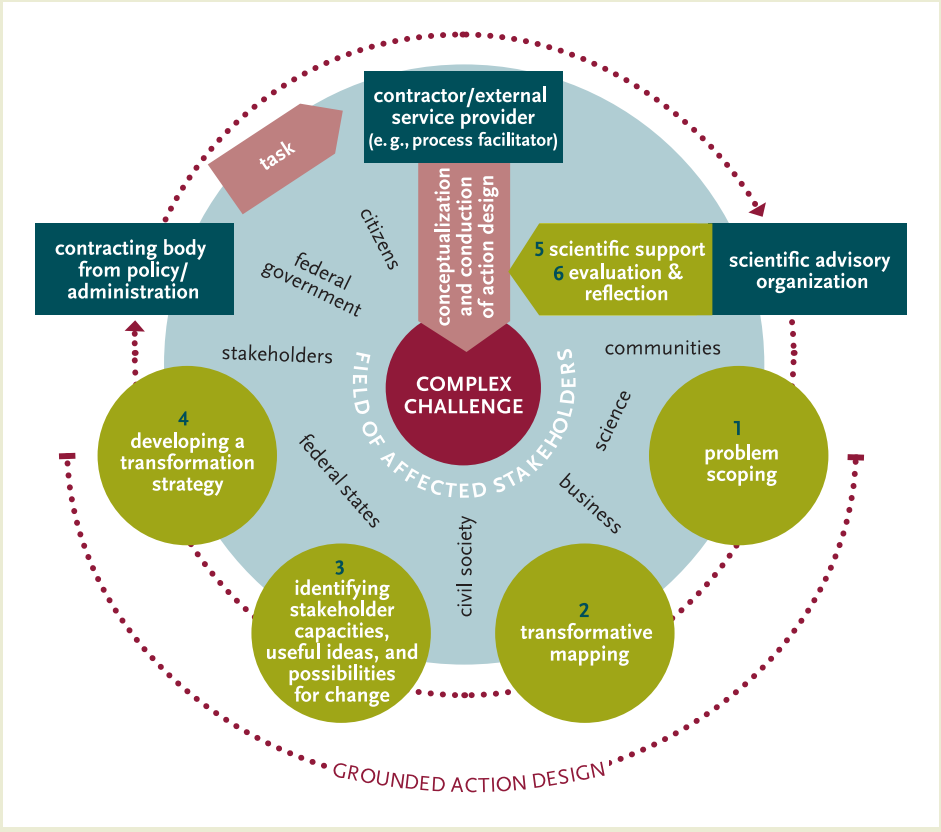
FIGURE 1: Grounded action design – a framework for a reflexive and co-creative process.



Guiding questions

1 Problem scoping: What are each stakeholder's hopes and expectations? What are their values, normative positions and goals? How do they perceive the problem and relationships among different aspects of the problem? What are the underlying assumptions?

2 Transformative mapping: What are the roles of those who are active in the problem space? What skills, competencies and other attributes do the various stakeholders have? What are their interests and positions? How are the stakeholders organized and how are they connected?

3 Identifying stakeholder capacities, useful ideas, and possibilities for change: Have unexplored stakeholder capacities become visible through the transformative mapping process? Which synergies among stakeholders and possibilities for future change can be identified?

4 Developing transformation strategy: Which measures could foster stakeholder capacities and possibilities for change?

This is the last column in this series which aims to alert GAIA *readers to useful frameworks for conducting transdisciplinary research.*

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