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Roles of Scientists in Sustainability Transformations: A Guide for Reflection and Workshop Facilitation

#### ABOUT THIS PUBLICATION

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Scientists, scientific experts, and knowledge brokers often find themselves in situations where they need to play new roles in society or are criticised for positioning themselves at the interface between science and other societal fields of action. The present guide aims to stimulate reflections on, and discussions of, roles that scientists perform. It offers insights from the literature reflecting on roles of scientists – in particular in the field of sustainability transformations – and provides sets of instructions to design workshop formats, along with tools for fostering reflection on roles, either individually or in groups.

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# Roles of Scientists in Sustainability Transformations: A Guide for Reflection and Workshop Facilitation

#### SDGs: The international UN Sustainable Development Goals

With this publication, the Swiss Academy of Sciences contributes to all 17 SDGs.

Science is essential to society's efforts to achieve all SDGs; however, it is challenging for scientists to know what roles to play when at the interface between science and other societal fields of action. This guide offers insights from the literature reflecting on roles of scientists – in particular in the field of sustainability transformations – and provides instructions and tools to design workshop formats for fostering reflection on roles, either individually or in groups.

> sdgs.un.org

> eda.admin.ch/agenda2030/en/home.html



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### 1 Why should we care about roles of scientists? – An introduction to this guide

Scientists, scientific experts, and knowledge brokers often find themselves in situations where they need to play new roles in society or are criticised for positioning themselves at the interface between science and other societal fields of action. The present guide aims to stimulate reflections on, and discussions of, various different roles that scientists<sup>1</sup> perform. It is based on insights from the literature that underline how **role variety** and **role clarity** enhance the quality of science and its support for society – in the context both of sustainability-oriented science and of science that does not have this normative orientation. The guide invites readers to explore the different roles that scientists can be expected to or may intuitively intend to perform – and to value the strength and purpose of each of these different roles.

#### 1.1 The role of science in society and societal change

Since science started being conceived of as a clearly defined socio-economic activity, the role of science within society has always been a topic of debate. The professionalization of science and the resulting product – scientific knowledge – have increasingly been considered both as worthy of scientific inquiry and as a production factor, in addition to material resources, labour force, and capital – guaranteeing wealth, security, and innovation.

In most democratic systems, science contributes to transforming society in three different ways. First, scientific knowledge can trigger *technical developments* that are diffused through economic or societal processes, leading to change in societies. A significant example today is digitalization. Second, scientific knowledge on critical topics such as migration, climate change, poverty, and artificial intelligence can trigger *societal reflection and debate*, also leading to changes in attitudes and corresponding action. And third, scientific knowledge is one *source of political decisions*, as it informs political processes; vice versa, society influences science in many ways, not least of all because societal decisions influence scientific priorities, as science is largely funded by public money.

Each of these three general functions of science in society lead societal actors to expect scientists to play specific roles; and scientists themselves intuitively or purposedly engage with society through these roles. But roles of scientists in concrete situations are sometimes a matter of contention; and diverging understandings of the roles of scientists can trigger heated discussions both in scientific communities and in the public sphere. A case in point is the COVID crisis: it led to intense debates about what role scientists should perform when interacting with politicians and the public. In many scientific communities, the principle of being 'policy-relevant, but not policy-prescriptive' is promoted. But is that so easy to do in practice? Can scientists act without contributing either to change or to the status quo in society? And what roles do they take on when they do so?

## 1.2 The context of societal transformation towards sustainability

Such questions are particularly relevant today: our world is largely characterised by non-sustainable development; problems are complex and change is urgent. Therefore, calls for a stronger role of science in orienting development towards sustainability are increasingly issued. For scientists who reflect on their professional activity, this raises fundamental questions about the roles they can play in society and how this relates to their understanding of the role of science in society.

The core scene of reflection and discussion for the present guide is societal transformation towards sustainability. Transformation is a special form of societal change and as such it is an object of research from interdisciplinary perspectives, inspired mainly by the social sciences and the humanities. 'Transformation, insofar as it is defined as a consciously intended change of basic social institutions, describes only those aspects of a process that can be designed by political decisions. The processes also include, however, informal institutions, mental models and attitudes, forms of living, culture, and all other structures generated by this conglomeration'.<sup>2</sup> Transformation (or transition) towards sustainability<sup>3</sup> is a normative model that aims at an intended change in a highly complex social system where scientists - from a theoretical macro-perspective – have so far played a minor role. There is now a growing interest in the role of scientists in societal transformation that is rooted in the urgency of finding sustainability solutions.<sup>4</sup> These questions basically tackle the grey zone between enlarging and defining roles of scientists on the one hand, and the role scientists play as 'scientific citizens' on the other.<sup>5</sup> The present guide takes this differentiation into account and provides tools for exploring the whole range of roles scientists may be called upon to play.

#### 1.3 Different understandings of science

Research approaches and roles of scientists are often strongly rooted in disciplinary norms; scientists from one discipline may not be aware of the spectrum of roles performed by scientists in other disciplines. To complicate things, in the broadly understood field of sustainability science, scientific activity is conducted in disciplinary, interdisciplinary, and transdisciplinary teams; in interdisciplinary research phases, knowledge production is the result of co-creation between scientists from different disciplines while in transdisciplinary phases, knowledge co-production takes place between scientists and other actors in society.

The distinction between transformation research and transformative research<sup>a</sup> is another important difference that influences understandings of roles in the context of sustainability science. Representatives of transformation research may see their task in providing analytical-descriptive examinations of change from an objective distance - for example, with research on drivers and barriers of change. In transformative research, by contrast, researchers may see themselves as part of the transformation process because they co-create knowledge with other societal actors, are aware of justice and power issues related to their academic positions, go through social learning processes with these other societal actors, and thus co-initiate social change in addition to researching the spread, mechanisms, and effects of change. Accordingly, researchers can contribute to transformation processes in different ways.

Indeed, depending on the observed or envisaged contributions to societal change, different roles are performed at the science–society–policy interface, either in the process of knowledge co-production or in the process of knowledge brokering for policy or other societal fields of action. Scientists and professionals working at the science–society–policy interface can better contribute to discussion on the value of scientific work and responsible science when they are aware of this spectrum of roles and of the power and justice issues related to these roles, and when they are able to negotiate the roles with other societal actors.

#### 1.4 Enhancing understandings of roles of scientists

Among the challenges that scientists need to meet when conducting transformative research is that they must perform new roles in non-academic contexts and cooperate with different stakeholders, sometimes also going through a process of social learning with them. This can lead to uncertainty and problems of communication among scientists, or between scientists and other societal actors (such as project partners, business, the media, policymakers, or civil society). Uncertainty regarding roles can also emerge in the context of knowledge brokerage, e.g. when scientists are asked to provide 'facts' that will then allow politicians to take action.

Reflecting on and discussing roles of scientists in different contexts is thus crucial because:

- It provides clarification and makes expectation management easier in collaboration and communication with other societal actors.
- It enables division of labour in inter- and transdisciplinary research teams and makes collaboration more effective and efficient.
- It allows scientists to communicate what role they want to (and are able to) perform.
- It enables all involved to make the boundaries of their roles explicit. This makes it possible for scientists to reflect on the power of their own position as scientists and enables others to participate in this reflection on power included in roles.
- It helps scientists to avoid defining their role(s) unilaterally and makes it possible for research groups and their partners to negotiate roles in accordance with the phase of a research or knowledge sharing project, this in turn helping to build trust.
- It helps scientists who take on a knowledge brokering role to identify possible conflicts of interest.

In addition, a reflection on and discussion of roles also makes it possible to address the following question: what impact will playing a specific role have on the following issues?

- Access to knowledge from different stakeholders and ways of understanding it,
- production and combination of knowledge,
- feeding knowledge back and forth between academic debates and societal transformation processes,
- power issues involved in owning and producing knowledge, and
- possible conflicts of interest when brokering scientific knowledge.

#### 1.5 Purpose and target audiences

This guide aims to stimulate reflections on, and discussions of, the roles scientists perform in sustainability transformations and beyond. It provides explanatory material and simple procedures to:

1. Raise awareness of different understandings of the roles of scientists and stimulate dialogue on the spectrum of different roles within the academic world;

- 2. Broaden the vocabulary and perspective of academics who engage in discussions on the role of science in society and thus want to improve their own positioning;
- 3. Raise awareness of the difference between acting as a scientist and acting as a citizen who has scientific knowledge;
- 4. Enhance the effectiveness of communication practices in science–society–policy interaction.

Thus, this guide primarily addresses academics in their various functions as researchers, project leaders, and teachers. But it also addresses professionals who work at the science–society–policy interface, for example in think-tanks or as members of the Academies, or as practitioners involved in co-production of knowledge.

#### 1.6 Origins of and sources for the guide

The guide was developed by the Platform Science and Policy of the Swiss Academy of Sciences. The project team drew on the knowledge and experience of many experts from the network of the Swiss Academies who contributed by being part of the project's sounding board, responding to a survey, making themselves available for interviews,<sup>b</sup> and providing case studies<sup>c</sup> and project examples<sup>d</sup>.

The experts on the Sounding Board represent a range of disciplines: from Geography, Environmental Science, Biology, Sustainability Science, Political Science, Anthropology, Agronomy, Sociology, Literature, and History. The Swiss Academy of Humanities and Social Sciences was engaged in the Sounding Board early on.

- b naturalsciences.ch/sustainability/transformation/deepening/ voicestfresearch
- c scnat.ch/roles\_of\_scientists/transformations
- d naturalsciences.ch/sustainability/transformation/examples

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#### How the guide works

In chapter 2, seven different models of roles of scientists described in the literature are presented. The first set (models 1–6) relates to roles that emerge in the context of transdisciplinary knowledge co-production, where the boundary between science and society is fluid, even allowing for engagement of scientists in transformative action. The second contains just one conceptualisation of roles of scientists (model 7) that accounts for different roles in which knowledge is brokered between science and society. In addition, four texts (texts 1–4) are offered as the departure point for discussions about whether and how to draw the line between science and public engagement (especially engagement in the form of activism).

#### 1.7 Where and when you can use this guide

Reflection on and discussion of roles is important for scientists and professionals at the science–society–policy interface, in particular for those who engage directly or indirectly in research on sustainability transformations. Such reflection on roles of scientists can take place in the following settings (with no claim to completeness):

- At the beginning of a research/transformation project, when the question emerges of how the project and the people involved in it will cooperate and contribute to change (and who has to take on what roles and why);
- In training and teaching settings (e.g. methodology seminar or training for science journalists);
- Within expert groups and university committees, to clarify positions held by the different members and to identify missing competences;
- In expert groups and university committees that collaborate to communicate scientific findings (e.g. factsheets, policy papers);
- In discussions on the 'science-public engagement' spectrum in academic and public settings;
- In teams conducting science-society-policy dialogue;
- In professional bodies, e.g. an ethics committee (e.g. for medical research);
- In situations where scientists may be confronted with a conflict of interest (e.g. during a crisis such as the COVID pandemic, where it was not clear how science should be represented in the public sphere and what level of political influence it should have. See the resulting 'Code of Practice for participants in the Swiss National Science Advice Network' published jointly in 2023 by the Swiss Institutions für Education, Research and Innovation<sup>e</sup>).
- swissuniversities.ch/fileadmin/swissuniversities/Dokumente/Hochschulpolitik/20231208\_CodeofPractice\_\_SwissNationalScienceAdviceNetwork.pdf

In chapter 3, step-by-step guidance is offered to prepare a reflection and discussion event. Step 1 helps select a model or a text from chapter 2 as a tool to trigger and frame a reflection on roles of scientists. Step 2 guides the reader through the process of choosing 'questions for reflection'. Step 3 offers suggestions on how to design a workshop, three examples of how to implement this (along with additional materials), and some facilitation tools.

On the website,<sup>f</sup> you will find the figures and models of this guide as separate files for use in workshops, along with further examples of events with useful lessons learned from their authors regarding organisation and facilitation. We encourage users of this guide to add their reflections on experience and thus contribute to a growing community of practice.

f scnat.ch/roles\_of\_scientists/transformations

### 2 Understanding roles of scientists in sustainability transformations

There is a substantial body of literature on roles of scientists. Based on a literature review and recommendations of the project's sounding board, we selected articles presenting understandings of roles that seemed most relevant to the purposes of this guide (sections 2.2 and 2.3). They are distinguished based on two different understandings of the relationship between science and other societal fields of action that influence the roles that scientists can play. We present this general distinction in section 2.1.

#### What do we mean by roles?

In general, **social roles** can be seen as 'comprehensive pattern(s) of behaviour and attitudes' that entail rights, duties, and responsibilities and supply a 'major basis for identifying and placing persons in a group, organization, or society'.<sup>6</sup> The concept of social roles is key to sociology: the function of a social role is to structure the behaviour of individuals in relation to their social environment. This concept is therefore also useful for understanding the scientific subsystem, where different ideas of what it means to be a scientist have evolved over a long time. In the context of sustainability, Wittmayer et al. conceptualise a role as a 'set of recognizable activities and attitudes used by an actor (in research processes) to address recurring situations'.<sup>7</sup>

Therefore, the concept of role helps us to think beyond research activities and products. To perform a role entails a (professional) attitude about how you want to do things – e.g. produce knowledge, provide knowledge for policy – and how you interact with others (and what you expect of them) in the process. These expectations are highly relevant and are determined by both internal and external understandings of roles, as they arise in a social context. Importantly, when scientists support policymaking by providing knowledge, this may be considered adequate in some cases but not in others.

#### 2.1 The relationship between science and other societal fields of action: a framework

A large array of attempts to conceptualise roles of scientists has emerged in the past two decades in analyses of research for sustainability transformations. These models do not tell us what to do. Instead, they systematically present *spectrums of roles* based on specific understandings of science, on empirical studies of research processes, and on specific questions related to the interaction between science and society.

We distinguish between two types of models based on how scientists understand and relate to the two processes of knowledge production and circulation of knowledge within society in the context of sustainability transformations (fig. 1, A and B):

- A. An array of conceptualisations of roles has emerged from 'Mode 2 science', i.e. science that aims to produce 'socially robust knowledge'.8 Mode 2 science requires that scientists work with other societal actors, e.g. using a transdisciplinary approach.<sup>9</sup> As a result, the boundary between science and society is blurred or 'messy' because interaction between scientists and other actors in society takes place and leads to knowledge co-production. In the process, scientists are called upon to play different roles. Some roles clearly characterise the scientist as an academic actor, and other roles (facilitator, advisor, mediator, etc.) bring scientists into situations where they need to distance themselves from their academic identity to be able to mediate between science and other societal fields of action. This can lead to the need for deciding whether and in how far engagement in a societal cause as a scientist is possible or even necessary.
- B. Another way of conceptualising the role of scientists interacting with other societal actors is based on perceiving **a clear difference** between the 'detached' role of the scientist producing knowledge and the scientist's role as an expert providing scientific knowledge to policymakers and other societal actors. To characterise this conceptualisation of **sharing knowledge** (as opposed to co-producing knowledge), Cash et al. propose the concept of '"boundary work" carried out at the interface between communities of experts and communities of decision makers' and conducted by 'boundary organizations'.<sup>10</sup>

In the first understanding of the relationship between science and society (mode 2 science or post-normal science<sup>n</sup>) and of how science can contribute to sustainability transformations – i.e. through co-production of knowledge – new research methods have been developed, characterised today as inter- and transdisciplinary, integrative, or even transformative. Scientific activity is carried out based on methods that are clearly understood as belonging to the realm of the academic world. But knowledge is considered to also emerge from other epistemic activities, with actors who do not work as academics. As a result, an exploration of different 'knowledges' is considered to be not only legitimate but necessary. In this context, roles of scientists can be very diverse, with new roles sometimes emerging from new forms of interaction for knowledge co-production and knowledge sharing. A key challenge to be kept in mind by scientists is: what hidden power issues are involved in co-producing knowledge and how do we deal with them?

In the second understanding of the relationship between science and society, this blurring of boundaries is not considered desirable. Scientific knowledge is the product of scientific activity carried out by scientists, based on methods that are clearly defined by scientific disciplines. Other types of knowledge need to be examined scientifically and cannot be integrated into scientific results without this filter. Most importantly, the worlds of science and politics need to remain separate. Scientists can inform politicians and other societal actors, but this is not part of their knowledge production role. They play other roles when doing 'boundary work'. A key challenge to be kept in mind in such work is: what are potential conflicts of interest and how do I avoid them?

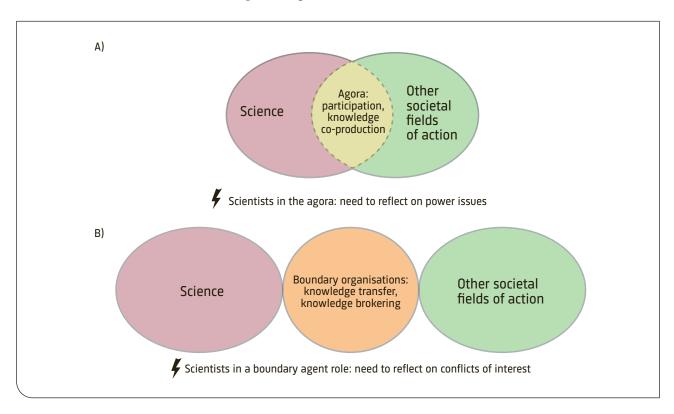


Figure 1: Two ways of understanding the relationship between science and other societal fields of action: A) When a transdisciplinary approach is used in research, knowledge is co-produced in the agora and the relationship between science and other societal fields of action is permeable; accordingly, scientists may play a number of different roles and need to be aware of potential power issues. B) When scientists are asked to provide policymakers or other societal actors with information from science, knowledge is produced by scientists and 'brokered' by boundary agents or boundary organisations to society; when playing a boundary agent role, scientists need to reflect on possible conflicts of interest. Source: figure adapted from Pohl et al. 2010, p. 269. This figure can be downloaded.<sup>g</sup>

# 2.2 Roles of scientists working in the agora where knowledge is co-produced

### Overall issues: dealing with fluid boundaries, power, engagement, change, and other challenges

In the agora of transdisciplinary knowledge co-production for sustainability transformations, it is necessary to develop a very good understanding of the different roles that a scientist may be called upon to play. Indeed, expectation management is essential in a context where the understanding of what science is, and how science relates to other societal fields of action, is *fluid*, leading to a need for negotiating understandings while at the same time relying on established expectations. Ideally, when a good understanding of roles is achieved through reflection on and transparency of roles, the 'messiness' of the boundary between science and society no longer leads to misunderstandings and conflicts but becomes a source of creativity where systemic thinking can be fostered. Moreover, such reflection can lead to a clarification of power relations and responsibilities associated with specific roles.

Another issue complicates work in the agora: scientists who engage in research for societal transformations may aim for change. They systematically interact with societal actors and try to capture different perceptions and lifeworlds. They engage in (self-)reflection on traceable and legitimate approaches to generate transformative knowledge. With other change-makers, they not only negotiate their roles but also engage in reflecting on the 'common good' they are striving for. Such settings are societal and usually highly contested, and scientists should be aware that their perspectives will not always meet with approval.

Nor should scientists use their position as academic experts to exert defining power, as this leads – at its worst – to expertocracy. Expertocracy is a system where expert knowledge gains a higher priority than the will of the people. As a result, expert knowledge replaces democratic discourse. The ensuing debate can be observed especially in situations of crises. Thus, scientists must be aware of a high responsibility not only within their scientific field but also in the public sphere.

An additional perspective on the importance of considering roles and role theory in the context of sustainability transformations is provided by Wittmayer et al.<sup>7</sup> Based on a literature review, the authors derive three aspects of roles that help to analyse interactions between different actors. First, a single role relates to other roles and has consequences for them, hence, we can analyse roles as single roles or as role constellation. Second, the aspect of time needs to be taken into account in order to understand changing roles. And third, roles can be actively used as a resource to contribute to sustainability transformations. In this sense, Wittmayer et al. show how important it is to acknowledge the dynamic nature of roles within various contexts.<sup>7</sup>

Rather than having fixed boundaries, roles possess a certain fluidity and may overlap. Scientists do not merely adopt pre-established roles but rather adapt and perform them based on their social positioning and experiences. Additionally, roles are co-produced, negotiated and influenced by actors with whom scientists interact and collaborate. Moreover, roles are context-specific and may require adaptation to a given setting. In a research team, different scientists can have complementary roles or scientists may perform different roles (with different intensities in different phases) throughout the research process. For further discussion of these issues, please consult the literature listed at the end of the guide.

# 2.3 Roles of scientists working in a boundary organisation or as a boundary agent

### Overall issues: dealing with potential conflicts of interest and expectations from society

The three basic functions of science in society mentioned in the introduction of the present guide (section 1.1) – i.e. leading to technical innovation, triggering societal reflection and debate, and informing policymakers who will then make political decisions – can be addressed by scientists through boundary organisations or by taking on the role of boundary agent.<sup>12</sup> Boundary organisations are professional organisations that bridge science and other societal fields of action, make communication between the two realms possible, and allow scientists to consciously deal with issues related to engagement.

Apart from having to acquire specific science communication skills, scientists who take on a boundary agent role need to reflect on potential conflicts of interest (see figure 1B above). These conflicts of interest may arise unawares and unexpectedly. They are the result, for example, of financing models for research or the realities of networking with specific societal actors. Reflecting on potential conflicts of interest is particularly important if one wants to follow the democratic principles that guide our decision making: if handled well, boundary work conducted in the role of a boundary agent will lead to better decisions and respect for democratic values (e.g. human dignity, equal access, fair processes, transparency). Roger Pielke Jr. is often cited today as a source of clarification for the roles in which boundary work can be done. He is the source of model 7.<sup>13, 14</sup>



#### Template for presenting the models of roles of scientists

To allow for comparison between the models found in the literature that we consulted, we systematically reordered the information about roles found in each text according to the following categories:

	What does the scientist do in this role?		How might the role contribute to change?
All models presented on the follow	ving pages contain information	the tables are extended accordir	ngly. None of the tables reproduce

All models presented on the following pages contain information about the first two columns. Only some models contain additional information that fits into the last two columns, in which case the tables are extended accordingly. None of the tables reproduce the original presentations in the corresponding articles and in some cases, the text was slightly simplified.

#### Symbols assigning the models to the framework

Each model is provided with one of two symbols corresponding to the framework in figure 1.



Indicates a model where knowledge is co-produced in a permeable agora and scientists may play a number of different roles. In such roles, it is particularly important to be aware of potential power issues. For example, when adopting the role of 'producer of scientific knowledge', the scientist may be implicitly attributed the power of social prestige attached to academic education by others, making it difficult for these other stakeholders to voice their knowledge.



Indicates a model where knowledge is produced by scientists and brokered to society by a boundary agent or boundary organisation. In the role of boundary agent brokering knowledge, the scientist needs to become aware of – and voice – potential conflicts of interest they may be exposed to, for example if they have been interacting with or been mandated by a business company or political actor to broker knowledge.

Note: all of the models and figures in this guide can be downloaded from the website<sup>h</sup> for use in workshops.

#### Model 1 after C. Pohl et al.<sup>15</sup>

This model was developed based on experiences of transdisciplinary research projects in Switzerland, Kenya, Bolivia, and Nepal. It identifies three different roles that researchers can perform when addressing the challenges of co-producing knowledge. Co-production of knowledge entails the production of knowledge in heterogenous group settings – involving experts from science and practice. In such settings, scientists must face the challenge of addressing power relations, linking different perspectives, and – often – fostering sustainable development. The three roles position scientists in the process of knowledge integration for sustainable development and the respective intensity and focus or content of interaction with other societal actors:

Role of scientist	What does the scientist do in this role?	What key issues need to or can be addressed in this role?
Reflective scientist	Provides expertise based on scientific knowledge validated according to the norms of the respective scientific disciplines.	Validating knowledge according to quantitative and qualitative procedures
Intermediary	Makes different perspectives visible and links them around common interests.	Providing leadership in view of representing common interests
Facilitator	Enhances communicative processes between involved actors and communities, based on respect, openness, and deliberation.	Promoting joint reflection oriented towards a common understanding of situations and collective action, as part of a learning process

#### Model 2 after C. Oberlack et al.<sup>16</sup>

This model was developed based on an analysis of sustainability research projects that worked with a Theory of Change (ToC) approach to formulate projects' assumptions about intended changes. The table below shows how different roles of scientists imply different activities and cater to different pathways to impact. The six roles position scientists with respect to the purpose of knowledge production as well as to the intensity and type of interaction with societal actors:

Role of scientist	What does the scientist do in this role?	How might the role contribute to change?
Producer of scientific knowledge	Conducts basic research	By developing scientifically valid and reliable knowledge for deliberation and decision- making; input for other activities
Teacher, lecturer, mentor, facilitator	Applies Education for Sustainable Development principles	By providing knowledge and fostering competences of future decision-makers, developing a critical mass of change agents
Advisor, based on professional expertise	Provides mandated policy advice	By providing advice for evidence-based decisi- on-making, synthesis assessments, capacity building
Contributor in public debate (e.g. media, events) based on professional expertise	Contributes to public debate	Through awareness raising, public debate and deliberation
Technical expert, professional expert	Provides open access to data and knowledge	By providing accessible and transparent data and knowledge, usable knowledge tools, and the possibility of public adaptation of knowledge
Facilitator, mediator, professional expert, technical expert	Supports multi-stakeholder processes	By supporting co-production of knowledge, social learning, technical cooperation, creation of new actor networks, conflict transformation





#### Model 3 after E. Bulten et al."

This extensive model emerged from a process-oriented transdisciplinary approach in sustainability science; the table summarises roles identified in a literature review. The article also highlights tensions between 'new' participatory roles and more traditional academic roles and points at possible ways of reducing these tensions. It also introduces roles that emerge when scientists go beyond the process of knowledge co-production and participate in transformative action.

Role of scientist	What does the scientist do in this role?
Traditional researcher (reflective scientist)	Provides scientific knowledge on the basis of analysis, validated by the respective discipline, to inform decision-making.
	Investigates application-oriented knowledge (legislation, best practices, etc.)
	Analyses dynamics, actors and actions (often ex post)
	Analyses outcomes
	Reflects on interventions, evaluates while disengaged from praxis
	Deconstructs problems into solvable parts
	Overlays existing concepts on problem narratives and frames
Self-reflexive	Writes observation protocols and research diaries (participates and observes)
scientist	Reflects on internal and external power-dynamics
	Reflects on own normative orientation
	Provides feedback to the other researchers in order to enable reflection about their interactions with practitioners
Knowledge broker	Synthesises academic knowledge and makes this accessible for practitioners and vice-versa
	Provides space for critical reflection
	Matches experts and stakeholder groups
	Translates, interprets and connects knowledge to different audiences
	Links scientific analysis to public debate
	Finds realistic problem-solution couplings
Process facilitator	Initiates and facilitates the learning and design process and experiment
	Organises and prepares work sessions
	Locates, selects and invites participants
	Encourages expressions of different viewpoints
	Provides space for critical reflection and deliberation
	Integrates knowledge
Transition	Participates in process that aims to address real-life problems
participant (change agent)	Actively intervenes in system innovation
Transition leader	Actively intervenes in system innovation by motivating and empowering participants to lead their own process
	Recognises the implications of current levels of capacity while also building capacity



#### Model 4 after J. Wittmayer and N. Schäpfke<sup>18</sup>

This model lists activities that researchers can engage in, along with the corresponding roles they take, to address four key issues (ownership, sustainability, power, action) they are likely to en-

counter when creating and holding spaces of social learning and action for sustainability transitions.

Role of scientist	What does the scientist do in this role?	What key issues need to be addressed in this role?
Reflective scientist	Analyses dynamics and actors	Ownership
	Provides knowledge on the basis of analysis	Sustainability
	Analyses outcomes	Power
	Observes, reflects on, and analyses actions	Action
Self-reflexive scientist	Engages in (self)-reflexive practice with regard to own normative orientation	Sustainability
	Engages in self-reflexive practice with regard to internal and external power dynamics	Power
Knowledge broker	Supports in making sustainability meaningful in the given context	Sustainability
	Provides space for critical reflection	
	Mediates between different perspectives	Power
Process facilitator	Initiates process	Ownership
	Selects participants	
	Facilitates process	
	Selects participants	Power
	Facilitates learning process	
	Encourages expression of all viewpoints	
	Facilitates process and experiments	Action
Change agent	Motivates participants	Ownership
	Empowers participants to lead/own the process	
	Initiates and participates in a learning journey based on sustainability values	Sustainability
	Networks with stakeholders outside the group	Power
	Participates in process and experiments	Action
	Supports policy formulation	



#### Model 5 after A. Hilger et al.<sup>19</sup>

This model presents 15 roles of actors engaged in transdisciplinary and transformative research, identified in a systematic literature review.<sup>20</sup> The roles are categorised in four activity realms: field, academia, boundary management, and knowledge co-production (see figure 2 below). This fine-grained model helps scientists to position themselves within a transformation process, to discuss complementary roles, and to contest the boundaries between scientists and practitioners. Interestingly, the model also contains the role of the 'troublemaker'.

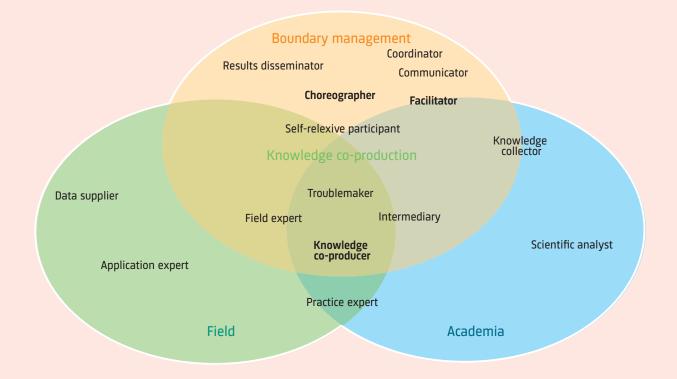


Figure 2: Overview of the 15 identified roles, arranged in four activity realms. The field (green) describes activities relating to expertise provided on the problem under investigation and the application of respective solutions, with roles primarily adopted by non-scientific actors. In contrast, the roles located in the realm of Academia (blue) involve research activities and tend to be adopted by researchers. The boundary management realm (yellow) includes activities required for establishing the processes of knowledge co-production; these take place in all the overlapping areas but especially where all three areas overlap. Roles highlighted in bold consist of more than one subcluster. Source: Hilger et al. 2021



Role of scientist	What does the scientist do in this role?	
Choreographer	«Sets the stage», organises and structures the process, and selects and invites participants.	
Facilitator	Facilitates and encourages knowledge integration and learning processes, balances different interests, empowers process participants	
Intermediary	Mediates between, integrates different perspectives; gives affected or underrepresented groups a voice	
Knowledge collector	Collects data, documents and presents the knowledge, uses participatory observation	
Knowledge co-producer	Contributes knowledge, contributes method, participates in problem framing, discusses and agrees on research question, and discusses results and suggested solutions	
Field expert	Contributes (local, tacit, traditional, experiential) knowledge, provides contacts	
Data supplier	Provides information or data and supports data collection as informant (surveys, interviews)	
Results disseminator	Disseminates results, generates recommendations, tools, popular science articles or reports; raises awareness	
Communicator	Engages in formal/informal communication	
Practice expert	Contributes expertise and application-oriented knowledge, supports experiment	
Scientific analyst	Contributes scientific knowledge, evaluates process, conducts system or actor analysis	
Self-reflexive participant	Engages in processes of (self-)reflection on normative orientation and internal/external power dynamics; thematises roles and self-awareness	
Coordinator	Leads process/case study, is a contact person	
Application expert	Tests and adapts project results in the application process, introduces them into decision-making process	
Troublemaker	Maintains previous relationships and conflicts with others, negotiates and contests rules of interaction, obstructs supply, use, or extraction of data from the field	

#### Model 6 after S. Hoffmann et al.<sup>21</sup>

This model draws on a conference workshop and literature review of inter- and transdisciplinarity (ITD), Science of Team Science (SciTS), and Science and Technology Studies (STS). It distinguishes between nine complementary roles played by 'knowledge integrators'. The roles position scientists with respect to their understanding of how to include different perspectives from science and other societal fields of action. The article also discusses researchers' motivations to play these roles and explicitly pleads for a professionalisation of roles to be able to support the careers of researchers who do not work in clear disciplinary silos:

Role of scientist	What does the scientist do in this role?	
Bridge builder	Brings different people together, establishes relations with, and builds bridges among them	
Boundary crosser	Navigates social boundaries and successfully embeds within social groups that embody different perspectives to be integrated	
Translator	Discusses, reflects on, and translates different perspectives and asks pertinent questions to make explicit uncertainties and assumptions underlying such perspectives	
Catalyst	Identifies potential tensions between different perspectives, leverages potential synergies between them, and generates new knowledge by recognising critical connections	
Facilitator	Designs, plans, implements, and facilitates integrative processes, assigns roles and responsibilities, and supports generation of integrated outputs	
Contributor	Provides own intellectual contributions to scholarship by, for instance, linking theoretical concepts, co-creating integrative frameworks, or developing interdisciplinary methods	
Mediator	Recognises power imbalances and interpersonal conflicts within and between different social groups and deals with the implications as transparently, methodically, and consciously as possible	
Advisor	Provides opportunities for learning, practicing, and teaching integration as well as accompanies, supports, or coaches others in leading integrative processes and reaching integrated outputs	
Evaluator	Monitors, assesses, and evaluates integrative processes and their integrated outputs	



#### Model 7 after R. Pielke Jr.<sup>13, 14</sup>

This model was developed in the context of an intense reflection on the science-policy-society interface. Pielke insists that scientists' perceptions of democracy and science<sup>22</sup> influence their understandings of what role they will play as a scientist:<sup>23</sup>

He distinguishes between four ideal-type roles (or 'modes of engagement') in which scientists can contribute to policy and political decision-making. The four roles position scientists in relation, first, to the main perceived purpose of knowledge production and respective impact (determining how strongly science is related to the expressed or perceived needs of societal actors), and second, to the kind of contribution one chooses to make to decision-making as a scientist: as someone adhering to a specific political conviction (according to 'interest group pluralism') or as someone who identifies as an expert (and contributes willingly or not to the elite's competition of ideas: the 'elite conflict'). Pielke explicitly argues for taking on the 'Honest Broker of Policy Alternatives' position, ideally together with other experts, because this role is the only one in his view that fulfils the requirements of functional democracy and disengaged, pluralistic scientific insight. According to the model in figure 3 below, scientists who want to contribute to public deliberation are one stakeholder group among many others ('Stakeholder Model' of science). This contrasts with the 'Linear Model' of science, where scientists see democracy as a simple process of idea development by an elite that simply takes scientific facts by 'pure scientists' into account. Although Pielke distinctly voices a recommendation for the 'Honest Broker of Policy Alternatives', he also provides examples of how the other ideal-type roles are taken up in specific situations, and what the implications of each role are. His model is reproduced in figure 3 and the resulting characteristics of the four roles are explained in the table that follows.

		View of science in society		
		Linear model	Stakeholder model	
democracy	Interest group pluralism	Pure scientist	Issue advocate	
View of d	Elite conflict	Science arbiter	Honest broker of policy alternatives	

Figure 3: Four idealised modes of engagement: 'In my book, The Honest Broker, I describe four modes of engagement by scientists and other experts (...). The different modes are a function of how we think about democracy and how we think about the proper role of science in society.' Source: rogerpielkejr.blogspot.com/2015/01/ five-modes-of-science-engagement.html

Role of scientist	What does the scientist do in this role?	
The pure scientist	In this ideal-type role, a scientist pursues knowledge production without interference with or from the political or practical sphere; he or she has no interest in policy's decision-making and simply shares some fundamental information about factors involved. S(he) does not see herself/himself as part of an interest group.	
The science arbiter	This role supports decision makers (the 'elite') by providing answers to questions that can be addressed empirically, i.e. using the tools of science, e.g. expert advisory committees (such as the Covid-19 taskforce in Switzerland). The scientist serves as a resource for the decision-maker, standing ready to answer factual questions that the decision-maker thinks are relevant. The Science Arbiter does not tell the decision-maker what he or she ought to prefer.	
The issue advocate	The defining characteristic of this role is a desire to reduce the scope of available choices brought into the democratic sphere by different stakeholders, often to a single preferred outcome among many possible outcomes. The Issue Advocate thus ventures into telling policy what they ought to prefer by making the case for one alternative over others.	
The honest broker of policy alternatives	The defining characteristic of the honest broker is a desire to clarify, or sometimes to expand, the scope of options available for action. 'Honest' implies that what is important in this role is the commitment to clarify the scope of possible action so as to empower the decision-maker. Honest brokering of policy alternatives is often best achieved through a collection of stakeholders working together with a range of views, experiences, and knowledge.	



#### 2.5 Texts to support reflection on drawing the line (or not) between science and public engagement

Models that focus on roles of scientists in sustainability transformations also include roles that are typically performed by practitioners, knowledge brokers, policymakers or other societal actors rather than scientists. Many of these roles are encapsulated in the concept of 'public engagement'. Pielke's model (model 7 in this guide) focuses exclusively on the implications of engagement for scientists with regard to their implicit or explicit understanding of democracy, while the other models (models 1-6) touch upon some roles where engagement can be exercised by scientists in the process of knowledge co-production, i.e. where scientists will participate in transformative action of some kind in the Agora. For those who believe in Pielke's 'linear model' of science (which he himself explicitly does not), roles that include such explicit engagement in transformation should not be performed by representatives of the academic system. In this regard, it is worth considering that a role is defined as 'purely scientific' based on clear epistemological premises<sup>24</sup> and on fundamental assumptions about science and society.<sup>25</sup> These assumptions can be questioned, particularly in the context of sustainability transformation.

As science is part of society and is often defined in a limited way, with corresponding limiting expectations, enlarging the role of a 'pure scientist' towards societal engagement in the public sphere may lead to difficulties: this is a sensitive boundary determined by the societal norm that science has to work in an 'objective' and 'neutral' way. If scientists are interested in engaging in societal and political processes, they can start by using the whole spectrum of political participation as an ordinary citizen in a democracy and keep themselves out of trouble by not mixing the roles. In this conception, the scientific role, even when engaging in the public sphere, is to inform politics and society with scientific knowledge. A political role implies the target to influence political decision-making, either as a citizen engaging in a social movement or as a voter. In these spheres, different forms of political participation are available in democratic societies.

However, in the context of public debates on hot topics such as environmental issues (e.g. climate change and biodiversity loss), the distinction between scientific and political roles is increasingly difficult for a scientist to uphold. It is also generally difficult to uphold it in the context of knowledge co-production (in the Agora), where the boundary between science and other societal fields of action is permeable.

The following four publications, which we offer as texts 1–4, can be used, first, to trigger reflection on this difficult and important issue, and second, to discuss the relationship between science and public engagement by teasing out whether and where there are intersections and clear boundaries between the two. These publications can be used to sharpen one's own (or a group's) vocabulary and understanding when engaging in a discussion about whether and where to draw the line between science and public engagement.

We would also like to draw attention to the excellent project conducted by Stefanie Boulila, Sabrina Heike Kessler, Sofie Behluli, Stefan Schlegel, and Clara Zemp, of the Swiss Young Academy,<sup>i</sup> on what it means to deal with science and public engagement, and how to address issues related to crossing the boundary between the two.<sup>26</sup>



#### Text 1

### From activism to science and from science to activism in environmental-health justice conflicts<sup>27</sup>

The authors of this article emphasise that knowledge is neither static nor unique. It can be exchanged between activists, academia, and policy circles: from science to activism and from activism to science. Existing scientific knowledge is being used by activists to expose wrongdoings or improve practices and knowledge in environmental and health conflicts. Activists can either adopt scientific knowledge and data in their own argumentation or produce new scientific knowledge, either by becoming scientists themselves or in co-operation with scientific experts. Local and scientific knowledge is combined to challenge government policies and the knowledge produced by corporate actors. The figure of the expert-activist is also explored. With scientists engaging in the public sphere and vice versa, the boundaries between activists and scientists are increasingly blurred.

#### Text 2

#### Scientists who become activists: are they crossing a line?<sup>28</sup>

This commentary explores a traditionally posited boundary between science and politics, with particular attention to activist scientists who engage in public communication. Work in fields like science and technology studies shows that framing this boundary in terms of epistemological rules can fail. Boundaries dictating proper scientific activities are at best pragmatic, context-dependent, and fluid. Undoubtedly, certain kinds of politics can undermine the integrity of scientific knowledge, but it is imperative to recognise that all science is political. As we see with activist climate scientists, specific scientific knowledge carries far-reaching political consequences. It is thus problematical to call for the 'de-politicization' of science or science communication. Perhaps a turn from epistemic to ethical concerns offers a more constructive way forward.

#### Text 3

#### How activist should scientists be? 29

This discussion paper addresses the question whether and to what extent scientists should engage in activism. The authors explore the tensions between traditional scientific objectivity and the ethical imperative to address urgent societal issues. They advocate for a balanced approach, wherein scientists can responsibly integrate activism without compromising the rigour of their research. The article discusses the potential benefits of scientists' activism in driving change towards sustainability and advancing social justice causes. It also highlights the need for clear communication, transparency, and consideration of potential biases in such engagements. The authors emphasise that while scientists have a role to play in addressing societal challenges, the degree of activism should be based on careful consideration of individual circumstances, ethical responsibilities, and the potential impact on the scientific community's credibility.

#### Text 4

#### Wissenschaftskommunikation: Expertise allein reicht nicht<sup>30</sup>

This newspaper article (in German) argues that scientists are increasingly being asked to provide expert knowledge and options for solutions. Scientists also increasingly position themselves in social media. They are expected to provide well-founded facts and insights but are also asked to give advice and opinions. If they do the latter, they risk being heavily criticised. Expertise is often not enough to guarantee scientific communication. So before exposing oneself to a debate as a scientist, the author argues, it is worth exploring the interests of the other parties; it's also worth reflecting on where one is with regard to the following different roles of a scientist, understood as stages of scientific activity: 1) knowledge generators, 2) interpreters of scientific facts and insights, 3) knowledge exchangers with scientists and others, 4) providers of recommendations, 5) holders of an opinion, 6) especially when the topic is not theirs. In roles 5 and 6, scientists are societal actors simply expressing opinions.

# **3** Step-by-step guide for reflecting on roles of scientists in sustainability transformations

In this section, we suggest a **3-step procedure** to initiate concrete reflection on and discussion of scientists' roles in sustainability transformations.

#### Individual reflection

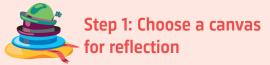
For individual reflection, you can directly follow the steps 'Quick Reflection' below. if you want to spend more time reflecting, go through 'Group reflection'.



Without any further reading, you can jump directly into a short reflection session by asking yourself:

- When did you experience a challenging situation as a scientist and started thinking about what it means to be a scientist?
- 2. If you are a scientist: How would you describe your role as scientist? If collaborating with scientists: How would you describe the roles of scientists in your professional context?
- 3. What roles of scientists in sustainability transformations can you think of? Which are you most/least familiar with?
- 4. Focus on the roles you are least familiar with: What do you value about these roles?
- 5. To what extent could collaboration with scientists performing different roles enrich your scientific work?
- 6. To what extent could collaboration with scientists performing different roles enhance the societal relevance of your work?
- 7. To what extent could performing different roles while collaborating with practitioners (in politics, civil society, administration, business, with citizens) enhance the societal relevance of your work?
- 8. To what extent might roles conflict with one another?

#### **Group reflection**



In this section, we provide guidance for choosing one of the models or texts introduced in chapter 2 to initiate a reflection on roles of scientists.

#### Select a model or a text

Questions for all scientists or for evidence-informed professionals collaborating with scientists:

I'm interested in exploring ...

- ... what scientists generate knowledge for (e.g. for scientific debate, for answering concrete questions from society and politics, for achieving a goal defined with other stakeholders). ► Model 2 or 7
- ... who/what different target group scientists can generate knowledge for. ► Model 2 or 7
- ... the different ways scientists can support the decisions of policymakers. > Model 2 or 7
- ... the different intensities of scientists' interactions with other stakeholders and the implications thereof for their roles.
   ▶ Model 1 or 2
- ... the different foci of interaction when scientists conduct research with other stakeholders. ► Model 1

Questions for scientists who are already aware of different roles of scientists and have experience with performing roles at the science-society-policy interface:

I'm interested in exploring ...

- ... the purpose of my role in different situations or areas (e.g. providing access to knowledge, providing advice based on it, supporting social learning and collaborations).
   Model 2 or 4
- ... different roles in knowledge integration. > Model 6
- ... process-oriented roles. > Model 3, 4 or 5
- ... tensions between different roles and how to deal with them. 
  Model 4 or 3
- ... the different normative orientations scientists bring along. Model 3 or 4
- ... the high diversity of roles in my inter- or transdisciplinary research team. ► Model 2, 3 or 6
- ... the boundaries between academics and practitioners (and questioning them). ► Model 5 or 1
- ... the boundary between scientific action and public engagement and the incorporation of scientific activity/knowledge into activist thinking. ▶ Text 1, 2, 3 or 4
- ... self-reflection about my role(s) / reflecting about our role(s) with my team. ► Model 6 or 3
- ... the spectrum of roles in sustainability transitions in a group of scientists and of extra-academic change-makers.

Model 2 or 5

Irrespective of which model or text you choose as a canvas for reflection, we recommend that you add the role of 'others' in the model you chose, in order to provide space for additional roles that may not be taken into account in the model. This will demonstrate that the model has heuristic value and is **not** prescriptive.

#### Select photos

Instead of models or texts as a canvas for reflection, you can also use photos showing concrete examples of scientists in action in situations that may enable sustainability transformations (see for example figure 4).<sup>31</sup>

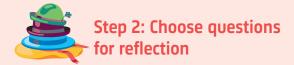
You can use these photos for generating a reflection on roles (see step 3). E.g.:

Scientists doing lab work in interdisciplinary and multicultural teams;

- Scientists on field excursions with local actors;
- Scientists contributing to assessing scientific understanding (e.g. IPCC or IPBES);
- Scientists intervening in the media;
- Scientists intervening in public spaces, e.g. climate activists;
- Scientists participating in roundtables or workshops with societal partners;
- Scientists doing desktop research;
- Scientists moderating a stakeholder dialogue;
- Scientists facilitating and participating in a game with local actors to explore understandings of a sustainability issue
- ...



Figure 4: Panel of photos showing scientists in different roles. Source: Simone Ritzer



#### Do you want to reflect on your own?

Understanding and acknowledging the spectrum of roles (Awareness Raising) ► Set 1

Strengthen your competences to position yourself more effectively in interactions with other actors engaged for sustainability transitions (with a target audience that is already aware of the spectrum of roles) (Improving Competences) > Set 2

#### Set 1

#### **Questions for awareness raising**

When looking at the model or picture of roles of scientists, you may ask:

- 1. What roles are you most/least familiar with?
- 2. Focus on the roles you are least familiar with:
  - What do you value about this role?
  - How does this role contribute to the production or use of knowledge?
  - What other aspects do you value?
- 3. What do you value about each of the other roles?
- 4. What are the risks when performing these roles: for the individual scientist, for the project team, and for the scientific system?
- 5. What could a division of tasks between the different roles for knowledge production and sustainability transformations look like?
- 6. To what extent could collaboration with scientists performing different roles enrich your scientific work?
- 7. To what extent could collaboration with scientists performing different roles enhance the societal relevance of your work?
- 8. Do you think that awareness of different roles of scientists would enhance clarity in the way you talk about science to ... other societal actors? ... fellow scientists? If yes, why?
- 9. Which roles help to maintain status quo, which induce change?

For a workshop setting, we recommend that you focus only on 2–5 of these questions.

#### Do you want to facilitate a group meeting on roles of scientists?

Support the group's understanding and acknowledging of the spectrum of roles (Awareness Raising) ► Set 1 + 1a

Strengthen your group's competences to position themselves in interactions with other actors engaged for sustainability transitions (with a target audience that is already aware of the spectrum of roles) (Improving Competences)  $\triangleright$  Set 2 + 2a

#### Set 1a

## Additional questions for awareness raising in a heterogenous group

In a group setting, you may also want to discuss the different positions within a group. To this purpose, you need to visualise the roles that are performed by the participants (see figure 5 below: Spider diagram to identify individual scientists' role profiles<sup>32</sup>). Then ask:

- When we look at the distribution of the roles in our group what is surprising? Did you expect a certain role to be more/ less prominent?
- Which role(s) do you think should we as representatives of the scientific system – foster?
- 3. Have you ever experienced ambiguity or conflict between roles? How did you deal with this? What kind of support is needed to deal with such situations?

#### Set 2

### Questions to reflect on one's own or others' position and improve role competences

When looking at the model of roles chosen previously, you may ask:

- 1. Which role do you identify with most?
  - What is the value and what are the risks of this role (for you personally, for the project team, and for the scientific system)?
  - In front of what audiences do you make this role explicit?
  - In what situations do you think that the quality of your work would be enhanced if you would communicate your role more explicitly?
  - What support would you need to be able to better perform this role?
  - What would happen if all researchers would perform that role?
- 2. Which other roles do you identify with?
  - Repeat questions under 1.
- 3. Does/do the role(s) you identify with (most) depend on the research phase you find yourself in?
  - If yes, how do you communicate this fluidity of roles?
- 4. Which role do you not identify with, but you value that other scientists do so?
  - What is the added value of this role for science and other societal fields of action?
- 5. Which role do you not identify with, but has been ascribed to you by others? How do you deal with that situation? What kind of support is needed to deal with such expectations?
- 6. Have you ever experienced ambiguity or conflict between roles? How did you deal with this? What kind of support is needed to deal with such situations?
- 7. Which role is missing in the spectrum of roles?
- 8. Which role would you like to take on more, but don't know well enough yet?

For a workshop setting, we recommend that you focus only on 2–5 of these questions.

Make sure you take into account the level of awareness within the expected audience.

#### Set 2a

## Additional questions for improving competences in a research team

In a workshop with a research team, you may want to draw consequences for teambuilding from the team's reflection on roles. To that purpose, you need to visualise the roles that are performed by the team members (for example using figure 5). Then ask:

- What did you learn from other team members today? (e.g.: was there a mismatch between self-perception and the perception of others?)
- 2. What does the distribution of roles in the group tell us about our collaboration?
- 3. Can you as a team become more explicit about the distribution of tasks?
- 4. Do you need to redistribute resources or hire someone to cover a specific role?
- 5. Do you have mechanisms in place to regularly monitor whether the roles have (implicitly or explicitly) changed?
- 6. How do you communicate these roles in interaction with change-makers?



a workshop, summarised in the table below. In addition, in the following sections we provide further elements that can be used to craft an inspiring workshop.

#### Key elements for designing a workshop

Generic workshop outline	Materials
<b>Introduction</b> Purpose of the workshop Why is this important	Presentation <sup>i</sup>
Participants familiarise themselves with the discussion canvas	Model, text or set of photos <b>(Step 1)</b>
Participants reflect individu- ally on questions They join to discuss questions	Questions selected (Step 2)
Debrief section	Questions for debriefing (p. 28)
Optional	
Participants read a case study and discuss questions	Working with case examples to strengthen awareness (p. 27)
Participants position themselves on a visualised spectrum of roles	Visualisation of roles (p. 27)
Discussion of distribution of roles	Spider diagram (fig. 5, p. 28) and sticky dots; or set of pictures and sticky dots
Use the chosen and processed visualisation of roles (to discuss one's own and others' positioning)	

#### Working with case examples to strengthen awareness

On our website<sup>i</sup> examples of how change-makers perceive scientists in sustainability transformations are provided. In the last section of each of these case examples, change-makers' perceptions of scientists are linked to a selection of models of scientists' roles.

If you decide to use one of these examples, we suggest that you first provide an input on the selected model (Step 1); then you can provide participants with the case example taken from the website and ask:

For students:

- Which of the presented roles are new to you? What would you need to feel prepared to perform this role?
- You can also ask learners to match the roles described in the text of the case described with the roles in the models presented in chapter 2 (while hiding the matching done by the authors of the case examples), or you can ask to what extent they agree with the matching of roles done by the authors of the text.

For representatives of public administration:

- Which of the presented roles are new to you?
- Which of these roles do you consider especially supportive?
- How would you proceed to find people able to perform these roles?

#### Visualisation of roles

To initiate lively group discussions, it may be helpful to ask participants to position themselves in a visualisation of typical roles of scientists.

- Either you can use photos of scientists in different roles as an input (Step 1), and provide participants with sticky dots to mark their favourite picture/role.<sup>33</sup>
- Or you can use a model from chapter 2 as an input and provide a spider diagram of the spectrum of roles.<sup>34</sup> Then ask participants to draw their profile in their own copy of the spider diagram (see for example fig. 5).

See question Set 1a and Set 2a for ideas regarding how to induce a group discussion based on such visualisations.

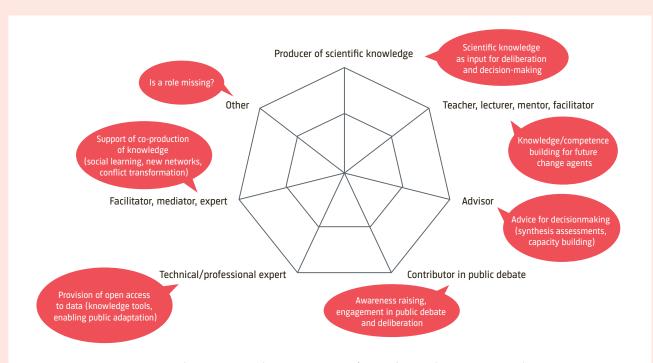


Figure 5: Spider diagram of model 2 to identify individual scientists' role profiles. For further description of the spider diagram method for discussing roles of scientists, see: Hofmann B, Salomon H, Hoffmann S 2025.

#### Questions for debriefing

Before closing a workshop, it is helpful to discuss how the workshop experience might influence participants' future work. Some of the reflection questions already contain a certain 'call for action'. You may complement them by asking:

- What is your main take away? What is the favourite sentence you heard or reflected on during this workshop?
- Have you found new words for how you talk about roles of scientists? If so, which ones?
- To what extent did this workshop strengthen your desire to do impactful science?<sup>35</sup>
- Where do you think you will act differently in future, based on your awareness of different roles of scientists?
- Etc.

#### General facilitation tips

- Irrespective of which discussion basis (model or set of photos) you choose, we recommend that you add the role «others» to provide space for additional roles that may not be explicitly mentioned in the model or set of photos, but correspond to something experienced by participants.
- We recommend that you invite participants to reflect first individually for some minutes and then to meet in small groups, before going into a plenary discussion.
- Make sure that the models are used as a basis for discussion, not as an analytical instrument to draw lines be-

tween roles: The strength of models of roles is to show that a person can contribute to knowledge co-coproduction, engagement, or knowledge brokerage with different work attitudes/intentions in a professional setting. For a specific activity, it is often difficult to draw the line between roles. However, discussing boundaries between roles may be helpful in a real-world situation, especially to clarify expectations, power issues and potential conflicts of interest. If conducted on an abstract/ theoretical basis, such a discussion aiming at demarcations is less productive.

- If not all your participants are scientists, you may use models that describe roles of scientists (as described by scientists themselves) as well as the perceived contributions/roles of scientists (as perceived by other societal actors). We used model 2 for that purpose, see example 3 on the website<sup>k</sup>. A recent article<sup>36</sup> used the typology proposed as model 5 in this guide, describing a much larger spectrum of roles that can be performed by scientists and other societal actors.
- In group settings, the spider diagrams filled in by individual participants can be displayed in a joint picture. This makes it possible to discuss the constellation of roles present in the group. This in turn enables a discussion of a division of tasks within the scientific system and teambuilding within the group (if applied in a research team).<sup>37</sup>

k scnat.ch/roles\_of\_scientists/transformations

### 4 References

#### 4.1 Cited literature and notes

- 1. In the interest of simplifying the text, when we use the term 'scientists', we mean all persons who have (had) a scientific career, including those who would prefer to call themselves 'scholars'.
- 2. Merkel W et al. (eds.) (2019) The Handbook of Political, Social and Economic Transformation.

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- 3. The website https://naturalsciences.ch/sustainability/transformation offers definitions of 'transformation', 'transition', and corresponding scientific approaches and issues that were elicited in interviews from members of the Swiss academic community in the field of sustainability. In the present guide, we have purposedly used a simplified conceptual framework.
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- **20.** We have summarised many activities presented as separate in the original Table 3 to ensure usability of the model.
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- 22. Political sciences differentiate between different models of democracy, which means that different CORE CRITERIA of what is essential for democracy is put at the centre of attention: the 'elite democracy model' focuses on the importance of elected members of parliament who should govern the policy fields in cooperation with the executive power. The 'pluralist model' stresses the importance of the organisation of interests and fair competition between them within the democratic process. They also influence parliamentarian processes. Last but not least, the participatory model of democracy aims to strengthen the role of citizens in the sense that they should not only be integrated as voters in regular elections but also as participants in discussion and deliberation processes, to be able to bring in their own ideas into politics. Pielke focuses on the first and second models.
- **23.** Here is Pielke's definition of the two perceptions of democracy and science: 'There is a profound difference between democracy as pure interest group pluralism and democracy as a competitive system in which elites bring options to the public. The former suggests that scientists ought to align themselves with their preferred political advocates and lend their expertise and legitimacy to that cause. The latter would suggest that some scientists help policymakers and the public to understand how scientific knowledge is significant for the scope of policy choice.' Pielke Jr 2007, p. 152.
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- 26. See for example Kessler SH, Rabinovich M, Boulila S (2024) Science vs. Activism? Exploring the Boundary: Perspectives of Young Researchers in Switzerland. Bern, Switzerland: Swiss Young Academy (SYA). https://api.swiss-academies.ch/site/assets/ files/130445/science\_vs\_activism\_exploring\_the\_boundaryperspectives\_of\_young\_researchers\_in\_switzerland.pdf

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- **31.** Many thanks to Simone Ritzer (Wageningen University & Research) for this contribution.
- **32.** Figure 5 and the idea of discussing roles of scientists using a spider diagram are based on the work by Sabine Hoffmann, Benjamin Hofmann, and Hanna Salomon (all at Eawag) and its application in the two projects Trapego and Trebridge.
- **33.** This method was suggested by Simone Ritzer. See example described by her on the website (Example 2)
- **34.** This method is described in Hofmann B, Salomon H, Hoffmann S (2025) **Roles of researchers in inter-and transdisciplinary sustainability research: a reflection tool.** Sustainability Science.
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