Chapter 2
The RIU Model as an Analytical Framework for Scientific Knowledge Transfer

2.1 Introduction to the RIU Model

Like the two friends sharing a beer in the first chapter, many researchers in the environmental sciences experience frustration because practical actors do not follow their scientific advice. Conversely, many politicians are frustrated with the naivety of natural scientists regarding the potential for political implementation of their recipes. The widely-assumed incompatibility between science and politics is the starting point for our analysis: We question whether there may be possibilities for successful scientific knowledge transfer in spite of the fact that the types of logic that political and scientific systems use are different.

In this chapter, we introduce our model of scientific knowledge transfer, which we call RIU, and which stands for research, integration, and utilization. The analysis in the six case studies that follow in Chap. 3 is based on this new RIU model of scientific knowledge transfer.

An understanding of the factors involved in knowledge transfer supports this model. These include state-of-the-art, independent research and the effective, practical utilization to which it leads. In addition, the model highlights the important "integration" activities. Here, the word "integration" refers to the active, bi-directional selection process of those research results that are relevant in practice. The term as a whole emphasizes the importance of special allies in practice who are powerful actors that support the use in society of the results that scientific research achieves.

The RIU model goes a step beyond the existing criteria used to determine the success of knowledge transfer, extending these to include the actors who are the recipients of scientific advice, and their interests and power (Böcher and Krott 2014a, b; Krott 2012). Moreover, we follow recent studies on the use of scientific

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findings in political practice that speak of a "politicisation of expertise" (e.g. Weingart 1999; Hoppe 1999) and conclude, given the different interests of the actors involved, that it is important to couple the demand of various actors actively with the available supply of expertise (Sarewitz and Pielke 2007; McNie 2007; Guston 2001). The RIU model focuses on three key factors for successful scientific knowledge transfer. By distinguishing between the three elements of research, integration and utilization, the RIU model focuses specifically on the logic of each element. Its main hypothesis is that an integrative selection process based on specific political or practical demands can link the observable and mostly independent action spheres of scientific research and politics (remember the conversation of the two guys having a beer…). This "integrative selection" step is crucial to our model, and we refer to it as integration because a selective integration process is always necessary to connect the worlds of science and politics in order to find science-based solutions for policy and practical problems.

The RIU model relies on the criteria of relevance, credibility and legitimacy (Cash et al. 2002; Mitchell et al. 2004) as applied to specific actors who play a role as allies of knowledge transfer. Here, the connection between scientific knowledge and the concrete demands and interests of the actors is especially important, as is also the link between scientific research results and the interests of actors in the political process (Böcher and Krott 2014a, b; Krott 2012). In addition, there is a need for an intermediation strategy oriented towards target groups (Müller-Rommel 1984; Renn 2003). This strategy should identify the media and formats needed for different addressees (e.g., science, political actors, citizens, administration). Each type of addressee needs its individual kind of science-based information and communication.

What is novel in our model is that it reflects many aspects of scientific knowledge transfer other than mere "communication". Many guidelines for scientific knowledge transfer often state that mostly all that is crucial for knowledge transfer is communication (see for example: Government Office for Science 2010; Moll and Zander 2006, pp. 59–72; Ugolini et al. 2015). Certainly, we agree that science communication in an important subtask of knowledge transfer. However, our political science background leads us to suggest that a much more important aspect to consider is how to connect science-based information to the resources (political power, finances) of political and practical actors. If science-based information is useful to the actors and their interests, then they will use their resources to promote the use of scientific knowledge in their specific realm.

The RIU model consists of three activities

Research,
Integration,
and Utilization.

Research applies scientific principles, methods and standards. For there to be knowledge transfer from science these research results have to be put to the service of the needs and demands of the practical allies and their interests. The requirements

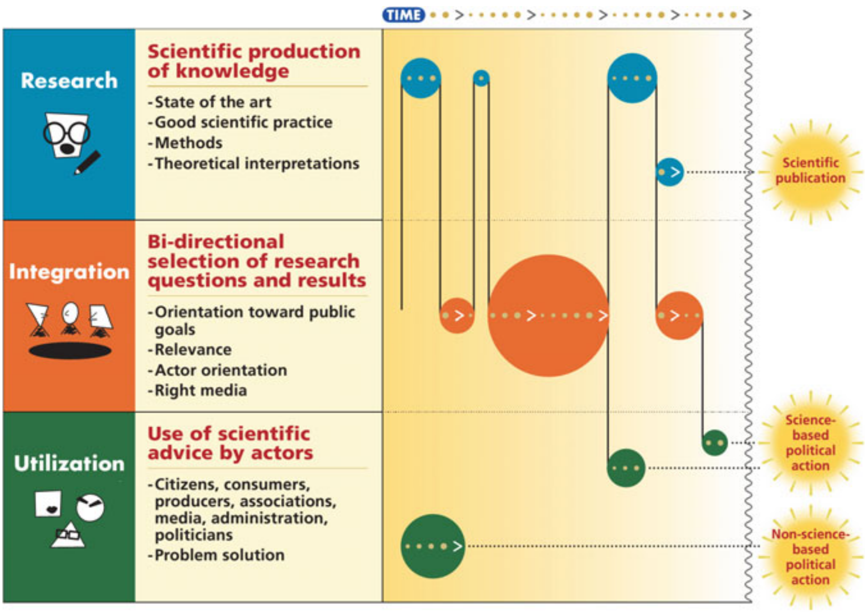

Fig. 2.1 The RIU model of scientific knowledge transfer

of political and practical problems and their solutions determine the criteria for selective integration and practical utilization.

Figure 2.1 shows the RIU model and the three activities necessary for scientific knowledge transfer, namely research, integration, and utilization, each with its respective main criteria for quality. The diagram also shows that scientific knowledge transfer processes take time. During this time period several switchovers between the different activities (from integration to research and vice versa) take place. These involve each of the activities to a different extent as they refer to the specifics of the individual knowledge transfer process and the underlying policy or practical problem. Not every political action is based on scientific knowledge, and our RIU model reflects this, in that it includes a category called “non-science-based political action”. Here, political decisions are not based on processes of research and integration. In other cases, continuous research and integration activities lead to science-based political action. Such processes differ in the amounts of research, integration, and utilization involved at any given time. In the figure, the circles represent this in that they have different sizes that correspond to the different lengths of time needed for each activity. The figure illustrates one of the basic ideas of RIU: Science-based political action has to be the result of research and of integration activities, whereas non-science-based political action does not need these. The products of RIU processes can be political and practical actions, by different actors, that use scientific advice. Another product, authored by the scientists involved, can be scientific publications that target the scientific community.

The following sections describe the model, its foundations and its analytical power in detail.

2.2 Scientific Knowledge Transfer and Its Subtasks: Research, Integration, and Utilization

How is scientific information "translated" into practice? Conversely, how are practical requirements "translated" into research questions that can be investigated through scientific research processes? We observed that there are a number of steps between research activities and their integration, in various cases in Austria, Germany, Croatia, Serbia, Japan and Indonesia (Böcher and Krott 2014a, b; Stevanov et al. 2013; Dharmawan et al. 2016; Heim and Böcher 2016; Nagasaka et al. 2016). In later chapters we present the results of some of the case studies from Austria, in which such steps have been taken within certain research programmes in sustainability research or within departmental research institutions. These steps lead from the activity of integration in which information about the requirements of practice for science-based problem solutions is collected and formulated. The next step is to conduct research activities that lead back to integration activities, if a concrete, science-based knowledge transfer product for practical utilization by politicians or practical actors is needed. At the end of this process the three activities, research, integration, and utilization (RIU), analytically understood as independent variables, lead to an active use of science-based information by different political and practical actors.

"Production lines" reflect the time dimension in this process (in Fig. 2.1 these go from left to right along the x-axis) and they reveal a typical alternation between integration and research activities over time, making clear that a science-based product for political and practical utilization must always comprise both research and integration (representing the demands of practice). This is a central prerequisite for successful scientific knowledge transfer. Integration is thereby the bi-directional orientation of scientific knowledge towards the solution of practical problems, and vice versa. Integration is a specific activity that is closely connected to science and that connects science to practice and its requirements (Böcher and Krott 2010, 2014a). Along the timeline of scientific knowledge transfer, there are steps that represent research activities, others that represent integration activities, and steps of a third kind that represent utilization activities.

What is scientific knowledge transfer?

According to our RIU model, we define scientific knowledge transfer as follows:

> Scientific knowledge transfer is the connection between research, *and* integration, *and* utilization. The content and extent of research and integration activities are derived from the requirements of utilization, which is determined by the demands of political and practical allies.

The functions of research, integration and utilization constitute different subtasks of knowledge transfer, but they are not necessarily sequential. They alternate constantly, particularly research and integration. This repeated change is shown in the production line. The production line ends at the time of utilization, the active use of science-based products by different actors. The different subtasks of RIU are described in more detail below:

2.2.1 Research

Research is a process that produces a specific form of knowledge by using scientifically accepted principles, methods and standards. (Schnell et al. 2008, p. 7 ff; Kromrey 2000, p. 67 ff.; Atteslander 1995, p. 30 ff.)

The main function of research for scientific knowledge transfer is to guarantee state-of-the-art scientific theories, methods and data that have been previously selected by integration activities as being relevant to the solutions of practical problems. In science there can be a lot of research that is devoted to theory development, and that follows the current trends in various scientific disciplines. Such research is normally independent from practical needs and influences. The process of integration reviews scientific research, identifies the type of research that is relevant for the solution of practical problems and separates it from the research that is not currently needed in practice, since there may be a lot of science that is irrelevant to current practical problem solutions.

The research process consists of the following steps (Bortz and Döring 2009; Schnell et al. 2008; Kromrey 2000; Atteslander 1995):

1. Identification of research questions
2. Definition of research objectives
3. Development of research methods
4. Data collection and data analysis
5. Scientific interpretation

At each of these research steps the scientific information has to be up to date. The underlying theories and research methods have to represent the most current information from the respective scientific discipline. Also, the criteria of "good scientific practice" have to be fulfilled (DFG 1998).

2.2.2 Integration

Integration is the direction of research to a practical problem with the aim of describing the problem and successfully solving it. This orientation is bi-directional: On the one hand, the demand of practice for science-based solutions has to be investigated and used for the selection of research questions, on the other, scientific research results are selected according to their relevance to the practical solution.

Integration connects scientific knowledge to actors' expectations in practice. Such a connection requires constant exchange between research and integration, and it is only possible with extensive knowledge of both science and political practice. Integration searches for matches, contradictions and gaps in practical goals. Congruence with goals serves as a signal for the successful description and solution of problems.

Gaps lead to adaptation, either by formulating new research questions or by learning from practice. If there are contradictions there is either an alignment of practical expectations with the actual available scientific knowledge, or scientific knowledge without practical relevance is abandoned.

Integration connects research with practical demands by selecting individual "bricks of knowledge." These bricks are valid for the purpose of integration because they reflect state-of-the-art science and because they are relevant in practice (Böcher and Krott 2010, p. 38; Jasanoff 1990, p. 250). The resulting products are integrative in that they meet the standards of scientific criteria and also deliver practical solutions. Integration, then, reflects the standards of both scientific and practical problem solving. However, integration is forced to compromise on both counts: In order to find practical solutions it reduces the amount of scientific knowledge weighed, and it also corrects the political expectations regarding existing scientific knowledge. Therefore, integration inevitably leads to friction with those who pursue broader research objectives as well as with those who represent the wishes of political actors.

2.2.3 *Utilization*

Utilization is the use of scientific knowledge by actors in practice. Actors decide by themselves what kind of knowledge and how much of it they want to use, and they can also force other actors to use this scientific knowledge. Utilization also includes the use of the scientific knowledge within the scientific discourse.

Utilization starts with the delivery of a finalized knowledge transfer product [scientific policy advice] to political and practical actors. The product can be delivered in different forms, such as written reports, brochures, suggestions for new regulation schemes and standards, or implementation guides (Böcher and Krott 2010, p. 41). Actors involved in practice (citizens, consumers, producers, associations, media, administration, politicians) then use scientific advice actively to solve problems.

Other potential products are disseminated to the scientific community via scientific papers or contributions to scientific meetings. This dissemination guarantees that the scientific research that is used to advise policy makers reflects the most current scientific knowledge and that it ensures the research quality of the entire RIU process.

Utilization leads to changes in certain actors' behaviour. It needs its own procedures and resources to gain influence on the actions of other actors. In utilization, knowledge transfer is no longer in the hands of the scientists involved. Once a knowledge-transfer product is released, scientists can no longer influence its content and use. Making a clear distinction between integration and utilization is very important. Integration is often a form of internal (hypothetical) information processing and mutual adjustment, be it solely in the minds of researchers or by means of collaboration with practitioners. The aim of integration is the development of knowledge transfer products of high practical relevance that can be released for the use of political actors, provided that they are finalized after a continuous bi-directional process between integration and research activities.

2.3 The Production Lines

The production lines illustrate and quantify the entire knowledge transfer process. They help to visualize the alternation between activities of integration and research until a utilization product is released.

The production lines enable us to compare the amount of time invested in research, integration and utilization. Furthermore, the activities of research, integration and utilization can be analyzed and revealed using the concept of production lines (Böcher and Krott 2010: 43 ff). The lines begin within the sphere of integration (e.g., a research project that is commissioned by a ministry) and lead back into the sphere of research (e.g., the demand of the ministry for science-based advice is reflected in the creation of a research project). The production lines later return to the sphere of integration (e.g., preliminary research results and their political implications are discussed with the ministry). This process continues until the finished advisory product can be delivered to an external target group. Switching between the subtasks of research and integration is typical of such processes. These production lines between research and integration cover the usual internal procedures of the scientific knowledge transfer processes. The lines reveal that a single advisory product generally combines integration and research and that it takes time to finalize a scientific knowledge transfer product (Böcher and Krott 2010: 25) (Fig. 2.1). The lines continue within the utilization process. Different actors use the scientific advice as a basis for their activities. They can also force other actors to consider and use the scientific advice. The periods of utilization can differ strongly. Some scientific advice is used for only months; other scientific results can be used for hundreds of years.

The production line allows the separation of the time resources invested and the quality of the activities. Even if research, integration and utilization are short, they can meet high quality standards and, conversely, a long period of research does not guarantee a high standard.

2.4 Allies for a Successful Transfer of Knowledge

The RIU model emphasizes the relationship between the criteria for successful knowledge transfer and the specific actors serving as allies for knowledge transfer. We speak of four different roles an ally can play: internal, external, learning and wise ally. Internal and external allies differ in the degree of involvement they show the research process. Learning and wise allies depend on the decision process of the actor itself. In practice, an ally can fulfil more than one role simultaneously, e.g. an internal ally that is also a learning ally.

> Allies are all actors that support knowledge transfer from science into political practice by means of their power.

2.4.1 Transfer Through Internal Allies

A mechanism that helps to transfer scientific knowledge into practical action is the political production, by internal allies, of acceptance. Internal allies are actors who are actively involved in the research process and the utilization of its results. They adopt a scientific solution because it promises them advantages over other actors. Internal allies use their available resources to ensure that other actors also adopt the solution. It is important to know the reasons why such actors want to follow a science-based solution and whether they can promote its acceptance by other actors. Weak actors do not help much in knowledge transfer, even if they are true followers of scientific advice, because they lack the power to exert enough of an influence over other actors so as to have them accept the advice as well.

2.4.2 Transfer Through External Allies

Another mechanism is the enforcement of science-based solutions by external allies. External allies are actors who do not participate in the research project, but who have the power to exert external pressure on other actors so that the latter seek cooperation with science and adopt science-based solutions. A strong actor forces other actors to solve their problems by themselves, supported by using scientific advice. This could reflect the strong actor's interests: If the other actors can solve their problems better by making use of scientific expertise, the strong actor does not have to invest resources to search for solutions.

2.4.3 Transfer Through Learning Allies

From the point of view of the actor, there is the option of learning. Learning allies are those actors who learn something new from scientific research and its results, in terms of their own interests. In fact, political actors assess scientific expertise always in light of their own interests, and seek to benefit. Nevertheless, they can sometimes alter the interpretation of what their own interests are, based on scientific fact. Actors would then change their own positions and their actions.

An example is flooding. If an actor wants to invest money to build houses near a river but scientists deliver strong empirical data indicating that during the next couple of years flood problems will arise, then actors might change their behaviour based on science. Actors' self-interests lead to their learning and help them accept critical scientific results. Guided by their interests, actors deal with scientific findings and seek their advantages. Based on scientific evidence, actors can see their interests in a different light, and then they reconsider their positions.

Critical and empirical science, the kind that acts independently from the direct influence of practice, is an important precondition for learning allies, because only independent research can produce critical results that contradict and challenge the expectations of practice. The production of solutions to issues of sustainability and the environment cannot function without sufficient scientific freedom.

It is possible that potential threats to actors' interests could trigger rethinking. To achieve such an effect, hard scientific facts and hypotheses are necessary. Learning allies exist, but political actors learning from scientific insight is a rarely-seen effect. Environmental issues cannot rely exclusively on the existence and the actions of learning allies.

2.4.4 Transfer Through Wise Allies

From the perspective of practitioners, scientific results reflect just one type of information. Most practical decisions are also based on traditions, sector belief systems, everyday knowledge and practical experience. Practical actors who have to make decisions are faced with the difficult task of evaluating various types of information and forming an overall judgement on which to base their decisions. Science provides little assistance with this task, since it lacks the ability to judge forms of knowledge other than scientific reasoning. Science only has the potential to reflect scientific thinking critically, not the many other types of knowledge that may be of worth.

Wise allies are those actors who are able to assess the importance of scientific knowledge against all other information correctly and to place scientific knowledge correctly within the overall decision-making process. They follow rules that consider more than solely scientific criteria. Science normally plays only a limited role in the generation of all the information used to make decisions. The idea of wise allies is very important for environmental issues. Environmental research results rely often on implementation by wise allies. For these allies, science plays only a limited role in decision-making. They make decisions based on different knowledge sources, of which science is a part, and by no means the only guiding criterion.

2.5 Transfer Through Integrators

All allies use scientific knowledge in a way such that it serves their own interests, and not only because of the objectives and epistemic aspects of science itself. This tension might not satisfy all scientists who are interested in the practical implications of their work. Nevertheless, individual interests are the reason why scientific knowledge can be incorporated into practical actions and political decision-making. The functions of the different allies for scientific knowledge transfer show that science may have an epistemic influence on practical decisions even in conditions under which political and practical actors follow their self-interests. This is an important difference between the RIU model and certain narrow functional models of scientific knowledge transfer that are based on simple public choice considerations and in which science does not have any epistemic influence on decision-making processes (see Chap. 4).

However, one must recognize that there is a tension between political interests and the cognitive interests of science. Political issues threaten the integrity and cognitive aspects of science. We have seen above that integration requires both an understanding of scientific principles and of practical aspects and actors' interests. Therefore, for successful scientific knowledge transfer by integration scientists have to be open-minded to both areas, scientific knowledge (which should be easy for them) and the requirements of the actors' practice. Scientists themselves need not necessarily adopt this bi-directional role. Rather, professional integrators can facilitate the integration tasks. They must build a close and trustful relationship with scientists and they have to understand the principles of scientific research at least to a degree. These integrators also have to build trust with practical actors. They have to understand the specific demands of practice, the time constraints and the interests on which practical actors base their decisions. The role of the integrator is to mediate between science and practice and to complete integration tasks. These integration tasks can overburden scientists, and they can lose their scientific legitimacy if they come too close to practical interests. There is a danger that scientists may not be able to ensure the quality of their work if they concentrate too much on doing integration—it simply takes time and lies outside the core of every scientist's competence. Developing professional integrating services might be a challenge for consultants.

2.6 Bricks of Successful Scientific Knowledge Transfer in the RIU Model

Processes of scientific knowledge transfer that influence (political) practice successfully have to incorporate research, integration, and utilization as individual activities that have to be carried out at the highest possible standards. Activities of the RIU model have to be combined in specific production lines. Within research, integration, and utilization, in turn, different subtasks also have to be fulfilled. These subtasks prescribe criteria for the description and explanation of procedures of successful scientific knowledge transfer. The main criteria for the three different aspects of the RIU model are:

1. Is there high quality scientific research?
2. Is there pluralistic and foresighted integration?
3. Is there assurance of a democratic utilization?

To assess and further elaborate upon these critical questions, research, integration, and utilization have to be understood in more detail.

2.6.1 High Quality Scientific Research

High quality scientific research consists of the following subtasks:

- Assessing current scientific information
- Compliance with the procedures of good scientific practice
- Cooperation with other scientific institutions and projects
- Independent meaningfulness of scientific findings

The criteria for research are depicted from the science system. They reflect the quality and the latest development stages of underlying scientific information and its production and use in the research process, by researchers themselves or by scientific institutions that further elaborate and use scientific information. Generally speaking, the research has to be an important part of the scientific discourse in order to maintain high scientific quality.

2.6.1.1 Assessing Current Scientific Information

Research that informs scientific knowledge transfer processes in respect of current political and practical problems has to represent the latest stage of development in the respective field. For instance, research that informs international climate policy should represent the newest and best possible scientific climate scenarios and prognoses that are currently available and that are evaluated by the scientific community in peer review processes. Part of the research process is to assess the national and international state of the art of research, to identify possible knowledge gaps and scientific inconsistencies or controversies, and to identify unsolved research questions. Research process activities that support these tasks are, for example, literature or data research, or contacting other scientists in the same research area. These activities help identify knowledge gaps to ensure that the scientific information that is produced and used is state-of-the-art.

The important questions to assess the quality of incorporated scientific information are:

- *Has the national and international scientific literature been collected and reviewed?*
- *Have the national and international data sources been collected and reviewed?*

2.6.1.2 Compliance with the Procedures of Good Scientific Practice

In times of scientific scandals and public discussions about scientific misconduct, the compliance of scientific research with procedures of good scientific practice is crucial. First, only science and scientific results that reflect good scientific practice can legitimately claim to become the foundation of political and practical science-based decision-making. Second, science risks losing its legitimacy in society if non-compliance with good scientific practice becomes apparent. Practical actors might lose trust in scientific work and its research results if there is any suspicion of violation of procedures of good scientific practice. The IPCC lost some of its public trust when it became apparent that some of the data it used were not secured by procedures of good scientific practice, like professional peer review processes (Beck 2011, 2012). There are established criteria available for the assessment of good scientific practice, for example, the criteria of the German Research Foundation and the UK Director General of Research Councils (DGRC) and Chief Executives of the Research Councils (DGRC and Chief Executives of the Research Councils 1998; DFG 1998).

The following are important questions to assess scientific quality according to standards of good scientific practice (DFG 1998: 7):

- *Does the scientific work adhere to professional standards?*
- *Are the research process and its results clearly documented?*

- *Will new findings be scientifically published?*
- *Has the expertise of external researchers been called in when facing difficult questions?*

2.6.1.3 Cooperation with Other Scientific Institutions and Projects

Cooperation between scientific projects and institutions (universities, private or public independent research institutes) is important in order to make use of the synergy that may result, and to maximise the potential for innovative insight. In addition, early cooperation can help avoid overlapping research and can increase the efficiency and effectiveness of research funding or of financial resources in general. The exchange of scientific information and scientific cooperation with research institutions at local, regional, national, and international levels makes it easier to detect knowledge gaps and to establish strategic cooperation in research working.

Some relevant questions to help assess cooperation with other scientific projects and institutions are:

- *Are other relevant and current scientific projects known and has the potential for cooperation been evaluated?*
- *Is there scientific exchange with relevant research institutions at local, national, and international levels?*

2.6.1.4 Independent Meaningfulness of Scientific Findings

In many big research projects consisting of a lot of smaller, individual research projects, a synthesis of results is mandatory. But this synthesis does not help scientific knowledge transfer in political practice. Research syntheses risk weakening important results of individual research projects, losing these results, or generating a lack of empirical descriptions of the individual parts of the entire research project. It is therefore important for the quality of research that individual research findings should be independently informative and empirically substantiated.

If this is the case, the quality of research carried out by larger research groups increases with regard to overarching research questions. The question used to assess the meaningfulness of independent scientific findings is:

- *Are scientific findings independently informative and empirically substantiated?*

2.6.2 Pluralistic Foresighted Integration

Pluralistic foresighted integration consists of the following subtasks:

- Orientation toward public goals (like sustainability, …)
- Relevance in regard to political processes
- Relevance in regard to allies
- Target-group oriented intermediation

Within integration activities, research is directed towards practical and political questions.

First, this means that the normative goals of society or of the actors demanding science-based information must come into play in integration.

Second, integration is an activity that does not necessarily need to be carried out by scientists themselves. Rather, special institutions, e.g., departmental research institutions, can perform important integration tasks, as can single actors, like consultants, who are able to understand scientific research results and the demands of practitioners who are involved in integration activities. Scientists can serve as integrators as well, but in such cases they alternate between the roles of researcher and integrator.

Third, integration implies the existence of some kind of foresight, since the integrating actors often estimate current or future demands of practical actors for science-based knowledge. Therefore we can speak of "foresighted" integration.

Fourth, integration reflects the plurality of society's interests. In modern societies there are many actors demanding science-based information. As mentioned above, in such cases these actors are "allies" of scientific knowledge transfer because they are able to implement science-based knowledge within their realm, even against resistance, due to their power. At first glance, this would seem to be a problem for democratic processes, and a situation that could lead to a "biased" use of scientific information, in a way that powerful actors often prefer. These risks remain small as long as the criteria for scientific knowledge transfer are fulfilled, in spite of the presence of powerful actors using science-based information.

An important factor to consider is that, in a pluralistic society, there are many individual power relationships in which some actors are able to influence others by using their power resources to implement scientific research results. In addition, many such relationships can change over time, if formerly weak actors become powerful, creating new opportunities for knowledge transfer. Such an example is the use of nuclear power in Germany: In the 1970s, as a result of extensive discussion on the potential dangers of atomic energy, environmental groups and "alternative" scientists wanted the German government to stop using nuclear energy. But it was not until the 2000s that—due to the great nuclear catastrophe in Fukushima (Japan)—a policy window opened that enabled these formerly weak actors to become more powerful and to force other actors to accept alternative science-based information. Therefore, within classic pluralistic theories we argue that many power relationships exist at microcosmic levels within society and can change over time. This multiplicity of power relations offers a variety of options for scientific knowledge to enter society and politics. The widespread idea of a society controlled in great measure by a few powerful actors ignores the fragmented character of power relations. Scientific knowledge does not need the alliance of the most powerful actor, because whenever one actor is slightly more powerful than another the first can push scientific knowledge through so as for it to become relevant for the second, weaker, actor.

2.6.2.1 Orientation Toward Public Goals (Like Sustainability, …)

Generally, in integration, research is directed towards society's political and practical questions. Our criteria for integration make it possible to assess the degree to which research reflects current political problems and practical demands. They help determine whether science-based information is being produced that really can help to achieve normative public goals, like sustainability.

Integration activities lead to the direction of scientific research toward public goals like sustainability. This means that the research process and its results are oriented toward ecological, economic, and social sustainability goals. It is important that existing deficits of research and its results regarding public goals are clearly expressed. Furthermore, it is necessary to clearly define public goals like sustainability and to develop them further, normatively. Knowing what specific public goals a research project follows and how it interprets them is decisive in order to assess its quality: In the case of sustainability research, it makes a big difference whether research is oriented toward "strong sustainability" or toward concepts of "weak sustainability" (Böcher and Krott 2011: 36 ff. or Böcher and Krott 2012). Therefore, the normative public goals, and their conceptualization, that are the basis of the research process, have to be clearly defined before the research process can be assessed with regard to integration tasks. In many cases, a democratically legitimized institution, like a ministry, supports research and defines the public goals to be achieved with the support of science-based information. In such cases, like in national research programmes for sustainability, the funding institution defines overarching public goals that have to be pursued by the individual research projects.

It is also important for scientific findings to be interpreted in the context of potentially different and competing public goals from various institutions or from one, and at national and international political levels. In many cases competing, or even contradictory, public goals exist—like aspirations of economic prosperity that may contradict goals of strong sustainability. Within integration such contradictions should be revealed in order to establish realistic expectations for the success of scientific information with regard to specific competing public goals.

Another important aspect is that researchers have to be independent from public funding authorities in order to able to hold their ground against criticism of their research results. They have to be able to produce research results even if these are not politically opportune. They should be able to defend their positions against critics even if a ministry finances them. An example for this is the German Federal

Agency for the Environment. In many cases, the agency demands environmental policy measures that go against the political interests of the German Ministry for the Environment (BMUB). The agency supported a maximum speed limit in Germany, against the vote of the German government and, in the 1990s, the agency wanted to adopt an ecological tax reform that was in disagreement with the official political direction of the government (Böcher and Krott 2010).

Researchers' independence from private interests is also enormously important. In controversial issues, like sustainability or climate change, it is very important to have research institutions with public resources that allow independent, unbiased research. Among the important functions of independent research are to look out for the public interest and to expose interest-driven biased research. A lot of research having to do with environmental issues is privately financed (by big companies) and needs to be critically re-assessed by independent researchers that serve as watchdogs. The emergence of "critical" counter-expertise has been discussed in science for a long time (see for example Eden 1996; Bäckstrand 2004; Topçu 2008). The example of the use of nuclear power, described above, illustrates this well, as do others having to do with important current topics, like genetic engineering for food production. In this case, there are strong accusations of bias, in that much of the research in this field is financed by the food industry and needs to be critically re-assessed by independent experts.

Questions to assess orientation toward public goals like sustainability are:

- *Are the research process and its results orientated towards ecological, economic, and social aspects of sustainability?*
- *Are deficits regarding sustainability requirements clearly expressed?*
- *Are the values of sustainability clearly formulated, or have they been developed further according to norms, where needed?*
- *Is there a legitimate public contracting authority, like a ministry, that defines public interest goals?*
- *Are scientific findings coordinated in respect of the competing public interests of different public institutions at national and international levels?*
- *Are the researchers independent enough to hold their ground against criticism of their research results?*

2.6.2.2 Relevance in Regard to Political Processes

Research has to produce knowledge of relevance for political and practical actors. Research results should deliver analyses and explanations of current practical problems and should supply alternative solutions. Research should also deliver science-based prognoses about the future development of problems. In addition, political and practical actors need science-based information that is timely, so that they have enough time to react and make changes. Having a "stock of scientific knowledge" with regard to problems that might occur in the future is also important.

Scientific explanations should be directed to natural scientific and socio-economic causes of current problems (explanation) and to deliver solution strategies (configuration). Furthermore, an assessment of future problems should address relevant problems (prognoses). Having an orientation toward sustainability issues that have potential future relevance is an important strategy that buys time if there are problems demanding practical science-based information in the future.

There is a close connection between the relevance of science-based information and the reputation for seriousness and credibility of researchers or research institutions. If scientific institutions and the researchers working within are regarded as credible, their credibility and the relevance of their science-based advice remain even in times of public conflict about the choice of right solutions. In these cases, their credibility and the weight of their scientific arguments increase among their supporters and also among critics of their scientific positions.

If researchers have practical experience, for instance, with administration and politics, the relevance of their research results increases as well. This leads to a better understanding of the political process, of the type of information political actors need, and also of the types that are needed for intermediation.

Questions for the assessment of the relevance in regard to political processes are:

- *Do the research results deliver explanations for practical problems?*
- *Are there science-based alternative solutions for practical problems?*
- *Are there science-based prognoses about the future development of problems?*
- *Are scientific results being delivered to political actors in time for them to take action?*
- *Is there a stock of scientific knowledge about practical problems that could arise in the future?*
- *Do the researchers and institutions maintain their seriousness and credibility independently of current disputes?*
- *Do the researchers have practical experience with administration and politics?*

2.6.2.3 Relevance in Regard to Allies

Integration in support of science that leads to practical solutions has to incorporate the potential of concrete actors to become allies for scientific knowledge transfer. Science-based solutions have no practical impact as long as they lack a direct connection to concrete actors and their resources (power and finances). For each specific topic the relevant actors have to be identified and supplied by using individual intermediation strategies. The chance for the implementation of science-based solutions emerges only if the solutions are compatible with the interests, potentials for action and available resources of national and international relevant actors and institutions. This implies the identification of potential supporters and opponents of a certain science-based solution and the design of science-based solutions in a way such that it can attract enough allies. Detailed knowledge about the background of practical and political problems is important to develop solutions that are relevant for utilization. The development of win-win-strategies builds upon a realistic estimation of the interests of actors.

It is important to find different potential allies (internal, external, learning, and wise) and to incorporate these actors with their characteristics and potentials to the application of science-based information. These allies can be internal allies who are part of the research process and who can push the results through in pursuit of their own interests. An example of this would be a company that is part of a research process on climate adaptation strategies in economic enterprises and that is able to implement internally a business adaptation strategy that becomes mandatory for all workers and managers. Then there are external allies who are external to the research process but who are powerful enough to exert political pressure on others to use research results. An example of this type of ally would be a ministry that funds research on environmental issues and that has the power to adopt science-based solutions in a new environmental regulation scheme that every actor has then to follow. Learning allies are those who change their behaviour due to the emergence of new research results that affect their individual interests. Learning actors can be actors that reassess certain problems after new research results have been revealed that contradict their interests. For example, a house owner may learn through science that, due to climate change, floods are more likely to damage his building, which is near a river, and act accordingly. Wise allies are those who judge scientific findings encountered in their everyday reality and then make use of these in combination with other, alternative, forms of knowledge (like traditional or lay knowledge).

Questions for the assessment of relevance in regard to allies are:

- *Are there (internal) allies who participate in the research process and who push through the results in their own interest, even against political resistance?*
- *Are there (external) allies who can exert political pressure for the practitioners to cooperate with researchers constructively?*
- *Are there (learning) allies who are prepared to rethink old convictions in order to learn from scientific findings?*
- *Are there (wise) allies who judge scientific findings fairly from their everyday reality, and who make use of them?*

2.6.2.4 Target-group Oriented Intermediation

A group of quality criteria for integration addresses the intermediation of science-based information. Actors here are seen as target groups for science-based information and they need to be addressed by using individually specified products, media, and communication channels. Using a target group-orientated language and timely intermediation are further criteria for this group.

Questions for the assessment of target-group oriented intermediation are:

- *Are the research results presented in a language that is understandable for the target groups?*
- *Are those media used that reach the target group?*
- *Is the scientific information given at a time at which the practical discourse is open?*

2.6.3 Democratic Utilization

Subtasks of democratic utilization are:

- Contribution to democracy
- Contribution to rule of law (constitutional legality)
- Contribution to "good governance"
- Appropriate solutions to problems
- Participation in the scientific discourse

Utilization means the use of science-based information by practical and political actors, like politicians, stakeholders, citizens or the media. In addition, researchers use research results to contribute to the scientific discourse by producing publications or by giving academic speeches. Utilization, like the other activities of the RIU model, has to fulfil certain criteria in order to become part of science-based political or science-based practical action. The activities of utilization should meet high democratic standards, comply with the rule of law, and contribute to good governance, problem solutions and participation in the scientific discourse.

2.6.3.1 Contribution to Democracy

The enlightenment of society is essential for the functioning of democracy. This applies especially to sustainability and environmental issues, since such topics are sometimes new and usually cannot be directly perceived by citizens. The lobbyists of opposing sides often instrumentalise existing uncertainties in policy debates. Science-based advice on sustainability issues is therefore an important contribution to the assurance of democratic quality. It is important for the citizens and the media to have access to scientific results. The research process and the conditions of research funding have to be transparent and traceable. This means that there are instruments and procedures to inform the citizens and the media. Furthermore, scientific advisory processes have to be transparent and well-documented. Transparency enables democratic control and surveillance of science by governments and parliaments as well as by media and citizens.

Questions to assess the contribution to democracy are:

- *Are the research processes transparent?*
- *Do citizens have access to research findings?*
- *Do the media have access to research findings?*

2.6.3.2 Contribution to Rule of Law (Constitutional Legality)

Good quality of utilization is safeguarded by application and the observation of fundamental principles of the rule of law. Science-based solutions have to be applied in accordance with the law and through an impartial administrative procedure. The application has to be economically efficient. This economic principle means that science-based solutions are effective and that there is an adequate cost-benefit ratio of the solution in regard to the expected outcome.

Questions to assess the contribution to rule of law are:

- *Are the solutions applied conforming to the law and through an impartial administrative procedure?*
- *Are the solutions legally watertight?*
- *Is implementation economically efficient?*

2.6.3.3 Contribution to "Good Governance"

Governance means that decisions are taken by involving actors from civil society, like NGOs or citizens, and private actors, like economic enterprises. "Good" governance needs political decisions to be transparent, accountable, and traceable. This can be achieved by providing all actors in society with the same ability to express their concerns and to shape political decisions actively. Another important contribution to "good governance" is for the use of science-based problem solutions to be ensured in the long run by laws or regulations that integrate new science-based information, for example.

Utilization's contribution to good governance can be assessed by means of the following questions:

- *Do citizens participate in the solution?*
- *Do NGOs participate in the solution?*
- *Do commercial enterprises participate in the solution?*
- *Do consumers participate in the solution?*
- *Is application secured in the long term?*

2.6.3.4 Appropriate Solutions to Problems

The appropriateness of problem solutions means that utilization measures reflect existing problems accurately. Science-based solutions should be in line with the current state of technology in (political) practice. Risks arising from the use of any particular solution should be made known, and should be accepted or rejected.

Questions to assess the appropriateness of science-based solutions are:

- *Does the solution reflect the current state of technology in practice?*
- *Is the distribution of the solutions' risks visible and acknowledged?*

2.6.3.5 Participation in the Scientific Discourse

For quality control, research needs to be part of the scientific community. This also applies to research that is part of the RIU model and leads to science-based utilization products. Therefore, researchers have to produce a critical mass of products for the scientific community to safeguard their connectivity to the scientific community. Such products can be scientific publications, scientific contributions to conferences or participation in networks or topic-related science organizations. Quality does not result from the quantity of such scientific products. Rather, the production lines of the RIU model lead to a critical mass of scientific products, one that is needed to connect with the scientific community in a specific field or topic. This can only be evaluated qualitatively; there is no exact quantity that can be determined *ex ante*.

The question to assess the participation in the scientific discourse is:

- *Are the solutions incorporated into the current scientific discourse?*

2.7 Checklist for Successful Scientific Knowledge Transfer

As a result of our RIU model, and based on the results of our empirical research (see the following chapters), we can derive the following checklist (Fig. 2.2). The checklist presents individual quality criteria related to the subtasks of scientific knowledge transfer that support the transfer of scientific knowledge into political practice. By applying these quality criteria there is a greater probability for scientific projects to have an impact on practice. The checklist helps considering the specific factors that are relevant for research, integration, and utilization (RIU). Practical utilization is more likely to succeed if the number of questions on the checklist that can be answered in the positive is greater.

		Success Factors
1	R	Is there high quality scientific research?
2	I	Is there pluralistic foresighted integration?
3	U	Is there assurance of a democratic utilization?

1 High quality scientific research

Assessing current scientific information

- ☐ Has the national and international scientific literature been collected and reviewed?
- ☐ Have the national and international data sources been collected and reviewed?

Compliance with the procedures of good scientific practice

- ☐ Does the scientific work adhere to professional standards?
- ☐ Are the research process and its results clearly documented?
- ☐ Will new findings be scientifically published?
- ☐ Has the expertise of external researchers been called in when facing difficult questions?

Cooperation with other scientific institutions and projects

- ☐ Are other relevant and current scientific projects known and has the potential for cooperation been evaluated?
- ☐ Is there scientific exchange with relevant research institutions at local, national, and international levels?

Independent meaningfulness of scientific findings

- ☐ Are scientific findings independently informative and empirically substantiated?

2 Pluralistic foresighted integration

Orientation toward public goals (like sustainability, …)

- ☐ Are the research process and its results orientated towards ecological, economic, and social aspects of sustainability?
- ☐ Are deficits regarding sustainability requirements clearly expressed?
- ☐ Are the values of sustainability clearly formulated, or have they been developed further according to norms, where needed?
- ☐ Is there a legitimate public contracting authority, like a Ministry, that defines public interest goals?

Fig. 2.2 Checklist for successful scientific knowledge transfer

- ☐ Are scientific findings coordinated in respect of the competing public interests of different public institutions at national and international levels?
- ☐ Are the researchers independent enough to hold their ground against criticism of their research results?

Relevance in regard to political processes

- ☐ Do the research results deliver explanations for practical problems?
- ☐ Are there science-based alternative solutions for practical problems?
- ☐ Are there science-based prognoses about the future development of problems?
- ☐ Are scientific results being delivered to political actors in time for them to take action?
- ☐ Is there a stock of scientific knowledge about practical problems that could arise in the future?
- ☐ Do the researchers and institutions maintain their seriousness and credibility independently of current disputes?
- ☐ Do the researchers have practical experience with administration and politics?

Relevance in regard to allies

- ☐ Are there (internal) allies who participate in the research process and who push through the results in their own interest, even against political resistance?
- ☐ Are there (external) allies who can exert political pressure for the practitioners to cooperate with researchers constructively?
- ☐ Are there (learning) allies who are prepared to rethink old convictions in order to learn from scientific findings?
- ☐ Are there (wise) allies who judge scientific findings fairly from their everyday reality, and who make use of them?

Target-group oriented intermediation

- ☐ Are the research results presented in a language that is understandable for the target groups?
- ☐ Are those media used that reach the target group?
- ☐ Is the scientific information given at a time at which the practical discourse is open?

3 Democratic Utilization

Contribution to democracy

- ☐ Are the research processes transparent?
- ☐ Do citizens have access to research findings?
- ☐ Do the media have access to research findings?

Fig. 2.2 (continued)

Contribution to rule of law (constitutional legality)

- ☐ Are the solutions applied conforming to the law and through an impartial administrative procedure?
- ☐ Are the solutions legally watertight?
- ☐ Is implementation economically efficient?

Contribution to "good governance"

- ☐ Do citizens participate in the solution?
- ☐ Do NGOs participate in the solution?
- ☐ Do commercial enterprises participate in the solution?
- ☐ Do consumers participate in the solution?
- ☐ Is application secured in the long term?

Appropriate solutions to problems

- ☐ Does the solution reflect the current state of technology in practice?
- ☐ Is the distribution of the solutions' risks visible and acknowledged?

Participation in the scientific discourse

- ☐ Are the solutions incorporated into the current scientific discourse?

Fig. 2.2 (continued)

2.8 Conclusion: The RIU Model as an Analytical Framework for Successful Scientific Knowledge Transfer

By using the RIU model described above, ongoing or planned scientific knowledge transfer processes and their parts can be scientifically analyzed and evaluated. Additionally, individual factors, like subtasks, can be derived which help researchers, research funding institutions, and integrators to steer their research process with regard to practical implications. By using the RIU model and the checklist it is possible regularly to check the success of the entire scientific knowledge transfer process. The RIU model reflects the current state of the art of research in political science (see Chap. 4) and has been successfully used as an analytical framework in many empirical cases. As a conclusion to this chapter, three main questions lead to analysis and improvement of the process of scientific knowledge transfer:

1. Is there **high quality scientific research**?
2. Is there **pluralistic and foresighted integration**?
3. Is there an **assurance of a democratic utilization**?

The answers can be found by using the criteria for research, integration, and utilization, described above, to identify the potential for improvement of the process and its subtasks. However, not all criteria have to be fulfilled in every process at the same time. Rather, these criteria deliver a framework of possibly important aspects of scientific knowledge transfer. In a concrete research project aiming at practical utilization, its topic, its target groups, and its production lines determine the specific criteria that have to be used in that particular case.

Research projects that become strong in all three aspects, research, integration and utilization, have a high probability of producing science-based knowledge that is used in practice.

References

Atteslander, P. (1995). Methoden der empirischen Sozialforschung (8., bearb. Aufl.. ed., Sammlung Göschen; 2100). Berlin {[u.a.]: de Gruyter.

Bäckstrand, K. (2004). Scientisation vs. civic expertise in environmental governance: Eco-feminist, eco-modern and post-modern responses. *Environmental Politics, 13*(4), 695–714.

Beck, S. (2011). Moving beyond the linear model of expertise? IPCC and the test of adaptation. *Regional Environmental Change, 11*(2), 297–306.

Beck, S. (2012). Between tribalism and trust: The IPCC under the. *Nature and Culture, 7*(2), 151–173.

Böcher, M., & Krott, M. (2010). Umsetzung des Konzepts einer modernen Ressortforschung im Geschäftsbereich des BMU (Vol. 39/2010, Umweltbundesamt-Texte). Dessau-Roßlau: Umweltbundesamt.

Böcher, M., & Krott, M. (2011). *Forschungsfeld "Raumbezogene Nachhaltigkeitsforschung" - Stand und Optionen für die Zukunft in Österreich*. Göttingen: unpublished Research Report.

Böcher, M., & Krott, M. (2012). Nachhaltigkeitsforschung in Österreich. *GAIA-Ecological Perspectives for Science and Society*, *21*(2), 155–157.

Böcher, M., & Krott, M. (2014a). *Mit Wissen bewegen! Erfolgsfaktoren für Wissenstransfer in den Umweltwissenschaften*. München: Oekom.

Böcher, M., & Krott, M. (2014b). The RIU model as an analytical framework for scientific knowledge transfer—the case of the "decision support system for sustainable forest management within climate change". *Biodiversity and Conservation, 23*(14), 3641–3656.

Bortz, J., & Döring, N. (2009). *Forschungsmethoden und Evaluation : für Human- und Sozialwissenschaftler; mit 87 Tabellen (4., überarb* (Aufl ed.). Heidelberg: Springer-Medizin-Verl.

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N., Eckley, N., & Jäger, J. (2002). Salience, credibility, legitimacy and boundaries: Linking research, assessment and decision making. KSG Faculty Research Working Paper 02-046. Cambridge MA: Kennedy School of Government, Harvard University.

DFG, (German Research Foundation). (1998). Safeguarding good scientific practice. *Memorandum*. Weinheim: Wiley-VCH.

DGRC and Chief Executives of the Research Councils. (1998). Safeguarding good scientific practice.

Dharmawan, B., Böcher, M., & Krott, M. (2016). Failure of science-based win-win solution in fishery management: Learnings from Segara Anakan Waters. Central Java, Indonesia. under review.

Eden, S. (1996). Public participation in environmental policy: Considering scientific, counter-scientific and non-scientific contributions. *Public Understanding of Science, 5*(3), 183–204.

Guston, D. H. (2001). Toward a “best practice” of constructing “serviceable truths”. In M. Hisschemöller, R. Hoppe, W. N. Dunn & J. R. Ravetz (Eds.), *Knowledge, Power, and Participation in Environmental Policy Analysis. Policy Studies Review Annual, 12*, (pp. 97–118). New Brunswick/London: Transaction Publishers.

Heim, J., & Böcher, M. (2016). CITES and science: Using the RIU-model to analyze institutionalized scientific policy advice in Germany for the case of ivory trade. *Journal of International Wildlife Law and Policy* (forthcoming).

Hoppe, R. (1999). Policy analysis, science and politics: From ‘speaking truth to power’ to ‘making sense together’. *Science and Public Policy, 26*(3), 201–210.

Jasanoff, S. (1990). *The fifth branch : Science advisers as policymakers*. Cambridge, Mass: Harvard University Press.

Kromrey, H. (2000). Empirische Sozialforschung : Modelle und Methoden der standardisierten Datenerhebung und Datenauswertung (9., korrigierte Aufl.. ed., Utb, 1040). Opladen: Leske und Budrich.

Krott, M. (2012). Value and risks of the use of analytical theory in science for forest policy. *Forest Policy and Economics, 16*, 35–42.

McNie, E. C. (2007). Reconciling the supply of scientific information with user demands: An analysis of the problem and review of the literature. *Environmental Science and Policy, 10*(1), 17–38.

Mitchell, R. B., Clark, W. C., Cash, D. W., & Alcock, D. (2004). Science, scientists, and the policy process: Lessons from Global environmental assessments for the Northwest forest plan. In K. Arabas, & J Bowersox (Eds.), *Forest futures. Science, politics, and policy for the next century* (pp. 95–111). Lanham, Boulder, New York, Toronto, Oxford: Rowman & Littlefield.

Moll, P., & Zander, U. (2006). *Managing the interface. From knowledge to action in global change and sustainability science*. München: oekom-Verl.

Müller-Rommel, F. (1984). Sozialwissenschaftliche Politik-Beratung - Probleme und Perspektiven. *Aus Politik und Zeitgeschichte, 32*(B25–84), 26–39.

Nagasaka, K., Böcher, M., & Krott, M. (2016). Science-policy interaction: Who does what? *Case of the forest and forestry revitalisation plan in Japan*. under review.

Renn, O. (2003). Sozialwissenschaftliche Politikberatung: Gesellschaftliche Anforderungen und gelebte Praxis. TA-Informationen(1), 4–13.

Sarewitz, D., & Pielke, R. A, Jr. (2007). The neglected heart of science policy: Reconciling supply of and demand for science. *Environmental Science and Policy, 10*, 5–16.

Schnell, R., Hill, P. B., & Esser, E. (2008). Methoden der empirischen Sozialforschung (8., unveränd. Aufl.. ed.). München {[u.a.]: Oldenbourg.

Science, G. O. F. (2010). *The government chief scientific adviser’s guidelines on the use of scientific and engineering advice in policy making*. London: Department for Business, Innovation and Skills.

Stevanov, M., Böcher, M., Krott, M., Krajter, S., Vuletic, D., & Orlovic, S. (2013). The research, integration and utilization (RIU) model as analytical framework for the professionalization of departmental research organizations: Case studies of publicly funded forest research institutes in Serbia and Croatia. *Forest Policy and Economics, 37*, 20–28. doi:10.1016/j.forpol.2013.03.006.

Topçu, S. (2008). Confronting nuclear risks: Counter-expertise as politics within the French nuclear energy debate. *Nature and Culture, 3*(2), 225–245.

Ugolini, F., Massetti, L., Sanesi, G., & Pearlmutter, D. (2015). Knowledge transfer between stakeholders in the field of urban forestry and green infrastructure: Results of a European survey. *Land Use Policy, 49*, 365–381.

Weingart, P. (1999). Scientific expertise and political accountability: Paradoxes of science in politics. *Science and Public Policy, 26*(3), 151–161.

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