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Before amplification: the role of experts in the dynamics of the social attenuation and amplification of risk

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ABSTRACT

In this article, we use system/network theory together with the social amplification of risk framework (SARF) to show how expert actors over time and across multiple events can contribute to social risk amplification and attenuation. The framework and the theory, in particular the concepts of risk emplacement and displacement, are employed in the analysis of an illustrative case related to the use of the feed additive, narasin, and provide explanations of how risks are part of continuously ongoing and dynamic social processes. By emphasizing the role of experts in such developments, connecting what happens in expert communities with the processing of risks and effects on the outside, the analysis shows the larger context within which social risk attenuation and amplification happen. Showing the value of integrating different theories and perspectives, this article lays the foundations for further studies of risk amplification and attenuation dynamics. Based on the results of the analysis, we indicate opportunities to update and further develop the SARF. We also present some implications for public policy and risk management practices including addressing the positive contributions of risk amplification and how this relates to adaptive risk management approaches.

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1. Introduction

The social amplification of risk framework (SARF) was introduced more than three decades ago in 1988 (Kasperson et al. 1988; Pidgeon, Kasperson, and Slovic 2003) with the goal of integrating the social experience and technical analysis of risk. It provided guidance for interpreting what happens after a triggering risk event, including effects on the risk at issue plus further downstream ripple effects on other risks. Much informative research followed, along with critical analysis of the framework. However, the original SARF offered no explicit guidance for interpreting events prior to or in addition to the triggering event, what led to that event, and how to view the event as occurring amidst other developments over time. Comparatively little risk research has been done on these sorts of questions.

In this paper, we present an example of how a series of events influenced the development of risks over time. Specifically, we focus on events leading up to the Norwegian chicken industry

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abandoning the routine use of the poultry feed additive narasin in 2015–2016. The example covers a 13-year period and illustrates how the social experience of risks associated with the use of narasin developed over time. Findings of antibiotic-resistant bacteria in chicken meat increased and were gradually communicated more often in the media and seen as connected to the use of the feed additive. Expert actors challenged existing risk definitions and regulations of narasin, while the established regulatory system's earlier risk framing and risk management efforts—or lack thereof—influenced later developments and responses.

The example used in this paper illustrates how the first seeds of risk amplification and attenuation can be seen as being sown in expert institutions and organizations—in this case, in the classification, the early framing of the risks associated with narasin, and the associated early development and design of the regulations. These acts, to a large extent, set the standard for how risk-related information and events were approached, communicated, and responded to along the way by actors who were part of the established regulatory system; however, that framing also influenced the response and reactions of other actors, such as other experts working outside the regulatory system and public consumers of poultry meat and produce.

Although the original SARF incorporates elements of system dynamics, including feedback possibilities and the links to other risks through ripple effects, little is offered in the way of tools for addressing systemic interactions. Furthermore, expert responses and interactions contributed to shape the risks associated with narasin, yet little research specifically connects the social and cultural processes in expert systems and institutions with their implications for risk amplification and attenuation. In the spirit of integration that motivated the development of SARF, we explore how system/network theory (Hilgartner 1992; 2008), and the concepts of risk displacement and emplacement in particular, can be applied together with the SARF to help the study and understanding of how many risks are part of continuously ongoing social processes in which they are constantly molded, shaped, and reshaped by different actors over time. In doing so, we look to identify the feasibility and utility of the combined approach in finding insights about risks as they develop. We argue that our analysis offers lessons that both address opportunities for constructive extensions of the SARF and have possible implications for public policy and risk management. In particular, we address the positive role amplification can play in revealing hidden hazards and in compelling risk management responses. These are issues that have been argued for in the past as part of adaptive risk management approaches (Goble, Kasperson, and Ratick 2017; Goble, Bier, and Renn 2018; Kasperson, 2003) and connected to suggestions for increased institutional permeability (Freudenburg 2003; Perrow 1984) but overall have received little attention in the literature on SARF.

The rest of this article is organized as follows: Section 2 describes the SARF as we use it combined with a description of our use of system/network theory. We then provide a brief description of the regulatory context and the actors in the illustrative case. In Section 3, we analyze the illustrative case, applying the conceptual approach outlined in Section 2.1. Thereafter, we discuss our findings in Section 4 before finally providing some conclusions from our work.

2. Concepts used and background for the illustrative case

2.1. Combining system/network theory with the social amplification of risk framework (SARF)

The authors of the original presentation of the SARF stressed that it was not a theory nor was it intended to be interpreted as such. The goal was a broadly integrated approach to combine diverse understandings of the social experience of risk and to integrate that with technical analyses of risks. The SARF applies communication theory and uses the amplification/attenuation metaphor to describe the ways in which various social actors generate, receive, interpret, and pass on risk signals (e.g. images, signs, and symbols)(Kasperson et al. 2003). Amplification denotes

the process of intensifying and turning up the volume of risk signals during the transmission and processing of information; meanwhile, attenuation refers to the deleting, weakening, or toning down of the volume of such signals. The framework covers not only how risks and risk-related information are processed, but also how they are perceived and responded to and how the responses may affect the risks people experience.

Social risk amplification may, for instance, be generated by an accident, information, or a report showing increased numbers of injuries and may spread by giving heightened perceptions of risk, stricter regulations, and distrust of risk managers and authorities. Social risk attenuation, on the other hand, may be illustrated by the opposite tendency, such as when a report shows a reduced number of injuries or a risk assessment demonstrates that a substance has no harmful effects. This tendency may spur a lowered risk judgment and increase the perception of safety (Gould & Fjæran 2019), which again may come to strengthen trust in risk-managing institutions, for instance, and potentially act to relax the regulations of these and other related risks.

In the original exposition of the SARF, Kasperson et al. (1988) noted that the concept of social amplification of risk is dynamic, anticipating the learning and social interactions resulting from experience with risk. In 1996, this new component, labelled 'Feedback and Iteration', was included in the graphical representation of the SARF template (see the highlighted portion of Figure 1). Despite the SARF's effort to bridge theories addressing the social and technical sides of risk, theories focusing on social dynamics and actor-oriented approaches to risks are often treated as conflicting or irreconcilable with the SARF framework; some of that research has also been used as a basis for criticizing the SARF. As first argued by Rayner et al. (1988), Petts et al. (2001) held that the SARF's central metaphor of amplification and the static and linear conception of communication could not deal adequately with the complex social organization of risk communication. Other researchers have argued that the SARF privileged individual over social interpretive processes (Murdock, Petts, and Horlick-Jones 2003; Rip 1988) and that insufficient attention has been paid to the role of interactions or struggles of the different players on the 'risk field' in social risk amplification processes (Busby and Onggo 2013; Hilgartner 1992; Murdock, Petts, and Horlick-Jones 2003). These criticisms are pertinent, but did not pay adequate attention

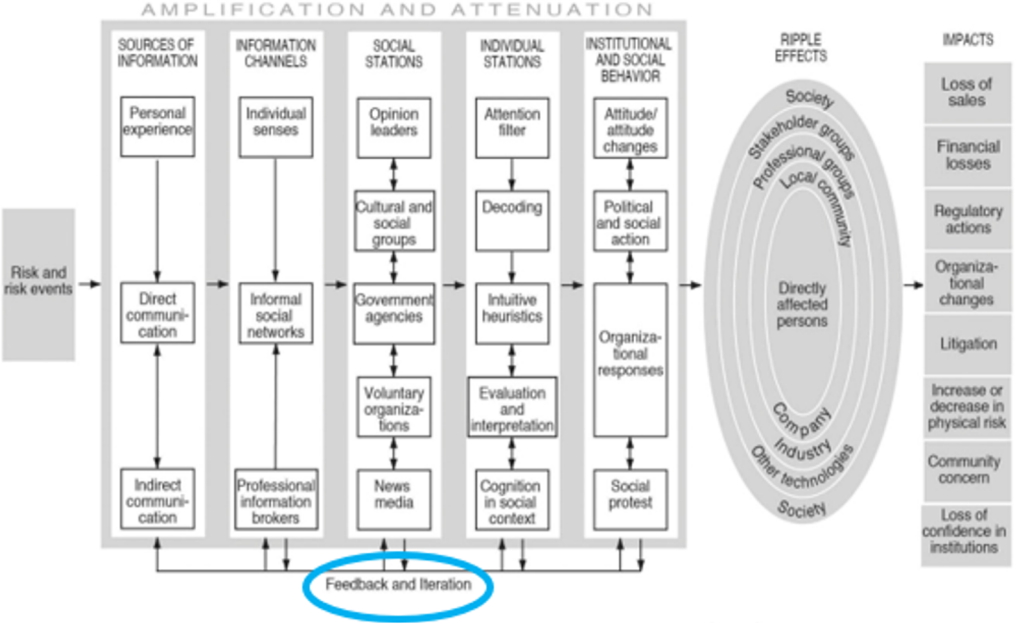

Figure 1. Social amplification of risk framework. Source: Kapserson and kapseron (1996).

to the dynamics built into the SARF; Kasperson pointed out that the SARF was never intended to reduce social complexity to a 'gross electronic metaphor' (Kasperson 1992; Kasperson and Kasperson 1996).

Despite the many clarifications of the basic ideas and intentions of the framework, the criticisms seem to have taken hold among many researchers, and little research has applied the SARF to help understand the dynamics and more interactive nature of risks.

When criticizing the SARF for what has been left out of the framework, an appropriate response, in our view, is to recognize that the spirit of the SARF presentation was to promote integration, as the SARF was never intended to be restrictive, and to take the opportunity to add missing elements to it. We note Bakir's (2005) observations that any apparent incompatibility may stem from gaps in research applying the SARF, rather than from limitations of the framework itself. We also agree with assertions that using the SARF in a nuanced way and in conjunction with other theories (Renn 2011) can help interpret and understand some of the complexities, constructedness, and messiness of real-world risk communication contexts (Pidgeon, Kasperson, and Slovic 2003).

Our particular criticism of the SARF starts from the template, as shown in Figure 1. The template begins with a triggering risk event and looks downstream to what happens after that. We have an interest in what happened upstream, what other events influenced the triggering event, and how that history affected the downstream developments. Moreover, considering the risk event as part of a chain of events over time provides a more dynamic framework from which to understand the social experience of risk and how it relates to technical analyses and approaches.

In pursuing this interest, we also argue that risk studies should pay more attention to the processes of how risks get defined and redefined over time; risk studies should study the role of different actors, including experts, in observing the social risk amplification and attenuation of risk. Numerous publications have addressed the impact of social-cultural factors on laypersons' perceptions of risk and risk amplification, yet few publications have also connected research on the social and cultural processes in expert systems and institutions and what this means for risk amplification and attenuation. Experts bring to their science and management not only expertise, but also, like other actors, the traditions, cultural values, and methodological biases of their particular commitments and approaches, influencing the framing of problems in certain ways, the data considered for analysis, and the management strategies seen as relevant (Hilgartner 2008; Power 2014; Wynne 1996).

In addition, in the past, considerably less work has focused on social risk attenuation than on risk amplification, and even less research has addressed the connectedness of risk amplification and attenuation processes and mechanisms. Poumadere and Mays (2003) pointed out that the degree of social risk amplification may sometimes be a function of the degree of prior attenuation in a given social context. More recently, the first author and Aven (Fjaeran and Aven 2019) demonstrated findings similar to those of Poumadere and Mays (2003)—namely, that past risk attenuation could explain some of the risk amplification and the extent of the amplification generated by later risk events.

System/network theory is one approach that can be drawn upon together with the SARF to better understand the role of experts in risk amplification and attenuation dynamics. Following this approach, many significant risks—from global climate change to hazardous technologies and chemical substances—are embedded in what can be seen as sociotechnical systems or networks, weaving together a variety of machines, people, procedures, laws, and other components (Bijker et al. 1987, as cited in Hilgartner 2008). These systems typically span organizational boundaries and, in many cases, shape risks through an incremental process, unfolding over decades and involving many spatially and socially distributed actors (Hilgartner 2008). Following such a perspective, for which actor–network theory has been a major influence (Latour 1993; Law and Hassard 1999), risks cannot be reduced to discursive entities and instrumental

knowledge separate from the social and technical fabric of the expert institutions and organizations. Risk perceptions become woven into sociotechnical systems and practices (Healy 2004; Williams 2008) by technical experts and other system builders (Hilgartner 1992).

Two related implications can be drawn from system/network theory for the study of risk amplification and attenuation dynamics over time. First, when the social experience of risk is studied in relation to a particular event, risk perceptions have in most cases already been built into the system from which the risk originates, often in ways that dominate how risks are assessed and managed. Here, 'built in' implies that actors involved in assessing and managing risks interact with the objects they study, shaping the evolution of the system. As previously noted, many times specific technologies and processes of knowledge production prevail, structuring communities of experts at various levels (Williams 2008) and in ways that can sustain the prevalence of certain risks and management approaches over others. Within risk research, others have pointed to how regulatory approaches and dominant organizational interests can govern the behavior of actors when identifying, assessing, prioritizing, and responding to risks (Kasperson et al. 2003; Short 1992). Second, the sociotechnical origin of many risks implies that the risk perceptions of already involved expert actors (e.g. scientists, engineers, government officials, and other system builders) and the actions they take to identify, assess, evaluate, and manage risks will influence the perceptions and responses of other actors, such as media and consumers, that also come into contact with the risks. For instance, as Kasperson et al. (2003) pointed out, how signals of incubating hazards are processed within sociotechnical systems and communicated to others outside the system do much to structure other actors' experiences with technological and industrial risks.

According to the system/network perspective (Hilgartner 1992),[1] a risk includes at least three elements: an object (e.g. the risk source; the agent, activity, or situation) that is said to pose a danger, an assumed harm, and a 'causal linkage connecting the source to the harm' (Hilgartner 2008, p. 7). In his works, Hilgartner used the 'risk object' concept to describe 'the things that pose hazards, the sources of danger, the entities to which harmful consequences can be conceptually attached' (p. 41) and emphasized that a risk object could be any biological, physical, legal, organizational, or conceptual entity. We underscore that 'object' is not to be understood here in a mere material sense (Boholm and Corvellec 2011).

In its simplest form, the process of socially constructing a risk, according to Hilgartner, involves defining an object and linking it to harm. Hilgartner (1992) named this process of turning an object and its risks into something to be reckoned with risk emplacement. This process is generally seen as a rhetorical process, and success often depends on emplacing new risk objects into the conceptual networks of organizations and institutions. Risks can also be emplaced if they cannot be enclosed within networks of control or removed from a system or if the networks of control surrounding the risk object are considered unreliable, such as after an accident or disaster. Displacement, on the other hand, refers to stripping a source and its risks of their significance. By challenging the existence of the source or severing the linkage between the source and harm, such 'neutralization' can also be done both rhetorically and through physical or technical control or via removal from the system. Following Hilgartner (1992), such displacement may help mitigate concern, but rarely eliminates or decouples a risk object from danger or harm. In sociotechnical networks, the task of defining a risk object and linking it to harm is performed mainly by technical experts and other specialized professionals, is displayed (e.g. in regulatory documents, assessments, standards) within specialized organizations or in public arenas (e.g. the media), and often involves more than one risk object. Seen in relation to the SARF, these acts have meaning for and influence risk perceptions and responses of other actors.

The system/network theoretical approach allows acts of risk emplacement and displacement to be seen as an endogenous part of risk that is important in influencing how many risks develop. According to Hilgartner (1992; 2008), acts or struggles to emplace and displace risk objects take

place constantly as sociotechnical systems or networks of actors evolve. These acts may be based on both actual and hypothetical occurrences and are grounded on factual evidence or other criteria, such as the attitudes to uncertainty or moral standards. Some actors actively work to establish links between a risk source and harm or to redefine old ones (i.e. risk emplacement) whereas others resist and try to 'break' these definitions and linkages by, for instance, collecting quantities of data or building new sociotechnical systems (i.e. risk displacement).

2.2. Context of the illustrative case

The use of antibiotics in animal feed (i.e. antimicrobial growth promoters [AGPs]) to stimulate growth and prevent intestinal diseases (i.e. coccidiosis) in poultry has long been and remains a practice in many countries (Chattopadhyay 2014). However, over the years, the use of AGPs became increasingly associated with the development of antibiotic-resistant bacteria and, in 1995, was banned in Norway due to the reported association between its use (i.e. the AGP avoparcin) and the occurrence of antibiotic-resistant bacteria (enterococci) in animal husbandry. At the European Union (EU) level, the use of antibiotics as growth promoters in animal feed was banned in 2006.[2] The use of AGPs was replaced with the use of coccidiostats, which inhibit reproduction and retard the development of coccidia parasites in a host cell. They are also used as growth-promoting agents, have both anticoccidial and antibacterial properties (Dasenaki and Thomaidis 2023), and are classified as an antibiotic in, for example, the US. Since 1996 and up until the culmination of the events described in this paper, the use of the coccidiostat narasin dominated the Norwegian poultry industry (NORM/NORM-VET 2003).

In the system/network approach (Hilgartner 1992) that we use, narasin can be seen as a risk object embedded in a large and complex sociotechnical system or network. The system or network has evolved over time, covering both national and European regulations, laws, and procedures as well as a set of spatially and socially distributed actors.

The main expert actors in the case can be divided into two groups. The first group are the actors representing the regulatory system and the associated system of control; those in charge of creating the basis behind and executing the systems related to the assessment, management, monitoring, and regulation of the risks related to narasin. In the case studied herein, this group of experts includes the Norwegian Food Safety Authority (NFSA), the Norwegian Scientific Committee for Food and Environment (VKM), and the National Veterinary Institute (NVT); however, because Norway (through the EØS agreement) complies with EU regulations for the use of coccidiostats, these actors also come from European regulatory and scientific institutions like the European Food Safety Authority (EFSA) and EFSA's panel on additives and products or substances used in animal feed (FEEDAP) as well as the European Commission (EC). The second group of expert actors are the scientists, researchers, and independent professionals outside the regulatory system (also referred to as the outside experts). The other main actors in the case are represented by the chicken industry (i.e. feed and food producers), consumers, and the media.

The EU Feed Additives Regulation, (EC) No 1831/2003, which also applies to Norway, establishes a common procedure for authorizing feed additives and rules for their placement on the market, labelling, and use. The use of narasin is regulated with maximum residue limits (MRLs), allowing a maximum of 70 mg/kg in feed. Narasin is not permitted for use in feed for egg-laying hens. The production of feed containing narasin has also shown the contamination of feed for non-target animal species, which may result in unexpected human exposure through the consumption of animal products containing narasin residues (Alexander et al. 2007), such as eggs. Commission Regulation (EC) No 124/2009 provides regulations and maximum levels for the presence of coccidiostats in food resulting from such cross-contamination.

Marketing, processing, and using narasin and other feed additives require authorization. According to Regulation (EC) No 1831/2003, the applicant company must provide information

on the toxicological prolife of the additive, control methods, conditions for use, and data demonstrating efficacy and safety (Dorne and Fink-Gremmels 2013). FEEDAP reviews the information and conducts a scientific assessment, in which product efficacy and safety related to the environment and to human and animal health are examined. If EFSA's opinion is favorable, the European Commission prepares a draft regulation to authorize the additive.

Whereas the risk assessment procedure is supervised by EFSA and harmonized at the European level, national authorities are required to control residues of coccidiostats in food and assess their safety (Rybicki 2020). In 2000, Norway established a national monitoring program for antimicrobial resistance in the veterinary and food production sectors. Since 2001, the NVT has monitored and published annual reports on statistics regarding the usage of antimicrobial agents and the occurrence of antimicrobial resistance in Norwegian livestock and food production, on behalf of the NFSA.

The Norwegian public typically places high trust in expert actors and representatives of the regulatory system. High levels of trust in authorities and governmental institutions are and have long been a hallmark of Norwegian society (Hedenigg 2021; Listhaug & Aardal 2011; NOU 2023; OECD 2022) and form part of the context in which the illustrative case took place.

3. Analysis

The analysis follows the dynamics of the process through which the social experience of risks associated with the use of narasin develop across a chain of events in which the risks are acted on, perceived, and responded to by different actors. The case covers events leading up to the Norwegian chicken industry abandoning the routine use of narasin in 2015–2016 (NORM-VET 2017). It describes how a set of expert actors can be seen as working to displace and emplace risks, contributing to different and connected rounds of social risk amplification and attenuation. Figure 2 presents an illustration of the developments described in the analysis. The line in the figure provides a simplified depiction of the social experience of risk associated with narasin among the actors engaged over time, illustrating how the developments are dynamic, fluctuating, and connected. Note that the figure does not show the whole picture of social risk amplification and attenuation dynamics. Different actors had different experiences and concerns related to the risks; these differences are not illustrated in the figure. Neither does the figure cover connections to technical aspects such as changes in exposure and vulnerabilities associated with the use of narasin.

The presentation of the case is based on the way in which the risks related to narasin were initially framed and dealt with by the expert system, later communicated in the Norwegian media, and responded to by a set of actors from 2003 to 2016. In the analysis, we looked upstream from round 4, which represents the stage in the case most resembling a typical example of social amplification of risk, and followed the trail of different actors as they came into contact with the risks related to narasin.

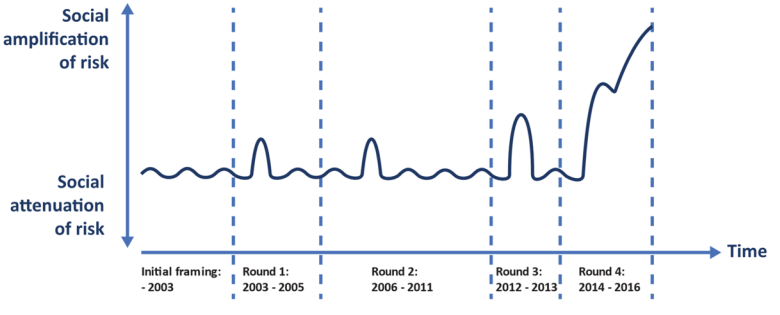

Figure 2. Rounds of social attenuation and amplification of risk.

3.1. Initial framing of the risk

The first actors in contact with the risks related to narasin are part of the regulatory system—namely, those in charge of creating the basis behind and executing the systems related to assessment, management, monitoring, and regulation (see Section 2). In the European Commission's act of classifying narasin as a coccidiostat, narasin can already be seen as having been constructed as a 'non-object' when it comes to its association with the development of antibiotic-resistant bacteria. Placing narasin on the EU's list of feed additives, despite its antibacterial effects and despite it being patented as an antibiotic and classified accordingly in many other countries, can be understood as a way of breaking or weakening the linkage between the risk object and the potential harm associated with the use of antibiotics in feed from the very start.

In what is defined as the initial framing stage of the case (see Figure 2, left side), the risks related to narasin are mainly conceptualized and communicated within the regulatory documents of the European Commission (EC) (first Council Directive 70/524/EEC in 1970, the Regulation (EC) No 1831/2003) and in the scientific opinions (i.e. risk assessments) of the EFSA.[3]

The risk assessments are of a technical character, framing risks as objectively quantifiable, demonstrating exposure levels below MRLs, and focusing on estimates showing low probabilities of negative effects. The vocabulary and the language used within the regulatory documents, authorization procedures, and the EFSA's scientific opinions are dominated by signals pointing to the safety and efficacy of narasin. Even the titling of these documents, 'Assessment of Safety and Efficacy', directs attention toward such aspects and appears to set the standard for the content, vocabulary, and language used in these assessments and the related regulations.

Enveloping narasin and other coccidiostats with the aforementioned regulations, assessment requirements, monitoring programs, testing procedures, and rules for authorization and communications can be seen as examples of what Hilgartner (1992) called displacement through control—namely, the building of a system or network of control around the risk object through which it is supposed to be neutralized.

The documents, procedures, and practices of the established regulatory system described thus far lay the foundation for what and how risks associated with narasin are accepted and introduced into society as well as how these risks are regulated and managed. Nonetheless, despite their significance, these remain largely invisible to the larger society, and consumers are generally unaware of the processes in which narasin is constructed, controlled, and managed as a risk object. Paired with high levels of institutional trust, the general unawareness of the public and the assumption of the regulatory system that established procedures and regulations providing sufficient control and protection from harm, the case can be seen as setting out from a track tilted toward risk attenuation. As seen in the next rounds, when the media start pushing narasin and its associations with antibiotic resistance into public view, it appears easier for the actors who are part of the regulatory system to displace rather than to emplace risks. The following rounds will also illustrate how the risk communication and responses of the regulatory system can be seen as risk objects in themselves, having consequences for how the risks related to narasin are experienced by actors and over time have different effects on social risk amplification and attenuation.

3.2. Rounds of risk attenuation and amplification

3.2.1. Round 1

In 2003, the Norwegian public was exposed to information pointing to a link between narasin and harm. The media reported that narasin residues had been detected in Swedish chicken and eggs. Swedish authorities were accused of keeping quiet about these findings, and narasin was

presented as a poison that, with just a couple of milligrams, could kill a horse (Aftenposten 2003; Rossland 2003). In response to the Norwegian media, the Swedish Food Agency dismissed the information, replying that Swedish chicken was safe and emphasizing the EU's zero tolerance of narasin in eggs. In this way, by drawing attention to earlier established safety regulations, highlighting the general policy of non-tolerance of narasin residues in eggs, and stressing safety signals, attention was directed away from the connection between narasin and harm indicated by the media. The link between narasin and harm was quickly severed; the risk was displaced, and ultimately the media coverage was short-lived, limited to Swedish conditions, causing no noticeable public reactions or consumer concern.

In the same year, as part of its annual testing procedures on behalf of the NFSA, the NVT detected narasin residues in Norwegian egg samples and an increase in the prevalence of antibiotic-resistant bacteria (Campylobacter jejuni) in broiler chickens (NORM/NORM-VET 2003). According to the NVT, the findings reflected the use of antimicrobials. However, as noted by the NVT, apart from coccidiostats (i.e. narasin), antimicrobials were rarely used in Norwegian poultry production (NORM/NORM-VET 2003). The Norwegian Medicines Agency (NMA) communicated similar signals in a publication in the same year, pointing to the antibacterial effect of narasin and the need for more knowledge on the development of antibiotic-resistant bacteria (NMA and Norwegian Medicines Agency 2003). This indication that narasin might have antimicrobial and antibacterial effects, although not classified as such, can be interpreted as an act of risk emplacement. Yet, despite the indications from the NVT and NMA of a potential connection between the use of narasin and the occurrence of antibiotic-resistant bacteria, they led to no changes in the regulation of narasin and the associated system of control: The classification and use of narasin was not questioned or reevaluated, nor were risks reassessed. Contrary to the media reports of detections of narasin in Swedish chicken and eggs, the NMA's report and the NVT's findings were not communicated to the 'outside' arenas. The information stayed within the arenas of the technical experts and specialists, indicating that what is presented in the media represents only a slice of all of experts' tests, calculations, and analyses. As illustrated by Round 1 in Figure 2, the responses that followed both the risk emplacement reported by the media and the examples of risk emplacement inside expert arenas can be seen as contributing to social risk attenuation.

3.2.2. Round 2

In 2006, information indicating linkages between narasin and harm was again shared with the public. This time, the media informed the public that residues of the 'forbidden drug' narasin were found in two egg samples in Norway. However, once again media attention was brief and rapidly cut off by the NFSA's responses demanding that the feed producer document that the findings only represented a single occasion of cross-contamination (Totland 2006), and the feed producer arguing that 99% of the feed for egg-laying hens was produced under safer conditions (Rasmussen 2006).

Again, by stressing in their communication that cross-contamination was rare and emphasizing aspects relating to safety measures and control, the representatives of the regulatory system and the feed producer together acted to displace the risks. The voices in the media were limited to these actors alone and, shortly after their responses, the issue again disappeared from the media and produced no apparent changes in consumer behavior. Thereafter, a longer period followed in which narasin received little or no attention from the media.

As in Round 1, the information about narasin and harm communicated in the media can be seen as setting off risk displacement responses involving no reassessment of the risk and no changes to the legislative or regulatory framework and actors (i.e. experts, feed producers, and consumers), who continued as before. Again, this outcome can be seen as serving to uphold

the perception that the risks related to narasin were low and to substantiate the previously described attenuation of the risks (see Figure 2 Round 2).

3.2.3. Round 3

In 2012, narasin and its potential consequences reappeared in the media, as antibiotic-resistant bacteria were again detected in 32% of Norwegian broiler chickens and chicken fillets while cross-contaminations of narasin were detected in two egg samples (Gronningen 2012). Once again, information indicating that narasin could be a risk object with the potential for harm was rapidly challenged by the responses of the regulatory system and chicken producers. The regulatory experts referred to risk assessments and stressed that concentrations of narasin in most egg samples, except one, were below threshold level values and, therefore, were safe for human health. Yet again, nothing was said of the fact that the egg-testing procedure only represented the investigation of a very small percentage of the annual egg production and that the real numbers could potentially be far higher. The resistant bacteria were attributed to the import of breeding material, and the low levels of antibiotic-resistant bacteria in Norwegian chickens relative to other European countries were emphasized. Furthermore, the findings were compared to statistics demonstrating higher levels of resistant bacteria (43%) in 2011. Of the three first rounds, Round 3 is where the information displayed by the media includes the clearest risk warnings and signals of incubating hazards (Kasperson et al. 2003).

However, information about potential harm was quickly responded to in the media and processed in the same way as earlier rounds, with the expert actors relying on the dominant framing and risk management approach to narasin established in the initial framing stage (see Section 3.1): maintaining a neutralization of narasin as a risk object and leaving an impression that no risk existed and that the regulatory system had things under control. Across all three rounds, acts of displacement can be seen as contributing to risk attenuation (see Round 3 in Figure 2, whose development is similar to that of Rounds 1 and 2). Feed producers continued to use narasin as a feed additive, and the public continued to consume chicken and eggs. Once again, some time passed—this time, another two years—in which the risks related to the use of narasin more or less disappeared from the media and the societal agenda. However, although this and previous rounds of events did not generate any visible or easily noticeable effects, the non-responses were absorbed in society in ways generating a more hidden set of effects. The acts of risk displacement can be interpreted as contributing to a form of risk attenuation at the societal level in which business goes on as usual, keeping perceptions of risks associated with narasin low, upholding the current consumption of poultry meat and eggs, and introducing no demands for changes to the legislative or regulatory framework.

3.2.4. Round 4

In 2014, the risks related to the use of narasin received extensive media coverage. Antibiotic-resistant bacteria were found in 70% of chicken fillets in Norwegian grocery stores. This time, the expert voices in the media were not limited to the those who were part of the established regulatory system. This time, 'outside' experts entered the arena and communicated messages that challenged and conflicted with the information dominating the media during previous rounds.

A professor in microbiology took the lead, explicitly connecting the findings of antibiotic-resistant bacteria in chicken with the use of narasin in poultry feed while also arguing that the use of narasin should be banned (Midtvedt 2014). Another expert outside the system, the head of the Norwegian Medical Association and a former member of the national expert group on antibiotic resistance (Gjessing 2014; Sunde 2014), further claimed that Norwegian chicken should be treated as a high-risk product due to the high level of antibiotic-resistant

bacteria and the uncertain effects posed to human health. At this stage, the NFSA acknowledged the need for more research to identify the source of the resistant bacteria and the effects on human health, yet the rhetoric regarding narasin continued on the same track, stressing the existence of only a limited amount of data showing an association between narasin and antibiotic-resistant bacteria and that potential risks could be handled by established measures of control. According to the NFSA, the risk of bacteria transference was small, as long as recommended hygiene and cooking advice was followed (NFSA 2014). As before, the rhetorical acts from the expert system rested heavily on the EFSA's risk assessment results and regulations, stressing exposure below established threshold values, the low probabilities of adverse effects, and the safety of chicken products.

SARF-related research has previously shown that, when there is conflicting information and distrust brewing, sources of negative information and news often appear more credible than those giving positive news (Slovic 1993). As Pidgeon, Poortinga, and Walls (2010) also demonstrated, in such situations, people are more inclined to trust information from the 'watchdogs': independent organizations and experts that keep an eye on developments and inform the public about potential consequences. These tendencies can also be seen in the developments in the studied case; contrary to prior events, this time information from the regulatory system displacing risks did not have the same effects as in previous rounds, and expert actors whose efforts were to emplace risks came to direct the media debate. The microbiology professor raised doubts about the system of control surrounding narasin and called into question the quality of the EFSA's risk assessments and its use of and reliance on incomplete data. He also accused the authorities and the chicken industry of setting aside the law and hiding the problem of narasin and multi-resistant bacteria, stressing that—although narasin was not classified as an antibiotic—it undoubtedly was one (Midtvedt 2015).

The statements of the outside experts generated responses indicating risk amplification: Many consumers changed behavior, and sales of chicken given feed containing narasin fell. Such outcomes had further ripple effects, as the chicken industry started to phase out the use of narasin in feed (see Round 4 illustration in Figure 2). The Norwegian authorities also responded by requesting new national risk assessments from the NFSA. The results arrived in December 2015 and showed a possible connection between the antibiotic-resistant bacteria and the use of narasin in poultry feed (Nesse et al. 2015). However, referring to the effect of safety measures (e.g. consumers' heat-treatment of meat), NFSA experts again displaced the risk by pointing to the effect of such risk-reducing measures. Overall, the new NFSA assessments were of the same character as the EFSA's risk assessments: Uncertainties and data limitations were framed as a lack of evidence of adverse effects, the assessments reflected the same language and the same methods and type of data, and they drew the same conclusions that the probabilities of consumer exposure to coccidiostats and resistant bacteria were negligible.

The events of Round 4 can be seen as a struggle among different experts, in which one group of experts was actively engaged in challenging the established definition of narasin to provide links between narasin and antibiotic-resistant bacteria, whereas another—the experts who were part of the established regulatory system—consistently acted to sever or break such linkages by conducting risk assessments, communicating their results, and emphasizing that risks were negligible and could easily be controlled with hygiene and cooking measures.

At this stage, the routine responses of the regulatory system no longer seemed to resonate with many members of the public, who instead appeared to rely on the statements of outside experts and professionals. Although regulatory experts' statements could have potentially contributed a more balanced portrayal of the risks connected to narasin, their attempts at risk displacement came to increase risk amplification rather than having a moderating or balancing effect on perception and responses. The struggle resulted in the outside expert actors successfully managing to emplace narasin as a risk object in a way that it took hold among many consumers. Part of this success can be ascribed to these outside expert actors drawing attention

to the previous risk attenuation of actors within the regulatory system identifying poor risk assessments (by the EFSA) and irresponsible actions of authorities and the chicken industry (i.e. setting aside the law and concealing the link between narasin and multi-resistant bacteria) as new risk objects linked to narasin. By looking back upstream, these new risk objects can be seen as being related to earlier acts of risk displacement and how the regulatory system responded to earlier risk warnings and signals during prior rounds.

At this point in time, all actors—both those displacing and those emplacing the risks—came to contribute to amplification in different ways: The outside experts attempted to emplace risks by questioning the reliability and the foundations of the established system and measures of control; the expert system continued to displace risks, stressing the negligibility of risk and the effect of hygiene and cooking measures. Although prevalent throughout the example, the role of the media as an amplification actor itself was also especially clear at this stage. In addition to representing the arena in which the struggle played out among the different actors, the media actively fed risk amplification by selecting the signals, symbols, and information to be given coverage—often negative, conflicting, and evocative ones.

In parallel, as described by the concept of ripple effects in the SARF, the consequences of amplification spread. Sales continued to drop and, by 2016, most of the Norwegian chicken feed and food industry had abandoned the use of narasin. These changes coincided with a growing focus on the problem of antibiotic resistance in other sectors, especially within the health sector, and national goals to reduce the use of narasin in feed and the overall use of antibiotics in the food production sector were set for the entire animal food and feed sector. The Norwegian chicken industry stopped using narasin in feed (it is now only used for treating outbreaks of infection) and replaced it with the use of a spray-on vaccine (Paracox-5®) administered to day-old chickens. This replacement can be seen as an act of risk displacement involving the removal of the risk object from the system; however, at the same time, it also involves the introduction of another potential risk object to the system.

Despite these changes, the regulatory system still classifies narasin as a coccidiostat whose use is still permitted in Norway, and it is still governed by the same regulations as before. In the EU, broiler farmers still make extensive use of coccidiostats in poultry feed (McDougal 2018; Rybicki 2020). However, the classification of narasin as a coccidiostat is the subject of recurring debate, and the European Commission is currently in the process of evaluating the legislation on feed additives, Regulation (EC) No 1831/2003 (European Commission 2022). Citizens and stakeholders were invited to provide input into the evaluation, and a closed public consultation on the impact assessment of the revisions of the Feed Additives regulation has been conducted. However, both processes were characterized by a low response rate from citizens (and farmers) and significantly higher participation by business associations (European Commission 2019). All in all, the main inputs have come from actors displacing risks; companies, business organizations, and associations almost unanimously describe feed additives as safe and efficacious, asserting that the EFSA's safety assessment of feed additives helped make feed additives safe for human health, animal health, and the environment. Attempts to emplace risks, which mainly came from the public, only formed a very limited part of the input provided to the ongoing evaluation.

4. Discussion

By analyzing a case that spans a longer period and across a series of events, our aim has been to contribute to a more comprehensive understanding of the dynamic nature of risk amplification and attenuation processes. The analysis of the illustrative case showed that using the SARF together with system/network theory helps clarify how the social experience of risk and associated responses can be related to multiple events and interactions among actors over time.

System/network theory and the SARF draw attention to different parts of 'the story' detailing how risks develop over time. Using them together helps see more of the picture and understand the larger context within which social risk attenuation and amplification happen. The risk displacement and emplacement concepts contribute to studying what happens and does not happen inside expert organizations and institutions and, by seeing the media as an interface between actors, the SARF connects such studies to the processing of risks on the outside and the effects—visible or not—that occur. The factors that led to risk amplification in Round 4 of the analysis not only cover the communication of actual findings of antibiotic-resistant bacteria, but also include what previously has and has not happened in the sociotechnical system.

In studying the dynamics that precede and shape the emergence of a designated risk event (Poumadere and Mays 2003), we identified a need to extend the usual understanding of what constitutes a risk event in the SARF research. The analysis of the case illustrates that acts that weaken or decouple links between a risk object and potential harm (i.e. risk displacement) also function as risk events. Sometimes, of course, there will be risk events that start with a bang or a burst of flames but, perhaps more often than not, risk events from which risks are further defined and controlled have no or few immediate effects or introduce no noticeable changes in risk perceptions. The consequences of such events often remain invisible until risk amplification occurs (Fjaeran and Aven 2019). In the illustrative case, the lack of risk amplification that followed the first three rounds does not disqualify them as risk events. On the contrary, these non-responses impact the further development of the risk, albeit in different ways than those events that are more easily observable and communicated to others.

The analysis demonstrated that experts play a central part in influencing the social experience of risks and how risk develops, underscoring that the social amplification and attenuation of a risk cannot be viewed independently from the processing and definition of risk that occur within specialized organizations and expert institutions (Hilgartner 1992; 2008). Consequently, when studying risk amplification processes, this means paying more attention to the 'risk management and internal regulatory processes governing the behavior of institutions in identifying, diagnosing, prioritizing, and responding to risks' (Kasperson et al. 2003, p.24). The illustrative case shows how the first seeds of risk amplification and attenuation can be seen as being sown in the early history of the risk—namely, in the classification, initial framing processes, and 'inside' responses to the less visible risk events. As the case developed, the expert acts further impact the social experiences of risk in at least two ways. First, the inside experts' acts of risk displacement communicated in the media during Rounds 1, 2, and 3 can be seen as hindering risk amplification from occurring in different ways. Second, expert acts had social impacts in that they later became risk objects themselves as the acts of risk displacement were connected to and contributed to shape the reactions and responses to later and more visible events as well as the development of subsequent ripple effects.

The analysis illustrates the role of the media as an arena and an interface (Kasperson et al. 2003; Murdock, Petts, and Horlick-Jones 2003) between the inside experts and a wider set of actors on the outside while also bringing to the public's attention information about less visible or previously hidden risks or risk events. In addition, by selecting which signals and information to cover and communicate related to other expert actors' acts of risk emplacement, the mass media itself is an actor that plays a potential role in stimulating or creating risk amplification. However, the case also shows how actors who raised doubts in the media about the network of control (indicating potential risks, communicating findings or information, establishing new connections between the risk object and harm) were quickly countered by the communicative responses of the actors who were part of the regulatory system trying to decouple or weaken any association between narasin and harm. Such activity commonly occurred by focusing on opposite signals (i.e. safety, efficacy, and control) and referring to earlier assessment results, existing regulations, threshold values (e.g. MRLs), and risk management measures (e.g. consumer cooking and hygiene procedures) as the rationale for decoupling the use of narasin from

antibiotic-resistant bacteria. Although outside expert actors emplacing risks entered the media from time to time, communicating signals that could have potentially contributed to a more informed portrayal of the risks, the regulatory system continued to respond by displacing risks.

The initial acts of risk displacement (as described in Section 3.1.) appear to have become fixed into a set of procedures and responses leaving an impression of being strategically aimed at neutralizing narasin as a risk object. These institutional arrangements can be seen as setting an overarching context for the amplification and attenuation process (Kasperson et al. 2003) and providing a limited repertoire and set of responses that robbed their members of flexibility. When faced with changes, uncertainties, and warnings (such as when information on the potential connection between the use of narasin and antibiotic-resistant bacteria was indicated by different actors, and when the quality of the data and the basis for risk assessment and regulations of the expert system were questioned), the experts who were part of the regulatory system continued to respond in the same way. The analysis provided support for how 'different institutional arrangements can be characterized as operating with predictable sets of amplification and attenuation rules' (Kasperson et al. 2003, p. 44). In this regard, it is relevant to mention that, in recent years, the EFSA has taken initiatives to open up and increase the transparency of some of the processes of the expert system surrounding feed additives. The EFSA's recent uncertainty reforms, for instance, include the public disclosure of scientific uncertainties as part of the risk assessment and scientific advisory procedures. As described in the last paragraph of Section 3.2, the EFSA has also attempted to involve citizens and stakeholders by inviting them to provide input into the current evaluation of the Feed Additives regulation. However, the actual effect of these involvement attempts on social risk amplification and attenuation processes remains to be seen and forms part of the developments within the EFSA that should be further researched and analyzed.

Our analysis of the illustrative case made extensive use of the SARF. The analysis asked more of the framework than has been demanded in its common applications and, thus, exposed some limitations. The analysis shows, we believe, that the framework could and should be strengthened and extended. As shown in Figure 1, the SARF does not encourage looking upstream to the context and the events that preceded a major risk event, such as Round 4 in the illustrative case. Yet the analysis shows that what happened can best be understood by also considering the initial framing and the three previous rounds. The SARF is usually applied to more dramatic amplification situations, such as Round 4, but it is also helpful in characterizing the attenuation that occurred in the previous rounds, marking an additional use for it. As previous research has indicated (Fjæran & Aven, 2019; Larson, Lin, and Goble 2022; Poumadere and Mays 2003), an upstream look will be important in many risk situations.

We believe that the illustrative case and its analysis show aspects of the dynamic social processing of risk for which there are opportunities to update the SARF and make it stronger and more expansive. Among these are:

- A SARF that pays more attention to the upstream context and upstream events rather than focusing on single events and their impacts;
- A SARF that pays attention to the sociotechnical and systemic origin of many risks and facilitates applications that include a broad set of actors; and
- A SARF that pays more attention to the role(s) of experts among the actors.

Viewing the social processing of risk as it appears across a series of events and interactions among actors over time shows that the combination of the SARF and systems/network theory provides a vantage point for considering more adaptive approaches in policy and risk management, particularly in circumstances of high uncertainty. In all rounds of the case studied herein, the established regulatory system had opportunities to change its approach, but did not. A focus on both the interaction and dynamics between social risk amplification and attenuation

and expert acts with their impacts can support the development of what has been argued for by, for instance, Goble, Kasperson, and Ratick (2017) and Kasperson et al. (2022) as more adaptive management strategies for coping with uncertainties. According to Goble (2021), such strategies will require collaboration among different scientific perspectives. As one step in this direction we point to the positive contributions risk amplification can make, which have, thus far, been less addressed in the literature on risk perception and communication. Throughout the example used in this paper, the regulatory system showed a consistent reluctance or inability to respond to information and events emplacing risks. White and Eiser (2006; 2010) described such reluctance to declare or inform the public about the presence of a risk as a strict response bias or a reject danger response bias. In line with others (e.g. Fjaeran and Aven 2021; Kraus, Malmfors, and Slovic 1992; Siegrist and Cvetkovich 2001), they have argued that people prefer and place higher trust in risk managers who assume danger and are open about decisions in the face of uncertainties, compared to those risking a negative outcome by assuming safety and not accepting risk in the absence of strong evidence or loads of data demonstrating causalities. When risks have been or are in the process of being amplified, such a strategy may act to place expert actors and those in charge of managing risks on the sidelines in defining moments of the game. In the narasin example, toward the end, such a response bias as a risk communication and management strategy came to feed the very risk amplification it appeared tailored to reduce or prevent. The strategy seemed to overlook the positive sides of risk amplification, such as helping to put previous hidden or attenuated risks on the agenda and raising awareness of other related risks or unconsidered causalities and connections. Such a strategy could have potentially helped reduce the opportunities for events and consequences to incubate over time (Gould and Fjaeran 2019).

The adaptive approaches discussed herein may also help avoid that struggles over risk definitions and management strategies first take place in the media as well as avoid some of the negative consequences of the media being the first to publicly communicate risks or risk-related information or events. Such media reporting is often associated with a negativity bias, in which disproportionate attention tends to be given to sensationalist and evocative events (e.g. accidents, discoveries of errors, or previously mismanaged risks; e.g. Slovic 1993; White and Eiser 2006). Media-driven amplification may not only lead to the overestimation of rare risks and events, directing attention away from other risks that may be more harmful, pressing, or likely to occur, but also prove costly to society, exacerbate conflict among actors, harm public trust in expert systems, and sometimes create highly persistent stigmas. Although avoiding these consequences of media-driven amplification is attractive, it is important to remember that the primary goal of adaptive risk management must be improved risk management. Public response and reactions are sometimes necessary when, for instance, the risk management system is inflexible or fails to respond.

An adaptive risk management strategy requires that many and diverse forms of risk emplacement be allowed to take place and for these emplacements to have a real potential to affect the initial framing of the risk, the designing of the regulatory system, the possibilities for monitoring changes, the measures of control, and the risk communication strategies. Increased institutional permeability has previously been suggested as an antidote to blind spots that become created and sustained by organizational exclusivity (Turner and Pidgeon 1997) within 'closed' expert systems (Freudenburg 2003). As such, experts should not only consider and look for knowledge inside the established expert institutions and organizations, but also search outside and make other experts, stakeholders, and the public and their experiences, values, and concerns 'part of the story'. In the narasin example, this would have involved also directing attention toward social values, priorities, and less clear connections to other risks; these aspects were muted or absent in the many documents, procedures, and processes that provided the foundation for the system and network of control surrounding narasin. A more inclusive risk management strategy from the outset might have contributed to an expert system and wider

network of connected actors and requisite variety of values and knowledge from which to interpret and respond to changes, uncertainties, and events as risks developed. Such a strategy might also have supported an increased sensitivity and relevance of expert risk communication throughout the various rounds of risk amplification and attenuation.

5. Conclusions

In applying system/network theory and making the connections between the concepts of risk emplacement and displacement and the risk amplification/attenuation metaphor, we argue that there is increased usefulness in having a broad toolbox of social theories for application within the risk field and that there are possibilities for making connections among them within the SARF. Our approach complements other research using the SARF in conjunction with social theory, such as psychometric approaches, media and communication research, and cultural analysis. Regarding the earlier criticism raised against the suitability of the SARF as a framework for integrating certain forms of social theory and conceptual incompatibility with more dynamic and interactive accounts of risks, we found no major obstacles in applying the SARF in combination with system/network theory. Indeed, the amplification/attenuation metaphor provided help for dealing with the complex social organization of risk communication in our analysis. It avoided the reduction of social processes and responses to individual creations by illustrating that there are preexisting 'things' (e.g. physical objects, institutional arrangements and rhetorical acts) that influence, though they do not determine, the social experience of risk.

Similar to Williams' (2008) application of actor–network theory in the domain of disaster studies, we found that the application of the system/network perspective proposes a relational, and often messier, social ontology between the subjects and objects of risk. This understanding of risk has been less emphasized in earlier research applying the SARF framework and, based on our research, we identified areas of opportunities to update and further develop the SARF to make it stronger and more expansive in terms of supporting the integration of these types of studies.

Our approach here has been conceptual and has drawn on an example for illustrative purposes. Consequently, the findings should not be used directly or alone as evidence of any social rules and dynamics, either in the domain of the example or across cases. The research has, however, brought to the fore a set of arguments—for seeing social risk amplification and attenuation as linked processes and for providing increased acknowledgement of the role of experts as actors in these—that contribute to laying a foundation for further research that applies a system/network perspective in combination with the SARF. Such a combination offers a good vantage point for considering opportunities in adaptive risk management as well as the difficulties in realizing such opportunities. An integrative approach that connects what happens in expert communities with the processing of risks and effects on the outside is relevant to the study of risks in contexts similar to our example, including other risks originating from and evolving in sociotechnical systems and networks, such as in relation to biotechnology, digitalization, and climate change. Following our findings relating to how expert acts impact the social experiences of risk, a particularly important and continuing question is whether further evidence exists of causal links between institutional behavior in expert communities and subsequent societal responses (Kasperson et al. 2003). We also attempted to show that the results from more socially oriented approaches such as ours do not undermine the importance of technical risk assessment, but can—and should—find ways to work alongside, supplement and, where appropriate, constructively debate prevailing approaches to risk. Such efforts will require increased reflexivity within expert systems concerning, for instance, who are relevant actors and what is considered relevant values and knowledge when assessing and managing risks, – and

for the actors operating in the expert systems to allow their own roles and practices to be assessed and evaluated.

Notes

1. Hilgartner (1992) used the terms "system" and "network" interchangeably; however, some works differentiate between these terms.
2. The EU also intended to ban all use of coccidiostats as feed additives starting in 2012, and trials were conducted in European countries to identify alternative measures to reduce or prevent coccidiosis, but no alternative efficient measures were identified; consequently, it was recommended that authorization for the use of coccidiostats be maintained, despite the side effects (Rybicki 2020).
3. Conducted by two respective panels: the Scientific Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) and the Scientific Panel on Contaminants in the Food Chain (CONTAM).

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