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GUEST EDITORIAL

Expanding the field of Responsible Research and Innovation (RRI) – from responsible research to responsible innovation

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ABSTRACT

In the last decade, Responsible Research and Innovation (RRI) has earned a prominent position in policy spheres by offering forward-looking approaches and a framework for reflecting on the societal impact of research and innovation. Nevertheless, RRI remains an immature and relatively narrow area of inquiry, with a top-down approach and guided by standardized principles. Further, the field lacks focus on how researchers, firms and other actors actually perform responsible research and innovation. By unveiling the heterogeneity of responsibility practice, this special issue broadens RRI's scope in two ways. First, by expanding RRI's narrow focus on the research processes towards an approach that also takes into account how new knowledge and new ideas are becoming research-based innovations in society. Second, by including a wider spectrum of responsible innovation processes, and not only those that are research-driven. This special issue includes 10 investigations of heterogeneous responsible innovation practices that cross sectors and regions. Using the lessons these contributions teach, we close the issue with suggestions for a new multidimensional, multi-scale avenue for RRI.

KEYWORDS

Responsible research and innovation (RRI); context; region; materiality; organization; discourse

Introduction

Growing concern about how to cope with Grand Societal Challenges has earned the RRI literature a prominent position, especially within policy spheres. This is particularly true in the European Union (EU), where debates centre on European research and innovation policies and how to link research and its impacts with innovation (European Commission, 2014; Stilgoe & Guston, 2017; von Schomberg, 2013). This discussion dates back to the Science and Technology Studies (STS) literature, which has long debated science 'responsibility', including the negative impacts of research – and how to avoid them (Jasanoff, Markle, Petersen, & Pinch, 1994; Schuurbiers, 2011; Zwart, Landeweerd, & van Rooij, 2014). Relatedly, the recent RRI literature contributes insight into research and innovation stewardship, including how these can become more inclusive and sustainable. RRI offers forward-looking approaches and frameworks for reflecting on societal impacts, with a focus on participatory research and innovation methods (Owen, Macnaghten, & Stilgoe, 2012; Uyarra, Ribeiro, & Dale-Clough, 2019).

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Nevertheless, RRI is also a relatively immature, narrow area of inquiry that takes a top-down perspective and relies on standardized principles about public governance of research and innovation. Further, it lacks focus on how researchers, firms and other actors actually perform responsible research and innovation. The concept's implementation has primarily been within the context of publicly funded research, underappreciating how it might be performed in other contexts (Martinuzzi, Blok, Brem, & Stahl, 2018). By highlighting heterogeneous responsibility practices, this special issue broadens the RRI scope in two ways. First, by expanding RRIs narrow focus on research processes towards an approach that also takes into account how new knowledge and new ideas are becoming research-based innovations in society. Second, by including a wider spectrum of responsible innovation processes, and not only those that are research-driven. The 10 investigations comprising this special issue on responsible innovation practices cross sectors and regions, broadening our understanding of RRI.

We begin this editorial by describing the state-of-the-art RRI framework. This framework, which is oriented toward publicly funded research, must be expanded to incorporate heterogeneous responsible innovation practices. Hence, in the following section, we provide an analytic model for a more context-sensitive perspective on responsible innovation. Thereafter, we introduce the 10 special issue articles and discuss how they are linked to this model. Finally, we discuss the lessons learnt from these studies and suggest a new multidimensional, multi-scale avenue for RRI.

RRI – the development of a framework

As a concept, RRI typically invokes scientific research, most of which is concerned with 'a policy and socio-ethical perspective and focusing on academic R&D environments' (Blok & Lemmens, 2015, p. 20). RRI is sometimes also referred to as responsible innovation (RI). There is no consensus on the distinction between RI and RRI, and these terms are used interchangeably (Stilgoe, Owen, & Macnaghten, 2013). However, RRI specifically highlights the fundamental role of research in innovation (e.g. Koops, 2015). Similarly, EU policy documents use RRI to emphasize the importance of including research and research activities in innovation. From an STS perspective, von Schomberg defined RRI as

> A transparent, interactive process by which societal actors and innovations became mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society). (2011, p. 9)

The emergence of RRI within EU policy discourse dates back to 2011, after which, it replaced the Ethical, Legal and Social Aspect (ELSA) framework for guiding research policy on emerging sciences and technologies (Zwart et al., 2014). The introduction of ELSA in the mid-1990s was – similar to the RRI framework – a top-down approach used by policymakers (most notably the European Commission) and funding agencies. ELSA focused on the negative consequences of research and, in fact, constrained the development of new research and technology (Zwart et al., 2014). By contrast, RRI has focused more on Grand Societal Challenges and placed greater emphasis on public research and innovation for the common good. Thus, the evolution from ELSA to RRI signals a policy-level willingness to challenge and rethink linear models of science and innovation

policy. This evolution also points to growing concerns about the public's valuation of science and the importance of demonstrating how publicly funded research and innovation impact society (Stilgoe et al., 2013).

At its core, the RRI literature is occupied with governing research and research-based innovation. This link to policy formulation (and, in turn, policy implementation) gives RRI a strong normative dimension. According to Owen et al. (2012), the RRI framework has three main features. The first feature expresses concern about the purpose of science and innovation; it stimulates discussion about research targets and innovation, and how these can be accomplished ethically, inclusively and democratically. This aspect of RRI directs greater challenge-led science and innovation, with broader framing than just research excellence. Since RRI particularly addresses questions such as how to ensure the 'right' societal impacts of research and innovation (Genus & Stirling, 2018; Stilgoe et al., 2013), it initiates discussions about 'desirable' societal benefits.

The second RRI feature is the need for developing mechanisms for reflection and inclusion in the research and innovation process. Broader discussion of the purpose underlying innovations, and their potential impacts, is needed. Linked to this is the importance that such reflections are open and include those affected by innovation, not just those directly involved in innovation activity. This is a markedly ambitious task, with an ideal outcome of ensuring the correct outcomes of research and innovation.

The third feature is a need to reframe the concept of responsibility. RRI is not a topic for researchers alone, but rather one that should engage entrepreneurs, businesspeople, policymakers, public institutions and research funding agencies. RRI argues for an expanded listing of legitimate actors to influence research and innovation processes. von Schomberg (2008) uses the term collective responsibility to frame this concept, which is a broader understanding of the actors responsible for ensuring the positive impacts of research and innovation. This feature suggests that RRI should incorporate issues of directionality and normativity, including societal values fostered by research and innovation (Uyarra et al., 2019). A general fear is that research policy is too heavily oriented towards excellence, while innovation policy is focused exclusively on competitiveness. RRI intends to counteract a scenario in which research milieux define the value of research while leaving innovation to commercial interests (Fitjar, Benneworth, & Asheim, 2019).

Importantly, we lack general agreement on the principles, methods and tools for achieving 'beneficial' societal outcomes or on how to stimulate the 'right' processes to achieve these goals. Stilgoe et al.'s (2013) four dimensions of RRI (anticipation, reflexivity, inclusion and responsiveness) is a promising approach towards clarifying this discussion. Stilgoe et al.'s (2013) approach and the four dimensions provide theoretical and analytic clarity for a coherent understanding of RRI. Anticipation regards the involved actors' ability to consider the potential impact, both positive and negative, of research and innovations. Involved actors also need to build their capacity to respond to these. Reflexivity deals with these actors' ability to reflect on their own and others' interests and needs in the research and innovation process. Inclusion emphasizes the need for broader participation in research and innovation decision-making processes. Finally, responsiveness deals with how involved actors respond to emerging needs by adjusting the research and innovation process. These actors also need to build capacity to be responsive. In the recent RRI literature, Stilgoe et al.'s (2013) approach has become a focal point for defining RRI and its application to academic work and policy implementation.

Much RRI research has investigated the research and innovation process surrounding the development of sensitive technologies such as nanotechnology, biotechnology and various forms of digitalization, with an emphasis on these new technologies' potential negative impacts (Thapa, Iakovleva, & Foss, 2019). Studies have also addressed ways to implement the RRI framework in publicly funded research institutions in Europe and the U.S. (Kerr, Hill, & Till, 2018). Nevertheless, the current RRI literature has two main shortcomings. The first concerns the types of innovation processes investigated. The second is the limited investigation of the broader societal impacts of innovations.

Regarding the first shortcoming, policymakers and researchers have developed RRI with a primary focus on ways to conduct responsible science and develop technology in a world where innovation is a linear, scientific-domain process. Further, the use of RRI does not differ between the research process and the commercialization and market introduction processes (Lubberink, Blok, van Ophem, & Omta, 2017) or convey a proper understanding of introducing innovations to the market, and tends to focus on the research process and ethical dimensions rather than economics (van Oudheusden, 2014).

Moreover, the literature does not differ between research-driven and other types of innovations, including experience-driven innovation in different business sectors, user-driven innovations, social innovations and public sector innovations. This poses challenges to implementing RRI in business or social contexts. Actors' interests and values when operating within a business context can vary markedly from those operating within academic or policy contexts; these groups each face unique challenges regarding responsiveness and inclusiveness. For instance, van de Poel, Asveld, Flipse, Klaassen, and Scholten (2017) argue that RRI has strong links to the principles of Corporate Social Responsibility (CSR), a well-established concept among firms and industries. Consequently, the implementation of RRI in a business context must learn from CSR experiences; companies' RRI strategies should be closely attuned to the more general corporate business strategy. In downstream innovation processes, actors and stakeholders must make decisions on a timescale reflecting actual day-to-day business challenges (Tait, 2017). Tensions will inevitably exist between firms' profit-oriented rationale and RRI's ethical and democratizing mandate. How to balance these tasks remains an open question within the RRI literature (Martinuzzi et al., 2018), which portrays a harmonious model of inclusiveness and participation. In reality, different stakeholders have varying motives and interests, as well as different abilities and resources to integrate their interests within innovation projects (de Hoop, Pools, & Romijn, 2018). Thus, how to apply RRI principles into innovation processes beyond those that are specifically research-based remains unclear (Lubberink et al., 2017).

The second shortcoming of the RRI framework is that it lacks concepts and models for investigating the broader societal impact of innovations. Tait (2017) notes the absence of any reference to social benefits that RRI may or may not be able to deliver. It has also been argued that RRI research tends to equate innovation with positive economic growth, as long as the research process has been responsible (de Saille & Medvecky, 2016). An in-depth discussion of how to understand and handle the societal and environmental consequences of economic growth has been lacking. Thus, RRI studies would likely prosper from a tighter interaction within the more well-established research field of innovation studies (Fagerberg, Fosaas, & Sapprasert, 2012), which includes a broader conceptualization of responsible innovation. The field of innovation studies also investigates topics

such as the environmental risk of innovation (Johnson & Lundvall, 2013), the unequal distribution of the benefits of innovation (Fløysand & Jakobsen, 2011; Lee & Rodriguez-Pose, 2013; Perez, 2013), the need for directionality within innovation policy (Tödtling & Trippl, 2018) and the ongoing transition towards more sustainable modes of production and consumption (Coenen, Benneworth, & Truffer, 2012). Scholars also argue the need to gain a better understanding of the consequences of the market-driven innovation ideas invading new domains of society (Martin, 2016), as well as the societal implications of strong positive connotations with the word 'innovation' (Godin & Vinck, 2017).

From responsible research to responsible innovation

The discussion above argues that the RRI scope needs broadening by (i) expanding its narrow focus on the research process by considering how new knowledge and ideas are implemented and become (responsible) research-based innovations, and (ii) including a broader spectrum of innovation processes beyond those exclusively research-driven. Broadening RRI's scope in these ways also means applying a more context-sensitive understanding of innovation. The RRI framework has generally been implemented within only the publicly funded research context (Martinuzzi et al., 2018).

Context refers to the circumstances that form the setting of a practice (Garud, Gehman, & Giuliani, 2014); such settings both provide structure to, and are structured by, practice. Contextual factors include research and technological specificities, industry sector characteristics, spatial or regional conditions, institutional dimensions, policy regulations and socio-cultural dimensions (Fløysand & Jakobsen, 2011; Isaksen & Jakobsen, 2017). Innovation is a dynamic and interactive process that involves the flow of knowledge and assets between networking actors. Innovation processes are situated within specific settings or contexts, and various settings or contexts provide different potentials and challenges for ensuring responsibility within that process. Context undoubtedly influences the way in which RRI progresses.

To extend the current RRI literature, and its strong focus on the research process, this special issue emphasizes how new knowledge and ideas are implemented and become (responsible) societal innovations. We include a wider spectrum of innovation processes beyond those that are research-based. Consequently, we focus more on responsible innovation than on responsible research. Figure 1 provides an analytic model for a context-sensitive understanding of responsible innovation. We define responsible innovation as innovation that, in addition to economic goals, also meets social, ethical and environmental goals (Fløysand & Jakobsen, 2017). Innovation processes set in motion to these ends should be analysed as socially constructed complexes with material, organizational and discursive dimensions. The material dimension contains aspects such as technology, infrastructure and natural resources. The organizational dimension concerns management, modes of organizing, networking between actors and policy frameworks. The discourse dimension concerns the knowledge behind innovations; new ideas and narratives about what are, should be and could become responsible innovations.

Beyond these are territorial dimensions, which refer to the geography of the innovation complex. Innovation is often anchored to a local or regional scale, where the scopes of action and contingencies are largely conditioned by former practices and choices (Martin & Sunley, 2006). However, recent innovation studies have expanded this

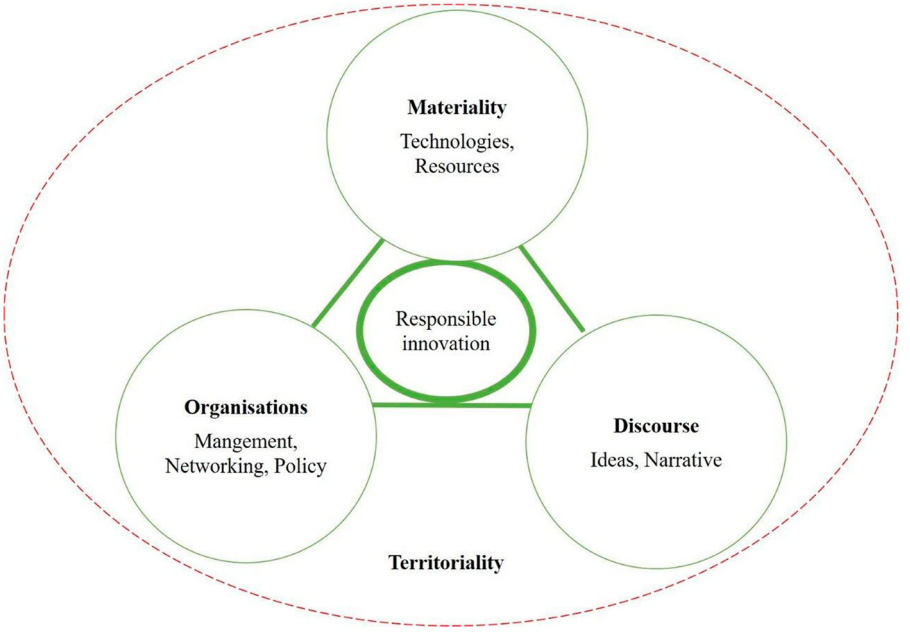

Figure 1. The responsible innovation complex.

concept to include extra-regional processes (i.e. national and international levels) and investigate the multilevel geography of innovation processes (Fløysand & Jakobsen, 2017).

Contents of the special issue

The 10 papers that follow investigate different aspects of responsible innovation. They include empirical data from Australia, Chile, the U.K., Germany, the Netherlands, New Zealand, Norway, Spain and South Africa. They investigate the material, organizational, discursive and territorial dimensions and cumulatively illustrate the heterogeneity of responsible innovation practices performed across multiple contexts.

The article by Rai Kumar Thapa, Tatiana Iakovleva and Lene Foss is a systematic review of the RRI literature, which they discovered investigates the material or technological dimension (specifically nanotechnology, biotech and digitalization), as well as how research and innovation within these themes may have negative societal consequences. Their detailed analyses of thematic areas within the RRI literature show that the issues debated are most often (in descending order): RRI tools, RRI process outcomes, drivers of RRI and barriers to RRI. Despite growing interest in RRI, these authors argue that the RRI concept remains ambiguous. In practice, this makes implementing RRI challenging. One aspect absent from the reviewed literature is the territorial dimension, or how RRI processes unfold within regional contexts. They also argue that the RRI debate is consistent with that occurring in the regional innovation studies literature, and claim that these literatures can enrich each other. RRI can strengthen regional innovation studies' understanding of governance and the policy dimension, while innovation studies can enrich RRI studies with its comprehensive discussions of both stakeholder involvement and innovation as an interactive process. Yet the question remains: how to

change institutions in ways that will incentivize all actors involved in innovation processes to endorse RRI ideas?

The contributions by Svein Sjøtun and Rune Njøs and by Maria De Los Angeles Pineiro Antelo and Ruben Camilo Lois Gonzalez investigate how to ensure responsibility within various technology systems. Instead of discussing how to enable technologies at the RRI literature core, the first paper discusses introducing greener and more responsible technologies to Norway's resource-based industries, while the second investigates how to ensure responsibility in a fishery community in Galicia, which is dominated by small-scale technology.

Sjøtun and Njøs analyse three strong industry clusters in Western Norway that host publicly funded projects to facilitate technological development: a petroleum cluster focusing on subsea solutions, a seafood cluster focusing on fish farming and a maritime industrial cluster focusing on cleantech solution. The investigators analyse the extent to which each contributes to a green cluster reorientation. They find that the subsea cluster represents a 'neutral route'. Due to a recent decline in oil prices, these cluster projects stimulated the firms to divert their efforts into the development of technology and products for related markets. The seafood cluster's strategy has been to make their production process greener by using more environmentally friendly fodder and new production technologies. The maritime cleantech cluster represents even more strongly such normative route, by advocating battery and charging technologies to maritime sector commercial use. Overall, these authors show that to develop green and responsible technologies, actors must be aware of how policy (i.e. the organizational dimension) can be pivotal in driving a green reorientation. They also stress the need for investigations into the role of discourse in these change processes; sometimes, green reorientation can be more 'rhetoric' than real.

Pineiro-Antelo and Lois-Gonzalez investigate Lira, a small coastal community in Galicia, Spain, where traditional fishery production methods coexist with intensive aquaculture. To ensure responsible technology development, new models for the co-operative management of marine resources were established through collaboration between industry, university and regional administration representatives. This process was supported by European fisheries funds, leading to a series of product development and commercialization projects, as well as new fishing resource conservation models. These new resource governance models and technology development projects have also led to innovation processes that are more inclusive. The involvement of various local institutions and stakeholders through co-operative networks has also made the production system more responsive to the needs of the local community.

The organizational dimension of responsible innovation was investigated within the contributions by José Luis Sánchez-Hernández and Johannes Glückler, and those by Jonathan R. Barton, Álvaro Román and Johannes Rehner. These papers are examples of how to extend the RRI literature scope toward addressing social innovations (Sánchez-Hernández & Glückler) and sustainable regional development (Barton, Román & Rehner).

Sánchez-Hernández and Glückler study bottom-up initiatives of economic coordination in six Spanish cities, focusing on alternative economic practices and how they resonate with RRI. Their study extends the research field towards responsible innovation by arguing that the interaction between alternative economic practices and politics at the

local level resonates with RRI's idea on how to take care of the future through collective stewardship (Stilgoe et al., 2013). They demonstrate how alternative economic practices relate to the interaction between institutions, and to urban policy regulation, in six Spanish cities. Madrid and Barcelona illustrate how cases of reinforcement strengthening institutions' alternative economic practices. Oviedo, Valladolid and Valencia illustrate substitution, insofar as regulatory changes were made consequent to interactions among institutions using alternative economic practices. Salamanca illustrates competition between institutions using alternative economic practices and urban policies. Reflecting on how this relates to RRI, Sánchez-Hernández and Glückler argue that responsiveness and reflexivity are pre-conditions for alternative economic practices; however, alternative economic practices vary in inclusiveness depending on the institution–regulation relationship. The reinforcement cases described in this paper were highly inclusive; the substitution cases were partly inclusive; and the competition case stands out as rigidly top-down in its approach. Finally, these authors argue that one can expect future development scenarios when formal strategic planning and international networking underpin the integration of alternative institutions into formal policies.

The contribution by Barton, Román and Rehner addresses top-down coordination of science and development policy in Chile and its relations to RRI. The authors begin by stretching the concept of RRI; they distinguish between Research and Innovation (R + I) as synonymous with neo-structural productivism and RRI as synonymous with the concept of sustainable regional development. Their scrutiny of evidence of any shift from R + I to RRI in public science, research and innovation investment shows that the top-down-initiated innovation and research policy in Chile – which culminated in the recent creation of a Ministry of Science, Technology, Knowledge and Innovation – shows few signs of such a shift. An exception to this is the creation of the partially RRI-focused Regional Research Centres, although these remain insignificant compared with investments in R + I. This situation was repeated when the authors examined Chilean investment in science, research and innovation in copper mining and salmon aquaculture. The mining case revealed a R + I focus on cluster development, while the RRI dimensions of indigenous conflicts and water stress resulting from mining activities were relegated to the underfunded critical social sciences sector. The aquaculture case provided similar results in terms of state support for R + I, or neo-structural productivism, with comparatively little investment in RRI or sustainable regional development. The study thus reveals a strong neo-structural fixation on science and development policy in Chile, while sustainable regional development requires further development.

The contributions by Philip Cooke, by John Overton, Warwick Murray and Kelle Howson and by Dieter Rehfeld all demonstrate ways to engage in discourse on what are, should be or could become responsible innovations. The article by Cooke illustrates how contemporary innovation is destroying more value than it creates. The argument is that innovation, which was considered a benign business objective (i.e. to innovate) until recently, rapidly became transformed into a malign set of ethics, incentives and prohibited business practices with monopoly power that neoliberal regulative slackness and pro-market propaganda allowed to fester, subsequently infecting cultural, social and economic values. This author points out RRI anti-norms operating in the 4.0 Industry. Examples of these knowledge-intensive services include research (R&D), financial technology ('FinTech'), software and systems design, cybertechnology (from cybersecurity

to cyberwarfare), artificial intelligence (digital technology or 'digitech'), robotics, biotechnology and genomics and cleantech. Underpinning this argument, the article explores the dark side of innovation in 'FinTech', digital positioning and geolocational analysis and digital 'company town' planning. Cooke draws three main conclusions from his analyses. First, there is a lack of transparency and breach of trust in this context. This is pronounced in the non-transparent FinTech sector, which relies on exploiting dark investment resource pools and profits from quasi-illegal transactional interchange. Second, there is a great need for RRI assessment of typical digitech and social media business practices, which engage in norm-transgressing infractions and break trust by exploiting investor funds for illicit gains and harvest data from social media consumers. Third, in the matters of control, propagandizing and electoral fraud, the largest global internet companies come close to, or cross the line, of appropriate regulatory conventions within democratic societies. More than anything else, this article promotes a massive research agenda for future RRI investigation.

Rehfeld follows up on the RRI discourse dimension by examining how to define the 'right' research and innovation outcomes and how researchers can successfully direct innovation towards such outcomes. This author also reflects on the normative base of RRI, and how it can be informed by regional innovation studies. Of special concern is the relationship between basic and applied research. To address this, Rehfeld refers to von Schomberg's (2013) five normative anchors in the Treaty on the EU: (i) the promotion of scientific and technological advances, (ii) competitive social market economies; (iii) the promotion of social justice, including gender equality, solidarity and fundamental rights; (iv) sustainable development; and (v) quality of life, with a high level of protection of human health and the environment. How these anchors are addressed in regional innovation studies is also discussed, whereas RRI and regional studies differ in how they approach the relationship between basic and applied research. While the role of bridging the gap between applied and basic research is consciously reflected upon and acknowledged in regional studies, it remains taken for granted within RRI.

Overton, Murray and Howson also demonstrate, in two steps, the need to extend studies of responsible innovation to capture the discursive dimensions. First, they apply a political economy analytical perspective. Second, they relate the four responsible innovation dimensions (anticipation, reflexivity, inclusion and responsiveness) to the ethical value chains in wine industries in South Africa, Australia and New Zealand. Their contribution is a useful illustration of the discursive dimensions in processes of responsible innovation; it also illustrates the value of taking a more discursive approach to capture these dimensions analytically. These authors focus on ethically responsible values of justice (fair trade in South Africa), sustainability (organic production in Australia) and provenance (geographical indications in New Zealand). Discussion based on this novel and wide empirical backdrop reveals that the scrutinized ethical value chains exemplify an anticipatory dimension for foreseeing new market niches and developing new marketing strategies to leverage ethical claims. They also illustrate a reflexivity dimension by introducing codes of compliance and certification schemes. Yet, despite the connotations of justice (fair trade) and sustainability (organic production), little evidence of strong inclusive governance exists. On the contrary, Overton, Murray and Howson argue that their cases of ethical discourses in fair trade, organic production and geographical indicators within wine production have been partly colonized by large corporations to capture the associated ethical 'rent'. They argue

that in the ethical marketplace, it is sometimes the connotation of 'doing good' rather than the empirical fact of doing so that operates as a catalyst.

The territorial dimension, or how responsibility plays out in different regions, is investigated in the contributions by Paul Benneworth, Kornelia Konrad and Verena Schulze-Greiving, and by Elvira Uyarra, Barbara Ribeiro and Lisa Dale-Clough. The former article explores repertoires of responsible innovation behaviour within two regional innovation networks: one primarily based on synthetic knowledge bases, and another primarily based on analytic knowledge bases. These authors argue that the RRI framework lacks a conception of space or territories for which research and innovation can take responsibility. They anticipate that investigating regional innovation networks would illustrate how regional specificities influence responsible innovation practices. The two regional innovation networks they select are in the health sector of the Twente region in the Netherlands. These authors find that the scope of responsibility repertoires within these regional innovation networks depend on the ways that the pre-existing network is organized. In the synthetic knowledge base network, patients are strongly coupled to innovation networks; this is associated with not only improved responsiveness, but also reduced inclusion and reflectiveness. The more weakly coupled analytic cases are associated with stronger anticipation and reflection, but weaker responsiveness. Overall, the authors argue that the RRI literature is characterized by 'placelessness', and that for innovations to be responsible, they must be coupled with informal collectivizes at the regional- and extra-regional scales in which these innovation processes operate.

Uyarra, Ribeiro and Dale-Clough investigate how RRI can be used as a lens for developing public procurement into an instrument for solving regional societal challenges. They base their analyses on empirical data from the U.K. In general, they argue that the RRI framework has a certain spatial blindness. Applying the principles of RRI in public procurement prompts the question of how societal challenges are being framed, what types of solutions are being proposed, and by whom, and what rationale lies behind choosing different instruments to address regional societal challenges. Their use of the RRI framework also means that the concept of public value needs to be better defined. There is, in general, a need for greater awareness of how public value occurs within specific systems and by particular actors. Public value is not universal; it is dependent on geography and shaped by regional institutions and policies. These authors link RRI, public procurement and regional innovation policy, arguing that their approach illustrates a way to broaden RRI's traditional, narrow research scope. This can be done first by developing the RRI focus on creating public value that is aligned with developments in regional innovation policy, and second, by moving beyond enabling technologies to consider the modulation of a broader spectrum of innovations, including social innovations.

New avenues for responsible research and innovation

There are several lessons to be learnt from the 10 papers in this special issue. First, they demonstrate that RRI is a multidimensional phenomenon that includes the processes of materiality, organization and discourse. Second, RRI is a territorially embedded practice involving a broad spectrum of actors, political interests and geographic scales. RRI research has traditionally operated within a relatively narrow understanding of innovation practice as something that takes place within the scientific community. We have been

expanding this approach by emphasizing responsible innovation as a practice involving a much broader spectrum of actors and processes. Research on responsible innovation practices needs to investigate multiple actors, their engagement with technology development, the introduction of new products and processes, discourse on what responsible innovation is and should be and related issues, including organization management, networking and policy. Third, although the contributions within this special issue have broadened RRI's scale and scope, they are relatively limited regarding how we understand the phenomenon. In other words, despite contributing to a metamorphosis in how multiple actors become mutually responsive to ethical acceptability, sustainability and social desirability through their innovation activities, discourse about responsible innovation has generally avoided undergoing a thorough conceptual deconstruction.

Thus, there are four primary lessons to be learnt from the articles in this special issue. First, there is a theoretically based need to conceptualize multidimensional approaches connecting the material, discursive and organizational dimensions of responsible innovation, and their synergistic effects on Grand Societal Challenges. Such conceptualizations should represent a broad understanding of responsible innovation as a point of departure for differing theoretical perspectives. Independent of theoretical inspiration, the conceptualizations should also engage in how the material, organizational and discursive dimensions of responsible innovation communicate. In these matters, Schwarz and Thompson's (1990) work within technology studies points in a promising direction. These authors define technological development as a dynamic, evolutionary process that is only possible if patterns of things (technological items) are accompanied by patterns of people (ways of organizing and disorganizing) and ideas (discourses). Inspired by this trinity, the previous section 'From responsible research to responsible innovation' introduced a tri-dimensional perspective on studies of responsible innovation (see also Fløysand & Jakobsen, 2017; Sjøtun, 2019) involving the material dimension (e.g. technology, resources), the organizational dimension (e.g. management, modes of organizing, policy) and the discursive dimension (e.g. ideas, narratives). Consistent with this, to proliferate responsible innovation, it is necessary – but insufficient – to establish the 'right' technological circumstances. We must also recognize the organizational and discursive scope of such systems, or the multidimensional dynamics they involve. This becomes especially relevant when standardized interaction patterns are rotating, such as when an industry creates environmental problems that emerging technologies are then developed to solve. Do such technologies alter systems of organization? Do they alter institutionalized narratives and claims that are currently taken for granted? Are they instead of an exclusively material character? To reflect on these questions effectively, we must be aware of the specific perceptions or narratives used by the actors to legitimate their practices and lawmakers to regulate them. An illustration of this is the logic behind the commercialization of inventions in a capitalist economy. Before reaching a market, an invention or idea is piloted; it becomes an innovation only when introduced to the market or are put into use (Schumpeter, 1934). The rationale behind innovation in a capitalistic setting has traditionally been to increase earnings and returns, and to contribute to the economic growth of the actors who innovate. Nevertheless, when analysing responsible innovation, we must look for a much broader spectrum of rationales. For some stakeholders, it might be important to address environmental challenges, while for others, it might be important to address the issues of value creation, recognition and distribution.

Emerging innovations are therefore part of a discursive process in that they have the potential to produce a dynamic shifting of 'rationalities'. Accordingly, analysing these from a multidimensional perspective means that responsible innovation development is a question of overcoming material, organizational and discursive challenges. Technological development, new ways of organizing and new narratives and rationales that legitimize changes in practice must all be stimulated in a particular direction if an innovation is to be realized as responsible.

Second, empirical knowledge regarding how global and local players address dilemmas and related tensions in different contexts when innovating in a global world is needed, as are multi-scale approaches for a global world that acknowledge the importance of identifying and understanding territorial specificities (e.g. regulations, innovation systems, resource bases). This is important both to comprehend the responsibility repertoire of regions (i.e. what the involved actors are doing) and to expose the main drivers of and obstacles to responsible innovation (i.e. why they are/are not doing it). For example, territories with strong systems of innovation may facilitate collaboration and the generation of new knowledge, fostering responsible innovation capabilities. By contrast, territories with weak systems may neglect inclusiveness and reflexivity in the innovation process. In these matters, the Global Innovation Network (GIN) literature represents a promising avenue (Chaminade & Vang, 2008). The GIN literature argues that multinational companies' activities are the core – but not the only – innovation settings. Although multinational companies influence economic, political, cultural and social development, differences remain in how interplay between contextual specificities and how multinational companies occurs. For example, processes of 'strategic coupling' imply that regional assets (both tangible and intangible) are aligned with multinational companies, and vice versa; in turn, this narrative is seen as both positive and negative for solving Global Societal Challenges. In other words, within the GIN literature, the material, organizational and discursive dimensions are mutually constitutive in time and space (Fløysand & Jakobsen, 2017). This literature also acknowledges that organizational changes in one geographical context may 'inherit' regional characteristics of a given GIN (e.g. narratives, practices, modes of production), meaning that dilemmas arising from solving Grand Societal Challenges are evident in most responsible innovation development processes, even though the tensions and controversies that follow, and how to solve them, are conditioned by territorial embedding.

Third, from a practical perspective, co-created knowledge is needed about how multidimensional and multi-scale innovation dynamics can be initiated and monitored to encourage economic value creation in parallel with solutions to environmental and social challenges. In these processes, there is a need for 'innovation-testing' to ensure the responsibility of the end product. The notion of living labs (Bulkeley et al., 2016) understood as sites devised to design, test and learn from innovation processes in real-time in order to respond to particular societal, economic and environmental issues, could here be a useful tool. Living labs emphasize experimentation understood as collective search and exploration processes in which a broad suite of stakeholders like firms, universities and actors from government and civil society are navigating, negotiating (and ideally) reducing uncertainty about innovations through real-world experiments, gaining knowledge and experience along the way in an iterative learning-by-doing and doing-by-learning process. By providing a space to negotiate problem definitions and

understandings, various claims to resources, authority or dominant ideologies, the living lab has the potential to contribute to changes in innovation practices. We believe there is a need to further elaborate on the concept of living labs across different contexts and sectors.

Fourth, and form an educational point of view, study programmes that emphasize the art of exploring and exploiting innovation need to be established at institutions of higher learning (March, 1991). Such innovation education programmes should provide state-of-the-art knowledge, skills and competence in 'innovation as exploration', covering central theoretical perspectives on, and core concepts of, responsible innovation. However, these programmes should also provide state-of-the-art knowledge, skills and competence in 'innovation as exploitation', training students in the real-world application of responsible innovation, how to scrutinize and evaluate key dimensions of responsible innovation, as well as how responsible innovation can contribute to Grand Societal Challenges, and solving key dilemmas in innovation processes. With such layered insight into RRI, including both exploring and exploiting innovation, candidates graduating from these programmes should be prepared to act as change agents promoting responsible innovations across varying contexts.

In conclusion, we believe a multidimensional and multi-scale approach, combined with the arts of exploring and exploiting innovation, is a fruitful new avenue for RRI. It paves the way for expanding the RRI research field beyond its current, narrow focus on practices within the scientific community to responsible innovation research that focuses on a much broader spectrum of innovation practises taking place within a multidimensional and multi-scale real-world setting.

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References

Blok, V., & Lemmens, P. (2015). The emerging concept of responsible innovation. Three reasons why it is questionable and calls for a radical transformation of the concept of innovation. In B.-J. Koops (Ed.), *Responsible innovation 2: Concept, approaches and applications* (pp. 19–35). Switzerland: Springer International Publishing.

Bulkeley, H., Coenen, L., Frantzeskaki, N., Hartmann, C., Kronsell, A., Mai, L., … Palgan, Y. V. (2016). Urban living labs: Governing urban sustainability transitions. *Current Opinion in Environmental Sustainability*, *22*, 13–17. doi:10.1016/j.cosust.2017.02.003

Chaminade, C., & Vang, J. (2008). Globalisation of knowledge production and regional innovation policy: Supporting specialized hubs in the Bangalore software industry. *Research Policy*, *37*, 1684–1696. doi:10.1016/j.respol.2008.08.014

Coenen, L., Benneworth, P., & Truffer, B. (2012). Towards a spatial perspective on sustainability transition. *Research Policy*, *41*, 968–979. doi:10.1016/j.respol.2012.02.014

de Hoop, E., Pools, A., & Romijn, H. (2018). Limits to responsible innovation. *Journal of Responsible Innovation*, *3*(2), 110–134. doi:10.1080/23299460.2016.1231396

de Saille, S., & Medvecky, F. (2016). Innovation for a steady state: A case for responsible stagnation. *Economy and Society*, *45*(1), 1–23. doi:10.1080/03085147.2016.1143727

European Commission. (2014). *Rome Declaration on Responsible Research and Innovation in Europe*. Brussels: European Commission.

Fagerberg, J., Fosaas, M., & Sapprasert, K. (2012). Innovation: Exploring the knowledge base. *Research Policy*, *41*, 1132–1153. doi:10.1016/j.respol.2012.03.008

Fitjar, R. D., Benneworth, P., & Asheim, B. T. (2019). Towards regional responsible research and innovation? Integrating RRI and RIS3 in European innovation policy. *Science and Public Policy*, 1–12. doi:10.1093/scipol/scz029

Fløysand, A., & Jakobsen, S.-E. (2011). The complexity of innovation. A relational turn. *Progress in Human Geography*, *35*(3), 328–344. doi:10.1177/0309132510376257

Fløysand, A., & Jakobsen, S.-E. (2017). Industrial renewal: Narratives in play in the development of green technologies in the Norwegian salmon farming industry. *The Geographical Journal*, *183*, 140–151. doi:10.1111/geoj.12194

Garud, R., Gehman, J., & Giuliani, A. P. (2014). Contextualizing entrepreneurial innovation: A narrative perspective. *Research Policy*, *43*, 1177–1188. doi:10.1016/j.respol.2014.04.015

Genus, A., & Stirling, A. (2018). Collingridge and the dilemma of control: Towards responsible and accountable innovation. *Research Policy*, *47*, 61–69. doi:10.1016/j.respol.2017.09.012

Godin, B., & Vinck, D. (Eds.). (2017). *Critical studies of innovation. Alternative approaches to the pro-innovation bias*. Cheltenham: Edward Elgar.

Isaksen, A., & Jakobsen, S.-E. (2017). New path development between innovation systems and individual actors. *European Planning Studies*, *25*, 355–370. doi:10.1080/09654313.2016.1268570

Jasanoff, S., Markle, G., Petersen, J., & Pinch, T. (Eds.). (1994). *Handbook of science and technology studies*. Thousand Oaks, CA: Sage.

Johnson, B., & Lundvall, B-Å. (2013). *Are there alternatives to growth pessimism? Reflections on how innovation strategies may contribute to sustainable development*. Paper presented at 2nd Lundvall-symposium, Aalborg, Denmark.

Kerr, A., Hill, R. L., & Till, C. (2018). The limits of responsible innovation: Exploring care, vulnerability and precision medicine. *Technology in Society*, *52*, 24–31. doi:10.1016/j.techsoc.2017.03.004

Koops, B.-J. (2015). The concept, approaches and applications of responsible innovation. In J.-J. Koops (Ed.), *Responsible innovation 2: Concept, approaches and applications* (pp. 1–15). Switzerland: Springer International Publishing.

Lee, N., & Rodriguez-Pose, A. (2013). Innovation and spatial inequality in Europe and USA. *Journal of Economic Geography*, *13*, 1–22. doi:10.1093/jeg/lbs022

Lubberink, R., Blok, V., van Ophem, J., & Omta, O. (2017). Lessons for responsible innovation in the business context: A systematic literature review of responsible, social and sustainable innovation practices. *Sustainability*, *9*, 721. doi:10.3390/su9050721

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, *2*, 71–87. doi:10.1287/orsc.2.1.71

Martin, B. R. (2016). Twenty challenges for innovation studies. *Science and Public Policy*, *43*, 432–450. doi:10.1093/scipol/scv077

Martin, R., & Sunley, P. (2006). Path dependence and regional economic evolution. *Journal of Economic Geography*, *6*(4), 395–437. doi:10.1093/jeg/lbl012

Martinuzzi, A., Blok, V., Brem, A., & Stahl, B. (2018). Responsible research and innovation in industry – Challenges, insight and perspectives. *Sustainability*, *10*, 702. doi:10.3390/su10030702

Owen, R., Macnaghten, P., & Stilgoe, J. (2012). Responsible research and innovation: From science in society to science for society, with society. *Science and Public Policy*, *39*, 751–760. doi:10.1093/scipol/scs093

Perez, C. (2013). Innovation systems and policy for development in a changing world. In J. Fagerberg, B. R. Martin, & E. S. Andersen (Eds.), *The future of innovation studies. Evolution and future Challenges* (pp. 90–110). Oxford: Oxford Scholarship Onlie.

Schumpeter, J. A. (1934). *The theory of economic development*. Cambridge, MA: Harvard University Press.

Schuurbiers, D. (2011). What happens in the lab. Applying midstream modulation to enhance critical reflection in the laboratory. *Science and Engineering Ethics*, *17*, 769–788. doi:10.1007/s11948-011-9317-8

Schwarz, M., & Thompson, M. (1990). *Divided we stand: Redefining politics, technology and social choice*. Philadelphia, PA: University of Pennsylvania Press.

Sjøtun, S. (2019). A ferry making waves: A demonstration project 'doing' institutional work in a green maritime industry. *Norwegian Journal of Geography*, *73*, 16–28. doi:10.1080/00291951.2018.1526208

Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy*, *42*, 1568–1580. doi:10.1016/j.respol.2013.05.008

Stilgoe, S., & Guston, D. H. (2017). *Responsible research and innovation. The handbook of science and technology studies*. Cambridge, MA: MIT Press.

Tait, J. (2017). From responsible research to responsible innovation: Challenges in implementation. *Engineering Biology*, *1*(1), 7–11. doi:10.1049/enb.2017.0010

Thapa, R. K., Iakovleva, T., & Foss, L. (2019). Responsible research and innovation: A systematic review of the literature and its application to regional studies. *European Planning Studies*, *27*. doi:10.1080/09654313.2019.1625871

Tödtling, F., & Trippl, M. (2018). Regional innovation policies for new path development – beyond neo-liberal and traditional systemic views. *European Planning Studies*, *26*, 1779–1795. doi:10.1080/09654313.2018.1457140

Uyarra, E., Ribeiro, B., & Dale-Clough, L. (2019). Exploring the normative turn in regional innovation policy: Responsibility and the quest for public value. *European Planning Studies*, *27*. doi:10.1080/09654313.2019.1609425

van de Poel, I., Asveld, L., Flipse, S., Klaassen, P., & Scholten, V. (2017). Company strategies for responsible research and innovation (RRI): A conceptual model. *Sustainability*, *9*, 2045. doi:10.3390/su9112045

van Oudheusden, M. (2014). Where are the politics in responsible innovation? European governance, technology assessment and beyond. *Journal of Responsible Innovation*, *1*(1), 67–86. doi:10.1080/23299460.2014.882097

von Schomberg, R. (2008). From the ethics of technology towards an ethics of knowledge policy: Implications for robotics. *AI & Society*, *22*, 331–348. doi:10.1007/s00146-007-0152-z

von Schomberg, R. (2013). A vision of responsible innovation. In R. Owen, M. Heintz, & J. Bessant (Eds.), *Responsible innovation* (pp. 51–74). London: Wiley.

von Schomberg, R. (2011). *Towards responsible research and innovation in the information and communication technologies and security technologies fields*. Brussels: European Commission. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2436399

Zwart, H., Landeweerd, L., & van Rooij, A. (2014). Adapt or perish? Assessing the recent shift in the European research funding arena from 'ELSA' to 'RRI'. *Life Sciences, Society and Policy*, *10*, 11. doi:10.1186/s40504-014-0011-x