RRI concepts, practices, barriers and potential levers

Deliverable D1.1

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This report is based on work that has been carried out by the whole FoTRRIS team:

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The **online survey** was technically implemented by Magdalena Wicher; Anett Ruszanov was coordinating the compilation of national (expert) **contact lists**, which have been compiled with contributions from all FoTRRIS partners.

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About the FoTRRIS project

FoTRRIS develops and introduces new governance practices to foster Responsible Research and Innovation (RRI) policies and methods in Research and Innovation (R&I) systems.

FoTRRIS stresses that RRI is a collaborative activity from the very beginning. Therefore FoTRRIS adds the prefix 'CO' to the acronym RRI. Important present-day challenges are of a global nature but manifest themselves in ways that are influenced by local conditions. Thus, FoTRRIS focusses on glocal challenges, i.e. local or regional manifestations of global challenges and on local opportunities for solving them.

FoTRRIS performs a transition experiment, i.e. an experiment to support the transformation of present-day research and innovation strategies into CORRI-strategies. It designs, tests and validates the organisation, operation and funding of CORRI competence cells. A competence cell is conceived as a small organisational unit, which functions as a local one-stop innovation platform that encourages various knowledge actors from science, policy, industry and civil society to co-design, -perform, and –monitor CORRI-projects that are attuned to local manifestations of global sustainability challenges.

Since research and innovation systems and practices in EU member states and within different research performing organisations vary, FoTRRIS experiments the implementation of new governance practices in five member states. These five experiments are evaluated, validated and constitute the basis for FoTRRIS policy recommendations towards EU and member states policy makers so as to enforce CORRI into the national and EU R&I systems. Training is dispensed to various stakeholders, so as to form them to establish other CORRI competence cells.

For more information see http://www.fotrris-h2020.eu

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Executive Summary

The present report was prepared as part of Work Package 1 of the project 'FoTRRIS - Fostering a Transition towards Responsible Research and Innovation Systems' (see info box above), which is funded within the European Union's Framework Programme for Research and Innovation (Horizon 2020), and runs from 2015 to 2018.

The **objective** of this report is to **contribute to the conceptualization of CORRI** (see FoTRRIS deliverable D1.2), which then will be tested and validated in five CORRI experiments, by a desktop research, and an exploration of knowledge actors' perspectives on (CO)RRI. For this purpose we carried out:

- an analysis of the currently prevailing R&I system based on scholarly literature;
- a review of the RRI literature appearing in scholarly journals, a review of the main results of accomplished and ongoing projects within this thematic field that were funded by the FP7 and H2020 programmes of the European Union, including examples of research and innovation efforts that appeared as RRI examples in the reviewed documents,
- expert interviews and an online survey.

The **first chapter** discusses actual trends in industrial and industrializing knowledge economies, which are criticised for not properly addressing societal needs. In contrary, they even contribute to lock-ins in regard to the big challenges our societies are facing, because they tend to 'externalise' many problems, of which pollution and resource depletion, poverty and the distribution of costs and benefits (in broad terms) of economic growth are the most pressing ones. However, these problems are 'internalised' as 'grand challenges' requiring evolutionary adaptations to the prevailing economic systems, and not as real challenges questioning the sustainability of the Western economic growth model in itself. This suggests that the dominant R&I systems may not properly address societal challenges.

The **second chapter** summarises results from a review of scholarly papers, RRI projects and examples of RRI practices. It explores the most cited definitions of RRI, the key features that make R&I responsible, and it explores practices that represent RRI with a particular focus on collective actions.

Since the normative foundations of RRI are not clear-cut, the concepts of RRI leave room for various interpretations. On one hand this may be benevolent, since it allows the concepts to be (locally) adapted to the specific contexts, on the other hand this brings about the risk of depreciating the term 'responsible', and open the way for practices that fit well into the present structures, remain unsustainable and unjust, but are also called RRI. When RRI seeks for its normative foundations it either uses very broad and blurred categories (that leave room for various interpretations – potentially also those contradicting with the 'spirit' of RRI), or use categories that are rooted in a specific (mainly Western European) context. However there are underlying assumptions that build up the RRI discourse, e.g. post-normal understanding of science, the belief in the benevolence and necessity of stakeholder participation, sustainability as a value, etc.

In regard to RRI practices, the review demonstrates that the participation of stakeholders plays an important role in RRI, but the mentioned practices represent very diverse ways and depth with regard to participation (so the expected role of stakeholders is not clarified). RRI is in many respects a top-down approach oriented towards researchers and policy-makers (so it is not the discourse of the stakeholders or citizens). Participation is very much oriented towards negotiating values (and maybe interests), but not towards actually making the decisions, and it remains unclear how to apply accountability to stakeholders. The collective aspect of RRI is unquestionable present in the literature, but this does mean that dealing with the collective aspect is evident, either theoretically or in practice. Thus it remains unclear what the

exact expectations in connection with the role of stakeholders (and in particular citizens) are, and how the practical implementation considers this.

Many cases presented in the reviewed papers relate to high-tech fields in high-income settings and focus on the research side. This suggests that RRI at present is the discourse of the research community in high income countries (and not the various potential stakeholders of the innovation process). This also suggests that RRI can easily be intrumentalised and be used as a tool to push forward certain controversial ideas. In spite of the fact that the theoretical principles of RRI allow for various different (even contradicting) interpretations, the cases too often take these categories (e.g. participation, deliberation, ethical) as granted and fail to reflect on the way they are turned into reality. Moreover, the analysed cases fail to reflect on the politics and non-neutrality of RRI, especially on the political content and moral principle implicitly put forward by the initiators of RRI practices (mainly researchers and policy-makers). This ignorance of the political aspect can easily result in the sustaining of the status quo (including mechanisms of oppression), and undermine the original aims of RRI.

The **third chapter** complemented the findings from desk research by exploring knowledge actors perspectives on RRI by means of expert interviews and an online survey. We asked what and whom they consider as main drivers of the current R&I system, how societal needs are addressed, and what they think about democracy in research and innovation. Moreover we explored their ideas about RRI in regard to expectations and collaborative practices.

They consider the dominant R&I system mainly being driven by academic rules and economic pressure; large public research organizations, in particular universities, funding bodies, and large industries represent the key players. For technical innovations market forces are supposed to be the main drivers, while social innovations are driven by civil society, social movements and enterprises beyond the mainstream business community.

The connection of R&I and societal needs varies across research fields, and this should be legitimate, because not all research is supposed to tackle concrete societal outcomes. However, publicly funded R&I should be accountable towards tax payers and serve societies' wellbeing. Even if there is a trend in R&I towards more emphasis on societal needs driven by specific research funding programmes, the socio-economic/societal impact is still perceived as too low. Experts also highlight that the definition of societal needs in research and innovation agendas might imply tensions (depending on who defines what), and that there is a risk of reproducing societal power relations when defining them.

The interviewed experts do not consider R&I democratic at all, and they think that participation respectively user involvement could represent an important tool for democratising the R&I system. Although we observed vast appreciation for more democracy in R&I, this also implied varying opinions on how this should look like: inclusiveness vs. necessity of specific expertise; upstream approach is widely appreciated, but not necessarily participation throughout the whole R&I process. Concerns about democratisation were voiced, that it may put the autonomy of R&I at risk, and introduce societal conflicts into the R&I domain.

According to interviewees' viewpoints, RRI may have various 'faces', and it may refer to the aims as well as to the process and the outcomes of research and innovation. Their ideas about RRI cover the full range of key elements, which are highlighted in the academic and policy discourse. There is uncertainty in what respect RRI will go beyond already existing concepts respectively innovative methodological approaches, but participatory, interactive or co-operative processes are supposed to be at the core of implementing RRI.

Experts pointed to lots of good examples of RRI-like practices, but taking (CO)RRI seriously would mean to get one step further. Co-operation between different disciplines and with societal actors beyond the R&I

community was highly appreciated as a core element of (CO)RRI; for some experts it represented even a precondition.

Ambivalence exists in regard to the institutionalisation of (CO)RRI: on the one hand it may help to make the concept more clear and easier to mainstream, on the other hand there are concerns that an institutionalisation may narrow down the concept. An institutionalisation should imply changes in the R&I system as well as in corresponding systems (e.g. economic system), thus it should be planned as a long-term process. Support for institutionalisation is expected to be given by tailored funding, acknowledgement for (academic) performance records and through specific centres, which initiate, coordinate and facilitate activities. An institutionalisation of (CO)RRI in the private sector is expected to be driven mainly by economic benefits.

The **fourth chapter** elaborated on levers and barriers that may influence the establishment of (CO)RRI systems, which were addressed within the literature and in the experts. A multitude of barriers for practicing RRI were identified, which mainly refer to institutional challenges, which indicate that advancing RRI is not merely a question of developing e.g. new engagement methods, but that it will be necessary to change the structural and institutional conditions in and outside the R&I community in order to successfully implement (CO)RRI systems.

Finally the fifth chapter concludes with the main insights we gained through the work carried out in the context of elaborating on this report, and what this would mean for the conceptualisation of CORRI.

1 Current R&I systems in industrial knowledge economies

By adopting a system perspective, this chapter discusses the current trends in modern European knowledge economies in which R&I systems are embedded.

1.1 The functioning of industrial knowledge economies

Industrial and industrializing knowledge economies aim in first instance at continuous 'growth', which is measured in terms of GDP and private profit, while social and ecological surplus values are less relevant (Snick and Cortier 2012: 4). They follow an economic paradigm that does not take side effects of economic acting on climate, biodiversity, social fairness, poverty, or armed conflicts as parameters that urge economic actors to adapt their actions, but as externalities.

Indeed globalising industrialised and industrialising economies do not perform very well with respect to sustainable development, neither according to its ecological nor its socio-economic dimension. Their unsustainability regards both their nature economies (e.g. in the form of climate change, resource scarcities, loss of biodiversity), their sustenance economies (e.g. inequalities and decreasing social cohesion) and their market economies (e.g. insufficient monetary resources to secure qualitative care and humane levels of pensions within an ageing society, lack of attractive, decent and satisfying jobs).

1.1.1 Knowledge economies' ecological dimension

According to the European Environment Agency, '*[…] the European economy needs huge amounts of resources to function. Apart from consuming minerals, metals, concrete and wood, Europe burns fossil fuels and uses land to satisfy the needs of its citizens. Demand for materials is so intense that between 20 and 30 % of the resources we use are now imported. At the other end of the materials chain, the EU economy generates around six tons of waste per person every year. With the boom in international trade, EU consumption and production may potentially damage ecosystems and human health not only within but also far beyond its borders*' (http://www.eea.europa.eu/soer/europe/material-resources-and-waste,). The total use of natural resources and production of waste increased by 34% between 2000 and 2007 and these increases are related to economic growth and increasing welfare. This has a considerable economic and ecological impact. Since easily accessible stocks nearly get exhausted, Europe is forced to seek refuge to mineral stocks that are less concentrated and less easy to access and to fuels with lower energy content. This implies that it can be expected that mining and use thereof will have a higher ecological impact per unit of produced material or energy. Since, finally, nearly 20% of the resources used within Europe are imported, it is exporting countries and regions that will to a considerable extent experience the ecological impacts of European consumption.

1.1.2 Knowledge economies' socio-economic dimension

The socio-economic sustainability dimension is not very promising either. A report of the OECD mentions an increase of poverty and inequality in two thirds of OECD countries (OECD 2008). Andrew Simms (2008) observes: '*During the 1980s, for every $100 added to the value of the global economy, around $2,20 found its way to those living below the World Bank's absolute poverty line. During the 1990s, that share shrank to just 60 cents. This inequity in income distribution—more like a flood up than a trickle down—means that for the poor to get slightly less poor, the rich have to get very much richer. It would take around $166 worth of global growth to generate $1 extra for people living on below $1 a day*' (ibid: 49).

A systematic replacement of human labour—another form of 'natural' capital—with technologies implies moreover that it becomes for an increasing number of people ever more difficult to find an attractive and inspiring job (Skott & Guy 2007). Technological innovation does not seem to fit easily with the creation of jobs. On the contrary, further automation is blamed as being a main cause for increasing unemployment. This relationship has been put forward since the 1930s, but it only started to be taken seriously since the 90s—with the introduction and rapid spreading of computers. Erik Brynjolfsson and Andrew MacAfee (2011) argue: '*In each case, economic theory is clear. Even when technological progress increases productivity and overall wealth, it can also affect the division of rewards, potentially making some people worse off than they were before the innovation. In a growing economy, the gains to the winners may be larger than the losses of those who are hurt, but this is a small consolation to those who come out on the short end of the bargain*.' Brynjolfsson and MacAfee distinguish between three sets of winners and losers: high-skilled versus low-skilled workers, 'superstars' versus everyone else and capital versus labour. They argue: '*Each set has well-documented facts and compelling links to digital technology. What's more, these sets are not mutually exclusive. In fact, the winners in one set are more likely to be winners in the other two sets as well, which concentrates the consequences*'.

1.1.3 The fairness dimension of industrial knowledge economies

Despite the continuous flow of scientifically and technologically induced substitutions, the ecological footprint of industrialised and industrialising countries could not be reduced, but it increased. An absolute decoupling between these economies and their use of natural capital could not be realised. This has not only to do with the so called 'Jevons Paradox'[1], but also with a direct relationship between environmental performance and global and national inequality (Dedeurwaerdere 2014). Inequality, in both income and power, does not only result in unequal access to ecosystem services, but also in unequal distribution of the costs of environmental degradation. As a consequence, inequality influences total use of natural capital. In the absence of social equality, a social driver is lacking to keep natural capital on a sustainable level or to enable ecosystems to better serve human life-capacities. Only in case a society guarantees its citizens access to a fair and reasonable part of ecosystem services, citizens can be expected to take responsibility for ecosystems' maintenance and improvement (Dedeurwaerdere 2014).

A lack of responsibility for life-supporting ecosystems should not one-sidedly be deemed a characteristic of the poorer part of the population for whom options for choice are rather restricted. As a study reviewing some historical examples of societal collapses concludes, in unequal societies '*the Elites—due to their wealth—do not suffer the detrimental effects of the environmental collapse until much later than the Commoners. This buffer of wealth allows Elites to continue 'business as usual' despite the impending catastrophe. It is likely that this is an important mechanism that would help explain how historical collapses were allowed to occur by elites who appear to be oblivious to the catastrophic trajectory* […]. *This buffer effect is further reinforced by the long, apparently sustainable trajectory prior to the beginning of the collapse. While some members of society might raise the alarm that the system is moving towards an impending collapse and therefore advocate structural changes to society in order to avoid it, Elites and their supporters, who opposed making these changes, could point to the long sustainable trajectory 'so far' in support of doing nothing'* (Motesharrei et al. 2014: 101-102).

An uneven distribution of wealth worldwide has resulted from resource-extractive, industrial pro-growth development (Dedeurwaerdere 2014). For the moment, 1,8 global hectares (gha) of bio-productive land exist per person. Human population is currently consuming 2,2 gha/person. So, the fair earth share is 1,8

[1] The Jevons Paradox occurs when technological progress increases the efficiency with which a resource is used (reducing the amount necessary for any one use), but the rate of consumption of that resource rises because of increasing demand (Bauer & Papp 2009).

gha/person. If we consider the figures below, however, we observe that Western industrial countries use more than 1,8 gha/person, while it is mainly African, South-American and Asian countries that use less than their fair share (http://sspp.proquest.com/archives/vol4iss1/0707-016.ohl.html).

Disparities of wealth, and related disparities of power, do not only influence how the pie of natural resources is sliced, but also the overall magnitude of the use of the natural resources (Baland et al. 2006 after Dedeurwaerdere 2014).

A democratic distribution of power and equitable distribution of wealth, therefore, can help to protect the environment. Environmental inequality and environmental justice are pressing research issues (Egmose 2015). Sustainable development aims at an equitable use of the different types of capital (natural capital, human capital composed of cultural capital, institutionalised capital, social capital and technological/produced capital) that are essential for the functioning of coupled social-ecological systems (Dedeurwaerdere 2014).

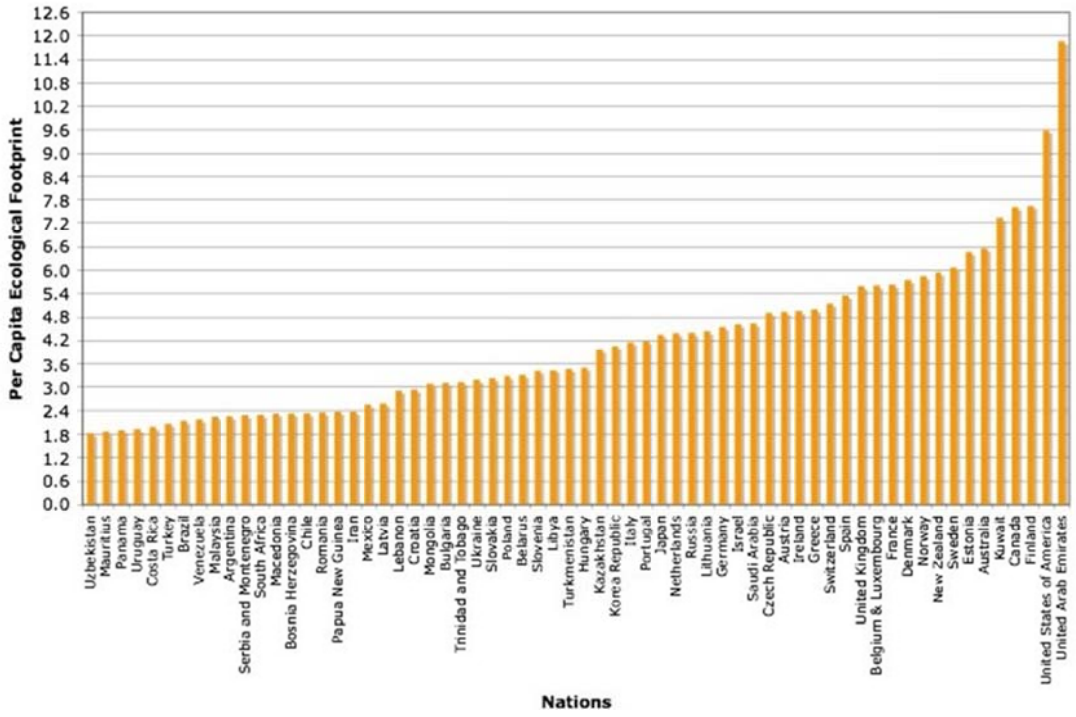


Figure 1: Ecological Footprint per capita

(source: http://sspp.proquest.com/archives/vol4iss1/0707-016.ohl.html)

1.2 The stated purpose of R&I systems

Current European and regional innovation policies aim at sustainability and social inclusion (http://ec.europa.eu/europe2020/index_en.htm). In order to realise sustainability and social inclusion, the Horizon 2020 funding strategy, aims at smart, sustainable and inclusive growth, and Europe promotes 'excellent science' as a means to boost Europe's competitiveness. In order to realise that, it assumes that staying at '*the cutting edge of new technologies will keep Europe competitive*' and that '*EU funding is helping to make Europe the best possible environment for responsible and dynamic multi-disciplinary cooperation on new and future technologies*'.
(https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/H2020_inBrief_EN_FinalBAT.pdf).

Economic growth is thus considered an intermediate purpose of R&I systems, i.e. a means to realise sustainability and social inclusion. In turn, technological novelty is considered an intermediate purpose to realise economic growth and to maintain and strengthen Europe's economic competitiveness in a globalizing context. Technological innovation and economic growth are thus both detours considered necessary to realise the purposes of social inclusion (at least at a limited, European- instead of a global-geographical level) and sustainability. In other words, in 'modern' industrial countries, R&I systems are considered subsystems of their economies. Or else, European R&I systems are organised and funded in the service of a specific political project: maintenance and strengthening of Europe's economic competitive position in a globalizing neoliberal market economy.

This is spectacularly reflected by the innovation systems literature. As Carlsson et al. (2002) put it, the function of an innovation system is to generate, diffuse and utilize technologies that have economic value. Innovation systems are considered to be effective if they are able to speed up technological change. Since technological change is considered to be the main driver of economic growth, the ultimate objective of the system is to contribute to economic growth. Historically, one of the most important precedents of the emergence of the 'innovation system' concept was the attention paid to the diversity of the growth potential of countries (Lundvall 1992, Nelson & Rosenberg 1993, Lundvall et al. 2002). According to this stream of literature, the expectation to focus on economic efficiency is clearly articulated towards theorists and practitioners of innovation policy: '*I assume that objectives – whatever they are – are already determined in a political process. […] With regard to innovation policy the most common objectives are formulated in terms of economic growth, productivity growth, or employment*' (Edquist 2002: 220). This implies that innovation policy is based on a set of information that embraces all those elements that influence the pace of the emergence and diffusion of innovations, and excludes everything else.

1.3 The functioning of R&I systems

Although economic growth is frequently questioned in academic literature as a means to realise sustainability (Benessia and Funtowicz 2015), and technological innovation is frequently questioned as a means to realise economic growth (if economic growth is understood as growth in employment and in rewarding jobs) and as a means to realise citizens' wellbeing and empowerment, both these goals/values keep the current R&I system in place.

These values are manifest

i. in the interpretation of sustainability as sustainable economic development;
ii. in the belief that strong public funding of New and Emerging Science and Technology (NEST) research are necessary conditions to sustain economic growth by the development of new products rather than transdisciplinary research;
iii. In the belief that science and technology are neutral, objective and universally valid (if allowed to act according to their own method, undisturbed by society).

However, a closer investigation reveals that the actual functioning of R&I systems on each of these levels – i.e. as the producer of 'neutral', 'value-free' science; as the producer of technological innovations enabling growth; and as a contributor to sustainable development – often runs counter to the stated values.

1.3.1 Unfounded beliefs about the universality and neutrality of scientific research

In Western knowledge economies knowledge production adds a coordination mechanism to the social system of societies, in addition to economic exchange relations and political control. The triple helix of university, industry and government shape each other's expectations (Leydesdorff 2012). This

entanglement of the science and innovation community with industry and government easily runs counter to researchers' critical distance from dominant beliefs and practices.

Science and technology are at most objective, but not straightforward true. Scientific insights derive their objectivity from their recognition by peers from within a specific disciplinary community. Those peers acknowledge scientific insights when they recognise - given the disciplinary paradigm they are familiar with - the research methods and procedures used to obtain these insights as valid and when they can imagine that they, given a similar research layout (infrastructural conditions, selection of empirical data, financial or time restrictions, …), could themselves have obtained similar research results. According to Benessia and Funtowicz (2015), the objectivity of scientific research goes hand in hand with normalizing strategies to reduce radical uncertainty and to mask the intrinsic blending of facts and values. '*The first standardizing strategy consists in asking only questions that can be answered by scientific quantitative reasoning. This procedure enables the translation of uncertainty and complexity in the statistical language of risk assessment, thus narrowing the decision-making processes within the norm of modern rational demonstration. Furthermore, the notion of objectivity can be standardized by enforcing a homogeneous epistemic culture in regulatory processes: if the values and interests at stake in shaping what is considered as relevant knowledge are shared by the members of the closed regulatory community, they do not stand out, they are neutral within a seamless background. Overall, the process of evaluation of the socio-environmental impacts of techno-science becomes then a bureaucratized technical fix, incorporating only the values that are legitimized by the institutions involved*' (ibid:). Scientific insights are, in short, historically contingent conceptual constructs. Therefore, they can never be straightforwardly 'true' or 'false'; they can at most be 'accepted' or 'unaccepted'—for the time being (Kuhn 1962).

This observation does not question the scientific ambition for objectivity: it is a good idea that scientists continuously expose their insights to the insights of their colleagues and adapt them in case they acknowledge the intrinsic value of critical comments. It does, however, imply that no definitive and unequivocal empirical foundation for scientific knowledge exists. Scientific knowledge—as all knowledge—remains susceptible to discussion, if not from within a particular disciplinary perspective, then at least from the perspective of other disciplinary paradigms or from non-scientific perspectives. Knowledge always remains to a certain extent empirically underdetermined and, hence, never straightforwardly 'true'. Building on this insight Stirling (2015) supports the practice of precaution, because it highlights that innovation policy and associated politics should pay more careful attention to the intrinsically problematic nature of knowledge, and its vulnerability to economic and political pressures. And, by recognizing this problematic nature, it points to the importance of diversity. '*By fostering more intensive encounters between varying kinds of knowledge and practice, deliberate diversification can also help enhance innovation processes themselves* […] *and make them more effective and socially robust* […] *Deliberate diversification is one key pragmatic way to enable greater precaution*. […] *Moreover, a focus on diversity may also help develop greater political tolerance, for the otherwise difficult, but inevitable, kinds of failure that are so essential to effective learning'* (ibid: 16).

Actual sustainability challenges are always complex. This implies that they can be considered 'wicked problems', which have, amongst others, the following characteristics (Vandenbroeck 2015):

- their framing is not unequivocal;
- a set of potential solutions exist;
- solutions are not simply true-or-false, but better or worse.

In complex situations, our knowledge is at most partial: we know some, but far from all causes and even less the possible interactions between various causes and initiatives, various actions and reactions. In such situations, ill thought-out application of scientific knowledge and technological know-how poses a risk: it can always lead to unexpected, irreversible, and undesirable consequences. Even stronger, many

environmental problems are to be understood as manifestations of technological interventions in the world (EEA 2010). Most researchers, however, do not get to the question whether their scientific or technological intervention does effectively more good than harm and to whom. This is obviously related to the fact that current regulation and governance of knowledge and technology basically overlook and are not really bothered by the possibility (a) that the benefit-cost ratio may be smaller than 1 or (b) the distribution of benefits and costs is unfair (Rommetveit et al. 2013). The emergence, since the latter part of the twentieth century, of a lively Science and Technology Studies (STS) community and efforts to promote and perform 'post-normal science' (Funtowicz & Ravetz 1993), risk and uncertainty research, technology assessment, foresight studies and transdisciplinary research did not change the fact that only a minority within the research community are in a position to act as if they acknowledge the non-neutrality and risks of scientific and technological bias and hubris.

Because of the inherently partly political (rather than strictly technical) nature of the interests and motivations driving technological pathways, Stirling (2015: 17) argues in favour of public participation in innovation: '*Public participation in innovation is simply about more rigorous exploration of specific ways in which legitimate judgements about 'benefits', 'excellence', 'relevance' and 'impact all depend in part (but irreducibly), on contexts, values and assumptions*'.

1.3.2 Unfounded beliefs about the role of science and technology

It is assumed that continuous technological development is an indispensable requisite for economic development and growth in modern societies. The imperative of innovation is frequently hailed as a *vade mecum* for many of our times' ills, but this has not paid off so far as illustrated in previous paragraphs by both the ecological, socio-economic and justice performance of Western knowledge economies (Rommetveit et al. 2013: 5).

Stirling (2015) admits that '*well-conceived innovations can undoubtedly offer important aids not only to economic productivity* […], *but also to enhancing many kinds of human flourishing or the public good*. […] *The more ambitious the aspirations to progressive social change, the greater the need for broad, diverse (and carefully scrutinised) kinds of innovation*'. However, McMurtry (2013) points to the specific economic and scientific rationality preventing constructive strategies to deal with our grand challenges. According to McMurtry, the meta-program of what is nowadays assumed to be economic—in particular—and scientific—in general—rationality consists of (a) self-maximizing strategies—instead of life-maximizing strategies of choice—in (b) conditions of scarcity or conflict over—instead of in the historical dynamic of social organization which continually transforms towards adequate provision or non-scarcity when not blocked against doing so by ruling privilege—evaluated against (c) desired payoffs—instead of life-capacitating vocation—at (d) minimum costs for the self—instead of life-value efficiency—to (e) succeed or win—instead of a mutual quest to prevail over limits to human life capacities. '*Market processes alone do not necessarily drive the best orientations for the kinds of innovation that are most needed from broader social viewpoints*. […] *So, one important role for innovation policy lies in helping to foster commercial innovation in the public interest*' (Stirling 2015: 2).

Actual R&I systems deny the political role of science and technology as an (un)critical production factor, i.e. a means to maintain or strengthen – unavoidably at the cost of other regions or nations – one's competitive position in a globalised market economy aiming at continuous growth. Consider—let us mention a rather extreme example—weapons of mass destruction. These are clearly meant to gain more power over one's 'enemies' and our 'enemies' are then those who we perceive as a threat for our future wealth and happiness. Much less extreme examples, but a day-to-day-reality are new and emerging technologies. These are, in the context of Western knowledge economies and from a political perspective, above all a

means to maintain or strengthen—unavoidably at the cost of other regions or nations—one's competitive position in a globalised market economy. Considered from an economic perspective, they are meant to claim a bigger part of the 'pie'.

1.3.3 Unfounded beliefs about economic growth as indispensable to avoid societal collapse

Nowadays according to Narberhaus (2015) two dogmas persist:

- The mechanisms of markets and competition (the invisible hand) are the best to create wellbeing in our societies.
- Economic growth is necessary to increase wellbeing, to improve the living conditions for the poor and to reduce inequality.

It does not seem that the scientific community questions the belief that economic growth is indispensable to avoid societal collapse, though several researchers individually question neoliberal capitalism. See e.g. Bollier (2015: 3): '*Neoliberal capitalism* […] *is demonstrably unable to meet basic human needs in socially fair, ecologically responsible ways. Its obsession with economic growth and private accumulation has become predatory and socially parasitic, and the overall system is wired to produce recurrent, catastrophic booms and busts*.' Empirical evidence, however, as illustrated above, does not confirm that economic growth prevents societal collapse. Therefore, many authors argue that economic growth is not compatible with sustainability (Jackson 2010, Heinberg 2011, Kenis and Lievens 2012).

Is the combination of economic growth and 'strong' sustainability really impossible? Until now, economic growth, as it is nowadays understood and institutionalised, did in any case not show the opposite. John McMurtry (2013) explains the inner logic that prevents industrial knowledge economies to consider a-growth as a normative anchor point for the economic dimension of sustainable development. He points to the present financial system as the ultimate seat of system rule: '*The core of the financial-rule mechanism is that over 95% of money and credit is issued by private financial institutions through individual and public debt contracts which are backed by 0-7% fractional currency reserves whose final guarantor is government and the public purse itself*'. A financial system based on debt forces enterprises to grow (in economic terms) in order to pay off their debts. Technological innovation is a dominant strategy to grow, supported by public authorities. Technological innovation allows entrepreneurs, indeed, to increase 'productivity'—that is, to make ever more expensive marketable products—and to reduce 'costs', for instance via replacement of 'expensive' human labour and via externalisation of environmental and social costs. This creates a vicious cycle. Public authorities invite big, small and medium enterprises continuously to innovate technologically, hoping that this will help to increase the economic 'pie', employment, and state revenue. Enterprises, in their turn, continuously call upon public authorities to commit larger budgets for (mainly natural-scientific and technological) research. For this, enterprises receive the support of both public and private research organisations as '*science itself is subjugated by the macro financial mechanism*' (McMurtry 2013).

A systematic replacement of natural capital by technology is—as Herman Daly has been arguing for a long time—ecologically inefficient: the more technology one introduces as a replacement of natural capital (the substitution concept), the more natural capital one needs to realise this substitution. To conclude, enterprises, public authorities and research performing organisations keep each other in a catch-22 situation, based on the justification that scientific and technological innovation and considerable public funding of new and emerging science and technology are necessary to maintain economic growth and national welfare (Rommetveit et al. 2013). At the end, both industry, government, the science community and the wider public find themselves in the same financial straightjacket, which does not take account of the state of our common (ecological and social) life-supporting means.

Main conclusions for CORRI
1. Western knowledge economies '**externalise**' many problems, of which pollution and resource depletion, poverty and the distribution of costs and benefits (in broad terms) of economic growth are the most pressing ones. However, these problems are **'internalised' as 'grand challenges'** requiring evolutionary adaptations to the prevailing economic systems, and not as real challenges questioning the sustainability of the Western economic growth model in itself. 2. The dominant discourse defines **economic growth as an intermediate purpose of R&I systems**, i.e. a means to realise sustainability and social inclusion. In turn, R&I systems are **focussed on technological innovation** as a means to maintain and strengthen Europe's economic competitiveness in a globalizing context. 3. This **dominant discourse** is however based on a. Unfounded beliefs about the neutrality and universality of scientific research; b. Unfounded beliefs about the role of science and technology; c. Unfounded beliefs about economic growth as necessary to avoid societal collapse.

2 A review of the responsible research and innovation literature and a selection of RRI projects in order to contribute to the concept of CORRI

2.1 Scope and methodology

'Responsible innovation' (RI) and 'responsible research and innovation' (RRI) have become discourse creating terms. The number of publications that explicitly use this term either in their title, abstract or among their keywords is rapidly increasing. The launch of the 'Journal of Responsible Innovation' gave an additional impetus to this process. On the top of this, the RRI discourse heavily builds on former achievements and is formed in parallel with other streams of literature (e.g. STS, post-normal science, citizen science, deliberative democracy etc.). Therefore the aim to provide an in-depth analysis of the whole RRI literature would be way too ambitious. Our endeavour is **to depict the borders and assumptions of this discourse and to focus on specific aspects** that are important in order to conceptualize on CORRI.

The review process was carried out alongside a template (see Appendix 1) that was designed to meet the abovementioned ambition. We used the template to serve as a guideline for reducing and restructuring the reviewed texts to parts that are relevant for our purpose. Then these restructured texts served as basis for our qualitative analysis. Therefore, our method can be characterized as qualitative content analysis (Titscher et al. 2000).

- The first section of the template asked how RRI is defined, and what makes RRI responsible. We searched how RRI was defined in the reviewed documents and whether specific are mentioned (or steps to be performed) that would make research and innovation responsible.
- The second section attempted to clarify key concepts that are crucial for conceptualizing CORRI, such as: participation, collective action and transformation.
- The third section asked whether the documents mentioned practices that are either precedents of RRI or can be regarded as being responsible for some reason.

- The fourth section served as a guideline for the review of the practical examples and cases analysed (or referred to) by the reviewed RRI projects. We decided to use the aspects stressed by the European Commission as guiding principles for conducting research and innovation in a responsible way: engagement, gender equality, ethical considerations, open science and science education (EC 2012). The review along these parameters served to reflect on the adequacy of these aspects when turning towards the practice of RRI; and also on the transformative potential of the RRI concept (by analysing whether the dominant assumptions are challenged or not alongside the given aspects).

2.1.1 Review of papers in scholarly journals

The findings of the literature review are based on a systematic mapping of the RRI discourse appearing in scholarly journals. The **sampling** occurred as follows:

1. We compiled a list of publications available at October 2015, which included the terms 'responsible innovation' (RI) or 'responsible research and innovation' (RRI) in their title or among their keywords or in their abstract. This database consisted of 205 items: 5 books, 50 chapters and 150 papers in scholarly journals.
2. We decided to limit the reviewed literature to those papers that appeared in scholarly journals and that contained the terms RI or RRI in their title. This limited the number of publications to 59.

The advantage of this sampling method is that it provided a clear guideline to include or exclude a paper. This also limited the number of reviewed publications to a feasible amount. On the other hand this seriously limited the scope of the review. Many important contributions of the RRI literature appeared as books or chapters (e.g. Guston 2004, 2006; von Schomberg 2011a; 2011 b; 2013; Owen et al.. 2013; van den Hoven et al. 2014; Koops et al. 2015; Stilgoe 2015).

The advantages of the applied sampling method:

- provides a clear guideline to exclude or include a publication;
- limits the number of reviewed paper to a feasible amount;
- the high probability that the intention of the reviewed paper is to contribute to the RRI discourse, since they chose to use this term in the title;
- the reviewed papers are peer reviewed;
- we believe, that the sum of the papers appearing in scholarly journals with the term RI or RRI in their title provide a meaningful overview of the scientific aspect of the RRI discourse.

The **disadvantages** of the applied sampling method:

- many works that made important contribution to the RRI discourse are probably excluded from the analysis;
- the review may be able to provide a picture of the borders and basic assumptions of the RRI discourse, but it will not be able to provide a comprehensive picture of the content;
- the picture this review provides is limited to the scientific aspect of the RRI discourse (while RRI is also a discourse creating term in the political arena).

Therefore, this review is not comprehensive, it does not embrace all the academic publications that are relevant for the concept of RRI. But we believe, it will be able to provide a reliable picture on the borders and basic assumptions of the RRI discourse. Supplemented by the review of the accomplished and ongoing

projects (in the thematic field of RRI under the frameworks FP7 and H2020) and the expert interviews conducted within the FoTRRIS project, it will let us to take stock and look ahead for the concept of CORRI.

All together 59 papers were reviewed. All of them are peer reviewed academic journals either from the fields of social sciences, natural sciences, life sciences or design and engineering. In line with the rapid growth of the RRI literature, most of the reviewed papers were published in 2014 and 2015. 22 papers out of the 59 appeared in the Journal of Responsible Innovation. A full list of the reviewed papers is provided by Appendix 2.

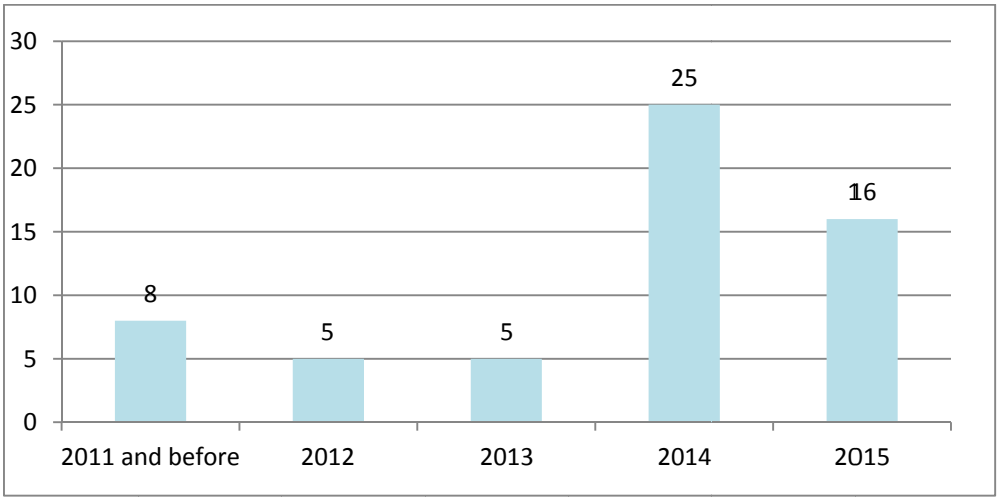


Figure 2: Number of the reviewed papers by the year of publication

2.1.2 Review of relevant projects

In addition to articles in scholarly journals, a review of potentially relevant accomplished and ongoing projects within this thematic field that were/are funded by the Euriopean Union's FP7 and H2020 programmes was carried out. The exploration included also a secondary review of case studies that have been investigated by these other EC funded projects.

The review process started from the compilation of 27 potentially relevant RRI projects (see Appendix 3), which were explored by means of key word search in documents available online, mainly project reports. In the next step those projects were prioritised, which explicitly address collective aspects as an important dimension of RRI. Finally 9 RRI projects were reviewed alongside the same template (see Appendix 1) as used for the review of the papers.

2.1.3 Review of RRI case studies and examples

During the review of scholarly papers and RRI projects, we devoted special attention to case studies, examples, or relatively detailed introductions of RRI practices, which were introduced by the reviewed papers and projects. The review was not comprehensive, but it provides an overview on examples how RRI might be implemented. Projects that explored how RRI may be implemented in practice presented considerably more cases than we included in our review. The selection from cases explored by previous project was limited to those case studies, which implied collaborative or participatory activities by means of engaging actors beyond the research community. For the analysis of the case studies we used the aspects stressed as guiding principles for conducting research and innovation in a responsible way by the European Union (EC 2012): engagement, gender equality, ethical considerations, open science and science education.

Full lists of the reviewed projects, case studies and related documents are provided by Appendix 4 and Appendix 5.

2.2 The concept of responsible research and innovation (RRI)

Present section provides an overview of what RRI is and what makes RRI responsible. What is the basis of considering R&I to be responsible? First we highlight the most cited definitions and the key terms used when defining RRI. Then we analyse what makes R&I responsible: what are the key features mentioned by the literature.

2.2.1 What is RRI?

The concept of RRI exists in two partially overlapping, but still very different **contexts**. Talking about RRI in the **scientific literature** is not necessarily the same as talking about RRI in the **policy arena**. Certainly these two terrains overlap and mutually shape each other to a given extent, but the difference may remain genuine.

The **scientific discourse** that led to the emergence of RRI is very complex and has been going on for decades. Very important elements frequently mentioned by the literature that directly shapes the concept of RRI are:

- the arguments of the Science and Technology Studies (STS) literature (e.g. Latour 2004; Callon et al. 2011);
- the post-normal understanding of science (e.g. Funtowitz and Ravetz 1993);
- extensive research done in the fields of risk and uncertainty, technology assessment and foresight.

And there are also lots of concepts and fields of interest that indirectly shaped the emergence of the RRI discourse; among others:

- sustainability research and in particular the understanding of the link between technological change and sustainability (e.g. Beck 1992, Latour 2004);
- literature on the ethics of technology;
- literature on practices and principles of social deliberation.

Therefore RRI is often considered to be a flexible umbrella term in the literature (e.g. Rip and Voss 2013; Li et al. 2015). It is a synonym of responsible innovation (RI). The reviewed papers almost always emphasized that RI is called RRI in the European policy context. The literature also refers to a number of concepts, which are either similar to, or precedents of RRI, such as: responsible development, anticipatory governance, risk analysis, technology analysis.

The emergence of the RRI concept in the political arena is well documented by the literature (e.g. Owen et al. 2012, Oudheusden 2014, de Saille 2015). The debates in the political arena have often touched upon similar issues than the scientific papers (e.g. stakeholder participation, steering values, desirable outcome). However, talking about RRI has not really changed the mainstream discourses, and thus RRI emerged in a context, which is quite incoherent. In the policy arena it is quite common to talk simultaneously about responsible research and innovation and smart and inclusive growth, the solution to the current economic crisis, etc.).

We could witness the depreciation of a number of former concepts, such as green, sustainable, etc. Many of the authors also report this process with regard to the term 'responsible' in the case of corporate social responsibility, and emphasize the instrumental motivations lying behind the use of these terms. Therefore we should really listen to two of these warnings appearing in the heart of the RRI literature:

- Owen et al. (2012: 753) warn that 'RRI [may be] narrowly, and instrumentally, motivated to support the delivery of a pre-committed policy, with economic growth as its main priority'.
- Stilgoe et al. (2013: 1577) emphasize that „the ease with which 'responsible (research and) innovation' can be inserted into policy documents should remind us of the risks of instrumentalising the phrase'.

The **definition of RRI proposed by von Schomberg** is doubtless the most cited definition in the literature. While it has appeared in a number of policy documents since 2010, it is also overwhelmingly present in the scientific discourse. However some authors emphasize that this is not a broad enough definition and very much rooted in the European thinking (Stilgoe et al. 2013).

> *'Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become 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).'* (Schomberg 2013: 63)

Stilgoe et al. (2013) also called for a broader definition that may be able to reflect the diversity of the RI and RRI literature more adequately. They emphasized that von Schomberg's definition 'is anchored to European policy processes and values'. So they suggested the following definition:

> *'Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present.'* (Stilgoe et al. 2013: 1570)

This is undoubtedly a much broader definition, and has several merits. Instead of demarcating societal actors and innovators, it talks about collective stewardship; and it is not stuck to a given ethical (and political) contexts. On the other hand it necessarily remains vague and unable to provide clear guidance for decision-making. Since its content has to be clarified and adapted to the given context, it leaves room for a very broad range of interpretations, and does not escape the threat of utilizing it for instrumental motivations.

Stahl (2013) draws attention that these definitions fail to emphasise to a sufficient degree that RRI is constituted by numerous activities, actors and foundations that in most cases predate the term considerably. He emphasizes that RRI consists of actors, norms and activities. On this basis he suggest the following definition:

> *'RRI is a higher-level responsibility or meta-responsibility that aims to shape, maintain, develop, coordinate and align existing and novel research and innovation-related processes, actors and responsibilities with a view to ensuring desirable and acceptable research outcomes.'* (Stahl 2013: 5)

This leads us to the main concern regarding the definitions of RRI. The above definitions together with the numerous further attempts to define RRI, depict a set of **key (defining) features of RRI**:

1. With regard to the ***outcome***: socially desirable (contributes to the overall good, conducted in the public interest, acceptable);
2. With regard to the ***process:***
    a. it is an interactive process where actors are mutually responsive;

b. transparency and accountability are vital.

If we look at these key (defining) features of RRI is becomes apparent that it leaves room for a broad range of interpretations and necessitates further clarification:

- It does not clearly declare its normative basis. The term socially desirable is vague. The possible meanings attached to it may even contradict (e.g. a utilitarian interpretation versus Sen's capability approach).
- While all the authors agree that RRI is an interactive process, it is not clarified what kind of contribution is expected from (or allowed to) the different groups of stakeholders. E.g. who shapes what is considered to be socially desirable (or acceptable), who sets the framework for the interactions, etc.
- Accountability for the (technological) decisions seems to be a clear expectation. But doesn't this imply the demarcation of decision makers from other stakeholders? If stakeholders are furnished with real decision-making power, are they willing to become accountable? Or if they are not given such a power, will it be a real participation?

So we argue that it is the details that are really important. The key question is probably how these terms are interpreted by different stakeholders, how they are put into practice. As Meyer (2015: 3) formulated: *'the question is perhaps not so much what responsible innovation is, but rather what is does and how it travels'*.

2.2.2 What makes RRI responsible?

The abovementioned features of RRI were identified as key defining features. But certainly, the literature goes well beyond them and provides a number of classifications, lists etc. that attempts to clarify responsibility.

Table 1: Main features of (R)RI mentioned by the reviewed papers

Authors	Main features identified
EC (2012), de Saille (2015)	inclusive engagement, commitment to gender equality, more science education, ethics defined as shared values reflecting fundamental rights, open access to data & developing new models of governance
Owen et al. (2012)	Democratizing the governance of intent (instead of what we do not want science and innovation to do → what we do want it to do), institutionalizing responsiveness (the institutionalized coupling of anticipation, reflection and inclusive deliberation to policy and decision-making processes) & reframing responsibility (values and not rules-based)
Stilgoe et al. (2013), Macnaghten et al. (2014), Zwart et al. (2014), Asveld et al. (2015), Landeweerd et al. (2015),	Anticipation (to ask 'what if' early enough), reflexivity (holding a mirror up to one's own activities, commitments and assumptions, being aware of the limits of knowledge), inclusion (there should also be room to question the framing assumptions of the participation processes themselves) & responsiveness (a capacity to change shape or direction in response to stakeholder and public values and changing circumstances)
Owen (2014)	Anticipation, reflexion, deliberation & responsiveness

	Reports in the paper that the UK Engineering and Physical Sciences Research Council (ESPRC) anticipate, reflect, engage and act (consistent with the above dimensions)
Wickson – Carew (2014)	Seven paired criteria: Socially relevant & Solution oriented: what types of problem are addressed (grand challenges vs. personal interests); and what kind of solutions are provided (wicked solutions vs. solutions that create new problems) Sustainability centred & Future scanning: considering social, economic and environmental sustainability; and anticipating potential futures, risks and benefits Diverse & Deliberative: refers to cross-disciplinarity; and mode of stakeholder involvement Reflexive & Responsive: clear identification of limitations, seeking feedbacks; ability to change after internal reflections and external feedbacks Rigorous & Robust: repeatability and reliability Creative & Elegant: novel problem framing or problem framing inside well defined paradigm; esthetical preconditions and use of resources Honest & Accountable: transparent identification and open communication of uncertainties and limitations; provide open access and acceptance of accountability for negative and positive impacts
Li et al. (2015)	Social alignment, responsiveness, anticipation & collective responsibility (inter- and trans-disciplinarity & institutional reflexivity)
Deblonde (2015)	Locally situated, transdisciplinary, action research & the normative anchor points are: strong sustainability, equality and a-growth) 'the concept of 'responsible research and innovation' is translated into the concept of 'glocal sustainability research', which takes the form of locally situated, transdiciplinary action research'
Armstrong et al. (2012)	Feature in case of finance: 1. Focus on function, 2. Focus on moral rules, 3. Focus on internalized values, 4. Focus on aggregate consequences, 5. Focus on accountability, 6. Focus on precaution & 7. Focus on democracy
Wender et al. (2014)	In case of anticipatory life-cycle analysis: Iterative & reflexive
Gardner – Williams (2015)	Healthcare related features: Clearly identified need, generating robust evidence, continuous reflexive evaluation & coordinated interdisciplinary action

As the Table 1 above shows there are certain very common features attached to responsible research and innovation. The dimensions proposed by Owen et al. (2012) and Stilgoe et al. (2013) gained significant attention in the literature and seem to be the basis of a consensus in this field:

- anticipation,
- reflexivity,
- inclusion and
- responsiveness.

The authors clearly stated that these are broad categories and attempted to clarify them in their paper. They formulated very strong requirements in this respect (see in the table). While the use of these categories has become common in the literature, the exact content and the questions and dilemmas raised by the authors are not really reflected by the literature, e.g. (Owen et al. 2012; Stilgoe et al. 2013):

- In case of inclusion there should be room to question not just certain policy issues but also the framing assumptions of the participation processes themselves;
- Reflexivity also means second-order reflexivity;
- The lack of anticipation may not just be a product of reductionism and disciplinary siloes. It may, at least in part, be intentional as scientists seek to defend their autonomy;
- Is it normative, substantive or instrumental motivations that drive RRI?
- Can innovation be responsible at all if it's not transformative?

Owen et al. (2012) draws attention that the features identified above are not necessarily new. It is the **institutionalised coupling of such integrated processes** of anticipation, reflection and inclusive deliberation to policy- and decision-making processes—i.e. the dimension of responsiveness—that is an important, contribution that RRI makes. (ibid: 755) And the reframing of *'responsibility in the context of innovation as a collective […], focusing attention on dimensions of responsibility such as care and responsiveness which are values- and not rules-based […] It is perhaps in this regard that research around the concept of RRI might make a truly novel contribution to intellectual thought.'* (ibid: 756)

It is obvious on the basis of the literature that RRI is a normative concept. Since it is proposed in a pluralist context there is a quest for some kind of **normative anchor points** to serve as a basis for the clarification of responsibility. There are genuinely different proposals in this respect:

1. The proposal of von Schomberg is highly cited in the literature. He suggest that we should build on the **Treaties of the European Union,** and denominated five anchor points: (1) promotion of scientific and technological advance, (2) promotion of social justice, equality of women and men, solidarity and fundamental rights, (3) quality of life, high level of protection, human health and environment, (4) sustainable development and (5) competitive social market economy.
2. Stahl (2013) highlights other possibilities for normative anchor points: (1) **Human rights** (appearing in the documents of the UN) and (2) the **millennia-old discourse on philosophical ethics**, which includes well established positions such as **virtue ethics, deontology or theology, feminist ethics, the capability approach.**
3. A further possibility is proposed by Deblonde (2015). She suggest (1) **strong sustainability** (2) **equality** and (3) **a-growth** as normative anchor points.

The problems with the list of von Schomberg are manifold: (a) it cannot be used outside (Western) Europe, (b) some of its elements are vague and open for very different interpretations (e.g. sustainable development, solidarity, social justice, technological advance). (c) But the main problem is probably that

some of its element may contradict each other. The very problem is that in some cases these categories may be incompatible (e.g. technological advance in its present form and social justice or sustainability; market economy in its present form with many other categories, etc.)

So it seems, that in this respect, the RRI discourse cannot do anything else but to participate the *'millennia-old discourse on philosophical ethics'* (Stahl 2013). This is also true in case of the categories used by Deblonde (2015) – e.g. equality of what? Furthermore the tensions between these three categories must be handled as well (e.g. what link is suggested between a-growth and equality).

Therefore what RRI turns out to be in practice, very much depends on the collective effort made to translate the above terms and features.

Main conclusions for CORRI

4. RRI is inherently collective since it inevitably faces value choices. However this is approached in a quite controversial way in the literature:
    - The RRI positions itself as a call for 'becoming ethical'. But actually the R&I process is always based on some kinds of ethical considerations. ***In fact RRI calls for a different ethical basis***.
    - When RRI seeks for its normative foundations it either uses very broad and blurred categories (that leave room for various interpretations – potentially also those contradicting with the 'spirit' of RRI), or use categories that are rooted in a specific (mainly Western European) context.
    - However there are underlying assumptions that build up the RRI discourse, e.g. post-normal understanding of science, the belief in the benevolence and necessity of stakeholder participation, sustainability as a value, etc.
5. Since its normative foundations are not clear-cut, the concepts of RRI leave room for various interpretations.
    - On the one hand this may be benevolent, since it allows the concepts to be (locally) adapted to the specific contexts.
    - On the other hand this brings about the risk of depreciating the term 'responsible', and open the way for practices that fit well into the present structures, remain unsustainable and unjust, but are also called RRI.
6. The RRI literature does not do too much about elaborating on the tensions between its main categories.
    - What is socially desirable, and for whom?
    - Equality of what?
    - What if something is socially acceptable (or desirable), but unsustainable?
7. There is a clear and well-documented difference between the scientific and the policy discourse about RRI.

2.3 Relevant practices

We analysed whether the reviewed papers refer to policy, research or innovation practices, which are precedents of (R)RI or considered to be responsible (or perhaps a building block of RRI). We found that RRI has a lot to build on, however, none of the authors argued that any existing practices may fulfil all the requirements of RRI. Some of the authors are critical about the mentioned approaches and emphasize that these are not the best way to implement RRI (e.g. Kiran 2012), while others suggest that it's the concrete implementation that matters with this respect (these can all be ill-implemented). As Stilgoe et al. (2013: 1577) warn us: *'ongoing experiments […] should not be taken as evidence of implementation'*.

Several fields of inquiry are mentioned as precedents or building blocks of responsible R&I approaches, such as (Oudheusden 2014; Deblonde, 2015):

- risk and uncertainty research;
- foresight studies;
- future studies;
- post-normal science;
- inter- and transdisciplinary research;

Table 2: Research and design methods mentioned by the reviewed papers

Approaches	Mentioned by e.g.
Different forms of technology assessment (participatory, constructive, interactive, discursive, real-time)	Owen – Goldberg (2010); Owen et al. 2012; Stilgoe et al. 2013; de Bakker et al. 2014; Grunwald, A. (2014); Nordmann 2014; Oudheusden 2014; Stahl et al. 2014b; Taebi et al. 2014; Zwart et al. 2014; Asveld et al. 2015; Deblonde 2015; Landeweerd et al.. 2015; Li et al. 2015;
Values sensitive design	Stilgoe et al. 2013; Taebi et al. 2014; Li et al. 2015;
Participatory design, socially responsible design	Kiran 2012;
Qualitative risk analysis	Owen – Goldberg 2010;
Better foresight, technology foresight, future-based scenarios	Owen – Goldberg 2010; Selin – Boradkar 2010; Oudheusden 2014; Asante et al. 2014; de Saille 2015
Systems analysis	Oudheusden 2014; Deblonde 2015
Midstream modulation	Owen – Goldberg 2010; Oudheusden 2014;
Use-inspired basic research	Pandza – Ellwood 2013

Table 3: Governance & regulation approaches mentioned by the reviewed papers

Approaches	Mentioned by e.g.
Anticipatory governance	Owen – Goldberg 2010; Owen et al. 2012; Stilgoe et al.

	2013;
Ethics advisory bodies, ethics review	Mali et al. 2012, Zwart et al. 2014
Ethical, legal and social assessment	Asveld et al. 2015;
(Adequate) regulation	Hemphill 2014
Civil-based and self-regulation	D'Silva et al. 2012
Priority-setting in research funding	Grunwald 2011

Stilgoe et al. (2013) listed a number of indicative techniques alongside the dimensions of RRI. Many of these are techniques of deliberative participation, which are often used (or stem from) other fields of policy-making.

Table 4: A list of indicative techniques alongside the four dimensions of RRI

(Source: Stilgoe et al. 2013:1573)

Dimension	Indicative techniques and approaches	Factors affecting implementation
Anticipation	Foresight Technology assessment Horizon scanning Scenarios Vision assessment Socio-literary techniques	Engaging with existing imaginaries Participation rather than prediction Plausibility Investment in scenario-building Scientific autonomy and reluctance to anticipate
Reflexivity	Multidisciplinary collaboration and training Embedded social scientists and ethicists in laboratories Ethical technology assessment Codes of conduct Moratoriums	Rethinking moral division of labour Enlarging or redefining role responsibilities Reflexive capacity among scientists and within institutions Connections made between research practice and governance
Inclusion	Consensus conferences Citizens' juries and panels Focus groups Science shops Deliberative mapping Deliberative polling Lay membership of expert bodies User-centred design Open innovation	Questionable legitimacy of deliberative exercises Need for clarity about, purposes of and motivation for dialogue Deliberation on framing assumptions Ability to consider power imbalances Ability to interrogate the social and ethical stakes associated with new science and technology Quality of dialogue as a learning exercise
Responsiveness	Constitution of grand challenges and thematic research programmes Regulation Standards Open access and other mechanisms of transparency Niche management[a] Value-sensitive design Moratoriums Stage-gates[b] Alternative intellectual property regimes	Strategic policies and technology 'roadmaps' Science-policy culture Institutional structure Prevailing policy discourses Institutional cultures Institutional leadership Openness and transparency Intellectual property regimes Technological standards

Owen et al. (2009: 6902-03) explicitly argued (and this argument was reflected by other papers as well) that innovation and **regulation** is playing catch up. Thus, 'there is a fundamental problem with relying solely on regulatory instruments: the often very considerable time delay between innovation, the products that result from it, and the subsequent case for amendment or development of regulation(s). One major reason for this time lag is the need for evidence; evidence that demonstrates that the products of an innovation are unsafe, or have undesirable social, health, or environmental impacts.' So there is well-recognized need to drive responsibility 'upstream' in the innovation process.

The reviewed literature mentions several techniques of stakeholder (public) participation in technological decision-making. Some of these provide lighter forms of participation (e.g. informing, or simply articulating values and interest), while others allow public deliberation.

Landeweerd et al.. (2015) mentioned that *„over the course of the past 30 years, different mechanisms have been put to practice in different regions and countries to reach a higher level of public participation. These include citizen juries, citizen panels, consensus conferences, planning cells, deliberative polling, focus groups, consensus building exercises, surveys, public hearings, open houses, citizen advisory committees, community planning, and referenda. This multitude of approaches, strategies and formats is applied in different settings, with different justifications and purposes.'*

Some of these techniques with some additions (e.g. citizen panels, consultative panels, deliberative polling, consensus conference, citizen jury, focus groups) are quite frequently mentioned by the reviewed papers (e.g. Grunwald 2011, Stilgoe et al. 2013; Nordmann 2014; Asveld et al. 2015; de Saille 2015; Li et al. 2015).

The techniques of deliberative participation are sometimes explicitly linked to the concept of **hybrid forum** put forth by Latour (1993) and Callon et al. (2011) (in the fields of Science and Technology Studies).

Some of the authors proposed new approaches that attempt to combine the advantages of existing practices and to overcome their shortcomings at the same time; e.g.:

- Owen et al. (2009: 6903) proposed that horizon scanning 'can be extremely powerful if it is (a) done continuously, (b) 'framed' socially […], and (c) coupled to risk assessment and risk management, supporting the timely deployment of resources and interventions.
- Wender et al. (2014: 203) argued that life-cycle analysis (LCA) ineffectively promotes RRI for at least two reasons: (1) Codified approaches to LCA are largely retrospective, relying heavily on data collected from mature industries with existing supply chains and (2) LCA underemphasizes the importance of stakeholder engagement to inform critical modelling decisions. On this basis they propose anticipatory life-cycle analysis, as a forward-looking, non-predictive tool that increases model uncertainty through inclusion of prospective modelling tools and multiple social perspectives. Anticipatory LCA may generate many models all with a high degree of uncertainty in order to explore a broad spectrum of possible futures (as opposed to a selected few, most likely) to build capacity to prepare for many potential outcomes (from retrospective to prospective) integrating social values.
- Deblonde (2015: 13.) proposed a type of knowledge arena – and some institutional preconditions for its institutionalisation – as a breeding ground for RRI. These knowledge arenas should act on the junction between the science community, policy, industry, and civil society. Their mandate is: (1) to start up dialogues between persons, groups, organisations that engage themselves for specific glocal sustainability challenges, (2) to support the co-definition of action-research projects, (3) to support the composition of transdiciplinary project teams, (4) to make ongoing research activities and results publicly accessible, (5) to document and archive project activities and results in order to make them accessible for further RRI activities.

It was quite spectacular during the review of the papers that the term **social innovation** never appeared. It seems that while these two discourses have a lot in common, they develop quite distinctly. Another (or supplementary) explanation for this may be that:

- we found that the literature of RRI mainly focuses on research practices and innovation practices that are closely connected to (state-of-the-art) research,
- while social innovation research focuses on approaches that are often informal and emerge outside the formal R&I system.

Nevertheless certain papers mention practices that are close to the social innovation discourse, and the authors think that they are also relevant for the RRI concept, e.g.:

- Buen Vivir movement (mentioned by Macnaghten et al. 2014);
- Crowd-sourcing (mentioned by Hemphill 2014);
- Inclusive, grassroots & empathetic innovation (mentioned by Macnaghten 2014; Li et al. 2015).

Main conclusions for CORRI

1. The review of the literature clearly demonstrates that
    - the participation of stakeholders plays an important role in RRI;
    - but, the mentioned practices represent very diverse ways and depth with regard to participation (so the expected role of stakeholders is not clarified).
2. The review of the papers suggests that RRI is in many respects a top-down approach oriented towards researchers and policy-makers (so it is not the discourse of the stakeholders or citizens). When it comes to practice:
    - the question is how a closed group of actors should invite further actors into the process;
    - activities outside the formal institutions of R&I are hardly mentioned (e.g. social innovation).
3. Participation is very much oriented towards negotiating values (and maybe interests), but not towards actually making the decisions. It also remains unclear how to apply accountability to stakeholders.

2.4 RRI as a collective action

The collective aspect of RRI is unquestionably present is the literature. However this does not mean that dealing with the collective aspect is evident either theoretically or in practice. For example, Keeler and Foley (2015: 83) argues that *'bioethical inquiry and techno-ethical scenarios comprise a significant portion of the scientific dialogue on the future implications of health innovation, while socio-technical **systems** including physical infrastructures, demographics, as well as the politics and power therein are infrequently referenced.'*

The literature takes Ulrich Beck's concept of **'organized irresponsibility'** as a starting point, when talking about the collective aspect of RRI:

- Stilgoe et al. (2013: 1569): highlights that '[…] scientists, research funders, innovators and others have a collective political responsibility or **co-responsibility**: [...] while actors may not individually be irresponsible people, it is the often complex and coupled systems of science and innovation that create what Ulrich Beck (2000) calls organised irresponsibility'.
- De Bakker et al. (2014) (citing Owen et al. 2013): 'Instead of individual responsibility we should think in terms of a **collective responsibility:** that allows the constructive and democratic stewardship of science and innovation in the face of uncertainty towards futures we agree are both acceptable and desirable'.
- Owen, R. (2014) referring to the statement of the EPSRC (Engineering and Physical Sciences Research Council) of the UK highlights that [RRI] 'is a **collective responsibility**, where funders,

researchers, stakeholders and the public all have an important role to play' and 'which goes beyond considerations of risk and regulation, important thought these are.'

Referring to the **arguments of STS** (science and technology studies) is also quite common:

- Armstrong et al.. (2012): 'The notion of hybrid forum refers to assemblies of informed, concerned parties that assume **collective responsibility** for one particular issue through their involvement in decision making, especially in situations where the consequences of action are highly uncertain (Callon et al.., 2001; Callon, 2007).'
- Stilgoe et al. (2013): *'Research in Science and Technology Studies (STS) suggests that conceptions of responsibility should build on the understanding that science and technology are not only technically but also socially and politically constituted (e.g. Winner, 1977).'*

Therefore RRI is the business of a number of stakeholders. We sorted the arguments emerging in the review papers into three categories:

1. Who are the actors, and what are their roles?
2. How should participation look like?
3. What are the limits of taking collective responsibility?

2.4.1 Actors and their roles

The **rationale** for inviting a wide range of stakeholders (including citizens) into the process is that *'governments cannot democratically control important scientific decisions and actions that directly bear on society, and the status of scientific knowledge is very much in question'* (Oudheusden 2014 citing Beck 1993).

In many cases the reviewed papers remained very general about the actors and their roles. It is explicitly stated that broad consultations involving as many relevant stakeholders as possible, in ways that enhance inclusiveness, transparency, and deliberation are needed. But in many cases this is not further specified. For example, Stahl (2013) states that research and innovation need to be beneficial to all stakeholders, who should thus be involved in all aspects of RRI. This includes early (upstream) engagement as well as midstream and downstream activities (Fisher et al.. 2006). This aspect can draw on a large array of possible activities (Rowe and Frewer 2005). It is at this point that deliberative democracy finds its linkage to RRI (Von Schomberg 2012).'

In most of the cases the reviewed papers deal with the **actors who are normally involved in the research and innovation process** (and ask e.g. how research should be carried out).

The responsibility of **funders** is frequently mentioned (e.g. Owen - Goldberg 2010, Stahl et al. 2014) . According to Owen (2014): 'The public rightly expect to be able to trust **funders** to ensure that scientists think about the potential impacts of their research and act responsibly'.

It is mainly the role of the **government** and the **researchers** to initiate public engagement. However, researchers are not necessarily ready for this. Landeweerd et al.. (2015) draws attention to the importance of empowerment in this respect.

But of course the **involvement of further stakeholders** is an issue that is also discussed. As Davis and Laas mentions: besides actors that are directly involved to the research and innovation process the participation of '**outsiders'** who are interested in the research some way is also important.

Several authors point out that **a number of decisions** in the research and innovation process **are normative**. For example: Wender et al. (2014) list the following normative decisions with regard to life-cycle analysis (LCA):

- system boundary definition (what activities are included),
- functional unit selection (what service the technology provides),
- impact category selection (what environmental impacts are considered), and
- weighting (to what extent impacts in one category matter relative to another)

However the participation of those who are normally not involved in the R&D process (in the reviewed literature mainly civil society organizations, very rarely the general public) is not just a mere political act. Several authors point out, that their **knowledge** is also vital (e.g. Grunwald 2011; Oudheusden 2014; Deblonde 2015), the knowledge and resources necessary to tackle grand challenges are scattered among a large set of stakeholders (Block 2014). Stakeholders are expected to act as the ***extended peer community*** (Funtowitz – Ravetz 1993) or to take part in ***hybrid forums*** (Callon et al. 2011).

Blok (2014) points out that public participation or stakeholder engagement is an important action in the innovation process:

> Firstly, because of the ***complexity of grand challenges*** and the uncertainty of the future impacts only stakeholders with different interests and values could understand better these problems.
> Secondly, via stakeholder engagement stakeholders could ***learn*** from each other which enables them to set common directions or goals.
> Thirdly, ***resources*** to handle grand challenges ***are scattered*** among different stakeholders.

Deblonde (2015), when describing the process architecture of RRI, mentions six activities where stakeholders have a role:

- co-creating a common problem definition together with various (local) stakeholders;
- describing both global and local causes and reasons for its coming into existence;
- co-envisioning;
- considering which types of scientific and practical knowledge and know-how are needed;
- co-designing and performing an experiment (i.e. action research), with the locally specific world as a real-life laboratory;
- monitoring the results of this experiment and adjust either the experiment, the envisioned future, or both when needed.

2.4.2 How should participation look like?

The literature is surprisingly scarce with this respect; just a few papers address the issue from a theoretical aspect. However, as we described in section 2.3, the reference to deliberative practices and techniques is frequent. On the top of this, the analysis of the case studies provide valuable additional information on how participation is practically understood.

Certainly the **principles** of RRI (inclusion, mutually responsive, transparent, etc.) and the techniques the literature refers to (consensus conference, constructive technology analysis, citizen jury, etc.) make it apparent that RRI call for a **real** (not just make-believe) **deliberative participation**. This is supplemented by some specific aspects in certain papers:

- 'Societal concerns and issues need to be addressed **right from the start'** (Meyer 2015);
- 'A **tick box approach would never work**, however attractive and easy it may be for some' (Owen 2014).

- Deblonde (2015) argues that RRI should take the form of locally situated, **transdiciplinary action research** (which also implies that researchers are **knowledge partners** instead of knowledge teachers).
- Blok (2014): During communication actors need to **focus on the grand challenges instead of expressing self-interests**, continuously search for common grounds and practice self-criticism to constitute a self that responsive to the other

However, these ideas do not necessarily turn into practice, or the attempts to put them into practice may not succeed. The **present practices may not suffice these ideal requirements**. For example, Mali et al.. (2012) highlight that ethical advisory boards (EABs) in Europe still function mainly as expert bodies rather than as hybrid forums.

Some of the papers suggest that different stakeholder groups may not have the same possibility to participate. Stahl et al. (2014) draw attention that the recognition of (social) problems is driven by **scientists/experts**, the solutions to these problems are elaborated by scientist/experts and the forecasting of future consequences is also done by scientist/experts. Although in this last step non-experts are also involved however they can just provide feedback mostly and are excluded from decision making. Wilsdon (2014) argued that **decision making is still controlled by politicians**.

As Oudheusden (2014) points out: '*RI proponents have little to nothing to say about the politics and power that play out in, and through, deliberative governance processes. How do actors 'co-create' outcomes? How do they deliberate? On whose terms is participation (i.e. deliberation) established, and why? What, in fact, is 'public' about the 'public interest', 'public expectations', and 'the public', and whose definition of the public counts?*'

So **very important questions remain mainly unaddressed**:

- How do the present practices perform from the angle of the principles of RRI?
- Does RRI expect participation that distributes power to stakeholders (e.g. to citizens), or is it convenient with symbolic involvement (tokenism as Arnstein (1969) would call it)? Who makes the decision at the end of the day?
- Does RRI call for a participation where the framework and the rules are set by the actors who are normally involved in the R&I process?
- Does RRI want to foster participation in claimed spaces?
- What is the judgement of RRI on the use of hidden or invisible power by certain actors?

2.4.3 The limits of collective actions

The abovementioned desideratum is identified by some of the authors, who urge asking questions in these fields. Stilgoe et al. (2013: 1572): *'There should be room therefore for public and stakeholder voices to question the framing assumptions not just of particular policy issues, but also of participation processes themselves.'*

When describing the key features of RRI we cited Owen et al. (2012), who argued that 'instead of what we do not want science and innovation to do' RRI should ask 'what we do want it to do'. But if we look at the discourse in the RRI literature about the collective aspect we see, that instead of what should be done, we find much more about what should not be done or what cannot be done. On the one hand, these critical arguments are very important in order to help avoiding ill-implemented efforts. On the other hand, the critics do not go beyond the general critiques of deliberative participation (and thus fall into the following trap):

- On the one hand it is true that the deliberative practices have a lot of shortcomings, and that possibilities of shaping decisions may not be the same for everyone, conflict may arise, and sometimes decisions have to be made anyway.
- On the other hand these characteristics are true for any kind of non-participative, non-deliberative decision making processes, so they are not arguments against participation and deliberation.

Several authors draw attention to the fact that it is not enough to simply call for deliberative participation (or stakeholder engagement). ***Proponents of RRI must face that there are conflicting values and interest, potentially valuable minority opinions, power biases and differences in skills for participation***:

- 'We are still left with the question of how responsibility is assigned and how deliberation is effectuated in practice, particularly in circumstances when interests, values**,** and stakes collide rather than align' (Oudheusden 2014).
- 'This […] does not imply that we can always **reconcile all these values**. In such situations, two scenarios are conceivable: (i) changing the design in such a way that it accommodates these conflicting values or (ii) making a value trade-off that decides which value should take priority in the design' (Taebi et al. 2014: 119).
- 'Even […] **minority viewpoints** can be valuable for policy-making, as they have more probative value than viewpoints on which there is substantial consensus.' 'It is unreasonable to brush aside the views of those objecting to a development as not reflecting the majority community opinion, since such a minority might represent those directly affected by the technology in question' (Taebi et al. 2014)
- 'We must also recognise **institutional and cultural resistance to anticipation**. [...] a lack of anticipation may not just be a product of reductionism and disciplinary siloes. It may, at least in part, be intentional as scientists seek to defend their autonomy' (Stilgoe et al. 2013: 1571).
- 'The problem is that RRI **assumes a willingness** of all stakeholders to share or communicate information, whereas in reality the most important stakeholder (industry) can be reluctant to do this because they dread the discussions taking a 'wrong direction'.' (de Bakker et al. 2014).
- 'With broader accountability of scientists there is an assumption that there will be **civil society actors willing and able** to call them into account'. But this may not be the case: 'civil society actors may not be able, or not be willing, to spend the necessary time and effort. This is already visible in so-called 'engagement fatigue'. (Rip 2014: 6).
- Only few experts understand complex technologies (Grunwald, A. 2011).
- RRI calls for accountability with regard to technological decisions. If stakeholders are truly involved are they willing to become accountable for the decisions?
- It seems that there is a **trade-off between transparency and inclusivity**; therefore 'closed' spaces for interaction and safe discussion arenas might be necessary to achieve more transparency (de Bakker et al. 2014).
- Groups with opposing interest are often handled separately in order to **ensure consensus** at the end of the process (Blok 2014).
- Zwart et al. (2014): innovation and industrial agendas in RRI **may silence critical voices** and outsiders

One the one hand (based on the presumptions coming from post-normal science and STS) it is clear, that R&I face challenges that cannot be overcome without public participation. On the other hand – as de Saille (2015) points out – participation in itself is not a solution. The abovementioned limits of participation should be clearly addressed.

1. First, it must be stated, that problems of deliberative participation (e.g. power and value conflicts, how consensus-seeking may silence minority voices, unwillingness and inability to participate) are not arguments in favour of non-participative decision-making, since the same problems arise there.

2. Second the problems of deliberative participation should be taken seriously and should serve as incentives for refining the process aspect of R&I decision making.

Main conclusions for CORRI
1. While the RRI literature clearly states the fundamental problem is systemic, the literature is very much oriented towards micro-level practices. 2. It remains unclear what are the exact expectations in connection with the role of stakeholders (and in particular citizens): • Does RRI want stakeholders to be able to shape the frameworks of participation? • What kind of space should be provided for stakeholders for participation? • What forms of power should they use (visible / hidden / invisible)? • To what extent should participation distribute power (is RRI convenient with symbolic participation)? 3. On this basis, it remains unclear, how do present practices perform in this respect. 4. The RRI literature does not provide guidance on how to deal with: • power conflict • value conflict • minority opinions • unwillingness to participate 5. The reviewed literature does not really address whether certain pre-conditions for participation apply or not: • willingness to participate • ability to participate • what is the role of empowerment (with regard to different stakeholders)

2.5 RRI in the making: a secondary analysis of case studies

While in section 2.3 we analysed all the illustrative examples, here we focus on cases that were devoted at least an independent sub-chapter in the papers, and a selection of cases that were explored by other RRI projects.

2.5.1 The cases

In sum 51 cases were reviewed (see list of reviewed cases in Appendix 5): in the reviewed scholarly papers all together 26 cases appeared that were devoted at least an individual sub-chapter, and 25 cases were selected that had been reviewed as RRI examples by previous projects. The most frequently addressed topics there were: nanotechnology (8), (environmental) sustainability (8), synthetic biology (6), information and communication technologies (5), health and wellbeing (5), and healthcare technologies (3). The remaining cases were related to geo-engineering, biotechnology, financial sector innovations, food safety, smart metering and immigration. Six cases did not deal with specific topics, but were generally devoted to engagement and participation in research and innovation. Although the examples covered a broad range of topics, the overwhelming majority of the cases related to high-tech fields.

On the top of this almost all of the cases were from high-income settings (mainly EU and USA), only four examples were located in the global south. Both of these facts are telling. RRI (at least at present) seems to be the discourse of high income countries. While the need to turn it into a global concept is often articulated, the analysis of the present practices suggests that this it rather an unfounded desire than the reality.

On the one hand several RRI cases refer to areas of research and innovation, which are characterised by a certain tradition of participatory and transdisciplinary approaches, such as in the field of sustainability or health care. On the other hand many cases stem from highly controversial technological fields (such as nanotechnology, synthetic biology or geo-engineering), which should make us cautious, and remind us to the warning of Stilgoe et al. (2013: 1577) about the 'risks of instrumentalising the phrase'. It may even urge us to formulate a **hypothesis** that: **the more the technological field is contested by citizens the more they tend to frame their activities as RRI**. However, the testing of this hypothesis would require further research.

2.5.2 The analysis of the cases

The analysis of the case studies was carried out along the aspects (engagement, gender equality, ethical considerations, open science and science education) stressed by the European Union (EC 2012), which are considered to serve as guiding principles for conducting research and innovation in a responsible way. The review let us to reflect on the adequacy of these aspects when turning towards the practice of RRI; and also on the transformative potential of the RRI concept by analysing whether the dominant assumptions are challenged or not alongside the given aspects.

The cases appearing in the reviewed papers were certainly not demonstrated alongside the dimensions we chose rely on in our analysis (engagement, gender equality, ethical considerations, open science and science education). Still, a relatively large set of information could be gained on them, however, the extent to which the given dimensions appeared were extremely unequal. Due to the choice of cases the dimension of 'engagement' was prominent in the analysed cases, while gender equality, open science or science education were less relevant. (see Appendix 4)

Due to the fact that we carried out a secondary analysis of these cases, the range of conclusions we can draw is limited. However, it seems to be quite clear that according to the information available in the reviewed documents, **present RRI practices have only limited potential to challenge the current structures and hierarchies**. On the basis of the analysed cases:

- What RRI ***mainly does*** is: contributing the existing practices by adding a little bit more in terms of thinking about the ethical aspects, about inclusion, transparency or gender issues.
- What RRI seems to be ***not*** doing is: to considerably criticize the existing hierarchies and mechanisms of oppression in the above fields (such as participation, gender, open science) and to deliberately challenge these dominating structures.

The analysed cases introduced a large set of information about participation, while much less were said about the other aspects of RRI. It is not inconceivable that the cases used aspects like 'gender equality', 'open science' or 'science education' as driving (horizontal) principles. But it seems to be quite unequivocal that the idea of transforming the status quo in these fields was not among the primary objectives of the analysed cases.

In our case study sample we only came across few cases, where the main focus was giving voice to those presently **voiceless** (or unheard). For instance the case of the San population in South Africa on genetic sampling for medical research (see Chennels 2015) represented a good example for the empowerment of marginalised groups, as well as for the acknowledgement of the value of traditional knowledge, and

stakeholders defining their own space within a participatory R&I activity. However, in the scholarly literature there was no case explicitly dedicated to giving a voice to voiceless. The authors simply stated that 'every voice has the same value' (Armstrong et al. 2012), or that 'the program was able to accommodate the interests of all participating stakeholders' (Voegtlin - Scherer 2015). However the formerly presented theoretical arguments and the knowledge accumulated with regard to participation, makes these statements problematic; and show the lack of reflexivity.

The issue of **open science** was explicitly approached by several case studies. One of them is a very interesting case about surgical innovations (Hodges - Angelos 2014) but not in the sense the European Commission refers to this aspect. The paper highlighted that the current structures prevent participants from divulging information about failed attempts, which results in the replication of the failures by others. In the further analysed cases the issue of how an idea is passed on (or not passed on) was not a central issue. We did not find clear statements that the way how the validity of knowledge is judged nowadays should be challenged either. **Science education** was somehow relevant in few of the analysed cases. An interesting example is represented by the case of DIY drug innovation in psychonaut subculture (Söderberg 2014), which strongly builds on informal peer education about risks related to psychedelic or hallucigenic drugs and knowledge co-creation through the engagement with medical facilities. Sustained efforts to systematise the information exchange within a larger community grew out of spontaneous interactions between drug users. The expert-lay dichotomy between drug producers and consumers seems to be blurred. However, apart from this example, we did not find any reference about the traditional educators-student relation being challenged. Although e.g. in the 'GEWISS – citizens create knowledge' case social actors are considered to become scientists through their interest and involvement in citizen science, which is acknowledged as a 'desirable addition to traditional science' (Kupper et al.. 2015), it remains unclear if this also aims at breaking down traditional knowledge hierarchies.

A little bit more was told about the **ethical considerations** lying behind the cases. However the arguments we introduced in section 2.2.2 about the ambiguity of the normative foundations of RRI were not really reflected by the cases. Many of the cases touched upon certain well-known ethical dilemmas like privacy or data protection (e.g. Gaskell et al. 2012, Frenken 2014, Stahl 2013), or draw attention to the presence of conventional aspects like 'client value', 'not letting down the customers with risky products' (Asante et al. 2014) or basic ethical principles in medical research (e.g. Savitch 2014, Kupper et al. 2015).

The analysed cases sometimes let us know that by whom the ethical basis of the demonstrated practice were laid down (mainly the experts and researchers initiating the process); but we could not gain any information on how this was exactly carried out, and what was the exact result. Therefore we can state, that the analysed cases contained very little reflection on the dilemmas of finding a normative basis for RRI:

- How to come up with this normative framework?
- What is exactly understood by the principle „to the benefit of all the stakeholders'?
- Should we choose to challenge the existing practices and attempt to bring about transformation?
- How to deal with tensions that may arise between the normative presumption (e.g. acceptable but unsustainable), or the values of different stakeholders?

Among the analysed aspects, most of the information referred to participation / engagement. We found that in most of the analysed cases experts had the leading role (e.g. Hodges – Angelos 2014; Brian 2015). The main features of the processes, the rules and scope of participation and also the ethical basis were laid down by them. This is not to say that the importance of citizen (lay) participation or stakeholders was not mentioned. The important role of citizens and stakeholders was mentioned by most of the cases, but their mandate was restricted:

- To participate in a pre-defined space (which is created by researchers, other experts and policy makers);
- to articulate and deliberate values and to seek for a consensus; and
- to contribute with their knowledge in order to arrive to a qualitatively better outcome.

In other words, usually stakeholders are invited to create knowledge, negotiate values and not to actually make decisions. A lot of telling examples underpin this, e.g.:

- Stemerding (2015: 141) argues that the focus is on „right impacts': 'what do we see as desirable goals in society and what might be the role of synthetic biology in attaining these goals?' In other words: synthetic biology in unquestionably there, the field of research and its underlying premises cannot be questioned.
- Gaskell et al. (2013: 19.) reported that: Those hesitating to participate in biobanks have lower trust in key actors and have greater concerns about data privacy and security. Such concerns will only be allayed by building trust and transparency and by engaging the public as partners in the biobank project. Connecting biobanks with society remains a considerable challenge that needs to be addressed with sensitivity…' Again, the technology is beyond being questioned. The suggested solution very much reminds of the traditional 'educator-student' relation (paternalism).
- Stilgoe et al. (2013: 1575) during the analysis of the SPICE project found, that: 'The responsible innovation framework had been separately funded and then embedded into the SPICE project once the latter was under-way'. 'The state-gate review was introduced after the project had been funded, with little scope for deliberation on the motivations for the research or whether the research should have been funded at all'.

However, we also came across other examples, such as the 'Knowledge for climate' project (Kupper et al.. 2015), which was based on a bottom-up, integrated multi-stakeholder participative approach in the context of a Dutch research funding programme. The aim was to ensure that long-term decision making would consider the impacts of climate change. Stakeholders were not only engaged in a thorough exploration of possible research themes, but also funding was (partly) determined by them. The 'Mistra Urban Futures' research programme in Sweden represents another interesting case in regard to opening up room for distributed process ownership and decision making: transdisciplinary projects with dual leadership (one researcher, one non-researcher) implied reflections of all participants on risks, benefits and existing beliefs in order to develop and modify the focus of the projects.

Still, it is relevant to refer to the general conclusion Stilgoe et al. (2013) provided: 'Ongoing experiments (including our own) should not be taken as evidence of implementation [of RRI]'. The dimensions of RRI are too often taken as granted by the analysed practices. This is very much problematic due to the fact that these principles give way for very different interpretations. In case we take them as granted we are very much likely to contribute to sustaining the status quo (which may be against the ideas of RRI). To try to make this argument clearer we would like to highlight two very interesting cases from the literature: 'NanoSoc' and 'Forum of Synthetic Biology'.

'NanoSoc'

Oudheusden (2014) introduced a case from the field of nanotechnology. 'NanoSoc', a Flemish technology assessment (TA) project was launched in 2006; but it was already based on an RRI definition. The author asks in the paper: 'where are the politics' in responsible research and innovation?

The author reports that 'it was simply assumed in the project that the involvement of more actors and issues would lead to better policy and enhance scientific quality'. But this way 'NanoSoc' became

vulnerable to strategic game playing and to various forms of 'noncommunicative' behaviour. 'As a consequence, participation […] undercut the deliberative process, which initiators sought to sustain'.

This example shows very clearly why it is naïve and also dangerous to take concepts such as participation or deliberation as granted. This clearly puts some into more advantageous position to the expense of others; and may undercut the objectives.

The case also highlighted another important aspect: stakeholders were invited to contribute to a qualitatively better scientific outcome. This is not a mandate for exercising democratic control over science. It was taken as granted the main intention of stakeholders was not the latter. However, such a presumption can easily prove to be false in reality.

'Forum of Synthetic Biology'

Meyer (2015) demonstrated a very interesting case in the field of synthetic biology. The so-called 'Forum of Synthetic Biology' was launched in 2013 in France. According to the organizers it was a 'space of open and pluralistic debate' in order to favour an 'enlightened and constructive discussion'. The first debate of this Forum took place in April 2013, but a group critical of technoscience and industry called 'Pièces et Main d'oeuvre' (PMO) interrupted the 'peaceful debate'. To block the debate, they used various methods: they showed posters (e.g. 'Participating is accepting'), revealed a banner ('No to synthetic life'), repeated slogans (e.g. 'false debate, we do not participate'), made noise, read a declaration, distributed pamphlets and told people to go home. PMO is an 'indivisible' actor who does not want to negotiate, nor discuss.

This extremely interesting case draws attention to the fact that the theory of RRI is not equipped to deal with issues, such as:

- emergence of claimed spaces for participation;
- not accepting the space and rules of participation offered by researchers and policy makers;
- not intending to arrive to consensus.

As Meyer (2015) concludes: 'concepts such as participation and responsible innovation are not politically and morally neutral.' 'We need to problematise such terms, that is, to step back and transform something given into a question' (on the notion of problematisation he refers to Foucault 1984).

Main conclusions for CORRI
1. The cases appearing in the reviewed papers relate to high-tech fields in high-income settings and focus on the research side. This suggests that RRI at present is the discourse of the research community in high income countries (and not the various potential stakeholders of the innovation process). This also suggests that RRI can easily be intrumentalised and be used as a tool to push forward certain controversial ideas. 2. In spite of the fact that the theoretical principles of RRI allow for various different (even contradicting) interpretations, the cases too often take these categories (e.g. participation, deliberation, ethical) as granted and fail to reflect on the way they are turned into reality. 3. The analysed cases fail to reflect on the politics and non-neutrality of RRI, especially on the political content and moral principle implicitly put forward by the initiators of RRI practices (mainly researchers and policy-makers). This ignorance of the political aspect can easily result in the sustaining of the status quo (including mechanisms of oppression), and undermine the original aims of RRI.

3 Knowledge actors perspectives on (CO)RRI

3.1 Scope and methodology

In order to complement the findings from desk research, empirical data were collected by means of expert interviews and an online survey.

3.1.1 Expert Interviews

The aim of conducting expert interviews was to complement the information gained through literature research as a basis to elaborate a CORRI concept that will represent the framework for the design of the transition experiments in FoTRRIS.

'Firstly, in relative terms, talking to experts in the exploratory phase of a project is a more efficient and concentrated method of gathering data than, for instance, participatory observation or systematic quantitative surveys. Conducting expert interviews can serve to shorten time-consuming data gathering processes, particularly if the experts are seen as 'crystallization points' for practical insider knowledge and are interviewed as surrogates for a wider circle of players.' (Bogner et al.., 2009:2)

Bogner et al.. (2009:7) refer in their book about expert interviews to a broader definition of expert (based on Meuser and Nagl), which explicitly became relevant since:

'…the emergence of a new type of research that is characterized by its practical relevance, project-like nature and transdisciplinarity, that is the inclusion of the knowledge spread across a range of very different actors ('Mode 2'). These considerations prompted Meuser and Nagel to extend their definition of the expert. Whereas their previous publications restricted the circle of experts to members of the professional functional elite, they now extend it in light of new (global) network-like negotiation processes of knowledge production to include the people actively involved in shaping public affairs. These include, for example, NGO representatives who have (often) acquired their expertise outside their professional role. In the course of their voluntary or professional activities, these people have acquired specialized problem-solving and analytical knowledge that is of relevance in expert interviews.'

Therefore, key persons from the local research and innovation community in Austria, Belgium, Hungary, Italy, and Spain, namely 62 experts from policy, civil society organisations, the business sector and academia have been interviewed from March to May 2016.

Method

All interview partners were personally contacted via e-mail and received a standardised invitation letter (see Appendix 6), which explained the context of the interview, and technical aspects, such as the estimated duration, and how the interview would be implemented.

Interviews were done via telephone/video-call or personally. Face to face interviews were preferred, but geographically distant interview partners have been interviewed via telephone or with a video-call (for instance via Skype).

For the semi-structured interviews standardised guidelines (see Appendix 8) with a set of questions have been prepared in English and were then translated into national languages. A variety of proposed prompt points provided for interview flexibility.

Those who agreed on being at our disposal received a comprehensive information sheet (see Appendix 7), which informed interview partners informed about FoTRRIS and our ethical principles, such as anonymity and confidentiality, and an informed consent form to be signed and handed back before the interview. The interview questions were as well provided beforehand.

Before the actual interview interviewees have been pointed to that the interview will be recorded (only for our interview analyses, the recordings will not be published), and that a draft transcript would be provided, if s_he would wish so.

All interviewers were provided with detailed interview guidelines (see Appendix 8) including advice on interviewer behaviour, possible biases, body language influence, and the advantages of using interviewer protocols, where circumstances of the interview (duration, type of interview/place, etc.), and the interviewer's individual reflection could be noted.

Sample

In order to gain socially robust knowledge (Nowotny 1999), it was considered as important to carry out the interviews with a group of experts as diverse as the actors in the field actually are. The interview sample aimed at representing a gender balanced group, which should be based on diversity criteria. That should include men and women of different age and backgrounds from academia, policy, civil society organisations, and the business sector. Still, despite the efforts taken, the sample of interviewees was actually imbalanced, and involved more man (63%) than women (37%).

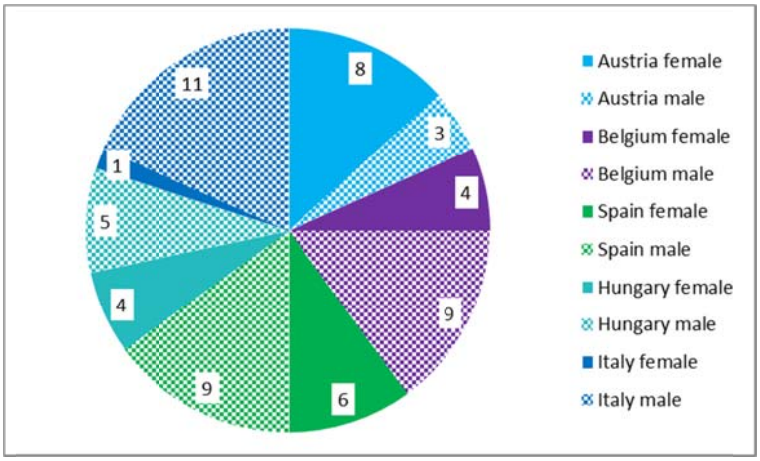


Figure 3: gender balance per county (numbers of completed interviews)

Moreover, in terms of institutional affiliation our sample very much mirrored where research and innovation is predominantly taking place: 45% of the interviewed experts are with Universities and public research organisations.

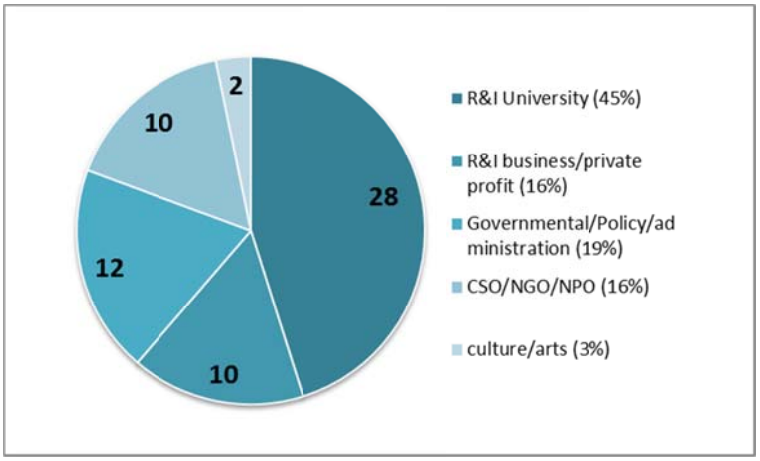


Figure 4: Interviewees' institutional affiliation

Interview Analysis

The analysis of the expert interviews was primarily a general content analysis of the answers (other than for instance linguistic / semantic analysis of narrative interviews) comprising a two-fold, horizontal and vertical analysis:

1. A summary of all main messages of each interviewee, including key sentences (with direct quotes from the interview – to be provided as word-by-word transcript and literally translated into English), which cover the basic attitude of this very interviewee (horizontal analysis).
2. A summary of all answers for each question from all interviewees to find similarities and differences (vertical analysis). Keeping in mind that 10-15 interviews per country are not enough to point out differences between groups, these supposed connections have been formulated as hypotheses to ask further questions in the online survey).

To analyse the interviews in a gender reflexive way, answers of all experts of all genders have been dealt with equally. In addition all researchers and interviewers have been instructed to avoid premature connections of differences to gender (as in the area of the expert interviews at hand gender was not meant as an influencing variable but rather a diversity criterion for the sampling).

The analysis of interviews was carried out in each national team based on a standardised interview analysis matrix, comprising English summaries of all answers per question per interviewee, a summary of each interview as a whole to get an idea how this person generally thinks about the topic at hand, and finally a summary of all interviewees' answers for each question by highlighting main similarities and differences within the respective national sample.

Finally all national interview analysis sheets have been collected, compared question by question and synthesised.

3.1.2 Online survey

The online survey was implemented from June to August 2016, and aimed at a quantitative validation of findings from the interview, and the literature review. In order to keep the questionnaire (see Appendix 9)

within a reasonable length, the survey focussed on knowledge actors' attitude towards co-operations - with researchers from other disciplines as well as with non-research actors, their experiences with collaborative practices, the challenges they face in collaborations, and measures that could enable future co-operative research and innovation activities.

Survey implementation and analysis

By using the software programme 'LimeSurvey', an open survey with no access restrictions was set up, in order to make the participation simple. The survey was fully anonymous, no personnel data were collected, and the programme's collector setting was settled in a way that did not permit the tracking of respondents' IP addresses.

Those partners, who had carried out interviews, distributed invitations containing the link to access the survey within their networks in Austria, Belgium, Hungary, Italy, and Spain. In addition, few more contacts from other countries were invited. For the distribution mailing lists were used, and to maximise the response rate, additional effort was put into addressing the survey request to personal contacts, and to ask them also for further distribution (snowball sampling).

The survey responses underwent a quantitative analyses by means of automatically generated Excel spreadsheets and by using SPSS software (version: IBM SPSS Statistics 22) to calculate correlations. The survey also included options for comments on certain questions, but only few respondents used this possibility. Their statements were collected in separate files and synthesised.

Sample

394 people started to fill in the survey, and 296 completed it: only fully completed questionnaires were included in the analysis. In contrary to the expert interview sample, gender balance was roughly given by 49,4% female and 45,8% male respondents[2]. Most respondents are in the age of 30 to 50 years.

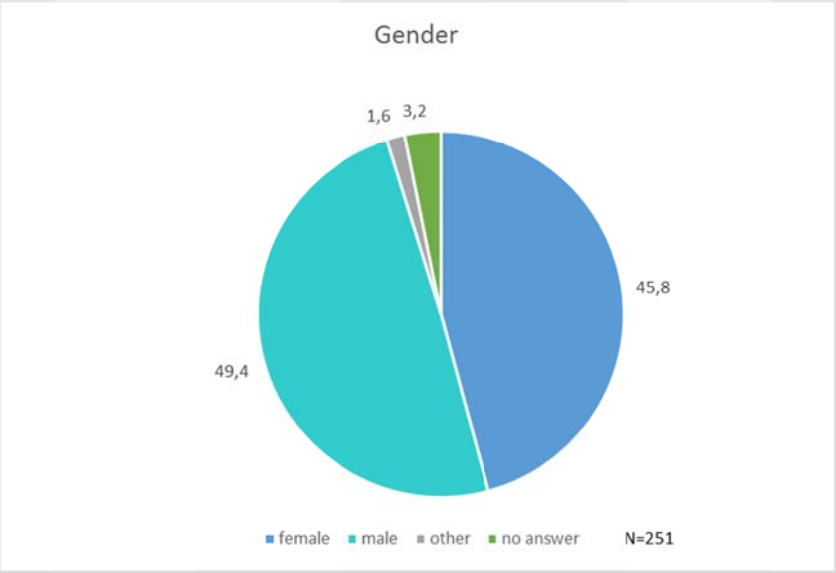


Figure 5: gender balance in survey sample (%)

[2] The questionnaire offered an 'other' for people, who do not feel comfortable with this binary category, like transgender or gender-queer persons

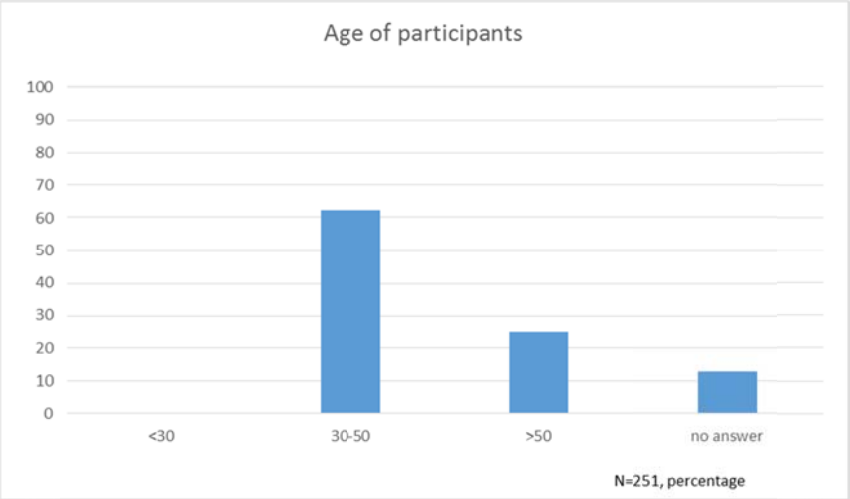


Figure 6: Age of survey respondents (%)

As a consequence of our invitation strategy, most respondents indicated that they are working in one of the partner countries.

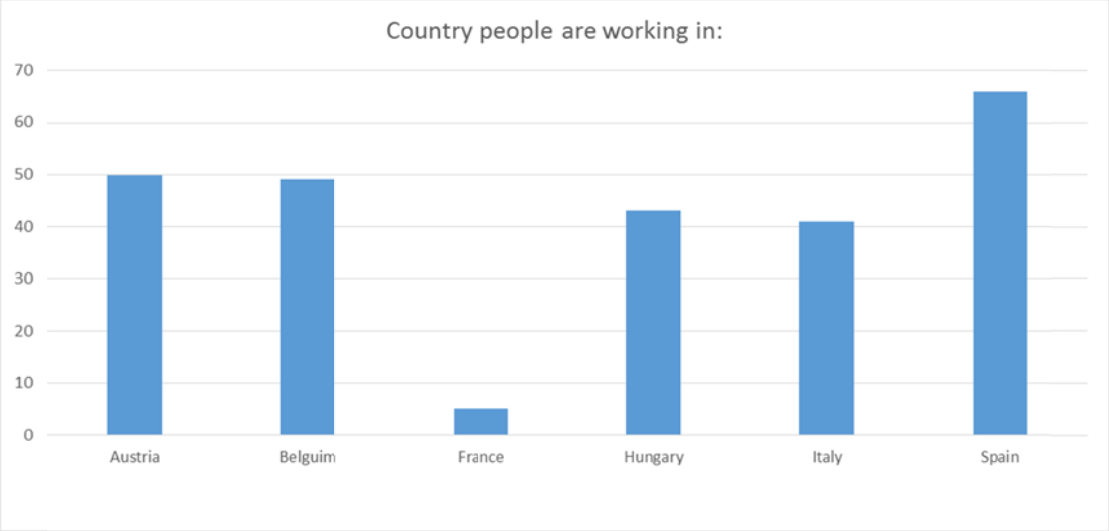
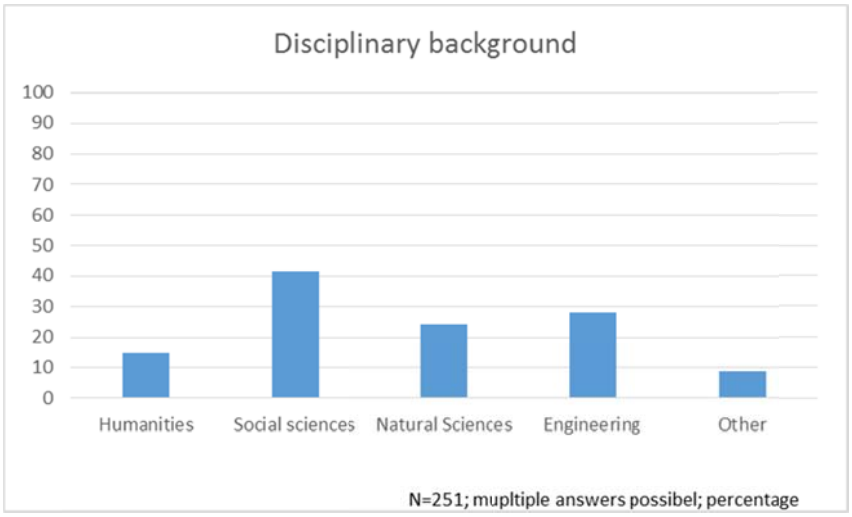


Figure 7: Countries survey respondents are working in (absolute numbers)

In regard to their disciplinary backgrounds and research/working fields, the sample embraced a broad variety of themes (see full list in Appendix 10), and covered Humanities (14,7%), Social Sciences (41,8%), Natural Sciences (24,3%), Engineering (28,3%) and other disciplines (8,8%), such as Arts. Several respondents indicated multiple disciplinary backgrounds (12,4%), and approximately a quarter of them has a disciplinary background, which combines so called 'soft' (Humanities, Social Sciences, Arts) and 'hard' sciences (Natural Sciences, Medicine, Engineering).



3.2 Picture of the current research and innovation system

To gain insights into what key actors from research and innovation think about the current system, we asked them about the main driving forces, the key actors setting the agendas, how this refers to addressing societal needs and challenges, about power relations in governing R&I, and what they think about R&I as democratic process.

3.2.1 Main drivers of research and innovation

Experts locate the driving forces for research and innovation primarily within two contexts: first of all inside the **academic research community**, and secondly they referred to **economic drivers** within and beyond the R&I community. **Funding** appeared as the most obvious driver, consequently also representing the most relevant instrument to steer research and innovation. The economisation of research due to its increasing dependence on research funding on the one hand, and expectations towards its contribution to foster economic growth and global competiveness on the other hand, was addressed by many interviewees, particularly by researchers. In contrary, representatives from funding bodies and policy makers tend to locate the main driving forces in academia, e.g. mentioning researchers' curiosity, publishing and academic excellence, which is supposed to be defined by the scientific community itself. While this could be somewhat regulated and steered through funding, in general it would be the research community that settles the direction. Above all, funding programmes would be elaborated based on R&I experts' advice too.

Social and other political drivers, such as subordinate EU policy agendas going beyond narrow research policies, which finally also manifest on the national level, were also considered being of relevance, but not that much as academic and economic drivers. However, there was discordance within experts how to judge the power of economics in steering the R&I landscape: While some were of the opinion that it would be important to direct R&I towards economically relevant outcomes, others criticised that economic benefits would mainly be directed towards certain stakeholders, thus not necessarily serving the whole society. Though, publicly funded research and innovation activities would be supposed to provide societal benefits for all (in contrast to privately financed activities). Another critical argument was that economic aims would be dedicated too much to the growth paradigm, which contradicts the core ideas of sustainability.

For interviewees, who are not very close to academia, it was difficult to assess what it actually is that may drive research and innovation. Non-governmental actors from Hungary even criticised little transparency, and emphasized a lack of clear guidance and a shadowy logic from the policy side.

In terms of who would drive research and innovation, experts mentioned most often individual researchers, large public research organizations, in particular universities, funding bodies, and large industries as key players. However there was also critique on the mainstream R&I system in terms of that the research carried out in universities and public research organisations provides too little socioeconomic impact, as well from the perspective of business innovations as in seriously tackling societal needs.

Concerning the driving forces of **(technical) innovations**, experts mention mainly market forces driving them, which is seen as a logic consequence for those, who define innovation as a core element of economic development. Any other societal objectives would be secondary. For others, who framed innovation in terms of **social innovation**, which should explicitly aim at tackling societal needs**,** civil society (especially social movements) or (small) enterprises acting beyond the mainstream business community were considered more relevant drivers than the mainstream R&I system, such as universities.

Main conclusions for CORRI
• The dominant R&I system is mainly driven by academic rules and economic pressure; large public research organizations, in particular universities, funding bodies, and large industries represent the key players. • Experts tend to perceive 'the others' • Market forces represent the main drivers of technical innovations, while social innovations are driven by civil society, social movements and enterprises beyond the mainstream business community.

3.2.2 Societal needs addressed by research and innovation

Since the R&I system is very diverse, embracing various activities from basic to applied research and a broad spectrum of innovation, several interviewees found it difficult to generalise in what respect R&I is tackling societal needs. Some experts argued that not all kind of research and innovation necessarily should be expected to tackle societal issues: for example basic research and work oriented solely towards academic discourses and scientific excellence. These fields of research should also in future get enough room to carry on work. However, the majority of experts was basically in favour of orientating R&I towards societal needs, especially R&I funded with public money would be **accountable of giving something back to society**.

Several experts mention that they could observe a **trend towards R&I increasingly dedicated to address societal needs**, and to orient it towards the grand challenges. Specific funding schemes that steer R&I activities towards societal needs (e.g. the smart specialization strategy, H2020, and several national programmes) were mentioned as important drivers for this development. Still, many interviewees perceive **shortcomings in regard to the actual situation**, and assess the socioeconomic impact of R&I as still too marginal. The anticipated reasons for deficiencies range from societal needs not being much of interest for the research community (e.g. due to the pressure of meeting excellence criteria)**;** a fragmentation in the research system, that makes it difficult to convey interdisciplinarity; difficulties in finding partners for transdisciplinary activities; too abstract definitions of how societal needs exactly look like, which makes it hard to efficiently tackle them and likely to result in a low societal relevance of research outcomes; to finally prevailing mainstreamed funding schemes.

The innovation system is also considered being too much **fragmented** and mainly oriented towards the market. Moreover it was criticised that many innovations would be developed **detached from the final users**, thus not really meeting their needs.

Few of the interviewees were quite sceptical about the idea of driving R&I by societal needs arguing that the **definition of societal needs might be contested** in terms of what kinds of needs and challenges are articulated and by whom.

Main conclusions for CORRI
• The connection of R&I and societal needs varies across research fields, and this should be legitimate: not all research is supposed to tackle concrete societal outcomes. • Publicly funded R&I should be accountable towards tax payers and serve societies' wellbeing. • There's a trend in R&I towards more emphasis on societal needs driven by specific research funding programmes. However, the socio-economic/societal impact is still perceived as too low. • The definition of societal needs in research and innovation agendas might imply tensions (depending on who defines what), and there is a risk of reproducing societal power relations when defining them.

3.2.3 Relevance of democracy in research and innovation

Democracy in the context of R&I means different things for the interviewees. For some it was even difficult to establish a link between the notion of 'democracy' and the research and innovation system. Thus 'participation' was introduced as a proxy for democracy, and often used synonymously in the interviews.

Experts widely agreed on that the **current R&I system would not be democratic at all** – neither within the research community, which seems to be driven by big players and research trends, nor in regard to the integration of research, policy, economy, and the civil society. Even though, opinions on how democratic the R&I system actually should be – or become, varied. While most interviewees were somehow in favour of the idea of more democracy in R&I, several of them emphasized at the same time on restrictions in regard to where democracy should be fostered, and who should have a voice in this process. Those being more critical on a broad democratisation of R&I suggested, that a voice on R&I decisions should only be given to actors, who are well educated, and therefore capable of developing a profound understanding of what is going on. In terms of scope of democracy, actors beyond the core R&I community could have a say on issues related to research funding, assessing the societal relevance of research or the formulation of research questions, but they should not be entitled to interfere in anything, particularly not in core research activities, such as the implementation of research. This could seriously undermine the integrity and **autonomy of research** or might even lead to a not legitimate **instrumentalisation of research** due to conflicting interest entering the research landscape from outside.

A different concern expressed in regard to stronger democratisation referred to **distrust in science and technology**, which might restrain the development of technological innovations as a consequence from a general scepticism towards, or even denial of certain technologies.

Moreover, there are doubts if real democratization might be possible at all as long as neither equal opportunities nor broad accessibility to knowledge is given within our society. However, those being more positive about that more democratisation would be possible, emphasised on the importance of upstream processes. Consequently democratic/participatory research would have to begin already at the stage of research agenda setting, which is rarely the case so far as several interviewees argued.

Only few experts stated their full support for a genuine participatory democracy in R&I, which essentially should include all *('taxpayers have to have a say'*, univ. research council_Be_I2), the collaboration between different sectors, provide equal opportunities, and build on diversity. How this could be implemented in

practice remained unclear, but social movements, such as student or Arab Spring manifestations, could represent useful learning cases as suggested by Spanish interviewees.

If it comes to the democratisation of innovation, interviewees referred on the one hand to stronger linkages with end users, respectively **interactive innovation** practices, but also to the granting of open access to innovations.

Participatory processes as a tool for more democracy in R&I were broadly appreciated, and basically seen as valuable for several reasons: participation is contemplated as an essential feature to enhance the societal relevance and impact of R&I, because it may help to better understand societal needs, it may help to tackle societal problems by enriching knowledge production with contributions of various types of knowledge, it may grant better access to knowledge and R&I outcomes and improve its impact, it may broaden the ownership of knowledge, and it may help to break down the 'ivory tower' of R&I.

> *'We have created a 21st century ivory tower. It is just that now it is not the research, which is in the ivory tower, but the organisation [management] of research. We need democratization to dismantle this ivory tower.'* (university researcher_Hu_I4)

Main conclusions for CORRI
• R&I is not democratic at all since it is steered by big players, research trends and particular (economic) interest. • Participation respectively user involvement represents an important tool for democratising the R&I system. • Vast appreciation for more democracy in R&I, but varying opinions on how this should look like: inclusiveness vs. necessity of specific expertise; upstream approach is widely appreciated, but not a participation throughout the whole R&I process. • Democratisation may put the autonomy of R&I at risk, and introduce societal conflicts into the R&I domain.

3.3 Experts' viewpoints on (CO)RRI

We asked interview partners how they would define 'Responsible Research and Innovation', in what respect this concept would be relevant for them, what they actually expect from RRI, and which concerns they have. Finally we wanted to know how RRI could be implemented, how the implementation of RRI could be supported, and what they think about an institutionalisation of RRI in public R&I organisations and in the private sector.

3.3.1 Key elements of RRI

Interview partners' characterisation of RRI referred to both, the **process** and the **outcomes**, but also to the **objectives** of research and innovation, which were generally formulated as achieving a (bigger) societal impact.

In terms of key aspects characterising RRI, interviewees came up with a very broad spectrum of characteristics, which all were in line with the key features defined within the academic discourse as well as the main pillars that were outlined by the EC (2012). They mention accountability (towards citizens), transparency, inclusiveness, responsiveness, anticipation, accessibility, scientific integrity, diversity in

research approaches/ in regard to, gender equality, equity, transparency (research process and results), open science, open access, open data, open system.

In regard to the process, RRI was for the most part defined as a kind of interactive, participatory or co-operative process. Key words referring to this, like (bottom-up/ active) participation, the involvement of beneficiaries/ end users/citizens/the society, listening to, giving a voice to final users/citizens, dialogue between science and society, open the system to all actors, debating, networking, cooperating, collaboration popped up in nearly all of the interviews. Since participatory processes are already (well) established in certain research fields, some interviewees raised the question what RRI would add new. Particularly those experts, who were familiar with concepts like transdisciplinarity, mode 2 knowledge production, participatory research, action research, participatory innovation or other integrated R&I approaches, were wondering if RRI would just be a new terminology for these already (well) established research models or if it would imply different practices.

Main conclusions for CORRI
• RRI may have various 'faces', and it may refer to the aims as well as to the process and the outcomes of research and innovation. • Experts' ideas about RRI cover the full range of key elements, which are highlighted in the academic and policy discourse. • Participatory, interactive or co-operative processes are at the core of implementing RRI. • There is uncertainty in what respect RRI will go beyond already existing concepts respectively innovative methodological approaches.

3.3.2 Expectations and concerns in regard to (CO)RRI

The interviewed experts were asked if and in which regard they think that there is a need for RRI, how RRI could contribute to tackle these needs, and which concerns they have in regard to implementing RRI.

Interviewees' first of all addressed the shortcomings they perceived in regard to **meeting societal needs**. They hope that RRI could help to more properly define these needs, to more efficiently address them, and thereby **increase the societal impact of R&I**. While some experts address single aspects to be improved by means of RRI, others expect a **change in the R&I system in the long run**. Several experts also argued that RRI could contribute making research and innovation a more **democratic** and **inclusive** enterprise, some explicitly highlighted gender equality and enhanced inclusion of societal minorities and disadvantaged groups. RRI could help to balance power relations, to reduce inequalities, and to emphasise more on humans' wellbeing beyond economic interests. Particularly the Spanish and Italian interviewees raised expectations towards RRI, which would not only tackle shortcomings within the R&I system, but go beyond this by addressing the general crisis of values within society (e.g. corruption, selfishness): they hope that RRI could promote normative changes within societies, and contribute to a broader societal transformation. In contrary, others did not think that it would be mainly the duty of the R&I community to touch upon societal values or to drive societal change. In their point of view this would be first of all to be tackled by politics.

In general, experts do not think that research and innovation basically builds on irresponsible practices in R&I, but researchers and innovators, both, individuals and organisations, would need to become more responsible in the sense of being more aware about the societal relevance of their work, and how the knowledge they produce may better serve societal needs. RRI could help raising awareness, and to gain commitment from the R&I community. However, there are also some critical voices, who consider the

system being too less organised, and who point to an inefficient (=irresponsible) use of resources in the current R&I system. They pin hopes of a better coordination of the system and a more responsible use of funding to RRI.

On the one hand RRI is expected to help to anticipate and consider the **unintended societal consequences** of R&I, it should help to recognise *'blind spots'* (univ. lecturer_Hu_I1), and put **ethical issues** more forward. On the other hand RRI should help to align the focus of R&I with really pressing societal challenges, and to generate outcomes, which could fundamentally contribute to finding solutions. Some interviewees see RRI even as a possibility to also take **non-mainstream paths** of finding new solutions into consideration, and thereby offer opportunities to **think outside the box**, e.g. by questioning prevailing economic paradigms when tackling societal challenges.

In regard to the perceived shortcomings in **participatory approaches**, such as little transparency, exclusiveness or instrumental purposes of gaining acceptance or legitimising R&I, RRI is expected to bring about more substantive, transparent, genuine inclusive upstream processes, and collaborative forms of engagement, which also empower for participation. As very central aim of participation, interviewees pointed to the definition of societal relevant issues in terms of who defines then, and how they are defined. Against the background of limited funding resources for R&I, they also highlight the relevance of participation in regard to the prioritisation of research topics and innovation paths. Several experts expect from RRI related participatory processes the production of a new type of knowledge, which results from the integration of various types of knowledge from different sectors and actor groups. This could lead to better results from R&I efforts in terms of being more relevant and tangible, thus more efficient in solving the problems at stake. Finally, participation in the context of RRI is expected to make the R&I more transparent and democratic in order to 'open the system to all actors' (researcher private non-profit institute_Es_I5).

Conceptualising RRI as a **log-term mutual learning process** (e.g. by setting up learning networks) could have the potential to change research cultures and consequently also the R&I system. However, several experts express worries that this only could happen, if the core idea of RRI would gain ground in the whole R&I system. Academia would need to change (from research funding to academic career development, e.g. more acknowledgement for 'third mission' related efforts etc.) in order to implement RRI sustainably and for researchers on every career level. Experts were not very confident in that this will become reality in the foreseeable future, since research and innovation is a global business, and evaluation indicators are deeply manifested in the system and actors' attitudes. Change might only come along with new generations:

> *'But we are talking about the whole system. The problem is that you cannot dismantle only a small part. If you think about the indicators of promotion in scientific career, counting the senseless citations and IFs. Those who are in leading positions at present earned this on the basis of this scheme of evaluation, and they will not let this go. […] This will be a matter of the change in the generations.'* (university researcher_Hu_I4)

Moreover, a sustainable implementation of RRI would also need to go along with fundamental changes in other societal domains that influence R&I, such as the economic system.

Some interviewees worry about a certain risk of RRI only staying a **buzzword**. They suspect that the concept will be purified and eventually mean nothing or may even serve as legitimation for risky research. Particularly as long as it would not become clearer what criteria would need to be met in order to call a research or innovation activity 'RRI', it leaves too much room for only re-labelling something, which keeps being more or less business as usual. Thus these experts realistically do not expect too much from an expansive introduction of RRI in R&I in reality - at least not in the short term. They even assume that it simply may become a kind of business for a small set of researchers, who implement innovative research approaches, or who research on the topic of RRI.

Other concerns relate to the **quality of research**, which might not meet academic standard quality criteria (e.g. verification and control of results) anymore, imply lengthy research processes, or inhibit the protection of intellectual property rights. As a consequence research organisations could lose competitiveness in the international context, which also might cause disadvantages for the individual researchers and innovators (e.g. threatening their careers). Several experts envisage a risk that RRI could be attached to any type of research and thereby diminish the space for basic research and scientific freedom. R&I organisations, individual researchers and innovators could lose autonomy, they might be instrumentalised by the interests of societal subgroups, and politics might increasingly interfere in their work.

Interviewees also anticipate a lack of interest of public administration, excessive bureaucratisation, and a lack of appropriate monetary compensation as well for the R&I community as for other societal actors. This would represent an additional burden for the single actors engaged, and thereby making an engagement in RRI less attractive.

Finally, some experts raised concerns in regard to the general role of R&I, and if the academic community really would have the power to drive societal change.

Main conclusions for CORRI

- Expectations towards RRI refer to:
  - anticipating the (unintended) societal impacts of R&I
  - ethical considerations and values in R&I
  - bringing R&I closer to societal needs and thereby improving its societal relevance
  - changing the R&I system by making it more democratic, inclusive and open towards society
  - promoting normative changes, and contribute to a broader societal transformation
  - providing opportunities for alternative paths and a thinking outside the box
- Concerns in regard to RRI referred to various problems, which are of particular relevance within the current mainstream R&I system context:
  - RRI as a meaningless concept that easily could be instrumentalised
  - RRI may undermine scientific quality and excellence
  - RRI may represent an additional burden that may threaten organisations' international competitiveness and individual careers
  - RRI may restrict scientific autonomy and diminish the space for non-RRI research
  - RRI may lack of commitment within the R&I community
  - RRI may lack appropriate funding

3.4 CORRI in practice

We asked experts about their ideas of how RRI could be implemented in practice, and if they could think about already existing practices, which maybe might not be explicitly called RRI, but still meet some criteria of how they understand RRI, and thereby represent a good basis for the establishment of (CO)RRI. We also were interested in already existing programmes that could support such practices, and finally interviewees were asked about how they think RRI could become an institutionalised practice.

3.4.1 The implementation of RRI in practice

Examples of **already existing practice**, which could be a starting point for bringing about (CO)RRI, given by interviewees encompassed various funding programmes and projects, which emphasised on one or several of the following aspects:

- engagement of various actors
- participatory approaches
- bottom-up approach
- co-operative activities
- strong partnerships
- transdisciplinary activities
- community based research
- stakeholder involvement/consultations
- citizen engagement
- science shops
- ethical committees
- mutual knowledge exchange
- social innovation
- social entrepreneurship
- reflected on ethical and/societal impacts
- granting open access
- science communication/education

Most interviewees had some experiences with activities that tackled such practices, thus might fit in one way or another into the broad scope of RRI.

When being asked about in what respect RRI might be actually different to the practices already in place, many of the interviewees, who are or were engaged in such projects, were not sure about what RRI might add new. Suggestions about how to further advance already existing RRI-like practices referred to a better alignment of methods with the power to realise a transition, long-term co-operations, which go beyond single projects, new forms of communication and improvements of participatory practices in the sense of moving it more towards genuine collaborative efforts that would highlight a cultural change in R&I. It was also argued that the particular additional asset of RRI would refer to the fact that it is an *'integrated concept, which brings together various already existing elements. This brings along its particular qualitative strength'* (university researcher_At_I7).

Opinions on the **institutionalisation of (CO)RRI in the public sector** were quite ambivalent: on the one hand this might support the diffusion of the concept, on the other hand it might go along with top-down mechanisms. Thus not all experts were in favour of an institutionalisation, arguing that this could eventually contradict the core ideas of (CO)RRI, it might imply a risk of narrowing down the concept, which finally might lead to standardised practices. This might limit the room for the implementation of (CO)RRI as a kind of bottom-up social experiment, which is seen essential by some few interviewees. Critical voices pointed also to the fact that an institutionalisation would need a long time, because this could only go along with fundamental changes in the R&I system, such as a different career paths, or rewarding system (e.g. considering societal impacts in the performance indicator and excellence discussions).

Others were more positive, and pointed to the need of an institutionalisation, since this could help to bundle specific (process related) expertise and build capacities over time, and it could foster the development of indicators in order to better monitor and evaluate (CO)RRI activities.

Most frequently the establishment of intermediary centres was suggested as a means to institutionalise (CO)RRI by coordinating and facilitating its practical implementation. Such centres are expected to

transcend boarders between disciplines, between institutions and actors within the R&I community as well as establishing links with the world outside. Often these centres were imagined to be hosted by Universities, but there were also voices in favour of (additional) experimental spaces to practice RRI beyond the proximate University context.

Another way to institutionalise (CO)RRI, respectively to drive such a development, was seen through enforcement via regulations linked to financial incentives, which would manifest in specific funding programmes, or evaluation criteria. Experts' assessment of the current situation is that the resource mobilisation is still limited, although there are already some funding programmes in place, which are explicitly dedicated to RRI.

Only few interviewees expressed opinions about an **institutionalisation of RRI in the private sector**: an institutionalisation could not be prescribed to private businesses, and most likely only economic incentives could push the development there.

In any case, an institutionalisation of (CO)RRI would need to build on increased awareness about the (potential) benefits (CO)RRI will bring about within the R&I communities (private and public sectors), R&I funding organisations as well as within other societal groups, which are expected to engage in corresponding activities.

Main conclusions for CORRI
• There are already good examples of RRI-like practices, but taking (CO)RRI seriously would mean to get one step further. • Ambivalence exists in regard to the institutionalisation of (CO)RRI: on the one hand it may help to make the concept more clear and easier to mainstream, on the other hand there are concerns that an institutionalisation may narrow down the concept. • Institutionalisation should imply changes in the R&I system as well as in corresponding systems (e.g. economic system), thus it should be planned as a long-term process. • Support for institutionalisation is expected to be given by tailored funding, acknowledgement for (academic) performance records and through specific centres, which initiate, coordinate and facilitate activities. • An institutionalisation of (CO)RRI in the private sector to be driven by economic benefits.

3.4.2 Collaborative actions as basis for the implementation of CORRI

Experts had clearly identified participatory practices as a key element for the implementation of RRI. However, FoTRRIS wants to emphasize on collaborative and co-operative processes, which should go beyond the prevailing current practices of participation. Thus we wanted to know what the expert interviewees think about its relevance. We asked them for their opinion on how collaborative actions could support RRI, who should be engaged, and how co-operations could look like. In order to gain more data on this core element of the FoTRRIS CORRI concept, the issue of cooperation represented also the focus of the online survey.

Interviewees' opinion on the relevance of cooperation for RRI was very much in line with their viewpoints on participation, respectively democratisation, thus highly appreciated, as one of the Spanish experts statements illustrates: *'I think that RRI is a collaborative action. If it is not collaborative, it is not RRI.'* (private non-profit research institute researcher_Es_I5)

Survey results are confirming this **high degree of appreciation**, as well for inter-disciplinary co-operations, and even more for co-operations with actors beyond the formal R&I community (see Figure 8). Respondent do not only accredit high relevance of such co-operations for their research fields, but most of them indicate that they would be willing to engage, as many of them already did. The assumed relevance seems to influence actors' willingness to engage in co-operative activities as the results confirm: the more relevant respondents assessed inter- and trans-disciplinary co-operations for the implementation of RRI in their research fields, the higher they indicated their willingness to engage in such co-operations[3] (see Figure 9).

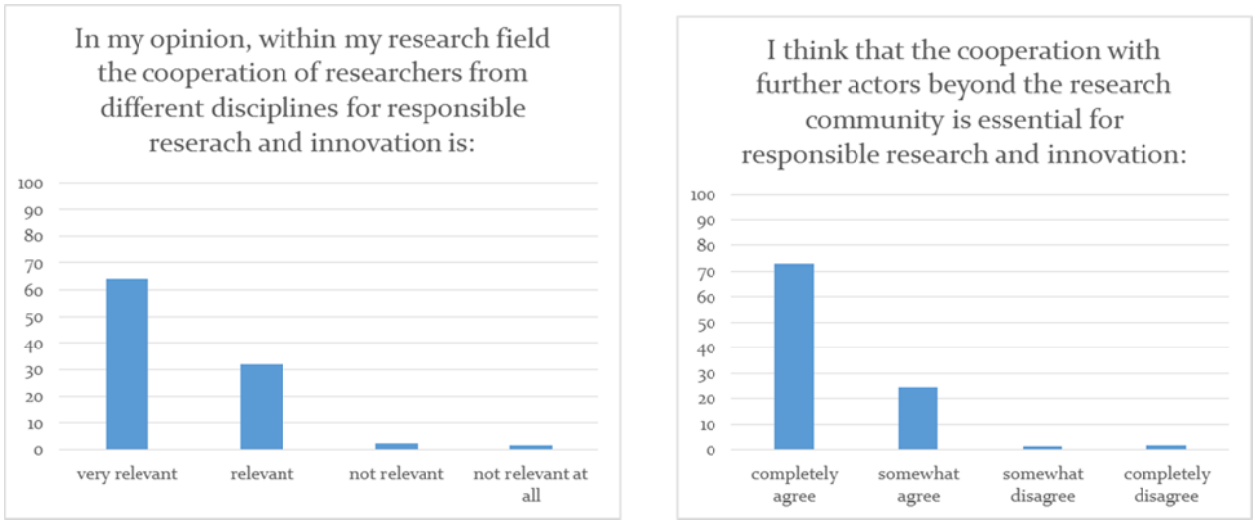


Figure 8: Online survey results on relevance of inter- and trans-disciplinary co-operations (%)

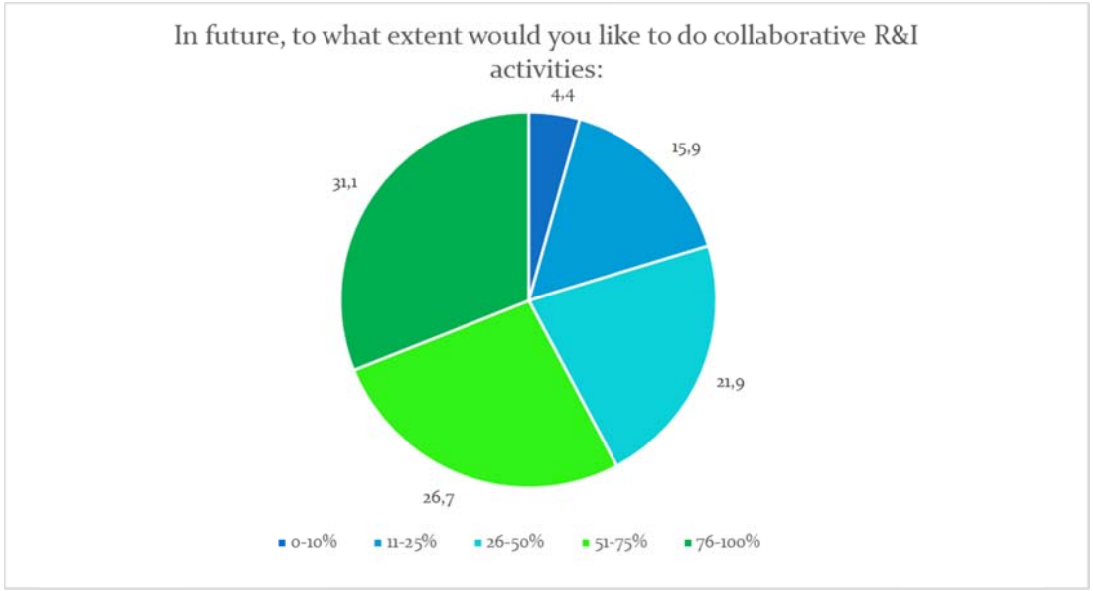


Figure 9: Online survey results on willingness to engage in co-operative R&I activities (%)

Particularly researchers, who have experience with transdisciplinary and participatory research, see the cooperative element as nearly logically inherent in RRI. As collaboration is in their definitions one of the **main criteria for RRI** anyway, thus the notion of **CO**RRI caused irritations for some interviewees, who questioned the necessity of adding such a prefix.

[3] Correlation for co-operations of reserachers from different disciplines: -.352, significant at the 0,01 level (2-tailed); correlation for co-operations with further actors beyond the R&I community: -.320, significant at the 0,01 level (2-tailed).

The process of **selecting the 'right' partners** was pointed out as crucial, and interviewed experts expressed similar opinions as in respect to democratising R&I as already outlined above (see 3.2.3). Most experts emphasised the need for a wide and inclusive collaboration between the research community and actors beyond. Some stressed that a broad spectrum of societal groups from various sectors should be included, others particularly highlighted the importance of CSOs and NGOs, and others pointed at the necessity of a 'qualitative selection', which would need to be tailored to the topic to be addressed, and which should be targeted towards the users of the envisaged outcomes of the respective R&I activities. Cooperation partners should not only vary in terms of representing interests and of relevant groups, but they should also hold various types of knowledge and specific expertise. Again, some interviewees pointed out, that it would be necessary, that those, who engage should all be familiar with the topic and have a basic understanding of the research and innovation activities at stake; only then they could be appropriate partners in research and innovation processes. Moreover, for certain activities the geographical scale would be of relevance too.

Also the survey participants were asked whom they consider as most relevant partners in collaborative efforts. Respondents clearly favoured co-operations with other R&I performing organisations: two third completely agreed that this is of relevance for their research field.

In regard to actors beyond the research community, the highest agreement referred to CSOs/NGOs and the business sector. The reference to the **business sector** is well in line with the increasing demand to R&I of producing economically exploitable results. There might be two reasons, why **CSOs/NGOs** received that much agreement: first, because CSOs/NGOs might be perceived as a well organised form of civil society representatives, which bundle lots of knowledge by being well informed about societal needs and concerns. In addition they usually have people, who hold sufficient knowledge to engage in a technical scientific discourse. Secondly, the involvement of critical CSOs/NGOs might be useful for the anticipation of criticism and resistance towards certain research and innovation activities.

The educational system and the policy sector also gained a high level of agreement. While co-operations with the **educational system** are in line with the trend of fostering scientific literacy and/or attracting young people, close contacts to **policy making** helps to improve the political impact of S&I, which is highly ranked in proofing the impact of R&I. The **general public** received comparably little agreement, which might be explained with the difficulty of co-operating with a basically abstract collective, as underlined in a survey comment: *'I have no idea how to cooperate with [the] 'general public' as an 'actor'.'* (OS_I120)

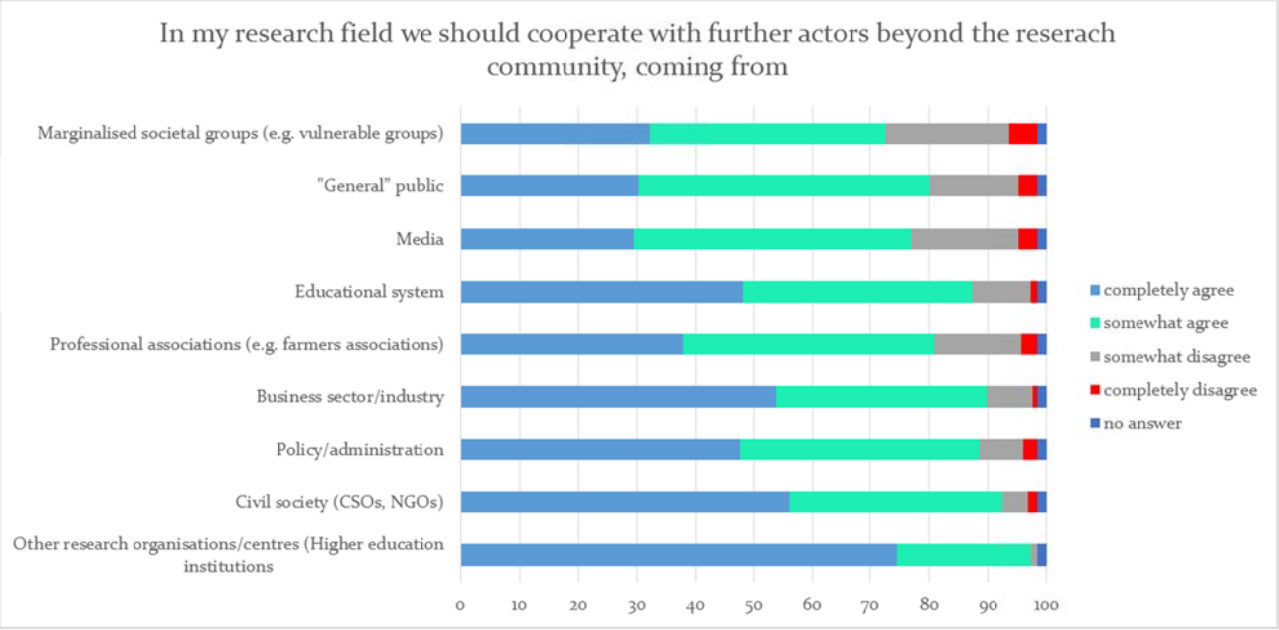
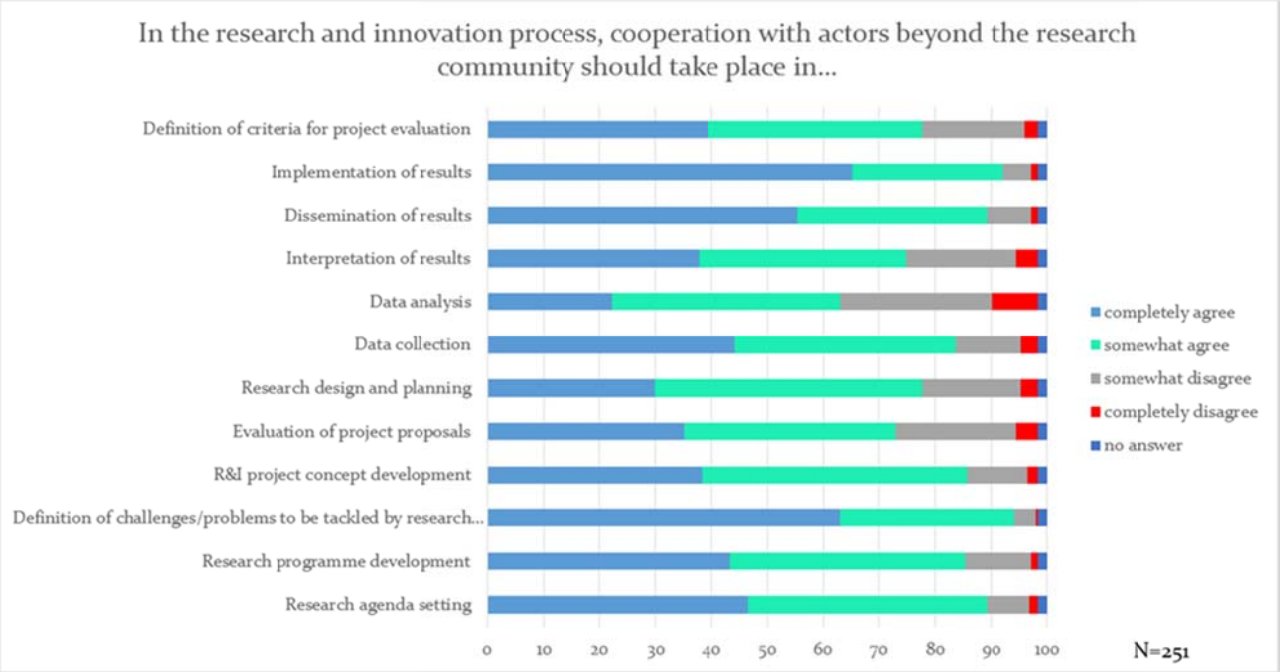


Figure 10: online survey results on relevance of various co-operation partners

Few survey participants, who considered co-operations with actors beyond the R&I community as not relevant at all, argued that such co-operations would threaten the **autonomy of science**, and that most scientists would be ahead of their time, thus being capable of assessing themselves what kind of research to be carried out and in which way.

'**Neutrality**' was mentioned in several survey comments as an important aspect in regard to the choice of co-operation partners, which underlines that even those who think that it is important to co-operate with actors outside the R&I community, are cautious about not putting their (putative) independence as researchers at risk.

In the interviews most experts expressed a preference for taking a **bottom-up approach** and **interactive processes** throughout all the R&I stages, which represents the main difference compared to usual participatory activities. However, not all agreed on the necessity for a close cooperation in all R&I activities, arguing that for certain activities the R&I community would hold the most relevant expertise. Here it would be sufficient if the knowledge exchange would be restricted to the transfer of information from the R&I community to e.g. users, who then could provide their feedback. The decision for how to consider this, would need to be attributed to the experts. In contrary, others consider it crucial for a co-operative effort to overcome hierarchies of expertise, and to co-produce knowledge throughout the whole process.



Although the survey results show that co-operative efforts are somehow relevant in any step of the R&I process starting from the very beginning (already in the stage of setting the research agenda), preferences are given to those activities, which refer to the definition of the issues to be tackled by research, data collection, and the implementation and dissemination of results. Less appreciated are collaborative activities in the context of tasks, that are considered to need specific technical expertise, such as data analysis and the interpretation of results. This may indicate, that even among those, who are open towards co-operative practices, actors are not yet fully prepared for fundamental changes in R&I practices. *'quadruple helix collaboration to define the what. Specialists define the how.'* (OS_I185)

However, several interviewees emphasised that the relevance of co-operative efforts depends on the R&I activities at stake, thus would need to be assessed on a case by case basis and accordingly tailored according to the specific context and the aims.

Main conclusions for CORRI
• Co-operation between different disciplines and with societal actors beyond the R&I community was highly appreciated as a core element of (CO)RRI; for some experts it represented even a precondition. • A positive correlation exists between the relevance of co-operations for a particular research field, and the extent of willingness of R&I actors to engage in co-operations. • Ideas about with whom to co-operate ranged from very inclusive to selective approaches. • Close co-operations with non-research-actors, (CO)RRI should not put the R&I community's autonomy and independency at risk. • Experts voiced a distinct preference for bottom-up approaches and interactive co-operation processes, which could set (CO)RRI apart from other participatory practices.

4 Transforming R&I systems into (CO)RRI Systems

4.1 Levers and barriers

This chapter gives an overview on the barriers and levers, which were addressed in the reviewed literature, and within the expert interviews. In addition, we included two questions in the online survey, which explicitly focussed on barriers and levers connected to collaborative practices, since we had identified collaborations as a basic requirement for practicing (CO)RRI.

4.1.1 Barriers

The literature review and expert interviews informed us about a multitude of barrier that challenges the transformation of R&I systems into (CO)RRI systems. Particularly institutional challenges indicate that advancing RRI is not merely a question of developing e.g. new engagement methods and innovative R&I approaches at the microlevel when putting (CO)RRI into practices.

Academic recognition and performance assessment

In the current academic rewarding system there is little recognition for non-academic research outputs (Egmose 2015). It focuses mainly on scientific excellence, evaluetd through high ranked peer reviewed publications, and/or outputs, such as patents or marketable products. Although there are rare attempts to capture also societal criteria in performance records, this is still of low or no relevance, neither for institutional rankings nor for personal academic career development. There is no accepted framework with adequate data sets comparable to e.g. Thomson Reuters' Web of Science, which enables the calculation of bibliometric values, such as the h index or journal impact factor (see e.g. Bornmann 2012).

The resulting strong pressure to publish in high ranking scientific journals makes the engagement in e.g. inter- and transdisciplinary R&I efforts less attractive. In contrast to traditional disciplines, the relevance of any particular piece of transdisciplinary work to any particular journal is often unclear, with the result that transdisciplinary scholars often find it hard to know where to target their work (Kueffer et al. 2007).

The lack of recognition of societal relevance is also reflected in prevailing funding and evaluation practices. Existing research evaluation procedures do not sufficiently support the type of open, mutual and adaptive

learning processes as requested for the implementation of RRI. The requirement to predict the impact of research and innovation projects does not facilitate research and innovation activities that build on societal experiments. Such experiments necissitate certain flexibility (Karner et al. 2010), and they are likely to entail unexpected results, which could on the one hand generate very innovative outcomes, on the other hand they also imply a certain risk to fail. This challenges their legitimacy and acceptence, as e.g. reported for certain forms of transdisciplinary research (c.f. 'Realexperimente', Groß et al. 2005), and researchers and innovators hardly get opportunities to experiment with transformative innovations, because the qualitative impacts are difficult to predict (Snick 2012, Snick & Cortier 2012).

The system of peer review, based on bibliometric citation analysis, has a structural bias in favour of established mainstream approaches and publications of articles in journals. This system respresents a major obstacle for more regionally oriented and qualitiative sciences (Radder 2009).

Acknowledgement from peers

Non-mainstream R&I approaches often lack of openess for from peers, who evaluate R&I proposals and activities makes it difficult to get appropriate appreciation and subsequently funding for (Co)RRI experiments (Snick 2012, Snick & Cortier 2012). Survey results also highlight the relevance of this challenge (see Figure 11): respondents found it more challengeing to get their work recognised within the R&I community (and beyond), that e.g. finding possibilities to publish their results in academic journals. One of the survey participants, who indicated that publishing was of less problem than gaining recognition from peers: *„with the right time, effort and rules of thumb of how to tackle it, it is doable. What I was more confronted with, was that a lot of researchers do not regard my research as 'real hardcore research' just because it is interdisciplinary'* (online survey_r136).

Knowledge as commodity product

Steering mechanisms driving the knowledge economy orient knowledge production towards economic rationales (Greenwood 2009). This contributes rather to an intellectual commodity production than aiming to sustain the sustainability of local communities, which has implications for the role of science in society (Egmose 2015), and also challenges the implementation of RRI. It causes a conflict between the rationalities, aims and requirements of the academic system, and the idea of engagingengaging with local communities, which also mirrors in the mismatch in modes of funding for research and what is required for facilitating effective community involvement (Egmose 2015). If knowledge results from a collective process, it should be a common good by nature, but this may limit its economic value. While knowledge first and foremost generates societal value when being disseminated, accessible and socially contextualised, within the current knowledge economy open access inversely reduces the possibility to dedicate, privatise and capitalise it (Kristensen 2008 after Egmose 2015). This paradox is likely to represent another challenge for the implementation of (CO)RRI

Time frame, capacities and committment

Due to a lack of long term funding (Dedeurwaerdere 2014), research and innovation frequently happens in projects of a short duration. Once the project stops, resources to develop innovative activities further are lacking. Hence the return on investment is often low, and 'stocks' of expertise cannot be built up (Snick 2012, Snick & Cortier 2012). This makes capacity building difficult, which is as well of relevance for the R&I community as for knowledge actors who engage. Especially for the engagement with low-income communities, e.g. as clients, suppliers and/or employees in the context of inclusive business models as addressed by Bierwirth et al. (2015), challenges in regard to knowledge and skills have been reported. R&I institutions lack of institutional infrastructure and capacities to produce and follow measures for RRI, which is not only an issue for universities and industry, but especially for small and medium size enterprises that often have very limited financial means (Lang & Griessler 2015).

(CO)RRI efforts are more time consuming and need more resources than conventional R&I activities (e.g. Kupper et al. 2015), but many R&I projects are financed through short-term funding programmes. This can make it difficult to create committment from collaborating actors, to realise continouity throughout all phases of R&I, and to ensure the sustainability of the outcomes.

As suggested by many of the interviewed experts, RRI should build on a more democratic governance of R&I, which should already be taken into account when setting up research (funding) programmes. However, current governance mechanisms have been critizised as still being organised top-down, steered by expert opinions or driven by subordinated policy agenda, and lack of transparency with respect to financial flows (Snick 2012, Snick & Cortier 2012). In order to implement more democratic processes, policy makers, funding bodies and/or government (local, national and supranational) may encounter difficulties in regard to governing such processes, since collaborative efforts of a variety of stakeholders who each have a particular interest makes the formulation of goals, which arguably meet consensus among most stakeholders, more challenging.

Benefits for non R&I actors

Practical benefits for community participants can be rarely seen as direct outcomes of projects, and current practices of engagement efforts often lack of remuneration for informal knowledge actors contributing to research and innovation activities (Snick 2012, Snick & Cortier 2012 check reference!). This may diminish informal knowledge actors' motivation to engage in R&I activities as well as their potential to engage (Karner et al. 2010).

Specialisation and fragmentation of the R&I landscape

The R&I landscape shows an ongoing division into different (sub)disciplines, which goes along with a strong favour for specialization and fragmentation of knowledge domains (Dedeurwaerdere 2014). This urges research and innovation actors to cut their projects into pieces, and to focus on single and very specific aspects to be investigated. While this may fit the requirements of academic and basic research, it is often not appropriate to investigate complex societal challenges, which are conceptualised as transversal or multidimensional challenges (Egmose 2015). Inter- and transdisciplinary research efforts are supposed to produce more useful outcomes, and related innovations are more likely to be effective if they emerge at the crossroads between diverse disciplines and at meeting places of various knowledge actors (e.g. practitioners, citizens) and experts.

Freedom of research

Interviewed experts, even if they were in favour of RRI, quite often raised the concern that a proliferation of RRI might go along with possible limitations of the freedom of science (see also Lang & Grissler 2015). This might on the one hand be caused through an increased political regulation of R&I activities, on the other hand through interventions from various societal actors. As experts anticipate that the implementation of RRI impose additional burdens, such as increased administrative efforts, need of additional skills, complex and delayed R&I processes, are particularly put on researchers, (justified) resistance is anticipated. As one of the Austrian experts highlights: *'I can see a risk that at a certain point everything needs to be RRI and researchers at a certain point will not be able to fulfil all the expectations anymore […] there still needs to be space for research that only follows academic criteria.'* (programme manager funding institution_At_I2)

Lack of trust and conflicting aims for societal desirability

If RRI implies to bring together a variety of stakeholders, a lack of trust between different societal stakeholders revealed to be a major obstacle (e.g. Lang & Griessler 2015). This often refers to vested interests of different societal groups opposed to the greater good or certain values, such as sustainability or

inclusiveness. Trust seems to be particularly low when contested R&I activities are at stake: either because stakeholders anticipate attempts to increase acceptance as the main aim of engagement activities, or because researchers anticipate a general suspicion towards their efforts (e.g. impact assessment studies) due to an assumed (financial) dependency on groups with certain interests (e.g. industry).

To aim for societal desirability can be very challenging for developers of innovative and enabling technologies, not least because societally desirable goals can conflict. For example, privacy might collide with public health as for instance reported for the UK National Health Service's 'Care.data' initiative, where every patient's medical records held by General Practitioners (GPs) to use--without informed consent-- to improve both public and private medical research and services. The benefits may be improved healthcare but the cost is largely an unauthorised loss of autonomy and privacy over what many consider to be their most personal data (Chand, 2014). In this case, the question becomes which is the more societally desirable goal, privacy or public health?

Economic competitiveness and profit making versus 'for the greater good'

Potential barriers for the implementation of RRI in the private sector have been identified e.g. in the 'Responsible- Industry' (http://www.responsible-industry.eu) and the NUCLEUS (http://www.nucleus-project.eu) project. Barriers may include conflicting priorities, such as to produce a return for shareholders, or profit margins, or to defend one's market position. Within a field of strong competition there would not be space for thinking about RRI (Flick & Stahl 2015). Additional work also means additional costs, and under economic pressure this may mean that RRI is not a priority. As industry representatives highlighted, the primary responsibility of enterprises is to make profit, and it tends to be of secondary priority to focus on R&I that concentrates on delivering societal benefits beyond (Mordan & Murphy 2016: 28). Thus the main question for engaging in RRI is how to get R&I deployed for the benefit of society and make money from it. As concluded by Lang & Grissler (2015), for industry *'RRI has to offer business opportunities or otherwise it will not be implemented'* (ibid: 17).

Companies are also concerned of being required to open up their data or patents. Finally, companies may be wary of the traceability of users of innovations – fixes or updates that solve issues responsibly may be unable to be pushed to devices or devices may not be easily recalled, according to one company (Flick & Stahl 2015: 21).

Barriers to the adoption of inclusive business models

RRI in the business context often refers to the notion of 'inclusive business models', which aim to benefit low-income communities by including them either on the demand side as clients or on the supply side as distributors, suppliers of goods and services, or employees in a sustainable way (UMDP 2008). As revealed in the PROGRESS project (www.progressproject.eu), this may imply the following challenges (Bierwirth et al. 2015: 15-16). First of all, inclusive business does not constitute a natural business function, and the language of shared value, sustainability or inclusive markets has not been uniformly adopted by business. The majority of motivations for businesses to engage in inclusive practices are defensive (avoiding loss/mitigating risk) or maintaining (staying competitive/keeping up). To reduce costs and mitigate risk, many companies are trying to transfer their usual business models to inclusive business, thus the 'old' business models remain dominant. Consequently, inclusive businesses are often expected to mature as commercial businesses and so are often judged by performance metrics that emphasize revenue and profit growth, which often represent inadequate performance metrics for inclusive efforts. Funding is again a key issue, and there is reluctance to provide adequate investment in developing and piloting inclusive business models. On the organisational level, lack of support from the top (CEOs) was criticized as often not going beyond lip services as well as shortcomings in companies capacities for incorporating inclusive business units.

Knowledge actor's perspectives on barriers for co-operative R&I activities

Within the online survey we also asked about the challenges people were confronted with in the scope of implementing collaborative R&I activities. Based on the findings from the literature review and what had been addressed by expert interviewees, we identified a series of aspects being relevant in collaborations, and survey participants were asked to indicate to what extent they were confronted with the following challenges:

- Building a meaningful common ground for the idea of the project with all actors engaged/research participants
- Planning and prioritising activities with all the actors engaged
- Dealing with conflicting interests of the actors engaged
- Making decisions transparent throughout the process to anybody concerned
- Achieving a clear understanding of the final results for everybody involved
- Keeping people motivated to participate throughout the process
- Not having sufficient flexibility within the project arrangements to adjust the project
- Finding myself in different roles (role as a researcher in academia and practice, as proposal writer, as facilitator, as citizen,…)
- Being confronted with problems based on cultural framework conditions (e.g. differences in working cultures, educational backgrounds, intercultural aspects)
- Needing more resources (funding, time) than initially planned for the project
- Clarifying intellectual property
- Fighting for recognition of my collaborative project in research and innovation community and beyond
- Lacking possibilities for publishing research results in academic journals

All suggested items were at least of some relevance (see Figure 11 below). However, issues related to intellectual property and to the flexibility of project arrangements in order to adjust project activities were of less relevance than expected. The comparably low relevance of intellectual property may be explained by our sample of respondents, of whom 74% indicated to be with a public research institute. Although we did not receive many comments through the survey, there were several confirming that intellectual property would contradict the idea of RRI, e. g. *'intellectual property goes against the grain of collaborative R&I'*, *'open access is the only option'*, *'intellectual property must be commons based (co-produced by the community, so it remains property of the community)'*.

The frequently in the literature addressed difficulties of generating publishable outputs from collaborative projects was of relative low relevance for respondents too: only 15% very much struggled with this problem, while more than 20% did not perceive it as a problem at all.

The highest agreement was on challenges related to building a meaningful common ground for the idea of the project with all actors engaged, 40% agreed very much.

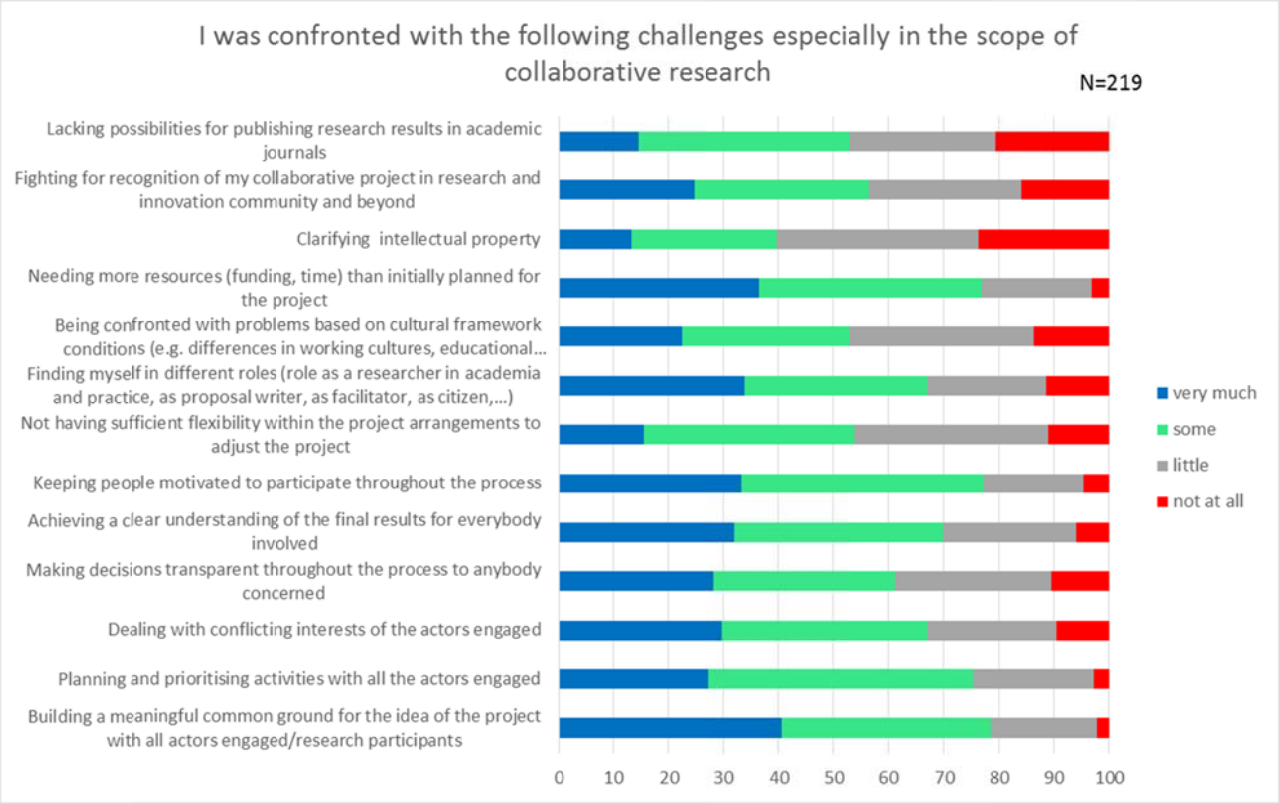


Figure 11: Online survey results on challenges of collaborative R&I activities (%)

4.1.2 Levers

Many barriers refer to institutional structures, which frame current R&I practices, thus changing the structural and institutional conditions in and outside the R&I community will be of particular relevance for the establishment of (CO)RRI Systems. In this section we list some aspects, that were mentioned within literature and by expert interviewees as important for creating a supportive environment for the implementation of RRI.

Creation of free thinking spaces

The creation of 'free spaces' for transdisciplinary research in which the quotidian duties and organizational expectations of academic research are set aside for a time, would allow knowledge actors to consider together how a more sustainable future might look like, to think 'beyond the horizon of the present' (Egmose 2015). Such spaces are places that allow for social imagination (which addresses the basic democratic question 'how do we want to live'), and where researchers' 'autonomy' can be restored. As Jonas Egmose highlights *'[…] the approach of trans-disciplinary methodology is far from opposing disciplinary modes of working. But it is, in fact, a question of insisting that the autonomy of the research is not merely constituted through the relation between the researcher and the research field, it is equally dependent on seeking intellectual freedom in terms of the opportunity to think freely beyond paradigmatically defined frameworks of understanding'* (ibid: 32). Transdisciplinary research would be an appropriate approach to replace 'knowledge production' by 'knowledge democracy'. 'While technocratic rationalities might deliver the environmental adaptation needed to cope with e.g. climate change, they will hardly enable democratic restructuring of society at local, national or global levels. Without democratic

approaches to the challenge of sustainability, it is not only the physical changes on Earth, but in fact also the potential future societal tensions grounded in social and environmental injustice, which might become decisive for our chances to sustain human life on Earth' (Egmose 2015, 11). Transdisicipliinary research is needed because, for research to take up challenges brought about through community engagement you need the involvement from specific research fields that are able to perceive the addressed challenge as a research issue' (Egmose 2015, 90-92).

Several of the expert interviewees also pointed to the importance of such spaces, which either could be organised within the formal R&I context or even in separate institutional contexts. However, it seems that the prevailing opinion on such 'free' or 'experimental' spaces is that they would rather represent niches than shaping the main R&I landscape.

Tailored funding programmes

One of the most efficient means to support a transformation towards a RRI system is to provide resources to researchers and business innovators and platforms for engaging civil society organizations or science educators. Corresponding funding programmes should consider the specific needs related to the implementation of RRI activities, such as providing room for experimental approaches by allowing for flexibility in terms of project processes and outcomes, or support for long-term cooperation between various knowledge actors (e.g. multi-actor research and innovation networks). Funds should also allow for an appropriate remuneration of non-R&I community participants in order to value their participation, which moreover may take some pressure from the RRI project in regard to its outputs (Karner et al. 2010).

Guidelines, training and capacity building

Besides institutional change, fostering knowledge actors' capabilities to pursue RRI is considered an important leverage. As suggested by expert interviewees this could be pursued in specific RRI trainings and seminars, and prospectively RRI would need to be considered already in the educational curricula. Additional support could be given in terms of practical guidelines for how to implement RRI activities, such as practical toolboxes (e.g. www.rri-tools.eu), institutionalised support units and experienced facilitators, and through the exchange of experiences and good practices within learning platforms or networks of RRI 'practitioners'.

Transparency

An important feature for the establishment of fruitful co-operations between knowledge actors is the establishment of trust, thus the principle of transparency represents a key for the governance of RRI (Lang & Griessler 2015). This implies transparency on funding procedures, transparency regarding the interest of different actors and stakeholder groups to be able to identify conflicts of interest, as well as transparency on the (potential) impacts of R&I processes and products by making data, methodology and results accessible.

Rewarding System

The implementation of RRI goes along with additional efforts compared to conventional R&I activities, and in order to increase knowledge actors' motivation to engage adequate remuneration strategies need to be put in place. For actors from the R&I community this might be better funding opportunities (see above) as well as measures such as more accredited publication opportunities, the acknowledgement of societal impact as central criteria for high quality research. In order to support the idea of RRI, research funding organisations and universities would need to modify their award criteria (Lang & Grissler 2015).

Knowledge actor's perspectives on supportive measures for collaborative R&I activities

The interviews and literature study revealed several measures, which could support a successful implementation of co-operative activities within R&I, which we also wanted to proof in the online survey. Thus we asked the survey participants about the relevance of the following measures:

- Acquiring specific skills for collaborative research (communication training; project management; specific training on responsible research and innovation)
- Including professional facilitators, who have specific skills for collaborative research (e.g. moderators, coaches, mediators, RRI-experts)
- Tailored funding programmes allowing for experimental and open process designs
- Funding programmes supporting long-term co-operations
- Possibility for financial remuneration for non-academic R&I partners
- Openness of peers for collaborative R&I approaches
- Evaluation of R&I beyond scientific excellence (e.g. societal impact)
- More recognised publication opportunities for collaborative research
- Acknowledgment of collaborative efforts in evaluating academic careers
- Guidelines for data protection and ethical principles

Non surprisingly, survey respondents anwers corresponded well with what they had indicated as perceived obstacles (see Figure 11 above). All suggested measure showed considerable relevance, but the most appreciated suport would be given by funding programmes, that allow for long-term cooperations and for experimental and open process design (see Figure 12 below). The introduction of evaluation (that naturally also refers to the academic rewarding system), which implies quality criteria beyond scientific excellence, such as societal impact also received very high appreciation. Least need was indicated concerning guidelines for data protection and ethical principles, which is in line with that data protection was not indicated to represent a very relevant issue in the context of collaborative R&I activities (see Figure 11 above).

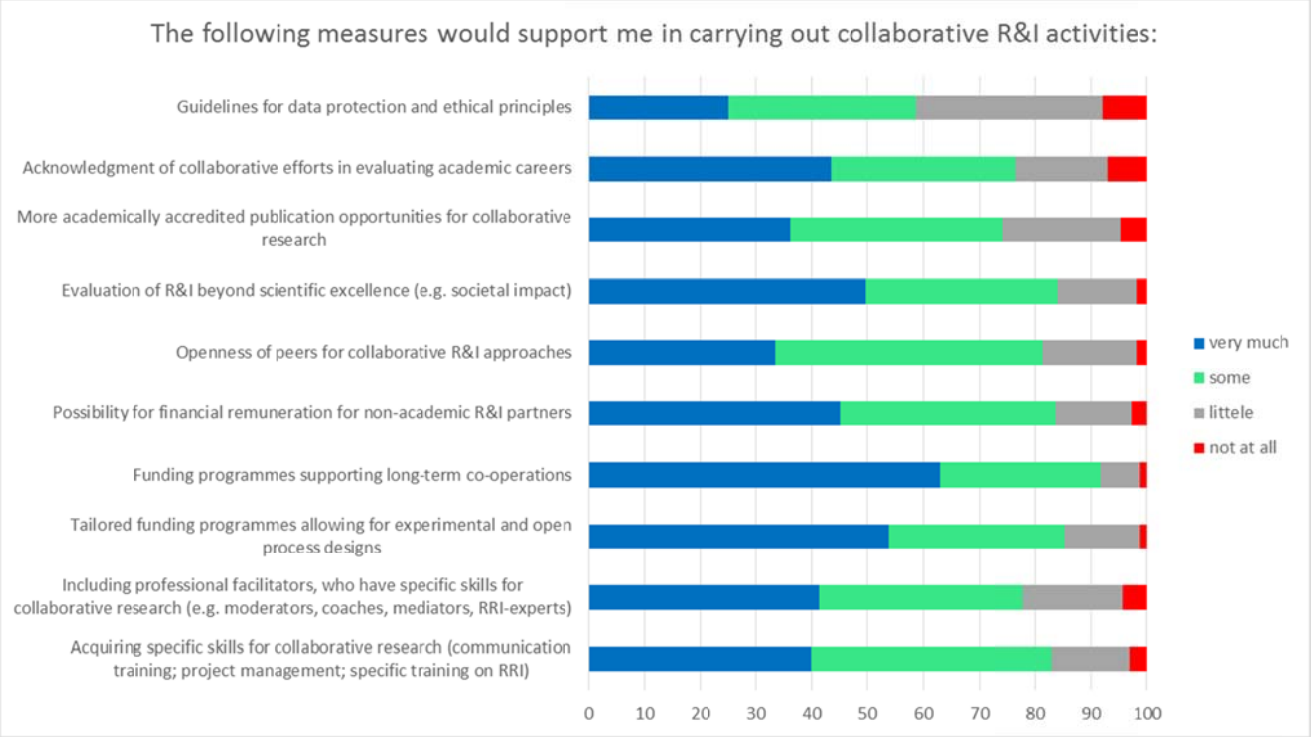


Figure 12: Online survey results on facilitating measures for collaborative R&I activities (% of respondents)

5 Conclusions

Need for RRI

Knowledge actors describe the prevailing R&I system as mainly driven by academic rules, and economic pressure, and big players with particular (economic) interests are seen as key actors, who steer the research agendas. Even if experts perceive a trend in orienting R&I more towards societal needs, the societal impact is still perceived as too low, and RRI is seen as a means to overcome shortcomings, which refer on one hand to (unintended) impacts of R&I, and on the other hand to tackling societal issues more efficiently.

Meaning of RRI

The definitions of what Responsible Research and Innovation means are context specific, thus highly diverse in terms of interpretations, practices, motivations and expectations. The conceptualisation of RRI refers to processes, practices and governance mechanisms as well as to the outcomes/products/impacts of R&I. While there is much attention about the conceptualisation of RRI in the academic and R&I policy discourses, it is not that much discussed within business/economic discourses.

Knowledge actors' ideas about RRI range from aiming to improve the societal value of current R&I practices and/or more efficiently addressing societal challenges, but without questioning currently prevailing system(s) and paradigms, to RRI as a tool for 'thinking outside the box'. While knowledge actors on the one end of the line seem to accept current systems as given context, in which RRI could serve to improve certain shortcomings, opinions on the other end acknowledge that values are inherent in R&I, and that its political dimensions should be revealed. They see RRI as a tool for critical reflection on the paths and societal impact of R&I, and expect RRI to lead to more radical transformations within and beyond the R&I system(s).

While in the context of emerging technological and research fields the basic assumptions and paradigms underlying R&I remain mainly unquestioned, other research fields seem to be more open towards a 'thinking outside the box'. For instance case studies, which address sustainability problems, suggest that basic assumptions about the societal problems and ways to tackle them (including sometimes also values) might be questioned. Here the engagement of a broad variety of viewpoints (including the critical ones) is considered as promising strategies for coming up with more effective solutions. Even if this does not (always) aim at changing the R&I system(s), this might be interpreted as a change in how to tackle societal challenges.

In scholarly literature and in EU policy documents the mostly cited definition of RRI is the one provided by von Schomberg (2013: 63.): *'Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become 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).'* However this definition is criticized for being valid only in high income settings (and especially in Europe). Therefore a wider definition provided by Stilgoe et al. (2013: 1570) seems to better reflect on the arguments of the RRI literature: *„Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present'.* However the broad definition allows for various (sometimes even contradicting) interpretations. The vagueness of the concept is perceived by knowledge actors with ambivalence: on one hand it provides enough room for context specific adaptations, e.g. to be collectively negotiated and refined on a case by case basis; on the other hand it makes the institutionalisation of RRI practices and the evaluation of RRI practices more difficult, or it may imply the risk of ending up with a concept of little meaning, finally calling anything RRI, which is not traditional research.

The main building blocks of RRI (anticipation, reflexivity, inclusion and responsiveness) are also open for various interpretations. What actually seems to serve as a (relatively) solid ground for RRI is the post-normal understanding of science; the reference to 'organized irresponsibility', and the belief that present structures are in many ways unsustainable and unjust.

Engagement as basic characteristics of RRI

There seems to be a consensus in the literature about the basic characteristics that make R&I responsible (e.g. stakeholder engagement, deliberation, anticipation, responsiveness, reflexivity). While the exact content of these concepts often remains shadowy (especially with regard to stakeholder engagement) in the scholarly literature, RRI case study related publications try to define RRI in order to make it clearer for the specific context and operational.

However, it may be concluded that the implementation of RRI very often builds on engagement of or cooperation with non-academic societal actors, which is implemented in various forms (different in e.g. timing within the R&I process, range of stakeholders, degree of participation, process ownership, actual impact on R&I process and outcomes). This was confirmed in reviewed case studies as well as in the expert interviews.

While expert interviews revealed a preference for genuine bottom-up collaborative processes that would distinct the implementation of RRI from other participatory approaches, current practices of engagement build mostly on closed groups of decision makers (researchers, innovators, sometimes policy makers), to which additional stakeholders are invited. Therefore participation occurs in pre-defined spaces with mostly pre-defined rules. The attempts of stakeholders to claim spaces for themselves may even seem to be irresponsible.

However, we also came across a few good practice examples, which implied considerable efforts to be inclusive and to allocate power to co-shape the process (e.g. through dual leadership) and decision making to knowledge actors beyond the formal R&I community, which also includes examples that took efforts to allow for co-shaping of the space in which participation occurs. The way in which engagement processes are organised in practice is linked to the thematic field, the aim of the engagement activities, the relevance of non-academic knowledge(s), and particularly to 'traditions' in research fields.

Normative, substantive and instrumental motives

Due to a widely spread perception that there is a need for RRI to improve the current R&I system in order to tackle societal problems more efficiently, the normative framing that RRI is something positive seems to be uncontested. However, there are also voices expressing concerns that the expansion of RRI practices must not undermine the freedom of research.

Emerging technological and research fields (with often controversial achievements) are especially eager to take the RRI concept on board. This draws attention to a certain risk that RRI may be underpinned by purely instrumental motivations in these R&I fields. In other fields, particularly when dealing with applied research tackling concrete sustainability problems, motivations seem to be as well instrumental (raising awareness for a problem, increasing acceptance for solutions, increasing the impact of outcomes), but also substantial in terms of actual knowledge co-production.

Politisation of R&I

RRI practices often fail to reflect on the politics and non-neutrality of RRI, especially on the political content and moral principle implicitly put forward by the initiators of RRI exercises, who are mainly researchers and policy-makers. Participation is very much oriented towards negotiating values (and maybe interests) not towards actually making decisions. Yet the RRI literature does not provide guidance on how to deal with power conflicts, value conflicts, minority opinions or reluctance for participation.

This ignorance of the political aspect can easily result in sustaining the status quo - including mechanisms of knowledge hierarchies, power relations and oppression of marginalised voices, and thereby undermine the original aims of RRI when it comes to practice.

Barriers and levers for RRI

Literally all issues, which represent barriers for practicing RRI, refer to structural and institutional conditions of current R&I systems, and to mechanisms, which govern it (e.g. economic logics). In order to get RRI deeply rooted in R&I practices, changes in the R&I system and its driving forces will be crucial.

5.1 Towards a concept of CORRI

To summarize the implications for the CORRI concept we ask and provide tentative answers to four questions (based on the review of literature, case studies and the knowledge actors' perspectives). We would like to emphasize that these answers are at best tentative answers, since the picture revealed by our analysis is very complex and fuzzy. If we look at the state-of-the-art of RRI we see the diverseness of interpretations, practices, motivations, expectations and underlying assumptions with some identifiable but not overwhelming tendencies.

The questions, building on the arguments of Stilgoe et al. (2013) and von Schomberg (2013) and the guiding principles proposed by the European Commission (EC 2012), refer to the product and process dimensions of RRI:

1) Does RRI have the explicit aim of producing answers/solutions to the 'big challenges'?
2) Is RRI always based on a systemic analysis of the root causes of current crises?
3) Does RRI take into account the real limits of the planet?
4) Is RRI always organised in such a way (engagement, gender equality, ethical considerations, open science, science education and governance) that it will lead to solutions for the 'big challenges'?

RRI addressing big societal challenges

Certainly the response to the grand challenges is in the core of the RRI discourse. We can state that the rise of the RRI concept is very much rooted in the failure of current R&I systems to address these challenges. However, some of our results suggest that RRI may not be fully equipped to tackle these challenges either.

First, RRI and its elements are very often cited in mainstream discourses, and emerge in contexts that are incoherent. In the policy arena it is quite common to talk simultaneously about responsible research and innovation and smart and inclusive growth. Alternatively when RRI is anchored in the European common values (Schomberg 2013), potentially conflicting values are listed. Therefore the risk that RRI may serve a pre-committed policy, with economic growth as its main priority (Owen et al. 2012; Stilgoe at al 2013) is very much real.

Second, RRI also implies the risk of serving pre-committed scientific or technological programmes. It is an alarm signal that most of the case studies presented by the literature derive from highly controversial high-tech fields.

Third, the analysed cases also suggested that advertising a process as RRI mainly implied certain changes in the process (adding more in terms of thinking about the ethical aspects, about inclusion, transparency or gender issues). But they did not imply heavy criticism of the existing hierarchies and mechanisms of oppression.

Therefore our tentative answer to the first question is that RRI has not brought a major change in addressing the grand challenges. RRI is rather manifested in modest changes in the research and innovation process.

RRI addressing the root causes

Our tentative answer to the question above also suggests that RRI may also have deficiencies in this respect as well. We must emphasize again that the theorizing about RRI (or RI) highlights that the fundamental problems are systemic. Systemic concepts, such as Beck's 'organized irresponsibility' is in the core of the discourse; as well as the call for 'collective responsibility' as an answer.

But if we look at the answers provided so far, we see that most of the attention is paid to micro-level practices. And most (but not all) of the analysed cases also reinforced that the main characteristics of the present systems are often taken as granted. The content of the projects appearing in the literature are often quite conventional, without 'out of the box' thinking (e.g. big solutions for the big problems; purely technological solutions; the lack of trans-disciplinarily).

So our tentative answer to the second question is that RRI has a limited ability to address the root causes of today's great challenges.

RRI addressing planetary limits

Just like in case of the above questions, here we can also state that sustainability is a core issue in the literature of RRI. But again the RRI community does not seem to perform faultlessly in this respect. This is a clear consequence of the abovementioned issues.

If RRI has a limited ability to address grand challenges, to tackle (systemic) root causes, carry out transdisciplinary research and to bring about change in the policy arena (where RRI and smart growth may go hand in hand), than there is not too much chance to actually further sustainability.

On top of this, the term RRI is very often used in fields that are controversial, contested by citizens or where the link to sustainability is a bone of contention (e.g. biotechnology, geo-engineering, nanotechnology, synthetic biology). And we can also see that many of the bottom-up initiatives (grassroots innovations, social innovations) that have the explicit aim of challenging current systems and hegemonies do not (or even refuse to) call themselves RRI.

Therefore our tentative answer to the third question is that RRI very often fails to actually address planetary limits; or the other way around: the addressing of the planetary limits does not seem to be a precondition of calling something RRI.

The process aspect of RRI

As our answers to the above questions suggested the way the process is organized seems to be more decisive in terms of what we call RRI. The characteristics of the process are in the core of the RRI discourse. In the scientific discourse around RRI the aspects put forth by Stilgoe et al (2013) are the most cited: anticipation, reflexivity, inclusion and responsiveness. In the policy arena: engagement, gender equality, ethical considerations, open science, science education and governance are the defining characteristics of a 'responsible' process. It is also clearly stated that RRI should not be about 'tick-boxing' these requirements.

However, the review of the RRI literatures and the case study analysis suggest that meeting the process requirement can also be problematic. Having a closer look at these categories makes it clear, that they

leave room for various interpretations. They can depict a process that is organized in a way, where problem identification, knowledge creation and validation are co-created in a trans-disciplinary effort. But can also depict a process where chosen actors are invited to a pre-given space where researchers and technologists can convince or educate them.

On the basis of our findings the RRI discourse overlooks the political content of the process or is naïve in these terms. It often fails to reflect on it political nature, the assumptions and value commitments of the process owners. RRI is likely to be a process that is initiated by researchers and policy makers, who invite selected actors into the process to discuss values and contribute with their knowledge (to the point it does not challenge their basic underlying assumptions). Stakeholders are invited to discuss but not to actually make decisions. We can also state that RRI has not fully overcome the traditional hierarchy of scientific (expert) and other kinds of knowing. The normative foundations of RRI are not clear-cut either which again leaves room for various (even contradicting) interpretations.

Therefore, our tentative answer to the forth question is that a process can easily be called RRI without actually being organized in a way that challenges present (unsustainable) structures.

On the basis of our analysis we identified shortcomings in the current RRI practices, which we will take into account for the conceptualisation of CORRI. It became clear that it is not the definition of RRI or CORRI that matters at the first instance, but it is the way of how the concept is translated into practice. This translation is inevitably connected to value choices and power conflicts, and therefore the core of practicing CORRI will be to negotiate on decisions to be taken, which will frame the CORRI activity. Since any societal challenge may be tackled through different ways, and more than one valid solution may exist, which imply different sets of available options, we consider it crucial to make this explicit in CORRI processes by reflecting on key aspects, such as:

- Ownership of the process: Initiate a new process or support an existing bottom-up process?
- Attitude towards policy-making: suggest or enforce?
- Aim of process: building consensus or making conflicts visible?
- Who takes part? Participation through invitations or claims?
- Whose voice should be heard? Directly or through advocates?
- What is the invitation for? Contribute or make decisions?

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Appendix 1

Template for literature review

NAME OF REVIEWER:	
REVIEWED PAPER/PROJECT: *(provide citation)*	

1. **General views on RI & RRI**

Does the paper/project develop a definition for RI or RRI?
(if yes, provide the definition with page number)

Does the paper/project refer to an existing definition from the literature?
(if yes, provide the definition and the reference)

Does the paper/project provide a list of the aspects / dimensions / main features / steps to perform of RI or RRI?
(if yes, provide the list of the aspects with a short description)

2. **The key concepts of CORRI**

Does the paper/project specify what is exactly meant by **participation / engagement** with respect to RRI?

- Does participation occur in a pre-defined space or do stakeholders have the opportunity to define and shape the space in which participation occurs?
- What kind of power is provided to stakeholders through participation? (e.g. be informed / articulate interest or values / take part in discussions / influence / make final decisions / evaluate)
- Who is excluded and through what kind of mechanisms?
- Do gender/emancipatory perspectives occur when participation or engagement is mentioned?

Does the paper/project specify in what way RRI is a **collective action**?

- Is it specified how RRI contributes to take collective responsibility?
- Is technological decision making the business of a closed group to which stakeholders are invited, or is it a social problem-solving activity to which technicians are invited?
- Is it specified how grand challenges should be identified (e.g. by whom)?

3. **Responsible practices**

Does the paper/project refer to **policy practices** that are precedents of RI & RRI or can be considered to be responsible? (e.g. consensus conference, constructive technology assessment etc.)
(if yes, provide a list of these practices)

Does the paper/project refer to **research practices** that are precedents of RI & RRI or can be considered to be responsible? (e.g. community-based research, value-based design etc.)

(if yes, provide a list of these practices)

Does the paper/project refer to **innovation practices** that are precedents of RI & RRI or can be considered to be responsible? (e.g. intermediate technology, participatory design etc.)

(if yes, provide a list of these practices)

4. Practical examples and case studies

(cases that are more than mere illustrative examples, at least a sub-chapter is dedicated to them)

(The following questions must be answered for each provided cases independently)

Basic features of the examples / case studies provided by the paper/project

- Title:
- Technological field / industry:
- Location:

Does the case study specify how **participation / engagement** are carried out?

- Does participation occur in a pre-defined space or do stakeholders have the opportunity to define and shape the space in which participation occurs?
- What kind of power is provided to stakeholders through participation?
- Who is excluded and through what kind of mechanisms?

Does the case study mention **gender perspectives**?

- What does gender equality actually mean in the provided case?
- What kind of excluded groups / exclusion mechanisms are mentioned?
- Does the idea of empowerment occur?

Does the case study specify the **ethical considerations** lying behind the actions?

- Where does the chosen ethical basis come from (who chose it through what sort of procedure)
- Is the chosen ethical basis different than that of the dominating one?
- Does the case study mention ethics with respect to the design of technology or the control over the technology?

Is the aspect of **open science** mentioned in the case study?

- How is the idea 'passed on' (are there any efforts mentioned that try to adapt the idea to other contexts)?
- Who judges the validity of the newly created knowledge?

Is the aspect of **science education** mentioned in the case study?

- Is the hierarchical relation of 'educator–student' approached?
- Is the expert–lay dichotomy approached?

5. An overall (subjective) opinion of the reviewer

(Anything the reviewer considers being important to mention about the paper/project or about the case studies appearing in the paper/project)

Appendix 2

Full list of the reviewed scholarly papers

Year	Authors	Title	Journal	Vol, Issue, Pages
2003	Hellström, T.	Systemic innovation and risk: technology assessment and the challenge of responsible innovation	Technology in Society	25, pp. 369-384
2009	Andereck, K. L.	Tourists' perceptions of environmentally responsible innovations at tourism businesses	Journal of Sustainable Tourism	17 (4), pp. 489-499
2009	Mahlouji, H. - Anaraki, N. K.	Corporate Social Responsibility Towards Social Responsible Innovation: A Dynamic Capability Approach	International Review of Business Research Papers	5 (6), pp. 185-194
2009	Owen, R. et al.	Beyond regulation: Risk pricing and responsible innovation	Environmental Science & Technology	43, pp. 6902-6906
2010	Owen, R. - Goldberg, N.	Responsible Innovation: A Pilot Study with the U.K. Engineering and Physical Sciences Research Council	Risk Analysis	30 (11), 1699-1707
2010	Selin, C. - Boradkar:	Prototyping Nanotechnology: A Transdisciplinary Approach to Responsible Innovation	Journal of Nano Education	2 (1-2), pp. 1-12
2011	Grunwald, A.	Responsible Innovation: Bringing together Technology Assessment, Applied Ethics, and STS research	Enterprise and Work Innovation Studies	7, pp. 9-31
2011	Stahl, B. C.	IT for a better future: how to integrate ethics, politics and innovation	Journal of Information, Communication and Ethics in Society	9 (3), pp. 140-156
2012	Armstrong, M. et al.	Towards a practical approach to responsible innovation in finance: New product committees revisited	Journal of Financial Regulation and Compliance	20 (2), pp. 147-168

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2012	D'Silva, J. - Robinson, D. K. R. - Shelley-Egan, C.	A game with rules in the making - how the high probability of waiting games in nanomedicine is being mitigated through distributed regulation and responsible innovation	Technology Analysis and Strategic Management	24 (6), pp. 583-602
2012	Kiran, A. H.	Does responsible innovation presuppose design instrumentalism? Examining the case of telecare at home in the Netherlands	Technology in Society	34 (3), pp. 216-226
2012	Mali, F. et al.	National Ethics Advisory Bodies in the Emerging Landscape of Responsible Research and Innovation	Nanoethics	6, pp. 167-184
2012	Owen, R. - Macnaghten: - Stilgoe, J.	Responsible research and innovation: From science in society to science for society, with society	Science and Public Policy	39, pp. 751-760
2013	Douglas, C. M. W. - Stemerding, D.	Governing synthetic biology for global health through responsible research and innovation	Systems and Synthetic Biology	7 (3), pp. 139-150
2013	Gaskell, G. et al.	Publics and biobanks: Pan-European diversity and the challenge of responsible innovation	European Journal of Human Genetics	21 (1), pp. 14-20
2013	Pandza, K. - Ellwood:	Strategic and ethical foundations for responsible innovation	Research Policy	42, pp. 1112-1125
2013	Stahl, B. C.	Responsible research and innovation: The role of privacy in an emerging framework	Science and Public Policy	40, pp. 708-716
2013	Stilgoe, J. - Owen, R. - Macnaghten:	Developing a framework for responsible innovation	Research Policy	42, pp.1568-1580

2014	Asante, K. - Owen, R. - Williamson, G.	Governance of new product development and perceptions of responsible innovation in the financial sector: insights from an ethnographic case stud	Journal of Responsible Innovation	1 (1), pp. 9-30
2014	Blok, V.	Look who's talking: responsible innovation, the paradox of dialogue and the voice of the other in communication and negotiation processes	Journal of Responsible Innovation	1 (2), pp. 171-190
2014	Davis, M. - Laas, K.	'Broader Impacts' or 'Responsible Research and Innovation'? A Comparison of Two Criteria for Funding Research in Science and Engineering	Science and Engineering Ethics	20, pp. 963-983
2014	de Bakker, E. et al.	Responsible research and innovation in miniature: information assymmetries hindering a more inclusive 'nanofood' development	Science and Public Policy	41, pp. 294-305
2014	Galasso, A. - Tombak, M.	Switching to Green: The Timing of Socially Responsible Innovation	Journal of Economics & Management Strategy	23 (3), pp. 669-691
2014	Ganzelves, J. - van Est, R. - Nentwich, M.	Embracing variety: introducing in inclusive modelling of (Parliamentary) technology assessment	Journal of Responsible Innovation	1 (3), pp. 292-313
2014	Grunwald, A.	The hermeneutic side of responsible research and innovation	Journal of Responsible Innovation	1 (3), pp. 274-291
2014	Halme, M. - Korpela, M.	Responsible Innovation Toward Sustainable Development in Small and Medium-Sized Enterprises: a Resource Perspective	Business Strategy and the Environment	23, pp. 547-566

2014	Hemphill, T. A.	Responsible innovation and patent assertion entities	Journal of Responsible Innovation	1 (3), pp. 314-320
2014	Hodges, K. - Angelos:	Responsible innovation in surgery: a proposal for an anonymous registry of surgical innovation	Journal of Responsible Innovation	1 (2), pp. 208-213
2014	Macnaghten: et al.	Responsible innovation across borders: tensions, paradoxes and possibilities	Journal of Responsible Innovation	1 (2), pp. 191-199
2014	Nordmann, A.	Responsible innovation, the art and craft of anticipation	Journal of Responsible Innovation	1 (1), pp. 87-98
2014	Oftedal, G.	The role of philosophy of science in Responsible Research and Innovation (RRI): the case of nanomedicine.	Life Sciences, Society and Policy	10 (5)
2014	Oudheusden, M.	Where are the politics in responsible innovation? European governance, technology assessments, and beyond	Journal of Responsible Innovation	1 (1), pp. 67-86.
2014	Owen, R.	The UK Engineering and Physical Sciences Research Council's commitment to a framework for responsible innovation	Journal of Responsible Innovation	1 (1), pp. 113-117
2014	Özdemir, V. et al.	Ready to put metadata on the post-2015 development agenda? Linking data publications to responsible innovation and science diplomacy	OMICS A Journal of Integrative Biology	18 (1), pp. 1-9
2014	Rip, A.	The past and future of RRI	Life Sciences, Society and Policy	10 (17)
2014	Stahl, B. C. et al.	The empathic care robot: A prototype of responsible research and innovation	Technological Forecasting & Social Change	84, pp. 74-85

2014	Stahl, B. C. et al.	From computer ethics to responsible research and innovation in ICT. The transition of reference discourses informing ethics-related research in information systems	Information & Management	51, pp. 810-818
2014	Taebi, B. et al.	Responsible innovation as an endorsement of public values: the need for interdisciplinary research	Journal of Responsible Innovation	1 (1), pp. 118-124
2014	van Geenhuizen, M.	Responsible innovators: Open networks on the way to sustainability transitions	Technological Forecasting & Social Change	87, pp. 28-40
2014	Wender, B. A. et al.	Anticipatory life-cycle assessment for responsible research and innovation	Journal of Responsible Innovation	1 (2), pp. 200-207
2014	Wickson, F. - Carew, A. L.	Quality criteria and indicators for responsible research and innovation: learning from transdisciplinarity	Journal of Responsible Innovation	1 (3), pp. 254-273
2014	Wilsdon, J.	From foresight to hindsight: the promise of history in responsible innovation	Journal of Responsible Innovation	1 (1), pp. 109-112
2014	Zwart, H. - Landeweerd, L. - van Rooij, A.	Adapt or perish? Assessing the recent shift in the European research funding arena from 'ELSA' to 'RRI'	Life Sciences, Society and Policy	10 (11)
2015	Asveld, L. - Ganzevles, J. - Osseweijer:	Trustworthiness and Responsible Research and Innovation: The Case of the Bio-Economy	Journal of Agricultural and Environmental Ethics	28, pp. 571-588
2015	Brian, J. D.	Special perspectives section: responsible research and innovation for synthetic biology	Journal of Responsible Innovation	2 (1), pp. 78-80

2015	de Jong, I. M. et al.	Responsible Reporting: Neuroimaging News in the Age of Responsible Research and Innovation	Science and Engineering Ethics	
2015	de Saille, S.	Innovating innovation policy: the emergence of 'Responsible Research and Innovation'	Journal of Responsible Innovation	2 (2), pp. 152-168
2015	Deblonde, M.	Responsible research and innovation: building knowledge arenas for glocal sustainability research	Journal of Responsible Innovation	2 (1), pp. 20-38
2015	Gardner, J. - Williams, C.	Responsible research and innovation: A manifesto for empirical ethics?	Clinical Ethics	10 (1-2), pp. 5-12
2015	Keeler, L. W. - Foley, R. W.	The Monster and the polar bears: constructing the future knowledge landscape of synthetic biology to inform responsible innovation	Journal of Responsible Innovation	2 (1), pp. 81-84
2015	Landeweerd, L.	Reflections on different governance styles in regulating science: a contribution to 'Responsible Research and Innovation'	Life Sciences, Society and Policy	11 (8)
2015	Li, F. - Owen, R. - Simakova, E.	Framing responsible innovation in synthetic biology: the need for a critical discourse analysis approach	Journal of Responsible Innovation	2 (1), pp. 104-108
2015	Malsch, I.	Communitarian and Subsidiarity Perspectives on Responsible Innovation at a Global Level	NanoEthics	9 (2), pp. 137-150
2015	Meyer, M.	Devices and trajectories of responsible innovation: problematising synthetic biology	Journal of Responsible Innovation	2 (1), pp. 100-103

2015	Petrescu, A-M. - Gorghiu, G. - Lupu, R. A.	Non-formal Education - Frame for Responsible Research and Innovation Demarches	Procedia - Social and Behavioral Sciences	180, pp. 682-687
2015	Schroeder, D. - Ladikas, M.	Towards principled Responsible Research and innovation: employing the Difference Principle in funding decisions	Journal of Responsible Innovation	2 (2), pp. 169-183
2015	Shortall, O. K. - Raman, S. - Millar, K.	Are plants the new oil? Responsible innovation, biorefining and multipurpose agriculture	Energy Policy	86, pp. 360-368
2015	Stemerding, D.	iGEM as laboratory in responsible research and innovation	Journal of Responsible Innovation	2 (1), pp. 140-142
2015	Voegtlin, C. - Scherer, A. G.	Responsible Innovation and the Innovation of Responsibility: Governing Sustainable Development in a Globalized World	Journal of Business Ethics	pp. 1-17

Appendix 3

List of the reviewed case study documents

Project	Case study	Authors	Year
Res-Agora Major goal: to develop a comprehensive governance framework for RRI	Linking responsible research and innovation on the farm: the case of participatory guarantee systems.	Allison Loconto	2013
	The responsiblisation and regulation of garage innovation: DIY drug innovation in psychonaut subculture	Johan Söderberg	2014
	Anchoring knowledge transfer activities. The EC CoC and normative anchor points in laboratory practices in Italy	Simone Arnaldi; Alessia Muratorio	2013
	Horizontal Foresight to Address Societal Challenges in Danish Priority-setting for Strategic Research	Morten Velsing Nielsen	2014
EISRI II Organized a summit on Summit) on the 'Role of the Media in Responsible Research and Innovation'	Special Initiative for Citizen Engagement In Science	Atomium European Institute for Science, Media and Democracy	2013
	Science Shops (website: http://www.livingknowledge.org/science-shops/about-science-shops/)	Living Knowledge Network	2010-ongoing
RESCUE Proposes an innovative vision about how to build the transitions towards sustainability through various innovative; forms of learning and research. The RESCUE vision is built around the idea of an open knowledge system, where knowledge is generated from multiple sources (some of which are scientific) and shared at every stage of its development; and where problems are defined and addressed by society as a whole, not just by scientists, or policy makers	Peg – A community indicators system for the people of Winnipeg	Christa Rust	2008
Synenergene The project aims to contribute to Responsible Research	No case studies	-	-

and Innovation (RRI) in synthetic biology by establishing an open dialogue between stakeholders concerning synbio's potential benefits and risks, and by exploring possibilities for its collaborative shaping on the basis of public participation.			
NERRI Aims to contribute to the introduction of Responsible Research and Innovation (RRI) in neuro-enhancement (NE) in the European Area and to shape a normative framework underpinning the governance of neuro-enhancement technologies	Roskilde 2045. A look into the future	Sheena Laursen	2015
RRI Tools Will develop a training an dissemination toolkit for fostering RRI	VOICES (Views, opinions and ideas of citizens in Europe on science)	Frank Kupper, Pim Klaassen, Michelle Rijnen, Sara Vermeulen, Remco Woertman and Jacqueline Broerse	2015
	PULSE exhibition and research project		
	Citizens create knowledge (BürGEr schaffen WISSen, GEWISS)		
	EuroBioAct, European Bioethics in Action		
	Knowledge for Climate (Kennis voor Klimaat)		
	Collaborative solutions for improvement of data-limited fisheries systems		
	Marlisco (Marine Litter in European Seas - Social Awareness and Co-Responsibility)		
	InnovAcciones 360°		
	Challenge-driven innovation (CDI)		
	Mistra Urban Futures		

Responsible-Industry intends to demonstrate how industry can work together with societal actors to integrate principles and methodologies of Responsible Research and Innovation (RRI) into research and development processes.	Ambiact	Thomas Frenken	2014
	My Brain Book	Nada Savitch	2014
	ICT-tool for multidisciplinary innovation teams	Steven Flipse	2014
ProGReSS Aims to promote a European approach to Responsible Research and Innovation (RRI) through a global network	The involvement of a marginalised indigenous population, the San population of Southern Africa, in health-related innovations.	Roger Chennells	2015
	Food Security: sarmap's satellite technology to monitor crop's production	F. Cavallaro, D. Schroeder, Han Bing	2014
GREAT Aims at developing an empirically based and theoretically sound model of the role of responsible research and innovation (RRI) governance	SPOCS (Simple Procedures Online For Cross---Border Services)	Barbara Grimpe, Marina Jirotka	2014 (?)
	ImmigrationPolicy2.0		

Appendix 4

List of all reviewed project documents

Year	Authors	Title	Project
2015	Edler, J; Randles, S; Gough, C	Deliverable D3.7 Final Synthesis and Lessons Report. Res-AGorA empirical programme of case studies, transversal lessons and illustrations to the Responsibility Navigator	Res-AGorA http://www.res-agora.eu
2014	Walhout, B; Kuhlmann, S; Dorbeck-Jung, B; Edler, J; Randles, S; Gee, S	Deliverable D2.2 – update Research heuristic and key concepts	Same as above
	Kuhlmann, S; Ordonez-Matamoros, G; Edler, J and Lindner, R	Governance framework for Responsible Research and Innovation Res-AGorA Policy Note # 2 of 3	Same as above
2015	Lang, A; Griessler, E	Deliverable D4.10 Position paper on key elements for the governance of RRI: synthesis report on five thematic stakeholder workshops	Same as above
2013	Loconto, A	Linking responsible research and innovation on the farm: the case of participatory guarantee systems.	Same as above
2014	Söderberg, J	The responsiblisation and regulation of garage innovation: DIY drug innovation in psychonaut subculture	Same as above
2013	Arnaldi, A; Muratorio, A	Anchoring knowledge transfer activities. The EC CoC and normative anchor points in laboratory practices in Italy	Same as above
2014	Velsing Nielsen, M	Horizontal Foresight to Address Societal Challeng-es in Danish Priority-setting for Strategic Research	Same as above
2011	Jäger, J; Pálsson, G; Goodsite, M; Pahl-Wostl, C; O'Brien, K; Hordijk, L; Avril, B; Cloetingh, S; Holm, P; Toonen, T; Reams, J; Berkhout, F	Responses to Environmental and Societal Challenges for our Unstable Earth (RESCUE), ESF Forward Look – ESF-COST 'Frontier of Science' joint initiative. European Science Foundation, Strasbourg (FR) and European Cooperation in Science and Technology	RESCUE http://www.esf.org/fileadmin/Public_documents/Publications/rescue.pdf
2008	Rust, C	Developing a Sustainability Indicators System to Measure the Well-being of Winnipeg's First Nations Community. Framework Development and the Community Engagement Process (Preliminary Report)	RESCUE https://www.iisd.org/pdf/2008/amc_dev_indicators_w

			pg.pdf
2015	Zwart, H	D3.5 Final Report WP3	NERRI www.nerri.eu
2015	Laursen, S	Roskilde 2045 A look into the future	Same as above
2015	Kupper, F; Klaassen, P; Rijnen, M; Vermeulen, S; Woertman, R and Broerse, J	D1.4 A catalogue of good RRI practices	RRI Tools http://www.rri-tools.eu/
		RRI Tools: towards RRI in action	Same as above
2015	López Verdeguer, I	1st Periodic Activity Report	Same as above
		Periodic Report Summary 1 - RRI TOOLS (RRI TOOLS, a project to foster Responsible Research and Innovation for society, with society.)	RRI Tools http://cordis.europa.eu/result/rcn/176440_en.html
2014	Klaassen, P; Kupper, F; Rijnen M; Vermeulen, S; Broerse, J	D1.1 Policy brief on the state of the art on RRI and a working definition of RRI	RRI Tools http://www.rri-tools.eu/
2014	Kupper, F; Rijnen, M; Vermeulen, S; Broerse, J	D1.2 Methodology for the collection and classification of RRI practices	Same as above
2015	Kupper, F; Klaassen, P; Rijnen, M; Vermeulen, S; Broerse, J	D1.3 Report on the quality criteria of Good Practice Standards in RRI	Same as above
2015	Kupper, F; Klaassen, P; Rijnen, M; Vermeulen, S; Woertman, R; and Broerse, J	D1.4 A catalogue of good RRI practices	Same as above
2015	Creek, M; Marschalek, I; Handler, K; Smallman, M; Steinhaus, N; Alix, J-P; Van Dyck, L; De Harambure, A; Goncalves, J; Debry, M; Giannakopoulou, A	D2.1 Guidelines for the implementation of the stakeholder consultation in relation to RRI	Same as above
2015	García, I; Serras, D; García, R; Varela, JR; Santamaría, G	D 3.1 Defining the RRI Tools Collaborative Platform	Same as above
2014	Alix, J-P; De Harambure, A	Communication and dissemination plan	Same as above
2015	Alix, J-P; De Harambure, A	D6.2	Same as above

		RRI Tools: looking back at the first year of the project	
2013	Atomium Culture	The Role of the Media in Responsible Research and Innovation	EISRI II http://2013.eisri-summit.eu/wp-content/uploads/2014/05/report-eisri.pdf
2013	Atomium Culture	HAVE YOUR SAY . . . ABOUT SCIENCE! Special Initiative on Citizen Engagement in Science	EISRI II http://www.eismd.eu/wp-content/uploads/2015/03/Report-SpICES-HAVE-YOUR-SAY-ABOUT-SCIENCE.pdf
2015	Flick, C; Stahl, B	D1.4 Horizon Scanning (a): Horizon Scanning in the area of ICT for an ageing society	Responsible-Industry http://www.responsible-industry.eu/dissemination/deliverables
2014	Søraker, J.H.; Brey:A.E.	D1.1 Systematic review of industry relevant RRI discourses	Same as above
2014	Porcari, A; Borsella, E; Mantovani, E	D2.4 Responsible-Industry A Framework for implementing Responsible Research and Innovation in ICT for an ageing society	Same as above
2014	Various	D1.2 Case Study Descriptions	Same as above
2015	Bierwirth, A; Cavallaro, F; Chennells, R; Schroeder, D	D4.3 Recommendations from industry and end-users for RRI	PROGRESS www.progressproject.eu
2014	Schroeder D et al	D3.1 Funder Reports - How innovation is driven towards societal desirability through funding requirements	Same as above
2014	Cavallaro, F; Schroeder, D; Bing, H	D4.1 RRI---Best Practice in Industry	Same as above
2016?	Grimpe, B; Goujon, P; Jirotka, M	GREAT_D 3 7 Final Report WP 3	GREAT http://www.great-project.eu/research/deliverables

2013	Pellé, S; Reber, B	DEL.2.2. Theoretical Landscape	Same as above
?	Gianni, R	D5.1 Framework for the Comparison of Theories of Responsible Innovation in Research	Same as above
?	Ikonen, V; Niemelä, M; Grimpe, B	D3.5 RRI requirements for model for guidance and governance	Same as above
?	Grimpe, B; Jirotka, M	D4.2 Case study report	Same as above
2016	Vuathena, M	Synenergene lessons learned on 'doing RRI' (preliminary)	Synenergene https://www.synenergene.eu/blog/synenergene-lessons-learned-doing-rri-preliminary
2016	Kit, H	Workshop summary report: CREATING RESPONSIBLE BIOECONOMIES	Synenergene https://www.synenergene.eu/resource/workshop-summary-report-creating-responsible-bioeconomies
2014	Kit, H	Summary report on the workshop 'Responsible Research and Innovation in Synthetic Biology', Darmstadt, 23 - 25 June 2014	Synenergene https://www.synenergene.eu/resource/summary-report-workshop-%E2%80%9Cresponsible-research-and-innovation-synthetic-biology%E2%80%9D-darmstadt

Appendix 5

List of the reviewed case studies

No.	Case study	Thematic field	Location	Engagement	Gender equality	Ethical considerations	Open science	Science education
	Linking responsible research and innovation on the farm: the case of participatory guarantee systems.	Sustainable agricultural practices	Bolivia, Colombia, India, Namibia, the Philippines and Uganda	+	-	-	-	o
	The responsiblisation and regulation of garage innovation: DIY drug innovation in psychonaut subculture	Recreational psychedelic drugs	worldwide	+	-	-	+	+
	Anchoring knowledge transfer activities. The EC CoC and normative anchor points in laboratory practices in Italy	Nanotoxicology	Italy	o	-	-	-	-
	Horizontal Foresight to Address Societal Challenges in Danish Priority-setting for Strategic Research	Engagement in scientific research	Denmark	o	-	-	-	-
	Special Initiative for Citizen Engagement In Science	Role of media in public engagement	Austria, Germany, Ireland, Italy, Spain)	+	+	+	o	-
	Science Shops (website: http://www.livingknowledge.org /science-shops/about-science-	Engagement of civil society	EU and non-EU locations; headquarters in	+	-	-	-	-

No.	Case study	Thematic field	Location	Engagement	Gender equality	Ethical considerations	Open science	Science education
	shops/)		Germany					
	Peg – A community indicators system for the people of Winnipeg	Wellbeing indicators	Winnipeg, Canada	+	-	-	-	-
	Roskilde 2045. A look into the future	Neuro-enhancement	Denmark	+	-	o	-	-
	VOICES (Views, opinions and ideas of citizens in Europe on science)	Climate action, environment, resource efficiency and raw materials	Europe	+	o	-	-	-
	PULSE exhibition and research project	Health, demographic change and wellbeing	Denmark	+	-	-	+	-
	Citizens create knowledge (BürGEr schaffen WISSen, GEWISS)	Science with and for society	Germany	+	o	-	o	-
	EuroBioAct, European Bioethics in Action	Ethics; health	Hungary	+	-	+	+	-
	Knowledge for Climate (Kennis voor Klimaat)	Climate change	Netherlands	+	o	-	+	-
	Collaborative solutions for	Fishery systems	Portugal	+	o	-	-	-

No.	Case study	Thematic field	Location	Engagement	Gender equality	Ethical considerations	Open science	Science education
	improvement of data-limited fisheries systems							
	Marlisco (Marine Litter in European Seas - Social Awareness and Co-Responsibility)	Climate action, environment, resource efficiency and raw materials	Portugal	+	-	-	o	-
	InnovAcciones 360°	Food packaging	Spain	+	o	-	+	-
	Challenge-driven innovation (CDI)	Research funding	Sweden	+	-	-	o	-
	Mistra Urban Futures	sustainable urban development	Sweden	+	o	-	+	-
	Ambiact	smart meter for social alarm systems	Germany	+	+	o	-	o
	My Brain Book	Dementia patients care	UK	+	+	+	-	o
	ICT-tool for multidisciplinary innovation teams	food and animal feed	the Netherlands	+	-	-	-	o
	The involvement of a marginalised indigenous population, the San population of Southern Africa, in health-related	access to genetic resources	Namibia, Botswana and South Africa	+	-	+	-	-

No.	Case study	Thematic field	Location	Engagement	Gender equality	Ethical considerations	Open science	Science education
	innovations.							
	Food Security: sarmap's satellite technology to monitor crop's production	Use of satellite technology to monitor crop yields	Asia	**+**	**-**	**-**	**-**	**o**
	SPOCS (Simple Procedures Online For Cross---Border Services)	Internet portals	EU	**+**	**-**	**+**	**-**	**-**
	ImmigrationPolicy2.0	immigration	EU	**+**	**-**	**+**	**-**	**-**

+ relevant; **o** somewhat relevant; **-** not explicitly addressed

Appendix 6

Secondary analysis of the case studies investigated by other RRI projects

Project	Case study	What was the added value?	What did the case change?	What was the motivation behind the specific efforts?	How does the case contribute to a '(re)politicization' of R&I?
Res-Agora	Linking responsible research and innovation on the farm: the case of participatory guarantee systems.	Better understanding the conditions under which a de facto RRI mechanism for governing sustainable practices is developed in extremely contextual circumstances. Different frames are identified to analyse innovators. Hybrid actors: multiple identities in horizontal and vertical frameworks.	PGS became a control mechanism driven by the NGOs Promotion of the participation of a plurality of actors. Yet as PGS are meant to be flexible, they trigger conflicts as flexibility and learning are seen as conflicts of interests.	Substantive: improving a situation (access to the organic market for small and medium producers); Normative: empowerment or small organic producers; Instrumental: gaining legitimacy for this type of commercial practice	Some actors join the networks not just to consume organic food but also to politically promote PGS certificates as a form of commercial reputation and recognition.
	The responsiblisation and regulation of garage innovation: DIY drug innovation in psychonaut subculture	Responsibilization in a field seen as highly irresponsible by contesting established knowledge channels similar to patient group activism. 2 ways of action: raising the cultural acceptance of risk and the responsibilization of the actors involved by peer education.	The actors involved developed a strong collective identity. The psychonaut subculture is self-regulating through customer reviews on dedicated websites, employ their own safety testing for substances—currently in a grey legal zone.	Substantive: knowledge sharing and knowledge co-creation (users, producers, medical facilities; collective efforts for setting up a network. Instrumental: increasing acceptance of designer drugs and the institutionalization of the drug counter-culture; avoid detection by major law	Attempts to re-draw the lines of morality (even between responsible and irresponsible) and also challenge the power relations for drug laws and regulations.

				enforcement agencies.	
	Anchoring knowledge transfer activities. The EC CoC and normative anchor points in laboratory practices in Italy	Illustrates how RRI governmental arrangements are translated in local responsibilization processes. How competitive frames of RRI are contested and negotiated. Investigation of regional, social and technical elements that influence the transformation of governance arrangements.	For soft regulations the rules need to be clear to be effective. Public funds increase public-private collaboration. The shared affiliation to a research cluster can stimulate collaboration between areas of interest otherwise not involved. Trainings on responsibilization can favour collaboration within an institute.	Normative: how sustainability and consumer protection are translated in knowledge transfer activities.	There is a moral dimension in including more people in the responsibilization of RRI governance: some expertise is no longer marginalized.
	Horizontal Foresight to Address Societal Challenges in Danish Priority-setting for Strategic Research	Exploring societal challenges in strategic research through: engagement of societal actors in research priority setting and the connection between foresight and policy-making. A mix of methods were used. The Minsitry decided to build their own model with 3 steps: OECD horizon scan of international societal challenges; compile suggestions into themes; with inputs from experts the Ministry narrowed the themes down to 21.	The inclusion of actors was much wider, thorough and systematic than for similar actions. It created constructive interactions between actors, yet some viewpoints never become part of the process. It closed down perspectives which did not match the main perspective.	Instrumental: creating a better foundation for governing strategic research.	Limited impact on values and behaviours. Addressing challenge of integrating various views, valuses, and interest (tension between achieving impact on policy making and being widely inclusive).

EISRI II	Special Initiative for Citizen Engagement In Science	Experimenting a new way to understand media needs and concerns for citizen engagement in science. Exploring new media tools: ICT technologies create a more participatory approach?	Policy makers do not take into consideration the public perspective. EC needs to put more effort into engaging citizens in developing research agendas. Media should play a role.	Substantive: finding a way for researchers, policy-makers and the public to engage.	The overall effect did not contribute to the politicization of RRI but had elements that might have done so: connecting scientific developments and values. Politics were also analysed but not considered in the conclusions: participant replies that the politicians do not listen to the public.
	Science Shops (website: http://www.livingknowledge.org/science-shops/about-science-shops/)	Scientific projects run by the academia on subjects on societal interest, usually free of charge. The international network of science shops provides a platform for horizontal cooperation.	Establishes partners in projects and work cooperation, establishing science shops as a brand.	Substantive: creating socially robust knowledge	Changes in traditional knowledge production
RESCUE	Peg – A community indicators system for the people of Winnipeg	Understand the well-being status of the First Nation; empower them to devise their own solutions.	Uniting individuals with the same experiences.	Substantive: improve the well-being indicators of a population	The empowering of the First Nation community to better identify their own problems and devise solutions.
NERRI	Roskilde 2045. A look into the future	Explore a bottom up a strategy (co-design) for explaining RRI within the area of human enhancement. Included ethics and concerns for	Drawing were very good at engaging people in discussions. Virtual reality was very popular; overall	Substantive: developing a concept for responsible human enhancement	Movements and networks to stir up social and cultural change;

		the future.	surveillance was regarded as not desirable.	Instrumental: increasing awareness about RRI.	Reflections on citizens roles as innovators of the future
RRI Tools	VOICES (Views, opinions and ideas of citizens in Europe on science)	Identify societal needs for setting research priorities for urban waste innovation.	Some of the ideas were used by EC to draft calls for research proposals.	Substantive: creation of more socially relevant knowledge	Citizen opinions can directly influence decision-making
	PULSE exhibition and research project	Creation of innovative exhibitions to encourage healthy lifestyles	It highlighted a need for changes at the methodological and organizational level.	Substantive: improving healthy lifestyles.	In the future, the project aspires to change policy and belief systems about healthy lifestyles.
	Citizens create knowledge (BürGEr schaffen WISSen, GEWISS)	Developing citizen science through network building, analysing activities and needs, promotion of activities, acquiring resources.	Development of a strategy for citizen science in Germany and of a resource toolbox for practitioners; building cooperation reduces distrust and increases acceptance of citizen science as addition to traditional science.	Instrumental: increasing acceptance for citizen science; Substantive: fostering citizen science	? (Unclear how citizen science would go beyond doing legwork for traditional research activities)
	EuroBioAct, European Bioethics in Action	Developing bioethics standards; accumulation of 'orientational knowledge'; promote dialogue between stakeholders; bioethical standards to become instruments of mutual monitoring between communities and politicians.	Promoted public and institutional engagement using ethically accepted practices; provided examples of how RRI standards can help establish partnerships between academia and local authorities; develop environmental awareness; benefit local communities	Substantive: developing bioethical standards	In its focus on increasing local consciousness of human relationships, animals, plants and the environment, values are mentioned.

			through tourism.		
	Knowledge for Climate (Kennis voor Klimaat)	Developing knowledge that assures that long-term implications decisions consider climate change. Using integrated multi-stakeholder participative approach.	Established a climate knowledge facility, actively participated in knowledge transfer; the approach was exported to other regions.	Substantive: develop more relevant knowledge	Increased understanding of each other's values
	Collaborative solutions for improvement of data-limited fisheries systems	Improve understanding of the main problems in the fisheries systems and negotiating solutions. Methodology: scope and rules of interaction set by participants.	Project placed critical decision-making in the hands of the group creating collectively accepted solutions	Substantive: creation of more robust knowledge Instrumental: increased acceptance for solutions	Including various forms of knowledge in decision making (participatory governance)
	Marlisco (Marine Litter in European Seas - Social Awareness and Co-Responsibility)	Raise public awareness to waste production; promote co-responsibility; define a more sustainable collective vision; facilitate grounds for concerted actions; mutual mobilization and learning process	The creation of the Portuguese Marine Litter Association; best practices, interactive game, documentary, educational material. Highlighted RRI´s potential of sharing responsibilities for social change building on individuals' unique strengths.	Instrumental: increase awareness; Substantive: co-creation of more robust social knowledge; Normative: co-responsibility	?
	InnovAcciones 360°	Fostering innovation through a circular flow of information. For this were employed: several networking public meetings; wide range of stakeholders.	Reflection was best in mixed groups (researchers, citizens and the industry); increased understanding and new ideas for packaging innovations; utilizing different forms of media can encourage and maintain	Substantive: stimulating socially relevant innovation.	It established a precedent for rethinking the relationship between researchers, citizens and the industry -

			their involvement.		
	Challenge-driven innovation (CDI)	Addressing societal challenges through the creation of consortia focused on specific challenges in a problem-oriented, transnational approach; create impact logic model for short and long-term outcomes; include partners with strong interest in the research and use of the results.	RRI is not just in the interest of the society at large but also in the interest of the individuals	Substantive: incorporating RRI in research processes.	?
	Mistra Urban Futures	Co-creation and co-production as key methodologies to address sustainable urban development issues. The project uses collaborative projects: 2 leaders for the project (one researcher, one practitioner). Process is very inclusive: puts accent on gender, social inclusion, a wide range of academic and non-academic actors. Promotes dissemination of results through scientific and non-scientific channels.	The model would need time to be introduced but the experiences are transferable. The importance of patience and allocation of sufficient time are underlined. All of the involved partners were essential for the outcomes.	Substantive: producing socially relevant knowledge through cooperation. Normative: participatory, inclusive governance	Conceptualising sustainable urban development as a co-creative enterprise
Responsible-Industry	Ambiact	5 principles of RRI were addressed, although societal engagement was not pursued from the very beginning.	Early engagement saves costs (by enhancing acceptability); participation linked to the possibility of having an impact on decisions; science education increases acceptability, also an effective marketing tool.	Substantive: development of socially sustainable product Instrumental: cost saving through increased acceptability; effective marketing tool	?

	My Brain Book	Dementia patient involvement (and of their families) in the development of a computer-based planning tool. Engagement included: parallel priority setting event, focus groups, involvement in design workshops and testing the prototype	Involvement of people with dementia has changed the way ICT specialists see them and directly impacted the final products. The project had a particular focus on gender and ethics.	Substantive: relevant knowledge	?
	ICT-tool for multidisciplinary innovation teams	Collaborative, interdisciplinary and integrated innovation. Both quantitative and qualitative data demonstrating enhanced socially responsible innovation with technical, economic and social aspects. The process helps 'internalizing' RRI for researchers.	Researchers demonstrated increased reflective awareness making them more responsive to societal considerations	Substantive: increases the RRI-ness of projects	Anticipation of and responsiveness to societal concerns
ProGReSS	The involvement of a marginalised indigenous population, the San population of Southern Africa, in health-related innovations.	The case outlines the demands of the San population for the use of their own genetic resources; informs industry what 'responsible innovation' is in relation to traditional knowledge.	The San took collective control over their genetic resources and participation in genetic research. They devised a protocol for involving the San in this kind of research: active engagement, involvement in adoption, assimilation and diffusion of innovations, involved in the impact of innovation as well.	Substantive: improving San´s involvement in the use of their own genetic resources Normative: empowerment of marginalised group	A change in power relations, ethical behaviours in research and upholding local values.
	Food Security: sarmap's satellite technology to monitor crop's	Developing a software that monitors natural resources and the environment: public-private partnership consortium. Aims: map	Improving security of the crop cultivation plus assisting small-holder farms	Substantive: providing a solution to the insecurity of rice production	?

	production	and monitor rice-growing area; estimate rice yields; forecast yields; produce an insurance product for farmers. In addition: informing and educating participants to access, interpret and use data.			
GREAT	SPOCS (Simple Procedures Online For Cross---Border Services)	Removing legal and administrative barriers to trade in the service sector in the EU. Methods: conducted pilot activities; face-to-face, paper based and online operations across the EU. Using the standard model with a few elements of the consultation model. Established 5 formal groups with external stakeholders.	Tensions between contradictory ethical regulations	Substantive: improving the regulatory situation	A macropolitical situation was built into the program by the requirements that the regulations from supranational and national ones were met. The project itself is a response to a tense macropolitical situation.
	ImmigrationPolicy2.0	Aim: develop ICT-based services for the collaborative development of immigration policies. Co-construction model: reshaping processes with the participation of all the stakeholders. Training seminars: towards a participative governance approach, to be fed into redesigning the information platform. Team members include a reflective phase.	The reflective phase was not realized but its lack was noted by the consortium. An ethical shortcoming pf the project: focus only on legal immigrants.	Substantive: improving immigration services Normative: aiming at participatory governance	Participatory governance of developing immigration policies