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What's wrong with global challenges?

David Ludwig ^a, Vincent Blok ^b, Marie Garnier ^c, Phil Macnaghten ^a and Auke Pols^a

^aKnowledge Technology and Innovation (KTI) Group, Wageningen University and Research, Wageningen, Netherlands; ^bPhilosophy (PHI) Group, Wageningen University and Research, Wageningen, Netherlands; ^cStrategic Communication (COM) Group, Wageningen University and Research, Wageningen, Netherlands

ABSTRACT

Global challenges such as climate change, food security, or public health have become dominant concerns in research and innovation policy. This article examines how responses to these challenges are addressed by governance actors. We argue that appeals to global challenges can give rise to a 'solution strategy' that presents responses of dominant actors as solutions and a 'negotiation strategy' that highlights the availability of heterogeneous and often conflicting responses. On the basis of interviews and document analyses, the study identifies both strategies across local, national, and European levels. While our results demonstrate the co-existence of both strategies, we find that global challenges are most commonly highlighted together with the solutions offered by dominant actors. Global challenges are 'wicked problems' that often become misframed as 'tame problems' in governance practice and thereby legitimise dominant responses.

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Global challenges; grand challenges; wicked problems; responsible research and innovation

Introduction

Global and grand challenges (GGCs) have become widely reflected in research and innovation governance (Efstathiou 2016; Kaldewey 2018; Kaltenbrunner 2020; Kuhlmann and Rip 2018; Ulnicane 2016). The notions of 'grand challenge' and 'global challenge' are of relatively recent origin in research and innovation governance, having gained prominence in the early 2000s by providing a shared frame for urgent social-environmental problems such as 'grand challenges in environmental sciences' (National Research Council 2001), 'global challenges in energy' (Dorian, Franssen, and Simbeck 2006), or 'global challenges in water, sanitation and health' (Rheingans and Moe 2006). While both 'grand challenge' and 'global challenge' can be usefully distinguished (Brammer et al., 2019), they are often used interchangeably as umbrella concepts that shape policy frameworks. For example, the 2009 *Lund Declaration* identified 'grand challenges' as the focus of research policy in the European Union that aims for 'sustainable solutions

CONTACT David Ludwig  david.ludwig@wur.nl  Knowledge Technology and Innovation Group, Wageningen University and Research, Hollandseweg 1, 6706 KN Wageningen, Netherlands

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in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics and security' (Swedish EU Presidency 2009; see also Kallerud et al. 2011). GGCs also has become established as a prime concern in European funding, as reflected in the 'Global Challenges and European Industrial Competitiveness' pillar of Horizon Europe (European Commission 2021). Similar developments have been prominent in US policy debates (Hicks 2016), as reflected in the promise to 'harness science and technology to address the "grand challenges" of the twenty-first century' in the 2009 *Strategy for American Innovation* of the Obama administration (White House 2009, 22), and more recently expressed in the Biden administration's emphasis on meeting 'accelerating global challenges from the pandemic to the climate crisis to nuclear proliferation' (White House 2021).

In the academic literature, emphasis on GGCs has become widely embraced as a vital component of responsible research and innovation (von Schomberg 2013; van Lente, Swierstra, and Joly 2017). The notion of GGCs has sharpened the focus on the urgent need for 'finding solutions to the world's biggest problems' (Brooks et al. 2009), especially in policy contexts of surging nationalism and populism (Long and Blok 2017; Fisher 2017; Schillo and Robinson, 2017). Furthermore, emphasis on GGCs can broaden policy concerns not only beyond national boundaries, but also beyond purely economic concerns towards a wide range of social and environmental issues (Flink and Kaldewey 2018). Finally, the status of an issue as a 'grand challenge' is itself the product of social negotiation, and the guiding role of GGCs has the potential to contribute to a democratisation of priority setting in research and innovation policy through participative processes. In this sense, Calvert (2013, 475) argues that the 'publicly stated priorities that are central to grand challenges could be seen as part of an attempt to establish a new contract for the public funding of science.'

While it has been widely recognised *that* GGCs guide research and innovation towards societal goals, there has been less attention to the question of *how* responses to GGCs are negotiated. The aim of this article is to address how appeals to GGCs interact with the responses that are put forward by governance actors. If research and innovation is framed through the urgent need to address GGCs, how do governance actors approach responses to them? Reflecting on expert-driven and participatory governance traditions, we explore how the need to address GGCs can give rise to a 'solution strategy' that legitimises the responses of dominant actors as solutions, and to a 'negotiation strategy' that highlights the contested status of GGCs and the need for negotiation between heterogeneous interests and perspectives.

To explore whether and how these strategies are employed, we combined semi-structured interviews and a document analysis in a research organisation that has increasingly framed its activities in terms of responding to GGC's, Wageningen University and Research. To situate the findings in a wider institutional context, we conducted two document analyses of research and innovation policy at the Dutch and European level. All three contexts show how appeals to GGCs often employ the solution rather than the negotiation strategy. Expressed in slogans such as 'Global challenges, Dutch solutions' (VNO-NCW 2017) or 'Global Challenges and European Industrial Competitiveness' (European Commission 2021), we found that GGCs often set the stage for legitimising dominant responses as solutions rather than encouraging reflexivity about heterogenous perspectives on contested social-environmental problems.

Our findings suggest that GGCs play an ambiguous role in participatory governance and wider attempts to reconfigure societal relations with science, technology, and innovation. GGCs turn attention towards societal problems, but their use in research governance does not necessarily foster more inclusive negotiations of them. We argue that this is problematic, as GGCs constitute ‘wicked problems’ with essentially contested problem formulations and responses, but which are commonly misframed as ‘tame problems’ that appeal to the expertise of dominant actors and their responses as solutions. Our conclusion, therefore, highlights the need to recognise the wicked character of GGCs in governance practices and to create space for the negotiation of contested responses beyond the legitimising function of appeals to ‘solving the world’s most pressing problems’.

GGCs as wicked problems

The notion of wicked problems (Rittel and Webber 1973; Edgeman 2015; Peters 2017; Rush 2019) has become widely adopted in policy studies to identify ‘complex, intractable, open-ended’ issues (Head 2008) that are characterised by uncertainty in both knowledge and the values at stake (Hoppe 2011). As Hoppe (2011, 73) points out, governance challenges can be located in a multi-dimensional problem space depending on whether the problem formulation and/or problem responses are contested. Wicked problems are paradigmatically considered contested along both dimensions, and GGCs such as global food production, global health, or sustainable energy are paradigmatic wicked problems regarding both their contestation and their ‘complex, intractable, open-ended’ character. The complexity and open-endedness of GGCs implies that their very formulation tends to be contested. For example, is the challenge of global food production at the core a challenge of addressing current hunger and malnutrition, of keeping up with the growing world population, of conserving diverse global food cultures, of conserving biodiversity, or of responding to climate change? And if the challenge of global food production relates to all of these issues at the same time, how are they negotiated when their corresponding priorities inevitably come in conflict with each other? As a result, the challenge of global food production will look very different for actors such as environmental NGOs, national governments, large agricultural producers, peasant communities, or consumer groups.

Furthermore, not only the formulation but also the responses to wicked problems are contested. Wicked problems do not have one straightforward solution, and responses tend to be contested as they affect stakeholders in dramatically different ways. To emphasise this point, wicked problems are commonly contrasted with ‘tame problems’, which have straightforward and technical solutions that can be provided by appropriate experts (Lach, Rayner, and Ingram 2005; DeFries and Nagendra 2017). Again, the contestation of global food production provides a salient example as agricultural sciences involve many tame problems with technical solutions (e.g. how to genetically engineer pesticide resistant seeds) as well as wicked problems (e.g. the desirable role of genetically engineered seeds in agricultural systems). In this sense, the wicked dimensions of GGCs like food production give rise to different future visions from agroecology to agricultural intensification, each with dramatically different implications for stakeholders in heterogeneous positions in global agrifood systems.

While it has been recognised in the literature that GGCs constitute wicked problems (Blok and Lemmens 2015; Neely, Edgeman, and Eskildsen 2015; Jordan et al. 2021; Wanzenböck et al. 2020), there has been relatively little attention to how responses to GGCs are approached in research and innovation. Assuming that such responses are not independent of wider traditions of expert-driven and participatory governance, we hypothesise that GGCs can be framed through a negotiation strategy and a solution strategy (Figure 1).

On the one hand, one may assume that recognition of GGCs leads to a negotiation strategy that can be situated in wider debates about ‘participatory governance’ (Blackstock et al. 2015; Braun and Könninger 2018; Brand and Blok 2019; Saretzki 2018) and ‘public engagement’ (Bensaude Vincent 2014, Selin et al. 2017; Macnaghten 2020) that aim to foster inclusive forms of co-creation and societal negotiation in science, technology, and innovation. For example, the wicked character of GGCs can be linked to transdisciplinary approaches that highlight the diversity of relevant forms of expertise and perspectives of stakeholders (Brown, Harris, and Russell 2010; Ludwig and Boogaard 2021; Pohl, Truffer, and Hirsch-Hadorn 2017; Schikowitz 2020). GGCs can also be interpreted through shifts in ‘modes of knowledge production’ including the well-established distinction between Mode 1, which employs a linear model from basic research to application, and Mode 2, which emerges out of application and negotiation in complex social and economic contexts (Gibbons et al. 1994; Nowotny, Scott, and Gibbons 2003). Finally, interpreting GGCs through the negotiation strategy also connects to frameworks of responsible innovation (RI) that highlight dimensions such as anticipation, inclusion, responsiveness, and reflexivity (Stilgoe, Owen, and Macnaghten 2013; Macnaghten 2020) and thereby shift the site of governance towards more participatory forms beyond mere ethical or legal evaluation (Zwart, Landeweerd, and van Rooij 2014; Guston et al. 2014). As responsible innovation has become institutionalised as a site

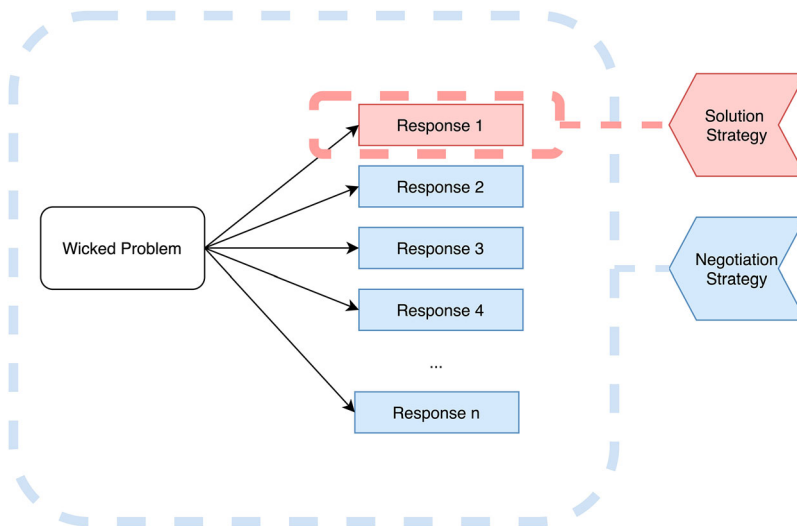


Figure 1. The Solution Strategy (red) identifies specific responses to GGCs as ‘solutions’ while the Negotiation Strategy (blue) highlights the diversity of available responses to a wicked problem.

for praxis and politics (Owen, von Schomberg, and Macnaghten 2021), its global dimensions and heterogeneity have become two of the main concerns of the debate (Doezema et al. 2019; Hartley et al. 2019; Wittrock et al. 2021). Both the institutionalisation of responsible innovation and its increasing reflexivity on global contexts provide clear entry points for exploring the negotiation of GGCs across heterogenous contexts.

Approaching GGCs through the negotiation strategy suggests a close link with familiar cases for participatory governance and public engagement that aim for societal embedding of research and innovation through inclusive and reflexive forms of alignment between actors. Putting GGCs at the centre means putting wicked problems at the centre that demand the inclusion of diverse perspectives and acknowledgment of the need for transformational change beyond linear models of innovation and economic growth-focused innovation systems (Schot and Steinmueller, 2018; Diercks, Larsen and Steward, 2019; Ludwig and Macnaghten 2020). This link between GGCs and the negotiation strategy may seem obvious and it is indeed presupposed in many of the academic debates about GGCs that are commonly situated in wider debates about transdisciplinary and responsible research and innovation.

On the other hand, responses to GGCs can also be framed through a solution strategy that does not appeal to participation but rather to the unique expertise of scientists and innovators in solving these challenges. While the academic discourse on governance commonly highlights negotiation and participation, existing governance structures are still often dominated by economically driven narratives (Marris and Calvert 2020) and the ‘output side’ of emerging technologies while keeping the ‘input side’ of research processes depoliticised (Hartley, Pearce, and Taylor 2017). In this sense, the solution strategy does not only correspond to older linear models of innovation (see Macnaghten 2020, chapter 1.1) but also remains deeply entrenched in structural features of ‘how institutions think’ (Douglas 1986) when appealing to experts to solve identified challenges.

Institutional appeals to expert-driven solutions become especially plausible in the context of increasingly commodified research (Radder 2010) that incentivises the framing of commodities as solutions to GGCs. For example, think of Monsanto’s frequent appeals to the ‘global challenge of sustainability’ that is mitigated through the ‘good news [...] that technology continues to advance on multiple fronts to meet these challenges’ (Monsanto 2018). Or Siemens’ ‘complete mobility strategy’, according to which ‘Siemens has answers to the challenges of growing global population, urbanisation, climate change and resource conservation’ (Siemens 2018). Or BP’s agenda of ‘global challenges, pragmatic solutions’ that require ‘a consistent policy approach that allows us to get on with the practical business of delivering solutions’ (BP 2011).

Rather than broadening the focus on participatory negotiation, emphasis on GGCs can also have the reversed effect of narrowing emphasis on expert solutions. Indeed, the focus on solutions is already part of the conceptual heritage of framing societal problems as ‘challenges’. As Flink and Kaldewey (2018) have recently pointed out, the conceptual history of GGCs traces back to sport competitions (e.g. ‘The Grand Challenge Cup’) that made their way into science and technology competitions (e.g. ‘The DARPA Grand Challenge for Autonomous Robotic Ground Vehicles’) before becoming extended into research and innovation policy. This conceptual history often remains embedded in how GGCs are oriented towards ‘solutions’ that are imagined to be developed by courageous actors who are ‘willing to meet the challenge’. This orientation of

GGCs creates tensions with their wicked character, not least because responses always create complex trade-offs between the concerns of heterogeneous stakeholders (Blok, Gremmen, and Wesselink 2015; Crowley and Head 2017; Termeer et al. 2015).

Both the negotiation strategy and the solution strategy provide *prima facie* plausible interpretations of appeals to GGCs in research and innovation governance. At the same time, they are clearly in tension with each other insofar as the former emphasises the availability of heterogeneous and often competing responses to GGCs while the latter highlights one of the responses 1 ... *n* as the solution (Figure 1). The *prima facie* plausibility of both strategies therefore raises the underexplored question of how appeals to GGCs interact with the formulation of responses in research and innovation governance. The following section explores this question through a study of an organisation, Wageningen University and Research, that has increasingly framed its identity through responses to GGCs. These results are further contextualised through a document analysis at Dutch and European levels that provide insights into wider research environments that have increasingly embraced GGCs as targets of research and innovation policy.

Materials and methods

The study addresses institutional responses to GGCs across three levels of organisation: The local level of Wageningen University and Research (WUR), the national level of Dutch research and innovation governance, and the international level of the *Framework Programmes for Research and Technological Development* of the European Union. The following sections analyse GGC discourses through the results of a multi-national research project on Responsible Research and Innovation (RRI) that involved twelve national case studies in Australia, Brazil, Bulgaria, China, France, Germany, India, Italy, Norway, the Netherlands, United Kingdom and the United States of America (Witrock et al. 2021). Responsibility was addressed through a variety of frameworks, including the AIRR framework of anticipation, inclusion, reflexivity, and responsiveness (Stilgoe, Owen, and Macnaghten 2013) as well as the 'RRI keys' of ethics, societal engagement, gender equality, open access and science education (see also Owen, von Schomberg, and Macnaghten 2021).

At the local level of WUR, we conducted 23 interviews between 2017 and 2021 and a document analysis of 40 university policy documents. 18 Interviews and all documents were selected as part of the wider RRI project. We conducted five additional interviews that broadened the scope beyond the RRI study by focusing on students and organisations at the intersection of the university and civil society in the negotiation of GGCs. The interviews, therefore, included key stakeholders at the university, including civil society, corporate communications, human resources, research groups, senior management, student representatives, university library, and value creation departments. With the help of WUR library, key institutional documents of WUR were identified, which include most importantly the Annual Reports 2007–2019 (published 2008–2020), three strategic plans, and core documents regarding different societal dimensions such as the 'Environmental Plan' and the 'Gender Action Plan' of the university. Two workshops were conducted to discuss responsibility at WUR and our preliminary results with key actors at the university.

While the project initially aimed at RRI, the focus on GGCs emerged inductively from our data as a core concept for organising and interpreting responsibility at the university.

Using Atlas.ti, we, therefore, re-analysed the 40 university policy documents, this time coding not only for ‘responsibility’ but also for (global, grand, societal, ...) ‘challenges’. Furthermore, we coded for actors who are mentioned as partners for addressing these challenges for quantitative analysis: from appeals to experts such as researchers to references to wider stakeholders such as NGOs or civil society. On the basis of this coding, we proceeded with a qualitative analysis of both documents and interviews to generate a more substantial understanding of the roles of different stakeholders, distinguishing an emphasis on participatory negotiation from expert-driven solutions.

In order to situate our findings in wider research governance landscapes, we conducted document analyses at both national Dutch and European levels. In both cases, we benefited from the embedding of our study in a wider project on RRI that involved 12 national case studies in Australia, Brazil, Bulgaria, China, France, Germany, India, Italy, Norway, the Netherlands, United Kingdom and the United States of America (Wittrock et al. 2021). The national case study of the Netherlands included nine interviews with experts and policymakers, as well as an analysis of key documents from influential organisations in Dutch science governance, including the Advisory Council for Science Technology and Innovation, the Royal Netherlands Academy of Arts and Sciences, and the Ministry of Education, Culture and Science (Van der Molen et al. 2019). Building on this data collection, we coded core documents of the national policy context for explicit appeals to ‘challenges’ alongside the actors who are presented for addressing them.

At the international level, the 12 national case studies generated 12 reports on national research and innovation systems that clearly indicated that our results had limited external validity at a cross-national level (Wittrock et al. 2021). Not all national research and innovation systems highlight GGCs as governance concerns, and the prominence of GGCs varies between national contexts. To evaluate whether our findings extend to governance contexts that do highlight GGCs, we focused on the European Commission as an international governance body that very explicitly highlights GGCs in its research and innovation policies. Studying the *Framework Programmes for Research and Technological Development*, we collected core institutional documents as well as the academic research literature on the recent transition from Horizon 2020 to Horizon Europe. Again, we coded these for ‘challenges’ as well as for the actors who are attributed as responsible for addressing them.

Results and discussion: negotiating responses and finding solutions

The local level: world leaders in responsibility

The case of Wageningen University and Research (WUR) provides an in-depth example of the emergence of GGCs and responsibility as organising concepts in a research organisation. This section traces this rapid development at WUR from a first phase of sporadic and non-systematic use (2007–2011), through a second phase of GGCs as an organisational goal (2012–2015), to a third phase of GGCs as a core institutional identity (2016–2019) (Figure 2).

From 2007 to 2011, the Annual Reports position the university as a leading research organisation in the life sciences without describing its identity in terms of GGCs. We found only two relevant mentions of ‘challenges’ in this period, which identify ‘the

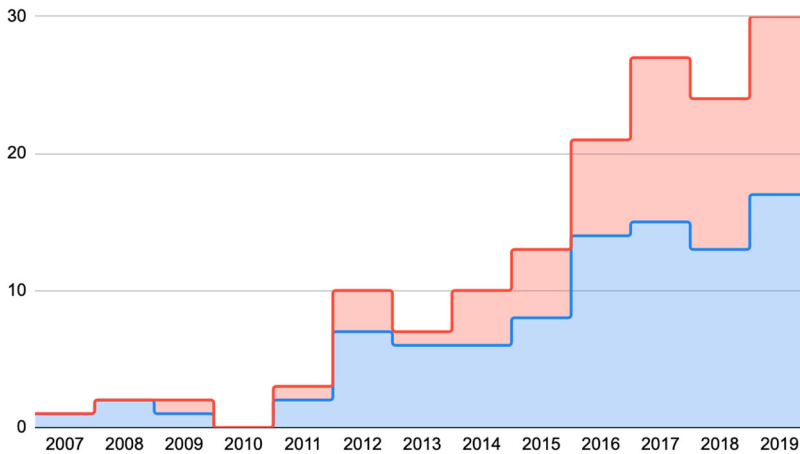


Figure 2. Stacked chart of mentions of responsibility (blue) and challenges (red) in the Annual Reports 2007–2019 of WUR.

challenge of sustainability’ (WUR Annual Report, 2009, 24) and ‘challenges posed by the economic and financial crises’ (WUR Annual Report 2011, 4). The Annual Reports 2012–2015 reflect a dramatic shift in how WUR positions itself strategically towards responsibility and GGCs. This is reflected not only in a quantitative growth of mentions of GGCs in the Annual Reports (Figure 2) but also in their qualitatively novel meaning. For example, this shift is reflected in strategically defined themes of the academic years: *Future Challenges* (WUR Annual Report 2012), *Responsible Growth* (WUR Annual Report 2013) and *Addressing Our World’s Great Challenges* (WUR Annual Report 2014). In the more recent reports, the organisation confidently presents itself as an ‘international leader’ in finding ‘sustainable solutions for the major challenges the world faces’ (WUR Annual Report 2017). As the *Strategic Plan 2019–2022* puts it: ‘WUR provides the highest quality knowledge, education and research to address global challenges [...]. In doing so, we take our responsibility to develop innovative technological, social and nature-based solutions’ (WUR 2019, 11).

The Annual Reports and Strategic Plans indicate a substantial expansion of the identity of the organisation from leading research in the life sciences to leading research in responsibly tackling GGCs. This shift towards GGCs affects not only the identity but also the practice of the organisation. For example, the organisation’s recent investment themes are directly justified through GGCs, as in the aim to address global biodiversity and natural resource challenges through the investment theme ‘connected circularity’, or the aim to address sustainability challenges of global demands in animal protein through the investment theme ‘the protein transition’ (WUR 2019). Our interviews further confirmed that this focus on GGCs has been ingrained in the identity of the organisation, and one respondent reflected on this development by describing the organisation as a ‘world leader in responsibility’.

The case study substantiates many of the promises that have been associated with GGC discourses. As Figure 2 illustrates, the focus on GGCs has co-evolved with a wider focus on ‘responsibility’ as an organising concept of the organisation. As an organisation that aims to act responsibly by addressing GGCs, WUR clearly exemplifies

research that is oriented towards social-environmental issues. At the same time, the case study also raises questions of how GGCs are being addressed. Responsibility at the substantive level of solving GGCs does not imply responsibility at the procedural level of negotiating them.

Our document analysis provides support for the solution strategy as the dominant strategy, according to which GGCs legitimise dominant responses as solutions rather than foster inclusive negotiation of heterogeneous responses. Coding the Annual Reports and Strategic Plans, we identified a set of 109 sentences that appeal to ‘challenges’ in a relevant sense, that is, that appeal to grand or global or social challenges rather than use the term in other ways such as the university being ‘challenged’ by growing student numbers or students being ‘challenged’ by the curriculum. Interpretations consistent with the solution strategy become salient through an analysis of the actors who are explicitly mentioned as partners for tackling GGCs (Figure 3). Analysing the 109 sentences, we found 129 references to actors who address GGCs. Of these 129 references, 95 appeal to the university, its research/researchers, or its education/students. One hundred and twenty-two refer more broadly to the ‘triple helix’ of universities, government, and business. There are only three generic mentions of NGOs, three mentions of local stakeholders/citizens and one general reference to society as actors for addressing GGCs. Furthermore, our sample did not contain a single mention of the importance of bringing marginalised stakeholders (say: minorities, peasants, women) into the conversation about GGCs.

At a qualitative level, our interviews provided further evidence for an interpretation of GGCs through the solution strategy, albeit one that some of our respondents saw as problematic. One frequently mentioned topic in interviews and workshops was that responses to GGCs were seen as shaped by public and private partnerships that presuppose dominant governance paradigms and technological priorities at WUR. With regards to public partners, some concerns were expressed about the role of international governmental organisations that aim to benefit from WUR’s expertise in agricultural, environmental, and health domains. For example, one respondent articulated worries about

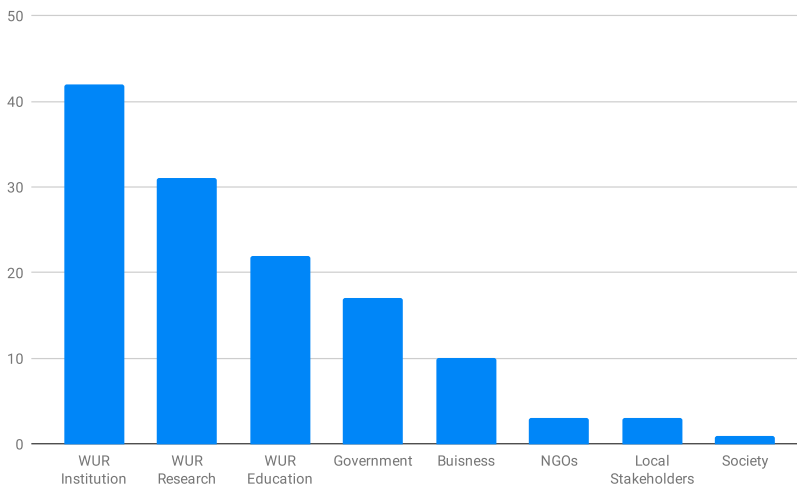


Figure 3. Actors mentioned as addressing GGCs in core WUR documents.

‘greenwashing’ in collaborations with international governmental organisations, using examples of two ultimately abandoned projects that had been framed in terms of sustainability, but that had raised concerns about land grabbing in the case of a project on ‘sustainable agriculture’ and labour conditions in a project on ‘sustainable architecture’.

Furthermore, many interviewees and workshop participants expressed unease about the structure of private partnerships that continue to play a key role in WUR’s claim to international leadership in agricultural, environmental, and health domains. Although it was recognised that private partnerships can catalyse the societal impact of life science innovations, participants expressed concerns that the framing of research with private partners often had the effect of predetermining which lines of research are pursued in areas such as food production. A focal point of these concerns has been the construction of large R&D centres of companies such as Unilever and FrieslandCampina on the university campus. As one respondent put it: ‘The Unilever opening for me is really where it started. I was really so uncomfortable [...] Having them there is such a symbol of where they want to go. The rest is not visible, like the only thing that is visible are these huge companies’. Another respondent linked these concerns to GGCs by arguing:

They are promoting themselves as tackling these global challenges and being present in this fight for food sovereignty, poverty, and all these other issues. But there is a big contradiction in many of these narratives. “*The number one most sustainable university in the Netherland.*” [...] They are clearly not. Based on the companies that they work with and the approaches that they take to agriculture.

These concerns are also reflected in wider debates about WUR beyond our interviews. For example, the role of private partnerships has been a major theme in public debates about research at WUR that culminated in a legal challenge arising from a journalist’s claim that research at the university had been directed by private interests (Trouw 2016). Another example is the Wageningen-based *Stichting Boerengroep* (Farmer Foundation) who publicly challenged the link between business partnerships and the research priorities of the university, asking: ‘why does WUR put such an emphasis on high-tech industrial agriculture and why are alternatives such as agroecology depicted as ‘romantic illusions?’ (Boerengroep 2016, translation by authors). In an interview with the Boerengroep, the WUR sociologist van der Ploeg tied the R&D centres of private partners even more directly to the exclusion of marginalised stakeholders:

If they would also offer [...] facilities to [the peasant organisation] Via Campesina. [...] But it’s absolutely not like that! And it’s ludicrous of course, we neither create our teaching rooms on the industry part, so why are they to come to the campus? It’s a brutal, it’s not neutral, it’s a brutal symbolic intervention. ‘We are here to dominate’. (Boerengroep 2016)

While the development of WUR strategy exemplifies a turn towards GGCs and responsibility in research organisations, the case also shows that GGCs are commonly interpreted through a solution strategy that highlights the responses of dominant actors and that legitimises these as solutions. This does not mean GGCs are exclusively interpreted through the solution strategy and our results also point towards a more complex story that allows for interpretations along with the negotiation strategy.

While the Annual Reports and Strategic Reports between 2007 and 2019 do not explicitly mention ‘wicked problems’, they do appeal to diversification and the need for

complex negotiation processes in the context of GGCs. For example, the Annual Report 2016 articulates an inclusive ideal of addressing GGCs through collaboration among heterogeneous stakeholders: ‘With local and regional stakeholders, we work on the sustainable approach that is required to meet the challenges regarding biodiversity and the increasing use of natural resources’ (WUR Annual Report 2016, 18). GGCs are at least occasionally mobilised to appeal to a broad range of stakeholders that demand inclusion. For example, the most recent Strategic Plan, titled *Finding Answers Together*, calls

upon new and existing partners, students, alumni and citizens to explore with us the potential of nature, to participate in defining and understanding the challenges facing us, to engage in discussing and navigating trade-offs, and to work with us on evidence-based and socially inclusive answers that drive transitions. (WUR 2019, 49)

The most recent Annual Report also reflects on this ambition by highlighting the need ‘to explore the potential of nature together, to acquire greater insight into the challenges that confront us and to discuss and navigate conflicting interests’ (WUR Annual Report 2019, 17).

Appeals to dialogue and negotiation suggest that the solution strategy does not cover the whole story about GGCs in our case study. Instead, there is also evidence that GGCs can point towards the complexity of social-environmental problems that require inclusive strategies along with the negotiation strategy. In our case study, GGCs, therefore, feed into different institutional imaginations. On the one hand, GGCs reinforce the imagination of WUR as an ‘international leader’ that produces ‘solutions’ on the basis of its ‘cutting edge technologies’ and ‘strategic partnerships’ with business and government. On the other hand, GGCs integrate with the university’s identity as an organisation that emphasises responsibility at the centre of its activities, and that has become increasingly explicit about the need to include heterogeneous stakeholders through strategic cross-WUR initiatives such as the ‘Wageningen Dialogues’ (WUR 2018) that aims to create spaces for exchange between different stakeholders. As the website of Wageningen Dialogues puts it:

Our current society is facing significant global challenges in the areas of health, energy, food, and sustainability. Opinions and interests vary widely in relation to these challenges, and they benefit from different perspectives. If we want to resolve these challenges and make room for the different opinions and interests, then a dialogue is required – one where we examine all those different perspectives together. (WUR 2021)

Evidence for both the solution and the negotiation strategy reflects the need for a more nuanced interpretation of the role of GGCs in research organisations such as WUR. Rather than assuming that GGCs always involve a legitimisation of dominant responses as solutions, appeals to GGCs at WUR feed into different organisational imaginaries that become reflected in heterogeneous institutional activities and documents with very different framings: from the *Dutch Solutions for Global Challenges* (WUR 2018) to *Finding Answers Together* (WUR 2019). At the same time, the dominance of the solution strategy often makes appeals to negotiation fragile and even, as some of our respondents claimed, as largely rhetorical:

They are clearly focusing on collaborating with certain types of industries and that’s been there since the beginning of Wageningen. And so, a very logical strategy is to put out a

message that “we’re all together in this” and that we include everyone. We’re not just with industrial farming but we’re also with local farmers, we’re with indigenous communities, and we’re all doing this together. But it’s to compensate for their lack of inclusivity.

The national level: global challenges, Dutch solutions

Our results at the organisational level highlight a tension in appeals to GGCs that is reflected in the co-existence of solution and negotiation strategies that present Wageningen University and Research as a ‘world leader’ in scientific and technological solutions as well as a place of public dialogue about complex societal questions. The following sections contextualise the findings of the organisational study through document analyses at Dutch and European levels to assess whether our findings are unique to one particular research organisation or whether they scale into its wider research landscape.

At the national level, our results show that the increasing focus on GGCs at WUR reflects wider dynamics of Dutch research and innovation governance. One of the most striking features of GGC discourses at the national Dutch level is the common pairing of ‘Global Challenges’ with ‘Dutch Solutions’ as it appears in the titles of a WUR research report (*Dutch Solutions for Global Challenges in the Agro Domain*, WUR 2018), a report of the Dutch Ministries of Economic Affairs and Education, Culture and Science (*Global challenges Dutch solutions*, MEA and MECS 2014), and a report of the Dutch Employers Association (*Global challenges, Dutch solutions. 2030 Agenda*, VNO-NCW 2017). The three reports use almost identical titles to emphasise the commitment of Dutch research and innovation to addressing GGCs, and the need to understand their international nature. For example, the WUR report (2018) develops detailed argumentation for why GGCs in the agri-food domain demand a focus on the ‘Global South’: namely, that Africa and Asia are the centre of global population growth (5), face the most serious threats to food security (12), experience the most dramatic dynamics of urbanisation (13), require the most urgent responses to youth unemployment, (23), and so on.

While the challenges are framed as global, all three reports are built around the claim that the solutions are Dutch. GGCs need to be solved *in* and *for* the Global South but also *by* Dutch actors. For the Dutch Employers Association, for example, GGCs are ‘crying out for solutions, but at the same time they create opportunities [...] for Dutch companies to penetrate new markets, including emerging markets in developing countries’ (VNO-NCW 2017, 13–14). Leadership of Dutch companies in solving GGCs is illustrated by examples from the largest Dutch companies that include: Phillips’ ‘ambition for 2025 is to improve the lives of three billion people every year’, Shell’s contribution to ‘local projects designed to give communities access to energy, for example with hydroelectric power and solar energy in the Philippines’, Unilever’s ‘purpose to make sustainable living commonplace ... It’s why we’re in business’, and Elsevier’s constant ‘striving to expand the boundaries of knowledge for the benefit of humanity’.

The report of the Dutch ministries develops a slightly broader perspective on relevant actors by emphasising the leading role of the so-called ‘Dutch Diamond’ or ‘Triple Helix’ of ‘relationships between the business community, knowledge institutions and government’ (MEA and MECS 2014, 8). At the heart of the report is the ‘Top Sectors’ policy of the Dutch government that identifies nine strategic investment foci such as agri-food, energy, and water, in which the Netherlands has historically been strong and

which are prioritised for the Dutch to play an internationally leading role in the future. The formation of the Dutch Diamond around these Top Sectors originally emerged as a strategic economic investment, but the report shifts the focus to broader sustainable development goals and emphasises the contribution of each of the Top Sectors to solving GGCs. By treating Dutch economic investment priorities as convergent with the solving of GGCs, the issue framing of sustainability acts to confirm and reinforce the current regime of research and innovation. And, as the State Secretary for Education, Culture and Science concludes in his foreword of the report: ‘Opportunities abound!’ (MEA and MECS 2014, 5). Representing all three corners of the Dutch Diamond (business community, knowledge institutions, and government), the three reports do not agree on all the details of ‘Dutch Solutions’. However, they converge in how they embrace the solution strategy in the sense that they prioritise the responses of dominant Dutch actors as providing solutions to GGCs while neglecting the representation of global actors beyond the Dutch Diamond and their heterogeneous concerns.

Concerns about a simple legitimising function of GGCs in our organisational study at WUR can therefore also be situated in a wider analysis of research and innovation governance at the national Dutch level. GGC discourses function as an instrument for sharpening the focus on societal impact and core concerns about issues such as sustainable food production, renewable energy, and water management. At the same time, appeals to Dutch solutions can obscure the wicked character of GGCs by treating them as tame problems to which dominant actors and their issue framings are best placed to offer solutions.

That being said, the Dutch governance context also exhibits ambiguity between solution and negotiation strategies. As has been previously highlighted in the literature, the Netherlands has a pronounced ‘history of public engagement in decisions affecting science and technology’ (Hagendijk and Irwin 2006, 179; see also Van der Molen et al. 2019) that can link Dutch approaches to GGCs to the negotiation strategy. While the Netherlands is characterised by an entangled ‘triple helix’ of links between academia, industry, and government, it has also a strong tradition of public engagement that is reflected in early adoption and institutionalisation of (participatory) Technology Assessment, Ethical, Legal and Social Aspects (ELSA) and more recently of Responsible Research and Innovation (RRI) (Zwart, Landeweerd, and van Rooij 2014; Van der Molen et al. 2019). As a result, many governance documents in the Netherlands such as the 2025 *Vision for Science* of the Ministry of Education, Culture and Science (MECS) appeal to the ‘Dutch Diamond’ in providing ‘Dutch solutions to societal challenges’ (MECS 2014, 48), but simultaneously highlight the need for public engagement: ‘Civil society should have more access to the added value which science brings in addressing societal challenges. [...] The ‘Trust in Science’ debates have taught us that closer contact between the scientific field and society is essential’ (MECS 2014, 9). Very much in line with our results of the organisational study, GGCs at the national level are primarily presented through the solution strategy that positions the Netherlands as a world leader in research and innovation while at the same time being linked to concerns about public engagement and the need for societal negotiation.

The European level: research missions and industrial leadership

Our findings from the local and national contexts do not generalise uniformly to the international level, as national science systems relate to GGCs in heterogeneous ways.

Geographical limitations of our findings were suggested by their embedding in a research consortium that studied twelve national science systems in which GGCs did not always feature prominently (see methods section). Wageningen University and Research and the Netherlands are the focus of this study because they stand out in their emphasis on GGCs rather than because they are assumed to be representative for research organisations or science systems at the international scale. However, the interplay between solution and negotiation strategies is also not unique to the Netherlands but can be located in supranational contexts such research and innovation policy in the European Union. To explore the relevance of our findings beyond the Netherlands, we focussed on the European Commission as an international governmental organisation that has embraced GGCs as a central organising concept from the Lund Declaration's 2009 focus on 'Grand Challenges' to Horizon Europe's 2021 'Global Challenges and European Industrial Competitiveness' pillar.

In providing some preliminary assessment of the interplay between negotiation and solution strategies in the European context, this section focuses on the transition from Horizon 2020 to Horizon Europe within the Framework Programmes for Research and Technological Development of the European Union. The Framework Programmes have been instrumental sites in promoting frameworks of societal engagement with science, technology, and innovation from earlier emphases on Ethical, Legal and Social Aspects (ELSA), to the promotion of Responsible Research and Innovation (RRI) in Horizon 2020, to the more recent emphasis on open innovation and societal missions in Horizon Europe. All of these frameworks can be linked to the negotiation strategy in the sense that they aim to foster societal engagement and the inclusion of diverse stakeholders in science, technology, and innovation. While this is most obvious in the way RRI has been embedded in the 'Science with and for Society' programme (SwafS) in Horizon 2020, it is also reflected in the centrality of 'openness' and 'co-creation' in Horizon Europe (Robinson, Simone, and Mazzonetto 2020). As the Strategic Plan 2021–2024 of Horizon Europe puts it: 'Faced with the challenges of our time, the cooperation and creativity – especially scientific, social and technological – are the bedrock of peace and prosperity for all' (European Commission 2021, 5).

While the Framework Programmes have an established tradition of public engagement in research and innovation governance, many of the explicit appeals to GGCs in Horizon Europe actually suggest an interpretation along with the solution strategy. Most strikingly, one of the three pillars of Horizon Europe, 'Global Challenges and European Industrial Competitiveness', mirrors framings of the national context that pairs global challenges and Dutch solutions in highlighting the strategic role of private sector actors in accelerating and steering transitions to the circular, climate-neutral and sustainable economy. This aspect becomes especially salient in the evolution of the Framework Programmes and the way in which 'Horizon Europe shifts the focus away from the research and knowledge production emphasis of H2020 to innovation' (Robinson, Simone, and Mazzonetto 2020) while emphasising GGCs in relation to European industry actors and 'the competitive edge they need for industrial leadership in global markets and promise breakthroughs to solving global challenges' (European Commission 2021, 24).

Various scholars have voiced concerns about these shifts in Horizon Europe that deemphasise RRI (Gerber 2018; Mazzonetto and Simone 2018) and frame GGCs as

a business opportunity as reflected in Horizon Europe's second pillar 'Global Challenges and European Industrial Competitiveness'. For example, Mejlgaard et al. (2018, 4) note that a 'particular concern [...] is the absence of support for the continued institutionalisation of responsible research and innovation (RRI)' in Horizon Europe, while Gerber (2018, 3) even suggests that this unclear fate of RRI could 'be criticised for having sacrificed a solid base of European scholarship on social innovation to the interests of big business and elite science'. As Mazzonetto and Simone (2018, 2) point out, this emphasis on the need for RRI reflects a wider concern that European research policy may be left without sufficient procedures for contributing to 'a democratisation process leading to connecting science to the values and interests of European citizens by means of participatory processes'. Similar concerns have been highlighted beyond the RRI community, for example in the 'Statement on the European Commission's Horizon Europe Proposal' by the Initiative for Science in Europe (ISE), which emphasises the risk 'that the agenda of this pillar ends up mirroring industrial interests almost exclusively, whilst critical issues of the global challenges receive little attention from private companies and rely strictly on public funding in order to be tackled' (ISE 2018, 2).

While debates about the transition from Horizon 2020 to Horizon Europe only provide a glimpse into the complex landscape of European research and innovation governance, they highlight how tensions between negotiation and solution strategies are not limited to the local context of WUR or the national Dutch context. Instead, GGCs also appear to feed into different imaginaries in the wider European context. On the one hand, the Framework Programmes introduce GGCs in relation to wider appeals to public engagement that acknowledge different stakeholders and their heterogeneous interests in negotiating research and innovation. On the other hand, GGCs are actually most commonly paired with dominant stakeholders and their solutions as reflected in Horizon Europe's 'Global Challenges and European Industrial Competitiveness'.

To sum up, we found evidence of tensions between the negotiation and solution strategies across local, national, and European levels of organisation. Across all three levels, while we found some links to societal engagement and participatory governance in strategic science policy documents, we also found that direct appeals to GGCs commonly shift attention to dominant actors by legitimising their responses as solutions. At the WUR level, GGC discourses run the risk of circumventing reflectivity about stakeholder diversity by foregrounding the values, issue framings and preferences of the university and its strategic partners. At the Dutch level, GGC discourses run the risk of reinforcing a lack of reflexivity about stakeholder diversity by foregrounding 'Dutch solutions' that are provided by the 'Dutch Diamond' of academia, government, and industry. At the European level, a similar dynamic is taking place when global challenges become framed as an opportunity for strengthening European industrial competitiveness as a partnership that holds the key to solving global challenges.

Conclusion

While appeals to GGCs have become ubiquitous, there has been little attention to how responses to these challenges are approached by governance actors. On the one hand, we emphasised that GGCs are wicked problems that can foster reflexivity about

different problem formulations and responses that remain contested among stakeholders with different needs and perspectives. We dubbed this interpretation the negotiation strategy. On the other hand, we hypothesised that appeals to GGCs could also be detrimental to the inclusion of heterogeneous stakeholders by highlighting the responses of dominant stakeholders as solutions to these challenges. We dubbed this interpretation the solution strategy.

Our results suggest a complex interplay between negotiation and solution strategies. First, we found evidence of both strategies at local, national, and European levels. The two strategies feed into different imaginaries that highlight the importance of public engagement and participatory governance while also emphasising dominant responses of actors in the 'triple helix' of academia, government, and industry. Second, our results show that the solution strategy often takes the centre stage in how governance actors relate to GGCs in practice. At the local level of Wageningen University and Research, GGCs are usually paired with the solutions that are provided by the university and its strategic partners in industry and government. Similar patterns are salient at the Dutch and European level and expressed through phrases such as 'Global Challenges, Dutch Solutions' or 'Global Challenges and European Industrial Competitiveness'.

While the solution strategy raises concerns about reinforcing dominant perspectives, a shift towards the negotiation strategy is not without problems, either. Instead, the negotiation strategy faces at least two major challenges. The first challenge directly relates to our results that indicated an often symbolic and superficial appeal to the negotiation of GGCs and the perspectives of diverse stakeholders. While institutions acknowledge the importance of stakeholder diversity, their approaches to GGCs often remain structured by a reliance on dominant stakeholders. In this sense, appeals to negotiation risk becoming largely legitimacy and symbolic exercises for solutions that are already in place (Macnaghten, Shah, and Ludwig 2021). Our results highlight that this dynamic is common not only in the private sector (e.g. in BP's (2011) agenda of 'global challenges, pragmatic solutions') but also among public research organisations and funders (e.g. in the common phrase 'global challenges, Dutch solutions').

Indeed, this risk of superficial and largely legitimacy appeals to stakeholder diversity has been noted beyond GGCs in other domains of research and innovation governance. In her study of Ethical, Legal, and Social Aspects (ELSA) and Responsible Research and Innovation (RRI), for example, Åm has shown that 'scientists try to accommodate rather than enact ELSA and RRI' (2019, 163) by meeting funder requirements through obligatory paragraphs on societal engagement that aim to legitimise existing research practices rather than reshape them. Similar concerns are also reflected in wider concerns about 'RRI washing' that rebrand existing activities without substantial engagement with underlying concerns of inclusion and public engagement (Grinbaum, Klein, and Vandermerch 2018). Our results can therefore be situated in wider concerns about research and innovation policy that find tensions between the transformative ambitions of governance frameworks such as ELSA, RRI, or GGC and their truncated accommodation into incumbent practices (De Hoop, Pols, and Romijn 2016; Ludwig and Macnaghten 2020; Macnaghten 2020; van Oudheusden 2014.). GGCs appear to be particularly vulnerable to this process as they allow a procedurally shallow reading of GGCs as tame problems that highlight the expertise of dominant governance actors and the perceived convergence between private and public interests.

Second, there are not only challenges of superficial but also substantial implementations of the negotiation strategy, especially given that the interplay of urgency and the wickedness of GGCs creates straightforward tensions (Kumar, Höffken, and Pols 2021). The wicked character of GGCs demands the inclusion of stakeholders who often have dramatically different goals and perspectives (Popa, Blok, and Wesselink 2021). Participatory governance provides a wide range of tools for inclusion – from citizen science to focus groups to multistakeholder platforms to participatory design to transdisciplinary methodologies. At the same time, the urgency of GGCs seems to clash with such practices of inclusion by highlighting the urgent need for immediate interventions rather than lengthy processes of negotiation and participation. However, it is precisely this move towards intervention without negotiation that reinforces dominant perspectives and that thereby often leads to responses that deepen inequality between stakeholders. The simultaneous characterisation of GGCs as urgent and wicked therefore creates complex governance challenges of navigating heterogeneity in meaningful ways while responding to the urgency of creating more just and sustainable responses to GGCs such as food security and climate change.

While the characterisation of GGCs as wicked problems is not a novel insight (Blok and Lemmens 2015; Neely, Edgeman, and Eskildsen 2015; Jordan et al. 2021; Wanzenböck et al. 2020), our results show that this insight translates at best poorly into current governance practice. Despite complex interpretations of the contested character of GGCs in the academic literature, GGCs are commonly accommodated into governance as tame problems that legitimise current practices. Our study, therefore, indicates the need for a critically reflexive debate about navigating heterogeneity that meaningfully gives way to diverse innovation futures. First, this requires a substantial rather than superficial appeal to negotiation in which heterogeneity is actually shaping research and innovation rather than merely legitimising them. Second, such a substantial interpretation needs to navigate between the urgency and wickedness of GGCs. Negotiation is a prerequisite for politically just responses towards GGCs that needs to be aligned with the urgency of intervention. While GGCs feature prominently in current governance landscapes, our results highlight the need for reflexive research on how GGCs become negotiated in the light of heterogeneous stakeholders with conflicting needs and priorities.

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Notes on contributors

David Ludwig is an associate professor in the Knowledge, Technology and Innovation (KTI) group at Wageningen University. His work in philosophy and social studies of science addresses global knowledge diversity and the interface of science and society. <http://david-ludwig.com/>

Vincent Blok is associate professor in Philosophy of Technology and Responsible Innovation at the Philosophy Group, Wageningen University (The Netherlands). His books include Ernst Jünger's Philosophy of Technology, Heidegger and the Poetics of the Anthropocene (Routledge, 2017) and Heidegger's Concept of philosophical Method (Routledge, 2020). Blok published over hundred articles in high ranked philosophy journals like Environmental Values, Business Ethics Quarterly, Synthese and Philosophy & Technology, and in multi-disciplinary journals like Science, Journal of Cleaner Production, Public understanding of Science and Journal of Responsible Innovation. See www.vincentblok.nl for more information about his current research.

Marie Garnier is a lecturer at the Political Communication and Journalism Group at the Universiteit van Amsterdam, as well as a PhD candidate at the Strategic Communication Chair Group of Wageningen University & Research. She holds an M.Sc. in Politics and Communication from the London School of Economics and Political Science, and a B.Sc. in Economics from the University of Costa Rica. Her research focuses on questions of news media, journalism, media power, and democratic public debate.

Phil Macnaghten is a Professor in the Knowledge, Technology and Innovation (KTI) group at Wageningen University. His PhD is from Exeter and he has held appointments at Lancaster, Durham and Campinas before joining Wageningen in 2015. Phil's research background is in science and technology studies (STS) and sociology and his current research focus is on responsible innovation, gene editing and the governance of science.

Auke Pols is a lecturer and researcher at the Knowledge, Technology and Innovation (KTI) group at Wageningen University. He is a philosopher of technology and responsible research and innovation. His research interests include the institutionalisation of RRI and innovation in energy systems, particularly in the global South.

ORCID

David Ludwig  <http://orcid.org/0000-0002-2010-5120>

Vincent Blok  <http://orcid.org/0000-0002-9086-4544>

Marie Garnier  <http://orcid.org/0000-0002-2331-3136>

Phil Macnaghten  <http://orcid.org/0000-0002-6611-4583>

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