The landscape of Science, Ethics and Public Engagement & their Potential for the Future
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Chapter 1 Executive summary
1 Executive Summary

We are living in a time where new scientific discoveries and technological developments are advancing at a staggering pace. Along with new discoveries, also come public debate and questions on ethical, legal, and societal issues. This report looks at how we can improve the connection and communication between science and surrounding society, increase mutual understanding and trust on the issues at stake, counter misunderstandings, and avoid science and technology that have undesired side effects, or that are not accepted by society. Academics and practitioners of public engagement have argued that to address the publics’ questions and concerns, we need a new approach to communication. Such an approach builds on joint reflection, anticipation and engagement on the ethical and societal issues related to scientific developments.

This report sets out to better understand how a range of publics have been engaged in ethical issues arising from scientific discoveries, in order to identify opportunities to engage the public intentionally, meaningfully, and effectively in discussions of ethical issues. To that end, the report maps the landscape of interaction between science, ethics, and public engagement, and examines how science in different fields has tackled engaging the public on ethical issues, so as to identify opportunities for learning and advancing the interaction between these three areas of practice.

We learned that publics have been engaged on ethical issues across scientific disciplines, and that they are willing and able to engage. We also saw that mapping aims and goals of such exercises is not straightforward, but that there exists a multitude of perspectives on the goals and outcome of the public engagement exercises. Our findings show examples of how public engagement can contribute to mutual understanding and trust-building with citizens; that it can empower citizens to participate in discussions, and thereby democratize expertise; that it can contribute to developing science and policy; and last, but not least, that the scientists who engage take valuable insights with them into their own work.
Nine Lessons on Public Engagement

1. The way public engagement activities are set up and organized influence the opportunity of publics to contribute. It also affects how scientists and other stakeholders perceive the usefulness of public engagement exercises.

2. There is tension on the role and goals of public engagement.

3. Public engagement can develop better science, policy, and understanding of the ethical, social and legal issues at stake. It can also contribute to building trust between science and society.

4. There is a link between science policy and political prioritization of scientific developments and available resources for public engagement activities.

5. Impacts of public engagement processes can be difficult to measure. Impact measurement is also dependent on how well desired impacts of the activities are defined beforehand.

6. Public engagement activities have a Western origin and legacy, but they have a proven ability for application in different cultural contexts and by different national actors across the world.

7. Linking up with decision-makers can be challenging, but it is often essential to reach the desired impacts of engagement activities.

8. Public engagement projects and activities are (often) situated in a context with competing interests.

9. There is a potential for increased learning on practices of public engagement between the academic and more practice-oriented communities of engagement.
The report suggests that:

- Public engagement can be a democratic tool to open scientific developments and decision-making to societal debate and democratic control.
- However, for public engagement to become such a tool, existing structures of power, interest and inequalities that shape the context of scientific and technological development and public engagement activities need to be made explicit as topics of debate.
- Such power structures can be understood at different levels of organization. From the micro-level of differences in education, background and societal status that would influence dialogue between a scientist and a citizen, to the macro-level power dynamics that shape dialogues on the direction of scientific developments at the global stage.

In the report, we give examples of the complex settings of public engagement exercises and show how the goal and role of the engagement activities were understood differently by different actors or changed over time. What each example shows, is that:

- It is essential to carefully define the goal(s) and desired impact(s) of the engagement exercises beforehand. Whether public engagement is undertaken as part of a democratization process, as a way of improving robustness of a policy choice and minimize controversy, or as a means to acceptance and trust in a specific decision that has already been made, such aims should be clear.
- There is a rich collection of methods for public engagement\(^1\). These list available methods and the multiple goals they can be used to achieve. The possibility for impact depends crucially on commitment and backing by actors with the agency to influence on-going developments. Who these actors are, may vary from context to context and over time. In some cases, it will be politicians, in others, researchers, media, industry, business, consumer groups or activists.
- Clear, transparent, definitions are crucial: firstly, the aims of the engagement; secondly, the role of the participants as data-subjects, participants, co-developers, or decision-makers—making sure the role given is one that can be realized—in the process as well as in the implementation of results. Organizers should also reflect on how role distributions enforce or challenge existing inequalities, and what the implications are for their engagement activities and their outcome. The most effective assurance, both as to role and to how results will be used, comes from agreement beforehand among all (or as many as possible) of those actors who can influence uptake and implementation of results.

Therefore, organizers face the task of clarifying the developmental stage of the scientific field or technological development they would like to engage with, the powerful actors and interests involved, and the related opportunities for impact. They must clearly describe the interests at stake, the role and sample characteristics of the citizen participants, the interests, and priorities

\(^1\)One example is the Engage2020 Action catalogue that helps organizers search for the method of engagement suited to a desired impact, type of participants and level of public engagement: http://actioncatalogue.eu/search
Another example is the RRI tools database: https://rri-tools.eu/search-engine
at play in the science, policy area and industry/business area, and the end goal of the results, as well as informing participants on how results are reached.

For future practice, it would be important to develop a more widely shared inventory of public engagement methods, mapped to possible goals and impacts. Collaboration between academics, public engagement practitioners, and other stakeholders could be an important step in developing such an inventory. This point also speaks to the amount of gray literature, practical experience, and non-Western or non-English language engagement experiences that are not described in peer-reviewed articles, and the need to build bridges and communities across these areas of practice.

Finally, we end with a larger question as to who should take responsibility for the future development of public engagement activities. At present, activities may be described as a patchwork of projects and programs, with varying degrees of policy or funding support and prioritization. The question is what type(s) of support, attention and organization are needed to move practices of engagement into the mainstream of science and technology policy and development?
Chapter 2
The Landscape Report on Science, Ethics, and Public Engagement
2 The landscape report on science, ethics, and public engagement

We are living in a time where new scientific discoveries and technological developments are advancing at a staggering pace. Artificial intelligence is widely positioned as the basis of a fourth industrial revolution that might change every aspect of our societies. Brain sciences and computing technologies are merging with promises of unprecedented access to and understanding of the human mind. Genetic technologies and life sciences are, increasingly, providing opportunities to intervene in the lifecycles of humans and animals, through changing the hereditary makeup of species or finding new ways of growing organs.

Along with new discoveries also come public debate and questions on ethical, legal, societal, and political issues. In addition, there is increasing attention to the potential of citizen participation in decision-making and agenda setting in public policy. A June 2020 report from Organization for Economic Co-operation and Development (OECD) describes this development as a tidal wave of experimentation with deliberative democracy across the world. The report “Innovative Citizen Participation and New Democratic Institutions: Catching the Deliberative Wave”, shows how deliberative exercises could play a part in addressing a mounting crisis of public trust in democracies and their associated governance structures. In part, the present democratic crisis stems from a failure on the side of policy to realize that the public is thirsty for increased participation and dialogue on policy, its development, and priorities (OECD, 2020).

Historically, one can argue the role of science has generally been understood as the harbinger of progress, with the role of society then being the recipient and owner of any questions, problems or even disasters brought forward by the societal application of scientific discoveries and ideas, and of the technological inventions of engineers and others. (Rip, 2014) The social order reveals itself in controversies and debate over scientific and technological developments that challenge the existing moral or social order. A popular aphorism that describes the relationship is Ravetz’s “Scientists take the praise for penicillin, but Society takes the blame for the Bomb.” Scholars have described this as a “division of moral labor” (Shelley-Egan, 2011), and have described it as the reason why conversation between scientists and other societal groups can be hard. In a study of how scientists frame the idea of talking to the public, Davies (2008) explains how scientists often, but not always, see the public in need of education and information about scientific progress. Once the public audiences understand scientific principles and ideas, they will be supportive of science (Davies, 2008). In practice however, conversations do not always play out in this way.

Part of the reason for this can be found in an increasing tendency for policy, publics, and scientists to ask questions about the benefits and risks of new and emerging science and technologies. Fueling the tendency are debates on scientific discoveries and technologies going back to discoveries such as nuclear fission, DDT, genetic technologies, biotechnology, and others. For example, the Bulletin of Atomic Scientists is an early example as far back as 1945. The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems is another recent example of scientists also raising questions and concerns about scientific developments and technologies.
animals and farming, and genetically modified crops (GM). Academics and practitioners of public engagement have argued that to address the publics’ questions and concerns, we need a new approach to communication. Such an approach builds on joint reflection, anticipation and engagement on the ethical and societal issues related to scientific developments. Engaging in dialogue and exchange of viewpoints helps address the challenge that controversies and conflict over scientific developments are hardly ever a matter of “facts”. Rather, they are often disagreement about what is “good” and “right” to do. Ethics has helpful principles and theories of guidance, but in concrete matters of implementation and political debate where many interests are at play, other approaches are needed. This is where carefully designed dialogues may help clarify the issues and interests at stake and discover alternative pathways of future developments for use and development of science in society.

2.1 What is public engagement?

The term “public engagement” is widely used across several disciplines, areas of practice and by different actors ([social] scientists working in academia, practitioners working outside of academia, educators working at science museums). The variety of uses of the term may be illustrated as in Figure 1.

Figure 1 – Illustrates how the term “public engagement” is applied across different types of activities, with different aims and purposes. The figure is a modification of a figure originally developed by the American Academy of Arts and Sciences (2019).

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3 At this point we should note that the description provided here is a Western interpretation of how the science-society relationship is and has developed historically. This might look different in other cultures, traditions, and ways of understanding the world and our place in it.

The wide distribution of public engagement activities also means that a clear definition of the term is hard to come by. Several scholars have commented on this, such as Avard et al., 2010, who write: “There is confusion about what is meant by public involvement, as it can have many different meanings along a continuum that ranges from low levels of communication to higher levels of involvement” (p. 511).

In the present report, we adopt a broad understanding of public engagement, emphasizing public engagement as activities with an opportunity for dialogue, exchange of viewpoints, or where the motivation is one of learning about the experiences and perspectives of others. We focus on the engagement of citizens, and therefore do not include engagement of other public groups or stakeholders. Our definition also excludes activities with the aim of informing the public about scientific or technological developments.

The understanding of public engagement as an opportunity for exchanging viewpoints, and for learning, stems from debates on two models for understanding the relationship between science and society. The first is referred to as Public Understanding of Science (PUS) or the “deficit model”, and the second as Public Engagement with Science (PES). PES developed as a response to the PUS model. The latter was criticized for the way it positions scientists as the knowledgeable experts, and publics as in need of information to require knowledge on science and associated discussions on policy and science policy discussions in scientific developments. The emergence of PES, as a scholarly and science policy agenda, turned the one-way communication model of PUS into a two-way model. PES assumes scientific experts and citizens that possess different types of knowledge, and therefore dialogue between them can help increase mutual understanding of the other’s perspectives, knowledge, needs and values. Furthermore, dialogue could be a way to open for a more democratic and open governance of scientific and technological developments. Today, it may be argued that the PUS as well as the PES models live on in the European Commission’s policy agenda on Responsible Research and Innovation (RRI).

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5 Davies (2008) examined how scientists talk about talking to the public and discovered that the dominant discursive framing is still one where the public is understood as in need of education about science. Interestingly, she also found that scientists see dialogue with the public as both difficult and dangerous.

6 The framework of Responsible Research and Innovation (RRI) was introduced as a cross-cutting priority in the European Commission’s research funding instrument Horizon2020. RRI is a European concept that embraces a rich academic legacy and on technology assessment and governance of science and technology is often summarized in descriptions of visions for how science and society can develop responsibly (see Stilgoe, Owen and Magnagthen 2013 for a description that covers the essential components. See also the UK Engineering and Physical Sciences Research Council (EPSRC), who adopted and promotes the framework: https://epsrc.ukri.org/index.cfm/research/framework/). From the European Commission the framework also encompasses six policy keys defined as areas in need of special attention for strengthening and developing the conversation, trust and understanding between science and society. The six keys are: Governance, ethics, public engagement, gender equality, science education and open access. The framework has been the subject of intense discussion and
In our understanding of public engagement, we draw heavily on Arnstein’s ladder of citizen participation. She conceptualized citizen participation in a 1969 paper in relation to political decision-making processes. In viewing citizen participation as citizen power, she developed a “ladder of participation” to illustrate the degrees to which power could be distributed to participating citizens (Arnstein, 1969). Notably, Arnstein’s ladder was directed at inclusion of underprivileged and hard-to-reach groups in political decision-making processes, so as to come to sustainable and acceptable solutions in challenged neighborhoods. The top three rungs of her eight-step ladder include “partnerships”, “delegated power” and “citizen control.” Rungs three to five include forms of participation where citizens are heard, but decision-making power remains in the hands of the already powerful actors; while the first two rungs are approaches aimed at informing and convincing citizens to follow instructions or programs without any possibility for providing input or affecting change.

Following Arnstein’s ladder, the ideal of citizen participation consists of inviting citizens to participate and have a say in decision-making processes. The ideal of citizen participation is represented by the higher rungs on the ladder (steps 6–8), where (some) power is delegated and citizens can influence developments. Public engagement consists, then, of opportunities to exchange viewpoints and learn (steps 3–5), but ideally engagement is involvement that gives influence to the participating citizens with the aim of democratizing decision-making processes, and developing better foundations for decisions based on the experiences, needs, values and concerns of all affected groups.

![Arnstein's ladder of citizen participation](image)

*Figure 2 – Arnstein’s ladder of citizen participation.*

experimentation during Horizon2020, including exchange with scholars and other experts outside of Europe. However, the framework largely remains a European discourse. At present it remains unclear what role RRI will play in the next framework program HorizonEurope (starting January 2021).
Finally, our understanding is shaped by our history and involvement with the international technology assessment (TA) community and the Democracy R&D network of practitioners and scholars. The Danish Board of Technology (DBT) was established in 1985 as an experiment in parliamentary TA. Our establishment was inspired by the US Office of Technology Assessment (OTA), an office with the task of assisting congress in questions on science and technology. In contrast to OTA, the mission of the DBT was more “open” in involving societal stakeholders and scientific experts in discussions and assessments of new technological developments and to create public debate. The original mission developed further, to include dialogue and engagement with publics in addition to stakeholder and expert dialogues, and in 1987 DBT developed the concept for, and hosted the first consensus conference on, “Gene technology in industry and agriculture.”

Drawing on our experience, and on arguments presented in literature related to the above-mentioned academic literature, one may list reasons for involving publics, as well as the benefits of engaging publics with science, including:

Rationales for involving public (Fiorino, 1990; Wynne, 1993; Abelson et al., 2003; Burgess and Chilvers, 2006, Stirling, 2006):

- Publics have a right to participate in discussions and developments that affect them.
- Publics hold valuable knowledge which would help the development of needs-oriented innovations (social robustness of scientific knowledge).
- Having the public involved in research and decision-making processes increases legitimacy of the processes, provides greater legitimacy for making hard choices, and, it is argued, leads to a higher degree of trust and acceptance of its outcomes.

Outcomes of involving citizens:

- Mutual understanding and trust and research that inform society, but which are also informed by society (counteract polarization and misinformation).
- Empowerment of citizens to participate in debate and make choices.
- Democratization of expertise by allowing the less powerful a seat at the table.
- More inclusive science policy, better representing needs, values, and interests of a diverse society.

The second key theme in this report relates to ethics or ethical issues. In the following section, we briefly introduce our working definition of an ethical issue.

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7 https://eptanetwork.org/
8 https://democracyrd.org/
9 The DBT was as a public independent council for the Danish parliament that was closed in 2011. Today the board continues its original mission as a non-profit private foundation.
10 OTA was closed in 1995.
2.2 What is an ethical issue?

Following Swierstra and Rip (2007)\textsuperscript{11}, we define an ethical issue as one that emerges in contestation or debate when, for instance, a scientific or technological development brings into question ways of acting or living that had before then been considered self-evidently “moral.” Examples include the debates on genetic technologies, biotechnology, animals and farming, and genetically modified crops (GM). New technological and scientific developments provide choices and opportunities for acting that did not exist before. Ethical issues then emerge in controversies and debates on how to adapt to the disruption of previously self-evidently moral routines.

Describing an ethical issue in this way, means we see discussion on social, economic, and legal issues as ethical. The issues are ethical in the sense that they involve debate on what is the good way of acting or living, and they refer to the interests and values of the parties involved in a discussion. Arguments on economy, for example, often draw on utilitarian argumentation on the maximization of “the common good” for the most people.

In their article, Swierstra and Rip (2007) also point to new ethical issues that arise due to the nature of enabling sciences and technologies, like nanotechnologies. The first concerns ambivalences created by the character of nanotechnologies. New risks may emerge each time new nano-enabled new properties are discovered. Therefore, there can be no stable risk assessment, no end to the question, but only an ongoing approach of learning about risks as one goes along. The second ethical issue that nanotechnologies bring out concerns about the distribution of active agency to non-human actors. The question is how one may solve questions on liability and responsibility in the case of a malfunction in a (semi) autonomous system. The third issue relates to the enabling character of nanotechnologies. Properties and functions of nanotechnologies emerge in co-production with contexts of application. How the technology is embedded in a system, applied, and taken up by society thus contributes to the production of effect and impact. The results in an unclear distribution of responsibility for the effects of a technological development.

In the present report, we draw on the NEST-ethical understanding of ethical issues to map the landscape of interaction between science, ethics, and public engagement.

\textsuperscript{11} The NEST-ethical pattern of argumentation took discussion on nanotechnologies as a starting point. However, the article also refers to examples from debates on other technologies and scientific developments like recombinant DNA, genetically modified organisms (GMOs), and green biotechnology.
2.3 Structure of the landscape report

The present report is commissioned by The Kavli Foundation. The aim of the report is to better understand how publics have been engaged in ethical issues that arise from scientific discoveries, and to identify opportunities to engage the public intentionally, meaningfully, and effectively in discussions of ethical issues. The report sets out to map the landscape of interaction between science, ethics, and public engagement; to examine how science in different fields has tackled engaging the public in ethical challenges; and to identify opportunities for learning and advancing the interaction between these three areas of practice.

The mapping and analysis operate at the intersection of three areas of activity and practice: science, ethics, and public engagement. Interaction between science and ethics is formalized through laws, rules, codes of conduct, ethics committees, scientific journals, and trainings. However, interaction on ethical issues, between societal stakeholders, publics, and science, is much less formally structured. To access this kind of interaction, we therefore focus on issues of debate or controversy as an entrance point to the intersection between science, ethics, and society.

The report begins by providing a landscape overview of ethical issues across scientific fields, and how or where public engagement comes into the landscape overview. It then dives into five focus areas (rDNA, nuclear power, biobanks, nanotechnologies, and AI) to provide a) examples of activities of public engagement, b) the actors that organize public engagement and their motivations, c) the setting, context, and outcomes of public engagement exercises. Finally, d) the report collects up what lessons may be learned from our analysis and sets out a perspective on the future role of public engagement on ethical issues in science.

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12 The EU project SATORI undertook a comparative analysis of ethics assessment practices across countries, disciplines, and types of organization (see: https://satoriproject.eu/work_packages/comparative-analysis-of-ethics-assessment-practices/)

13 In the present report we focus on interaction between science and ethics outside of formalised ethics education, laws, review boards, professional codes of conduct and similar institutionalized forms of interaction.
Chapter 3
Mapping the Landscape of Science, Ethics, and Public Engagement
3 Mapping the landscape of science, ethics, and public engagement

Public engagement, ethics and science can be seen to interact in many diverse ways. Our study was a six-month project, and therefore necessarily limited in terms of the depth and completeness of overview. The aim of our study was to provide a landscape overview of the overlaps between science and ethics, and between science, ethics, and public engagement across scientific disciplines. From our landscape overview, the next step was to investigate the role of public engagement across five focus areas, and to see what lessons for the future we could draw from these on the potential of public engagement.

We took a three-pronged approach to our data collection. First, we performed a literature search with the intention of providing a visual landscape overview in two installments, the first showcasing interactions between ethics and science, the second illustrating interaction between science, ethics, and public engagement.

Based on the landscape overview, and deliberation within the task team, we picked five focus areas for a deeper investigation. Once we had picked them, we performed an additional round of literature search, this time focused on the five focus areas. The literature found in this search was also used to identify interviewees. We knew countries outside of both Europe and the US to be underrepresented in the literature on public engagement (Guenther and Joubert, 2017). To try and include aspects on how public engagement is practiced and understood elsewhere, we drew on our own network so as to identify practitioners working with public engagement in Asia, Africa, and South America. However, that meant we had to compromise our topical focus of the five focus areas, as we could not fulfill both requirements simultaneously.

We performed 23 semi-structured interviews. The interviews were with experts knowledgeable on the one of the five focus areas and/or experts within public engagement and/or policy. An overview of our interviewees is in Annex A, a standard interview guide in Annex B, and the details of our methodology can be found in Annex C.

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14 In terms of investigating public engagement practices and understanding their cultural meaning and implications, language is a non-trivial factor. Internationally, English is the standard language for sharing research findings in academic literature, making it hard for many non-native English speakers to share their findings. There also exist parallel communities of knowledge exchange in many countries and world regions where English is not the language of communication. Furthermore, language barriers can make it hard to exchange lessons and experiences in practice, and finally, not all practitioners of public engagement are academics. This all implies that knowledge, activities, and practices of public engagement outside of higher learning environments are probably not shared or acknowledged as widely as they could be.

15 Still, our sample is limited to one interviewee in in each of the countries South Africa, Columbia, Taiwan, and Japan, and much more could be done on investigating the way public engagement is developed and adapted to the cultural and political contexts around the world.
In the following sections, we present the key details and findings of our initial search and the resulting visualizations that helped paint a broader picture of the science, ethics, and public engagement landscape.

3.1 Landscape overviews of ethical issues and ethical issues and public engagement across scientific disciplines

Our literature search provided the following landscape overviews of the interaction between science, ethics, and public engagement. Figure 3 gives an overview of; the ways ethical issues and scientific disciplines intersect; and the topics and issues of debate. Figure 4, expands on the overview in Figure 3 to show on what topics in what scientific disciplines there has been public engagement activities.
Figure 3 – Landscape overview of science and ethics: This visualization presents scientific topics (blue) that have been linked to controversy and subjected to ethical debate within the scientific community. These topics are linked (by an unbroken line) to one of 7 research areas (yellow) in which these topics were prominent. These research areas are comprised of clusters of scientific disciplines, the relative size of the box indicating how many articles were considered in each of them. Finally, the ethical issues (red) most prominent in discussions of the different topics (linked by a broken line) are presented in a few keywords.
Figure 4 – Landscape of overview of science, ethics, and public engagement. The overview builds on figure 3. It provides a heat map (red dots) which showcases where public engagement is more prominently featured in the scientific literature, centered on the identified topics (light blue). Those topics where no significant overlap could be detected have either been removed or been given a lighter blue shade. The dark blue boxes present a more general description of public engagement activities in relation to the identified topics – a relation illustrated by the broken lines. The yellow boxes represent research areas, linked to topics by unbroken lines.
3.2 Picking the five focus areas for in-depth analysis and interviews

Our literature review showed the life sciences dominate the landscape of science, ethics, and public engagement. Sub-categories include neuroscience and biotechnology, and associated ethics disciplines of bio- and neuroethics. Environmental science, medicine, and healthcare follow as the second, third and fourth most visible disciplines for an investigation of the intersection of science, ethics, and public engagement.

In picking our five focus areas, we wanted examples from the major disciplines of life sciences and physical sciences; examples that could tell us about science, ethics, and public engagement historically; and focus areas that could tell us about this dynamic in examples of scientific developments closer to our present day.

Following our criteria, we chose recombinant DNA and nuclear power as our two historical focus areas, one from the life sciences and one from the physical sciences. From the life sciences, we added a focus on biobanks. In our landscape overview, biobanks were the one topic that consistently scored highly across our different keyword searchers. Biobanks also present a bridge between the historical focus areas and the more present-day developments. Nanotechnologies and AI were chosen as the two focus areas closer to our present day. These two areas have grown out of the disciplines of engineering physics and computer science.
Chapter 4 Exploring the Landscape of Public Engagement with Science
4 Exploring the landscape of public engagement with science

Looking through the lens of the five focus areas, we first sought to map the ethical issues we came across in each example in relation to public engagement activities. Without aiming to be exhaustive, our mapping includes the ethical issues mentioned by interviewees and literature. It also includes interviewees’ reflections on the most pressing ethical issues for public engagement activities in our present day.

Next, we present an overview of the public engagement activities we came across in our interviews and literature studies. Our aim was to map the activities according to the goal of the public engagement exercises. However, we soon realized that mapping activities to goals and outcomes was not a straightforward exercise. There exists a multitude of perspectives on the goals and outcomes of the public engagement exercises that we found. Therefore, our final sections focus on exposing these tensions, and trying to understand how we can learn from them in organizing public engagement events in the future, by looking at the kinds of actors that initiate public engagement activities, their motivations, and the timing for organizing public engagement activities, and how activities were framed and understood by our interviewees. Finally, we describe the outcomes and impacts of public engagement exercises that we found in our sample, and we compare these with the ideal list presented at the beginning of the report.

4.1 Historical and current ethical issues in our five focus areas

In investigating our focus areas, we wanted to better understand what the ethical issues were in each example. We follow Swierstra and Rip (2007)16 in understanding an ethical issue as contestation or debate that emerges when, for instance, a scientific or technological development brings into question ways of acting or living that had otherwise been morally self-evident. That means we understand discussion on social, economic, and legal issues as ethical in the sense that this involves debate on what the “good” way of acting or living is, and it refers to the interests and values of the parties involved in any discussion. The overview shows that ethical issues cut across our five focus areas.

Table 1 – Gives an overview of examples of ethical issues that we found in our interviews and literature review for each of the five focus areas. While we have tried to note all the ethical issues we came across, the table must not be taken as a complete representation of the ethical issues discussed in each topic area.

<table>
<thead>
<tr>
<th>Ethical issue</th>
<th>Focus areas where the issues were found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can/should we stop the scientific or technological development? If we do not develop it, our competitors/someone else will, so the technological development will happen anyway.</td>
<td>rDNA, nuclear power, biobanks, nanotechnologies, AI</td>
</tr>
</tbody>
</table>

16 The NEST-ethical pattern of argumentation took discussion on nanotechnologies as a starting point. However, the article also refers examples from debates on other technologies and scientific developments like recombinant DNA, GMOs, and green biotechnology.
Is it a problem that our morality is challenged by new developments? Might it just be a matter of time before morality adapts to new opportunities?

How can we shape and steer a technological or scientific development to embody ethical principles and values?

Are risk assessments able to capture all types of cost and benefits/are we conceptualizing costs and benefits correctly?

When should the precautionary principle be applied, and how?

How can we balance the possibility of future benefits with the possibility of harm to humans, the natural world, and animal-life, today and in the future?

Do we prioritize the advancement of knowledge and economic growth over risks of discrimination, violations of human rights (like privacy), unequal distribution of costs, benefits, and access?

Should we draw some limits on what we as humans interfere with, and who should be involved in drawing up those limits?

Table 1 gives an overview of how ethical issues are distributed across the five focus areas. In addition, we also found ethical issues that show the ambivalences pointed at by Swierstra and Rip (2007) in the case of nanotechnologies. To sum up, there are:

1. The character of the scientific or technological discovery or application makes it impossible to close any discussion on risk (new properties and thus new risks are continuously introduced)

2. The technology is (semi-) autonomous, or imagined acting independently in the world (questions on liability and responsibility for action(s))

3. The effects of any application are co-produced by the system in which the new technology is embedded, and the societal context in which the system is planned to operate (mass scale (ir)responsibility)

Across our five focus areas, the additional ethical ambivalences are visible in the case of rDNA (1), Nuclear power (3), Biobanks (3), AI (1,2,3).

It is also worth noting that AI as a concept was born in the 1950s (McCarthy et al., 2006), with the purpose of developing computers that could solve problems for humans. AI today is being developed with the purpose of performing tasks with human-like intelligence, and importantly learning while doing so. This has led to a resurgence of interest and investment in AI (Yang et
al., 2018) and to huge efforts towards developing ethical frameworks for its further advancement. In 2017, no less than seven ethical guidelines for AI and algorithmic governance were published17.

Since 2017, work has continued to evolve on definitions of AI and ethical frameworks and guidelines for ethical development of AI. One example is the EU high-level expert group on AI, which in 2018 published its first draft of ethical guidelines for the development of trustworthy AI, how to work with the ethical principles in practice, and a definition of AI. The guidelines were revised in early 2019 based on feedback and comments received. They were also sent into a piloting process for testing by organizations working with AI. The process is scheduled to lead to a revised document in 2020.

In addition to these ethical guidelines, the European Commission published a white paper on AI in February 2020. The white paper was open for public consultation until June 14, 2020: comments could be submitted by filling a questionnaire and/or attaching a written document to the survey. However, apart from news articles in the mass media and open online surveys, there seems to be little dialogue with the public on AI. One exception is the EU Human Brain Project that organized citizen dialogues on AI in the fall of 201918.

4.1.1 Pressing ethical issues for the future

In our interviews, we also asked interviewees to relate to the most pressing ethical issues in our present day and future. The type of ethical issues can roughly be divided into three groups.

In the first group, we found concern as to how new scientific and technological possibilities support existing inequalities in power (like the growing gap between very rich and the rest of society; or the position and influence of global companies and industries; political abuses), effects on human rights, and other rights such as access to new technological opportunities or scientific insights. The concern for individual rights was recently echoed in “A conversation about a future digital Europe”19 where the historian Shoshana Zuboff remarks how “We are


18 Citizen Dialogues: EuropeSay on Artificial Intelligence: https://tekno.dk/article/eusay-ai/?lang=en

marching naked into the digital age,” referring to the almost complete lack of legal protection for individual fundamental rights.

In the second group are questions on liability and responsibility. Such questions come up in relation to for example using predictive algorithms to predict disease risk, or to make inferences on someone’s employability. In addition, use of predictive algorithms raise questions on the protection of citizens from harm, and safeguards of their options to protest injustice (channels and resources). Several interviewees also pointed to the on-going COVID-19 pandemic. Interviewees pointed to questions on societal organization and the questions on individual rights versus common good that the pandemic has brought to light. The pandemic has also exposed a lack of preparedness and poor planning across the world for a risk that was well known. It has shown how tensions in international politics hamper collaboration and joint action. The central question is then, how to change these dynamics for future handling of pandemics, and for joint action on climate change and energy production and consumption.

In the third group, interviewees pointed to a pervasive problem, which they described as the inability to debate or question the normative orientations of science (see also Stemerding et al. 2019). They pointed to a public engagement exercise where participants’ role was to provide input on applications or future products. According to the interviewees, focusing on applications or use reduces engagement exercises to being simply consumer testing panels. It prevents the asking of questions on the desirability of applying a technology in a specific way. That could be, for instance, questions on using probability assessments as predictive tools for future disease risk. Finally, some interviewees also questioned the limits and ability of ethics to solve the questions and dilemmas raised by new science and technology. Instead, they argued that discussion on future directions of science should be recognized as belonging in the arena of political decision-making, and ways should be found for more democratic and inclusive debates on the choices made in science and in technological developments. As one interviewee expressed it:

“The main ethical issue is the fact that there are different ethical frameworks. In other words, any exercise addressing something as a matter of ethics must, if it is itself to be ethical, acknowledge it will be unable to come up with prescriptive ethics-based recommendations, because what is, or is not ethical, will be a political matter. And one cannot, through expert ethical deliberation, resolve incommensurable political issues. How you do that is through democracy, not through ethics. So that would be the main ethical issue for me, that an ethics frame is itself unethical in a democracy.” (B1, 2020)

The point resonates with a final reflection in the paper by Swierstra and Rip (2007). The impossibility of finding consensus on incommensurable ethical frameworks and worldviews excludes ethics from taking the role as the solution to the dilemmas introduced by new science and technology. Instead of thinking that ethics can bring an answer to the question ‘What is the ethical right thing to do?’, ethics can contribute with insight into what ‘could be good and right to do’, but debate should be framed as political, with actors (with their interests, differences in position and power), competing for legitimacy of their position and suggestion for action. To ‘win’, actors must debate and argue in the struggle to enroll allies to their cause.
Democratizing and equalizing the structure of that debate is essential, and in that process public engagement approaches could have an important role to play.

4.2 Examples of public engagement in our five focus areas

At the beginning of the report, we said we would “operate with a broad understanding of public engagement, but with emphasis on an understanding of public engagement as activities where there is an opportunity for dialogue, exchange of viewpoints, or where the motivation is one of learning about the experiences and perspectives of others.” Looking across our five focus areas, we could say that we have seen examples of this type of public engagement in all of them.

Table 2 - Types of public engagement activities across our focus areas.

<table>
<thead>
<tr>
<th>Topic area</th>
<th>Examples of public engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>rDNA</td>
<td>*Asilomar conference (Berg et al. 1975, Taylor and Dewsbury, 2019; Wright, 1986)</td>
</tr>
<tr>
<td></td>
<td>Cambridge City Council (Petersen, 2010)</td>
</tr>
<tr>
<td>Nuclear power</td>
<td>*Townhall meetings in the US (B3, 2020)</td>
</tr>
<tr>
<td></td>
<td>*Deliberative polling on finishing building nuclear reactors, Korea (F2, 2020)</td>
</tr>
<tr>
<td></td>
<td>*Deliberative poll on energy policies, Japan following Fukushima (F2, 2020)</td>
</tr>
<tr>
<td></td>
<td>*Citizen dialogue by Sciencewise and UK Department of Energy and Climate Change on placement of nuclear waste (Sciencewise, 2016)</td>
</tr>
<tr>
<td>Biobanks</td>
<td>*Genomics England (Samuel and Farsides, 2018)</td>
</tr>
<tr>
<td></td>
<td>*UK Biobank (Avard et al., 2009; Wallace, 2005)</td>
</tr>
<tr>
<td></td>
<td>*First BC Biobank deliberation (O’Doherty, and Burgess, 2009)</td>
</tr>
<tr>
<td></td>
<td>*Townhall deliberations US (Walmsley, 2010)</td>
</tr>
<tr>
<td></td>
<td>*Second BC biobank deliberation (Burgess, 2014)</td>
</tr>
<tr>
<td>Nanotechnologies</td>
<td>*Theatre plays, nanosupermarket, science cafes, vignettes on ‘soft impacts’ in the Netherlands</td>
</tr>
<tr>
<td></td>
<td>*National Citizens’ Technology Forum (NCTF) on nanotechnologies and human enhancement, in the US (Guston, 2014)</td>
</tr>
<tr>
<td></td>
<td>*US, Experimentation with ‘materialized deliberation’ through games, simulation (Guston, 2014)</td>
</tr>
<tr>
<td></td>
<td>*OpinionPoll on Nano (F5, 00.21)</td>
</tr>
<tr>
<td>AI and computing</td>
<td>*EuropeSay on AI reaching more than 900 citizens in 13 countries²⁰</td>
</tr>
<tr>
<td></td>
<td>*EC White paper consultation on AI²¹</td>
</tr>
</tbody>
</table>

²⁰ Event description and report: https://tekno.dk/article/eusay-ai/?lang=en
The following sections aim to better understand the public engagement events in Table 2, and the way these activities emerge in interaction with science, ethical issues and the actors that initiate and organize public engagement exercises. We start with an investigation of the actors involved in public engagement exercises in the five focus areas. We also draw on insights gained from our interviews. The in-depth look helps in grasping the context, motivations, and goals of the exercises, and better understanding which actors are involved; and helps to point to challenges and potentials for a specific type of engagement exercise. We are interested in who initiate and who funds public engagement, with what motivation, and at what point in time actors become involved with public engagement activities.

4.2.1 Initiators of public engagement activities

When looking at the actors that initiate public engagement activities, we found four groups of actors. They are government; social science or humanities scholars; natural and physical sciences scholars; and private foundations, NGOs and CSOs. Within each of the four groups differences could be found between the motivations and starting conditions for the public engagement activities. We investigate them in turn.

**Government actors**

From our focus areas, one of the earliest examples of government actors initiating public engagement comes from the example of recombinant DNA. Politicians and governance organizations were struggling with their positions on the new scientific discovery. In 1976, the US Cambridge City Council had been asked to approve renovations of buildings for higher risk research with rDNA at Harvard University. The request led the city council to order a three-month voluntary moratorium on this type of research until a committee could investigate all

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22 More on this survey here: https://societyandethicsresearch.wellcomegenomecampus.org/project/your-dna-your-say

23 We have aimed to cover as much ground as possible in our study through the lens of the five focus areas we have investigated. However, seeing our analysis is limited by its focus on five specific areas, as well as narrowed to certain moments in time, the overview must not be taken to represent a comprehensive picture of all the types, structures, and funders of activities in the nexus between science, ethics and public engagement.
relevant aspects of the new laboratories and the intended research. The investigation included extensive public hearings, led by a review board that also included participation by seven citizens (Petersen, 2010). Similarly, the Michigan Biomedical Research Council had also faced discussion on the expansion of rDNA research on its premises.

Taking the example of nuclear power, the UK government’s Sciencewise program was part of a policy on supporting public dialogue events on placement of nuclear waste. The events were co-funded by the UK Department of Energy and Climate Change (DECC)24. The meetings were part of a process of developing a white paper on a process for disposal of waste from nuclear plants. Apart from officials remarking that the meetings resulted in a two-thirds change of the original policy, a follow-up report on the effects of the public dialogue events also noted the profound (and positive) effect the experience had had on staff at the UK Department of Energy and Climate Change (DECC). The below is quote from the Sciencewise evaluation report (Sciencewise, 2016).

“It was an understanding that we can have these conversations with the public. We had a view that it was quite complicated and difficult to have a conversation but actually it was quite clear when we were in the meetings with them that they could grasp quite complicated things very quickly and get to grips with the policy quite quickly... we don’t usually get an opportunity to talk to people beyond our usual suspects so using those tools to talk to members of the public, to hear the views from the person on the ground who doesn’t know about this or hasn’t got previous experience of it is very helpful in testing the developing policy.” (DECC, 2016)

Looking towards the focus area of biobanks and nanotechnologies, both areas saw government investment in projects and programs for public deliberation and dialogue25 events in several countries. For nanotechnologies, scientific and governing bodies sought to prevent a situation around nanotech which mirrored what had been seen with GM foods, especially regarding similar concerns over environmental and human health impacts (Kearnes et al., 2008). As a result, several large-scale R&D efforts were put in place to further both strategic developments and the public perceptions of nanotechnologies through an up-stream and proactive approach, different from the approach used with genetically modified organisms (GMOs). In the US, efforts were led by the National Nanotechnology Initiative. Since 2001, the initiative has seen investments of more than $20 billion (National Science and Technology Council et al., 2014), the Center for Nanotechnology in Society at Arizona State University being allocated some $12.5 million. These funds were used to initiate citizens in large and exploratory activities which, by raising discussions of the ethical implications of nanotechnology, also sought to develop methods and platforms for engaging society in science in a broader sense (Guston, 2014). In Europe, successive European Commission framework programs supported


25 These programs also supported efforts to inform the public on the purpose of biobanks and the promises of nanotechnologies.
academics engaging with publics, stakeholders, and nano scientists on ethical and societal issues\textsuperscript{26}. In the Netherlands, the government supported ongoing efforts of ethical and societal reflection and public dialogue on nanotechnologies \textsuperscript{27}. In the US, public engagement on nanotechnologies are supported by the US environmental Agency\textsuperscript{28}.

The large-scale investments on public engagement with nanotechnologies also meant that a growing number of academics from social science and other disciplines became involved. Many of the senior researchers came fresh from the experiences of the ongoing and often intense GM debates. In contrast however, it would prove quite a lot harder to engage other publics on the ambiguous nanotechnologies. Most publics were not as aware of, or informed on, nanotechnologies, and the field itself was harder to explain in concrete ways. This in part related to the very breadth and scope that was packaged into nanotechnology, drawing from many disciplines. This all required exceedingly careful structuring of engagement efforts. It only made it more difficult that the definition of nanotechnology as “near-future gamechanger” was also debated among scientists (Wood et al., 2008).

Examples of government funding ethical reflection and engagement activities on biobanks include the British Columbia Biobank deliberation in Canada, and a great number of different types of activities in the UK starting around the year 2000, and a large body of international academic literature on the associated discipline of genomics. From our interviews, it seems the funding possibilities to work on ethics and public engagement are closely tied to political priorities. One interviewee describes the UK context as:

“ [...] But basically, the number of people who are working on these issues [genomics issues] now in the UK is very, very small. They had a sort of boom about 10 years ago. When you would go to a meeting on genomics in the social sciences and you would have 200 people, and now you try to organize something like that, you might get 30. So, yeah. So partly it is a function of the funding landscape, and that clearly reflects government priorities in terms of these processes of legitimation [...]” \textsuperscript{(C3, 2020)}

Looking to the focus area of Artificial Intelligence (AI), public funding for academic reflection on ethical issues and public engagement activities are also part of supporting collaborative relationships. The European Commission launched its draft strategy for AI in Europe in February 2020. The strategy takes a two-pronged approach to the successful development of AI in Europe, arguing for the twin development of ecosystems of excellence and trust. Its guidelines for developing trustworthy AI are based in the working of an AI high-level expert group. The suggestions from the AI high-level group, as well as the EU white paper, have been subject to public hearings (through online surveys).

\textsuperscript{26} Example projects include: NanoTrust, NanoCode, Seeing Nano, Observatory Nano, Framing Nano, Nano2all, NanoDiode and GoNano

\textsuperscript{27} Example projects and pioneering research programs include NanoNext NL (http://www.nanonextnl.nl/); NWO-MVI (http://www.nwo.nl/en/research-and-results/programmes/responsible+innovation)

\textsuperscript{28} This includes the US National Nanotechnology Initiative: https://www.nano.gov/
From the sample we looked through, it seems that government or funding agencies sponsored public engagement subject to political priorities in the choice of topic and timing of events. Our sample also shows that government-initiated public engagement activities can influence policies, and initiate learning on the part of government representatives involved in the deliberative processes.

When it comes to understanding the timing and drivers for government to initiate public engagement initiatives, we need to first look to the activities and experiences of those funded to do the engagement work – often (but not exclusively), these are social science and humanities scholars.

**Government supported social science or humanities scholars**

In our sample, we found a larger part of public engagement activities were initiated by scholars supported by funding, most often from research councils. Government funding, and/or funding from research agencies, seems to have played a large role in financing research activities on ethical issues in the examples of nuclear power, biobanks, AI, and nanotechnologies. In the example of recombinant DNA (rDNA), government funding also played a role in so far as it helped fund various committees and meetings to develop guidelines for handling of rDNA and for dialogue on disagreement on the safety of the technique and its products.

Taking the example of biobanks and genomic technologies, public engagement exercises aimed at gaining an overview of needs, concerns and values in these areas are particularly abundant. In the UK, two public biobank projects each implemented strategies of public engagement. The two were UK Biobank, established in 1998, and the 100,000 Genomes Project established in 2012.

UK Biobank incorporated public engagement from the beginning and ran several focus groups, workshops, and interviews (Wallace, 2005). The 100,000 Genomes Project implemented a range of public engagement strategies including town hall meetings, focus groups, patient, and participant panels (Samuel and Farsides, 2018).

Speaking with our interviewees, we found the public engagement activities taking place in an entanglement of actors and motivations. In the example of the UK Biobank, one of our interviewees describes it as a clash between social scientists’ and ethicists’ views on how to develop governance frameworks of biobanks, and how those scientists felt used by policy to legitimize already decided developments.

“I think there has been a rather cynical and strategic use of bioethics committees, to drive legitimation for this grand project. [...] I mean, you know, there are different actors involved in

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29 Mapping the human genome was arguably the next scientific frontier in the life sciences following on the heels of ethical and scientific debates on rDNA. The Human Genome Project, a 15-year investment, did allocate 5% of its annual budget to research into the ethical, legal, and social implications of its research.

30 Genomics England is part of the 100,000 Genomes Project of the UK National Health Service. It is a company owned by the UK Department of Health, and it is responsible for the part of the 100,000 Genomes Project that relate to cancer and rare diseases.
these projects, you know, and clearly a lot of the commission’s researchers, public policy people, are concerned about the bioethical questions. Clearly, they have raised big ones, which are very mainstream now, about data access, anonymity, et cetera. And UK Biobank established its Ethics and Governance Council [...] reasonably early on with serious attempts to establish a strong normative framework for the governance. I think that was important in the case of UK Biobank, and I think that was taken seriously [...] by the people who were involved in that. They did good work [...] I think that was a genuine attempt within UK Biobank to do it properly.” (C3, 2020)

In the case of the 100,000 Genomes Project, the clash between the worlds of policy, science and social scientists’ understanding of the purpose of public engagement activities becomes clearer still.

“Public engagements in the UK with these past initiatives has been largely tokenistic. [...] The establishment of the Hundred Thousand Genome Project. That was a cabinet level initiative [...] it was never peer reviewed. It was never – it was pushed through basically as a political project. And then there was a retrofitting. The ethics committee that was established for the UK Biobank did most of its work after the initial project was established and outlined. The public engagement in that is very political. There were times when the public was engaged, but mainly because of participation issues [...] they had big problems getting a lot of the rare disease patient organizations on board in the first instance, and they organized a series of town hall meetings and public engagement events in order to improve recruitment. So those events were very focused on specific instrumental goals, rather than framing this as something that was open for public scrutiny, democratic debate, and deliberation. The UK tradition of public engagement in these areas has been very instrumental and strategic and motivated by attempts to legitimize and win people over to a project that is already existing.” (C3, 2020)

Samuel and Farsides (2018), describe similar concerns in relation to the public engagement activities of the 100,000 Genomes Project. They found employees of Genomics England expressing a desire to listen and adapt policies according to public input. However, they found that public engagement as good practice had to compete with public engagement as a strategy for securing trust, support, and enrolment of participants in the biobank.

In Canada, four public engagement events on biobanks were funded by Genome Canada and Genome British Columbia (Burgess, 2014). One of the scientists involved with two of these four deliberations explained about their motivations and process:

“When we started this work with biobanks, the impetus was from us as researchers. You know, we as researchers decided that this was an important way to tackle these questions. We wanted to contribute to the scientific literature. The ethics, essentially the ethics kind of public health, genomics literature, how do you deal with these sorts of things. But over time, that has changed. When we got the second BC deliberation process, there was a very strong call from that group of pathologists that I mentioned, because they were setting up biobank infrastructure in British Columbia, and they wanted public input. And there were all sorts of questions that they were grappling with. So, for example, one of the questions that they were grappling with, was [...] when people have had tumors removed, or biopsies or something like that, the tumor is not removed
for research [...] researchers sometimes become interested, and say well there is this collection of tumors, and I have to study that, you know, could benefit from this. But the patient from whom the tumor was removed was never contacted about this [...] They have never given consent, and they do not even know about this research. The pathologists were concerned about this, and they wanted our help to understand the ethical issues and so they thought it was very important to do this research. [...] Now, there has been a call from either other researchers, who have identified similar problems in other areas that want to do something similar, or there have been calls from some scientists, or from decision makers about those issues [...].” (C1, 2020)

The researchers in the BC biobank case report three motivations for engaging in public engagement exercises: They considered deliberative public engagement to be a good methodology; they wanted to contribute to literature; and the pathologists and policymakers wanted their research interest or policy priorities legitimized.

Additional motivation includes wanting to understand what publics would like, and how they think about certain ethical issues.

“[…] There are lots of social scientists who have done all kinds of participation exercises to get people to, you know, all over Europe, also in Africa, in many different places – social scientists and ethicists have done engagement exercises to understand what people want to be done with the data.” (C2, 2020)

When it comes to the example of nanotechnologies, engagement activities have a history going back to the early 2000s. The government funded engagement initiatives supported a wide variety of engagement activities carried out by social science and humanities scholars. The motivation for these scholars to engage, was the sense that here was an opportunity to influence a science and technology in an early stage. Public engagement activities could take place ‘upstream’ as these scholars put it. While public engagement activities on nanotechnologies are still an active field, some of our interviewees pointed to a certain degree of ‘engagement fatigue.’

“[…] I was involved in nanotechnology. But then really after, by 2009, you know, it just felt there was not that much more which could be said meaningfully at the time. It didn’t seem to be [...] a domain that was particularly worth continuing on.” (E2, 2020)

Government also commissions social science and humanities researchers for specific public engagement projects. The Center for Deliberative Democracy, at Stanford University, is such an example. Requests for the Center to set up public engagement events come from all over the world, for instance, the August 2017 deliberation on continuing or suspending the construction of two nuclear reactors in South Korea31.

In Europe, the EPTA network (European Parliamentary Technology Assessment network), brings together advisory councils and groups providing national parliaments with services and advice, including different forms of public engagement events. The network includes associated

31 For a full overview of the Centre’s activities and commissions, go to the website and follow the timeline: https://cdd.stanford.edu/deliberative-polling-timeline/
members from the whole world, and members with similar missions to the full members of the network.

When it comes to the timing of government funded public engagement activities, the above examples of biobanks and nanotechnologies show that public engagement is often organized in relation to a policy priority and a need to create trust in science policy decisions and create legitimacy for these decisions.

Additionally, we found examples of public engagement activities as a response to disastrous events. Following the explosion at the Fukushima nuclear facility, Japan’s government initiated a public engagement exercise to better understand public opinion on nuclear energy. The results, however, ended up being ignored due to shifts in governmental power (F4, 2020).

**Natural and physical sciences scholars**

Asilomar, in 1975, presents one of the first instances in history where scientists, and not policy makers, were the ones to initiate public debate on the safety and social implications of their work. Prior to the conference, a small group of scientists had written a letter calling for “a voluntary moratorium on certain experiments with rDNA” (Gisler and Kurath, 2011: 214). Hence it was scholars from the natural and physical sciences who initiated the call for engagement with publics on new science and technological options. The initiators of the Asilomar conference, motivated by a desire to protect both the public and laboratory workers, wanted to establish agreed safety measures for working with the new technique before moving forward (Berg et. al. 1975). The result was that in February 1975 molecular biologists, lawyers, government officials and journalists gathered for the Asilomar Conference on Recombinant DNA (rDNA) (Berg, 1995: 9011, Gisler and Kurath, 2011: 214, Berg et al., 1975: 1981).

Public and scientific debate on rDNA was intense in the years 1975–77. In the US, the debates and government regulations and investigation increasingly left the scientific community frustrated. The US scientists feared falling behind their international colleagues. In the years 1977–79, public debate shifted character and became much less open. Historian of Science Susan Wright argues there was a disappearance of public debate, and that the emergence of consensus on rDNA came about because of three closed meetings. Officially the meetings were called to discuss scientific evidence on the hazards of rDNA, but she writes, the meetings had more a character of brainstorming meetings on how to overcome opposition to rDNA research. The central interest at stake was scientific freedom and not the needs of the public or laboratory workers. (Wright, 1986).

In 2004, the specter of past debate on GMOs and bovine spongiform encephalopathy (BSE) motivated the UK Royal Academy of Engineering to publish a report trying to anticipate on social impact of nanotechnologies (Macnagthen and Guivant, 2011).

One of our interviewees explained the sentiments of the time as:

“Mostly because scientists had to say, okay, nanotechnology is going to be the next big thing and we need money for it, but we don’t want to be annoyed by society. We should also have some ethics basically to say that we are safe. There was a national discussion [US] organised [...] It was a huge investment of taxpayers’ money in nanotechnology because that was to be that technology of the future. You have all this excitement about promises and great things that will be done, thanks to this and that technology that finally we will fight cancer and world hunger. It’s the same discourse [...]” (F3, 2020)

Ensuring public trust and support for the new science and technology was essential, as was public engagement as a way of achieving such support. In the years following the UK Royal Academy of Engineering report on nanoscience and nanotechnologies, and until the present day, public engagement initiatives continue in the world of nanotechnologies.

**Foundations, Non-Governmental Organizations and Civil Society Organizations**

Finally, we also found examples of private foundations, non-governmental organizations (NGOs) and civil society organizations (CSOs) that work on projects of public engagement with science. Our sample includes an NGO in Colombia, and a civil society organization in the UK. Finally, the Danish Board of Technology Foundation is a private non-profit organization that works on public engagement with scientific and technological issues, and it was also mentioned by many of the interviewees.

The interviewees gave us some insight into working with public engagement activities within their contexts. The NGO in Colombia is a collective of different types of people and organizations working on topics they see as meaningful. Topics of engagement are decided by the central organization or by the associates that ask for certain topics to be taken up. In each case, funding needs to be raised and the organization needs to motivate and interest both a public audience, but also actors at the policy level and scientists. Challenges to engagement include a lack of incentive and interest on the part of scientists to engage, difficulty finding and building collaboration with policy, and ensuring that any collaboration takes the outcome of a public engagement into account. In addition, the interviewee mentioned that for citizens it can be hard to prioritize participation in engagement projects as they also need time to work and provide for their families.

The CSO in the UK explained they worked with social and popular movements to identify issues and topics to work on. The organization also collaborates with popular movements in Latin America. What they experience is that movements and organizations in that context look for long-term public engagement activities to address questions of equality and distribution of cost and benefits from new seed technologies. The CSO worked on similar issues in India on genetically engineering cotton. They saw technology not only as the engineering of the cotton, but as the organization of money and power that, over time, the CSO helped grassroots movements address. Challenges to engagement included difficulty in sustaining action when funding ends, and lack of political support for addressing issues of inequality.
4.2.2 Framing of engagement exercises
From our interviews, we learned there is a central challenge to the organization of public engagement with policy or in areas with high political importance. Challenges mentioned were independence of the engagement processes, manipulation of the engagement exercises themselves, dismissal of the outcome of public engagement exercises, suppression of results and threats to researchers. One of our interviewees gave an example of an engagement exercises that was manipulated to produce a certain result:

“[…] I was at a major exercise a few years ago on radioactive waste. I overheard a discussion among the facilitators that they were under pressure to select a particular NGO representative for the citizens’ panel, from, or on the part of government, because that NGO representative was so alienating that that would be a very good way to influence a panel in the opposite direction. Sure enough, that is exactly what happened.” (B1, 2020)

Another challenge to the organization of engagement exercises is how the invitation to engage is framed, both in terms of the topics that can be discussed, as well as how the discussion takes place.

The United States Nuclear Regulatory Commission (NRC) describes public participation as a “cornerstone of strong and fair regulation of the nuclear industry”33 The website contains information on meetings open to public participants and documents on which members of the public can comment. Public participation is not new at the NRC, but a longer standing commitment “The NRC has a long history of, and commitment to, transparency, participation, and collaboration in our regulatory activities.”34

One of our interviewees explained the way this worked in practice: “[…] something would happen at a nuclear plant. Usually, a license amendment to a life extension of the plant and so forth. And we would go out and we would have public hearings, public meetings […]” (B3, 2020)

Our NRC interviewee explained the standard process of the meetings, which took the form of public hearings. The hearing would typically take place in a school, or another rented location. Participants would come from the local area, but also from further away. At the hearing, an NRC representative or staff member would explain the decision the NRC were in the process of reaching and explain the timeline for finalization. Once the official presentation was done, public participants would have chance to speak.

In terms of the aims of hosting the meeting, both the NRC website and our interviewee emphasized transparency in governance and decision-making. Transparency would counter conspiracy theories and mistrust.

“[…] You have to tell them [the public] what you’re doing, give them an opportunity to express their views and to listen [to them], there would occasionally be something important that would come up. But if you do not, particularly in nuclear area, if you do not give people the opportunity

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33 See NRC website “Public meetings and involvement”, https://www.nrc.gov/public-involve.html
to speak and [if you] are [not] completely honest with them, it is easy for people to have a conspiracy theory about what the basis of the decision is [...].” (B3, 2020)

Countering conspiracy theories and getting insight into the “intensity of feelings” (B3, 2020) were presented as the two key motivations for the public hearings.

On occasion, the input from the public participants was important, but mostly their input was experienced as less valuable. Our interviewee explained that publics had a hard time relating to technical information and reports several hundreds of pages long, and therefore the information the NRC would provide in cases where such documents were the basis of decision was not perceived as very useful.

The NRC public hearings are an example of public engagement playing the role of legitimizing a decision-making process. The central motivations are to produce decisions that cannot be reasonably questioned (no conspiracy theories). The possibility for input exists but input from the public participants must adapt to an expert format. No effort, apart from the presentation at the meetings themselves, are made to translate and explain expert documents to the public audience to lower the threshold for participation.

Restricting the debate to technical or expert-dominated scientific discussions also happened at the Asilomar conference in the example of rDNA. As Taylor and Dewsbury (2019) explain, limiting discussion to a matter of technical issues effectively shuts out other participants from being part of the debate. It also excludes the inclusion of discussion on any other types of concerns other than those that can be solved by technical means. It also leaves only one role for publics to play in a debate. They can only react to messages coming from scientists.

As one of our interviewees explained, an area of concern is that the participants at the meeting do not get an opportunity to engage in a discussion on the societal and environmental impacts of hosting a nuclear energy plant in their communities. The example from the interview relates to the Human Genome project:

“(...) At the moment that you say, well science and technology have this transforming force. And at that moment—when you decide to have a human genome project—then you have already taken a decision which might have a very strong impact on society. Then from that perspective, it might be very important to have already [got] input from society in debates about the innovation agenda [...].” (A3, 2020)

We already saw how limiting a discussion to technical details cuts out questions related to societal, environmental, justice related questions and other types of impacts. Several of our interviewees also mentioned how the timing of an engagement exercise can limit the type of questions that can be discussed. Hosting a debate after a decision has been made to fund a large project, like the Human Genome Project, undercuts any public discussion on the decision to invest public funds in that project. In the focus area of nuclear energy, we found an additional dependency influencing the kinds of questions that can be discussed. Nuclear power plants are in communities. At least in some places, those communities become dependent on the nuclear plant for local infrastructure and jobs. Such added dependencies further limit the
questions that can be (reasonably) discussed. Anyone questioning the existence of the nuclear plant will at the same time threaten the livelihoods and stability of whole community:

“[...] It was really very interesting that the publics in the vicinity of nuclear power plants were very supportive of them. Their neighbors work at the plants, the foundation for the local tax base. They, you know, they paid for the schools, [...] paid for the fire department. And we will go there and try to have a discussion with the local community about [it]. [...] What do you think [...] if we extend the license of this plant for 20 years and the people, a local community, [do you think they] would be angry with us? ‘Why are you delaying this? Why haven’t you done it already? Of course, we want that plant.’ You get the people who are further out, who do not get the economic benefits. Maybe they just, do not know the people in the plant, do not see the benefits of the nuclear power plant. That is where the opposition would arise [...]”. (B3, 2020)

Additional dynamics that influence the setting of public engagement events, and the questions that can be discussed, include imaginaries of science, technology, and progress; and how influential cultural, political, and national understandings of the role of science and technology are. An example from the discussion on biobanks:

“[...] I think biobanks are entanglements where the national banks are mixed up in these national projects, partly about national economic development policy, about national identity. So there’s been some interesting work in Finland looking at the relationship between Biobank and Finnish national identity [...] Inevitably, biobanks get entangled in these very well established institutions and the political narratives about identity [...] understanding the contemporary biobank, it’s not just in the context of our economy, but also in the context of politics and national competitiveness and national identity [...] fundamentally it was about building the UK bio-economy and improving the health of the nation. So, it fitted you know, I would not say it is nationalistic, but it fits the national discourse.” (C3, 2020)

Some interviewees had also experienced the strength of political narratives and priorities on what questions can be asked:

“I have to be careful what I say here. So, well, put it this way. Some of my colleagues have been critical in a very mild way and have been privately rebuked and warned off doing that again by people in positions of power. In other words, being critical now in this space in terms of things like the Hundred Thousand Genomes project is a risky thing to do in terms of your career. That was not the case when biobanks started 20 years ago.” (C3, 2020)

Before moving on to lessons learned from our analysis, we look at what we found on the outcomes and impacts of public engagement with science.
4.2.3 Outcomes and impacts of public engagement

Before turning to lessons learned and our recommendations for developing public engagement activities in the future, we look at the outcomes and impacts we found in our research.

From the literature on public engagement, outcomes of involving citizens include:

- Mutual understanding and trust and research that informs society, but is also informed by society (counteracting polarization and misinformation)
- Empowerment of citizens to participate in debate and make choices
- Democratization of expertise by allowing the less powerful a seat at the table
- Better representation of needs, values, and interests of a diverse society, achieved through a more inclusive science policy

We found these aims and impacts back in our work, and present some of them below. From the interviews on biobanks, we learned that the deliberations served a multitude of purposes.

**Mutual understanding and trust**

The first type of impact illustrates how engagement can contribute to mutual understanding and trust. The interviewee describes how engagement helped to inform academic debate, eventually informing decision-making, and helped also to demonstrate to sceptics that engagement with lay citizens is possible and makes sense. This outcome was also mentioned by other interviewees:

“[…] Take the case of the first research biobank deliberation. Really, that did not produce actionable results in the way that you and I talk about actionable results. Nevertheless, I think it was a very successful project. For many reasons. But even on the substance of the issues that were discussed, they were published in academic journals and literature, and they certainly informed academic debate, which then changed thinking and that had a knock-on effect, and in the end led to different decisions […]” (C1, 2020)

“[…] probably the far bigger impact of the biobank deliberation was really showing how you can meaningfully open up ethical questions to public scrutiny, and how you can, in a very concrete way, get public input on these kinds of ethical questions. I think especially in disciplinary philosophy, some people are still kind of sceptical about […] [these] […] deliberative processes transform[ing] these ethical questions. I think that is probably one of the really big consequences.” (C1, 2020)

We already saw how the staff of the UK DECC who participated in ScienceWise activities appreciated their experiences. Similar sentiments were also shared by our interviewee in Taiwan:

“[…] The people [who] participated in this engagement activities learned a lot, and they [will] never forget this experience.” (F4, 2020)

“[…] 30 or 40 percent of the public officials engaged in this kind of public discussions, they change their attitudes to public engagement” (F6, 2020)
Several of our interviewees also shared with us their personal stories of becoming involved with public engagement activities. A common thread in their stories is that they began as scientists, and gradually realized the value of organizing and engaging in dialogue with society. They reported different motivations that include realizing that science and scientists do not have all the answers, that issues at stake are bigger than a scientific discipline and that scientists should be open to challenges and to reconsidering their findings.

In addition to providing a better understanding of the issues and needs at stake, interviewees also gave examples of tangible results. One example is again from the biobank focus area, where our interviewee explained that the deliberations had informed the development and implementation of educational tools:

“[...] I think the main kind of change that happened was through the group of XX, who was involved in building the biobank infrastructure in British Columbia. XX then later moved on to set up educational tools for biobanks and biobank management. XX used the information or the conversation from that deliberation to inform how XX set up certain things in his processes. [...] That had a fairly bold impact I believe.” (C1, 2020)

Other examples from our sample come from the interviews. In Colombia, public engagement was used to inform the set-up and development of a new ministry.

“[…] Last year, we had a very important transition from science council in Colombia to the establishment of a proper ministry. In that process, from becoming a science council to a ministry, we organised some dialogues that involved civil society in the discussion of what the new ministry should consider when it is configured and built. We had 10 or more sessions where people gathered around and discussed about what the new ministry should consider. We sent a document to the people organising the planning in Colombia, and to the government so they could think about this these suggestions. In most of the cases our opinion was considered, and so that is a really good example of a public engagement.” (F5, 2020)

This last example also overlaps with public engagement as contributing to (science) policy. Before we provide further examples of how public engagement can contribute to that outcome, we first look at how public engagement can strengthen democratic participation.

**Empowering citizens and democratizing expertise**

In our interviews we also found evidence that public engagement exercises increase motivation of citizen participants to participate in debates on science and technology, and it introduces new channels for interaction and participation:

“We also conducted research on the impact of public engagement in the science and technology issues [...] We found that more public engagement, or more opportunities to have the general public involved in discussions on science and technology issues, increases the lay participants literacy [on] policy, or [on] science and technology and that [means] their political efficacy, and their motivation to participate in a future public discussion [...] I think from the perspective of citizen organizations, they have [i.e. there is] positive feedback from this kind of public discussion,
because this practice has created more opportunities and more channels for diverse stakeholders to have their voices heard, especially by the government [...]” (F6, 2020)

“The evaluations [...] always consistently show that people feel empowered by it and they feel that the materials are balanced. The moderators did not impose their own views. The small group discussions are what they value the most when they evaluate the whole thing. Ninety percent or ninety five percent always say it is extremely valuable.” (F2, 2020)

In the next section, we return to the impact of public engagement on (science) policy.

**Developing (science) policy**

In our sample we found many examples of public engagement processes that had influenced policy development. The examples also include decisions that involve scientific and technological applications or development, but do not directly touch upon science policy or priority setting.

To begin, the OECD 2020 report on innovative citizen engagement practices reports on twelve models for involving citizens in political decision-making. In the report the OECD writers give examples of application of the different models. Their findings cover OECD countries and show overwhelming overweight of application in Europe and the US, with some examples also in Japan and Korea.

Examples include the 2016–2018 Irish citizen assemblies on the 8th Amendment of the Republic of Ireland’s Constitution on abortion, ageing populations, referendum processes, fixed-term parliaments, and climate change. This, among other actions, led to a national referendum on the 8th Amendment which widely improved opportunities for Irish women’s access to abortion. In 2007, in the US, there was a deliberative poll on Vermont’s energy future. On June 6th, 2015, the United Nations (UN) supported the “largest ever global citizen consultation on climate and energy”, WorldWideViews on Climate and Energy (2015), launching its report on September 26th during the General Assembly of the UN. In Canada, the Toronto Planning Review Panel, begun in 2015, provided advice on issues of planning and transportation in the city; and in 2017, Citizen Dialogues discussed Canada’s energy future. Also, in 2017, a Korean deliberative poll on the construction of Shin-Gori nuclear reactors led to recommendation on continuing construction of the reactors, which was implemented by the

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36 More information here: https://cdd.stanford.edu/2007/deliberative-polling-on-vermonts-energy-future/ - please also see the ‘timeline’ on that page for even more examples.
37 More information on World Wide Views here: http://climateandenergy.wwviews.org/
39 More information on the Canadian citizen dialogues here: https://canadaenergyfuture.ca/resources/
Korean government\textsuperscript{40}. Finally, one example, of involving citizens in science policy formation, is the Citizen and Multi Actor Consultation on Horizon Europe (CIMULACT), that engaged citizens across Europe in providing input for future research topics. Input from the project was used in formulating calls for research projects in the last phase of Horizon2020\textsuperscript{41}.

There is therefore ample evidence that citizens can participate and deliberate on complex policy issues involving science and technology. The question is how scientists and funders of scientific activities would like to involve the public in dialogue and debate on the directions, governance, and priorities of scientific research.

In the following section we take stock of our findings and lessons learned, and we reflect on the role of public engagement in contributing to science development in the future.

\textsuperscript{40} More on the deliberative poll on the Shin-Gori nuclear reactors here: https://cdd.stanford.edu/2017/proposed-deliberation-in-south-korea-on-closing-two-nuclear-reactors/

\textsuperscript{41} Read more on the project here: http://www.cimulact.eu/
Chapter 5

Lessons learned: The potential of public engagement for future advancement of science
5 Lessons learned: The potential of public engagement for future advancement of science

In the present report we have looked at the nexus of ethics, science, and public engagement through five focus areas. Our aim has been to understand how ethical issues and controversies have shaped trajectories of collaboration and interaction in each example, and to learn more about the role of public engagement. In each focus area, we saw examples of public engagement activities. From our analysis we can draw the following lessons:

1. The way public engagement activities are set up and organized influences the opportunity and potential of publics to contribute. It also affects how scientists and other stakeholders perceive the usefulness of public engagement exercises. There is also a link between how public engagement activities are organized and the level of appreciation of the activities. Staff at the UK Department of Energy and Climate Change (DECC) described how the publics they engaged with were able to grasp issues quickly and contribute in a useful way to policy development. The ScienceWise public engagement exercises follow a common approach emphasizing in-person, engagement, a purpose of discussing ethical and societal issues, and requiring investigators to be willing to change their minds. They also emphasize the need to provide publics with a balanced overview of different perspectives on the issue at stake42. That set-up is different to one where publics are asked to react to technical issues, like in the example of the NRC hearings. Although in that example, the importance of listening and of transparency are mentioned as well as described on the NRC website. In these public hearings also “there would occasionally be something important that would come up.” (B3, 2020). In general, one could say that if organizers of public engagement activities would like to be sure that the activities are useful and meaningful, then a format closer to the ScienceWise example is a better guarantee for achieving such an outcome.

2. There is tension on the role and goals of public engagement.

In our sample, we show public engagement activities take place in contexts characterized by meetings between actors with different backgrounds, motivations, areas of expertise, socio-economic, epistemic, and societal status and access to resources and power. These background conditions of engaging lay publics in discussions on ethical issues in science, make engagement activities and their outcome vulnerable to shaping, interpretation, manipulation, or dismissal by more powerful actors. One example is the UK 100.000 Genomes project that one of our interviewees described as a “cabinet level initiative”. Public engagement activities were used to boost participation levels of the biobank and not to discuss the aspirations or directions of

the project itself. The tension was also felt by employees of the biobank that felt they
needed to navigate in a politically tense space between listening to and persuading the
public of their participation and trust in the biobank (p. 35 in this report). The tension
that arises is on the balance between three rationales of engagement 1) a normative
rationale, that public engagement is a necessary activity in democracies to allow
everyone affected by a decision influence on that decision, 2) a substantive rationale,
that involving actors with diverse background increases the knowledge behind, and the
quality of a decision, and 3) an instrumental rationale, that public engagement is a way
of restoring trust, credibility and gain support for a specific decision (see also p. 15 of
this report). All three of these rationales are typically drawn upon in arguing for public
engagement. However, conflict and tension is built into these three rationales for public
engagement as they are not internally consistent. One tension comes from the
substantive rationale that implies that a decision can be changed after an engagement
process, while in the instrumental rationale, decisions are not opened to change as a
result of the engagement activities.

3. Public engagement processes can develop better science, policy, and
understanding of the ethical social and legal issues at stake.
Public engagement exercises provided policymakers and researchers with a better
understanding of views and issues, needs and values at stake, as in the example of
British Columbia’s BC Biobank deliberations. We also found examples of public
engagement contributing to developing training materials and guidelines (Taiwan), and
to the development biobank policies through, for instance, training materials and
guideline development in the biobank example. Finally, we found public engagement
can affect, among science and policy participants, a general appreciation of public views
and their relevance.

4. There is a link between science policy and political prioritization of scientific
developments and available resources for public engagement activities.
In our sample, political and scientific motivations for prioritizing certain scientific
developments play a significant role in making resources available for public
engagement. Many public engagement exercises were organized and carried out in
relation to the initiation of bigger scientific projects or investments, like the UK Biobank
and the UK 100,000 Genomes Project. Initiators of these projects were governments
and academics and others who receive funds from government to develop and run the
engagement activities. The engagement exercises often took place after the decision
to prioritize a specific research area or bigger science project, or in relation to a
controversy (as in the example of rDNA), or in hope of avoiding a controversy (as in the
example of nanotechnologies).

5. Impacts of public engagement processes can be difficult to measure. Impact
measurement is also dependent on how well desired impacts of the activities are
defined beforehand.
In our sample, we found that public engagement impacted policy development and research agenda-setting. We also found that differing views exist on the desired impact(s) and goal(s) of engagement exercises. Furthermore, our interviewees and the related literature point to challenges with measuring the impact(s) of public engagement activities. To improve on the possibility of measuring impact, it is necessary to carefully define the desired impact(s) and goal(s) of engagement exercises beforehand. In developing evaluation criteria, one needs to consider that indirect outcomes, such as influence on attitudes, ideas, and opinions of policymakers and scientists, or that outcomes can take a longer time to manifest in negotiations and discussions after an engagement event or report.43

6. **Public engagement activities have a Western origin and legacy, but they have a proven ability for application in different cultural contexts and by different national actors, across the world.**

From our material it is also clear that public engagement literature has a strong Western origin and legacy. However, the concept of engaging the public in discussions on science and technology has shown to translate well to other regions of the world. Consensus conferences and other deliberative practices have been applied in Taiwan, Japan, and South Korea. In addition, engagement activities in Columbia and India present as motivated by grassroots and social movements wanting to discuss societal issues such as equality and the influence of global companies, and high-tech products such as GMO seeds impacting local agriculture. It would be an interesting project to explore differences, similarities, and cultural adaptions of public engagement methods.

7. **Linking up with decision-makers can be challenging, but it is often essential to reach the desired impacts of engagement activities.**

Arnstein’s typology and ideal of citizen participation also guide present day understandings of the hierarchy of public engagement activities. Both across the literature we read and the interviews we conducted the ambition of providing space for citizens and society to influence decision-making processes or priority-setting was presented as the central goal of public engagement. Stilgoe, Lock and Wilsdon (2014) present considerations on why we should promote public engagement with science. Their key point is that public engagement is a governance tool in a wider effort of promoting reflection on the normative orientations and goals of science, and in initiating action that helps steer scientific development in increased harmony with public needs and values. We also learned that a connection to decision-makers seems essential for the chances of uptake of the outcome of the public engagement activities—a connection that can at times be challenging to manage, as public input and recommendations become part of political or organizational negotiation.

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processes. However, as Nowotny (2014) argues, we need to accept that public engagement with science is a political activity.

8. Public engagement projects and activities are (often) situated in a context with competing interests.
   In addition to the finding that public engagement often takes place in connection with political prioritization, we found that these activities operate in intersections of competing interests and motivations. Take the focus area of biobanks. We found the academic ambition of contributing to literature or securing the acceptability of a strain of research, mixed with political goals of securing public support and participation in the biobank. The mix of interests will influence all aspects of the engagement exercise: its setup, its process, and how the results are interpreted and appreciated.

9. There is a potential for increased learning about practices of public engagement between the academic and more practice-oriented communities of engagement.
   Across the world many actors are working on realizing and implementing public engagement activities. They include academics, governments and associated organizations and centers, civil society, and non-governmental organizations. They work in contexts of science, technology, and (local) policy or education. There are gaps in knowledge sharing between actors working in different contexts, topics as well as parts of the world.

5.1 Towards future public engagement activities

In the introduction, we described how public engagement can be used to address a mounting democratic crisis in Western societies. While science might not yet face a similar crisis in its relationship with the public, academics have pointed to a crisis on the reproducibility of science and the proper governance of science (Saltelli and Funtowicz, 2017). There are similarities in the crisis of science and the crisis of governance and democracy more broadly. Both are influenced by cultural and political changes.

This section discusses what we can learn from the report and its findings. We look at the future role of public engagement exercises, and who should initiate and organize them, how to decide on the method, goal, and timing of engagement activities.

Part of the challenge facing science in building and maintaining public trust, can be understood by the way scientific developments at the same time shape and challenge individual and national identities. Information and knowledge are available online, allowing citizens access and opportunities to shape and participate in communities of like-minded individuals. Disagreement between scientific values and ideals, and ideals and values of other societal groups, like religious groups, have always existed. These value conflicts are exemplified in movements such as the resistance of anti-vaccination communities to vaccination policies, or protests over the lack of gender and diversity representation in scientific models of many kinds. In addition, the political arena is shaped by an increasing demand for participation and influence (OECD, 2020). Although not yet evident, one could speculate that the public would like more influence on the values that drive scientific development.
Public engagement specialists and social scientists argue the only way to avoid a crisis is for science to engage with society in deliberations on values, priorities, and directions of research. What are the values, issues, and priorities that are advanced when a society decides to promote and support science and technology such as biobanks and AI technologies? How is concern for individual privacy, consent, transparency, commercialization, profit, sustainability, environmental risk, climate, pollution, discrimination, bias, gender equality, equal access, accountability, power inequalities and other fundamental rights weighed, and by whom? Who are the powerful actors that influence the direction and decision-making processes on scientific priorities, and technological developments? Who should they be? Are global companies like Google, Amazon, and Facebook, undermining or building up our democracies? What kind of society do we want, and what role should science and technology play in that society?

*Public engagement activities can take on multiple roles, and there are tensions and disagreement on these roles.* Importantly, engagement activities can show alternative future directions for our societies with science and technology and inviting citizen in as part of decision-making processes. All of which have a role to play in strengthening the relationship and trust and increasing the understanding between science and society. However, if the ideal is a science that contributes to solving complex societal issues, citizens and societal stakeholders must necessarily be part of analyzing the problems and finding solutions. Our sample shows that citizens are both willing and able to engage on complex scientific and ethical issues. However, it also points to entrenched power differences between citizens, scientists, and policymakers. Science and scientists have a unique epistemic position, and politicians a special access to power and decision-making, yet neither group is trained in engagement or dialogue with citizens. Furthermore, a fourth category of player; industry and business, increasingly sets the agenda on how science and technology are prioritized, developed, and implemented—and these actors have no or little incentive to engage in dialogue and sharing of decision-making power with citizens.

What role could public engagement then play if any at all? The report suggests that:

- Public engagement can be a democratic tool to open scientific developments and decision-making to societal debate and democratic control.
- However, for public engagement to become such a tool, existing structures of power, interest and inequalities that shape the context of scientific and technological development and public engagement activities need to be made explicit as topics of debate.
- Such power structures can be understood at different levels of organization. From the micro-level of differences in education, background and societal status that would influence dialogue between a scientist and a citizen, to the macro-level power dynamics that shape dialogues on the direction of scientific developments at the global stage.

In the report, we give examples of the *complex settings of public engagement* exercises and show how the goal and role of the engagement activities were understood differently by different actors or changed over time. What each example shows, is that:
• It is essential to carefully define the goal(s) and desired impact(s) of the engagement exercises beforehand. Whether public engagement is undertaken as part of a democratization process, as a way of improving robustness of a policy choice and minimize controversy, or as a means to acceptance and trust in a specific decision that has already been made, such aims should be clear.

• There is a rich collection of methods for public engagement44. These list available methods and the multiple goals they can be used to achieve. The possibility for impact depends crucially on commitment and backing by actors with the agency to influence on-going developments. Who these actors are, may vary from context to context and over time. In some cases, it will be politicians, in others, researchers, media, industry, business, consumer groups or activists.

• Clear, transparent, definitions are crucial: firstly, the aims of the engagement; secondly, the role of the participants as data-subjects, participants, co-developers, or decision-makers—making sure the role given is one that can be realized—in the process as well as in the implementation of results. Organizers should also reflect on how role distributions enforce or challenge existing inequalities, and what the implications are for their engagement activities and their outcome. The most effective assurance, both as to role and how results will be used, comes from agreement beforehand among all (or as many as possible) of those actors who can influence uptake and implementation of results.

Therefore, organizers face the task of clarifying the developmental stage of the scientific field or technological development they would like to engage with, the powerful actors and interests involved, and the related opportunities for impact. They must clearly describe the interests at stake, the role and sample characteristics of the citizen participants, the interests, and priorities at play in the science, policy area and industry/business area, and the end goal of the results, as well as informing participants on how results are reached.

For future practice, it would be important to develop a more widely shared inventory of public engagement methods, mapped to possible goals and impacts. Collaboration between academics, public engagement practitioners, and other stakeholders could be an important step in developing a such an inventory. This point also speaks to the amount of gray literature, practical experience, and non-Western or non-English language engagement experiences that are not described in peer-reviewed articles, and the need to build bridges and communities across these areas of practice.

Finally, we end with a larger question as to who should take responsibility for the future development of public engagement activities. At present, activities may be described as a patchwork of projects and programs, with varying degrees of policy or funding support and prioritization. The question is what type(s) of support, attention and organization are needed

44One example is the Engage2020 Action catalogue that helps organizers search for the method of engagement suited to a desired impact, type of participants and level of public engagement: http://actioncatalogue.eu/search
Another example is the RRI tools database: https://rri-tools.eu/search-engine
to move practices of engagement into the mainstream of science and technology policy and development?

5.2 Conclusions

This report set out to better understand how publics have been engaged in ethical issues that arise from scientific discoveries, and to identify opportunities to engage the public intentionally, meaningfully, and effectively in discussions of ethical issues. The report set out to map the landscape of interaction between science, ethics, and public engagement, and to examine how science in different fields has tackled engaging the public in ethical challenges, and to identify opportunities for learning and advancing the interaction between these three areas of practice.

We learned that publics have been engaged on ethical issues, and that they are willing and able to engage; that mapping the aims and goals of such exercises is not straightforward, but that there exists a multitude of perspectives on the goals and outcomes of the public engagement exercises. Our findings show examples of how public engagement can contribute to mutual understanding and trust-building with citizens; that it can empower citizens to participate in discussions and thereby democratize expertise; that it can contribute to developing science and policy; and last, but not least, that the scientists who participate in this public engagement take valuable insights with them into their own work.

Our report also sets out nine lessons on public engagement:

1. The way public engagement activities are set up and organized influences the opportunity and potential for publics to contribute. It also affects how scientists and other stakeholders perceive the usefulness of public engagement exercises.

2. There is tension on the role and goals of public engagement.

3. Public engagement can develop better science, policy, and understanding of the ethical, social, and legal issues at stake. It can also contribute to building trust between science and society.

4. There is a link between science policy and political prioritization of scientific developments and available resources for public engagement activities.

5. Impacts of public engagement processes can be difficult to measure. Impact measurement is also dependent on how well desired impacts of the activities are defined beforehand.

6. Public engagement activities have a Western origin and legacy, but they have a proven ability for application in different cultural contexts and by different national actors across the world.

7. Linking up with decision-makers can be challenging, but it is often essential to reach the desired impacts of engagement activities.
8. Public engagement projects and activities are (often) situated in a context with competing interests.

9. There is a potential for increased learning on practices of public engagement between the academic and more practice-oriented communities of engagement.

The report also revealed the complex settings of public engagement activities, and a struggle for meaning and role of engagement activities.

- Public engagement can be a democratic tool for organizations and for policymakers who wish to open scientific developments and decision-making to societal debate and democratic control.
- However, for public engagement to become such a tool for policy or for organizations, the actors that apply the engagement methods need to have the agency and power to address and challenge existing structures of power, interest and inequalities that shape the context in which a public engagement activity take place.
- Such power structures can be understood at different levels of organization. From the micro-level of differences in education, background and societal status that would influence dialogue between a scientist and a citizen, to the macro-level power dynamics that shape dialogues on the direction of scientific developments at the global stage.

We also conclude that it is essential to carefully define the goal(s) and desired impact(s) of the engagement exercises beforehand. Depending on how much support one can generate for a specific goal, the greater the chance of having an impact. In areas, where large-scale investments have already been made, it will likely be harder to affect change in alternative directions. There probably does not exist a 'perfect' opportune moment for engagement as such. Rather, there are moments in time when specific impacts are possible (if backed by actors with the agency to influence on-going developments). Several inventories of methods for public engagement exist. These list available methods and the multiple goals they can be used to achieve. Systematizing goals, methods, and possibilities for impact and outcomes could be a fruitful next step in further developing public engagement practices.

Clear, transparent, definitions are crucial: firstly, the aims of the engagement; secondly, the role of the participants as data-subjects, participants, co-developers or decision-makers—making sure the role given is one that can be realized—in the process as well as in the implementation of results. The most effective assurance, both as to role and to how results will be used, comes from agreement beforehand among all (or as many as possible) of those actors who can influence uptake and implementation of results. Further, organizers must carefully consider how the sample of citizens is defined, and according to what criteria.

Therefore, organizers face the task of clarifying the developmental stage of the scientific field or technological development they would like to engage with, the powerful actors and interests involved, and the related opportunities for impact. They must clearly describe the interests at stake, the role and sample characteristics of the citizen participants, the interests, and priorities at play in the science, policy area and industry/business area, and the end goal of the results, as well as informing participants on how results are reached.
Chapter 6
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6 References


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Annex A
Overview of interviewees
### 7 Annex A: Overview of interviewees

*Table 3 – Gives an overview of our interviewees and their background as well as geographical location.*

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Focus area</th>
<th>Field of expertise</th>
<th>Country</th>
<th>Type of affiliation</th>
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<tr>
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<td>rDNA</td>
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8 Annex B: Standard Interview Guide

Interview questions:

Investigating the potential of public engagement for science

1: Your background and experience working with science, ethical issues, and public engagement:

2: Addressing ethical issues in science: Example of nuclear energy and technologies:
- What was your motivation to work on nuclear power and science?
- Can you talk me through the ethical issues involved, and how they were approached in this case?

3: Public engagement and/or debate on nuclear power
- Was there a scientific or public debate/controversy on the case?
- Was there an attempt to engage with a public audience on those issues?
- What were the motivations for engagement?
- How was the engagement planned and carried out and by whom?
- What was the impact of the public engagement exercise?

4: Today’s ethical issues in science and the potential for public engagement
- What are the pressing ethical issues in science today?
- Do you see a role for public engagement on those issues?
- What should the goal be of public engagement?
- What could be achieved for science, for society?
Annex C

A description of our methodology
9 Annex C: A description of our methodology

Our literature search consisted of three steps. The first steps were an exploratory and open search aimed at qualifying our approach; the second step aimed to provide an overview of which ethical issues are represented across scientific disciplines; and the third step explored the representation of ethical issues coupled with public engagement across scientific disciplines. We used this research to develop our landscape overviews of science and ethics, and science, ethics, and public engagement, as well as to help us focus on five case studies.

Once we had selected our cases, we performed an additional round of literature search, this time focused on the five cases. Here, the emphasis was more on providing depth and background to the cases, considering related public engagement and ethics activities. In the following section, we will present the different steps taken and our results.

Step 1: Qualifying the search
As a first step, we explored different search terms and their combinations through use of Google Scholar as well as the databases Web of Science and Scopus. In our searches we included terms such "public engagement", "ethics" and "controversy", along with related terms and variations of these—"participatory methods" and "ethic*" and "Controvers*". Similar searches were made within different scientific fields and categories such as chemistry, nanotechnology, and computer science to identify more field-specific controversies and cases where the looked-for elements were in play. The hit rates of search entries, key articles, keywords, and related texts were noted along with our own notes, pointing to potentially interesting topics. This search, while only presenting smaller patches of a much larger picture, thus served two main purposes. The first was to give us an idea of some central objects of concern and to qualify future search phrases, and second, it allowed us to begin to identify and consider potential cases represented in the literature, posing as potential candidates for deeper examination later.

Step 2: Overview of ethical debates in scientific literature
The next step in our literature search was to produce a visualization of a landscape overview of science and ethics to see how ethics issues are distributed across scientific disciplines. We used the “Preferred Reporting Items for Systematic Reviews and Meta-Analysis” (otherwise known as the PRISMA Statement and the associated flow chart) (Moher et al., 2009) which presents a methodology for conducting literature reviews. It is most often used within medicine for clinical reviews helping in study designs, but it has also been used in other contexts, for instance in social science reviews (Voorberg et al., 2014).

Having defined the scope of the first visualization, being to showcase ethical issues as they were represented in science, we took our first step in accordance to PRISMA by setting up the eligibility criteria for the screened records to be assessed on. For this first inquiry, it was clear that these would have to be quite broad, given that we wanted to encompass a broad spectrum of sciences. Thus, our criteria were that the selected entries should address one or more ethical issues. Ethics primarily internal to science or professions would be filtered out. Finally, we
focused on review articles to provide us with overviews of the debates and ethical questions that the sciences were dealing with.

As search terms, we used (ethic* AND controvers*) and applied them in the databases of Scopus and Web of Science, and limited the range of years from 1990 to 2020 and the language to English. Here we were provided with a total of 7,844 and 4,591 records, respectively. At this point, an overview could be retrieved from Web of Science, which gave an indication as to how these materials were ordered into different research areas, as seen in the figure below. This pointed to a prevalence of biomedical sciences and an undefined mesh of topics covered by social sciences, with a significant amount of overlap between these categories to be expected.

Once we had excluded anything but reviews from this pool of articles, we were left with 1,469 reviews on Scopus and 552 on Web of Science. As one final limitation, given the large representation of medical sciences partly due to the inclusion of the word ethics, often used in medicine under in quite specific circumstances, we decided to leave out the reviews that were tagged as being under the “medicine” category on Scopus, leaving us with 1,010 hits and their metadata were exported. Once duplicates had been removed, we were left with 689 reviews to screen. While screening on title and abstract level for our broad criteria, the research area and topic were also checked and demarcated in the same process. This allowed for us to group the reviews into smaller pools to inform our visualizations.

Once we had screened the articles, we were left with 200 demarcated reviews, from which place our first map took shape, as we first started to group different related sciences together into larger research areas for us to compress some of the many categories, allowing us to better visualize the data and limit clutter. For instance, the two wide groups of biotechnology and bioethics were bracketed together, as were the many sub-fields of medical sciences and ethics, another category of “environmental sciences” being made to represent the natural sciences and concerned with natural systems and their health. Once grouped, the most prevalent topics
of the different categories were skimmed through to allow for the details of the ethical
dilemmas to come forward and inform the visual landscape overviews.

**Step 3: Search on public engagement and ethics across scientific fields**

In the third step our goal was to add to the prior mapping of ethical issues in science, and to visualize areas of interaction with public engagement. Here, we also followed the PRISMA methodology. Our approach was to find public engagement activities by focusing on examples of debate or controversy within a scientific discipline. We focused on review articles to obtain a general overview. Searching for “public engagement” and ethic* provided too small a sample of only 39 reviews, we broadened our scope to first and foremost include the terms controvers* and “issue,” which we deemed would help in highlighting more prevalent debates likely to reach outside of scientific communities. As for the topic of public engagement, our definition was quite loose, because we wanted to allow for some flexibility in how this term was represented in our search— ‘public engagement’ alone presented only around 3,300 hits altogether in both Scopus and Web of Science. We added ‘participat*’ and synonyms of this word to our search, and these synonymous terms vastly increased the number of records provided. Together with the use of the word ‘Ethic*’, this inclusion did have the effect that clinical and medical studies, in which both “ethic*” and “participat*” are commonly applied, were overly represented. Thus, a significant amount of the encountered hits were initially represented in this pool. To limit some of these, we decided to leave out some categories of specialized medical sciences, such as nursing, immunology and veterinary, although the overall category of medicine was included in our search. In all, this led to the following string of search terms:

\[
\text{ethic* AND ( controvers* OR issue ) AND ( public engagement OR participat* )}
\]

This was further limited by the focus on reviews and exclusion of certain categories, as already mentioned, while non-English reviews were also excluded. In addition, as our focus was more on the current than the historical landscape for this visualization, we limited the articles to those stemming from the years 1990–2020. Ultimately, this ended up providing us with 956 eligible entries, of which 883 remained once duplicates had been removed. Had we included journal articles; the number of articles would have been more than five times of that. In our next step, this would have proven a challenge. Screening of the records was first done based on article name, journal, and abstracts, and grouped into low, medium and high relevance initially, based on how they matched our criteria. With a somewhat broad definition of both public engagements and ethics, this meant it was at times hard to exclude some entries based on their title and abstracts. Thus, only about two thirds (568) of the records labelled as low relevance were excluded in the first round of screening, the remainder of the articles touching on ethics and engagement to varying degrees.

For the second round of entries, those not yet excluded were once again considered, this time by also considering full texts to the extent it was needed to deem them relevant or not. In the same round, all entries were provided labels in terms of their topic and the discipline in which they belong, based on their journal affiliations, contents, and own keywords. This left us with
≈130 reviews of relevance to our overview, showcasing where and how public engagement was prevalent.

In addition to this search, we made initial searches to double check the degree to which the different topics identified in our previous mapping could be linked to the term “public engagement” in the literature. These searches helped inform our heatmap showcasing the degree to which public engagement was prevalent in our landscape, while some of the additional articles were also able to supplement our sampled reviews.

**Analyzing our interviews**

All interviews were carried out and recorded with permission from our interviewees. Interviews took place via Zoom or conventional telephone. All interviews were transcribed. First transcription took place in two rounds. The first transcription was done using transcription software “Trint” (https://trint.com/), and the second round was done by a member of the project team. Transcriptions focused on producing a readable summary of the content of the interviews. Quotes selected for inclusion in the report have been edited by the project team to be understandable as written text, without editing the original meaning of what was said by the interviewees. Following transcription, all interviews were coded and indexed according to several predetermined themes following from our research questions that focused on:

- What actors engage on ethical issues and how?
- How does public engagement come in, and with what motivations?
- What role has public engagement played?
- How is public engagement understood?
- What ethical issues are currently the most pressing?