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ARTICLE

Geoengineering the climate and ethical challenges: what we can learn from moral emotions and art

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ABSTRACT
Climate change is an urgent problem, requiring ways and approaches to address it. Possible solutions are mitigation, adaptation and deployment of geoengineering. In this article we argue that geoengineering gives rise to ethical challenges of its own. Reflecting on these ethical challenges requires approaches that go beyond conventional, quantitative methods of risk assessment. Quantitative methods leave out important ethical considerations such as justice, fairness, autonomy and legitimacy. We argue that emotions and art can play an important role in ethical deliberation about geoengineering. Emotions can point out what morally matters. We also examine the role that works of art can play. Recently, artists have become involved with risky technologies. We argue that such artworks can contribute to emotional-moral reflection and public deliberation on geoengineering, by making abstract problems more concrete, letting us broaden narrow personal perspectives, exploring new scenarios, and challenging our imagination.

KEYWORDS Geoengineering; climate; risk; ethics; emotions; art

Introduction

Climate change – if not averted adequately and in time – could cause serious disruptions in society including issues associated with global warming and sea-level rise. It has been argued that geoengineering could potentially help alleviate at least some of these disruptions (Keith, Parson, & Morgan, 2010; Tuana, 2019). Geoengineering is the 'deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change' (The Royal Society, 2009, p. 1). One can distinguish two categories of climate alterations caused by absorbing CO_2 out of the air – also referred to as Carbon Dioxide Removal (CDR) – and climate alterations caused by partially reflecting sunlight back into space – also called Solar Radiation Management (SRM) (The Royal Society, 2009). While it was already known in the previous century that large volcanic eruptions could have an impact on the regional

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and global climate, it was only after the seminal paper of the Nobel laureate Paul Crutzen (2006) that the idea of SRM started to receive increasing attention in the policy world (Blackstock & Low, 2019a). A specific form of SRM concerns the idea of injecting aerosols, i.e. tiny particles, often sulphate, into the stratosphere in order to partially reflect sunlight; this is also referred to as Stratospheric Aerosol Injection (SAI). SAI is considered to be an effective and affordable method that could, in principle, be deployed within years. However, critics have pointed out that SRM and, more specifically, SAI could also cause droughts, ozone depletion and impact on agriculture, leading to potentially profound societal disruptions.

Hence, geoengineering could also be disruptive of its own, due to its potentially large-scale risks. This means that decisions about geoengineering involve a trade-off between different risks (Huttunen, Skytén, & Hildén, 2015; Linnér & Wibeck, 2015). One major challenge for such a trade-off is that geoengineering risks could be temporally dispersed in unequal ways. In other words, the risks imposed on future people by any decision in the present to pursue geoengineering could be greater than the risks imposed on the people making this decision. Another major challenge relates to the geographical distribution of risks in any time slice. For example, geoengineering could be used to promote the interests of the world's most advantaged and powerful people to the detriment of the global poor.

These and other ethical challenges raised by geoengineering must be addressed. In this paper, we will provide a new perspective concerning ethical deliberation about geoengineering, by focusing on emotions and art. We will argue that works of art can help people to reflect on, partially unfamiliar, ethical questions that might be raised by geoengineering deployment in the future. This is because art can prompt moral emotions, and as we argue, these are key to moral reflection. We will propose emotions and art as hitherto overlooked but potentially helpful ingredients for ethical deliberation. A commonly heard objection to involving emotions in the public discourse is that it is supposed to make the discourse vulnerable to populistic thinking. We will discuss a framework of moral emotions and art that avoids this concern, and we will argue that emotions and art can actually help us to critically reflect on the desirability of potentially disruptive technologies that involve ethical challenges, such as SAI. We propose that art that engages with new technologies can enable us to reflect on the social and ethical implications of these technologies, also involving (moral) emotions. We argue that this offers a promising avenue for thinking about the ethical challenges posed by geoengineering

We will proceed as follows. In section 2 we will discuss how the deployment of geoengineering could give rise to unanticipated risks. That is, partially unanticipated negative effects of geoengineering could take place, and negative effects could happen at a yet undefined moment at a yet undefined

place in the future, as a result of which ethical problems could emerge. In Section 3 we will then explore in more detail how art and emotions can contribute to such ethical deliberation.

Ethical challenges of geoengineering

Decision making on SAI and other types of geoengineering also involves a decision on the acceptability of risks. Conventional approaches to making such decisions are based on a quantitative notion of risk, most often expressed in terms of the likelihood of unwanted consequences of a technology or activity and their severity (Hansson, 2009). Risk assessors then often use expected utility and risk cost benefit analysis in order to assess and compare risks. While the risk management literature shows an increasing attention to the ethical aspects of risk management (Doorn, 2015), it is still based on this quantitative notion of risk, which does not cover the full range of ethical aspects of risk (Shrader-Frechette, 1991). First of all, the quantitative approach already makes normative assumptions as to what counts as an unwanted effect. Mostly this is in terms of annual fatalities and economic damage. However, arguably one should also consider severe illness, effects for the environment, and other impacts on people's well-being, such as privacy and ways of life, and the distribution of such effects (Asveld & Roeser, 2009; Roeser et al. 2012). Furthermore, while quantitative notions of risk are able to distinguish between different levels of severity, they cannot differentiate between consequences of fundamentally different nature, for example between consequences that are reversible and those that are irreversible (Doorn, 2018). Especially in the context of climate change and the implications of SRM and SAI, the to all intents and purposes irreversible impacts may be a weighty consideration. SAI therefore prompts a need for methods or approaches for risk assessment that go beyond mere quantitative assessment.

Indeed, there is literature reflecting on the ethical desirability of geoengineering, discussing possible positive and negative implications of SRM and, specifically SAI (Burns & Strauss, 2013; Gardiner, 2010; Keith et al., 2010; The Royal Society, 2009; Tuana, 2019). Some scholars argue that SRM's potential is simply too large to be neglected. Baard and Wikman-Svahn (2016) have considered potential obligations for developed nations to provide for SRM options, in case that their other obligations to mitigate or adapt to climate change fail. Horton and Keith (2016, p. 80) are resolute in their conclusion: that is, since climate change risks will disproportionately affect the poor – in developing countries but also in industrialized countries – we have a consequentialist 'moral obligation to conduct research on solar engineering' because its benefits are for all. This argument has been criticized by Hourdequin (2018, p. 270) for disregarding the fundamental question of justice that needs to first be answered before we can recommend its application for the benefit of some people, especially concerning the world's poor.[1] Other scholars argue that the potential risks of SRM are too

large to justify its application. Robock (2008), for instance, lists '20 reasons why geoengineering might be a bad idea', mostly focusing on risks such as regional droughts, ozone depletion and impact on agriculture due to fewer sunlight. Kortetmäki and Oksanen (2016) discuss the food production risks that would result from these effects. Gardiner (2010) argues that geoengineering could create political inertia in achieving the actual solutions to climate change, namely mitigation and reduction of emission gases. Because of the risks, the deployment of geoengineering has often been considered by many as a last resort, only to be used if 'the political will needed to effectively mitigate climate change might not emerge in time to avoid serious, potentially catastrophic damage to future populations around the world' (Blackstock & Low, 2019a, p. 2). In other words, mitigation (i.e. reducing emission gases) is the gold standard, but if we do not act in time, we could (soon) reach a tipping point with the accumulated emission gases in the atmosphere after which mitigation efforts – along with adaptation – may no longer suffice to limit the consequences of climate change. As the argument goes, beyond this point mitigation would not help any more to avoid the further exacerbation of climate change. We will then need – in addition to adaptation – 'technological fixes' such as SAI. Hence, while capable of avoiding potential disruptions caused by climate change, SAI and other forms of geoengineering could cause certain societal disruptions due to their potentially large-scale risks that will be dispersed both spatially and temporally. This means that decisions about geoengineering involve a trade-off with risks of insufficient mitigation (Blackstock & Low, 2019b, p. 41; Linnér and Wibeck (2015); Huttunen et al., 2015). What morally exacerbates this problem is what Gardiner (2011, p. 143) calls 'the tyranny of the contemporary'; that is, when a 'fix' helps to resolve the worst impacts in the short or medium-term while it worsens those impacts in the longer term, all of which could enable the application of 'parochial geoengineering' that only provides benefits to the present generations (and immediately following ones) while disregarding the interest of long-term future generations (Gardiner, 2013, p. 522). Fragnière and Gardiner (2016, p. 15) therefore argue that SAI should not be considered as 'Plan B'.

There are other important aspects that further complicate addressing the ethical challenges of SAI. We here highlight two. First, aerosols have a limited life-time, while the intended positive impacts may require that aerosols would be injected continuously. More importantly, if the aerosol injection would stop in the future the temperature could again increase to the temperatures before the injections started, or even to higher temperatures. Stopping could therefore exacerbate previous effects. It has been argued that when SAI is applied for realizing temperature change, termination of the deployment could 'produce warming rates up to five times greater than the maximum rates under the business-as-usual CO_2 scenarios' (Irvine, Sriver, & Keller, 2012, p. 97). Can it be justified from a perspective of intergenerational justice to apply SAI, thereby potentially imposing perpetual responsibilities

on future generations? How should we deal with these questions throughout the period of deployment of SAI and, more specifically, the obligations that each generation would then impose on the subsequent generations? Preston (2016) argues that for seriously considering geoengineering, there must be a 'cessation requirement' in place from the outset that stipulates how easy it could be stopped after it has been taken into use.[2] It should be noted that some advocates of SAI argue that if we commit to aggressive mitigation while deploying SAI, then deployment could eventually be scaled down and even stopped, without previous impacts kicking in again. There will therefore be no perpetual responsibilities imposed on future generations. However, given that large-scale and aggressive mitigation has proven to be hard to achieve so far, it is doubtful whether this will work in combination with geoengineering. To the contrary, policy makers, industry and society could be even be less committed to aggressive mitigation given the promise of the technological fix provided by the deployment of geoengineering.

Second, the long-term risks of geoengineering are mostly unknown, because there have not yet been large-scale experiments with SAI and other forms of geoengineering. Some scholars argue that the effect of geoengineering experimenting cannot be tested without full-scale application, but that this 'can only be tested by injection into an existing aerosol cloud, which cannot be confined to one location' (Robock, Bunzl, Kravitz, & Stenchikov, 2010, p. 530). As a result of this, the consequences are not only dispersed temporally, but will also be dispersed spatially. In other words, a problem such as drought could happen somewhere, sometime in the future, but it is difficult to anticipate when and where it will happen and how severe it will be. It is commonly accepted that there will be regional disparities when SAI is applied; these disparities are also sometimes proposed to be effectively used to create regional climate change, such as cooling (Irvine, Ridgwell, & Lunt, 2010). Of course, this example assumes that we are familiar with the nature of such risks, which is sometimes not the case with new technological innovations, leading to problems of ignorance and unanticipated risks. What morally exacerbates this problem is that we cannot quickly stop negative potential impacts in the future, because – as mentioned above – stopping the deployment of aerosols could lead to rapid warming, to levels substantially more than before the SAI deployment (Robock, Marquardt, Kravitz, & Stenchikov, 2009).

In this section we discussed how ethical challenges could be relevant for reflecting on the desirability of SAI as an option for geoengineering the climate. It is in this regard important to realize that this reflection on the desirability of SAI and other forms of geoengineering does not require a one-off engagement. Instead, it requires continuous ethical reflection from early stages of development of these options throughout the process of development, implementation as well as (long-term) deployment.

While risk ethics has developed as a relatively new area within moral philosophy to provide tools to deal with the ethical considerations of risks and uncertain outcomes (Hayenhjelm & Wolff, 2012), SAI poses challenges that go beyond the current state of risk ethics. Social scientists and philosophers studying risks have argued that decision-making about risks is not a purely scientific and quantitative issue, rather it requires ethical considerations, such as due attention for distributive issues, autonomy, availability of alternatives (cf. Krimsky & Golding, 1992; Asveld & Roeser, 2009; Hansson, 2013; Doorn, 2015; this is also starting to be acknowledged by risk managers Aven & Renn, 2009). However, these ethical considerations are less helpful in case of technologies, and associated risks, that are unfamiliar to us and at the same time potentially of such a disruptive nature as SAI. Such technologies require methods to deliberate on and make sense of the disruptive nature itself, rather than guidelines that look, for example, primarily at the distributive aspects of the technology or the question whether there are less risky alternatives available. What is needed therefore, are approaches that spark our moral imagination and that help us to deliberate about the risks of these potentially disruptive technologies, before they will be applied but also continuously while they may be introduced into society. We will discuss such approaches in the next section.

Emotions and art as resources for moral reflection

As we have argued in the previous section, decision making about geoengineering requires ethical reflection. It is plausible – although we shall not argue the case here – that only public deliberation about the ethical questions raised by SAI and other forms of geoengineering will be adequate to make progress towards answers (cf. e.g. Roeser et al. 2012; Roeser, 2018a). As well as raising ethical questions, new technologies also often give rise to emotional responses (Slovic, 2010). This is seen by many scholars as a reason why deliberation about new technologies is difficult, as they see emotions as an obstacle to rational deliberation (Loewenstein, Weber, Hsee, & Welch, 2001; Sunstein, 2005). Furthermore, as we have seen in the previous sections, given that the scientific information about risky technologies involves uncertainty, ethical considerations concerning risky technologies can themselves be uncertain. This is especially the case with new technologies such as geoengineering and SAI that may involve unexpected technological developments and their effects on nature and society. We will argue that art and emotions can play an important role in ethical deliberation about such hard to predict developments.

Emotions and values are typically considered as matters on which people differ and which lead to problems and conflicts. However, as indicated in the previous sections, values are inherent to decision making about risky

technologies such as geoengineering. We will argue that emotions can serve as important indicators of what people value, and emotional reflection and deliberation can be facilitated by works of art. We will discuss this step by step in what follows.

Values

There are many core values which people can find important, for example sustainability, wellbeing, justice and autonomy. People may disagree as to how to prioritize these different values (Perlaviciute & Steg, 2015). However, in polarized debates, this may be portrayed or perceived as a fundamental clash of values, where one group only seems to care about one value and another group only about another value (e.g. Dignum et al., 2016). This is frequently also mirrored in the media, leading to further polarization and people withdrawing into their own virtual or real-life 'bubbles', which serves as a centrifugal force, taking people further apart. However, public deliberation could also be construed in a very different way: by trying to take as the basis for deliberation the values that people agree about. People could be encouraged to first find common ground instead of emphasizing differences of viewpoints from the outset. Starting from this common ground can provide for better understanding of where people's viewpoints diverge, and for which reasons. This relates to the role of the imagination and of empathy, leading us to our next point.

Emotions

In the academic literature on risk, emotions are frequently portrayed as opposed to rationality and as a threat to decision-making (Sunstein, 2005, 2010, cf. Kahneman, 2011 on Dual Process Theory). However, emotion research emphasizes that emotions can have cognitive aspects, which means that they can be of vital importance for practical, ethical and political decision making (e.g. Frijda, 1986; Hall, 2005; Kingston, 2011; Nussbaum, 2001, 2013). Moral emotions can be an important source of moral wisdom (Roeser, 2011).[3] Research by the neuropsychologist Antonio Damasio (1994) on amygdala patients as well as research on sociopaths (cf. Nichols, 2004 for a review) shows that without emotions, we would not be able to make particular moral judgments and behave socially. In other words, emotions do their work unnoticed, all the time. They serve as the social glue that lets us communicate, understand and relate with each other. Emotions can be a gateway to a better understanding of each other's perspectives, and particularly, how we value things and why. For example, by listening to the story of people who are upset about the negative side-effects of a technology on their life, others can sympathize with their experiences and understand

why they matter, which can lead to different ideas on how a technology could be developed or implemented. Emotions could then be seen as a starting point for deliberation about moral values in decision making about risky technologies (Roeser, 2018a; Roeser & Pesch, 2016).

This can also provide for an important perspective in the context of climate change and the possible role of SAI and other forms of geoengineering. Moral emotions can help us to fully grasp the moral implications of climate change for people who are geographically or temporarily far away, which can in turn provide us with motivation to change our behavior and make personal sacrifices in order to mitigate climate change, for example, by changing our lifestyle (Roeser, 2012). Effects of climate change are continuous or chronic, which can make it easy to ignore them, and people may lack motivation to change their behavior (McKinnon, 2011). Climate engineering can play a role in mitigating and adapting to climate change, but it gives rise to additional ethical questions as it introduces potential burdens for society. However, mitigating as well as adapting to climate change requires more awareness of the problems than is currently the case, and a willingness to make personal sacrifices by, for example, changing one's lifestyle. Of course there are also powerful political forces at stake, but next to that, mitigating climate change requires a moral appeal to individual human beings to reflect on and adapt their behavior. Emotions can further help us deliberate about normative aspects of geoengineering. Because the normative aspects of such new technologies are partially uncertain, we cannot fall back on predefined moral norms; rather, we have to engage in ongoing reflection, also involving introspection into our own values and caring about implications for other people. Emotions can help us in this reflection, as they serve as signals as to what we and others value. Making emotions explicit can bring latent concerns to the fore and encourage people to investigate ethical implications that are not yet clearly developed.

However, explicating such latent concerns and undefined values can be challenging. Furthermore, emotions can also be biased and misleading, for example by being grounded in self-interest. Moral emotions can play a role in overcoming such biases. For example, shame, guilt and feelings of responsibility can let us critically asses our initial emotions and broaden our outlook to also include the perspective of others (Roeser, 2010). However, this can be difficult, as moral emotions can themselves be misleading, due to being grounded in stereotypes, triggered by irrelevant influences, and also because people's emotions and moral views are deeply ingrained in their personality as well as in their culture and surroundings (Greene, 2013; Haidt, 2012; Kahan, 2012). This means that we need approaches that further facilitate emotional-moral reflection. Art might provide for such a perspective, by creating space to explore and reflect on the moral ambiguities, paradoxes and complex moral questions involved in technological developments such as SAI and other forms of geoengineering.

Art

Various philosophers have developed accounts concerning the importance of how art can contribute to moral and political reflection, also involving emotions (e.g. Carroll 2001; Nussbaum, 2001; Gaut, 2007; Kingston, 2011, p. 209; Kompridis, 2014). Art typically engages our imagination and reflection and gives rise to emotional responses, all of which can help to reflect on and understand different perspectives and scenarios. Presumably, this could also be the case concerning art that engages with new technological developments (e.g. Roeser, Alfano, & Nevejan, 2018; Roeser & Steinert, 2019). Indeed, we owe paradigmatic points of reference in moral reflection on technologies to artists and writers who developed visions on technological developments long before they were a reality. Think of novels such as *Frankenstein, Brave New World* and *1984*. In foreshadowing possible developments, negative as well as positive, works of art and literature can serve as a guide on where to go, as well as a warning sign on where not to go, or which implications to prevent, by developing more responsible technologies. In this way technology-focused art can contribute to ethical reflection on technological developments, also and specifically when these are hard to predict, by exploring possible scenarios in a more tangible way.

Over the last decades, more and more artists and writers have developed works that engage with technological developments; this is what we would like to call 'techno-art' (cf. Reichle, 2009; Wilson, 2010; Myers, 2015 for extensive overviews). Bioartists experiment with and reflect on biotechnology. For example, Adam Zaretsky plays with the possibilities of genetic modification, by creating zebrafish with two heads, thereby challenging legal and ethical boundaries. The Culture and Art project has created a 'victimless leather' from tissue engineering. Anna Dimitriu makes artworks from bacteria. There are other artists who experiment with AI, robotics, and nuclear energy, to mention just a few controversial areas of technology with which artists engage. These artworks focus on risks and potential benefits for society, also involving emotional responses of the audience. Works of techno-art can shed important light on complex ethical questions related to technological innovations. This different focus of techno-art means that current philosophical theories on the relation between art and morality do not suffice in studying these kinds of artistic developments and their relevance for emotional-moral reflection. This is largely uncharted territory that has so far not been explored by many philosophers (for some exceptions see Zwijnenberg, 2014; Roeser et al., 2018; Roeser & Steinert, 2019).

Technological risks give rise to ethical challenges that require a reexamination of conventional ethical theories as these are not adequately equipped to deal with risk and uncertainty, by typically assuming full knowledge of consequences (Hansson, 2012, also see Gardiner, 2011). Similarly, in order to understand the role

of technology-engaged art in public debates about risks, this requires new aesthetic theories. Existing philosophical approaches to the relationship between art and morality do not focus on artworks that engage with science and technology. There are empirical studies on the contribution of images and narratives on emotions, awareness and behavior change related to climate change (Leiserowitz, 2006; Spence & Pidgeon, 2010), and foresight scenarios to explore the impacts of SRM (Low, 2017). Works of visual art and literature could play a crucial role in such contexts (Mehnert, 2016; Mobley, Vagias, & DeWard, 2010). We distinguish visual techno-art from literary techno-art, i.e. visual art works versus works of literature which engage with science and technology. Visual techno-artists often do not use traditional materials and techniques such as painting, photography and sculpture. Rather, they use scientific and technological techniques, such as biotechnology, robotics or new media, to develop artworks. This is less the case with literary techno-art, but in both cases, the artist or author engages with scientific or technological developments. Furthermore, these artists and authors engage with different topics than other artists, frequently concerning the implications of a technological development for society, and these also inspire different emotional responses.

This relates to a currently hotly debated topic in epistemology and cognitive science concerning the role of external features to aid our thinking, cognition and knowledge (cf. Clark & Chalmers, 1998 on the extended mind; Giere, 2002; Palermos & Pritchard, 2013 on socially extended knowledge). However, not only practical devices such as maps and notebooks can play the role of extended cognition and knowledge, but artworks can do so too (cf. Krueger & Szanto, 2016 on the role of music and emotions for extended knowledge). Techno-art can also be seen as a form of 'socially extended knowledge' (Roeser, 2018b). This idea needs further elaboration and can draw on as well as contribute to the debate on extended cognition and knowledge. For example, artists often think out of the box and can help us take our imagination further than the more strictly regimented steps in which scientific researchers and engineers tend to proceed. Furthermore, they provide for much more concrete images and narratives than the abstract argumentation of philosophers, thereby appealing to people's imagination, sympathy and understanding, which can provide for different and complementary ethical insights than purely cognitive and analytical reasoning.

For example, techno-art can present society with visions that give rise to emotional engagement with technology, emphasizing positive prospects as well as risks and ambiguities. Techno-art can explore the boundaries of emotionally laden moral notions such as dignity, suspicion, and trust. Techno-art can explore moral dimensions of technologies in a very visible or tangible way that can lead to a more direct experience and more concrete, context-specific ethical insight than abstract reasoning. In this way, techno-art can make a constructive contribution to the public debate as well as to the academic

ethical debate on technological risks, by providing additional insights and perspectives that might get overlooked in a purely theoretical academic or public debate. In that way, it can make ethical deliberation more accessible for a broader range of stakeholders. In what follows we will discuss examples of techno-art in the context of climate change and climate engineering, and how these can contribute to emotional-moral reflection.

There are novelists who write about climate change, such as Cormac McCarthy (*The Road*) and Lauren Groff (*Florida*). They provide for powerful, dystopian narratives that show the ultimate implications of our choices. Such narratives appeal to people's imagination and sympathy, which can provide for additional motivation to adapt one's behavior. Emotions that are inspired by such artworks can provide for more powerful ethical insights than abstract reasoning, as well as for more motivational force (Roeser, 2012). Recently, leading novelist Amitav Ghosh (2016) has argued that more writers should engage with climate change as it is one of the most pressing problems of our times, and writers can uniquely contribute to bringing these largely abstract and long-term developments closer to people's awareness by creating narratives that appeal to our imagination.

Next to climate novelists, there are climate artists working with visual art forms and installations, such as David Buckland and Boo Chapple. Boo Chapple has created an interactive project that plays with the suggestion from geoengineers to shield the earth under a white layer to reflect sunlight away from the earth as a way to combat climate change. This is an idea that resembles SAI, but it would be even more invasive. Chapple asked people to wear reflecting white hats and to deliberate on the impact of such technologies and whether they are desirable. In this way she appeals to people's imagination and reflective emotional capacities, inspiring ethical deliberation that is fueled by concrete experiences.

In 2018, there was a widely discussed exhibit at the Stedelijk Museum Amsterdam called 'Coded Nature' by the artistic duo Studio Drift. Their works reflect on our relation with technology and nature. At this exhibit, a film with the name 'Drifters' was shown. In this poetic film, concrete blocks rise up from a lake in a hilly landscape and rise seemingly weightless, becoming more and more like a flock of birds and finally collapsing into a monolithic whole. The concrete blocks are paradoxical: feathery and at the same time heavy, coming from nature but also strange and ultimately dominating. In a very subtle way, this film touches on our emotions and therefore allows us to reflect on our relationship with nature on the one hand and technology on the other. Like the concrete blocks in the film, we originate from nature, but we also change it. We are natural beings on the one hand and cultural beings on the other, and without people there would be no technology and no concrete blocks that are part of our current landscape but also threaten this. The blocks of concrete can be seen to symbolically relate to geoengineering: they protect

nature while also dominating it, and once this technology is in place there may be no way back. We will then irrevocably be locked[4] in such a system, just like the blocks of concrete that eventually cover the sky in the video 'Drifters'.

These examples illustrate that artworks can make a powerful contribution to ethical deliberation throughout the process of development, implementation and (long-term) application of geoengineering such as SAI. Art can help to make climate change more salient and probe people to take actions, and to let people critically reflect on the possible role of for example geoengineering. The vast challenges posed by climate change require our best possible efforts to reflect on ethical implications on technological developments that are hard to foresee at this moment. Artists can help in deliberation, by providing works that can spur critical reflection on which values may be furthered or threatened, by triggering our imagination and moral emotions. This can provide for an important new resource for existing approaches to participatory technology assessment (cf. Van Asselt & Rijkens-Klomp, 2002 for an overview of such approaches). In such approaches, scenarios are sometimes developed by policy makers, communication experts or social scientists and used for reflection (e.g. Boenink, Swierstra, & Stemerding, 2010). However, arguably, artists and writers can provide for more challenging and intriguing scenarios and images, as they are experts in creating images and narratives that profoundly challenge our imagination and trigger reflection. In conventional technology assessment, the focus is on scientific information and to the extent that it includes ethical reflection, that is based on rational argumentation. Focusing on art, values and emotions can provide for much more profound reflection, understanding and insight (Roeser & Pesch, 2016). This can make ethical challenges explicit, which would be more difficult in abstract, rational reflection. Artworks and narratives can make scenarios and unclear and ambiguous normative implications of geoengineering more tangible and easier to imagine, thereby stimulating critical reflection, based on imagination, compassion, sympathy, introspection and understanding.

Of course it is important to note that techno-art is not a foolproof solution for ethical deliberation on geoengineering. Like all other forms of insight and deliberation, it can be biased, mislead or even intentionally used for manipulation. In other words, techno-art is not a 'silver bullet' to ethical deliberation about geoengineering, and in general, there are no 'silver bullets' to such complex issues. However, given the profound challenges we are facing it is important to draw on all resources that we have, and techno-art can provide for such a possible additional resource which has until now not been sufficiently recognized. If techno-art will be included in deliberation on geoengineering, it will be important to build in checks and balances, for example, involving different artists who provide complementary perspectives (cf.

Roeser & Steinert, 2019 for further discussion of this). In this way, techno-art can broaden people's horizons and challenge their imagination, thereby contributing to critical ethical reflection.

Conclusion

Climate change could cause disruptive effects for society, requiring new, innovative strategies on how to combat or adapt to climate change. Geoengineering, for example in the form of SAI is a *technological* strategy to address some of the challenges of climate change, but it would also create environmental and societal disruptions of its own, due to its potentially large-scale risks. This means that decisions about geoengineering require a trade-off between different types of risk. What makes such a trade-off problematic is that these risks are spatially and temporally dispersed. All these issues pose not only technological challenges but also ethical challenges, requiring explicit ethical deliberation. Also, unanticipated technological risks could in the future give rise to unforeseen ethical challenges and, by that, make earlier applied moral norms for assessing the desirability of geoengineering less relevant. Similarly, our understanding of moral norms and what we consider 'good' in society may change over time.

We need, therefore, a continuous ethical 'monitoring' in which the performance of SAI and other types of geoengineering is continuously assessed from a technological as well as from a normative-ethical perspective, and based on this, adjusted and adapted in an iterative process. This also requires new deliberative strategies. We have argued that emotions and art can play crucial roles in this, as they can be important gateways to values and critical reflection. 'Techno-art', especially art that engages with climate change and geoengineering can trigger our reflection and imagination concerning future scenarios, bringing these closer to home and thereby bridging the problematic gap between our current actions and their remote, yet profound impacts.

Techno-art can make a powerful contribution to important debates facing contemporary society, by providing for a new, not yet explored avenue of public deliberation and emotional-moral reflection about technological risks. Organizations that can use such an approach are (inter)national governments, policy advisory boards, technological research organizations and NGOs representing citizens' interests, in order to facilitate public dialogue. Researchers who develop new technologies can be inspired by techno-art to derive insights into emotional-moral considerations that can contribute to more responsible innovations.

This approach is hitherto largely unexplored, while it could contribute to making progress in decision making concerning one of the most complicated challenges that have ever faced humanity. If we do not act now, it could be too late; yet, imprudent and hasty action to promote technologies such as SAI

and other types of geoengineering could lock us in situations where there is no way back. Art, emotions and values can help us to reflect on complexity and uncertainty, providing us with wisdom in the light of the ethical challenges presented by climate change and geoengineering.

Notes

1. See also (Hourdequin, 2016).
2. Preston argues that between the two types of geoengineering, CDR will probably be the easiest to stop, while SRM (including SAI) will be much more difficult to stop. Also see McKinnon (2019) on the ethical problems with the risk of getting 'locked in' SRM.
3. With the notion 'moral emotions', we refer to tokens of emotions that can be relevant for moral insight and reflection. Hence, next to paradigmatic moral emotions such as guilt and shame, also fear can be a moral emotion when it draws attention to morally relevant issues (cf. Roeser, 2011).
4. Cf. McKinnon (2019) on lock-in of SRM.

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