

Perceptions of the climate and its changes are polarized: the clear majority is worried about global warming, the boisterous minority considers cooling as a more likely scenario (Poortinga, Spence, Whitmarsh, Capstick and Pidgeon, 2011). Common to both factions is the worry about the dynamic nature of the Earth's atmosphere which has resulted in different geological periods in the course of the planet's history. This assumption motivates us to develop capabilities to take the edge off the scary future. When dangerous things are about to happen with regard to climatic conditions, we become alerted and feel like we are entering a state of emergency.

This article elaborates the idea of dangerous climate change and its policy implications for the ethics of solar radiation management (SRM). Dangerous climate change, or - as we will call it - a "climate emergency" refers to such sweeping changes in the cyclical occurrence of weather events that severely impact and deteriorate our living conditions and those of many other species. A climate emergency can be also regarded as a "radical emergency," a phrase that designates the extremely complex perilous situation the humanity faces. Because of the characteristics of the situation, the responses to it have to be large-scale and trustworthy despite the fact that they cannot be properly tested before the implementation.

Besides global warming other instances of a radical emergency include quickly spreading and highly lethal infectious diseases, a meteor crashing the Earth or a massive volcanic explosion (a supervolcano). Climate emergency denotes a specific state of affairs on the planet Earth that contains at least the two following features: First, the climate change is an immediate or impending threat to life and health of humans and many other life forms. Second, there is a high probability of escalation of the social disorder, for example economic turmoil and mass migration of climate refugees, if no immediate action is taken. Abrupt changes in climatic and weather conditions can appear suddenly and the scale of the effects is unpredictable. There are several alternative scenarios for the ensuing events once certain thresholds are crossed. The acknowledgment of human-induced global warming can also awake a sense of existential angst upon informed and a sense of guilty majority for causing anthropogenic climate change both of which may erode the quality of life (cf. Thompson, 2009, p.80, 96-97).

Presuming that the negative effects of climate change do not occur gradually<sup>1</sup>, we want to investigate, in particular, whether there is any kind of rational basis to the conclusion that a state of climate emergency would require geoengineering implementations such as SRM. Related to this, we will pose the question whether there can be exemptions from conventional morality justified by climate emergency for instance to use such largely untested geoengineering methods like SRM. We will take a look at SRM from an ethical point of view and analyze the concept of climate emergency and its policy relevance in order to assess the moral justification for the implementation of SRM.

### **Geoengineering as a response to a climate emergency**

By definition, an emergency not only allows exceptional action but calls for it. Can emergency be responded in a collective way through which humans jointly aim to protect themselves or does emergency result in disarray and turmoil that compels humans individually to seek for saving themselves and perhaps their nearest? If the latter scenario actualizes, there is not much room for ethical reflection and precautionary measures are ineffectual to a great extent. The former scenario opens up two basic alternatives, legal and technological, that can often be used simultaneously. Most nation-states have emergency laws, the purpose of which is to maintain capacities to respond to crises in an organized manner. When a state of emergency is present, a legal authority can be granted emergency powers so as to steer the nation out of the predicament even at the cost of normally protected rights. As the Roman philosopher and statesman Cicero put it, “*Salus populi suprema est lex*” (“The safety of the people is the highest law”) (quoted in Walker 2008, p.370). As far as we know, no one has thus far suggested that a state of emergency should be “declared” because of global warming ( see Gardiner 2011a, p.20). However, in the context of related debate undemocratic opinions have been expressed (e.g. Shearman & Smith 2007). The talk of an emergency has rather been metaphorical and alarmist, not judicial. The emergency powers may entitle its holder to accept the use of technological solution. The belief in technological solutions is widespread and is also applied to the context of global warming.

The scary possibilities have led to the emergence of the idea of “fixing the climate” in the

form of intentional climate modification, i.e. geoengineering. It refers to human attempts to control climate so as to stabilize the physical conditions on this planet. As the proponents see it, geoengineering - especially SRM - is the best available solution to lessen the drastic consequences that climate change is expected to bring about (see Keith, Parson, & Morgan 2010, p.426; Victor, Morgan, Steinburner, & Ricke 2009).<sup>2</sup> According to a very broad definition, geoengineering is “the intentional large-scale manipulation of the environment” (Keith, 2000, p.247). The environment here denotes both the climate system and the biosphere as a component of the climate system.<sup>3</sup>

Proposals for geoengineering are numerous and they do not conveniently fall into one homogenous category (see Keith, 2000; Lenton & Vaughan, 2009). Because the prevailing concern is the warming of the climate, the proposed technological means aim to tackle the increasing temperatures. There are two basic ways to seek it: the reduction of the absorption of incoming radiation from the sun (SRM) and the removal of the carbon dioxide from the atmosphere (carbon dioxide removal, CDR) (Lenton & Vaughan, 2009, p.2562; Shepherd et al., 2009). In this paper, the focus is on the ethical analysis of solar radiation management. Perhaps the most discussed SRM method is stratospheric sulfur injection (Crutzen, 2006). However, other techniques have also been suggested, such as using micro bubbles in water in order to increase water surface reflectivity (Seitz, 2011).

The views on the necessity and acceptability of geoengineering are grossly dividing (see Ikle & Wood 2008; Robock 2008). In this respect, the geoengineering debate indirectly echoes the debate on policy responses to global warming. Those who deny human-induced climate change can handily take a conservative stance to geoengineering. Nevertheless, it is possible to have other reasons for controlling and manipulating the climate, such as to promote “natural” climate change, to put off the future ice-age, or to increase productivity.<sup>4</sup> The current debate on geoengineering takes for granted anthropogenic global warming. This is indicated in the influential report by The Royal Society *Geoengineering the Climate* where geoengineering is defined as “the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change” (Shepherd et al., 2009, p.1).

Hardly anyone denies the risks involved in human meddling with the Earth’s climatic system, but it appears that some geoengineering methods are safer than the others. As an

example of a less ecologically detrimental method, the Royal Society report mentions CDR (see Shepherd et al. 2009, p.xi). However, the safer methods, e.g. large scale afforestation, might not be quick enough to respond to the situation. When we think of our present situation as exceptional and realize that our well-being or, at worst, our very existence is in danger, many of us might be ready to give green light to more exceptional measures, such as SRM. The Royal Society report (Shepherd et al. 2009, p.45) refers to it as a survivalist measure in the state of a climatic predicament. SRM could be combined together with mitigation policies and would require possibility to discontinue SRM implementation if necessary.

Climate and other natural scientists more generally have paid a great deal of attention to identify events and long-term trends that indicate tipping points or thresholds for major and sudden alterations in climatic conditions (for instance Alley et al. 2003, p.2008-2009). By interpreting scenarios, models and theories people are able to make informed judgments concerning the state that they are in. Still, it is not our task to analyze the validity of these judgments; this paper is not a critical review of the state of the art in climate science.

In this section, we have focused on introducing how most societies have socially, legally and technically prepared for the appearance of ominous situation. Global warming is, however, a new kind of emergency that may require new kind of technology to alleviate and control the situation. The next section focuses on the ethics of emergency more generally and considers how moral problems arising from these situations should be treated.

### **On the ethics of emergency**

There are various kinds of emergencies in different situations of life. Wars, natural disasters, infectious diseases and such accidents as fires and car crashes are examples of emergencies and some of them have been targets of philosophical scrutiny in one way or another (e.g., Walzer 2004; Sandin 2009). All of them are apparent cases, but they seem to have a different concept of emergency when it comes to the severity, scale, endurance and intensity of the situation and the realization of value(s) threatened. The last-mentioned refers to possible loss caused to objects of value, that is, to concrete entities such as human

individuals as well as to abstract objects, for example biodiversity and national sovereignty. Wars are cases of “supreme emergency”, as Michael Walzer (2004, p.33) claims, when “our deepest values and our collective survival are in imminent danger” due to an attack. Such an emergency can be instantly recognizable, although there can be continuous debates about the justifiability of the use of armed forces. Natural disasters and human accidents are less political but not wholly apolitical because the foreseeable damages can be mitigated through, for example, civic education, zoning ordinance, building standards and other safety measures. Global warming is a specific kind of emergency because it is an abstract idea and a highly scientific affair; its symptoms, or its consequences such as wars, forest fires and flood disasters, are more visible.

It is typical for a state of emergency that it gives rise to moral problems. Concerning moral thinking more generally, a moral dilemma is a moral emergency if something should be done instantly, but people hesitate over the right course of action, including the possibility of omission. However, omission either might not be an option or could result in more catastrophic results than any other alternative open to us. It is not, of course, that all moral dilemmas are cases of moral emergency: some of the dilemmas are conflicts of principles that simply exist in theory. Let us take a brief look at the topic of emergency in the field of applied ethics.

To illustrate the seriousness of climate emergency, both health analogies to the state of climate and warfare analogies to global warming have been made. Most famously, the British “geophysicist” James Lovelock speaks about “planetary medicine” (Lovelock 2000) and compares present situation with the situation before the World War Two (see Lovelock, 2008, p.3888). Back then there were only a few medicines that were known to be effective on diseases despite the well-founded science of physiology. Lovelock compares the situation with present climate science and geoengineering plans and raises the question of sufficient expertise in balancing the effects of anthropogenic global warming.

Especially, the debate about the methods of bioethics seems relevant to our discussion. Bioethicists have analyzed the role of principles in decision-making and guiding action. Beauchamp and Childress’s *Principles of Biomedical Ethics* (1977) has become the paradigm example of the so-called principlist approach. According to it, there is a set of prima facie principles: autonomy (respect person’s own will); beneficence (do good to

people); nonmaleficence (avoid harming people); and justice (benefits and burdens must be distributed fairly). These principles are fundamental moral intuitions that can be reflected and tested in moral analysis of actual cases. In addition to principles, ethical decision-making consists in confirmed facts and widely accepted background theories. Together these principles, facts and theories constitute an ethical decision-making method known as wide reflective equilibrium (see Daniels 1979). The real-life decisions are reached by taking principles into account in the way that decision-makers should pursue the coherence of principles, perceptible facts and background theories when deciding about policies. An impending climate emergency provides a challenge for decision-makers who could benefit from the interconnection of relevant *prima facie* principles, background theories and up-to-date climate science in making appropriate decisions. Considering the SRM, the decision-makers should not only know about the facts, contesting scenarios and available alternative technologies, but also about relevant moral principles that constrain decision making. Because the decision is collective, autonomy here should be understood in a less rigid way as a majority decision in a national parliament. Beneficence requires that the implementation really does good for the people, and in this case it is so that SRM implementation is better for them than the other alternatives, including doing nothing. Nonmaleficence requires that people should not be harmed but because the SRM requires that mirrors must be transported to space there are risks, such as the explosion of the carriers. Finally, the principle of justice requires that the implementation of SRM must not benefit one group of people at the expense of others. All in all, the components of decision-making are many and they are often contested making the attainment of the optimal decision infeasible.

The time available for decision-making in an emergency situation can be severely limited and our understanding of the essential features of the situation are not optimal because of knowledge gaps and perhaps the distortion of information. This is a serious problem for principlism in some cases of emergency. For instance, health professionals should perform required actions routinely. There are, very roughly, two kinds of medical emergencies requiring a patient's treatment: those in organized and well-managed situations and those in chaotic situations. Typically emergency situations in health care are rather specific and well-managed in a sense that everyone involved knows their role. This is so because the scope of emergency is limited to the troubled patients. In the chaotic cases, the health-care and other infrastructures have collapsed and confusion prevails; consider cases like massive

earthquakes and flooding where thousands of injured people simultaneously require treatment which no one can provide for them. The consequences of global warming could be interpreted in this way. We suggest a new attribute to describe this kind of a situation: radical emergency.

Radical emergency is comparable to the concept of complex emergency, sometimes used in military medical sciences to single out situations

“in which mortality among the civilian population substantially increases above the population baseline, either as a result of the direct effects of war or indirectly through increased prevalence of malnutrition and/or transmission of communicable diseases, particularly if the latter result from deliberate political and military policies and strategies” (Salama, Spiegel, Talley, & Waldman 2004, p.1801).

This definition of a complex emergency does not include natural disasters because they are thought of as having more short-term effects. In contrast, climate change can have a long-term (that is, thousands of years) adverse effect on the biosphere. Therefore it is best use a new concept to designate a new situation that is both complex and long-term and new to the humanity.

On the basis of this excursion to ideas of emergency a question arises naturally: are we in regard to climate change getting closer to an emergency setting that is similar to the ones constantly encountered in medical practices or at war? A radical emergency designates a situation where conventional risk management falls apart. This might be also possible in the case of a radical emergency and runaway climate change.

Proponents of geoengineering bring the emergency arguments and potential emergency measures into the climate debate in two intertwining ways. Geoengineering can be argued for as a precautionary measure or as an emergency measure. In the former argument, geoengineering is viewed as human potential to react to dangerous climate change and therefore geoengineering capabilities should be created, even though not necessarily used. For example, Victor et al. (2009, p.66) have pleaded that “The time has come to take it [geoengineering] seriously. Geoengineering could provide a useful defense for the planet – an emergency shield that could be deployed if surprisingly nasty climatic shifts put vital

ecosystems and billions of people at risk.”<sup>5</sup> In the latter argument, geoengineering capabilities should not only be created but also used as quickly as possible because we are in the state of emergency.

Is the precautionary argument distinguishable from the emergency argument in practice? As we see it, the arguments are intertwined. First of all, technological determinists claim that if a technology has been developed, it will be used at some point of time. This is not a very plausible argument against the research and development of geoengineering, since we are unable to say for sure that it is happening. A stronger argument is that it is the decision about the use of geoengineering technology depends on our perception and we may start using it as a precautionary measure in the early stage of global warming. There is even a further incentive to use the technology inappropriately: the research and development requires experiments and the best experiments are conducted in the natural laboratory. Therefore, the step from research and development to the actual use of technology is very low.

To summarize, cases of emergency and their management are numerous. Therefore the vocabulary of emergency is rather heterogeneous, reflecting the fact that car accidents should be reacted differently than wars and infectious diseases. Global warming is an emergency that has multiple layers, since it may be the ultimate cause of more proximate problems, such as the spread of new diseases, flooding and droughts. We have characterized the possible bleak scenario that the global warming might cause as radical emergency. Next we will argue that there are better ways to react to this problem than geoengineering.

### **A survival kit without geoengineering**

Because the purpose of this article is not to determine whether or not we are in the state of climate emergency, we will simply assume that we are very close to such a situation and base this assumption the latest state of art in the study of climate change. We have also assumed that principlist method is the best existing method to analyze the alternative ways of action. What kind of emergency relief or a survival kit is needed to confront the possible

climate emergency? The survival kit should provide for a radical emergency where the traditional infrastructures of rescue services disintegrate. It is obvious that a climate emergency is not the only potential impending crisis at the beginning of the 21<sup>st</sup> century. There is also evidence of a large-scale sustainability predicament including climate change together with issues of water and food security and peak oil. We are not to ignore the threat of nuclear winter caused by nuclear weapons either (Robock, Oman, & Stenchikov 2007).

The most prominent tool of a survival kit would be mitigation and fast decarbonization of the economy and infrastructure. Currently, the climate science is incompatible with the objective of avoiding climate emergency with existing political and economic realities regarding mitigation. In other words, as things now stand, rapid decarbonization is neither economically feasible nor politically acceptable. It is quite obvious however, that avoiding an emergency situation should be the priority in climate and any other policy. All the same, one of the problems with introducing geoengineering to the climate policy forum is the possible dependency on these schemes, for instance stratospheric sulfur injections<sup>6</sup>. The benefits and risks of SRM are assessed in a greater detail in Robock (2011) and Robock, Marquardt, Kravitz, & Stenchikov (2009).

The proposals for treating a climate emergency without SRM are based among others on the following arguments. Firstly, according to the slippery slope argument SRM will open the door to novel and detrimental implementations of climate modification technologies. Although there is no definitive proof of large-scale realizations of ecologically damaging implementations it does not make the slippery slope argument wholly ineffective. It is possible that preliminary testing of geoengineering proposals leads eventually to ecologically detrimental consequences. Secondly, the technical fix argument considers that SRM might work successfully in enhancing albedo; however, it does not fix the root of the problem itself which also has to be taken into consideration with regard to the cumulative greenhouse gas emissions. Thirdly, in the unpredictability argument SRM is deemed ethically dubious in a utilitarian framework because its effects cannot be reliably predicted (see Keith 1998, p.87; 2000, p.277). Keith discusses the most common arguments against geoengineering and we consider these arguments to apply to SRM implementation proposals, too. Hence, we are in a situation where impending climate catastrophe might be at hand and one of the proposed solutions to climate emergency, SRM, faces ethical challenges that need clarification for the decision making whether to adopt SRM as a

functional part of climate policy.

Besides the previous arguments against geoengineering, there are at least two more arguments that consider SRM methods in their present form ethically unacceptable. Bunzl (2008, p.18) considers the issue from social justice perspective. He brings up the possibility the SRM implementations can be planned and decided in an unfair and elitist manner and its benefits and harms can be distributed unevenly. The final argument, formulated by Robock (2008, p.17), proposes that the research and development of SRM techniques might also generate the weakening of political will to engage in mitigation and adaptation options relevant to climate policy. Moreover, the investments in research on SRM might also prohibit the emergence of novel and sustainable solutions to challenges created by climate change because the research funding pool is limited. These above-mentioned arguments pose relevant arguments against geoengineering however cannot yet solve the question whether to grant ethical acceptability to SRM or not.

Opposite to the previously mentioned arguments, we can also identify various arguments in favor of SRM. First, the cost-effectiveness of SRM proposals seems to make them tempting to accept. Victor et al. (2009, p.69) even claim that “there is general agreement that the strategies are cheap”. Second, no international administrative body will be needed; thus implementations could be executed unilaterally through corporative or state administration. This point could also be turned upside down. For instance, a rogue state might have questionable geoengineering plans without powerful international agreements or actors. Third, technological geoengineering innovations are not as troublesome as to renew the global energy regime away from fossil fuel based substances.<sup>7</sup> However, these circumstances which seem to support the implementation of certain SRM proposals appear to be short-sighted. For example, Gardiner (2010, p.287-288) makes a point that the cost-effectiveness counts only the price of the sulfur and its potential ways to shoot it into the atmosphere, not the potentially hazardous side-effects it could have on the biosphere. On top of it, the unilateral implementation is however politically and legally complex an issue and requires an international agreement. Without a modified international agreement, geoengineering implementations could be interpreted as a violation of the Convention on the Prohibition of Military of Any Other Hostile Use of Environmental Modification Techniques, ENMOD (see Robock 2008, p.17).

The arguments in favor and against geoengineering depict the discussion around geoengineering. Contradictory viewpoints in the presence of impending climate emergency make the question concerning the morally adequate decision making process vexed. In the next chapter we will look at the argument from radical emergency and its relevance to the discussion of the ethical acceptability of SRM in a climate emergency.

### **An argument from radical emergency**

Saving or losing the lives of millions of innocent people who are in immediate danger because of the choices of the few is also a potential situation present in a radical climate emergency. We have used the concept of radical emergency refer to the situations that are complex, new and have long-term effects and considered that global warming exemplifies it. An argument from radical emergency consists of a group of arguments which claim that in special occasions one is morally exempted from everyday norms and morality. In other words, the tragic situation allows an agent - which could also be a state or an institution - to perform actions that would normally be prohibited as too risky or considered immoral in conventional activities. Radical emergencies are often moral emergencies since there is a tragic element present: every option open to use bears moral costs, such as the violation of individual rights or threats of collective survival. If an emergency situation is a kind of a moral blind alley, one can ask how responsibility is included in the action of choosing one option over another.

If a radical climate emergency is understood as a situation where business-as-usual everyday rules and norms cease to govern, can the imminent threat provide justification to promote SRM techniques? SRM has entered the discussions on the basis that, first of all, in an emergency situation - in this case radical climate emergency - we must depart from usual everyday morality; therefore also untested and potentially detrimental implementations could and should be introduced as a survival kit despite potential adverse side effects and unknown repercussions. Briefly, an emergency morally requires taking extraordinary risks. The second reason why SRM has entered the climate change discussions in the form of argument from radical emergency is that it is the lesser evil compared with actualizing climate catastrophe. The lesser evil argument maintains that

SRM schemes should be implemented regardless of the fact that it has adverse and unknown side effects or it is otherwise considered as ethically unacceptable because the imminent climate emergency on the verge of a catastrophe is far worse than intentional climate modification. Thus, the best mode of action - morally speaking - would be to engage in geoengineering the planet rather than face runaway climate change. Gardiner (2011b, p.180) makes this point in reflecting on the problem of lesser evil. However, it is essential to notice that there are more options than facing climate catastrophe or engage in SRM implementations.

The lesser evil argument implies that in an emergency one should be detached from common morality and discover emergency morality (if such a thing exists) as something different from our conventional morality. We interpret radical emergency, paraphrasing Walzer's concept of supreme emergency, as a severe vulnerability or disintegration of collective values and survival. In that kind of climate emergency which is also a moral emergency the lesser evil argument should be carefully analyzed. That is to say, lesser evil argument maintains that we could be absolved from our responsibilities to tackle climate change with morally acceptable and environmentally sustainable means because we do not have the time or the means to do that. Perhaps the principlist approach and its earlier mentioned prima facie principles can offer guidelines for action in a radical emergency where there is limited time for negotiations of the best alternatives of action. Even though the gloomiest projections of radical climate emergency have not established yet, we still think that the current situation in the light of climate science requires assuming a climate emergency of some kind. Does this prove that in a radical climate emergency SRM goes when it comes to morality?

At worst, the emergency situations are extremely complicated situations for making morally right decisions. Of course, the acceptability of measures used also depends on theoretical commitments whether they are for instance consequentialist, non-consequentialist or based on virtue ethics or some other ethical approach. For instance, the conclusion of morally right action depends on the emphasis whether the consequences of the action or the procedure leading to action or some other factor are morally relevant. Moreover, a proposed course of action may violate the basic human rights, justice or contradict for example with the outcomes of the cost-benefit analysis. In every war and catastrophe, the otherwise absolute rules seem to become flexible and the request to accept exemptions from them

pops up.

Even in an emergency, there are still options to choose from even if they are morally questionable ones. Therefore it is implausible to maintain that moral responsibilities cannot be involved in a non-antagonistic emergency such as a climate emergency that is “a moral black alley” (see Sorell 2002; Sandin & Wester 2009). To consider current SRM proposals morally justified, one should not only grant that a radical emergency is possible but also refine the ideas of sustainability and protection of the environment in order to ensure the continuance of a flourishing biosphere including humans.

Consequently, a (tragic) moral dilemma can be seen as a case where choices have to be done between two or more evils. There can be a situation where one action is the lesser evil than the other and possibly thus should be chosen. In this case, a right course of action can be found. In other words, an action is as good as it can get in that tragic situation. Nevertheless, choosing the right or lesser evil option does not exclude the fact that there is still wrongness included in that action. By definition, the best or right option is not available at all. (Raz 1988, p.359.) Walzer (2004, p.49) describes this kind of situation in these words: “This is the essential feature of emergency ethics: that we recognize at the same time the evil we oppose and the evil we do, and that we set ourselves, so far as possible, against both.” In the case of SRM, a radical climate emergency might suggest that available options including SRM involve evil in any case for several reasons<sup>8</sup>. In other words, there might not be any good choices available. However, even the alarmist conception of climate change can consider moral norms of some kind applying to radical climate emergency on the basis of *prima facie* principles. Those principles can be applied to all occasions regardless of the gravity of the situation. For instance, the principle of nonmaleficence implicates that in every situation one should choose the lesser evil and aim to minimize the damages whenever necessary.

## **Concluding remarks**

In this article, we have reflected on different interpretations of lesser evil argument with regard to SRM. We do not advocate the perspective that in an emergency we exit the moral

realm and enter a territory of emergency or a moral black hole where conventional morality no longer affects. Neither do we agree on that in a climate emergency we do not exit the moral realm but stretch our morality and accept the lesser evil regardless of the fact that it involves evil<sup>9</sup>. Instead, we proposed the *prima facie* principles to be used as guidelines in a radical climate emergency.

The interpretation of a climate emergency as a radical emergency and the adequate means to operate with regard to climate change depends at least on the following matters: the prevailing paradigm of science, the state of the art in climatology, the prevailing ethical perspective (anthropo- or biocentric, consequentialist, non-consequentialist, principlist etc.), relevant and current ethical issues and international climate policy. Our thesis in this article has been that a radical climate emergency needs a specific definition before the risky last resort measures, for instance SRM implementations, can be taken into consideration as part of a sustainable climate policy. Furthermore, we want to emphasize that there is neither a moral black hole situation nor permissible exemptions from conventional morality on a *prima facie* basis. As the principlist approach suggests, norms guiding action can be flexible in a way that one of the four main principles can be predominant in comparison with the other principles; however, the principles are relevant even in the most desperate situation.

Can we accept SRM as a morally satisfactory method to tackle climate emergency? The answer depends on the situation in which the emergency is declared. Some say a climate emergency is currently at hand, others think it is decades away or just an alarmist provocation. Unlike the house on fire, the planet on fire is non-evident. However, evil is still evil whether done in an emergency or not. This means that if SRM is considered as morally evil, it is still that even in a climate emergency. Hence, we recommend creative solutions to construct future scenarios including the ethical aspects along with technical engineering. The only way to mitigate a potentially catastrophic climate emergency is to transform human practices. The history of humanity is a history of remarkable progress and creativity in many occasions and failures in others. One should be suspicious of imagining that SRM is the most impressive invention to save the biosphere from an impending climate catastrophe. The relevant climate thresholds should be carefully evaluated one by one in order to decide the relevant and sustainable climate policy and whether to add SRM or other similar proposals to the survival kit of climate emergency.

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## Endnotes

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1 Those adverse effects include for instance rising polar temperatures, diminishing and melting of icebergs, icecaps and glaciers; reduced permafrost; changes in ocean currents, wind patterns and precipitation; heat waves; droughts; loss of biodiversity and overall increasing frequency and intensity of extreme weather events.

2 They could argue for the development of this technology by claiming that the effects of climate change are human rights violations (Caney, 2009, p. 127; 2010: Hayward, 2005, p.29). Caney mentions that climate change will threaten at least three rights: the right to life, the right to health, and the right to subsistence. Although Caney and Hayward both argue that adverse effects of climate change could violate fundamental human rights, they have not proposed geoengineering schemes in order to hinder the negative effects of climate change. We simply mention the argument here as a potential argument for geoengineering. In addition to human rights view, Moellendorf (2011) analyzes different responses to dangerous climate change.

3 Geoengineering should not, however, be confused with ecological engineering, the intentional large-scale manipulation of the ecosystems although they overlap each other.

4 In the 18<sup>th</sup> century, Carl von Linné, Pehr Adrian Gadd and numerous other scholars in Sweden considered the local warming of the northern climate. For them local warming meant increasing productivity and wealth, and it was achievable by means of population growth, deforestation and draining of wetlands. (Niemelä 2008.)

5 Victor et al. (2009, p.66) suggest that emergency measures as a shield is a political choice. However, political solutions in the case of climate change are not known to be particularly swift decisions. This presents a dilemma for geoengineering and the policy making of climate change.

6 Failed or suddenly stopped geoengineering could lead to rapid warming of the climate (Matthews & Caldeira 2007, p.9949; Brovkin, Petoukhov, Claussen, Bauer, Archer, & Jaeger 2009, p.255).

7 Caldeira and Wood (2008) and Virgoe (2009) also discuss the second and third point.

8 Arguments against geoengineering usually involve references to e.g. quick and ecologically unsustainable techno-fixes and side effects, unreasonable human hubris over positive outcomes of meddling with nature, ill-tested proposals and unsolved issues of geoengineering governance and social and intergenerational justice.

9 For the sake of the argument let us assume that there are no morally excellent or good options available.