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CLIMATE CHANGE AND ETHICS OF GEOENGINEERING — IMPLICATIONS OF CLIMATE EMERGENCY ETHICS

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ABSTRACT

Global climate change and intentional climate modification, i.e. geoengineering include various ethical problems which are entangled as a complex ensemble of questions regarding the future of the biosphere. The possibilities of catastrophic effects of climate change which are also called "climate emergency" have led to the emergence of the idea of modifying the atmospheric conditions in the form of geoengineering. The novel issue of weather ethics is a subdivision of climate ethics, and it is interested in ethical and political questions surrounding weather and climate control and modification in a restricted spatio-temporal scale. The objective of geoengineering is to counterbalance the adverse effects of climate change and its diverse corollaries in various ways on a large scale. The claim of this dissertation is that there are ethical justifications to claim that currently large-scale interventions to the climate system are ethically questionable.

The justification to pursue geoengineering on the basis of considering its pros and cons, is inadequate. Moral judgement can still be elaborated in cases where decisions have to be made urgently and the selection of desirable choices is severely limited. The changes needed to avoid severe negative impacts of climate change requires commitment to mitigation as well as social changes because technical solutions cannot address the issue of climate change altogether. The quantitative emphasis of consumerism should shift to qualitative focus on the aspiration for simplicity in order to a move towards the objective of the continuation of the existence of humankind and a flourishing, vital biosphere.

Keywords:

Applied ethics, climate ethics, weather ethics, geoengineering, climate emergency, biocentrism, principlism

TIIVISTELMÄ

Globaali ilmastonmuutos ja ilmastonmuokkaus sisältävät useita eettisiä ongelmia, jotka kietoutuvat monimutkaiseksi kysymysten sarjaksi koskien koko biosfäärin tulevaisuutta. Ilmastonmuutoksen aiheuttamia mahdollisia katastrofaalisia seurauksia kutsutaan myös ilmastohätätilaksi. Ajatus ilmastonmuokkauksesta on syntynyt tämän mahdollisen hätätilan myötävaikutuksesta. Soveltavan etiikan uusi alue, sääetiikka, on ilmastoetiikan osa-alue, joka on kiinnostunut ajallisesti ja paikallisesti rajatuista sään- ja ilmastonmuokkaukseen liittyvistä eettisistä ja poliittisista kysymyksistä. Ilmastonmuokkauksen tavoitteena on tasapainottaa eri tavoin suuressa mittakaavassa ilmastonmuutoksen haitallisia vaikutuksia. Tämän väitöskirjan keskeisin väite on, että on olemassa eettisiä perusteita, joiden mukaan tällä hetkellä laajamittaisesti toteutettu tai suunniteltu ilmastojärjestelmän muokkaaminen on eettisesti kyseenalaista.

Ilmastonmuokkauksen oikeutusta ei voida puolustaa vain arvioimalla sen hyötyjä ja haittoja. Sellaisissakin tilanteissa, joissa moraalinen päätöksenteko on tehtävä välittömästi ja toivottujen valintojen valikoima on äärimmäisen rajallinen, on kuitenkin mahdollista tehdä päteviä moraalipäätelmiä. Ilmastonmuutoksen haitallisten vaikutusten välttämiseen tarvittavat muutokset edellyttävät kuitenkin sitoutumista kasvihuonekaasujen hillinnän lisäksi myös sosiaalisiin muutoksiin, sillä pelkät tekniset ratkaisut eivät pysty käsittelemään ilmastonmuutoksen haasteita. Kulutusmyönteisyyden ja -keskeisyyden sijaan tulisi tavoitella laadullisesti arvokkaampia asioita, kuten esimerkiksi pyrkimystä yksinkertaisempaan elämäntapaan. Tämän pyrkimyksen tavoitteena on ihmiskunnan olemassaolon jatkuminen, mikä sisältyy elinvoimaisen ja kukoistavan biosfäärin elämään.

Asiasanat:

Soveltava etiikka, ilmastonmuutos, ilmastonmuokkaus, ilmastoetiikka, sääetiikka, hätätilan etiikka, biosentrismi, prinsiplismi

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In 2008, having a cup of tea with my advisor Markku Oksanen, we discussed the research of climate ethics and I had a rudimentary plan of my dissertation regarding the subject. Markku mentioned a documentary he had seen about weather modification and we talked about what a peculiar research topic of applied ethics that would be — like doing research on some sort of science fiction enterprise. At that time, the amount of publications regarding ethics of weather and climate modification was quite low, and now looking backwards, they seem to have multiplied in just a few years. After the launch of "The Ethics of Global Warming" project funded by the Nessling Foundation in 2008, it soon became quite obvious that the schemes of weather and climate modification to tackle climate change were so closely related to my research project of climate and emergency ethics that they became the central issue of this dissertation.

I want to thank my advisor Markku Oksanen for his tireless and supportive guidance during these years. Markku wanted me to "kill my darlings," in other words to let go of my preconceptions and unfruitful jargon in philosophical writing, and engage in scientific research with an open mind. His advice worked out so well I ended up questioning just about everything. A big thank you also goes to all of the staff at the philosophy unit I had the honour to work with in a peaceful atmosphere: my other advisor Eerik Lagerspetz, Hanna-Mari Salonen for her relentless assistance on practical challenges, Juha Räikkä for his words of encouragement since day one, and all the other fellow philosophers and co-workers, including Timo Vuorisalo from the Department of Biology /Environmental Sciences. The support from my loved ones has also been irreplaceable and I am grateful for that. This dissertation is dedicated to my two wonderful sons who have given me more joy and wisdom than one can ever imagine and have taught me the true meaning of perseverance.

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c) Joronen, Sanna, Oksanen, Markku and Vuorisalo, Timo. “Towards Weather Ethics: From Chance to Choice with Weather Modification.” *Ethics, Policy & Environment* 14, no. 1 (2011): 55–67.

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ABBREVIATIONS

ACC Anthropogenic climate change

AMS American Meteorological Society

BAU Business as usual variation of the moral hazard problem

BECCS Bioenergy with carbon capture and storage

C&C Contraction and convergence

CCS Carbon capture and storage

CDR Carbon dioxide removal

CFT Counterfactual trajectory variation of the moral hazard problem

CO_2 Carbon dioxide

DAI Dangerous anthropogenic interference with the climate system

ELSD Erring on the least side of drama

ENMOD United Nations convention on the prohibition of military or any other hostile use of environmental modification techniques

ESR Emergency scenario rhetoric

GHG Greenhouse gas

ICC Intentional climate change

ICCP International Commission on Clouds and Precipitation

IPCC Intergovernmental Panel on Climate Change

NGO Non-governmental organization

NOAA National Oceanic and Atmospheric Administration: United States Department of Commerce

PB Perverse behaviours variation of the moral hazard problem

PPP Polluter pays principle

SSI Stratospheric sulphate injection

SRM Solar radiation management

UNFCCC United Nations Framework Convention on Climate Change

WAIS West Antarctic Ice Sheet

WMA Weather Modification Association

WMO World Meteorological Organization

WRE Wide reflective equilibrium

INTRODUCTION

> "Technicism reflects a fundamental attitude which seeks to control reality, to resolve all problems with the use of scientific-technological methods and tools. Technicism entails the pretence of human autonomy to control the whole of reality. Human mastery seeks victory over the future. Humans are to have everything their way." (Schurmann 1997, 38.)

Schurmann (1997), a philosopher of technology, characterizes the attitude of pervasive human control of the natural world as technicism. This dissertation presents one representative example of such an endeavour of comprehensive control: intentional climate modification, also known as geoengineering or climate engineering, and its ethical implications. The objective of geoengineering is to counterbalance the adverse effects of anthropogenic climate change (ACC) and its diverse corollaries in various ways which will be further elaborated in this study.

Ubiquitous human impact on Earth system processes has given rise to discussion concerning a new geological epoch, the anthropocene (Crutzen and Stoermer 2000). Since the late 18th century, anthropogenic greenhouse gases (GHG) have accumulated in the atmosphere causing noticeable and global changes in the long run. The anthropocene and guiding of the societies towards environmental sustainability might require efforts to optimise the climate, for instance, via geoengineering. Nevertheless, in 2002, when Crutzen suggested this potential optimisation of the climate he also mentioned that these plans are "largely treading on terra incognita." In this dissertation, I claim that the geoengineering research, including the scientific and ethical domains of weather and climate modification, is still terra incognita on a scale that gives no rise to proclaim geoengineering as a credible solution to the challenge of ACC.

At the end of the 19th century, the Swedish chemist Svante Arrhenius linked GHGs[1] to the greenhouse effect, and speculated about the connection between GHGs and climate variations in the long term (Arrhenius 1896). Nevertheless, the ethical problem is not the existence of the greenhouse effect in itself. The ethical issues are related to increasing levels of GHGs due to inadvertent human action, the interconnectedness of GHGs, and ACC as well as the negative effects on climatic conditions. Although various environmental problems have existed prior to awareness of ACC and have caused adverse effects—for instance, deficiency of adequate nutrition, lack of availability of clean drinking water, pollution, and damage to the flourishing of biosphere—there are three relevant factors distinguishing ACC from historically preceding environmental problems.

First of the reasons why ACC differs from previous environmental problems is the complexity of it. ACC makes the identification of causality difficult, and leaves the characterization of its effects open to uncertainty and dispute. This increases the uncertainty of reliable policy-making, and reduces the chances of choosing an adequate direction of action between different climate policy options. The problem is that by the time the uncertainties are reduced to a degree of certainty, the adverse effects of ACC could have already become obvious and irrecoverable. Secondly, issues of moral obligations and responsibilities are open to various interpretations and require normative clarification. Those most vulnerable to the effects of ACC can be those that pollute the least or those who have not even been born yet. This raises ethical issues regarding, for instance, intergenerational justice. Thirdly, obligations regarding the environment and collective action as a challenge also differentiate ACC from historically preceding environmental problems. Despite the fact that individual actions might not be harmful to the environment—in other words, living organisms produce GHGs and that function is not an ethical problem in itself—however, all actions combined together contribute to the detrimental effects of ACC. (Hood 2007, 674–675.)

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[1] Greenhouse gases, most commonly known as GHGs, include for instance carbon dioxide, water vapour, ozone, methane, and nitrous oxide. In this dissertation the focal point is on anthropogenic carbon dioxide emissions originating mostly from the burning of fossil fuels. This strategy is widely shared, for instance by the IPCC (2007a).

In addition, ACC is *non-evident* and apparent at the same time. The non-evident nature of ACC refers to the fact that the changes caused by ACC are not necessarily directly apparent to the human senses. Although science can identify the changes in climatic conditions and connects them with rising atmospheric concentrations of GHGs predicting detrimental long term consequences for the biosphere, the global effects of ACC or a potential climate emergency have not received such worldwide attention. This is partly due to the non-evident nature of ACC. The Sun still rises every day, and bad weather comes and goes without triggering a sense of danger in the daily routines of humans—at least not in a substantial way that would significantly change the actions of individuals and communities towards an environmentally sustainable and low-carbon direction.[2] An emergency that is not clearly noticeable in daily life does not raise concerns as much as a clear and present climate emergency would. Like Al Gore in the Guggenheim documentary *Inconvenient Truth* (2006) demonstrates, the truth in the case of ACC certainly is inconvenient although it is not evident in human behaviour all the time. These characteristics make it even more relevant to clarify the ethical challenges regarding ACC.

The increasing amount of publications regarding climate ethics discusses, for instance, classic issues of distributive and intergenerational justice, the nature of harm, and moral obligations to rectify harmful effects of ACC (see Arnold 2011; Caney 2005, 2011; Gardiner et al. 2010; Gardiner and Hartzell-Nichols 2012; Harris 2010; Shue 1999). These issues are most certainly of great importance, not only because of the international policy-making concerning ACC, but also because the scientific results emphasizing the importance of addressing the climate challenge in the near-term future are inconsistent with each other. The results of international negotiations concerning mitigation and adaptation have not been reassuring enough to conclude the challenge of ACC as even close to a solved one (Shue 2011). In addition to various detrimental climatic conditions, the number of climate

[2] Shue criticizes the lack of urgency in an effective outcome of the mitigation negotiations. The failure of effective abatement is a violation of basic rights of humans including the rights of the humans of future generations. (Shue 2011, 292–293.) This is an instance of the non-evident nature of the danger of ACC where the rising concentrations of GHGs do not affect the actions of individuals and communities in a large scale despite the need for it.

refugees due to ACC has been estimated to grow. However, there is no definite consensus on the estimates of the number of people displaced by ACC, neither currently nor in the future. (Black et al. 2011; Gemenne 2011). An environmental refugee due to deteriorating environmental conditions, for example ACC, is a person forced to leave their habitat because it fails to provide adequate and decent conditions for living[3].

The most well-known instance of a nation declaring to execute a plan to relocate environmental refugees is Tuvalu in the Pacific Ocean (World Disaster Report 2002, 84). A similar need to relocate in order to survive faces also some non-human species which are unable to adapt to the modifications of their environment (Attfield 2009, 230). This has resulted in discussion about assisted migration[4] (e.g. Minteer and Collins 2010; Albrecht et al. 2013). The options in the case of changes of the habitat are to adapt, relocate, or perish, for all living entities in the biosphere. This state of affairs, as well as the questions of burden-sharing between winners and losers, requires ethical reflection of the morally right and fair actions. Attfield (2009, 226) proposes a reappraisal of the scope and content of ethics in a way that takes into consideration various foreseeable impacts of human activities and policies, including non-intervention and inaction with regard to ACC. In the light of current ACC and climate emergency it is appropriate to look into the possibilities of ethics to answer the challenge of ACC and climate emergency.

The scary possibilities of catastrophic effects of ACC which are also called "climate emergency" have led to the emergence of the idea of fixing the climate in the form of geoengineering (Caldeira and Keith 2010; Crutzen 2006; Heyward and Rayner 2013; Lenton 2013; Long et al. 2013; Shepherd et al.

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3 The Geneva Convention and UNHCR (2007) have not recognized the status of environmental refugees. Conisbee and Simms (2003) suggest that environmental refugees should be acknowledged in the international community by the extension of the"polluter pays principle" (PPP): the ones fleeing from their homes should be compensated by those who are responsible for causing ACC, mainly the industrialized states. Neuteleers (2011) points out that the issue is a much more complex one than it seems at first glance, and considers the environmental refugees as belonging to the category of deterioration refugees.

4 The similar concepts with assisted migration referring to the translocation of plant and animal species to novel ecosystems are managed relocation and assisted colonization (Minteer and Collins 2010).

2009). Intentional climate modification refers to human aspirations to control climate and stabilize the physical conditions on the planet to a desired state. According to a broad definition, geoengineering is "the deliberate large-scale intervention in the Earth's climate system, in order to moderate global warming" (Shepherd et al. 2009, ix).[5] One of the essential features of geoengineering is intentionality, the explicitly stated aim to counterbalance the effects of cumulative GHG emissions. Without a deliberate objective to counteract ACC, weather and climate modification schemes do not classify as geoengineering. Some of the proposals to tackle ACC do not classify as geoengineering either due to their non-intentionality or their limited scope. Such are, for instance, the development of low-carbon sources of energy, carbon capture and storage (CCS) at the locus of the emissions, conventional afforestation as well as avoided deforestation. (Shepherd et al. 2009, 1, 6.)

As the advocates see it, geoengineering is the best solution available for averting the drastic consequences that ACC is expected to bring about because of failed mitigation efforts (see Keith et al. 2010, 426; Victor et al. 2009). Nevertheless, the hubris of controlling the climate is not as equivocal as it may seem. There are reasons to consider geoengineering as a plan B—justified or unjustified—(Goodell 2010; Inman 2010; Kintisch 2010b, 16), last resort (Crutzen 2006), lesser evil (Gardiner 2010b; 2010c) or even something out of the question and unthinkable (ETC Group 2010; Gardiner 2010c, 299; Hamilton 2014; Preston 2011) when considering the nature of geoengineering and the proposals to tackle ACC.

The ethical aspects of climate engineering—which are the main subject of this dissertation—also require thorough reflection. These technologies have been claimed to solve problems with regard to ACC by removing excessive GHGs from the atmosphere in order to avoid crossing certain thresholds considered to be dangerous to humans and the overall flourishing of the biosphere. Hence, one option is to remove carbon from the atmosphere and store it in a safe location. Another option of

[5] Geoengineering should not be confused with ecological engineering, the intentional large scale manipulation of the ecosystems, although they can in some cases overlap each other (Boucher, Gruber and Blackstock 2011, 2).

geoengineering technology is to alter the amount of incoming solar radiation in a way that diminishes the rising of the average temperature of the Earth. Tempting ideas to use in order to tackle the negative effects of ACC are not, however, ethically unequivocal due to their different implementation methods, detrimental and unevenly distributed secondary effects, risks, issues of fairness and control as well as the questionable nature of the technology itself. In 2009, the prestigious Royal Society published a report called *Geoengineering the Climate* where it was clearly stated that the greatest challenges concerning geoengineering are neither scientific nor technical, but "social, ethical, legal and political issues associated with governance" (Shepherd et al. 2009, xi).

The novel issue of weather ethics is also explored in this dissertation. Weather and climate ethics both come under the section of applied ethics. Weather ethics is a subdivision of climate ethics, and it is interested in ethical and political questions surrounding weather and climate control and modification in a restricted spatio-temporal scale. The scope of climate ethics is broader than in weather ethics because it includes ethical issues surrounding large-scale and global climatic conditions. However, these domains intertwine because both weather and climate modification can be seen as one possible solution to defeating environmental problems caused by ACC, and they include the idea of intentional modification of atmospheric processes. Weather modification or, more precisely, the desire to modify the weather is a phenomenon older than geoengineering and it was not originally linked to ACC. The original objective of weather modification was initially to enhance the local conditions burdened by harsh weather conditions. Yet, both weather and climate modification contain various risks, issues of fairness, and possible adverse outcomes, and hence need to be assessed also from the ethical viewpoint.

The ethical issues regarding geoengineering, weather modification, and climate emergency establish the central research questions of this study:

1) Do the arguments presented for and against geoengineering have ethically justified policy relevance?

2) What kind of a situation in an ethical sense can be called a climate emergency, if any— and can climate emergency even be defined and recognized?
3) Are the arguments regarding geoengineering ethically applicable also or even in an emergency?
4) Are there ethical grounds to suggest that geoengineering is a justified method to counteract inadvertent effects of ACC also and even in an emergency?

This dissertation has been written from the viewpoint of biocentric principlism. A biocentric theory of environmental ethics embraces the inherent worth of all life on Earth and challenges the position of humans as morally superior beings compared to non-humans. The history of biocentric thinking in western philosophy began with the development of environmental ethics in the 1970s, when discussions regarding the value of nature and the moral considerability of living entities took off. The first environmental ethicists were mainly concentrated on the rejection of the anthropocentric notion of the value of nature, living entities, or species (see Naess 1973; Routley 1973; Singer 1973).[6]

Biocentric principlism is based on a life-centered theory of attitude of respect for nature by Paul Taylor (1981; 1986). All living entities have inherent worth and are ends in themselves without reference to their usefulness, interests, sentience, or any capabilities. Taylor's (1981, 197–201) biocentric theory includes the following aspects: first of all, every entity has a good of its own—or in other words well-being or welfare—that can be either benefited or harmed. The good of a being hence preserves its well-being. For instance, the good of an organism is realized in its capabilities in maintaining its flourishing existence throughout various stages of life specific for that certain species which the organism represents. An entity having a good of its own is dependent neither on being sentient nor being aware of its interests or the capability to comprehend whether it has interests at all.

[6] The early discussions of environmental ethics did not only involve the debate between non-anthropocentrism and anthropocentrism. Also the dichotomy between holism (Rolston III 1975) and individualism (Regan 1983; Taylor 1986) as well as between pluralism (Brennan 1992) and monism (Callicott 1999) were addressed.

The biocentric theory of respect for nature includes the recognition that moral considerability is embedded in inherent worth of biotic entities and implies that all living beings are members of "Earth's community of life."[7] They deserve to be taken morally into consideration by moral agents in actions or omissions that affect the entities in question. In addition, inherent worth contains a notion of intrinsic value. Every entity should thus be treated as an end in itself and not be considered as if its value is dependent on its instrumental use or utility. (Taylor 1981, 197–201.) As mentioned before, humans as well as other living entities constitute a community of life which is a complex totality of interconnected elements. This biocentric outlook on nature resembles the Gaia theory developed by James Lovelock (2008) where the Earth is accounted a self-regulating system, Gaia.[8] Each of the elements in this totality, the biosphere, pursue their own good and have their own goals; Taylor (1981, 210) refers to them as "teleological centers of life." The biocentric denial of human superiority over other living entities follows from these previous conceptions.

Biocentrism is criticized for not being able to solve conflicting interests between living entities (if a situation occurs that includes conflicting basic interests). This is accurate on one hand: if all living entities are considered as equal, it places a difficult choice on humans in situations with conflicting interests. On the other hand, if the equality of entities is not presumed, the theory fails to be a biocentric theory and is inevitably anthropocentric. (Sterba 1995, 204.) Nevertheless, the biocentric outlook does not entail that animals and plants have moral rights. The problem with the notion of equal inherent worth concerns competing claims. (Taylor 1981, 216.) For instance, a strict biocentric theory would require a person to choose between the life of a bee and the life of a human: the interest of a bee is to maintain its existence and a human being also has an interest to survive. In a situation where a bee is about to sting a human who is lethally allergic to a bee sting, a choice has to be made

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7 The phrase "Earth's community of life" is a direct citation from Taylor himself and refers to all living beings as equal members of the biosphere. Equal inherent worth does not, however, include equal treatment between entities. (Taylor 1981, 201.)

8 The difference between the Gaia theory by Lovelock and the biocentric outlook of Taylor is that Lovelock emphasizes the Earth as an organism whereas Taylor is more oriented towards underlining the inherent worth of individual entities in a community of life.

between harming, and possibly killing, the bee or allowing the human to be lethally stung. As mentioned, this interpretation of biocentric theory is too demanding to actually be a normative theory of environmental ethics.

However, Taylor claims that biocentric value theory does not entail that humans would have to sacrifice themselves at any cost to promote the good of non-human entities (Taylor 1983, 243). The suggestion for a solution to this contradiction is in the interpretation of inherent worth and equality. Even if all entities are considered as possessing inherent worth, they can still be treated differently despite the attitude of respect for nature.[9] (Sterba 1995, 194.) Humans have a moral obligation not to harm non-humans or avoid harming them as well as promoting their own good whenever possible without excessive sacrifice (Taylor 1981, 197–198).[10]

The biocentrist theory does not have to be committed on a monist theory of value (Brennan 1992; Sterba 1995). Pluralistic theories of environmental ethics can be based on various adequate background theories and values without the need to necessarily declare one value or theory as superior to the others or universally applicable. Hence, the theoretical outlook of this dissertation regarding theory of value is pluralistic and defends the applicability of principlism in environmental ethics. The biocentric outlook in this dissertation assigns moral considerability to humans as well as non-humans, and forms a plausible theory of environmental ethics which accepts the attitude of respect for nature and takes living beings into consideration in the world of ACC. There can be several different foundations of adequate moral theories. This is one of the important notions with regard to democratic policy-making and its politically pluralist basis. In addition, biocentric outlook on nature does not have to be accepted

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9 Sterba (1995, 204) makes a comparison between liberal and libertarian views on human equality and species equality. In short, welfare liberalism grants every human equal rights to welfare and libertarianism an equal right to liberty. These views allow different treatment of humans despite the acknowledgement of equal value. The equality of humans and non-humans can be comprehended in a similar manner.

10 The account of prima facie moral obligations of humans that are owed to non-human entities can be explored in full detail in Taylor (1986).

in order to extend moral consideration also to non-human entities.[11] Democratic and fair policy-making in order to boost mitigation and prevent a climate emergency does not have to be based on a biocentric theory of value of nature. It is sufficient from a pragmatic point of view that the imminence of urgency is acknowledged and actions are taken to prevent detrimental effects of ACC.

Granted that the living entities of the biosphere have inherent worth, the biocentric theory of environmental ethics does not have to get involved with the problems of value realism. The locus of inherent worth is living beings, however, the source of the value is initially based on a valuation of a moral agent. Thus, a biocentric value theory can be agent-based and does not consider the inherent value of nature and living entities existing independently from a moral agent. Taylor recognizes the source of the value of non-human entities by stating: "We must keep in mind that inherent worth is not some mysterious sort of objective property belonging to living things that can be discovered by empirical observation or scientific investigation." (Taylor 1981, 204.) The moral principle of value argues that intrinsic values have moral significance if and only if they are based on the valuing of a moral agent. The assignment of value judgement of the valuing agent and the object of value do not even have to exist at the same time. (Pietarinen 2000, 45, 51–53.) Hence, the inherent worth of all living entities granted by a moral agent implies that all these living beings should be taken into account in the assessment of the morally right actions also in the world of ACC, geoengineering and climate emergency.

Along with biocentrism, principlism also plays a role in this dissertation as a background theory. Climate emergency and the mere possibility of encountering a dire global situation leaves an ethicist thinking about what kind of moral theory, rules or guidelines could be applied even in the most

[11] For instance, environmental pragmatism (Light 2002, 445), weak anthropocentric value theory (Hargrove 1992), and convergence hypothesis (Norton 1997) are all examples of theories of environmental ethics which are not biocentric and do not consider non-human entities either completely lacking of intrinsic value or merely as an instrument of utility. Like biocentrist theories, they can also function as a background theory to warrant policies of environmental protection (see Light 2002, 436, 445).

stringent situation. It is easier to think about applying normative ethical theories to everyday situations and have an example of Jane and John Doe deciding which is the morally optimal choice between having an organic vegetarian lunch or one made out of veal grown in a factory farm. Principlism offers a suitable set of mid-level principles[12] which can be applied even in an emergency. Paul Taylor's non-interventionist biocentric thinking adds its own contribution to the analysis of principlist emergency ethics as well as the ethics of ACC and geoengineering. Pluralist biocentric principlism offers normative guidance for complex moral judgement in cases where decisions have to be made urgently and the selection of desirable choices is severely limited.

The debate with regard to the methods of bioethics is relevant to discussions about emergency situations. Bioethicists have analysed the role of principles in both decision-making and guiding action. *Principles of Biomedical Ethics* by Beauchamp and Childress (1977) has become the paradigm example of the principlist approach. According to principlism, a set of prima facie principles give guidance in choosing a morally right course of action. These are autonomy, beneficence, non-maleficence, and justice. These principles are widely recognized and can be implemented in moral decision-making without the commitment to one specific moral theory. Considering geoengineering and ACC, autonomy is more complex a principle than referring only to humans. It can be interpreted as an empowering principle for humans to be able to participate in the decision-making regarding the future of the Earth and the means to tackle ACC. In addition, the Earth can be comprehended as an entity which has its own autonomy, metaphorically. Does the patient Earth wish to be treated with geoengineering when feeling feverish?

Principles of beneficence and non-maleficence can be applied to the case of geoengineering and ACC. The prohibition to cause harm can be extended to non-human entities in a similar way than in the biocentric theory. The moral considerability of non-humans can emerge in various policies of

[12] Mid-level principles are not ultimate principles. However, they can be coherent, useful and accepted by different theories as a part of a normative theory.

environmental protection as restrictions for detrimental exploitation of nature. Beneficence encourages to benefit the good of living entities: helping, rescuing, defending, and restoring as well as balancing between benefits and harms. This principle is similar to the biocentric notion of moral obligation of humans towards other living entities. They are not to be harmed, and their well-being should be promoted on the basis of inherent worth of living entities. The principle of justice involves the aspects of fair and equal treatment between humans as well as between humans and other living entities.[13] Furthermore, environmental restoration can be considered to follow from the principle of justice to compensate for losses and damages.

These prima facie principles are fundamental moral intuitions—not strict normative theories—so that they can be reflected and tested in moral analysis of actual cases. Together with these principles, ethical decision-making consists of confirmed facts and widely accepted background theories. Together these principles, facts, and theories constitute an ethical decision-making method known as the wide reflective equilibrium (WRE) (Daniels 1979; Rawls 1974–1975). The moral decisions in actual situations are made by taking principles into account with an aspiration to achieve a coherence of principles, observable empirical facts, and background theories. This objective also applies to policy-makers in the collective decision-making regarding ACC. An impending climate emergency provides a challenge for decision-makers who can utilize the interconnections between relevant prima facie principles, background theories, and up-to-date climate science in making appropriate judgements.

The research material for this dissertation is multidisciplinary due to the complexity of the issue of ethics of ACC. Scientific research material from academic journals, edited books, and reports have been essential to exploring the current information on ACC and geoengineering. Besides natural scientific studies of ACC, research material from philosophy—especially applied ethics—as well as social sciences has been relevant for analysing the socio-political and ethical aspects of ACC and

[13] As mentioned in the context of criticism of biocentrism, moral considerability and equal inherent worth does not imply that humans should sacrifice themselves due to the promotion of the lives of non-humans.

geoengineering.

This dissertation consists of four main chapters which discuss different aspects of ethics of ACC and geoengineering. In the first chapter, the basic themes of ethics of ACC are explicated and the ethical nature of the connection between geoengineering and ACC is given closer scrutiny. Moreover, the concept of climate scepticism is also analysed. In the second chapter, a novel topic in applied ethics, intentional weather and climate modification, is studied and its ethical problems are depicted. Also, the prominent arguments for and against geoengineering are represented. The third chapter concentrates on the concept of climate emergency and emergency ethics. There seems to be a polarity between the manner of speaking about the imminent climate emergency. To some, it deters and works as a disincentive. To others, it empowers and encourages to act on mitigation and environmental protection. In the fourth chapter, the politics of geoengineering, and the administrative challenges of ACC and geoengineering are discussed. If the global community has failed in mitigation efforts, as well as in solving other environmental challenges in the past, what could make one believe that the governance and implementation of massive geoengineering implementations would work this time in a situation spiced by haste and uncertainties? The issues of the illusion of planetary control and the attractiveness of technical fixes as the lesser evil are also examined. To summarise, this dissertation has two objectives. First, to introduce a novel topic of applied ethics, weather ethics, and analyse it with ethics of geoengineering and ethics of emergency. This triumvirate has not undergone intense ethical scrutiny enough. Second, to argue that the justification to pursue geoengineering on the basis of considering its pros and cons, is inadequate. The ethical analysis of complex issues of different geoengineering technologies has to be analysed individually and take into consideration for instance viewpoints of fairness, intergenerational justice, risks, the delusion of planetary control, and governance.

1. ETHICAL ASPECTS OF CLIMATE CHANGE AND GEOENGINEERING

By labelling climate change as a problem, one refers to unintended, but nevertheless anthropogenic, effects on the atmosphere caused by GHG emissions. The effects of the constantly growing anthropogenic GHG emissions[14] are mostly negative: for instance, the rise of global mean temperature and polar temperatures, the diminishment and melting of icebergs, icecaps, glaciers and permafrost, changes in ocean currents, wind patterns and precipitation, acidification of the oceans, heat waves, droughts, loss of biodiversity as well as the overall increasing frequency and intensity of extreme weather events (see Houghton 2009, IPCC 2013, Shepherd et al. 2009). In addition, regardless of the source of the GHGs, the whole atmosphere is affected, hence generating a global problem (Grubb 1995, 465). In this first chapter, the central ethical challenges of climate change are brought forward.

1.1. Climate change as an ethical issue

ACC is often regarded as a topic of natural sciences with constantly growing research and publications that focus on the phenomenon and its effects. Moreover, it is often considered as an economic issue due to the consequences which can be calculated in monetary terms, and deciding whether it is cost effective to react to the challenge[15] (e.g. Stern 2007, Nordhaus 2007, DARA 2012, 43). However, ACC and its research as well as policy-making should involve ethics as a part of normative considerations when choosing from various options of action.

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[14] The GHG emissions have been growing constantly in a global scale despite the claims for a need for massive mitigation efforts. One of these advocates is the global grassroots movement 350.org, which was founded by author and environmental activist Bill McKibben. The carbon dioxide levels measured by the National Oceanic and Atmospheric Administration NOAA (2013) reached a highest record in May 2013 reaching 400 ppm for the first time in recorded human history. The 350.org (2008) pushes intensive mitigation as an objective to reach climate safety by reducing atmospheric concentrations to below 350 ppm.

[15] There is a vast literature on economics of ACC. The academic journal Climatic Change dedicated an issue in 2008 to the Stern review and the discussions continue also in the post-Rio20+ world (see e.g. Spash 2012).

The ethics of ACC is in one sense essentially about the issues of distributive justice transcending spatial and temporal boundaries involving issues of justice between rich and poor, winners and losers as well as between present humans and future humans (Shue 2001, 449; Caney 2009). Freedom of choice of actions creates an atmosphere of responsibility (Gardiner 2011a, 20). With regard to the responsibility of chosen actions, the whole biosphere and future generations should also be taken into account. Hence, the choices in the world of 400 ppm and beyond should include ethical considerations on how to take into account all the relevant stakeholders—regardless of whether they are human or non-human. The disparity between richer and poorer countries is the ability to adapt as well as the responsibility for the past emissions. In this way, ACC reveals inequalities in global causes and consequences that are policy relevant (Stern 2007, 29). Despite the importance of economic analyses, ethics has a role to play in considerations of alternative actions in tackling ACC due to the importance of, for example, issues of intergenerational equity and justice (Barker 2008, 176).

There are several viewpoints which affirm the notion that the challenge of ACC also has other ethical dimensions. In the fifth assessment report of the United Nations Intergovernmental Panel on Climate Change (IPCC), the ethics of ACC is considered widely for the first time (IPCC 2013c). Previously in its third assessment in 2001, the IPCC recognizes the ethical nature of climate change as follows:

> Natural, technical, and social sciences can provide essential information and evidence needed for decisions on what constitutes "dangerous anthropogenic interference with the climate system." At the same time, such decisions are value judgments determined through socio-political processes, taking into account considerations such as development, equity, and sustainability, as well as uncertainties and risk." (IPCC 2001, 2.)

The discussions regarding the limits of dangerous anthropogenic interference with the climate system (DAI) will be further elaborated in the third chapter. The rising GHGs result from the anthropogenic

emissions mainly from the use of technology and maintenance of the infrastructure of the industrialised countries based on the use of fossil fuels. The overall GHG emissions are constituted mainly of fossil fuel use, agriculture, waste and energy, deforestation, decay, and peat. These include transportation, nutrition, and housing as well as everyday life of humans. (IPCC 2007a, 36.) The assessment of normative guidelines of the adequate and fair level of GHG emissions is a complicated task with multiple aspects which have to be taken into account. One possible approach by Henry Shue will be presented in chapter 1.1.1.

ACC inflicts harm on humans in two fundamental ways: first, the atmospheric concentration of GHGs poses a question of moral responsibility on the behalf of the emitting party. In the long-term, the effects of ACC do not necessarily affect those who have contributed the most to the high atmospheric concentrations of GHGs. Those emissions change the composition of the atmosphere in a way that has severe and detrimental effects on certain areas of the globe. Shue poses a question that if a smoker can be responsible for the cancer of his non-smoking children, why cannot the same responsibility apply to the negative corollaries of ACC. The second harm inflicted by ACC concerns a less evident loss. The effects of ACC can prevent people from obtaining resources vital for their survival. In this way, the absorptive capacity of the atmosphere can be seen as a vital resource. This kind of necessity to produce GHG emissions is not only an ethical problem, but also an issue of scarce resources because of ACC. (Shue 2001, 449–450.) ACC addresses ethical issues regarding access to scarce resources, namely the absorptive capacity of the atmosphere without changing the climatic conditions for the worse (Singer 2006). It is important to acknowledge that not only do the negative effects of ACC inflict harm on humans, but also non-humans, and the biodiversity is experiencing dire alterations. (Singer 2002, 19).

The predictions of a climate emergency create ethical challenges, too. As stated earlier, the decisions guiding human action need ethical reflection. The considerations on whether the negative effects of

ACC can be regarded as a climate emergency need clarification. A climate emergency could, for instance, emerge as massive crop failures or a collapse of large ice sheets in Greenland (Caldeira and Keith 2010). A declaration of being in a climate emergency might require different action compared to discussions of distant and perhaps even not detrimental effects of ACC. Natural variations in the natural world and atmospheric processes have occurred before present ACC, and the emergency it might generate. However, the existence of ACC is an ethical problem because it has emerged from human action and thus being subject to normative evaluations.

1.1.1. Mitigation and ethics

Natural variations in the climate system have occurred long before humans—in a form that we know of—have existed. However, the current rising GHG emissions are based on anthropogenic emissions mainly from the use of fossil fuels, and at the moment they are necessary in one way or another to humans. The philosopher Henry Shue (1993) has divided the GHG emissions into two categories depending on the indispensability of the GHG emissions. Emissions that are irreplaceable for human well-being are subsistence emissions. Luxury emissions, on the other hand, are the ones that can and should be abated in order to curb global overall GHG emissions, and it can be done without jeopardizing the basic well-being of humans, since those emissions are not necessary or vital. Hence, luxury emissions are the priority target of mitigation. (Shue 1993.)

Nevertheless, there are vast differences in the emission levels of GHGs both on the individual and the national levels. These differences complicate the classification of emissions as to which category they should belong to. The subsistence emissions of the stakeholders might quantitatively differ greatly from each other. In addition, it is complicated to separate emissions into these two categories on the basis that there is no clear unanimity of what is included in subsistence emissions in the first place. How

many pairs of shoes is a person entitled to have in order to live a good life without generating extravagant luxury emissions?[16] Even if this categorization does not elaborately define how the distinction between luxury and subsistence emissions should be made, the categorization does have an important aspect to it. There are types of emissions with regard to consumption, nutrition, housing, and lifestyle that could be mitigated with new innovations and decreasing excessive consumption without reducing the quality of human life itself.

Tim Hayward has contested the viewpoint of subsistence emissions with the concept of ecological space. Emission rights to pollute and produce GHG emissions cannot be considered as human rights. The human right to ecological space refers to a fundamental right to adequate environment that supports human well-being and health. Ecologically sustainable environmental services and natural resources that are available for humans constitute the framework of ecological space. The right to produce GHGs can be seen as a necessary and contingent feature of the current economic system, hence it cannot be considered as an inalienable human right as Shue suggests. (Hayward 2007, 439–440, 445.)

The current societies are carbon-dependent in a way that it makes it justifiable to discuss the necessity of producing GHGs. The concept of ecological space makes room for considerations of global justice and how to provide decent living conditions for humans without exceeding the carrying capacity of the globe. These discussions are of great importance due to research that indicates risk factors in global sustainability. The Swedish environmental scientist Johan Rockström together with his collaborators has specified planetary boundaries within which it is possible to operate without a great risk of abrupt and detrimental environmental changes (Rockström et al 2009). In addition to ACC, there are eight other planetary boundaries that are discussed in chapter 2.3.1. Certainly, this does not diminish the

[16] For instance, a person living in Northern Europe with its four seasons and temperatures ranging from at least -25°C to +25°Creally needs to have appropriate shoes and accessories for different seasons to be on the move all year round. Consumption of accessories adequate to the weather conditions can be considered to produce subsistence emissions.

importance of mitigation and adaptation to ACC although there are also other global environmental challenges.

Mitigation of GHGs, reduction of consumption, or decreasing material possessions are not yet widespread solutions to confronting challenges brought by ACC. Even if new technologies would diminish the burden on environment and would abate GHG emissions, the question remains: is the continuation of consumption-based lifestyle ethically well-founded? Or could it be that environmentally unsustainable practices should be replaced with not only just novel technology, but also new conventions which consider the vulnerability and sustainability of the biosphere more carefully as Gambrel and Cafaro (2010)? How can the new practices be feasible and justified to replace old habits and practices of industry and the humanity as a whole? For the time being, denial and repression of the results of climate science and its predictions for future scenarios help in justifying the continuation of consumption-based lifestyles. Also climate scepticism and parties with vested interests maintain illusions of acceptability of lifestyles supporting business as usual (BAU). More about climate scepticism in the next chapter 1.1.2.

Mitigation does not have to be considered as a sacrifice or a decrease of the experienced happiness of an individual. Instead, the notion of simplicity can support the flourishing of an individual and societies as well as non-human flourishing. Simplicity as a process of striving towards a meaningful and content life includes voluntary material modesty and simplicity, and careful consideration of one's consumption, and ecologically sustainable lifestyle choices. It does not refer to coercive minimization of property, poverty, or a complete denial of material and technological facilities. Simplicity as a lifestyle produces benefits in various aspects of life such as economic balance, health, self-esteem, autonomy, communal responsibility, and the commitment to environmentally sustainable practices. (Gambrel and Cafaro 2010.) The rejection of highly consumptive and environmentally unsustainable lifestyle requires changes in societies with respect to practices that make material simplicity possible for individuals and

embrace the significance of consuming less (Cafaro 2010, 13). Simplicity as a way of life produces less GHGs, hence it can be understood as an adequate manner of diminishing the amount of luxury emissions.

There is a consensus among researchers that the developed countries should take a leading role in the burden-sharing of the costs of ACC, whereas developing countries would even be allowed to increase their emissions for some time before reaching the sufficient capacities for efficient mitigation (see Gardiner 2004, 579, 590; Shue 1999, 545; Traxler 2002; Peterson 1999, 192). Two essential ethical questions regarding the policy-making of fair allocation are first of all, where to set the ceiling of emissions including mitigation targets. The second question is how to allocate the GHG emissions allowed by that ceiling in a fair manner (Gardiner 2006, 398). Also, the differences of opinion mostly appear when discussing the justification of responsibilities concerning GHG emissions, and its form and extent (Gardiner 2004, 579).

The following table illustrates the classification of arising ethical problems between anthropogenic and naturogenic climate change, and reveals challenges that require ethical reflection.

Table 1

CLIMATE CHANGE AND THE REQUIREMENTS FOR ITS ETHICAL CONSIDERATION		
	ANTHROPOGENIC CLIMATE CHANGE	NATUROGENIC CLIMATE CHANGE
REQUIRES ETHICAL CONSIDERATION	a) responsibility for past, present, and future GHG emissions b) adaptation c) mitigation d) allocation of GHG emissions e) geoengineering e) fairness regarding a–e	a) the distribution of restoration effects for environmental damages due to climate change b) responsibilities concerning international assistance and aid in a period of crisis and emergency due to climate change c) adaptation to changed habitats d) fairness in a–c
DOES NOT REQUIRE ETHICAL CONSIDERATION	natural sciences statistical research (social & natural sciences)	natural sciences statistical research (social & natural sciences)

The table illustrates that naturogenic climate change can pose questions that do not require specific ethical reflection as well as can be in the case of ACC. In other words, there are several questions that do not fit in the area of ethics of climate change and require analysis of other scientific fields of expertise. These questions are related to natural scientific measurements and various statistical and social sciences research concerning climate change. Provided that the research has been conducted in

an ethical manner typical of the specific research field, no ethical questions necessarily arise. The natural sciences in themselves do not conduct special ethical analysis on their research target. Hence, it is the task of ethics to analyse fundamental questions regarding ethical problems of specific research targets. Ethical questions regarding responsibilities of GHG emissions, mitigation, adaptation, geoengineering and the fair allocation of GHGs require ethical analysis. In addition, the intergenerational aspect needs to be taken into consideration. ACC puts future generations in a situation where the present generation can benefit from its temporal position and stall difficult political decisions (Gardiner 2012, 244).

In summary, the ethical problems of ACC acknowledge the notion that mitigation has failed. According to proponents of geoengineering, mitigation of GHGs is not the only option to deter ACC. In fact, they argue that it is likely an insufficient way to tackle ACC at all. (Ikle and Wood 2008, 21.) However, ACC is not entirely accepted among scientists and lay people. The next chapter analyses the nature of the denial of ACC. Despite the differences in viewpoints about the origin of climate change, both parties can accept the need for geoengineering research and development.

1.1.2. Denialism, scepticism, and anthropogenic climate change

Despite the presence of critics of climate science in the media, the scientific community is not divided. Currently climate change is regarded as anthropogenic by the majority of the scientific community (Cook et al 2013; Oreskes 2004; 2007; IPCC 2013a). The scientific consensus concerning ACC is comprised of several factors. The IPCC is the leading international agent that produces systematic reviews of peer-reviewed and published scientific sources for the policy-makers and the public at large. So far, it has published 5 reports: the first in 1990 and the latest in 2014 with the aim of forming a view of the current state of affairs and their implications to humanity and to specific countries and regions.

Moreover, peer-reviewed scientific articles provide a strong evidence for ACC. In a research analysing 928 abstracts from the years 1993 to 2003 regarding climate change, none of them refuted ACC altogether. Although there is disagreement over the specific aspects of climate change, scientific consilience supports ACC. (Oreskes 2004; 2007, 66–71.)

Author John Cook and his collaborators analysed published and peer-reviewed scientific articles related to climate change and came to similar conclusions with Oreskes (2004). 97,1% of selected scientific articles based on self-ratings and 97,2% articles based on abstract ratings supported ACC (Cook et al 2013).[17] According to a researcher Keynyn Brysse and his research team, there is evidence that although scientific consensus is robust, researchers tend not to lean on alarmism, i.e. overreacting to data supporting ACC. Rather the other way around; scientists tend to lean on the opposite stance of overly cautious statements of the state of the of climate. This tendency is referred to as erring on the least side of drama (ELSD). One reason for ELSD is self-control as a norm of the science community, guiding researchers to be preferably moderate than dramatic in reporting their results. The manner of communication in science differs from the communicative conventions of the media. Maintaining credibility by not over-dramatizing the results is relevant in order to be heard in the scientific community as well as outside it. Moreover, the fear of being labelled as an alarmist is another reason to report the research results in a cautious manner. (Brysse et al. 2013, 327–331, 333.)

For instance, in the reports of the IPCC some of the predictions have been more underestimating than exaggerating.[18] Especially in group assessments ELSD tends to play a role more often than in individual scientists' reports. Scientific moderation and taciturnity can be seen as a result of the tense political framework in which climate scientists currently function. Although moderation and systematic

[17] However, there is a wide gap between citizens' opinion of scientific consensus on climate change and actual scientific unanimity. According to The Pew Research Center (2012), only 45% of respondents in the US answered positively to the question: "Do scientists agree the Earth is getting warmer because of human activity?" Nevertheless, this gap does not refute ACC.

[18] The underestimating of predictions concerns, for instance, the rise of the sea level and West Antarctic ice sheet loss (Brysse et al. 2013).

scepticism are part of the norms of science, ELSD as a systematic bias is inclined to understate the predictions of changes in the climatic system. (Brysse et al. 2013, 327–331, 333; see also Risbey 2008, 33.) Thus, the trend in reporting climate science is to downplay the results rather than dramatize them.

An analysis of alarmist language with regard to climate change research showed that the terms concerning alarmism were used adequately and in relevant situations. (Risbey 2008; Brysse et al. 2013, 329). There have been opposite views that alarmist language works inefficiently in communicating climate science and fails to convince the public to take action (Hulme 2006; O'Neill and Nicholson-Cole 2009). Investigating whether alarmist language is characterizing climate science showed that instead of viewed as alarmist, the parlance of climate science has used the words accurately. The phrases "catastrophic," "rapid," "urgent," "irreversible," "worse than thought," and "chaotic" were found to be used coherently in relevant situations in discussions of climate science. (Risbey 2008.)

A minority of scientists claim climate change as naturogenic or not essentially as dangerous as usually supposed, and thus question the research results behind ACC. A portion of researchers do not actively support ACC due to several reasons, e.g. alleged politicisation of climate science and alarmism. Also, twisted or misinterpreted climate science and labelling ACC as just another trend among environmentalists are explanations to dismiss ACC (Oreskes and Conway 2010b, 687). The designations can be overlapping, however, the basic idea of refuting ACC is a common factor for sceptics, deniers and contrarians.[19] The theories of climate science and ACC have been confronted by obfuscating, misrepresenting, manipulating, and suppressing research. In addition, intimidating or threatening sanctions on scientists have also been used as a resistance method as well as invoking existing procedures and biases: the former is employed in the political system and the latter in the media. (McCright and Dunlap 2010, 111.)[20]

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[19] For instance, Oreskes and Conway (2010a; 2010b) have done research on ACC denial and used all three concepts in their publications.

[20] McCright and Dunlap (2010) use Molotch's (1970) societal analysis of a power structure as their source. Molotch (1970)

Denialists charge researchers promoting ACC as being alarmists who exaggerate the research results of human impacts on climate (Brysse et al. 2013). Denialism deviates from scepticism in the way that it is mostly connected to political conservatism and lobbying think tanks publishing literature supporting their ideology (Dunlap and Jacques 2013). For a denialist, any new evidence against one's own ideological view cannot change one's mind about ACC. The idea of denialism does not concern only the debates about the origin of the climate change. The debates regarding the connection of HIV and AIDS, the credibility of creationism, and the health effects of smoking have the same thing in common. All of the debates involve participants who refuse to accept the results of scientific consensus. The tactics of denialism feature notions of conspiracy theories, usage of unqualified experts, selective referencing of scientific results which only support one's own views, and misrepresentation of the opponent. (McKee, 2009.)

Although scepticism has here been involved with the denial of ACC, certain scepticism is a normal part of scientific research. Were climate change to turn out to be a naturogenic process, ethical questions would be different than in the case of ACC, and would also require different policies. Nonetheless, ethical questions, for instance, regarding the distribution of the costs of restoration for an environmental disaster would be relevant even if naturogenic climate change would bring about those damages. Even if climate change would not appear to be human-induced there are still reasons for the study of climate from a philosophical perspective (Jamieson 2008, 8). Scepticism as an attitude resists the widely shared results of the scientific community and the consensus of evidence. The higher education of science includes scepticism as one of the basic attitudes of a scientist, but the readiness to change one's perspective has to be assimilated as a part of the research. This aspect separates denialists and sceptics from other scientists.

However, weather and climate modification schemes are not dependent on the evidence of ACC. In

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uses the oil spill of Santa Barbara (USA) as an example that reveals the power structures of the whole society.

case that the scientific evidence would prove in the future that climate change will not occur as a large-scale phenomenon as predicted or is not anthropogenic, the research questions of this dissertation still remain relevant. As noted, this does not seem probable at the moment. Geoengineering and carbon sequestration proposals could be seen as solutions to improve lives even without ACC (Isomäki 2009, 4). Hence, geoengineering is not necessarily connected with ACC. Jamieson (1996, 323) calls the relationship of geoengineering and ACC "strange bedfellows" because the proponents of ACC seem to be reluctant to promote geoengineering, and the advocates of geoengineering are not very inclined to refer to ACC.

Geoengineering and weather modification proposals still need ethical assessment even if the world as we know it changes relatively little compared to the estimates of an impending climate emergency. So, if the expected changes turn out to be even more dramatic than the current worst case scenario anticipates, this dissertation can be perceived as a prelude when it comes down to the battle of survival like in the science fiction novel *Sands of Sarasvati* by Isomäki (2013).[21] Although denialists with their sceptical arguments of ACC make noise in the media, it should be noted that they are a small minority in the scientific community. Among the proponents of ACC, the proposed solution for the looming climate emergency, geoengineering, has divided researchers into different parties regarding the acceptability of geoengineering. The methods and idea of intentional climate modification techniques will be introduced more closely in the next chapter.

1.2. Geoengineering technologies

The stances to the necessity, urgency, and acceptability of geoengineering are grossly divided (see Hamilton 2013a; Ikle Wood 2008; Keith 2014; Robock 2008). In this respect, the geoengineering debate

[21] Sands of Sarasvati is an ecothriller about an anthropogenic environmental catastrophe where the protagonist is working to stop a giant flood and embrace a global emergency.

indirectly echoes the debate on policy responses to ACC. Those who deny or mistrust the evidence of ACC can handily take a conservative stance to geoengineering as a policy response. At the same time, weather modification can be seen as acceptable for other reasons without reference to ACC. Thus, it is possible to have other reasons for controlling and manipulating the climate, such as to promote the so-called "natural" climate change, to put off a future ice-age, create favourable weather conditions for certain areas, or to increase productivity[22] without reference to ACC. This has happened in the past due to various efforts of weather modification. Weather modification should not, however, be confused with geoengineering since they have different motives. Geoengineering is concentrated on diminishing the adverse effects of ACC in the long term on a global scale, whereas weather modification is restricted in time and place. Various modes and motives to enhance weather and climate are further analysed in the second chapter of this dissertation.

The current debate on geoengineering takes ACC for granted based on wide scientific consensus. This is indicated in the influential report by the Royal Society called *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, 1). Proposals for geoengineering are numerous and they do not conveniently fall into one homogeneous category (Lenton and Vaughan, 2009; Shepherd et al. 2009). Because the prevailing concern is the warming of the climate, the proposed technological means aim to lower the rising temperatures. There are two basic ways to seek such results which include several different methods in both categories. The objective of the first category of methods is the reduction of the absorption of incoming radiation from the Sun by solar radiation management (SRM), also known as solar geoengineering. The other group of methods aims to reduce the levels of GHGs in the atmosphere by carbon dioxide removal (CDR), or carbon geoengineering (Lenton and Vaughan, 2009, 2562; Shepherd et al., 2009).

[22] In the 18th century, Carl von Linné, Pehr Adrian Gadd, and numerous other scholars in Sweden considered what would it mean if the northern climate would be heated locally. As they saw it, local warming meant increased productivity and wealth, and it was achievable by means of population growth, deforestation, and draining of wetlands. (Niemelä 2008.)

Geoengineering is even considered as a third proactive strategy alongside mitigation and adaptation to tackle ACC (Blackstock et al. 2009). There are ambiguities in this categorization of proactive strategies. Mitigation and CDR both have a common objective to reduce the GHG levels in the atmosphere. SRM and adaptation have commonality in the efforts to lessen the negative corollaries of ACC. Heyward suggests the rejection of this triumvirate as well as adding CDR, SRM, and rectification as additional proactive strategies. Rectification as a strategy endorses compensation and symbolic acts such as apology as a restorative or ameliorative effort. (Heyward 2013, 23–25.) Although these five strategies are not widely acknowledged yet, Heyward has an important standpoint in the notion that geoengineering should not be a third response to ACC. Instead, it should be disaggregated and focused to concentrate on specific methods one at the time. As a concept, geoengineering is vague and includes various dissimilar methods. The ethical analysis should be directed to individual methods as well as the assessment of the general idea of a technological fix.

The most discussed CDR[23] proposals for removing GHGs from the atmosphere among others are reforestation and afforestation, bioenergy with carbon capture and storage (BECCS) (Benson 2014), ocean iron fertilization (Branson 2014; Smetacek Naqvi 2008), and geochemical carbon management (Stephens and Keith 2008). These methods can be further divided into land-based CDR methods and ocean ecosystem methods (Shepherd et al 2009, 9–18). With regard to SRM[24] reflecting incoming radiation from the Sun, the most debated proposals are the injection of stratospheric sulphate into the atmosphere (Crutzen 2006; Keith 2013), tropospheric cloud seeding and marine cloud brightening (MCB) (Salter et al. 2008), and the installation of reflecting mirrors or lenses in space between the Earth and the Sun (Angel 2006).

The potential reduction of the use of fossil fuels has also contradictory effects besides restraining the emissions of GHGs. In mitigation, not only is fossil fuel use cut back, but also the aerosol density is

[23] CDR is also referred to as negative emission technologies (see Benson 2014).
[24] The benefits and risks of SRM are assessed in greater detail in Robock (2011) and Robock et al. (2009).

reduced which reflects the sunlight away from the Earth and acts as a cooling agent. This leads to even more rapid ACC if the reflective aerosols are withdrawn from the atmosphere. (Lovelock 2008, 5.) The reduction of aerosol density could possibly be compensated by SRM which aims to reflect incoming radiation from the Sun away from the Earth. Other techniques have also been suggested, such as using micro bubbles in water in order to increase water surface reflectivity (Seitz, 2011).

The definition of geoengineering includes the scale and intent of a method in order to classify it as geoengineering. For example, gardening cannot count as geoengineering because it does not have intentional, large-scale effects although it can affect the climate. Neither can GHGs count as geoengineering due to the unintentionality of the GHG emissions. The third requirement for an action to classify as geoengineering is the degree to which the geoengineering action serves as a countervailing measure to tackle ACC. (Keith 2002, 412.) These characteristics are common in different geoengineering methods even when they differ greatly in other instances.

Hardly anyone denies the risks involved in human meddling with the Earth's climatic system. The assessment of the methods implies, however, that some geoengineering methods can be safer in a sense of preserving environmental sustainability more effectively than others. As an example of a less ecologically detrimental method, the Royal Society report mentions CDR (Shepherd et al. 2009, xi). However, the safer methods, e.g. large scale afforestation, might not be quick enough to respond to the situation of climate emergency and the urgent need of mitigation. With the realization of the uncommon situation of the biosphere in unprecedented jeopardy due to ACC, many might be ready to give the green light to more exceptional measures, such as geoengineering. The Royal Society report (Shepherd et al. 2009, 45) refers to it as a survivalist measure in the state of a climatic predicament. Evidently, geoengineering could be combined together with mitigation policies and it would also require a possibility to discontinue implementations, if necessary.

Whereas some techniques might reduce the radiation from the Sun to the Earth, some other problems concerning GHGs would still remain. For example, even if SRM methods succeeded in reducing the radiation from the Sun to the Earth, the acidification of oceans would continue because SRM does not diminish the atmospheric concentrations of GHGs. Consequently, it seems obvious that the present level of mitigation without the political will to scale up the efforts is not seen to be effective enough to bring down the adverse effects of ACC. Nevertheless, geoengineering is neither a mitigation nor an adaptation strategy.

The American Meteorological Society (AMS) (2009; 2013) considers geoengineering as a third proactive strategy for reducing the risks of ACC contrary to Heyward (2013). Although AMS acknowledges the risks of geoengineering, it recommends geoengineering as a risk management and adaptation strategy to slow down ACC, and improve the capacity of societies to adjust to the changes in the climatic conditions. This view is debatable for at least two reasons. First of all, it considers geoengineering as a proactive strategy which it obviously is not on the strength of the uncertainties, ambiguities with regard to its governance, issues of distributive justice, and negative side effects it is very likely to cause. Secondly, it is contrived to consider geoengineering as an adaptation strategy. Geoengineering involves technical solutions to weather and climate modification. These methods do not necessarily include adaptative efforts regarding ACC.

1.3. The diversity of designation of intentional climate modification

Intentional climate modification, also known as geoengineering, has many different names such as climate engineering (Keith 2013), intentional climate change (Jamieson 1996), and planetary engineering applied to the Earth. One of the first appearances of the term "geoengineering" was in the context of injection of carbon dioxide (CO_2) into the deep ocean to mitigate the climatic impacts of fossil fuel

combustion (Marchetti 1977). Prior to that article, Schneider and Kellogg (1974, 1163) had referred to climate control as climate stabilization. According to them, there are three options in confronting climate change: the first option is to do nothing. The second option involves massive alteration in human land and sea use towards ecological sustainability in order to mitigate the effects of climate change. The third option is climate stabilization in order to abate the adverse effects of climate change by reducing natural changes and preventing anthropogenic influence on climate. Dale Jamieson (1996) wrote an article about the ethics of geoengineering as early as 1996, calling it intentional climate change (ICC).

Prior to the presented references to climate engineering, in 1967 scientists McCormick and Ludwig took up intentional climate modification in their article "Climate Modification and Atmospheric Aerosols." Other suggestions have also appeared to clarify the semantics of intentional climate modification. For instance, due to the imprecision and broadness of the term geoengineering, one of the substitutes that has been suggested is "climate remediation." The US-based think tank Bipartisan Policy Center refers to geoengineering as "intentional actions taken to counter climate effects of past greenhouse gas emissions to the atmosphere" (Long et al. 2011, 3). At all points, intentional climate modification in this regard is aimed to counterbalance the negative effects of growing GHG emissions.

Russ George, a commercial advocate[25] of ocean iron fertilization method, refers to the remediative aspects of geoengineering by calling it "a restoration project" (Goodell 2010, 149). George's OIF projects have faced international opposition and have led to a moratorium by the United Nations Convention on Biological Diversity (CBD) and the London Convention. (Lukacs 2012; Goodell 2010, 160; Victor et al. 2013). The CBD decision X/33 bans large-scale geoengineering experiments (CBD 2010; ETC Group 2013). Non-governmental organization ETC Group (2010, 4) has given geoengineering a negative label as "geopiracy" due to potential detrimental impacts of geoengineering

[25] George has been involved, for instance, in corporations such as Planktos Inc. and Haida Salmon Restoration Corporation.

technologies, absence of public debate as well as the inability to address inequalities between richer and poorer countries with regard to historical responsibility for ACC. All of the designations of geoengineering embed the notion of intervention and manipulation although advocates and opponents can disagree on the acceptability of the method.

Together with the term geoengineering, "climate engineering" is also commonly used in publications regarding intentional climate modification (e.g. Keith 2014; Preston 2012). Geoengineering attained publicity as ecohacking in the Oxford Word of the Year 2008 shortlist, where it was defined as "the use of science in very large-scale projects to change the environment for the better/stop global warming" (The New Oxford American Dictionary 2013). Planet hacking and climate hacking are similar terms, used by Kintisch (2010a; 2010b) who wrote a book called *Hack the Planet* about geoengineering. An old saying "A beloved child has many names" describes well the situation of geoengineering. Which name is chosen to discuss the subject, it remains clear that it is anything but unequivocal. However, the question that interests an ethicist the most is in what kind of conditions, if ever, can the manipulation of weather and climate be considered morally acceptable?

2. WEATHER ETHICS AND ETHICS OF GEOENGINEERING

The possibility to modify the weather has always fascinated the human mind resulting in works of art, rituals, and technologies. In Michael Crichton's thriller *State of Fear* (2004), a group of eco-terrorists acts in the hope of raising awareness of ACC. One of their plans is to create a thunderstorm resulting in a fatal mud flood. In 2008, the Olympics opening ceremony in Beijing was a magnificent production. It is possible that a part of the glory belongs to the Chinese weather engineers who prevented the rainy forecast from becoming true and thus saved the event (see Wade 2008; Zheng 2008). Although the former case comes from fiction and the latter is reality, questions concerning weather modification and

influencing the climate arise.

Perceptions of the climate and its changes are polarized: currently, the clear majority is worried about the rise of the mean temperatures, and the boisterous minority considers cooling as a more likely scenario (Poortinga et al. 2011). Back in the 1970s, without scientific consensus on ACC as the research community has nowadays, the views were polarized too. ACC was seen as an economic policy question which should be taken into account on both corporate and policy-making levels (Weart 2010, 72). Although the denialists are currently the clear minority, 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 to develop capabilities to take the edge off the scary future. When dangerous things are about to happen with regard to climatic conditions, alert condition enables entering a state of emergency. Possible abrupt changes in the light of growing GHG emissions awake considerations of climate emergency and the use of geoengineering implementations. In the 1980s, ACC transformed into a moral problem mostly due to Bill McKibben's influential book *End of Nature* (1989) (Weart 2010, 72). Following that trait, ideas of weather and climate as well as their history and linkage to ethics are brought forward in this chapter.

2.1. The history of weather and climate modification

Since ancient times, modification of climate and local weather against hard weather conditions has been yearned for (Schneider 2008, 1). Such capability for weather modification has earlier been thought to be possible only for ancient gods. For example, the American Indians had rain dances and in this way they presupposed to have influence on gods who enable favourable weather. Additionally, the Zuni Indians had priests who performed rituals in order to summon rain-making spirits to assure precipitation. The indigenous Zinacantecos in Mexico had rituals performed for "earth-owner" god, Yahval Balamil,

which were to ensure rain.

Ancient attempts to affect the weather consisted of prayers and sacrifices to appease gods and supernatural beings (Neiburger et al. 1982, 369).[26] The impact of weather modification upon tribal societies appears in three cultural areas. Firstly, cosmological beliefs are intertwined with meteorological phenomena. Secondly, the ceremonies performed for weather control function also as a booster of social integration and social control. The third cultural impact of weather modification is balanced ecological adaptation of tribal societies. (Vogt 1966, 374, 383, 389.) Nowadays, this competence of weather and climate modification is not only reserved for supernatural entities, but also for climate engineers (Fleming 2007, 50; Fleming 2010; Schneider 1996, 291; 2001, 417).

Weather modification already had a research tradition before the scientific discussions of geoengineering began. The Cold War and military interests in weather modification pushed the research forward as well as commercial interest in cloud seeding experiments in arid farming areas. Hence, the introduction of this novel branch of applied ethics does not imply that weather modification is a fully newborn idea.

The research to modify weather was initiated in the United States of America in the 1940s by James Pollard Espy. His experiments were based on the idea of the thermal theory of storms: by lighting a large scale fire one could enhance thermal updrafts to generate artificial rain. Espy experimented with his theory by setting fire to a vast track of forest which ended in failure. Fleming points to this rise of research on weather control as the first cycle of promise and hype in the pathological history of weather and climate control. It lasted for about a century, concentrating for the most part on enhancing

[26] For instance, Native Americans performed rain dances in order to enhance precipitation. Also, Finnish folklore includes the elves of weather which were to be treated with respect to secure crop yield and game. Other practical demotic means to influence local weather have also existed. For example, in the Tiwanaku culture, by the Lake Titicaca, a cultivation method with irrigation ducts was applied to areas sensitive to frost (Pärssinen 1992). This implies that Native Americans living in that particular area have had a fair idea of the emergence mechanism of frost.

precipitation although definite proof of success of experiments could not be established. (Fleming 2006, 3–8.)

The modern forms of weather modification in the United States were developed after World War II. The second cycle by Fleming in the pathological history of weather and climate control is situated from the 1940s onward. (Fleming 2006, 8.) In 1946, Vincent Shaefer conducted an experiment in which he dropped three kilograms of dry ice into a cloud making it snow. (Steinberg 2006, 128; Fleming 2006; Neiburger et al. 1982, 369.) Schaefer was probably familiar with the theoretical model of the origin of precipitation. In the so called Bergeron–Findeisen process, the amount of ice crystals in the upper clouds grows rapidly when the water vapour transfers into ice crystals and causes precipitation. The process requires the simultaneous coexistence of supercooled water droplets and ice crystals in the cloud. (McIlveen 1992, 168; Sumner 2000.)[27] However, this technique did not turn out to be particularly efficient, for the average increase in precipitation was only about 20 percent. (McIlveen 1992, 168.)

Irving Langmuir and his associates at the General Electric Corporation also had visions of weather control which turned into research on weather control for military purposes as a result of the wish to avoid lawsuits based on inadvertent side effects of the experiments (Fleming 2006, 8–9). Although the idea of human action affecting the climate was present in Western science at the end of the 19th century, ACC was not an issue of concern yet. In the 1950s, plans of interfering with solar radiation by seeding clouds or spreading particles in the atmosphere created speculation about the technical means of "climatological warfare." (Weart 2010, 68–70.) Thus, when exploring the history of weather modification, the militaristic dimensions of meteorological studies should not be ignored. During the Cold War, both the USSR and the USA were active in weather and climate control research and

[27] This model was developed in the 1930s by the two meteorologists, Tor Bergeron and Walter Findeisen, independently of each other. It was adapted in the 1940s by seeding ice crystals or metallic salts, mostly silver iodide (AgI), into particular types of clouds.

implementation. Meteorology was a field of strategic research, and the idea of "climatological warfare" played at least a minor role in the arms race of the superpowers. The weather was seen as a part of the security policy of the Cold War, and perceived as a powerful weapon (Harper 2008, 20; Keith 2000, 250–252; Robock 2008, 14; Fleming 2006; 2007, 54–56; Weart 2003, 23).

The research of weather and climate modification had been intense both in the Soviet Union and the USA ever since the 1930s. (Keith 2000, 249–252; Bauer et al. 1999.) In the Soviet Union, weather management techniques, especially cloud seeding, were developed in the 1930s (Keith 2000, 250).[28] At the height of the Cold War, flamboyant ideas were expressed about the domination of the socialist society over forces of nature (Ziegler 1987; see also Rusin and Flit, sine anno). The second cycle of promise and hype according to Fleming (2006, 8–14) ended when the UN Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) entered into force in 1978. The debate on the permissibility of using weather as a weapon initiated from the cloud seeding operations of the United States in Vietnam, Laos, and Cambodia in 1967–72.[29]

The attraction to weather modification faded out in the 1970s (Keith 2000, 253). One of the reasons was the legal disputes between some affected landowners who wanted to defend their "natural weather" and the advocates of weather modification. To the latter's misfortune, in 1972 while weather engineers were seeding clouds in South Dakota, the city of Rapid South encountered a massive downpour causing a flash flood. More than 200 people were killed, and questions about the weather engineers' involvement in the incident were widely circulated. (Steinberg 2006, 127–147; see also Fleming 2006, 7–8; Glantz 2003, 177.) Even so, the ideas of weather modification were not completely

[28] As a superpower China has not opted out of the development of weather modification: according to the Meteorological Administration of China, the first weather modification enterprise was implemented in 1958 (CMA 2008).

[29] A detailed description of the plans of climatological warfare can be found in the book Arming Mother Nature (Hamblin 2013).

buried.[30] Weather modification seemed to raise hopes for improving the living conditions of those who suffered from droughts or excessive precipitation, and other climatic hardships.

The history of modern weather modification dates back to the first part of the 20th century although the idea of environmental modification—which weather and climate modification are definitely a part of—is much older. The difference between weather and climate modification in the 20th century and nowadays is clear since earlier weather modification was seen as an instrument to improve natural states of weather conditions, mitigation of natural hazards, or as a weapon of the Cold War. Unlike those objectives, the current aim of climate modification is abatement of anthropogenic hazards, for example, due to GHGs.[31] However, both weather and climate control are on the menu this time.

In the 21st century, a third cycle of promise and hype in the pathological history of weather and climate control has begun (Fleming 2006, 3). It has been argued that in order to tackle the adverse effects of ACC, geoengineering would be preferable than solely mitigating GHG emissions (Schneider 1996, 291). Some researchers (Crutzen 2006; Wigley 2006; Ikle and Wood 2008) suggest that both geoengineering and mitigation could be implemented. These proposals to tackle the detrimental effects of ACC also raise questions of the ethics of weather and climate modification. Should we or could we engineer the Earth's climate on a small scale, on a large scale, both or neither? If the answer to any of the first three options is yes, could it be executed in a way that would reject the adverse consequences of polluting the atmosphere with excess CO_2 without major and destructive side effects?

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30 According to the reference database Web of Science, the interest continued all the way to the beginning of the 1980s, partly because of the development thinking.

31 For a comprehensive history of weather modification, see Fleming (2010) and Weart (2010).

2.2. Ethics of weather and climate modification

The acceptability of weather modification can be examined by analysing its underlying assumptions and its relevance to the politics of the climate as well as applying the principlist approach. So far the various unfavourable weather conditions including, for instance, the occurrence of dry seasons and heavy storms have been a game of chance. Some people happen to inhabit regions with auspicious weather, while other people live under hazardous weather conditions. Accumulated human knowledge of and technological skills in influencing and, actually, governing weather formation restructures the situation: we shift from chance to choice. The choice to actively manipulate weather and climate implies that we are morally responsible for whatever modifications are made.

Are there any situations in which we really should make an attempt to affect the course of a particular weather? These and parallel research questions do not conveniently fall into any of the established subfields of applied ethics, since weather and climate became only very recently a research topic for ethical inquiry. For this reason, a new concept of "weather ethics" is proposed in this dissertation. Even though the implementation of weather engineers' visions might not yet be actualised in a large scale, following the precautionary principle and principlist as well as the biocentrist notion of non-maleficence, one should openly discuss the ethics of intentional weather and climate modification.

The subject matter of weather ethics partly differs from that of climate ethics. Weather ethics usually addresses ethical problems related to local attempts to modify short-term weather conditions, as was the case with the Olympics in Beijing. Climate ethics, in turn, focuses more widely on the ethical aspects of ACC and attempts to give normative guidance on a long-term basis. The research problems of climate ethics are diverse and include questions of the nature and the assignment of responsibilities, the conditions of adapting to climate change, fairness, the mitigation of greenhouse gases, and the justification for geoengineering.

Ethics of weather and climate modification share some of the same characteristics with applied ethics—especially with the ethics of emerging technologies, synthetic biology, bioethics, and nanoethics. The emerging novel technologies are not only novel, but also receiving a lot of attention both in the media and in the field of interdisciplinary research. They share the same features in the way that they all contain not only risks, uncertainties, and hazards, but also potentialities and high hopes of solving the great challenges of the 21st century in the form of diseases, climate change, famine, diverse environmental disasters, and other challenges. However, the ethics of geoengineering is distinct from them and deserves to be analysed on its own as a subset of climate ethics. Geoengineering is the first technology in human history that plans intentionally to modify the complex systems of the Earth on such a large scale, and with assertions of immense effects. (Preston 2012, 1.) This reason alone gives justification for the need of ethical analysis of geoengineering.

World Meteorological Organization (WMO) (2013) released a report on current weather modification projects around the world and their relationships to geoengineering. The report emphasized the viewpoint that although 42 countries in the year 2013 were involved in weather modification projects these cannot be associated with geoengineering proposals. The major disparity in weather modification and geoengineering is difference in spatial scales. In addition, WMO does not support geoengineering implementations due to inadequate understanding of the effects of large scale experiments[32]. (WMO 2013, 6.) Proponents of weather modification have imaginative visions gushing partly from the wish to be able to control weather conditions related to ACC. For example, hurricanes could in the future be moderated or relocated to areas where they would cause less harm. Some extreme weather events will become more powerful as the global temperature rises (see Elsner, Kossin & Jagger 2008).

[32] In the WMO (2013) report, in addition to their own recommendation not to proceed with geoengineering without comprehensive understanding of the effects of it, there is also an appendix attached to the report by the International Commission on Clouds and Precipitation (ICPP). They also suggest that geoengineering—referring in this case to SRM—should not be implemented at this stage due to poor understanding of its interactions with clouds, aerosols, and precipitation, and that it could not solve the problems caused by climate change on its own. (ICPP 2013, 1.)

The active modification of weather should be wholly distinguished from the mainstream means of ACC mitigation, such as emission reduction by renewable energy sources, replacement of fossil fuels with nuclear energy, or preservation of carbon sinks. Weather modification refers to the systematic enhancement of desirable local and regional weather events, and the prevention and weakening of unsuitable weather conditions without abatement strategies.

The most eligible instances of weather modification are the increasing of precipitation, the dissection of hail, the breaking up of hurricanes, and the moderation of rainstorms (Harper 2008, 20, 22; see also Neiburger et al. 1982, 369–378). Weather conditions can be affected either directly or indirectly. The objective for affecting the weather directly is aimed at the particular part of the atmosphere where the weather phenomena essential to us occur. The primary aim of the latter, indirect implementations, is not to affect the atmosphere though the implementations nevertheless have effects on the weather conditions. Land use is an example of this kind of indirect impact on the atmosphere, where air humidity and particle concentration are altered.[33]

Another way of classifying weather modification is to consider whether it is intentional or unintentional. For instance, the water vapour trails of jet planes (i.e. contrails) cause cloud formation unintentionally. Direct influencing of the weather is in most cases delineated, whereas indirect influencing of the weather can be said to be unplanned and unintended. Nonetheless, neither intentional nor unintentional influencing of the weather is outside the scope of moral consideration. Discussions about risks, uncertainties, precautionary actions, and advantages of such techniques have sprung up, and there will be an increasing demand for various weather modification methods.

[33] The active use of empirical knowledge of weather in the placing of buildings and plantations is parallel with active land use. Traditionally there has been an effort to locate residential buildings in a way that the Sun is able to warm them in a convenient manner. In urban planning the weather conditions such as temperature, precipitation, and air flows are routinely taken into consideration (Oliver 1973). The cities suffering from smog benefit from construction planning resulting in increase of airflow. The placing of tall buildings in the cities affects the up flow of air. These examples do not pose ethical problems in themselves unless one considers the interference with the naturalness of weather conditions an ethical problem.

The following table represents the intertwining of weather and climate modification. Two essential opposites feature in the table: the direct or indirect, and intentional or inadvertent influence on the atmosphere.

Table 2

THE INTERTWINING FIELDS OF WEATHER AND CLIMATE MODIFICATION		
	Intentional influencing of the atmosphere	**Inadvertent influencing of the atmosphere**
Direct influencing of the atmosphere	A) Geoengineering a) SRM b) Carbon capture B) Weather modification: a) recreational modification b) modification as hedging c) modification as a requirement d) military modification e) terrorist modification	Atmospheric emissions from a) industry b) power production c) air traffic d) waterborne traffic e) land traffic
Indirect influencing of the atmosphere	The conservation of forests and other carbon sinks - soft geoengineering	Land use

According to the Synthesis report (2007a) of the IPCC, geoengineering implementations are not considered as realistic adaptation mechanisms. Prior to the Synthesis report, the publication of Working Group III "Mitigation" brought up the following techniques:

> "Geo-engineering options, such as ocean fertilization to remove CO_2 directly from the atmosphere, or blocking sunlight by bringing material into the upper atmosphere, remain largely speculative and unproven, and with the risk of unknown side effects. Reliable cost estimates for these options have not been published." (IPCC 2007b, 15.)

The latest IPCC Summary for Policy makers (2013, 27) acknowledges the existence of geoengineering methods. However, there is limited evidence with regard to the feasibility of SRM and CDR methods. Both of the methods inflict global effects extending over a long time with side effects. In addition, the level of long-term CDR carbon offsetting is unknown, and the method has biochemical and technological limitations. SRM methods have the potential to counteract rising global temperature, but not without affecting the global water cycle. Ocean acidification would not be abated and SRM termination would cause rapid rise of the global surface temperatures. Hence, the uncertainties and negative effects give the IPCC reasons not to give a green light for geoengineering. In the fifth assessment report geoengineering is given a closer examination, however, it is still not endorsed yet (IPCC 2013c).

2.2.1. Ethical aspects of weather modification

To analyse weather modification from an ethical point of view, it is useful to systematize the potential uses of techniques. Weather modification can be classified into five basic forms on the basis of motives: luxury, preventive, development, military, and terrorist weather modification. Using the motives as a classification criterion differentiate this classification from other possible classifications that may be based on moral judgement of the consequences of particular weather modification techniques.

The most common form of *luxury weather modification* is simply a wish to have a certain kind of weather in a certain place at a particular time. The weather modification of the Olympics in Beijing is a case in point. One might also be willing to pay a considerable sum of money to make sure that the weather during an intended golf contest will be optimal. These can be called the luxury motives of weather modification which are dubious in their character due to conflicting interests. Apparently in many cases the wishes of the various stakeholders for the type of desired weather conditions might differ.

Preventive weather modification refers to the minimizing of or the obstruction of extreme weather events, the power of which can be very destructive. Such modification can be executed, for instance, by directing hurricanes or typhoons to sparsely inhabited regions or by smothering their destructive power. Also the controlled disintegration of mist and cloud formations can be seen as preventive weather modification. Furthermore, the *weather modification as hedging* can be related, for example, to ACC in order to protect oneself from various unfavourable and extreme weather conditions. ACC becomes apparent in diverse demanding inconvenient weather and climate conditions which require adaptation, and might therefore tempt to justify weather and climate modification proposals.

Weather modification as a requirement for development aid aims to secure the habitability of a certain geographical area for humans. A paradigmatic case of this kind of weather modification is to create precipitation in regions suffering from drought. The difference between development-based and preventive-based modifications is that the former is targeted at amending existing poor conditions, whereas the latter is aimed to counterbalance hypothesized, but not yet occurred extreme weather events.

The modification of the weather can also be based on political and strategic motives. The objective of *military weather modification* is to alter weather conditions to be appropriate and beneficial for military operations or to be otherwise detrimental to the enemy. The artificial rain caused by the United States

in Vietnam, Laos, and Cambodia in 1967–72 (Fleming 2006, 13–14; Hamblin 2013, 179–196; Harper 2008, 20, 25; Weart 2003, 45;) is an exemplar of military weather modification.

Military weather modification is comparable to *terrorist weather modification*. These two types differ in their objective. The goal of weather modification for terrorist purposes is to cause fear and damage among the public in a situation where no war has been declared, whereas military modification is a part of the institutionalised warfare and the conventional arms race. Still, they are not unmistakably separable from each other. For instance, the Iraqi troops in the first Persian Gulf War lit oil wells and inflicted environmental damage on local climate conditions. For some people, this was eco-terrorism. Others have made similar claims about the US weather modification operations in South-East Asia, which resulted in a piece of new international legislation. The United Nation's Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) proscribes the signed parties to engage in use of military or any other hostile use of environmental modification techniques (Convention 1976; Bauer et al. 1999, 27; Fleming 2007, 56; 2010).

2.2.2. Ethically acceptable weather modification?

It is clear that using the weather as a weapon and as a set of means for destruction raises most pressing questions although other modes of weather modification are beyond critical analysis neither.[34] Jamieson

[34] The World Meteorological Organisation (WMO) has a research program concerning weather modification. In 2007, WMO organized a conference in Oslo where international regulations concerning weather modification were agreed upon on a general level. These regulations seek to take into account the social and legal aspects of weather modification. (WMO 2007.) Furthermore, American non-profit interest group Weather Modification Association (WMA) has an ethical code of practice. WMA announced that their mission is "enabling persons, political entities and other organizations to make informed decisions about the application of weather modification technologies, to provide for adequate water supplies, and reduced natural weather hazards." (WMA 2008; about the history of the association see Steinberg 2006, 127–147.)

(1996) introduced a series of questions concerning the acceptability of intentional climate modification (ICC). He suggested that there are four criteria for guiding the ethical analysis of intentional climate modification. However, these criteria can also be applied to intentional weather modification:

1) The project is technically feasible;
2) Its consequences can be predicted reliably;
3) It would produce states that are socio-economically preferable to the alternatives;
4) Implementing the project would not seriously and systematically violate any important, well-founded ethical principles or considerations (Jamieson 1996, 326).

In other words, Jamieson mainly explores the acceptability of intentional climate modification from the consequentialist point of view where the acceptability of an act is dependent on the consequences of the act in question. As shown later, these criteria can also be interpreted from a non-consequentialist perspective.[35]

Jamieson's criteria are not devoid of difficulties. The first one has problems with defining the possibilities of technical implementation. As discussed above, there is a wide spectrum of methods of climate modification techniques which all require an assessment of their own in order to determine their technical feasibility (Crutzen 2006; Robock 2008; Shepherd et al. 2009).

The front lines are drawn between visionaries defending the possibilities of climate modification and sceptics. For instance, climatologist Alan Robock singles out 20 different reasons why testing and implementing possible climate modification techniques might be a bad idea (Robock 2008). The existing uncertainties concerning both weather and climate modification methods present a plausible

[35] The intention is not to promote the consequentialist interpretation; rather to bring Jamieson's criteria to the debate and thus continue the debate he evoked already in the 1990s.

reason to abandon modification plans for the time being.

The second criterion presented by Jamieson, the credibility of climate modification enterprises, seems disputed. In fact, Robock claims that the modes of geoengineering are at the moment unreliable because there are no chances to predict their immediate consequences (Robock 2008b, 16–17; see also MacCracken 2006, 240). For instance, both weather and climate modification can affect rainfall in ways that decrease precipitation (Robock 2008, 15). This assertion questions the effectiveness of weather and climate modification, and calls into question Jamieson's third criterion. Climate modification can have unpredictable and unforeseen secondary effects which have a bearing on determining the socio-economic impacts of the geoengineering option in question (Jamieson 1996, 328). Not only are the uncertainties constantly present in the evaluation of weather modification proposals, but also it is impossible to assess the socio-economic impacts due to the diversity of preferences. The economic impacts should be secondary to environmental and social impacts and ecological values. Therefore, Jamieson's list of criteria should include an evaluation of the underlying values concerning, for instance, the relationship between humans and nature in the discussion.

For the sake of an argument, it can be assumed that both the technical and financial resources exist, and all imaginable risks are recognized and carefully managed. One could still pose the question of whether there is a moral obligation to engage in weather and climate modification. Behind this leading question is a notion that humans have a prima facie obligation to assist each other and non-humans whenever possible based on the principle of beneficence. Or, at the very least they ought not to hinder the use of means on which one could lean in distress on the basis of the principle of non-maleficence.

However, the principle of non-maleficence is essential in this case, since it commands to refrain from weather modification activities that could harm both humans and the natural environment. For that reason, weather modification activities would probably be banned, or at least tightly regulated, in most

of the cases due to the fact that the risks and the uncertainties are not entirely perceived and controlled, and in addition, due to ethical and legal ambiguities stemming from difficulties in avoiding the harmful consequences. In the same way, other puzzling questions can be asked and responses be formulated. Which organization would have the authority to supervise the implementation and outcomes of the geoengineering enterprises?[36] This question will be addressed in the fourth chapter. Failures with the new techniques would inevitably take place. On several occasions, Schneider has urged the need for an international institution whereas at the same time he admits that the set-up of such a reliable and long-lasting institution seems highly unlikely (Schneider 1996, 300; 2001, 419; 2008, 1). One possible supervising authority for geoengineering enterprises might be the secretariats of the climate treaty of the United Nations Framework Convention on Climate Change (UNFCCC 1992).

The fourth criterion suggested by Jamieson seems conceivable at first glance, but includes severe difficulties in interpretation on what exactly the violation of ethical principles could stand for in this context. The fundamental considerations in the context of weather and climate modification include distributive justice, democracy, precautionary action, risk evaluation, and conceptualisation of the appropriate relationship between human and non-human world. Since the weather is not a private good, any proposal for modifying it must pass a democratic process. The decisions affect people over large areas and beyond national borders, hence it is challenging to perceive how such a democratic process could be carried out in a fair manner. A supervising authority would again be needed here. It would be eminently problematic to justify climate modification engagements implemented by the most affluent states, and the question in such cases remains: would the geoengineering implementations end up aiding those who need it the most? It is presumable that the weather and climate modification as commercial action would delimit its accessibility to those willing and able to pay for it.

Although weather modification as development aid based action is possibly the most acceptable form

[36] Virgoe (2009) deals with the question of international governance of geoengineering implementations, and Victor (2008) concentrates on its regulation.

of weather modification, there are grounds to assume that the techniques might reach only those farmers of affluent states who enjoy public subsidies and gain advantages over farmers in developing countries. The same can be predicted in the case of storm control: extreme weather events, such as hurricanes, could be channelled to regions less prosperous and less able to defend themselves. This would obviously raise various questions with regard to distributive justice. (See Bunzl 2008.) A situation could also be imagined where the redirection of a hurricane would destroy, instead of densely populated areas, pristine nature with high biodiversity values. Consequently, the problems indicate strategic and self-indulgent weather and climate modification where international negotiations and the needs of others are ignored in order to advocate self-serving interests. Without careful consideration of adequate human and non-human values concerning the issue, no ethical justification can be granted to weather modification.

2.2.3. Ethically questionable weather modification

In the spirit of the precautionary principle and the principle of non-maleficence, there are reasons not to engage in an activity which could cause irreversible damages to the environment. Accordingly, one should withhold from weather modification at least until the most pressing questions will be resolved and threats will be minimized. Unless we opt for not to engage at all in such activities on the grounds of the methods being too risky and that they could cause negative impacts on the whole biosphere. Even considering such planetary and local scale activities is a sign of indifference to our appropriate limits of intervention in natural processes and therefore should not be further elaborated. Although this viewpoint is emphasized in this dissertation, not everyone agrees with it. Some parties support the view that implementing geoengineering enterprises might be justified if and when ACC reaches a point where mitigation strategies are proven inefficient, and ACC significantly alters the living conditions of humans, other species, and the biosphere on the whole.

Based on the previous classification it is clear that the greatest ethical problems are associated with the luxury, military, and terrorist weather modification. The most important issues are not, however, the most morally acceptable modes of weather modification, but the idea of atmospheric control by and large. The idea of fully manageable weather is a clear sign of human hubris, and hence unpersuasive. Moreover, turning from chance to choice in weather modification asserts that there would be winners and losers as a result of deliberate weather modification. Needless to say, picking out winners in this case would be highly unethical.

Similarly, ethical problems would arise if for some reason decisions were made to give up the successor of the Kyoto Protocol, and instead investments in developing geoengineering techniques would be made to minimize harm caused by ACC. This would mean giving up on the hope and objective for effective global climate policy and proactive strategies, such as mitigation and adaptation. In such a situation, participating in the development of geoengineering techniques would be, from the standpoint of principlist biocentrism, morally dubious.[37]

The prediction and assessment of the ultimate environmental impacts of weather modification is difficult. The possibility of irreversible changes in weather conditions contradicts the ideal of sustainable development. Myers (1995) warns against considering environmental problems as separate because their interaction can produce unforeseeable "environmental surprises." The possibility of learning from one's mistakes, for instance, by restoration, is lost if irreversible environmental damages occur (Jamieson 1996, 330).

If geoengineering implementations become technically feasible, the successful enterprises reinforce human arrogance in a way that the relationship between humans and nature is considered as

[37] Additionally, the naturalness of weather and climate phenomena could be considered lost in most weather and climate modification schemes, making them ethically unacceptable. Although appealing to some, this argument may not have much importance when considering ACC, which is by itself an unnatural phenomenon.

domination of the previous over the latter. Arrogance also indicates that confidence in the capabilities of weather and climate engineers is overrated. A more realistic approach recognizes the limits of human knowledge and skill with regard to the control of the climatic system. Although Jamieson is rather hesitant about the acceptability of intentional climate modification, he nevertheless states that humankind may reach a point where intentional climate modification is the lesser of two evils when it comes to solving issues and adverse effects posed by ACC (Jamieson 1996, 330–333). More on lesser evil in chapter 4.3.

The ethical criteria presented by Jamieson raise questions which also have significance for the consideration of the ethical aspects of local weather modification. These criteria, though not fully conclusive, call the attempts to modify the weather into question. Neither the idea of lesser evil nor the weather modification implementations are supported on the grounds that the uncertainties, risks, possible adverse side-effects, and inadequate precautionary measures create such an unconvincing justification for implementing weather or climate modification proposals—even if they could moderate ACC or, for instance, relieve drought as a short-term solution. Extreme precaution should be followed in weather modification research and discussion about its deployment.

2.3. Arguments on geoengineering

There are diverse arguments either defending or opposing geoengineering. Some arguments prove the idea of geoengineering problematic without definitive conclusion. Arguments against geoengineering rely on various different justifications, for instance, the unacceptability of unforeseeable consequences, the undemocratic nature of governance procedures, unfair or unsustainable outcomes of the implementation processes, or the lack of motivation for abatement in the case of intensive research,

development, and implementation of geoengineering on a large scale.[38] Robock (2008) displayed a group of at least 20 reasons why geoengineering may not be a justifiable means to tackle ACC.

One essential feature in common with the reasons by Robock (2008) deals with the environmental hazards that geoengineering can inflict. For instance, changes in precipitation patterns are one (Schneider and Kellogg 1974, 1168). Especially in the case of SRM, the stratospheric sulphur injections emulate volcanic eruptions and affect the precipitation patterns. (Robock 2008, 15.) By analysing the natural analog of SRM, a volcanic eruption of Mount Pinatubo in 1991, SRM implementations were recognized to have the same effects as its natural analogy: a decrease in precipitation patterns, and risk of reduced freshwater supplies as well as drought. (Trenberth and Dai 2007, 1, 4; Robock et al. 2013). Principle of non-maleficence and justice lead to a conclusion that major negative effects for the biosphere are a justified reason not to implement a method with major detrimental effects.

In addition, the continuing acidification of the ocean is another cause of concern. Acidification of the ocean is accelerated by increasing anthropogenic GHGs in the atmosphere which absorb into the ocean and decrease the pH value of the sea water. Acidification could be averted with effective CDR. However, the current CDR proposals would reduce global temperatures slowly with a delay of several decades, so the ameliorative effect on the pH level is insufficient. Moreover, CDR has high potential for inadvertent and undesirable corollaries (Shepherd et al. 2009, 18, 47). With SRM or failed mitigation efforts, the acidification of the oceans will continue because the amount of GHGs in the atmosphere is not reduced. These reasons present geoengineering as a high-risk enterprise due to its potential massive negative impacts on the climate system, the oceanic ecosystems, and the biosphere. Alternatively, there are also arguments supporting geoengineering. The rest of the chapter concentrates on arguments for and against the methods as well as the problem of moral hazard which stirs up trouble in careful analysis of the arguments.

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[38] A detailed presentation of the arguments for and against geoengineering can be found, for instance, in Betz and Cacean (2012), IPCC (2013), and Rayner et al. (2013).

2.3.1. The problem of moral hazard

The moral hazard argument proposes that the research and development of geoengineering techniques might generate the weakening of political will to engage in mitigation and adaptation options relevant to climate policy (Robock 2008, 17; Keith 2000, 276; Bunzl 2008). Especially non-governmental organizations (NGOs) have argued that geoengineering not only weakens the political will to control GHG emissions, but also might give an incentive for governments to fund a geoengineering project of their own (Victor et al. 2013). The investments in research on geoengineering might also prohibit the emergence of novel and sustainable solutions to challenges created by ACC because the research funding pool is limited. This could indicate the diversion of resources away from adaptation and mitigation (Shepherd et al. 2009, 4).

The term "moral hazard" is adapted from insurance discourse. An insured stakeholder is more apt to expose oneself to risk and engage in hazardous behaviour. Associated with geoengineering, moral hazard poses a risk that the investments on mitigation and adaptation fade out as a result of the belief that geoengineering provides an insurance against the adverse effects of climate change. On the contrary, geoengineering might also encourage parties to demand effective action on mitigation. (Shepherd et al. 2009, 37, 43.) This could happen if the imminence of climate emergency and rising GHG emissions activate stakeholders to engage in mitigation.

Moral hazard deserves a closer look about its moral nature of which philosopher Ben Hale (2009) claims that it is not a moral issue by nature. Moral hazard can be considered as taking advantage of insurance in a way that the insured party might increase one's exposure to risk. For instance, a person taking an insurance on her house against fire might become more careless when it comes to fire safety issues. (Hale 2009, 5.) Although a normative notion might arise that moral hazard is something morally objectionable or at least problematic, Hale (2009, 20) suggests that there is no moral element in moral

hazard related to lying, cheating, or stealing. A notion that there is nothing morally problematic in increasing one's exposure to risk is not supported. However, I claim that the problem of moral hazard includes normative elements especially in the context of ACC.

Ethical problems regarding moral hazard and geoengineering are the following: first of all, it is widely known that ever-growing atmospheric concentrations of GHGs are fortifying the adverse effects of ACC, and the international negotiations that aim to reduce them are going on with slow progress. The risk of fortification of political inertia, amplified by moral hazard, can be seen as a moral failure. This claim is a result of the research that indicates the well-being of the biosphere being already hard-pressed. According to Rockström et al. (2009), the planetary boundaries as a framework suggest that human actions are the main drivers of global environmental changes. These changes and their irreversibility are categorized into nine interlinked planetary boundaries which determine biophysical thresholds. Some of these thresholds have already been crossed and can cause abrupt and irreparable damages to the biosphere. These are the loss of biodiversity, climate change, and interference with the nitrogen cycle.[39] Hence, moral hazard as an obstacle to large scale mitigation involves a normative element because ACC causes irreversible detriments to the biosphere, and decreases the potential of humans to live a satisfactory life. Moral hazard can also prevent action in the direction of sustainable development in all of the biophysical thresholds of planetary boundaries. In this way, there is a moral element in moral hazard by not taking the effects of rising GHG concentrations seriously enough.

There is a second moral element in moral hazard with regard to ACC and climate emergency. Moral hazard indicates that risky behaviour is conducted more frequently with an insurance than without it. When it comes to climate emergency, it would be irrational to engage in risky activities in an already risk prone situation of a climate emergency, where deteriorating changes in environmental conditions

[39] The other six planetary boundaries are phosphorus cycle, stratospheric ozone depletion, ocean acidification, global freshwater use, change in land use, atmospheric aerosol loading, and chemical pollution. As long as the thresholds are not crossed, Rockström et al (2009, 475) propose that ”humanity has the freedom to pursue long-term social and economic development”.

can be abrupt, harmful, and severe. In other words, in a high risk situation of escalating ACC it would be ethically preferable to act collectively, and prevent crossing of thresholds by mitigating GHGs as much as possible. Moreover, preparing adaptive measures for the most vulnerable regions would also be advisable.

It is unjustifiable to deny the moral element in the moral hazard problem, and the moral significance of mitigation and adaptation in a situation, where a climate emergency is possible in the near future. Principlism offers guiding principles for both common and emergency morality, hence giving guidelines for flourishing of the biosphere which is also necessary for human well-being. If certain tipping points[40] are crossed, the adverse effects of ACC could be irreversible, and worsen the life quality of the biosphere significantly. This is an ethical problem in the sense in a situation where individuals and collectives are aware of the dangers of worsening ACC they have the opportunity to choose between inaction and different courses of action. (Shepherd et al. 2009, 78; Gardiner 2011b, 166).

One of the aspects of moral hazard is that it might encourage BAU lifestyle without any efforts to cut GHG emissions (Bunzl 2008). For example, in a case of flood insurance moral hazard can be noticed as a greater inclination to build houses in locations prone to floods than without the insurance. In the context of geoengineering, an easy and tempting option would be not giving up consumerism, and for example, spray aerosols in the sky to cool the planet. (Goodell 2010, 19–20.) However, the problem of ACC is not solved that easily with aerosol spraying due to the fact that SRM neither abates GHGs nor addresses the problem of ocean acidification.

The moral hazard argument has been claimed as too vague, and creating more ambiguities than it clarifies in the challenges of mitigation, ACC, and geoengineering. It cannot be predicted on the basis of moral hazard whether the stakeholders engage in massive mitigation and adaptation efforts, or

[40] Tipping points in climate science refer to a slight change that can generate rapid and unpredictable changes from one state to another. More on tipping point and its rhetoric in chapter 3.1.1.

whether geoengineering ensures the continuation of consumption based lifestyles with minor abatement efforts or none at all (Hale 2012, 113–115). Although there are only estimates about the accuracy of the moral hazard problem, in the case of climate emergency and geoengineering it would be justifiable to take the problem of moral hazard seriously because the growing GHG concentrations will eventually lead to changes in climatic conditions unprecedented in human history. Individual recklessness, and adventurism as a result of taking an insurance, is a problem of a wholly different level compared to global climatic changes.

An additional problem with moral hazard is that the existence and awareness of technological fixes have an effect on the beliefs about ACC, and the action it requires from individuals and collectives. ACC might not be seen as a great challenge or danger that would call for immediate action if geoengineering is believed to alleviate the threats of ACC on a scale that is sufficient to counteract the alleged damages. The mere belief on the remediative aspects of geoengineering suffices to induce moral hazard and demotivate to engage in mitigation. The criticism towards the moral hazard problem being not an essentially moral problem (see Hale 2012) is still a morally relevant viewpoint. Individual and collective action to mitigate and adapt to ACC has so far been insufficient, if one takes into consideration the current ever-growing GHG concentrations on a global scale, and the scientific research results that emphasize the urgency of mitigation. Provided a technological fix solution in the form of geoengineering is widely embraced, it can be assumed that the motivation to support, and actively engage in mitigation, and adaptation to ACC would not increase on a worldwide scale—rather the opposite.

The problem of moral hazard has at least three different formulations to explicate why it does not clarify the ethical challenges of geoengineering. According to the first variation of the moral hazard problem, business as usual, geoengineering admits established practices without alterations to collective action. According to the second formulation, counterfactual trajectory variation (CFT), geoengineering

shifts from being a plan B to a viable scheme, and part of BAU climate policy. As a third variation, perverse behaviours (PB) claim that geoengineering gives an opportunity to change one's behaviour in a different way than without that option. Hence, a moral agent is more prone to risky behaviour. The exposure to hazardous activity in a world of ACC and geoengineering is distinct from a world without such risky activity. (Hale 2012, 115, 119–121.)

The eminent proponent of geoengineering, David Keith (2000, 276; 2007), uses the first variation of the moral hazard problem (BAU) in his rhetoric. The awareness and knowledge of geoengineering methods might discourage commitments to mitigation efforts. Hale (2012, 120) disagrees on the ethical problem on this viewpoint, and argues that moral hazard cannot establish what is the ethically problematic aspect in laissez-faire BAU, if geoengineering manages to avert the detrimental effects of ACC. This is an utilitarian interpretation of the moral hazard problem: if the outcome is beneficial overall, the problem no longer exists.

The ethical problem in carrying on with BAU is that the planetary boundaries restrict the continuance of current levels of ecologically unsustainable consumption. If these boundaries are carefully recognized, there are grounds to admit that crossing certain thresholds makes the stakeholder morally responsible for one's actions. These boundaries implicate that the statement according to which BAU contains no moral aspects, if geoengineering can prevent and restore the adverse effects of ACC, is not valid. This is due to the fact that geoengineering cannot deter all the damages caused by ACC. Second of all, BAU has other effects in addition to GHG emissions leading to ACC. Crossing planetary boundaries by being aware of the limited resources of the biosphere is morally questionable. Hence, BAU variation of the moral hazard problem is valid in a way that the weakening of political, individual, and collective will to engage in massive mitigation efforts can happen if the beliefs and knowledge concerning geoengineering methods convince stakeholders to believe that geoengineering tackles the problem of ACC enough without mitigation efforts.

The second variation of the moral hazard problem, CFT, is concerned with plan B geoengineering becoming a viable climate policy option. (Hale 2012, 120–121.) The problem with this variation is to find a justification for geoengineering and BAU together. Hale seems to require grounds for claims of why CFT would be a morally bad option. However, other climate policy options are required also, such as adaptation and mitigation, to create ecologically sustainable climate policy options for the future. As stated in the case of BAU variation, excessive use of fossil fuels in highly consumptive societies is ecologically unsustainable. Any innovation that supports the continuation of unsustainable consumption of fossil fuels and consumerism is destroying the potential of the biosphere to sustain life in all its diversity. Moreover, from the viewpoint of distributive justice it is untenable to overuse limited resources, and impair the possibilities to a well-balanced life in a flourishing biosphere. Geoengineering does not participate in tackling the problem of excessive consumption of resources, hence it cannot be considered as a sustainable solution for resource depletion or negative effects of ACC.

According to the third variation of the moral hazard problem, PB, geoengineering lures moral agents to act more irresponsibly compared to the world without it, and exposes the stakeholders to excess risks. This could indicate resigning from mitigation and rising GHG concentrations. Hale (2012, 121–122) does not consider exposure to risk necessarily as a negative thing because geoengineering might bring about other benefits, too. As an example, Hale mentions that some geoengineering methods are inexpensive, and could free resources for other instances, such as building hospitals. The example is not credible as there are no guarantees that the research funding for geoengineering would be available to the social sector in any way.

Nevertheless, geoengineering should not be ethically assessed solely from the utilitarian viewpoint. The estimations on the consequences of geoengineering are currently uncertain, and foreseeable consequences are not the only aspects to be considered in a comprehensive ethical assessment of the methods. The questions of distributive justice and ecological sustainability as well as the constraints of

limited resources are also issues to be taken into consideration. In addition, one essential ethical question is the ethical acceptability of engaging in massive manipulation efforts of the climate system with the technical knowledge mastered by only few of the most educated experts in the world—if even them.

It is inconclusive what it is that the variations of the moral hazard problem actually oppose or criticize. Hale presents 16 different variations altogether, and calls for clarification of the problem. (Hale 2012, 122–129.) Is not the earlier mentioned unsustainable growth of GHG emissions the main reason for the moral hazard problem to be ethically dubious? Although the solely utilitarian viewpoint was rejected earlier, there are grounds to hold the moral hazard problem as ethically unacceptable. The reason for this is that the failed mitigation efforts are not ethically justified due to the hazard to the flourishing of both human and non-human life in the biosphere. In addition, it also violates the principles of autonomy, justice, non-maleficence, and beneficence based on greater exposure to risk.

Views that moral hazard can in effect encourage mitigation efforts, have also been presented. This means that geoengineering implementation would not necessarily diminish the motivation to engage in mitigation, and would not increase exposure to risk. As an analogy, Caldeira and Keith (2010) argue that the development of safety belts in cars has not increased recklessness in traffic.

In the light of current scientific knowledge, it is difficult to think of how it can be morally permissible to continue both BAU, and growing GHG emissions. Even though some advocates of geoengineering claim that it is worth taking a risk rather than watching the mitigation efforts fail, this is not self-evident. In any case, the changes caused by ACC can be considered negative for the most part, and those adverse effects can be deemed as ethically unacceptable from the viewpoint of the biocentrist principlism as well as the three basic moral theories: utilitarianism, deontology, and virtue ethics. In the next chapter, the arguments promoting geoengineering are analysed.

2.3.2. Arguments for and against geoengineering

The detrimental effects of a climate emergency would affect humans as well as the biosphere as a whole. This kind of narrative that aims to persuade people to accept potentially dramatic measures in order to avoid an impending and pervasive environmental catastrophe can be called *emergency scenario rhetoric* (ESR). It includes millenarian thinking (Heyward and Rayner 2013), tipping point rhetoric (Markusson et al. 2013; Heyward and Rayner 2013), environmental apocalypticism (Veldman 2012), catastrophism (Szerszynski and Urry 2010), alarmism (Risbey 2008), and any other kind of rhetoric in the ACC discussion that calls for urgent and unconventional action to tackle the crisis. ESR in its various forms shares the objective of warning about the impending catastrophe, and exhortation to immediate action to avert the looming environmental disaster. ESR will be elaborated more closely in the third chapter concerning climate emergency.

The arguments pro geoengineering are based on various justifications which will be elaborated as follows. The Royal Society presents two perspectives that promote geoengineering. The first one is that geoengineering is a method for buying back some of the time that was lost on the failed international mitigation negotiations (Shepherd et al. 2009, 45). This argument is a common one among proponents of geoengineering, even if the advocate admits to be disinclined to embrace the idea of intentional climate modification (Crutzen, 2006). Keith (2007) argues that with geoengineering, it is possible to buy time to boost mitigation efforts. The time gained by geoengineering is suggested to be used to develop clean energy, and delay the climate catastrophe (Kintisch 2010, 16). Nevertheless, there is no certainty of active mitigation efforts if geoengineering is executed. There is a possibility that the argument of buying time is just wishful thinking among the proponents of geoengineering.

Another perspective of geoengineering the Royal Society presents is that geoengineering is an insurance policy against major mitigation failure (Shepherd et al. 2009, 45). Arguments promoting geoengineering

as plan B and a lesser evil have emerged in the same context depicting geoengineering as a shield or a protective measure (e.g. Crutzen 2006; Victor et al. 2009; Blackstock et al. 2009; Gardiner 2010c; 2011). Proponents of geoengineering bring forward the gloomy future scenarios, and claim that there is no time to develop trouble-free solutions to tackle ACC. Hence, geoengineering is needed even if it would have several negative side effects because it has the potential to weaken catastrophic ACC (Kintisch 2013, 307). One of the advocates of geoengineering, David Keith (2007; 2013), uses this lesser evil rhetoric in his arguments for pursuing research and development of geoengineering. Research programs of geoengineering should be initiated in order to discover the level of feasibility of the various geoengineering technologies. Keith's (2013) viewpoint is a simplification of the multitude of options of climate policy. The problems with this kind of binary reasoning are not to be ignored because delimiting alternatives for action regarding ACC to either geoengineering or facing dangerous ACC is short-sighted, and should be substituted with more broad-minded perspectives.

One of the problems with introducing geoengineering to the climate policy arena is the possible dependency on these schemes, for example, on SRM. Failed or suddenly stopped SRM implementations could lead to rapid warming of the climate (Matthews and Caldeira 2007, 9949; Brovkin et al. 2009, 255; Goodell 2010, 20). Not only is it a challenge to establish a reliable and functioning long-term geoengineering method, but also the appropriate reliability of continual human action is an open question. Is humanity talented enough to take action in the demanding task of stabilizing and keeping the climate in balance (Lovelock 2008, 6; Robock 2008)? Sometimes things fall apart due to human error, and this factor has to also be taken into consideration in assessing the reliability of implementations.

The arguments against geoengineering are also manifold. The Royal Society features an argument against the implementation of geoengineering based on a claim that geoengineering portrays a hazardous manipulation of the Earth systems, and is therefore inherently unethical (Shepherd et al.

2009, 45). This viewpoint is brought forward, for instance, by the Indian environmental activist Vandana Shiva (2010; 2014), and the international organization ETC Group[41] (2010, 33). Shiva (2010; 2014) points out that the problem of ACC cannot be solved with the same engineering paradigm that initially caused the whole problem of ACC. ETC Group (2010) lists several reasons why geoengineering is inherently unethical. Not only does geoengineering violate international treaties like ENMOD, and is untestable in its experimental phase, geoengineering is also risky, unpredictable, unequal, possibly unilateral in an unfair manner, and an excuse for governments not to engage in mitigation efforts. The list of reasons considers ethical questions regarding distributive justice, the moral hazard problem, equitable governance, unknown and unpredictable environmental effects, and inequitable unilateral implementations. From the point of view of an ethicist, the ETC Group's list has diverse arguments and cannot be ignored although geoengineering does not have to be judged as inherently unethical, before careful assessment of the arguments. The moral acceptability of geoengineering is much more complicated an issue than to label it as straightforwardly unethical or ethical. The methods should be assessed individually such as the arguments.

Martin Bunzl (2008, 18) considers geoengineering from the perspective of social justice. He brings up the possibility that the geoengineering implementations can be planned and governed in an unfair and elitist manner, and its benefits and harms can be distributed unevenly. A part of the opposition directed to geoengineering originates from the notion of delusion of planetary control, and moral objectionability of excessive intrusion and manipulation of planetary systems—in this case the climate (see Preston 2011).

In conclusion, the arguments against geoengineering are not only concentrated on the negative

[41] ETC Group (full name Action Group on Erosion, Technology and Concentration) is an international organization concentrated on exploring socio-economic and ecological issues concerning new technologies and their effects. Their main focus is on cultural and ecological diversity, and human rights. ETC Group has also established a campaign against geoengineering "Hands Off Mother Earth" (H.O.M.E. 2010) which works as a platform for organizations and individuals that oppose the research and development of geoengineering experiments.

corollaries of the implementations which obviously are important issues. However, the notion of human mastery over the climate evokes ethical challenges as well. There is a limited understanding of the atmospheric processes which gives rise to the suspicion that the ethical justification of geoengineering is questionable. In the next chapter, the concept of climate emergency is analysed, and its connection with ethical aspects of geoengineering is explored.

3. CLIMATE EMERGENCY AND GEOENGINEERING

In this chapter, the discussion regarding climate emergency and ACC, and the pleading to avoid them with geoengineering is analysed. The rhetoric around geoengineering is rich and filled with ambiguities. For instance, the most prominent advocates of geoengineering, David Keith and Ken Caldeira (2010, 57) claim: "Like it or not, a climate emergency is a possibility, and geoengineering could be the only affordable and fast-acting option to avoid a global catastrophe." Already in 1992, UNFCCC intensified the discussion concerning dangerous climate change. Article 2 states that the objective of signatory nations is to stabilize GHG emissions to a level that "would prevent dangerous anthropogenic interference (DAI) with the climate system" (UNFCCC 1992). In assessing DAI, there are multiple aspects to be taken into consideration. A prominent American climate scientist James Hansen (2005, 13; 2006, 950, 969) emphasizes the importance of mitigation, and states that an alternative scenario of slowing down the growing concentrations of the GHGs is possible. However, it will not be realizable without strong climate policy leadership, advancements in clean energy technologies, and prompt international co-operation[42].

The scope, probability, and occurrence of timing of the effects of DAI can vary greatly (Keller et al.

[42] Hansen's (2006, 966) alternative scenario to avoid DAI has two interdependent requirements. To put it shortly, intensive mitigation should happen before the 2050s, and in addition to CO_2, abatement should also include methane, carbon monoxide, and black soot.

2007, 227). DAI can emerge, for instance, as the disintegration of the West Antarctic Ice Sheet (WAIS) or as widespread bleaching of coral reefs. Climate emergencies are defined as circumstances in which severe consequences of ACC occur swiftly, and cannot be averted by mitigation due to the long lifetime of GHGs in the atmosphere (Blackstock et al. 2009, 1). The IPCC (2001) has assessed five reasons for concern to identify the key vulnerabilities of ACC: risks to unique and threatened systems, risk of extreme weather events, distribution of impacts, aggregate impacts, and risks of large scale discontinuities. Currently, the estimations of the limit of DAI circle around 2°C rise to the average temperature of the Earth[43] (Mann 2009, 4066). Nevertheless, the declaration of a climate emergency is far more multifaceted an issue than solely observing the rise of the average temperature, and potential limits of DAI to assess an impending climate emergency.

Even if a certain threshold or a tipping point could be assessed adequately, it would also require policy decisions and moral judgement to evaluate what kind of level of risk associated with the tipping point is acceptable, and how it could be averted if a decision to do so was made. Hence, DAI cannot be predicted accurately. The definition of DAI is a political decision linked to the adaptive capacities of the social, ecological, and the climatic system. In other words, science identifies certain critical levels which need to be taken into consideration in policy making as well as defining DAI. (Parry et al. 1996 2, 5–6.) Suraje Dessai and his associates (2004) analysed the danger associated with ACC. It cannot only be interpreted as an external danger by technical analysis of risk and thresholds. The internal definitions of danger also play a role in interpreting dangerous ACC. These internal definitions are based on complex processes of experienced or anticipated insecurities that are associated with the climatic events of ACC, or lack of safety with regard to ACC by individuals, collectives, or societies. An adequate climate policy response contains both of these definitions in the assessment of dangerous ACC and climate emergency.

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[43] There are several estimates of the limits of DAI. Keller et al. (2005) consider 2,5◦C as a climate limit that reduces the probability of triggering WAIS disintegration to low levels. Hansen (2006, 966) considers 1◦C average warming as an ideal objective to avoid DAI.

The most relevant ethical questions regarding climate emergency are related to the possibilities of morally right actions in emergency situations. The promotion of geoengineering has been brought forward in the context of climate emergency, and it is seen as a restorative or protective enterprise (Crutzen 2006; Victor et al. 2009). There are opposing viewpoints about the moral acceptability of geoengineering as a remediative technique to tackle ACC and climate emergency (e.g. ETC Group 2010; Long et al. 2011; Hamilton 2013a). This chapter analyses climate emergency, and its relationship with geoengineering.

3.1. Climate emergency

Currently, ACC and nuclear winter are considered two of the most perilous phenomena to the future of humankind (i.e. Coates 2009; Morgan 2009). The scenarios of an imminent climate emergency originate from the notion of failed mitigation and adaptation efforts. Despite international negotiations and agreements mitigation has not been successful, and has created confusion and ethical challenges. What is a climate emergency—or radical emergency—and under what conditions of ACC can it be declared? Two British researchers, Clare Hayward and Steve Rayner have defined a climate emergency as "a rapid and drastic physical change in the Earth's climate, which could have extremely pernicious effects on human well-being" (Heyward and Rayner 2013, 16). Apart from humans, the ecological sustainability, and the flourishing of ecosystems are also in danger. From the viewpoint of international law, a climate emergency would have to be considered as "grave and imminent peril" in the eyes of governments and international community in order to be defined as an emergency. (Markusson et al. 2013, 4.) In this chapter, the three prevalent climate emergency approaches are analysed individually.

3.1.1. Three climate emergency approaches

At least three different approaches can be discovered in the ACC debate and be applied to climate emergency. The first approach, *scepticism*, challenges the climate science, and relies on an assumption that if climatic conditions undergo changes, they are mostly due to natural processes rather than anthropogenic. In other words, if there is reason to worry about natural variances of the climate, it is not related to cumulative anthropogenic GHG concentrations. In addition, scepticism does not encourage financial investments in adaptation and mitigation concerning ACC as compared to other global challenges. (Szerszynski and Urry 2010, 1, 2.) Other interpretations of this approach also exist, for instance, sceptics who promote geoengineering. In this case, there is an aspiration to master the naturogenic changes in weather and climate. Weather modification is one instance of intentional weather and climate modification without necessary reference to ACC.

The second approach regarding ACC and climate emergency is *gradualism*. It is promoted primarily in the reports of the IPCC (1990–2014), according to which climatic changes are mainly slow and gradual processes, leaving space and time for action on tackling ACC. Individuals and societies have the potential to adapt to future changes if they choose to pursue that direction. The third approach is referred to as *catastrophism*. It emphasizes the significance of limits of science and related uncertainties—in this respect it is similar to the views of sceptics. However, catastrophism shares with gradualism a view about ACC. The fundamental difference with the other approaches is the emphasis on non-linearity, thresholds, and abrupt climate change caused by positive feedback resulting in disturbances of equilibrium of climatic conditions and ecosystems. (Szerszynski and Urry 2010, 1, 2.) All of these approaches have different views on when or how a climate emergency could occur.

Catastrophism recognizes the emerging climate emergency as a problem of the present whereas gradualism predicts that a climate emergency might loom in the future if mitigation and adaptation

efforts fail, or are not undertaken in the first place. Scepticism can acknowledge some alarming characteristics of climate change, however, it does not suggest that they should be responded to in the same manner as catastrophists suggest. For instance, one major difference between these two approaches is the cost-effectiveness of mitigation. Thus, depending on the approach, a climate emergency can be seen as a remote challenge of the future generations, or an actual problem of current societies waiting to be solved. This dissertation concentrates on the approach that acknowledges the reality of ACC, and concentrates on the proposed solutions for climate emergency aid. For this purpose, the abrupt ACC and catastrophism as a combined interpretation of the climate emergency offer the best possibilities to sketch the ethical problems of the issue.

Abrupt ACC refers to changes that are unpredictable, and occur by crossing the relevant thresholds causing disastrous effects. As opposed to abrupt paradigm, the interpretation of the impacts of ACC are the gradual and incremental climatic changes which have been formerly predominant regarding the understanding of the characteristic features of ACC. This change of paradigm from gradualism to an abrupt scenario follows from the realization that the climatic system has irregular properties (Gardiner 2007, 2).

Climate and other natural scientists have paid a great deal of attention to identifying events and long-term trends that indicate tipping points or thresholds for major and sudden alterations in climatic conditions (Alley et al. 2003, 2008–2009; Lenton 2011; 2013)[44]. The discussion regarding tipping points did not originate from the observations of abrupt changes in the climatic events. The tipping point originally referred to epidemiology, and Malcom Gladwell (2000) adapted the term to describe the emergence of rapid social changes. Tipping points share three characteristics: first of all, the phenomenon is contagious and can spread fast. Second, even minor actions can have substantial effects. Third, changes do not occur gradually, but abruptly in an instant. (Gladwell 2000, 9–14.) The

[44] Thompson and Sieber (2010) consider tipping points as identical to dangerous bifurcations of non-linear dynamics as well as tipping elements, which all refer to transitions to a qualitatively different state by changes in climatic events.

characteristics of a tipping point metaphor are also applied to the discussion regarding ACC. By interpreting scenarios, models, and theories, informed judgements concerning the current state of ACC can be made. The real challenge with the observation of tipping points is that by the time they are identified it might be too late to reverse the apparent climatic changes underway (Lenton 2013, 1).

A researcher of religion and nature, Whitney Sanford (2011) has explored the issue of environmental degradation caused by industrial agriculture from the viewpoint of rethinking the agricultural practices through moral imagination. In other words, moral imagination guides the re-interpretation of practices which takes into consideration their effects on the biosphere. For instance, Land Ethic as presented in the book *A Sand County Almanac* (Leopold 1949) exemplifies the aspiration to create alternative narratives of the interaction between humans and nature. The holistic viewpoint of Leopold emphasizes the interdependence of a biotic community. The biocentric principlism shares a similar notion of the biosphere as an ecological totality of interconnected entities. Humans are members of that community, should act accordingly, and take into consideration the effects of their actions which affect the biosphere. The legacy of Leopold and Taylor, and their alternative narrative of humans as members of the biotic community as well as Sanford's suggestion of rethinking the practices of human action are also relevant in respect to ACC and geoengineering. Instead of leaning on the conventional ways of a mechanistic world view and solutions to environmental degradation, ACC could be interpreted in novel ways which do not necessarily involve geoengineering in the future climate policy palette.

The re-interpretation of the roles of human beings with regard to the natural world can clarify the interaction between those two entities. Currently, the interaction between humans and the natural world can be defined as amorphous. The relationship is vaguely defined because it fails to provide specific normative guidelines for human action. A moral agent can declare her love or appreciation to nature without any implications that the declaration will be materialized in activity. Sanford suggests that

stories and the assessment of roles are tools for critical examination of current human practices. Ecological imagination in particular, can be used as a tool for expansion of moral imagination to link humans to the surrounding biosphere, and re-evaluate the relationship between humans and nature. Metaphors and morality can be combined in a way in which metaphorical structures frame and reframe moral thinking. This framework can be examined through analysis of our moral reasoning and through the use of metaphors. (Sanford 2011, 286–287.)

Sanford's (2011) interpretation of ecological imagination is applicable to the ethical analysis of ACC and climate emergency. It is of vital importance to notice that the narratives which are used to describe and promote or oppose geoengineering are not objective interpretations. The emergency scenario rhetoric (ESR) as mentioned in the previous chapter, is a conscious choice that aims to emphasize the urgency and the hazardous character of the situation. As a part of ESR, Markusson et al. (2013) introduce pre-emptive arguments that identify a potential threat—climate emergency—and call for research and deployment of geoengineering. Although it is not an inevitable fact that those detrimental prospects will actualise because the scientific understanding of prediction and definition of a climate emergency is limited, pre-emptive arguments draw upon visions of an emergency. ESR seems to affirm uncertainty about the future, and makes it an even more a vexed question how to decrease the level of uncertainty in climate science. Markusson et al. (2013) suggest that ESR should not be used in climate policy due to its ability to constrict discussion and politics. Hence, the rhetoric based on visions of a controlled world of geoengineering, or Earth in distress because of a climate emergency, delimit deliberation and narrow down the scope of moral and ecological imagination.

As for climate emergency and its inevitability, the abrupt nature of ACC does not implicate that climate policies should necessarily concentrate on avoiding tipping points (Heyward and Rayner 2013, 5). ESR is a constructed narrative that involves elements of impending and dangerous ACC, apocalyptic visions of future, and claims to engage in efficient mitigation efforts either with or without geoengineering,

and could instigate policy-making in various different directions depending on the selected objectives. Nevertheless, the target of the emotional aspect of ESR is to motivate actors to transform their practices. By emphasizing fear, ESR and climate emergency rhetoric can deter people from engaging in mitigation and demotivate them. Appeals to fear, as well as alarmism (O'Neill and Nicholson-Cole 2009) and apocalyptic references (Skrimshire 2010), are prevalent in ACC narratives.

ESR can oppose the research and development of geoengineering, and suggest fast decarbonisation of societies as a solution to the problem of ACC. Also, it is possible to promote geoengineering within the ESR by arguing that geoengineering is the lesser evil compared to a climate catastrophe. In addition, geoengineering can be advocated within ESR as a plan B after mitigation of GHGs, suggesting that the plan A of mitigation failed. Third possibility to promote geoengineering within the ESR is to endorse its potential as a leverage to buy time to initiate massive mitigation efforts. A critical question to the last proposal is to challenge the assumption that mitigation would ever reach large-scale implementation if one is aware of the political inertia and slow progress that has been reached in mitigation of the GHGs globally (Gardiner 2010c). It would require a complete transformation of the international negotiations to speed up mitigation plans, something which does not seem likely at the moment. As a physicist and a proponent of geoengineering, Lowell Wood stated in a gloomy and pessimistic manner: "Mitigation is not happening and is not going to happen" (Fleming (2007). Nevertheless, an ethicist would be happy to admit being wrong alongside with mitigation pessimists if the negotiations in international climate policy would shape up and speed up abatement efforts.

The political claims about the necessity of certain climate policies, and the assertions of the inevitability of an impending climate catastrophe have roots in millenarian[45] thinking. The so-called green

[45] Millenarianism is initially a Christian doctrine about the apocalyptic expectations and the second coming of Christ narrated in Revelations. It is also a widely used concept to describe the anticipation for a transformation of society which initiates a new era. Rayner (1982, 248) defines millenarianism as "movements which organise their activity around the belief that the world will be turned upside down by the imminent intervention of an external agency, which will exalt the weak and humble the powerful."

millenarianism originates from the time of the rise of the environmental movement in the 1960s. The impending environmental crisis in its various forms gave science the authority to suggest and justify certain actions, for instance, environmental protection and prevention of resource depletion. Millenarian thought concentrates on the impermanence of the current world order, and includes an idea of preparedness for the new era. Action and behavioural change is encouraged before it is too late to avoid a catastrophe. (Heyward and Rayner 2013, 5, 9, 11, 12.) In the context of ACC, green millenarianism is a part of ESR, emphasizing the importance of decarbonising societies in order to avoid a climate emergency and pave way to new, coal-free future. So far, climate emergency has been referred to only as the looming detrimental effects of ACC. Different interpretations of emergencies are elaborated in the next chapter.

3.2. Supreme emergency and radical emergency

There are various kinds of emergencies in different situations in life. Wars**,** natural disasters, infectious diseases, and accidents such as fires and car crashes are examples of emergencies which have been targets of philosophical scrutiny in one way or another (e.g. Walzer 2004; Sandin 2009). They are obvious cases of dire circumstances although they seem to have a different concept of emergency when it comes to the severity, scale, endurance, apparentness, and intensity of the situation, and the realization of values threatened. The last-mentioned refers to losses caused to objects of value: to concrete entities such as human individuals as well as to abstract objects, for example, biodiversity and national sovereignty. Sandin (2008) classifies threats to humans into two different categories, antagonist and non-antagonist ones. Antagonist threats include an identifiable opponent. ACC and its negative effects can be considered as a non-antagonist threat to humanity and the biosphere. The so called adversary in the case of abstract ACC is a non-evident entity. Non-antagonist threats can also be described in Walzer's terms as supreme emergencies as will be further explicated.

Wars are cases of "supreme emergency," as Michael Walzer (2004, 33) claims, when "our deepest values and our collective survival are in imminent danger" in an assault. Such an emergency can be instantly recognizable although there are debates about the justifiability of the use of armed forces. Natural disasters and accidents are also political in their nature because the foreseeable damages can be mitigated and governed through, for instance, civic education, zoning ordinance, building standards, and various other safety measures. ACC is a specific kind of an emergency due to its abstract and non-evident as well as transnational character, and it is a highly scientific affair. The symptoms of an emergency caused by ACC or its consequences such as wars, disobedience, forest fires, and flood disasters, are however, clearly visible although the emergency of the situation might be non-evident, at least at first glance.

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 it involves hesitation over the right course of action including the possibility of omission. It does not follow, of course, that all moral dilemmas are cases of moral emergency. Some of the dilemmas are conflicts of principles that exist in theory. Alternatively, with a sufficient time frame, the adequate guiding principle for morally justified action can be found.

The topic of emergency appears also elsewhere in the field of applied ethics. To illustrate the seriousness of a climate emergency, both health analogies to the state of climate, and warfare analogies to ACC have been made. Most famously, Lovelock (2000) speaks about "planetary medicine," and compares the present state of affairs with the situation before World War II (see Lovelock, 2008, 3888). Back then only a few medicines were known to be effective on diseases despite the well-founded science of physiology. Lovelock compares those conditions with present climate science and geoengineering plans, and raises the question of sufficient expertise in balancing the effects of ACC.

In an emergency situation, educated 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. The emergency can be treated either in a hospital or the personnel can be transported to the scene of the action. This is so because the scope of the emergency is limited to the patients or affected groups in need of assistance. 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 an emergency due to ACC could be interpreted in this way. The suggestion for a new attribute to describe this kind of a situation is *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 et al. 2004, 1801).

This definition of a complex emergency does not include natural disasters because they are thought of as having more short-term effects. Yet, ACC can induce long-term—even thousands or more years—adverse effects on humans and the biosphere. Therefore it is best to use the novel concept of radical emergency to designate a new situation created by ACC that is both complex and long-term as well as perhaps even unprecedented in human history. Evidently, climate emergency is a crisis that cannot be solved by BAU policy, and therefore it requires special attention and action (Morgan et al. 1999; Spratt

and Sutton 2008, 63). Because of the characteristics of the situation, the responses to it have to be large-scale and trustworthy, despite the fact that they might not be properly tested before the implementation. This refers especially to ESR promoting geoengineering: methods are advocated although the techniques themselves are not yet ready for reliable large-scale implementation.

Besides ACC, other instances of a radical emergency include quickly spreading and highly lethal infectious diseases**,** a meteor crashing to the Earth, or a massive volcanic explosion, also known as a supervolcano. Climate emergency denotes a specific state of affairs on the planet Earth that contains at least two following features. First, the ACC is an immediate or impending threat to life and health of humans, and non-human entities. Second, there is a high probability of escalation of the social disorder in the form of economic turmoil and mass migration of climate refugees, if no immediate action is taken. The possibility of abrupt ACC strengthens the idea of impending danger. Then, climatic and weather conditions can appear suddenly, and the scale of the effects is unpredictable. There are alternative scenarios for the ensuing events once certain thresholds are crossed. However, due to the abrupt nature of ACC, estimations cannot be completely accurate. Still, on the level of national legislation, state of emergency and martial law can be established as a backup plan for a climate emergency.

One of the ethical problems that is essential in the context of a climate emergency and ESR is whether the conventional norms are seen to apply in emergency situations. Climate emergency is non-evident at first sight which obviously causes confusion and disagreement in diagnosing, and declaring of the emergency. Still, ethical questions are not devoid of content, but instead evoke new topics: are selfish or morally dubious propositions and actions morally permitted in a climate emergency, even if those actions are regarded as morally prohibited in common morality? This would include, for example, looting or forms of excessive physical violence for self-defence. The same ethical problem in a larger context would be, for example, whether nation states are morally required or allowed to assist their

citizens at the expense of other nation states and their inhabitants. This question arises especially in considering the moral acceptability of intentional weather and climate modification which may benefit some areas or nations, and cause detrimental effects on others. There are no straightforward answers to these ethical quandaries. Wide reflective equilibrium as a research method guides us to take principles, facts, and background theories into consideration when constituting ethical decisions. Principlism together with biocentrism and up-to-the-minute information on climate science makes adequate ethical assessments possible.

On the basis of this excursion to ideas of emergency, a question arises naturally: in regard to ACC, are we getting closer to an emergency setting that is similar to the ones constantly encountered in medical practices or in war? As mentioned earlier, radical emergency designates a situation where conventional risk management falls apart. This might also be possible in the case of a radical emergency and runaway ACC as a non-antagonist example of imminent danger. Emergency in a situation like a transnational pandemic has characteristics of a radical emergency. Transnational emergency is different from an emergency declared by a single nation state. Before the actual emergence of an emergency, ethical principles can be established, and preparedness plans including those principles can be elaborated (e.g. Tuohey 2007[46]).

Proponents of geoengineering bring the emergency arguments and 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 ACC, and therefore geoengineering capabilities should be created, even though not necessarily used. Climate emergency measures used as a shield are a political choice. However, political solutions in the case of ACC are not known to be particularly swift decisions. This presents a dilemma for geoengineering and the policy-making of ACC. In the latter argument, geoengineering capabilities

[46] Tuohey (2007) brings forth emergency preparedness plans for pandemic outbursts that include an ethical matrix of principles to support decision making in emergency situations.

should not only be created, but also used as quickly as possible because the planet is already in a state of emergency. The problem with ESR argumentation in the case of ACC for quick emergency implementations is that it is difficult to establish the accurate critical stage in which the climate emergency is actually at hand. This makes ESR particularly dangerous due to the risk that some parties will engage in environmentally detrimental activities by referring to an actual 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 inevitably be used at some point in time. This is a possible scenario in the case of geoengineering, since there are several methods and research projects that have vested interests in research and development (Hamilton 2013b). Another argument is that the decision about the use of geoengineering depends on our perception of the imminent danger. Geoengineering might be applied as a precautionary measure in the early stage of ACC with risks involved. For instance, there might be an incentive to use the technology inappropriately and in destructive ways. 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 the technology is very short even though the moratorium by the United Nations Convention on Biological Diversity (CBD) and the London Convention is still in effect (CBD 2010; ETC Group 2013).

Saving or losing the lives of millions who are in immediate danger because of the choices of the few is also a potential situation present in ACC as radical climate emergency. The concept refers to the situations that are complex, novel, and have long-term effects. 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 a moral agent—which could also be a state or an institution or a community—to perform actions that would be prohibited as too risky, or considered immoral, in conventional situations.

Radical emergencies are often moral emergencies since there is a tragic element present: every option open bears moral costs, such as the violation of individual rights or threats to collective survival. If an emergency situation is a kind of a moral black hole, one can ask how responsibility is included in the action of choosing one option over another (Sorell 2003). A moral black hole argument consists of the notion that in antagonist and non-antagonist[47] emergencies common morality is subsided and gives rise to a situation where moral norms are stripped of their power. This argument has not gained empirical evidence, though. Altruistic behaviour and the need to maintain social bonds have been found in instances of crises. Although it is possible for a moral black hole to emerge, it is still not very probable in the case of a non-antagonist climate emergency. (Sandin and Wester 2009.) This potential altruism does not, however, rule out the significance of precautionary measures of possible emergency situations.

Geoengineering has entered the discussions on the basis that in an emergency situation—in this case a radical climate emergency—one should 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.

Radical emergency can be interpreted from paraphrasing Walzer's concept of supreme emergency, as a severe vulnerability or disintegration of collective values and survival. The principlist approach can offer guidelines for action in a radical emergency where there is limited time for negotiations for the best alternatives of action. Even though the gloomiest projections of a radical climate emergency have not been established yet, the current situation in the light of climate science requires the consideration of the possibility of a climate emergency. It is not supportable to withdraw oneself from the sphere of common morality to enter a moral black hole in an emergency. The principlist viewpoint can apply to

[47] A non-antagonist emergency is a situation other than war or other conflict where there are at least two opposite adversaries. In non-antagonist emergencies, for instance, in natural disasters there are no such identifiable opponents,

all situations on the basis that the mid-level principles give room for individual deliberation, and the consideration of background theories, such as biocentrism in this dissertation. In this manner, there is a possibility for making ethical decisions in all possible situations.

At their worst, 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, principlist, or some other ethical approach. For instance, the conclusion of a morally right action depends on 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 basic human rights, or 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. To consider current geoengineering proposals ethically justified, one should not only grant that a radical emergency is possible, but also refine the ideas of sustainability and the environmental protection in order to ensure the continuance of a flourishing biosphere including humans. Hence, the perspective that in an emergency the moral realm is abandoned, and one enters a territory of emergency or a moral black hole where conventional morality no longer affects, is not supported in this dissertation. Neither stretching common morality in a climate emergency nor accepting the lesser evil regardless of the fact that it involves evil is not encouraged either[48]. Instead, the biocentric principlism should be used as guidelines of ethical decision-making also in a radical climate emergency.

[48] For the sake of the argument, let us assume that there are no morally excellent or good options available.

The interpretation of a climate emergency as a radical emergency and the adequate means to operate with regard to ACC depend at least on the following matters: the prevailing paradigm of science, the state of affairs in climatology, the prevailing ethical perspective (anthropo- or biocentric, consequentalist, non-consequentalist, principlist, etc.), relevant and current ethical issues, and the state of international climate policy. A radical climate emergency needs a specific definition before the risky last resort measures can be taken into consideration as part of a sustainable climate policy. Furthermore, 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. Thus, the principles are in effect even in the most desperate situation. Biocentric principlism entails that other living entities as stakeholders are also taken into consideration in the decision-making of relevant emergency action in ways that are as humane as possible.

The answer whether geoengineering or some of its methods are morally satisfactory means to tackle climate emergency 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 a house on fire, it is extremely important to notice that the burning planet Earth due to ACC is *non-evident*. However, morally evil actions are still evil whether done in an emergency or not. This means that if geoengineering—or at least some part of it—is considered as morally indefensible, it is still that even in a climate emergency.

Hence, creative solutions to construct future scenarios including the ethical aspects along with technical engineering are recommended. The only way to mitigate catastrophic climate emergency is to transform human practices, and enhance mitigation and adaptation. The history of humanity is a history of remarkable progress and creativity in many occasions as well as failures in other areas. One should be suspicious of imagining that geoengineering is the only or 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 on the relevant and sustainable climate policy, and whether to add geoengineering or other similar proposals to the survival kit of climate emergency control.

Pacala and Socolow's (2004a) suggestion of mitigation with stabilization wedges does not mention geoengineering in the climate policy portfolio at all. By intensifying mitigation in a portfolio of various existing technologies, Pacala and Socolow (2004a, 968) are convinced of the solution to ACC: "Humanity can solve the carbon and climate problem simply by scaling up what we already know what to do." CCS is mentioned as one of the potential means of decarbonization. It resembles CDR in a small scale, hence the stabilization wedges approach has possible connections to some geoengineering methods of removing carbon from the atmosphere. (Pacala and Socolow 2004a, 968–969.)

To summarize, cases of emergency and their management are various. Therefore, the vocabulary of emergency and ESR is rather heterogeneous, reflecting the fact that car accidents should be reacted to differently than wars or infectious diseases. For instance, the clearly apparent emergency of a major disaster such as a major aviation accident is different from non-evident emergency of ACC, for example, in a form of a relatively slow rise of the sea levels. Hence, ACC is a transnational 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. It is non-evident, yet it can be detrimental and apparent the next moment due to the abrupt nature of ACC. The possible bleak scenarios that the ACC causes as a radical emergency are gloomy. Furthermore, I will argue that there can be more reasonable ways to react to this problem than geoengineering.

3.3. Geoengineering and climate emergency

The debate of climate emergency within ESR has begun in the media, the political arena, and in scientific discussions. Gardiner (2011a, 20) makes a point that a public declaration of a climate emergency regarding ACC has not been done yet. Or has it? The United Nations secretary general Ban Ki-moon visited Antarctica in November 2007 to learn about the effects of ACC. In an interview he expressed the following: "This is an emergency and for emergency situations we need emergency action." (BBC News 2007.) Of course, this was made to prompt action, not to declare an emergency in the legal sense. US president Barack Obama's senior advisor on issues of science and technology, John Holdren (2008, 5) prefers the designation "global climatic disruption" to "global warming" due to the abrupt and irregular nature of ACC, and claims that humankind is already experiencing DAI with the climate system. As a pressing challenge Holdren brings up the question of whether catastrophic human interference with the climate system could be avoided or not. Thus, for some distinguished researchers a climate emergency is already a reality, and not just a minor probability far away in the future.

Moreover, in the context of climate emergency, undemocratic opinions have been expressed (e.g. Shearman and Smith 2007). The discussions about climate emergency have been mostly metaphorical, not judicial. The emergency powers may entitle stakeholders to accept the use of technological fixes, for instance, geoengineering. The belief in technological fixes is widespread among the proponents of geoengineering.

An emergency not only allows exceptional action, but calls for it. Can an emergency be responded to in a collective way through which humans jointly aim to protect themselves, or does an emergency result in disarray and turmoil that compels humans individually to seek to save themselves and perhaps their nearest? If the latter scenario actualises, 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.

There could also be time for ethical reflection and application of useful ethical principles. 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. Climate emergency as a transnational phenomenon creates novel challenges to the decision-making.

Presuming that the adverse effects of ACC do not occur gradually, it is worth investigating whether there is any kind of rational basis to the conclusion that a state of climate emergency would require geoengineering implementations, for instance, such as SRM. However, before geoengineering methods can be implemented, they have to be developed adequately. Caldeira and Keith promote the need for geoengineering research in the manner of ESR, and promote geoengineering to be tested right away. They conclude that SRM field experiments should be started because in a climate emergency "it would be reckless to only then begin SRM field tests." (Caldeira and Keith 2010, 62.) Jamieson (2013, 4) assumes that there might be a tendency to promote geoengineering proposals, especially SRM, due to the low cost estimates and the use of methods only as a last resort. Those could possibly avoid the critical scrutiny that other proposals to counteract ACC go through, for instance, plans to build more nuclear power.

Although it might sound tempting for some to grant that geoengineering is needed in order to avoid a climate catastrophe, there are more than two sides to a story. Gardiner (2011, 174) points out that there are other options available than facing a climate catastrophe or engaging in geoengineering—a viewpoint that the Royal Society report does not take into consideration. These alternatives are, for instance, investing in alternative energy sources, food supply, and ecosystem integrity protection projects, and climate assistance and refugee programs (Gardiner 2011, 174). Thinking about the

innovative human inventions since the dawn of humankind it is difficult to accept that geoengineering is the best possible option available to tackle ACC and to avoid a climate emergency.

Sandin and Wester (2009) argued for the evidence of altruistic behaviour in non-antagonistic emergencies. There are contrary viewpoints, too: whenever social control mechanisms fail, individuals start to struggle solely for their own survival. This notion of so-called lifeboat ethics is originally described by Garrett Hardin (1974). He presents a metaphor of a lifeboat, referring to limited capacities and environmental resources. In order to survive, the individuals in the lifeboat should carefully deliberate whether to take others on board at all, and how to stay alive in a dire situation. In addition, this approach has similarities with "limits to growth" debate in the 1970s initiated by the Club of Rome in a way that emphasizes the scarcity of natural resources and promotes alarmism (see Meadows et al. 1972). Moving away from the discussion of the scarcity of resources, the contemporary climate debate is concentrated on the absorptive capacity of the atmospheric sinks (Eastin et al. 2011, 19). These perceptions raise important questions with regard to human selfishness. For instance, one can ask whether people are entirely selfish in chaotic situations out of anyone's control or is there organized and benevolent behaviour to be recognized. There seems to be empirical evidence for both factions, selfishness and altruism in an emergency. The ethical problems cannot be solved solely by empirical evidence. Principlism would lean on altruistic behaviour, though self-sacrifice is not ethically required in helping other entities, human or non-human.

How to assess the moral acceptability of geoengineering? The operationalisation of the moral criteria for acceptability of geoengineering proposals is equivocal. Cost–benefit analysis and other assessments of geoengineering implementations have been done (see Lenton and Vaughan 2009). There are also numeral ratings of the methods of geoengineering on the basis of several criteria. For instance, the Royal Society provided an evaluation of the geoengineering methods assessed on the basis of effectiveness, affordability, timeliness, and safety (Shepherd et al. 2009, 48). Still, the evaluations based

on numeral estimates are not accurate in assessing their policy relevance regarding ACC (Morgan et al.1999).[49]

However, there are no tools available for numeral comparison of ethical aspects of geoengineering. A temptation to compare numeral calculation might occur because there is an urgent need to test these various proposals as well as to assess their effectiveness and moral acceptability. The attempt to calculate moral dimensions of geoengineering underrates the ethical analysis and confuses the role of it. The objective of ethical analysis in the context of applied ethics is to clarify ambiguous concepts, and assess ethical limits to morally acceptable behaviour in a certain area of life. In addition, derived from moral theory, applied ethics can suggest norms for behaviour although not by numeral estimates. Hence, ethical analysis of geoengineering is an intricate issue and requires more profound approach.

Whether or not we are currently in a state of climate emergency cannot be determined in this dissertation. The assumption is that a climate emergency may not be very far in the future, and the justification for this assumption lies in the latest state of the art study of ACC as well as perceptions of the stakeholders. Another notion is that the biospheric and principlist method is the best method to analyse the alternative actions regarding ACC and geoengineering. 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 21st century. There is also evidence of a large-scale sustainability predicament including ACC together with issues of water and food security, and peak oil. In addition, the threat of nuclear winter caused by nuclear weapons has not faded either (Robock, Oman & Stenchikov 2007). Global environmental changes in planetary-scale systems can appear abrupt and non-linear if certain tipping points are crossed. The

[49] Morgan et al. (1999) claim that traditional policy analyses based on, for instance, utility theory, cost–benefit analysis, statistical decision theory, multi-attribute utility theory, or contingent valuation do not apply in the case of ACC due to the fact that diverse scales of global change including ACC call for a different kind of approach.

boundaries concerning ACC, the rate of biodiversity loss, and the changes in the global nitrogen cycle have already been crossed, and require active stewardship of all planetary boundaries in order to avoid detrimental social and environmental effects (Rockström et al. 2009).

The most prominent tool of a survival kit would be mitigation and the fast decarbonisation of the economy and infrastructure of the societies. 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 decarbonisation 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. Stabilization wedges could nevertheless efficiently mitigate the rising GHGs even without geoengineering or drastic emergency measures (Pacala and Socolow 2004b, 10). The main observation concerning a climate emergency is that it isi non-evident, surrounded by various interpretations and cultural assumptions. However, it can be approached with biocentric principlism in order to have tools for closer scrutiny. In the next chapter, the ethical and political domains of geoengineering will be further analysed.

4. POLITICS OF GEOENGINEERING

As early as 1974, climatologists Stephen H. Schneider and William W. Kellogg (1974, 1163) discussed the issue of winners and losers in the case of weather and climate modification. Because the implementations can cause unforeseeable consequences in climatic systems, some areas can benefit from implementations while others suffer from adverse effects.[50] Schneider and Kellogg (1974, 1170) reflected on the idea of unbiased international panel which would evaluate and reconcile disputes between the affected parties. There is an immense difference in the GHG emissions and considerable

[50] For instance, in 1972 there was a flood in Rapid City in Oklahoma, USA. It was argued that cloud seeding experiments conducted in the area had contributed to the detriment; others denied the claim (Schneider and Kellogg 1974, 1170).

differences of opinions between the stakeholders regarding the ways mitigation, adaptation and GHG allocation should be carried out in practice. In this chapter, the ethics and politics surrounding geoengineering, mitigation, and planetary control are examined.

4.1. Political inertia and the allocation of GHGs

The widely shared consensus among the policy-makers around the globe is that mitigation of GHGs is of great concern in order to avoid the adverse impacts of ACC. The latest report of the IPCC (2013) presents us with similar clear visions of the urgency of mitigation if there are wishes to clamp down on the negative corollaries of ACC. Nevertheless, the agreed mode of the accurate procedure is still under discussion, and is in need of elaborate analysis in the context of fairness (see Ringius et al. 2002, 5; Caney 2009). A survey of approaches to assess the allocation of GHGs contains more than 40 different proposals which illustrate the complexity of the challenge of burden sharing (Bodansky et al. 2004). However, the issue of fair allocation also concerns more wide-ranging issues than just the sole allocation of GHG emissions. A comprehensive summary and analysis of approaches is also found in the World Resources Institute's working paper *Building the Climate Change Regime: Survey and Analysis of Approaches* (Moncel et al. 2011). The whole discussion on burden sharing and a fair allocation of GHGs is linked to the wider concept of international distributive justice and cannot be evaluated without taking the wider perspective of distributive justice into consideration (e.g. Caney 2001).[51]

One fundamental challenge of international co-operation is the fair allocation of the costs of mitigation and adaptation with regard to ACC. The absence of an authority to enforce international

[51] There are several issues concerning fairness and allocation with regard to ACC. Such important questions are for instance the following: what is a fair allocation of the costs of preventing the avoidable effects of ACC? What are the costs of coping with the social consequences of unavoidable ACC? What kind of background allocation of wealth allows for fair international negotiations regarding the previous two questions? (Shue 1993, 40.)

agreements does not help to solve this challenge either. (Traxler 2002, 101.) Gardiner (2007) calls this inability to effective political action *political inertia.* ACC is an appropriate example: the main conclusions of the IPCC have been widely accepted among leading scientists in the world for years; however, the process of solving the problem of ACC has not been efficient. On the contrary, GHG emissions have grown with each passing year, and there are no substantial reductions in GHG emissions in sight unless post-Kyoto negotiations result in major changes in the mitigation policy in the near future.

Political inertia can be clarified further in three ways. First, action with regard to mitigation can be seen as unjustified on the basis of economic assessments. However, if ACC is seen as an abrupt danger that threatens everyday life on our planet, this assertion could undermine political inertia. In other words, severe abrupt changes in climatic conditions would weaken the reliability and attractiveness of economic arguments, e.g. the cost–benefit analysis, hence these calculations do not apply in situations where unexpected climatic events of ACC might occur. Opposed to the abrupt character of the impacts of ACC are the gradual and incremental climatic changes which have been formerly predominant regarding the understanding of the characteristic features of ACC. This change in paradigm follows from the realization of the irregular aspects of the climatic system. (Gardiner 2011a, 187–191.)

Furthermore, political inertia can be explicated psychologically. Moral agents are able to consider only a certain amount of worries at a time. Hence, an increase of worry of one degree which motivates to action might decrease concern about other worries and thus demotivate to act. The other psychological reason Gardiner, following Weber (2006), brings forth is the role of the human processing system comprising of affective and analytical systems of which the previous dominates in cases of risk, uncertainty, and ACC. This domination of the affective processing system can lead to the rejection of relevant scientific information concerning ACC. Personal experience with serious consequences related to ACC is still quite uncommon in many regions of the world, or the causal connection between

phenomenon and ACC is not recognized. (Gardiner 2011a, 193–196.)

Weber (2006) suggests that only a growing scientific support combined with the conception of the abrupt paradigm of ACC can diminish political inertia. Finally, the third problem regarding political inertia is connected with intergenerational justice. If the current generations ignore the idea of sustainable consumption and environmental protection, the damaging effects of this behaviour are likely to pile up onto the next generations. This might undermine political inertia in a way that the impacts of ACC can be detected either in our lifetime or that of our children's, and the comprehension of these imminent conditions might invoke action. (Gardiner 2011a, 196,197.)

Although a full agreement on all aspects of fairness has not been reached yet there is no justification for political inertia. There is no need to have a complete agreement on the theory of justice in order to attain a limited plan of climate action (Shue 1993, 47). This applies also to the debate concerning fair allocation of GHGs. However, the same does not apply to geoengineering implementations. Geoengineering and fair allocation do not share the same characteristics, risks, and uncertainties, hence the same notion cannot be applied to both of them. Still, geoengineering has entered the policy arena and is included, for instance, in the next report of the IPCC although the issues of fairness and acceptability are still in their infancy.

One of the essential clarifications regarding ethics and politics of ACC and geoengineering is Stephen Gardiner's (2006; 2011a) characterization of ACC as a perfect moral storm. With this metaphor Gardiner refers to three dimensions which describe ACC as an ethical problem consisting of global, intergenerational, and theoretical aspects, and most importantly, moral corruption. Global storm emphasizes the fact that the impacts of GHG emissions are detached from their original source in a way that the effects occur globally despite independent emission sources. (Gardiner 2011a.) Although it is obvious that affluent nations have been the prominent emitters so far, the effects of ACC spread

throughout the globe in various ways creating a configuration of winners and losers.

The second aspect of a perfect moral storm is the intergenerational storm which considers the temporal challenges of ACC. Both the long persistence of the GHGs in the atmosphere and the slow realization of the amplitude of the effects of ACC make it a resilient, deferred, and back-loaded phenomenon. This challenge of collective action is referred to as intergenerational buck-passing Each present generation has the incentive to be concerned only with the challenges of the currently living persons. (Gardiner 2011a, 160–164.)

The excessive consumption may thus continue as usual on the grounds that mitigation and downshifting, and lifestyles of simplicity require too many sacrifices in the form of a vast restructuration of BAU societies based on fossil fuel consumption. This is a moral problem, hence an active global regime motivated to tackle ACC might neither be in the interests of the present generation nor quick to react to their considerations. In other words, the current generation might have no motive or resources to build up a global regime for solving issues of ACC and climate emergency in their lifetime. (Gardiner 2011a, 32–38.) Global action on the problem of ACC is challenged not only by the climate sceptics, but also by those with vested interests to maintain the BAU. In addition, the vested interests with regard to patenting and research on geoengineering and ACC affect also policy-making regarding ACC (Hamilton 2013b, 139). The various objectives of individual and collective actors confuse the actors and cause them to fall upon the first solution available, and thus be exposed to the trap of moral corruption.

Next, the conundrum concerning fair allocation of GHGs is analysed. The perfect moral storm makes the current generation susceptible to moral corruption, as stated by Gardiner. The temptation to leave dire challenges to the future generations is reality, and unfortunately is not the only challenge of the politics and ethics of ACC. The complexity of the suggestions of fair allocation of GHG emissions

makes it challenging to reach a good judgement. Nevertheless, the objective is to elaborate the structure of equitable emissions in order to boost international negotiations.

4.1.1. Just and backward-looking proposals

As mentioned earlier, the concepts of justification, extent, and form of responsibilities regarding the allocation of GHG emissions demand clarification. Martino Traxler suggests a criterion for dividing backward-looking proposals from forward-looking ones to clarify the responsibilities with regard to GHG emissions. (Traxler 2002, 117; see also Gardiner 2004, 579). Both of the principles regarding fair allocation of GHG emissions are now explored.

The backward-looking principles are just and fault-based, and hence take into consideration the past emissions when contemplating responsibilities regarding the allocation of GHG emissions. For instance, the following assertions fall under this category of backward-looking proposals with regard to the allocation of GHG emissions: firstly, one should expected one's payment or contribution to be commensurate with the benefits received from the emitted GHGs. This principle seems plausible because it places the burdens of addressing the cause of the current ACC, the GHGs, on the emitters. This viewpoint has its complications to be further explicated.

The distinction of GHGs between luxury and subsistence emissions should also have relevance in defining the moral acceptability of fair allocation (Gardiner 2004, 584). Subsistence emissions are necessary for survival, and a part of human rights in consumer societies based on the usage of fossil fuels (Shue 1993, 53–54; Gardiner 2004, 585). Luxury emissions on the contrary are unnecessary or expendable (Traxler 2002, 108). Consequently, there can be moral grounds to limit luxury emissions, but not subsistence emissions since those are necessary for attaining the minimal quality of life. Those

indispensable GHG emissions could also be unequally distributed, and vary depending on a certain time, region, existing technologies, and alternatives available. (Gardiner 2004, 585.) To put it more simply, even if a global ceiling could be assessed for GHG emissions, subsistence emissions could not be mitigated any further without compromising the objectives of environmental sustainability, and inflicting serious damage on humans.

However, the backward-looking principle takes the advantages gained from subsistence emissions into consideration in such a way that one accrues more responsibility from those emissions than from luxury emissions. Therefore, the principle arrives at a counterintuitive position because the subsistence emissions obviously benefit humans the most, and at the same time these same emissions are penalized by this principle. In another backward-looking just principle, one should be expected to pay or contribute in proportion to GHGs emitted. The problem with this kind of principle is with the inadequate separation of the quality of GHG emissions. It does not consider subsistence and luxury emissions to be distinct, and looks at emissions as one lump sum instead of comprehending the grounds for emitting as dissimilar from each other. (Traxler 2002, 117–119.)

Backward-looking principles concerning the allocation of GHG emissions can be interpreted in at least two ways. First, they refer to the polluter pays principle (PPP), according to which industrialized countries should clean up their mess in reference to their GHG emissions. Furthermore, the atmosphere could be seen as a common resource which should not be polluted unjustly (Traxler 2002, 120–121). The capacity of the atmosphere to absorb GHGs is a limited resource, giving rise to questions of fairness. Peter Singer introduces backward-looking principles as historical principles referred to as PPP and "You Broke It, Now You Fix It." (Singer 2002, 19, 28–29.) The historical emissions of industrialized and developed nations are taken into consideration this way in backward-

looking proposals.[52] Those responsible are then the industrialized, developed countries which should contribute to the burden-sharing of the effects of ACC more than developing countries. (Shue 1999, 544–545.) Deliberating the implementation of geoengineering technologies, these states can be held responsible for past emissions, and hence could be under a duty to execute restorative actions. Geoengineering should not, however, be considered as an act of restoration or compensation due to the massive uncertainties concerning the outcome. The target of compensation in the proper sense should be ameliorative actions to the suffering party, not the risk of unprecedented unknown negative corollaries.

Backward-looking principles can also be understood as a causal responsibility. A moral agent is causally responsible for a certain action X, by herself or with others, if the agent has caused the action X and this causal responsibility corresponds with the degree of causal influence (Jagers and Duus-Otterström 2008, 579–582). The most famous principle in this context that relies on causal responsibility is the previously mentioned PPP (Shue 1993, 52). There are complications in addressing the certain causal responsibilities to states, companies, or communities in the case of ACC climate since there are no appropriate means to detect which actor caused certain GHG emissions, and during which time period. Hence, specific causal responsibility for local distress may not be adequately traced back to particular GHG emissions (Traxler 2002, 106).

These backward-looking principles can be contested by arguing that the developed countries were mostly ignorant of the problems GHGs would cause—at least until the first report of the IPCC was published in 1990. However, this disputation is not decisive because there is no conclusive information on how, for example, the links between carbon emissions and the possibility of global warming were recognized a century ago. Besides pleading on ignorance, perhaps past emissions could be ignored in

[52] This division comes originally from Robert Nozick (1974, 153–155), who elaborates distinctions between historical and end-result principles.

the fair allocation of GHGs on the grounds that it is impractical to take all the past emissions into account (Gardiner 2004, 581). This view is convincing on the basis that there are still no signs of a binding international agreement of distributive justice with regard to the past GHG emissions (Traxler 2002, 128). Disputations against compensation are not convincing for two reasons. First of all, it is not clear when exactly the connection between ACC and GHG emissions has become mainstream knowledge in the international community. Still, some kind of agreement regarding compensation could be made. In addition, there is no need to have a comprehensive mutual understanding and agreement about international justice with regard to the past in order to assess some aspects of it, in this case the responsibilities and fairness of past GHG emissions. (Gardiner 2004, 581–583.) If total agreement of the negotiated case was needed in order to reach some kind of mutually binding and satisfactory agreement, international negotiations would never reach any resolutions. Reaching mutual solutions in global problems requires an open mind and a willingness to accept the outcome as the best possible compromise that is sufficiently adequate for all the negotiating parties.

These just and backward-looking principles examine the plausibility of the claims that the developed countries should share most of the burdens caused by the certain allocation of GHG emissions.[53] One of the most pressing problems with backward-looking principles is a practical one. Even if the principles of fair allocation of GHG emissions were just and plausible, they may fail in their implementation because they lack an authoritative international decision-making body to enforce the procedures (Traxler 2002, 121). The same can be said of geoengineering implementations that are technological fixes for environmental hazards (Fauset 2008, 9–11).

Geoengineering technologies might assist in compensating the past GHG emissions in realizing backward-looking principles. However, some researchers, for instance, Stephen Schneider, are sceptical

[53] There are also other backward-looking principles, for instance, paying the costs of allocation in proportion to the unjust taking of the GHG absorption capacity, and paying the costs of allocation in proportion to one's ability to pay (see Traxler 2002, 121-123).

about the possibility of establishing an international supervising authority and governance for these kinds of schemes to supervise long-term implementations (Schneider 2008, 15). This issue becomes especially problematic if backward-looking proposals are taken into consideration, and potentially hazardous geoengineering implementations would be seen as compensatory actions by the affluent states. In that case, the fairness of backward-looking proposals should be reassessed on whether to apply the PPP or some other proposal, or several principles combined, if geoengineering implementations were executed uni-, bi-, or multilaterally.

4.1.2. Fair and forward-looking proposals

The second group of proposals consists of fair and forward-looking principles which are not based on previous actions. They concentrate on promoting well-being for the future, whereas backward-looking principles seek rectifying measures on the basis of the injustices of the past (Traxler 2002, 117). When deliberating present and future GHGs, one viewpoint is to present an acceptable overall level of GHGs and divide it among the world's population. This assures every human on the globe an equal share of the GHG emission entitlements: this approach is referred to as the contraction and convergence (C&C) approach. (Attfield 2014, 207–212.) Nevertheless, there are diverse problems with this entitlement. For instance, it does not take into account any of the potential inequalities in the past GHGs, and hence might turn out to be effortless for some to implement, while extremely grievous for others to follow. Additionally, there is no division made between subsistence and luxury emissions (see Shue 1993) if GHG emissions are addressed in this way. The accurate calculation of subsistence emissions is in any case an extremely complex process, and needs to take into account the divergent living conditions around the globe, and variable potential for the mitigation of GHGs. Instead of claiming humans have a right to pollute and produce GHGs, the right to clean environment and fulfilment of basic needs of good human life and health are more appropriate (Caney 2009; Hayward 2007).

Forward-looking principles can be interpreted as remedial responsibility as opposed to causal responsibility. In other words, responsibility of an actor occurs if one has a moral obligation or a weighty moral reason to correct or counter X, or the effects of X in diverse ways. These two responsibilities, causal and remedial should be seen as separate. (Jagers and Duus-Otterström 2008, 579–582.) Remedial responsibilities do not take into account the past in a way that backward-looking proposals do. For instance, the agent who performed an action X which caused a situation that requires compensation would not necessarily be the same one who will be remedially responsible for rectifying the situation in question (See Miller 2004, 247). Thus, in the case of ACC, the past GHG emissions might not be considered at all in fair allocation of GHGs, but instead future entitlements could be divided in a new fair way regardless of the past.

Another fair and forward-looking principle consists of a fair chore division of GHG emissions. In this division scheme, parties are required to make equally burdensome sacrifices with regard to mitigating their GHGs. The same opportunity costs follow every agent, however, subsistence emissions cannot be mitigated, and hence are morally excused. In addition, each party faces distinct though equally burdensome chores which motivate action, thus avoiding the prisoner's dilemma concerning rational action and free-riding. (Traxler 2002, 126–129.) Problems with Traxler's view concern, first of all, the issue of global commons. There are weak grounds to claim that his example manages to escape the prisoner's dilemma. Furthermore, fair chore division is problematic on the basis that it demands massive actions from the affluent countries as negotiating parties before any actions from the poorer ones (Gardiner 2004, 588–589). It should be noted that the parties are not homogeneous regarding their economic status. Therefore, the suggestion fails to be convincing.

Geoengineering applied to fair and forward-looking proposals does not lean on causal responsibilities. Regardless of past GHG emissions, geoengineering implementations can be seen in the context of remedial responsibility, where a capable party engages in such activities in order to affect climatic

conditions in a desired way. However, there is a danger of causing political inertia if the past GHG emissions are not taken into account and potential geoengineering implementations gather all the attention of the policy-makers. This problem is related to the problem of moral hazard discussed in detail earlier in chapter 2.3.1.

The potential disastrous impacts of ACC could save us in a way that the threatening forthcoming climatic events could diminish political inertia. Formerly political inertia has manifested as slow progress with regard to mitigation, adaptation, and action in general to tackle the adverse effects of ACC. This stagnant political situation concerning ACC could now be transformed into novel activities if seen from the abrupt paradigm of ACC. The situation could also wake up the policy-makers to consider fair and effective proposals for climate action. However, geoengineering proposals might restructure both the international negotiations and the formation of ethical analysis of fair allocation of GHGs in a way that the whole concept of fairness of allocation of GHGs would have to be reconsidered instead of leaning on the old conversations and choices between forward-looking and backward-looking proposals. Moreover, the possible implementation of geoengineering enterprises changes the structure of international negotiations regarding fair allocation of GHG emissions, hence in that case the criteria for fair allocation can completely be altered depending on the mode of modification as well as on the question of whether it is executed uni-, bi-, or multilaterally. Therefore, the implementation and governance as well as ethical aspects of geoengineering schemes are in need of further exploration as well as the diverse alternatives for fair proposals for GHG allocation.

As mentioned earlier, both backward-looking and forward-looking proposals can include possible geoengineering proposals in their implementation, however, the considerable risks and uncertainties that these schemes entail are not solved even if the proposals could accept geoengineering enterprises as a part of the application of the proposal. Also, it is uncertain how quickly different schemes could be implemented if undertaken as a part of the emergency climate policy action. As described in chapter

1.2., geoengineering technologies vary greatly from each other by falling into at least two distinct categories of CDR and SRM (Heyward 2013). In those categories, there are several distinct methods with separate risks, uncertainties, effectiveness, costs, impacts, reversibility, timeliness, and safety of the methods (Shepherd et al. 2009). Thus, each of the proposals has to be ethically assessed individually from other methods, combined with the background theory (in this case biocentrism), state-of-the-art climate science, principles of autonomy, justice, non-maleficence, and beneficence as well as the adequate principle of fair allocation of GHGs.

In conclusion, none of the proposals, neither just nor fair ones are superior in a way that could be claimed as the most plausible one for the time being. Both the paradigm of abrupt ACC and development of geoengineering technologies should be taken into consideration while assessing the plausible criteria of fairness in allocation of GHG emissions and raise the discussion into a whole new level. Recent debate on geoengineering has sprung from the lament regarding failed mitigation. In the following chapter, mitigation is left to the background, and the prospects of technological fixes as well as planetary control are explored.

4.1.3. The problem of technological fixes

The suggestion of including geoengineering as a part of the portfolio of climate strategies is a definite step towards developing a technological solution to a problem that is social in its essential nature. Weinberg (1966) reflected on this issue in the 1960s and referred to social problems such as population growth, environmental degradation, and poverty. The difference between social problems and technological ones is that the former ones are more difficult to identify and solve because they are tied to social interaction and its desirability. The latter technological problems are more focused, and less

affiliated with a large group of individuals and their decision-making.[54] Since technological engineering does not require large social changes the kind social engineering does, technological solutions are less complicated to implement compared to social engineering. (Weinberg 1966, 4–5.)

The origin of social problems is rooted in the activities of individuals and communities, and the solution would require changes in the behaviour of individuals and guidance of that behaviour in order to have an effect on undesired social phenomena. Weinberg analyses the question of how complex social problems could be approached with technological solutions. Although social problems are more complex than technological ones, and more difficult to identify, the challenge with technological fixes is that they do not necessarily create a long-lasting solution to social problems because they neither press for social changes nor require deep changes in the attitudes of individuals. Durable social changes call for legal, educational, moral, and organisatorial measures which create incentives for individuals to redirect their activities. The justification for claiming that technological solutions are easier to organize is based on the observation that technological fixes entail neither massive changes in individuals' attitudes nor modification of human behaviour. (Weinberg 1966, 4–5.)

Weinberg's viewpoint is interesting with regard to the problem of moral hazard and geoengineering. The social change needed in order to activate rapid mitigation and adaptation measures seems like a demanding challenge which has not succeeded so far as effectively as natural scientific predictions for avoiding DAI would require.[55] On the other hand, geoengineering as a technological solution appears as

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[54] Weinberg (1966, 4-5) refers to the solving of technological problems as ”crisp and beautiful” technological solutions that are simpler to organize as technological engineering than mobilize social changes with social engineering.

[55] This comprehension of possible imminent danger of massive environmental degradation is one of the major factors that has contributed to the emergence of ESR. There are dissenting views regarding the effectiveness of ESR. Some say it dispels actors away from environmental activism and discourages engagement in mitigation (Weber 2006; Buell 2010; Markusson et al. 2013). Others think ESR encourages apocalyptic environmental activism (Veldman 2012). The old story of Chicken Little is a tale about a mistaken notion of the world coming to an end. Chicken Little thought the sky was falling on the basis of an acorn falling on her head. From that sentiment, she gathered a group of animals with her to go and tell the King about it. The story has multiple endings in various folk tales, but one common ending is Chicken Little and her friends ending up eaten by a fox. The moral of the story also with regard to geoengineering is that there are no grounds for the promotion of imminent danger without relevant evidence. Otherwise, without evidence and justification, one might end up in a more dreadful situation than before the declaration of the imminent danger.

an easier settlement to implement quickly in the near future rather than engaging in massive mitigation efforts. Weinberg (1966, 8) acknowledges that technological engineering cannot replace social solutions altogether. As a temporary remedy, technological solutions can provide social engineering broader options and make problems less complicated to solve. One of the essential features of technological solutions is buying time for social changes. Keith (2007) pleads this aspect of technological engineering when promoting SRM to rapidly cool the climate. Proponents of geoengineering argue that it can buy humanity time so that it is possible to establish a social change—in this case global mitigation programs.

Weinberg (1966, 8) concludes that technological solutions can assist in building a better society and in solving social problems. Technological solutions need, however, to be scrutinized more closely before they can be accepted as an adequate element of social solutions. The same also applies to geoengineering as a technological solution. Sarewitz and Nelson (2008) have developed three criteria which assist in the decision making regarding the possibly amenable technological solutions suitable for application to social engineering.

The first criterion by Sarewitz and Nelson (2008, 871) to assess the compliance of a technological solution as a part of the social solution is that the problem and its technological solution need to be connected by a cause–effect relationship. As an illustration of the first criterion, a systematic vaccination of children provides a clear advantage in fighting contagious diseases when compared to social solutions, and has an established cause–effect relationship. The technological solution has to be effective in the network of complex socio-technical systems, and its corollaries need to be detectable. (Sarewitz and Nelson 2008, 871.) When applied to geoengineering, the cause–effect relationship is not that evident. For example, SRM might succeed in lowering the average temperature in affected regions. Nevertheless, there is no thorough understanding of comprehensive effects on a local scale nor on the scale of the biosphere, including unknown long-term effects. The cause–effect relationship is also

vague in the case of geoengineering because the solution geoengineering offers takes no stand with regard to mitigation of GHGs. Due to this, Pielke Jr. does not consider the first criterion of Sarewitz and Nelson to be suitable for applying to geoengineering, with one exception. Some forms of CDR seem to meet this first criterion in cases where it is considered as a mitigation strategy. (Pielke Jr. 2010a, 59; 2010b.) Pielke's suggestion affirms the viewpoint that an adequate assessment of geoengineering is to individuate the methods.

The second criterion of assessment of compliance of technological solutions as a part of social engineering is that the technological solution has to be ready to be analysed with uncontroversial criteria. (Sarewitz and Nelson 2008, 871). Pielke Jr. (2010a, 59) brings forth the undesirable side effects of geoengineering as an example of this criterion. It is difficult to estimate accurately the consequences of geoengineering, for instance, side effects such as extreme weather conditions, precipitation, and changes in the biodiversity. This second criterion is hence not suitable for assessment of geoengineering as a technological solution.

According to the third criterion by Sarewitz and Nelson (2008, 371–372), research and development is most likely to contribute to solving social problems when utilising existing technological knowledge and its applications. Geoengineering is still in its infancy when it comes to research and development. The technological know-how of CDR exists on a small scale due to CCS (IPCC 2005), however, the stage of development of SRM is not ready for implementation. The position of Pielke Jr. is that all of the three criteria fail when SRM is considered as a form of technological solution of geoengineering to counterbalance the adverse effects of ACC. Nevertheless, CDR has potential as a mitigation strategy although geoengineering as CDR would not fit the criteria. (Pielke Jr. 2010a, 61.) In other words, the storage of GHGs as a mitigation strategy is already an existing technology which could be further investigated to ascertain its feasibility both in the ethical sense as well as otherwise.

Sarewitz and Nelson (2008, 872) consider CDR as passing all of the three criteria. The cause–effect relationship is clear, the method addresses the initial cause of the problem of ACC which is the increasing concentrations of GHGs in the atmosphere, and the efficiency of the method is assessable. In addition, the technology needed for effective CDR exists for the most part. This does not entail that the need for mitigation outside the strategy of storage of GHGs is vanishing, or that CDR alone would be a sufficient method for the abatement of GHGs.

Meeting the criteria shows that the method in question—in this case geoengineering—could bring significant progress with regard to solving the problem. However, without a standardized core research and development programmes are not to be expected to succeed. Rather, they should be considered as an instrument of creating novel approaches and basic knowledge with a noteworthy possibility of failure (Sarewitz and Nelson 2008, 872.) Geoengineering methods as a partial technological solution to ACC are hence still questionable. The problem of moral hazard can induce the decline of motivation for mitigation if technological fixes are added to the climate policy portfolio. The diminished motivation for engaging in mitigation is already an unsolved ethical problem and the problem of moral hazard could make it even worse. The case of technological fixes is an unresolved issue for at least two reasons. First of all, although they would pass Sarewitz and Nelson's criteria, it is not guaranteed that the technological fix would assist in solving the current social issue. Secondly, if the technological fix does not change behaviour or human action, how durable and reliable would this so-called change or alleviation in the social problem be in the long run. These observations make it difficult to approve ethically any short- or medium-term technological fixes to the problem of ACC in the form of geoengineering without plans for long-term alterations in fossil fuel based societies and their practices regarding the environmental, social, cultural, and economic sustainability.

4.2. Planetary control and technological fixes

Environmental problems—including the adverse effects of ACC—are encountered due to technological systems that produce GHGs as a by-product, and that have not taken the carrying capacity of the biosphere into consideration in environmentally sustainable ways. On the eve of a climate emergency, the proposed solution is represented in a form of new technologies: for example, hydrogen cars, de-carbonised coal, and geoengineering. The investments in novel technologies would not require such a dramatic changes from humans in their consumption habits and lifestyles. This is one of the explanations as to why technological solutions are popular. (Jamieson 2008, 12–13.) In this chapter, the attractiveness of technological fixes is contested.

Not only does the delusion of planetary control apply to the idea of global scale geoengineering and its empirically measurable effects, but it is also related to the idea of insufficiency of traditional western moral theories in providing adequate normative guidance for a climate emergency or other natural catastrophes. A comprehensive moral theory needs not exist in order to justify action to tackle climate change, nor has one to lean on one specific moral theory (Moore and Nelson 2010, xxi). This is the standpoint of the pluralism represented in the introduction. The kind of moral imagination is needed that creates surroundings for interconnectedness and empathy for the biosphere. (Moore and Nelson 2010, xxi; Sanford 2011). The attitude of respect for nature as in the biocentric theory of Taylor (1986), or the acceptance of the principlist approach do not, however, entail that a moral agent has to be particularly emotional. The biocentric outlook on nature as well as the principlist approach are morally guiding approaches which are not based on a moral agent loving or feeling compassionate about the living entities of the biosphere. The mentioned adoption of simplicity as a lifestyle is also based on attitude and virtue, not merely on emotions.

The idea of planetary control is connected to Bill McKibben's 1989 book *The End of Nature* which

deals with the loss of meaning of natural inhabitations due to ACC. The change from pristine nature to globally modified environments due to ACC was clearly initially unintentional and indirect, however ubiquitous. On the contrary, the planetary control exercised by means of geoengineering is completely different due to its intentionality and directness. With intentional modification, a novel responsibility for altered climatic conditions also arises. Not only are humans responsible for their ordinary and everyday actions, but along with geoengineering the responsibility stretches to maintaining the atmospheric homeostasis, or anthropocene conditions, for as long as humankind exists. An ethical question arises then, on whether it is possible to be responsible in a successful and sustainable way for a project of this magnitude in the long term. Another pressing question is whether humankind is willing to take the step of planetary control and is able to flourish alongside non-humans in a geoengineered world.

What then is ethically dubious in the altered climate and manipulation of the climatic conditions if it is aiming for benefiting the humankind and biosphere altogether? CBD (2010) has established a moratorium on geoengineering due to the massive uncertainties regarding the issue. The issue should not only be considered from the consequentalist standpoint. The notion of human hubris, and capability to control the climatic conditions deserves a closer look. Even if planetary control in the form of geoengineering could be executed successfully, this does not imply that it is ethically justified to do so e.g. from the standpoint of the biocentric principlism. A mastery of climatic conditions would enforce a distorted relationship between humans and the rest of the biosphere, and would boost human arrogance (Jamieson 1996, 332). As an analogy, one of the first things a person learns when practising martial arts is that though one has strength and potency for powerful actions, one is never to use those powers in order to injure others on purpose.

The objective of planetary control differs from the actual potential of geoengineering. On top of the ethical problems of planetary control and human hubris, none of the methods proposed so far meet

the basic criteria for effectiveness, safety, and affordability. These criteria summarize the statement of CBD that no large-scale experiment should be executed "in the absence of science based, global, transparent and effective control and regulatory mechanisms for geoengineering" (Williamson et al. 2012, 9, 102).

4.3. Lesser evil

Geoengineering has entered the discussions of ACC in the form of argument from radical emergency: that it is the lesser evil compared to an actualised climate catastrophe. The lesser evil argument maintains that geoengineering schemes should be implemented regardless of the fact that they have adverse and unknown side effects, or that they are otherwise considered ethically unacceptable. The justification is that the imminent climate emergency on the verge of a catastrophe is far worse than geoengineering and its effects. Thus, the best mode of action—morally speaking—would be to engage in geoengineering the planet rather than face runaway climate change. Gardiner (2011b, 180) makes this point reflecting on the problem of the lesser evil. However, it is essential to note that there are more options than facing a climate catastrophe or engaging in geoengineering implementations.

One of the most pressing arguments in favour of geoengineering, especially SRM, i.e. stratospheric sulfate injection (SSI), is related to climate emergency. When facing a climate emergency as a possible scenario, implementation of SSI would constitute a lesser evil compared to the detriments of a climate emergency. By acknowledging the metaphor of the lesser evil it is recognized that there are ethically dubious aspects in supporting geoengineering in general and SSI in particular. The powerful appeal of a looming catastrophe might override the ethical considerations by affirming that emergency action is needed at once. Research on geoengineering is promoted by arguing that those experiencing the most adverse effects of ACC might be willing to engage in geoengineering to alleviate their dire situation.

Hence, research on geoengineering should be spurred in order to have adequate research basis for implementation of geoengineering enterprises if and when one of the stakeholders decides to act on it. Gardiner calls this the desperation argument, and claims that it does not manage to justify geoengineering on its own. (Gardiner 2013, 28.)

If a rogue state develops nuclear weapons just in case that they need to engage in a war, a similar argument might be developed with the desperation argument. Let us assume that I am gripped by a belief that I am in a dire situation where the implementation of nuclear weapons could alleviate my situation. Can I, or the rogue state mentioned before, then defend the research and development of nuclear weapons on the basis that one day someone might think they need to use them? Regarding nuclear weapons, it is difficult to form a justified belief that the development of weapons would be ethically justified. Let us take a look at geoengineering in the following.

First of all, the desperation argument fails to take into consideration the role of consent in justifying the enterprises. In a stringent situation, a nation state might be anxious to promote geoengineering. However, the decision making process is narrow considering the intergenerational aspects and effects of geoengineering. As a large-scale implementation, it affects the whole biosphere. The plausibility of the desperation argument suffers from the fact that ACC has created an environment where the actual array of choices is severely diminished. Some actions cannot be justified regardless of the rigorousness of the situation on the basis of restriction of, for instance, fundamental rights. The consent to engage in geoengineering is not in itself a cogent reason enough to ignore all the ethical, social, and other relevant aspects which should be included when assessing the feasibility of geoengineering. (Gardiner 2013, 28.)

The lesser evil argument assumes that we could be absolved from our responsibilities to tackle ACC with morally acceptable and environmentally sustainable means because we do not have the time or the

means to execute environmentally sustainable actions. Precaution should be exercised in declaring a climate emergency, and the lesser evil geoengineering, especially if it involves breaking the norms of common morality or conventional norms. Hence, the previously mentioned ESR should be practised with caution, however, not underestimating the risks and estimated dangers.[56]

Consequently, a tragic moral dilemma can be seen as a case where choices have to be made between two or more evils, or morally indefensible choices. A situation might occur where one action is the lesser evil and should possibly thus be chosen. In this case, a right course of action can be found, and an action is as good as it can get in that tragic situation. Nevertheless, choosing the right or the lesser evil option does not exclude the fact that wrongness can be included in that action. By definition, the best or right option may not be available at all. (Raz 1986, 359.) The arguments that oppose geoengineering can be based on criticizing the massive interference with natural processes (Jamieson 1996, 325). On one hand, it is a fact that humans have already meddled with nature ever since the dawn of humankind in such a way that large-scale management of natural processes is not a newborn idea. On the other hand, the aspect which raises ethical questions is the extent of intervention. Instead of restoring the climate to its previous state prior to the so-called anthropocene (Crutzen and Stoermer 2000), there might be temptation to alter the climate to be more suitable for human purposes. This objective bears a resemblance to weather modification and its luxury, preventive, development, military, or terrorist modes presented in the second chapter. The problem of the lesser evil evokes thoughts about human hubris and arrogance, and reaching for an objective that is not ethically justifiable. Hence, the old saying comes to life: two wrongs—in this case ACC and geoengineering to counteract the consequences of ACC—do not make a right. (Jamieson 1996, 326).

Walzer (2004, 49) describes this kind of situation in these words: "This is the essential feature of

[56] There are two different viewpoints with regard to ESR. Markusson et al. (2013) emphasize the delimitations of emergency rhetoric and suggest not using it. On the other hand, Brysse et al. (2013) bring forth the aspect that researchers tend to underestimate the research results with regard to the effects of ACC in order to avoid the stigma of being an alarmist.

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 geoengineering, a radical climate emergency might suggest that available options, including geoengineering, involve some evil in all cases for several reasons[57]. In other words, there might not be any good choices available. However, even the alarmist conception of ACC can consider moral norms of some kind applying to a radical climate emergency based on principlism. Those principles can be applied to all occasions regardless of the gravity of the situation. For instance, the principle of non-maleficence sets the goal to minimizing the damages for humans and non-humans whenever possible.

Are there really just two options with regard to tackling ACC and geoengineering? Just an evil option and a lesser evil one? Instead of the polarizing viewpoint of only having two choices when facing a climate emergency, the situation can also be seen from the perspective of wedges as suggested by Pacala and Socolow (2004). According to stabilization wedges, ACC could be faced with multiple actions, together resulting in massive mitigation of GHGs. The viewpoint of a lesser evil was brought to public eye by Crutzen (2006, 217) when he stated that the most desirable option is massive abatement of GHGs so that geoengineering plans would be made useless. However, successful abatement appeared to him as "a pious wish."

4.4. Governance of geoengineering

In the case of massive risks, scientific uncertainty, diverse public conversations and opinions, media stir, and the rigid schedule of international negotiations there is an ever-growing need to analyse the ethical dimensions of ACC, and especially geoengineering because decisions of action or inaction concerning

[57] 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.

ACC will be made regardless of readiness of ethical application of the issue. Therefore it is essential to engage in such debates, clarify ambiguous concepts, and assess moral arguments concerning new technologies, action or inaction, and the right conduct. It is not the task of an ethicist to solve the natural science problems concerning the origin and the causes of the ACC phenomena or create technical solutions. It is the phenomena and its ethical implications which need assessment, especially in the case of geoengineering and weather modifications, where publications of applied philosophy or environmental philosophy have only existed for a short time.

The consent of all stakeholders with regard to geoengineering is a challenging issue. Especially when it is not unequivocal to identify all the stakeholders. The industrialized countries that have contributed to the problem of ACC the most are now mainly discussing the geoengineering option as a technological solution. Even if the poorer countries would benefit from geoengineering, without a democratic decision making procedure the decisions would not be just. (Jamieson 1996, 329.) At the same time, poorer countries are susceptible to risky experimentations due to less stringent environmental regulations.

Gardiner (2007) represents the argument for moral emergency concerning the options for action in order to avoid or deter the adverse effects of ACC. He claims that the idea of geoengineering is "intuitively crazy to most people" for two reasons. The first reason is scientific: Gardiner refers to the chaotic elements of the climate system and reasons that there is not enough scientific data of details of atmospheric processes to manage climate successfully. The other reason is political and interlinks serious consequences of geoengineering with global politics. Governance issues have enormous challenges in solving what kinds of rights and responsibilities should govern global agreements concerning geoengineering. (Gardiner 2007.)

The cost-effectiveness of geoengineering proposals, especially SRM, seems to make them tempting to

accept. Victor et al. (2009, 69) even claim that "there is general agreement that the strategies are cheap." Moreover, implementations could be executed unilaterally through corporate or state administration. This point could also be turned upside down. For instance, a rogue state might have morally dubious geoengineering plans without powerful international agreements or actors. Technological geoengineering fixes are not as troublesome to implement compared with renewing the global energy regime away from fossil fuel based substances.[58] However, these considerations, which seem to support the implementation of certain geoengineering proposals, appear to be short-sighted. For example, Gardiner (2010a, 287–288) makes a point that the cost-effectiveness of SRM counts only the price of the sulphur and the methods to shoot it into the atmosphere, not the potentially hazardous side-effects it has on the biosphere. If that is the case, the economic calculation of the cost-effectiveness of SRM is inaccurate.

Jamieson (1996, 329) brings forth questions concerning the fair governance of geoengineering. Without taking all the stakeholders into consideration in the decision making process concerning implementations of geoengineering, the procedure is morally problematic. On top of it, a unilateral implementation is also a politically and legally dubious issue that requires consent from neighbouring countries and an international agreement. Without an explicit 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, 17; UN 1976). Contradictory viewpoints in the presence of an impending climate emergency make the question concerning the morally adequate decision making process vexed.

[58] Caldeira and Wood (2008) and Virgoe (2009) also discuss the second and third point.

5. CONCLUSION

Geoengineering and climate emergency are bulging with various ethical problems which are entangled as a complex ensemble of questions regarding the future of the biosphere. This nexus of these ethical issues has been the issue of this dissertation. The main argument of this dissertation is that the solutions regarding the challenge of ACC should be carefully analyzed from the ethical viewpoint. In other words, the several ethical issues considered in this dissertation need to be taken into consideration while assessing the alternative courses of action to tackle ACC. The history of weather and climate modification reveals the complexity of the development of novel technologies. Not only are they created for beneficent purposes, but also for militant or even terrorist actions. This observation from the history should make one realize that the attitude of technicism can have its dark and ethically questionable side also with regard to geoengineering and climate emergency.

The problem of political inertia is essentially related to mitigation and adaptation to ACC. Had ambitious climate policy gained ground in the beginning of the 21st century and woken up parties to the reality of ACC, geoengineering would not have entered the climate policy debate in the grand scale that it has done recently. A technical fix, geoengineering, is incapable of eliminating the root of the problem of ACC although it has been suggested as a third strategy to tackle ACC alongside with mitigation and adaptation. This technical fix can only alleviate the negative effects of ACC without addressing the ultimate culprit, increasing anthropogenic GHG concentrations of unparalleled levels in the atmosphere.

The justifications of argumentation regarding geoengineering and factors that makes agents, communities, institutions, and states close their eyes from dangerous ACC has been one of the issues of this dissertation. The problem of moral hazard explains in part why the motivation to engage in aggressive mitigation decreases. If there is a safe way out, for instance the possibility of a technological

fix, it endorses agents to think that there is neither an emergency to cut GHGs nor any kind of urgency to do so. This kind of mindset drifts further and further away from the commitments of UNFCCC to avoid DAI with the climate system. In addition, it can encourage arguments that promote geoengineering as a solution to ACC and climate emergency. However, from the standpoint of biocentric principlism there are more reasons to oppose geoengineering than to promote it. First of all, even in a climate emergency, the respect for all life and the principles of autonomy, justice, beneficence and non-maleficence pave the way for morally right actions. Although each of the technologies should be assessed individually, there are ethical justifications to claim that no large-scale intervention to the climate system is ethically acceptable. In addition to the fact that it would violate the basic notions of biocentric principlism, it would cause irreparable harm to the biosphere.

Arguments against geoengineering involve references to hasty and ecologically unsustainable technological fixes, and their negative side effects, unreasonable human hubris over positive outcomes of meddling with nature, ill-tested proposals, and unsolved issues of geoengineering governance as well as issues of social and intergenerational justice. The biocentric theory of environmental ethics does not give justifications for geoengineering, for instance, on the basis of excess intervention on biospheric processes. The large-scale management of the ecological processes is not ethically justified due to prima facie duty of non-interference (Taylor 1986). Although Taylor referred mainly to natural systems that can be considered as wild, the same principle can be applied to ecological processes at large because human influence on global ecosystems is currently extensive. However, the arguments against geoengineering are not tied to the distinction between non-anthropocentrism and anthropocentrism. It is possible to formulate arguments against geoengineering without any references to the previously mentioned distinction.

The changes needed to avoid dangerous ACC would also require social changes because technical solutions cannot address the issue of ACC altogether. Arguments against geoengineering have ethically

justified policy relevance due to the capability to protect and respect life in the biosphere especially from the viewpoint of biocentric principlism. Although climate emergency is non-evident and non-linear, climate science is consistent in its evidence on ACC. The abrupt nature of ACC and limited time frame can make it difficult to make consistent ethical judgements. In this sense, biocentric principlism can be applied in a climate emergency even in the most stringent situations. The mid-level principles guide action however do not provide a comprehensive normative theory. In the middle of chaotic events of a climate emergency, who would even have the time to long for a carefully detailed normative theory!

The geoengineering enterprises have to be analysed individually in order to conclude whether they are ethically and technically justifiable. However, what they all have in common is the degree of intentional modification which is in itself an issue of ethical interest in analysing the acceptability of the endeavour. There is an inconsistency between the growing demands for resources of the increasing human population and the carrying capacity of the biosphere. Hence, BAU is an ecologically unsustainable way of life for humanity, and requires a comprehensive change of lifestyles in communities in order to secure the well-being of humans and the biosphere that supports all life. The challenges caused by ACC cannot be answered by the means of control by the current fossil fuel based societies. Evolutionary measures are needed through maturation into post-carbon societies. The current culture of consumerism can be compared to a teenager with attention-deficit disorder about to win the Darwin award[59]. (Schönfeld 2011, 130–134.) Although this comparison might seem like an exaggerated accusation, it makes sense when considering the state of the ecosystem services. It is irrational and short-sighted to ignore both the biospherical limits of human impact on the ecosystem services and the negative effects of ACC which affect the whole globe, and the living conditions of entities. From the standpoint of biopherical principlism the respect for nature and the application of mid-level principles

[59] The Darwin award is a humorous commemoration of persons who eliminate themselves from the human race by way of a foolish incident thus improving the chances of the survival of the human species in the long term (see Northcutt 2000).

produce the ethically justified actions.

Solely technological fixes to tackle the challenges brought by ACC are not going to provide an adequate response to the challenges of ACC, geoengineering and climate emergency. The most threatening global challenge of the 21st century needs creative approaches, moral imagination, ethical alertness, a readiness for adjustments and adaptation, and courage to question the current laissez-faire attitude. The shift from quantitative emphasis of consumerism to qualitative focus on the aspiration for simplicity in order to coexist and flourish in and with the biosphere is a necessary step towards the objective of the continuation of the existence of humankind and a vital biosphere.

REFERENCES

350.org. "What We Do." Available: http://350.org/about/what-we-do/(22.8.2013).

Albrecht, Glenn et al. "The Ethics of Assisted Colonization in the Age of Anthropogenic Climate Change." *Journal of Agricultural and Environmental Ethics* 26 (2013): 827–845.

Alley, Richard. B. et al. "Abrupt Climate Change." *Science* 299 (2003): 2005–2010.

American Meteorological Society (AMS). *Geoengineering the Climate System: A Policy Statement of the American Meteorological Society.* Available: https://www.ametsoc.org/policy/2013geoengineeringclimate_amsstatement.html (6.1.2013).

_____. *Geoengineering the Climate System: A Policy Statement of the American Meteorological Society.* Available: http://www.ametsoc.org/policy/2009geoengineeringclimate_amsstatement.html(16.9.2009).

Angel, Roger. "Feasibility of Cooling the Earth with a Cloud of Small Spacecraft Near the Inner Lagrange point (L1)." *Proceedings of the National Academy of Sciences* 103 (2006): 17184–17189.

Arnold, Denis G., ed. *The Ethics of Global Climate Change.* Cambridge: Cambridge University Press, 2011.

Arrhenius, Svante. "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground." *Philosophical Magazine and Journal of Science Series* 5, vol. 41 (1896): 237–276.

Attfield, Robin. *Environmental Ethics: An Overview for the Twenty-First Century. 2nd edition.* Cambridge: Polity Press, 2014.

_____. Robin. "Mediated Responsibilities, Global Warming and the Scope of Ethics." *Journal of Social Philosophy* 40, no. 2 (2009): 225–236.

Barker, Terry. "The Economics of Avoiding Dangerous Climate Change. An Editorial Essay on The Stern Review." *Climatic Change* 89, no. 3–4 (2008): 173–194.

Bauer, Peter, Seboldt, Wolfgang, and Klimke, Michael. "Earth Weather and Climate Control: Can Space Technology Contribute?" *Space Policy* 15 (1999): 27–32.

BBC News. "UN Chief Makes Antarctica Visit". *BBC News* Available: http://news.bbc.co.uk/2/hi/science/nature/7088435.stm (10.11. 2007).

Beauchamp, Tom L., and Childress, James F. *Principles of Biomedical Ethics.* New York: Oxford University Press, 1977.

Benson, Sally M. "Negative-emissions Insurance." *Science* 344, no. 6191 (2014): 1431.

Betz, Gregor and Cacean, Sebastian. *Ethical Aspects of Climate Engineering.* Karlsruhe: KIT Scientific Publishing, 2012.

Black, Richard et al. "The Effect of Environmental Change on Human Migration." *Global Environmental Change* 215 (2011): S3–S11.

Blackstock, Jason J. et al. *Climate Engineering Responses to Climate Emergencies*. Novim, 2009. Available: http://arxiv.org/pdf/0907.5140. (22.4.2010).

Bodansky, Daniel, Chou, Sophie, and Jorge-Tresolini, Christie. *International Climate Efforts Beyond 2012: A Survey of Approaches*. Pew Center on Global Climate Change, 2004.

Boucher, Olivier, Gruber, Nicolas, and Blackstock, Jason. "Summary of the Synthesis Session." In *IPCC Expert Meeting Report on Geoengineering*, edited by Edenhofer, Ottmar et al., 1–7. Potsdam: IPCC Working Group III Technical Support Unit, Potsdam Institute for Climate Impact Research, 2011.

Branson, Michael C.. "A Green Herring: How Current Ocean Fertilization Regulation Distracts from Geoengineering Research." *Santa Clara Law Review* 54, no. 1 (2014): 162 – 200.

Brennan, Andrew. "Moral Pluralism and the Environment." *Environmental Values* 1, no. 1 (1992): 15–33.

Brovkin, Victor et al. "Geoengineering Climate by Stratospheric Sulfur Injections: Earth System Vulnerability to Technological Failure." *Climatic Change* 92 (2009): 243–259.

Brysse, Keynyn et al. "Climate Change Prediction: Erring on the Least Side of Drama?" *Global Environmental Change* 23 (2013): 327–337.

Bunzl, Martin. "An Ethical Assessment of Geoengineering." *Bulletin of the Atomic Scientists*, 64 (2008): 18.

Cafaro, Philip. "Getting to Less." *Ethics, Place & Environment* 13, no. 1 (2010): 11–14.

Caldeira, Ken, and Keith, David. "The Need for Climate Engineering Research." *Issues in Science and Technology* (2010): 57–62.

Caldeira, Ken and Wood, Lowell. "Global and Arctic Climate Engineering: Numerical Model Studies." *Philosophical Transactions of the Royal Society A*, 13 (2008): 4039–4056.

Callicott, J. Baird. *Beyond the Land Ethic: More Essays in Environmental Philosophy*. Albany: State University of New York Press, 1999.

Caney, Simon. "Climate Change, Energy Rights, and Equality." In *The Ethics of Global Climate Change,* edited by Denis G. Arnold, 77–103. Cambridge: Cambridge University Press, 2011.

_____. "Justice and the Distribution of Greenhouse Gases". *Journal of Global Ethics* 5 (2009): 125–146.

_____. "Cosmopolitan Justice, Responsibility, and Global Climate Change." *Leiden Journal of International Law* 18, (2005): 747–775.

_____. "International Distributive Justice." *Political Studies* 49 (2001): 974–997.

China Meteorological Administration (CMA). Weather modification. Available: http://www.cma.gov.cn/english/About_us/t20070627_200245.phtml (9.9.2008).

Coates, Joseph F. "Risks and Threats to Civilization, Humankind, and the Earth." *Futures* 41 (2009): 694–705.

Conisbee, Molly, and Simms, Andrew. *Environmental Refugees: The Case for Recognition.* London: New Economics Foundation, 2003.

Convention of Biological Diversity (CBD). "Decision X/33." *Tenth Meeting Nagoya, Japan.* (19.12. 2010). Available: http://www.cbd.int/climate/doc/cop-10-dec-33-en.pdf.

Cook, John et al. "Quantifying the Consensus on Anthropogenic Global Warming in the Scientific Literature." *Environmental Research Letters* 8, no. 2 (2013): 1–7

Crichton, Michael. *State of Fear.* Harper-Collins: New York, 2010.

Crutzen, Paul. "Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?" *Climatic Change* 77, no. 3–4 (2006): 211–219.

_____. "Geology of Mankind." *Nature* 415, no. 23 (2002): 23.

Crutzen, Paul & Stoermer, Eugene F. "The Anthropocene". *Global Change Newsletter* 41 (2000): 17–18.

Daniels, Norman. "Wide Reflective Equilibrium and Theory Acceptance in Ethics." *Journal of Philosophy* 5 (1979): 256–282.

DARA and the Climate Vulnerable Forum. *Climate Vulnerability Monitor 2nd edition: A Guide to the Cold Calculus of a Hot Planet.* Madrid: Fundación DARA Internacional, 2012.

Dessai, Suraje et al. "Defining and Experiencing Dangerous Climate Change". *Climatic Change* 64 (2004): 11–25.

Dunlap, Riley and Jacques, Peter. "Climate Change Denial Books and Conservative Think Tanks: Exploring the Connection." *American Behavioral Scientist* 57, no. 6 (2013): 699–731.

Eastin, Josh, Grundmann, Reiner and Prakash, Aseem. "The two Limits Debates: 'Limits to Growth' and Climate Change." *Futures* 43 (2011) : 16–26.

Elsner, James. B., Kossin, James P., and Jagger, Thomas. H. "The Increasing Intensity of the Strongest Tropical Cyclones." *Nature* 455 (2008): 92–95.

ETC Group. "Opposition to Geoengineering: There's No Place Like H.O.M.E." *Opinion Article, Geoengineering Our Climate Working Paper and Opinion Article Series.* (2013) http://wp.me/p2zsRk-72.

_____. *Geopiracy: The Case against Geoengineering.* Communique #103, 2010.

Fauset, Claire. *Technofixes . A Critical Guide to Climate Change Technologies. Corporate Watch Report 2008.* London: Corporate Watch, 2008.

_____. *Fixing the Sky: The Checkered History of Weather and Climate Control.* New York: Columbia University Press, 2010.

_____. "The Climate Engineers: Playing God to Save the Planet." *WilsonQuarterly* 1 (2007): 46–60.

_____. "The Pathological History of Weather and Climate Modification: Three Cycles of Promise and Hype." *Historical Studies in the Physical and Biological Sciences* 37 (2006): 3–25.

Gambrel, Joshua C. and Cafaro, Philip. "The Virtue of Simplicity." *Journal of Agricultural and Environmental Ethics* 23 (2010): 85–108.

Gardiner, Stephen. "A Desperation Argument for Geoengineering" *PS: Political Science and Politics* 46, no. 1 (2013): 28–33.

_____. " Are We Scum of the Earth? Climate Change, Geoengineering and Humanity's Challenge." In *Ethical Adaptation to Climate Change* edited by Thompson, Allen and Bendik-Keymer, Jeremy, 241–259. Cambridge: MIT Press, 2012.

_____. *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*. Oxford: Oxford University Press, 2011a.

_____. "Some Early Ethics of Geoengineering: A Commentary on the Values of the Royal Society Report." *Environmental Values* 20, (2011b): 163–188.

_____. "Ethics and Climate Change: An Introduction." *WIREs Climate Change* 1 (2010b): 54–66.

_____. "Is "Arming the Future" with Geoengineering Really the Lesser Evil? Some Doubts about the Ethics of Intentionally Manipulating the Climate System. In *Climate Ethics: Essential Readings*, edited by Gardiner, Stephen et al., 284–312. New York: Oxford University Press, 2010c.

_____. "Saved by Disaster? Abrupt Climate Change, Political Inertia and the Possibility of an Intergenerational Arms Race." *Journal of Social Philosophy* 40, no. 2 (2009): 140 –162.

_____. "Is Geoengineering the Lesser Evil?" *Environmental Research Web* (18.4.2007). http://environmentalresearchweb.org/cws/article/opinion/27600.

_____. "A Perfect Moral Storm: Climate Change, Intergenerational Ethics and the Problem of Moral Corruption." *Environmental Values* 15 (2006): 397–413.

_____. "Ethics and Global Climate Change." *Ethics* 114 (2004): 555–600.

Gardiner, Stephen and Hartzell-Nichols, Lauren. "Ethics and Global Climate Change." *Nature Education Knowledge* 3, no. 10 (2012): 5.

Gardiner, Stephen et al., ed. *Climate Ethics: Essential Readings*. Oxford: Oxford University Press, 2010.

Gemenne, François. **"**Why the Numbers Don't Add up: A Review of Estimates and Predictions of People Displaced by Environmental Changes." *Global Environmental Change* 215 (2011): S41– S49.

Gladwell, Malcom. *The Tipping Point: How Little Things Can Make a Big Difference*. Boston: Little Brown and Company, 2000.

Glantz, Michael H. *Climate Affairs – A Primer*. Washington DC: Island Press, 2003.

Goodell, Jeff. *How to Cool the Planet: Geoengineering and the Audacious Quest to Fix Earth's Climate*. New York: Houghton Mifflin Harcourt, 2010.

Grubb, Michael. "Seeking Fair Weather: Ethics and the International Debate on Climate Change." *International Affairs* 3 (1995): 463–96.

Guggenheim, Davis. *An Inconvenient Truth*. Los Angeles: Paramount Classics, 2006.

Hale, Ben. "The World that Would Have Been: Moral Hazard Arguments against Geoengineering" In *Engineering the Climate: The Ethics of Solar Radiation Management,* edited by Christopher Preston, 113–131. Lanham, Lexington Books, 2012.

_____. "What's So Moral About the Moral Hazard?" Public Affairs Quarterly 23, no. 1 (2009): 1–25.

Hamblin, Jacob D. *Arming Mother Nature: The Birth of Catastrophic Environmentalism*. New York: Oxford University Press, 2013.

Hamilton, Clive. "Geoengineering and the Politics of Science." *Bulletin of the Atomic Scientists* 70, no. 3 (2014): 17–26.

_____. "No, We Should Not Just 'At Least Do the Research'." *Nature* 496 (2013a): 139.

_____. *Earthmasters: The Dawn of the Age of Climate Engineering*. New Haven, CT: Yale University Press, 2013b.

Hands Off Mother Earth (H.O.M.E). "About H.O.M.E. Campaign." (2010). Available: http://www.handsoffmotherearth.org/about/about-h-o-m-e-campaign/ (20.7. 2011).

_____. *Vandana Shiva debates Geoengineering with Gwynne Dyer on Democracy Now!* Available: http://www.handsoffmotherearth.org/2010/07/vandana-shiva-debates-geoengineering-with-gwynne-dyer-on-democracy-now/ (8.9.2010).

Hansen, James. "Can We Still Avoid Dangerous Human-made Climate Change?" *Social Research* 73, no. 2 (2006): 949–971.

_____. "A Slippery Slope: How Much Global Warming Constitutes 'Dangerous Anthropogenic Interference'?" *Climatic Change* 68 (2005): 269–279.

Hardin, Garrett. "Living on a Lifeboat." *Bioscience 24* (1974): 561–568.

Hargrove, Eugene. "Weak Anthropocentric Intrinsic Value." *Monist* 75, no. 2 (1992): 183–207.

Harper, Kristine C. "Climate Control: United States Weather Modification in the Cold War and Beyond." *Endeavour* 32 (2008): 20–26.

Harris, Paul. *World Ethics and Climate Change. From International to Global Justice*. Edinburgh: Edinburgh University Press, 2010.

Hayward, Tim. "Human Rights versus Emissions Rights: Climate Justice and the Equitable Distribution of Ecological Space." *Ethics and International Affairs* 21, no. 4 (2007): 431–450.

Heyward, Clare. "Situating and Abandoning Geoengineering: A Typology of Five Responses to Dangerous Climate Change. *PS: Political Science & Politics* 46, no. 1 (2013): 23–27.

Heyward, Clare, and Rayner, Steve. "Apocalypse Nicked!" *The Climate Geoengineering Governance Working Paper Series* 6 (2013).

Holdren, John. *Meeting the Climate Change Challenge.* Eighth Annual John H. Chafee Memorial Lecture on Science and the Environment. Washington, DC: National Council for Science and the Environment, 2008.

Hood, Robert. "Global Warming." In *A Companion to Applied Ethics,* edited by Frey, Raymond Gillespie and Wellman, Christopher Heath Wellman, 674–685. Malden: Blackwell Publishing, 2007.

Houghton, John. *Global Warming: The Complete Briefing. Fourth edition*. Cambridge: Cambridge University Press, 2009.

Hulme, Mike "Chaotic world of climate truth." BBC News, Available: http://news.bbc.co.uk/2/hi/science/nature/6115644.stm (4.11.2006.)

Ikle, Fred and Wood, Lowell. "Climatic Engineering." *The National Interest* 93 (2008): 18–24.

Inman, Mason. "Planning for Plan B ." *Nature Reports Climate Change* 4 (2010): 7–9.

International Comission on Clouds and Precipitation (ICPP). "Statement on Radiation Management Climate Engineering." Appendix B in Report from Expert Team on Weather Modification Research for 2012/2013. Available: http://www.wmo.int/pages/prog/arep/wwrp/new/documents/Doc_3_6_weather_mod_2013_Final_tn.pdf.2013.

International Federation of Red Cross and Red Crescent Societies. *The World Disasters Report 2002*. Geneva: IFRC, 2002.

IPCC. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Edited by Stocker, Thomas F. et al. Cambridge: Cambridge University Press, 2013a.

_____. 2013b: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change edited by Stocker, Thomas et al. Cambridge: United Kingdom and New York, USA, Cambridge University Press, 2013.

_____. Working Group III – Mitigation of Climate Change, Final Draft. 2013c. Available: http://report.mitigation2014.org/drafts/final-draft-postplenary/ipcc_wg3_ar5_final-draft_postplenary_chapter3.pdf.

_____. *Climate Change 2007: Synthesis report. Contribution of Working groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Edited by Core Writing Team, Pachauri, Rajenda. K. and Reisinger, Andy. Geneva: IPCC, 2007a.

_____. "Summary for Policymakers" in: Metz, B. et al. (Eds.) *Climate change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.*

Cambridge: Cambridge University Press, 2007b.

_____. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Edited by Metz, Gregory et al. Cambridge, United Kingdom and New York,USA: Cambridge University Press, 2007.

_____. *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Edited by Watson, Robert T. and the Core Writing Team. Cambridge and New York: Cambridge University Press , 2001.

Isomäki, Risto. *Sands of Sarasvati.* Helsinki: Into, 2013.

_____. *64 Ways to Absorb Carbon and Improve the Earth's Reflectivity – From Reasonable Options to Mad Scientist Solutions.* Helsinki: Into, 2009.

Jagers, Sverker C. and Duus-Otterström, Göran. "Dual Climate Change Responsibility: On Moral Divergences Between Mitigation and Adaptation." *Environmental Politics* 4 (2008): 576–91.

Jamieson, Dale. "Some Whats, Whys, and Worries of Geoengineering." *Climatic Change* 121, no. 3 (2013): 527–537.

_____. *Ethics and the Environment: An Introduction.* Cambridge: Cambridge University Press, 2008.

Jamieson, Dale. "Ethics and Intentional Climate Change." *Climatic Change* 33 (1996): 323–336.

Keith, David. *A Case for Climate Engineering.* Cambridge: The MIT Press, 2013.

_____. "A Surprising Idea for "Solving" Climate Change" *TEDtalk* (09/2007). Available: http://www.ted.com/talks/david_keith_s_surprising_ideas_on_climate_change.

_____. "Geoengineering." *Nature* 409, no. 6818 (2002): 420.

_____. "Geoengineering the Climate: History and Prospect." *Annual Review of Energy and the Environment*, 25 (2000): 245–284.

_____. "Geoengineering Climate." In *Elements of Change,* edited by Hassol, S.J and Katzenberger, 83–88. Aspen, Colorado: Aspen Global Change Institute, 1998.

Keith, David, Parson, Edward, and Morgan, M. Granger. "Research on Global Sun Block Needed Now." *Nature* 463 (2010): 426–427.

Keller, Klaus et al. "Avoiding Dangerous Anthropogenic Interference with the Climate System." *Climatic Change* 73 (2005): 227–238.

Kintisch, Eli. "Dr. Cool." *Science* 342 (18.10.2013): 307–309.

_____. "Climate Hacking for Profit: a Good Way to Go Broke". CNN Money (21.5.2010a). Available: http://money.cnn.com/2010/05/21/news/economy/geoengineering.climos.planktos.fortune/index.htm.

_____. *Hack the Planet: Science's Best Hope – or Worst Nightmare – for Averting Climate Catastrophe.* New

Jersey: Wiley & Sons, 2010b.

Lenton, Timothy. "Can Emergency Geoengineering Really Prevent Climate Tipping Points?" *Geoengineering Our Climate Working Paper and Opinion Article Series* 2013. Available: http://wp.me/p2zsRk-7Z (22.10.2013).

_____. "Early Warning of Climate Tipping Points." *Nature Climate Change* 1 (2011):201–209.

Lenton, Timothy M. and Vaughan, Naomi E. "The Radiative Forcing Potential of Different Climate Geoengineering Options." *Atmospheric Chemistry and Physics Discussions* 9 (2011): 2559–2608

Leopold, Aldo. *A Sand County Almanac: And Sketches Here and There.* New York: Oxford University Press, 1949.

Light, Andrew. "Contemporary Environmental Ethics: From Metaethics to Public Philosophy." *Metaphilosophy* 33, no. 4 (2002): 426–449.

Long, Jane, et al. *Task Force On Climate Remediation Research: Geoengineering: A National Strategic Plan for Research on the Potential Effectiveness, Feasibility and Consequences of Climate Remediation Technologies.* Washington D.C.: BiPartisan Policy Center, 2011.

Lovelock, James. "A Geophysiologist's Thoughts on Geoengineering." *Philosophical Transactions of the Royal Society A*366 (2008): 3883–3890.

_____. *Practical Science of Planetary Medicine.* London: Gaia Books, 2000.

Lovgren, Stefan. "Climate Change Creating Millions of 'Eco Refugees', UN warns." *National Geographic News.* Available: http://news.nationalgeographic.com/news/2005/11/1118_051118_disaster_refugee.html (8.11.2009).

Lukacs, Martin. "World's Biggest Geoengineering Experiment 'violates' UN rules." *The Guardian* (15.10.2012.)

MacCracken, Michael. "Geoengineering: Worthy of cautious evaluation?" *Climatic Change* 77 (2006): 235–243.

Mann, Michael E. "Defining Dangerous Anthropogenic Interference." *Proceedings of National Academy of Sciences of the United States of America* 106, no. 11 (2009): 4065–4066.

Marchetti, Cesare. "On Geoengineering and the CO_2 Problem." *Climatic Change* 1 (1977): 59–68.

Matthews, H. Damon and Caldeira, Ken. "Transient Climate-carbon Simulations of Planetary Geoengineering." *Proceedings of the National Academy of Sciences of the United Stated of America* 104, no. 24 (2007): 9949–9954.

McCormick, Robert and Ludwig, John. "Climate Modification by Atmospheric Aerosols." *Science* 156, no. 3780 (1967): 1358–1359.

McCright, Aaron M. & Dunlap, Riley E. "Anti-reflexivity: The American Conservative Movement's Success in Undermining Climate Science and Policy." *Theory, Culture & Society* 27, no. 2–3; 100–133.

McIlveen, Robin. *Fundamentals of Weather and Climate*. London: Chapman & Hall, 1992.

McKee, Martin. "Denialism: What is it and How Should Scientists Respond?" *European Journal of Public Health* 19, no. 1 (2009): 2–4.

McKibben, Bill. *End of Nature*. New York: Random House, 1989.

Meadows , Donella et al. 1972 *The Limits to Growth*. New York: Universe Books, 1972.

Miller, David. "Holding Nations Responsible." *Ethics* 114 (2004): 240–268.

Miller, G. Tyler. *Living in the Environment. Principles, Connections, and Solutions*. Pacific Grove: Brooks/Cole, Thomson Learning, Inc., 2005.

Minteer, Ben & Collins, James. "Move It or Lose It? The Ecological Ethics of Relocating Species under Climate Change." *Ecological Applications* 20, no. 7 (2010): 1801–1804.

Molotch, Harvey. "Oil in Santa Barbara and Power in America." *Sociological Inquiry* 40, no. 1 (1970): 131–144.

Moncel, Remi, McCall, Kevin and Levin, Kelly. "Building the Climate Change Regime: Survey and Analysis of Approaches." *Working Paper. World Resources Institute United Nations Environment Programme* 2011.

Moore, Kathleen and Nelson, Michael. *Moral Ground: Ethical Action for a Planet in Peril*. San Antonio: Trinity University Press, 2010.

Morgan, Dennis Ray. "World on Fire: Two Scenarios of the Destruction of Human Civilization and Possible Extinction of the Human Race." *Futures* 41 (2009): 683–693.

Morgan, Granger et al. "Why Conventional Tools for Policy Analysis are Often Inadequate for Problems of Global Change." *Climatic Change* 41 (1999): 271–281.

Myers, Norman. "Environmental Unknowns."*Science* 269 (1995): 358–360.

Naess, Arne. "The Shallow and the Deep: Long-Range Ecology Movements." *Inquiry* 16 (1973): 95–100.

National Oceanic and Atmospheric Administration: United States Department of Commerce (NOAA). "Carbon Dioxide at NOAA's Mauna Loa Observatory reaches new milestone: Tops 400 ppm". Available: http://www.esrl.noaa.gov/gmd/news/7074.html (13.12.2013).

Neiburger, Morris, Edinger, James and Bonner, William. *Understanding our Atmospheric Environment*. San Francisco: W.H. Freeman and Company, 1982.

Neuteleers, Stijn. "Environmental Refugees: A Misleading Notion for a Genuine Problem." *Ethical Perspectives* 18, no. 2 (2011): 229–248.

Niemelä, Jari. "1700-luvun utilismi ja toive ilmaston lämpenemisestä." *Auraica* 1 (2008): 71–80.

Nordhaus, William. *The Challenge of Global Warming: Economic Models and Environmental Policy*. New Haven: Yale University, 2007.

Northcutt, Wendy. *The Darwin Awards: Evolution in Action*. New York City: Plume 2000.

Norton, Bryan. "Converge and Contextualism: Some Clarifications and a Reply to Steverson." *Environmental Ethics* 19, no. 1 (1997): 87–100.

Nozick, Robert. *Anarchy, State and Utopia*. New York: Basic Books, 1974.

Oliver, John. *Climate and Man's Environment. An Introduction to Applied Climatology*. New York: John Wiley & Sons, 1973.

O'Neill, Saffron and Nicholson-Cole, Sophie. "'Fear Won't Do It: Promoting Positive Engagement with Climate Change Through Visual and Iconic Representations." *Science Communication* 30, no. 3 (2009) 355–379.

Oreskes, Naomi. "The Scientific Consensus on Climate Change: How Do We Know We're Not Wrong? " In *Climate Change: What It Means for Us, Our Children, and Our Grandchildren*, edited by DiMento, Joseph F. C. and Doughman, Pamela, 65–99. Cambridge: MIT Press, 2007.

_____. "The Scientific Consensus on Climate Change". *Science* 306, no. 5702 (2004): 1686.

Oreskes, Naomi and Conway, Erik. *Merchants of Doubt: How a Handful on Scientists Obscured the Truth Issues from Tobacco Smoke to Global Warming*. London: Bloomsbury, 2010a.

_____. "Defeating Merchants of Doubt." *Nature* 465 (2010b): 686–687.

Pacala, Stephen, and Socolow, Robert. "Stabilization Wedges: Solving the Climate Problem for the Next 50 years with Current Technologies." *Science* 305, no. 5686 (2004a): 968–972.

Parry, Martin, Carter, Timothy and Hulme, Mike. "What is a Dangerous Climate Change?" *Global Environmental Change* 6, no. 1 (1996): 1–6.

Peterson, E. Wesley F. "The Ethics of Burden-sharing in the Global Greenhouse." *Journal of Agricultural and Environmental Ethics* 11(1999): 167–196.

Pielke Jr., Roger. "Climate Engineering: Alternative Perspective." In *Smart Solutions to Climate Change: Comparing Costs and Benefits*, edited by Lomborg, Bjorn, 52–61. New York: Cambridge University Press, 2010a.

_____. *Climate Fix: What Scientists and Politicians Won't Tell You about Global Warming*. New York: Basic Books, 2010b.

Pietarinen, Juhani. "Ihmislähtöiset luontoarvot ja luonnon omat arvot." In *Arvot ja Luonnon Arvottaminen,* edited by Haapala, Arto and Oksanen, Markku, 38–54. Helsinki: Gaudeamus, 2000.

Poortinga, Wouter et al. "Uncertain Climate: An Investigation into Public Scepticism about Anthropogenic Climate Change." *Global Environmental Change* 21 (2011): 1015–1024.

Preston, Christopher. "The Extraordinary Ethics of Solar Radiation Management." In *Engineering the*

Climate: The Ethics of Solar Radiation Management, edited by Preston, Christopher, 1–11. Lanham: Lexington Books, 2012.

_____. "Re-thinking the Unthinkable: Environmental Ethics and the Presumptive Argument Against Geoengineering." *Environmental Values* 20 (2011): 457–479.

Pärssinen, Martti. "Ihminen ja ympäristö prekolumbiaanisen ajan Keski-Andeilla." in: Muuttuva maailmamme. Ympäristöongelmia eilen ja tänään. Julkaisuja no. 24, edited by Kuparinen, Eero, 33–46. Turku: Turun yliopiston historian laitos, 1992.

Rawls, John. "The Independence of Moral Theory." *Proceedings and Addresses of the American Philosophical Association* 48 (1974–1975): 5–22.

Rayner, Steve. "The Perception of Time and Space in Egalitarian Sects: a Millenarian Cosmology." In *Essays in the Sociology of Perception*, edited by Douglas, Mary, 247–274. London: Routledge & Kegan Paul, 1982.

Rayner, Steve et al. "The Oxford Principles." *Climate Geoengineering Governance Working Paper Series* 1 Available: http://geoengineering-governance-research.org/perch/resources/workingpaper1rayneretaltheoxfordprinciples.pdf (15.10.2013).

Raz, Joseph. *The Morality of Freedom*. New York: Oxford University Press, 1986.

Regan, Tom. *The Case for Animal Rights*. Berkeley: University of California Press, 1983.

Ringius, Lasse, Asbjörn, Torvanger and Underdal, Arild. "Burden Sharing and Fairness Principles in International Climate Policy." *International Environmental Agreements: Politics, Law and Economics* 2 (2002): 1–22.

Risbey, James. "The New Climate Discourse: Alarmist of Alarming?" *Global Environmental Change* 18 (2008): 26–37.

Robock, Alan. "Bubble, Bubble, Toil and Trouble." *Climatic Change* 105 (2011): 383–385.

_____. "20 Reasons Why Geoengineering May Be a Bad Idea." *Bulletin of the Atomic Scientists* 64 (2008): 14–18, 59.

Robock, Alan et al. "Studying Geoengineering with Natural and Anthropogenic Analogs." *Climatic Change* 121 (2013): 445–458.

Robock Alan et al. "The Benefits, Risks, and Costs of Stratosphere Geoengineering." *Geophysical Research Letters* 36 (2009): L19703.

Robock, Alan, Oman, Luke and Stenchikov, Georgiy. "Nuclear Winter Revisited with a Modern Climate Model and Current Nuclear Arsenals: Still Catastrophic Consequences." *Journal of Geophysical Research* 112 (2007).

Rockström, Johan et al. "Planetary Boundaries: Exploring the Safe Operating Space for Humanity." *Ecology and Society* 14, no. 2 (2009): 1–33.

Rolston III, Holmes. "Is There an Ecological Ethic?" *Ethics* 85, no. 2 (1975): 93–109.

Routley (Sylvan), Richard. "Is There a Need for a New, an Environmental Ethic?" *Proceedings of the XVth World Congress of Philosophy* (1973): 205–210.

Rusin, Nikolai and Flit, Liia. *Man versus Climate*. Moscow: Peace Publishers, sine anno.

Sandin, Per. "Firefighting Ethics: Principlism for Burning Issues." *Ethical Perspectives* 16 (2009): 225–251.

_____. "Supreme Emergencies without the Bad Guys." *Philosophia* 37, no. 1 (2009): 153 – 167.

Sandin, Per and Wester, Misse. "The Moral Black Hole." *Ethical Theory and Moral Practice* 12 (2009): 291–301.

Sanford, A. Whitney. "Ethics, Narrative and Agriculture: Transforming Agricultural Practice through Ecological Imagination." *Journal of Agricultural and Environmental Ethics* 24 (2011): 283–303.

Salama, Peter et al. "Lessons Learned from Complex Emergencies over Past Decade." *Lancet* 364 (2004): 1801–1803.

Salter, Stephen, Sortino, Graham and Latham John. "Sea-going Hardware for the Cloud Albedo Method of Reversing Global Warming." *Philosophical Transactions of the Royal Society A* 366 (2008): 3843–3862.

Sarewitz, Daniel and Nelson, Richard. "Three Rules for Technological Fixes." *Nature* 456 (2008): 871–872.

Schneider, Stephen. "Geoengineering: Could We or Should We Make It Work?" *Philosophical Transactions of the Royal Society A* 366 (2008): 3843–3862.

_____. "Earth Systems Engineering and Management." *Nature* 409 (2001): 417–421.

_____. "Geoengineering: Could – or Should– We Do It?" *Climatic Change* 33 (1996): 291–302.

Schneider, Stephen and Kellogg, William W. "Climate Stabilization: For Better or Worse?" *Science* 186, no. 4170 (1974): 1163–1172.

Schurmann, Egbert. "Philosophical and Ethical Problems of Technicism and Genetic Engineering." *Techné: Research in Philosophy and Technology* 3. no. 1, (1997): 27–44.

Schönfeld, Martin. "Plan B: Global Ethics on Climate Change." *Journal of Global Ethics* 7, no. 2 (2011): 129–136.

Seitz, Russell. "Bright Water: Hydrosols, Water Conservation and Climate Change." *Climatic Change* 105 (2011): 365–381.

Shearman, David and Smith, Joseph Wayne. *The Climate Change and the Failure of Democracy*. Westport: Praeger, 2007.

Shepherd, John et al. *Geoengineering the Climate: Science, Governance and Uncertainty*. London: Royal Society, 2009.

Shiva, Vandana. "Destroying Planet Earth: Geoengineering is the Ultimate Hubris, without Democratic

Control. Interview with Vandana Shiva." *Global Research* Available: www.globalresearch.ca/destroying-planet-earth-geoengineering-is-the-ultimate-hubris-without-democratic-control/5370179 (23.2.2014).

Shue, Henry. "Human Rights, Climate Change, and the Trillionth Ton." In *The Ethics of Global Climate Change*, edited by Arnold, Denis, 292–314. Cambridge, Cambridge University Press, 2011.

_____. "Climate." In *Companion to Environmental Philosophy,* edited by Jamieson, Dale, 449–459. Oxford: Blackwell Publishers, 2001.

_____. "Global Environment and International Inequality." *International Affairs* 75, no. 3 (1999): 531–545.

_____. "Subsistence Emissions and Luxury Emissions." *Law & Policy* 15 (1993): 39–59.

Singer, Peter. "Ethics and Climate Change: A Commentary on MacCracken, Toman and Gardiner." *Environmental Values* 15 (2006): 415–422.

_____. *One World: The Ethics of Globalization*. New Haven: Yale University Press, 2002.

_____. "Animal Liberation." *The New York Review of Books* 20, no. 5 (1973): 17–19.

Skrimshire, Stefan. "Eternal Return of Apocalypse." In *Future Ethics: Climate Change and Apocalyptic Imagination,* edited by Skrimshire, Stefan, 219–241. London: Continuum, 2010.

Smetacek, Victor and Naqvi, Wahij. "The Next Generation of Iron Fertilization Experiments in the Southern Ocean." *Philosophical Transactions of the Royal Society A*, 366 (2008): 3919–3945.

Socolow, Robert et al. "Solving the Climate problem: Technologies Available to Curb CO_2 Emissions." *Environment* 46, no. 10 (2004): 8–19.

Sorell, Tom. "Morality and Emergency." *Proceedings of Arostotelian Society* 103 (2002): 21–37.

Spash, Clive. "Green Economy, Red Herring". *Environmental Values* 21 (2012): 95–99

Spratt, David and Sutton, Philip. *Climate Code Red: The Case for Emergency Action.* Melbourne: Scribe, 2008.

Steinberg, Ted. *Acts of God. The Unnatural History of Natural Disaster in America.* 2nd ed. Oxford: Oxford University Press, 2006.

Stephens, Jennie and Keith, David. "Assessing Geochemical Carbon Management." *Climatic Change* 90 (2008): 217–242.

Sterba, James P. "From Biocentric Individualism to Biocentric Pluralism." *Environmental Ethics* 17, no. 2 (1995): 191–207.

Stern, Nicholas. *The Economics of Climate Change: The Stern Review.* Cambridge: Cambridge University Press, 2007.

Sumner, Graham. "Precipitation." In *The Oxford Companion to the Earth, edited by* : P. Hancock, Paul and Skinner, Brian, 848–850. Oxford: Oxford University Press, 2000.

Szerszynski, Bronislaw and Urry, John. "Changing Climates: Introduction." *Theory, Culture and Society* 27, no. 1 (2010): 1–8.

Taylor, Paul. *Respect for Nature: A Theory of Environmental Ethics*. Princeton: Princeton University Press, 1986.

_____. "In Defense of Biocentrism." *Environmental Ethics* 3, no. 3 (1983): 237–243.

_____. "The Ethics of Respect for Nature." *Environmental Ethics* 3, no. 3 (1981): 197–218.

Thompson, J. Michael T. and Sieber, Jan. "Predicting Climate Tipping Points." In *Geo-Engineering Climate Change: Environmental Necessity or Pandora's Box?*, edited by Launder, Brian and Thompson, J. Michael T., 50–83. Cambridge: Cambridge University Press, 2010.

The New Oxford American Dictionary. "Oxford Word of the Year 2008: Hypermiling." (2008). Available: http://blog.oup.com/2008/11/hypermiling/

The Pew Research Center. "More Say There Is Solid Evidence of Global Warming." (15.10. 2012). Available: http://www.people-press.org/2012/10/15/more-say-there-is-solid-evidence-of-global-warming/.

Tilmes, Simone, Müller, Rolf and Salawitch, Ross. "The Sensitivity of Polar Ozone Depletion to Proposed Geoengineering Schemes." *Science* 320, no. 1201 (2008): 1201–1204.

Traxler, Martino. "Fair Chore Division for Climate Change." *Social Theory and Practice* 28 (2002): 101–134.

Trenberth, Ken and Dai, Aiguo. "Effects of Mount Pinatubo Volcanic Eruption on the Hydrological Cycle as an Analog of Geoengineering." *Geophysical Research Letters* 34, L15702 (2007): 1–5.

Tuohey, John F. "A Matrix for Ethical Decision Making in a Pandemic. The Oregon Tool for Emergency Preparedness. *Health Progress* 88, no. 6 (2007): 20–25.

United Nations Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques. (1976). Available: http://www.un-documents.net/enmod.htm (8.7.2009).

United Nations Framework Convention on Climate Change (UNFCCC). (1992). Available: http://www.unfccc.int. (8.9.2009).

United Nations High Commissioner for Refugees (UNHCR). *Convention and Protocol Relating to the Status of Refugees*. Geneva: United Nations High Commissioner for Refugees, 2007.

Veldman, Robin G. "Narrating the Environmental Apocalypse: How Imagining the End Facilitates Moral Reasoning Among Environmental Activists." *Ethics & the Environment* 17, no. 1 (2012): 1–23.

Victor, David. "On the Regulation of Geoengineering." *Oxford Review of Economic Policy* 24 (2008): 322–336.

Victor, David et al. "The Truth about Geoengineering." *Foreign Affairs* 92, no. 2 (2013).

Victor, David et al. "The Geoengineering Option: A Last Resort Against Global Warming?" *Foreign Affairs* 88 (2009): 64–76.

Virgoe, John. "International Governance of a Possible Geoengineering Intervention to Combat Climate Change." *Climatic Change* 95 (2009): 103–119.

Vogt, Evon. "Some Implications of Weather Modification for the Cultural Patterns of Tribal Societies." in *Human Dimensions of Weather Modification*, edited by Derrick Sewell, 373–392 . Chicago: Chicago University Press, 1966.

Wade, Stephen. "Rain Out: China Aims to Control Olympics." *USA Today* (29.2.2008). Available: http://usatoday30.usatoday.com/weather/research/2008-02-29-china-weather_N.htm.

Walzer, Michael. *Arguing about War*. New Haven: Yale University Press, 2004.

Weart, Spencer. "The Idea of Anthropogenic Climate Change in the 20th Century." *Wiley Interdisciplinary Reviews: Climate Change* 1 (2010): 67–81.

_____.*The Discovery of Global Warming*. Cambridge: Harvard University Press, 2003.

Weather Modification Association (WMA). Available: http://www.weathermodification.org/organization.htm (7.7.2011).

Weber, Elke. "Experience–based and Description-based Perception of Long Term Risk: Why Global Warming Does Not Scare Us (Yet)." *Climatic Change* 77 (2006): 103–120.

Weinberg, Alvin. "Can Technology Replace Social Engineering?" *Bulletin of Atomic Scientists* 12, no. 10 (1966): 4–8.

Wigley, Tom. "A Combined Mitigation/Geoengineering Approach to Climate Stabilization." *Science* 314, no. 5798 (2006): 452–454.

Williamson, Philip et al. *Impacts of Climate-Related Geoengineering on Biological Diversity. Part I of: Geoengineering in Relation to the Convention on Biological Diversity: Technical and Regulatory Matters*. Secretariat of the Convention on Biological Diversity. Montreal, Technical Series No. 66, 2012.

World Meteorological Organization (WMO). *Report from Expert Team on Weather Modification Research for 2012/2013*. Geneva Available: http://www.wmo.int/pages/prog/arep/wwrp/new/documents/Doc_3_6_weather_mod_2013_Final_tn.pdf (9.9.2013).

_____. Executive Summary of the WMO Statement on Weather Modification. The Commission for Atmospheric Sciences Management Group, Second Session. Available: http://www.wmo.int/pages/prog/arep/wmp/documents/WM_statement_guidelines_approved.pdf (19.6.2009).

Zheng, Yu. "Beijing Uses High-tech to Prevent Rain from Dampening Olympic Opening." *Xinhua* Available: http://news.xinhuanet.com/english/2008-07/28/content_8787101.htm (28.7.2008).

Ziegler, Charles. E. *Environmental Policy in the USSR*. London: Frances Pinter, 1987.