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Kirsten Meyer
Christian Uhle

IRI THESys
Transformations of Human-Environment Systems

IRI THESys - Integrative Research Institute on
Transformations of Human-Environment Systems
Humboldt-Universität zu Berlin
Unter den Linden 6
10099 Berlin

Phone: +49 30 2093-66336
Fax: +49 30 2093-66335
Web: www.iri-thesys.org

Author Contacts:
Kirsten Meyer (corresponding author)
Institut für Philosophie, Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany
Phone +49 30 2093-8185, Fax +49 30 2093-7438, E-mail: Kirsten.Meyer@philosophie.hu-berlin.de
Christian Uhle
Institut für Philosophie, Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany
E-mail: christian.uhle@web.de

Editor in Chief:
Jonas Østergaard Nielsen (IRI THESys)
jonas.ostergaard.nielsen@hu-berlin.de

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Geoengineering and the Accusation of Hubris

Kirsten Meyer & Christian Uhle (Humboldt-Universität zu Berlin)

Abstract

Geoengineering aims at a large-scale manipulation of the planetary environment in order to counteract climate change. Different ethical worries concerning geoengineering have been formulated. Amongst these a core wrong is often believed to be captured by a certain character trait, namely hubris. The value of referring to the concept of hubris, however, is not at all clear. What exactly does this concept entail, and what is its merit in evaluating proposals of geoengineering? This paper analyses the concept of hubris. It then argues that referring to this concept does indeed add an important perspective to an evaluation of the various proposals for geoengineering.

Keywords: climate change; geoengineering; hubris; virtue ethics; climate justice

Contents

1. Introduction

The problem of climate change caused by anthropogenic emissions of greenhouse gases has been known for decades, but global emissions of carbon-dioxide have not been reduced. In the light of this seemingly widespread unwillingness to change human behavioural patterns, considerations in favour of geoengineering (GE), i.e. a „large-scale technical intervention in the climate system that aims to cancel some of the effects of greenhouse gas emissions" (IPCC, 2014b, ch. 3.3.7.), are becoming increasingly popular.

GE proposals include, for example, the injection of particles into the stratosphere or the fertilisation of oceans in order to cause effects which counteract climate change. These techniques bring about a variety of technical worries. All approaches carry risks and uncertainties (IPCC, 2014b, ch. 6.). For example, the aforementioned injection of particles could affect the African and Asian summer monsoons, "threatening the food and water supplies to billions of people". (Robock et al., 2008). Furthermore, it would increase ozone depletion (Tilmes et al., 2008) and does not reduce ocean acidification (Moreno-Cruz & Keith, 2012). Moreover, it is connected to a 'termination-problem', because a breakdown of the particle supply would presumably lead to a drastic and dangerous warming (IPCC, 2013, p. 634; Brovkin et al., 2009; Matthews & Caldeira, 2007).

Different ethical worries concerning GE have also been considered. Certain GE-technologies have been criticized for not meeting the requirements of distributive, intergenerational and procedural justice (see, for example, Preston, 2013; Svoboda et al., 2011; Goes et al., 2011; Burns, 2011; Gardiner, 2010, p. 294; Jamieson, 1996, pp. 329-331). Furthermore, several political risks of GE have been stressed. For example, Stephen Schneider (2008) emphasises that global cooperation is insufficiently stable to ensure that world climate control could be maintained without interference by severe ideological disputes or even wars (cf. also Goes et al., 2011; Robock, 2008). A related field of problems emerges from the fact that some techniques could be implemented unilaterally by single actors and without international agreement (IPCC, 2014b, ch. 13.4.4.).

In the following, however, we will not discuss arguments of this kind in detail, but instead explore a general criticism of GE: namely *hubris*. As Jeffrey Kiehl (2006, p. 227) locates hubris within GE: "On the issue of ethics, I feel we would be taking on the ultimate state of hubris to believe we can control Earth." Stephen Gardiner (2010, p. 303), who raises several objections against GE, states that "at least one core wrong associated with geoengineering is best captured by gesturing at certain character traits, such as hubris". So hubris is a common theme in the debate on geoengineering (cf. also Hale, 2012; Preston, 2013; Royal Society, 2009, p. 39).

GE technologies are not the first ones that provoked such thoughts. General worries concerning the attempt to control nature have also been articulated in debates about nuclear energy, genetically modified organisms, and nanotechnology. The intellectual and ethical value of referring to the concept of hubris, however, is not at all clear. What exactly does this concept entail, and what is its value in evaluating potentially dangerous aspirations? Does the accusation of hubris go beyond merely articulating a fear of new technologies?

2. The concept of hubris

In order to reveal what the accusation of hubris amounts to and to furthermore investigate if it is a justified charge in the context of GE, we should first clarify the concept of hubris. It can be, and often is, traced back to ancient philosophy. Aristotle conceived hubris as follows:

„The person who gives insult also belittles; for insult [hybris] is doing and speaking in which there is shame to the sufferer, not that some advantage may accrue to the doer or because something has happened but for the pleasure of it; for those reacting to something do not give insult but are retaliating. The cause of pleasure to those who give insult is that they think they themselves become more superior by ill-treating others." (Aristotle, Rhetoric, 1378b).

For Aristotle, hubris is the deliberate infliction of shame on someone else. It is a form of dishonouring that someone feeling superior does to someone else. Contrary to popular belief, this attitude is not necessarily linked to any offence against divine powers (Fisher, 1998). Even though there are different understandings of the notion of hubris today, we can identify common features, which fit with what Aristotle had in mind: hubris is connected to a conviction of superiority. This conviction is criticized for being unjustified. Moreover, hubris is treated not just as an epistemic, but also as a moral failure.

With regard to modern usages of the concept of hubris, we should first focus on the accusation of hubris in criticising the deployment of certain technologies. In this context, hubris is frequently understood as an attempt to transgress human boundaries or 'playing God'. This phrase is revealing particularly with regard to GE, since the elements were traditionally said to be controlled by gods. In the early stages of in vitro fertilisation (IVF), however, 'playing god' was also a common criticism (Banchoff, 2011). Now that more than five million babies have been born by means of IVF worldwide, IVF enjoys wide social acceptance and the accusation of 'playing god' is rarely heard. This example raises the worry that the concept of hubris, as commonly understood, is based on conservative and time-dependent feelings.

Nevertheless, the criticism of 'playing god' has noteworthy connotations. Why did some people criticise the introduction of, for example, IVF by using this formulation or the term of hubris? The more secular point seems to be that humans try to exceed the boundaries of their competence (Schöne-Seifert, 2006, p. 79). It then becomes clear why IVF is not referred to as a way of „playing God" anymore. It is because it proved that humans actually do have the ability to control this technology and do not misuse it to a severe degree. However, in other areas the criticism of overestimated human capabilities might still be a justified claim. In the following, we will argue that in the case of GE, this is indeed so. We will illuminate the conviction that the prospect of geoengineering "demonstrates a hubristic attitude about the kind of capabilities that humans possess" (Preston, 2013, p. 26).

But first a further aspect needs to be explored: within environmental ethics, the concept of hubris has been linked to deliberate ignorance of the intrinsic value of nature. Holmes Rolston (1982, p. 150), for example, points to hubris when criticising the denial of the intrinsic value of nature: "Never have humans known so much about, and valued so little in, the great chain of being. […] We rationalize that the place we inhabit has no normative structures, and that we can do what we please. […] In this arrogation of value to ourselves, there is what the theologians call hubris, overbearing pride." This also comes close to the

Aristotelian concept of hubris, since Aristotle talks about the *belittlement* of an entity towards which hubris is being displayed.

However, referring to the intrinsic value of nature does not seem to be decisive in our context, since it could speak both against and in favor of GE. On the one hand, research on GE can be driven by the moral conviction that GE is not just owed to other human beings, but also to other parts of nature. For example, it could be aimed at a prevention of species extinction due to global warming.[1] On the other hand, referring to the intrinsic value of nature could also serve as a justification for the refusal of GE, because this technology seems to neglect the intrinsic value of *untouched* nature and instead reveals a hubristic attitude towards altering it. Thus GE could in principle be both rejected and endorsed by invoking the intrinsic value of nature. Hence, in the discussion of GE the mere affirmation of the intrinsic value of nature provides us with no singular direction.

After distinguishing the relevant from the irrelevant aspects of the concept of hubris for GE, we can now formulate a definition of hubris which is suitable for our topic and which will be the basis of our subsequent discussion: Persons (or groups of persons) show hubris, if they act with a reprehensible overestimation of their abilities. In the case of GE these persons overestimate their technical abilities and the epistemic abilities connected to them. They have inadequate beliefs about the probabilities that certain technologies will be successfully implemented. Note that it *might* retrospectively turn out that the hubristic agent was actually successful in reaching these goals. Thus in this sense, there might be cases of successful hubris. This is because the overestimation of one's abilities consists in a misjudgement of the *probability* that one will successfully achieve certain goals, and one might be extremely lucky in achieving these goals against all justified predictions. But in this case, hubris still involves an epistemic failure – an overestimation of one's abilities.

Moreover, this misjudgement is *reprehensible*, because it is not simply caused by misinformation, but results from an arrogant mind-set. It includes a reprehensible underestimation of the probability of a potential failure that implies severe risks for others.[2] Hubris disregards those who will have to live with the potential failure of the technologies in question. Taking their interests seriously would lead to a rigorous examination of the limits of one's abilities, but such an examination is being neglected. Amongst the various reasons for neglecting its importance, taking pleasure in one's alleged abilities to control certain processes might be noteworthy. In this sense, there is indeed a similarity to Aristotle's considerations. Moreover, Aristotle's concern about the *belittlement* of the entity towards which hubris is being practised is also reflected in our definition. It consists in neglecting the severe risks that one imposes *on others* by misjudging one's abilities. Furthermore, the fact that GE is a hazardous solution to a problem *we ourselves caused* is often neglected (Gardiner, 2010, p. 293). And it might be tempting to downplay this moral fault by overestimating our technical abilities to fix this problem.

[1] The IPCC (2014a, ch. 4.3.2.5.) states that there is „high confidence that climate change will contribute to increased extinction risk for terrestrial and freshwater species over the coming century", leading to a "permanent loss of unique forms of life."

[2] We thank Christian Seidl and an anonymous referee. Their remarks encouraged us to sharpen our definition. Seidl also stressed the relevance of the fact that hubris consists in a misjudgment of the *probability* that one will successfully achieve certain goals.

For these reasons, a focus on potential cases of hubris may help us to identify extremely risky technologies. Thus our main concern is to evaluate different geoengineering technologies by focusing on the potential accusation of hubris. The underlying question is whether the accusation of hubris can contribute to a better assessment of these technologies and the associated dangers. Strictly speaking, it is not the technologies themselves that are hubristic: hubris is on the side of the agent. The question is thus whether certain technologies will tend to be more attractive to hubristic agents. But if this is the case, this speaks against advocating for these technologies. Thus, we are asking for the heuristic value of the concept of hubris within the debate on GE and we discuss whether this concept can provide reasons against such technologies.

3. Geoengineering and the overestimation of our abilities

We stated that persons (or groups of persons) display hubris, if they act with a reprehensible overestimation of their abilities. In case of GE, this primarily concerns a misjudgement of the probability that we can reliably estimate potential negative side-effects of these technologies.

First of all, it appears highly unlikely that we are able to understand the climate system to a sufficient degree (Matthews & Turner, 2009; Robock, 2008; Kiehl, 2006). This is due to the enormous complexity and related non-linearity of the climate system, which makes climate prediction “difficult, if not impracticable” (Rial et al., 2004, p. 30) or even “unreal” (Lovelock, 2008, p. 3884). This problem will persist in the future. Because even though “prediction systems are expected to improve over coming decades, the chaotic nature of the climate system and the resulting butterfly effect will always impose unavoidable limits on predictive skill. Other sources of uncertainty exist.” (IPCC, 2013, p. 965).

In particular, regional climate and weather phenomena are not adequately predictable (IPCC, 2013, pp. 2013 and 1255). But these phenomena are of central concern for the potential dangers of both climate change and GE. Climate control has to imply weather control to a certain degree – or at least a reliable influence on the probability of certain weather events occurring. Otherwise it would miss the point – which is, for example, to prevent floods, hurricanes and other concrete, regional weather phenomena. Certain GE-technologies, however, are likely to have exactly these phenomena as negative side-effects. For example, the injection of particles into the stratosphere is likely to alter regional temperature and precipitation patterns (Irvine et al., 2010; Brovkin et al., 2009).

Apart from the arrogance that consists in neglecting the limits of our current knowledge, information from the past is typically ignored in cases of hubris as well. Even though no deliberate large-scale manipulation of the climate system has taken place yet, the past indeed seems to bear prime examples of hubris with regard to intentions to control the climate. In his review essay on GE, Stephen Schneider (2008) mentions an essay by N. Rusin and L. Flit, “written at the height of human technological hubris in the mid-twentieth century” (Schneider, 2008, p. 3844), in which the authors claim that “the Arctic ice is a great disadvantage, as are the permanently frozen soil (permafrost), dust storms, dry winds, water shortages in the deserts, etc.” They proceed by claiming that “if we want to improve our planet and make it more suitable for life, we must alter its climate” (Rusin & Flit, cited after Schneider, 2008, p. 3844). In order to warm the Earth and melt the Arctic ice, they refer to the proposal of surrounding the earth with a ring of white particles suspended in space in the path of solar radiation. This was supposed to light up the night sky and to

increase solar radiation.[3] Schneider also mentions other examples of what he calls "geoengineering folklore", such as the plan to create a Mediterranean drain back into Central Africa.

Examples of this sort contribute to an awareness of possible epistemic failures. For example, the authors of the suggestion concerning the Mediterranean drain back did not mention the importance of the Mediterranean for the Gulf Stream which allows north-western Europe to enjoy its moderate climate. The authors of the proposal to heat the earth in order to melt the Arctic ice even had as a goal the opposite of what current proposals of GE are aiming for. The dangers of these past proposals were obviously underestimated from a modern point of view and, even worse, the aims were itself highly questionable from our point of view. Focussing on actual interferences with parts of the Earth system, H. Damon Matthews & Sarah Turner (2009, p. 7) stress that "the ecological literature provides a rich source of examples of human intervention in complex systems, which have resulted in complex and unanticipated consequences." Gareth Davies (2010, pp. 112-113) summarizes this research as follows: "[T]here is evidence of a human tendency towards hubris – that when faced with exciting and innovative solutions, people overestimate benefits and the chances of success and underestimate risks and the chances of harm."

Our confidence in geoengineering the climate should be undermined by these schemes of the past and their likely failure. These examples reveal a general bias towards overestimating our technical abilities and underrating the possibility of failures and disasters. This seems to be especially in place when we are faced with apparently ingenious and comfortable solutions which promise us avoiding unwelcome alternatives such as changing our behaviour. Instead of focussing on solutions like mitigation and adaptation, which aim to transform our behavioural structures, GE is "a way to modify earth's parameters so that humans do not need to change." (Preston, 2011, p. 465). Moreover, we are inclined to overlook the risks of GE because, in the case of a failure of GE, it is presumably not primarily us who will suffer the possible consequences. GE has enormous risks that we (the current generation in the industrialized countries) impose unto others, whereas radical mitigation strategies have unwanted consequences mainly for ourselves.[4] It has been argued that radical mitigation strategies have unwanted consequences for developing countries as well, because it would deprive them of the right to further develop their industries and thereby fight poverty (see e.g. IPCC, 2014b, ch. 4.). However, if the industrialized countries suggest GE in order to meet the demands of the developing countries, these suggestions should be viewed with great caution. We are tempted to pass on the costs of climate change to the poorer and weaker citizens of the world, and the present generation is tempted to pass the problem on to future generations (Gardiner, 2011b). This becomes obvious, for example, in some attempts to compare the costs of GE with the costs of mitigation

[3] For this and similar examples of Soviet attempts to modify climate, see also Fleming, 2006 and 2010; Keith, 2000; Robock, 2008. Fleming displayed many more crude attempts to control weather and climate in several publications and derives a very critical standpoint towards GE from his historical studies (see also Fleming, 2007).

[4] A possible counterargument would be one that refers to an alleged 'emergency case' where GE has to be applied as an ultima ratio. Here one could think that there is an argument in favor of GE that is based primarily on the alleged needs of others, who would eventually need these techniques. It might even seem that we are morally obliged to develop these techniques to assist others, who find themselves in such an emergency case. It is, however, not at all clear how to conceptualize such an emergency case. Another problem is that GE would have impacts on a global scale which might require a 'global' emergency case in order to justify the implementation. It is, however, even less clear how to conceptualize such a global emergency case. Unfortunately, we cannot go into the details here. For an insightful critique of arguments grounding on emergency-scenarios see Gardiner 2010.

and adaptation (see e.g. Barrett, 2008). Even if the costs of GE were lower, this would not justify taking the cheaper option. We, the members of wealthy countries, are the ones who are morally obliged to pay the price for our own failures to meet the demands of intra- and intergenerational justice.

Because of our reluctance to face former and current moral failures, our hubristic attitudes provoke future moral failures as well. This is also because GE proposals might reduce the moral force of the demand to undergo policies of radical mitigation. Ben Hale (2012) criticises such "moral hazard arguments" – arguments which articulate the fear that we use GE to offset our concerns about reducing our emissions – for being ambiguous and vague. A reference to hubris, however, can point out that we are tempted to overlook the risks of GE, because we are not the ones who have to take these risks ourselves. And it might be tempting to reduce the moral force of the demand to undergo policies of radical mitigation by an overestimation of our technical abilities.

These considerations are in line with a general scepticism concerning various techniques of GE, and they could be criticised as being based on a technological pessimism that is common among environmentalists but uncommon among engineers and scientists. Moreover, we must keep in mind that one could argue for GE on the basis of desperation. One may claim that GE is still better than serious climate change and reject any accusation of hubris on this ground. The question arising in such a case is what particular GE strategy is defended. In order to avoid the failure of an oversimplified general criticism concerning technical solutions to certain problems, we should focus more closely on the concrete proposals for GE. Thus in what follows, we will highlight the argumentative potential of the concept of hubris with regard to an assessment of different GE technologies.

4. Hubris and different kinds of GE-technologies

Different kinds of GE-technologies have been accused of being connected to morally problematic attitudes to a different extent. Gardiner (2011a, p. 182), for example, finds it plausible to prefer the technological removal of carbon-dioxide to the injection of reflecting particles into the atmosphere because the former establishes "a more appropriate relationship between human beings and the rest of nature". Christopher Preston (2013, p. 26) articulates such a gradual evaluation with a reference to the notion of hubris: "Afforestation does not appear to display hubris in the same way that placing mirrors in space might […]." In the following, we will provide further reasons for this conjecture.

The Earth's climate is determined by numerous factors and interdependent subsystems, among which the hydrosphere, cryosphere, lithosphere, atmosphere and biosphere can be considered as the main subsystems. There are different cycles within and between these subsystems such as the carbon cycle (IPCC, 2014b, an. I; IPCC, 2013; Shikazono, 2012). Anthropogenic climate change is primarily caused by interferences with the composition of the atmosphere. Humans have done so especially by emitting carbon-dioxide, which means taking a hand in the carbon cycle. As a consequence of this interference, other subsystems (respectively cycles or parameters) of the Earth system are influenced, first of all the

Earth's radiation balance.[5] This has impacts on temperatures and hydrological cycles, since, for example, evaporation is increased. Due to these changes the biosphere and different ecosystems, such as marine ecosystems, are affected.[6] All subsystems and cycles are linked interdependently to one another in such a way that the climate system has to be described as non-linear (Lovelock, 2008; Rial et al., 2004; Kiehl, 2006).

Different GE-technologies can be distinguished according to the specific part of the Earth system that they aim to influence directly. The interdependent relationships of all subsystems, cycles, parameters, etc. are always influenced indirectly. It is due to this circumstance that there are numerous ways to affect the climate system as a whole. However, there are two main categories of GE: Methods that are supposed to work by reflecting sunlight back into space and methods that are supposed to work by removing carbon-dioxide from the atmosphere.[7] Approaches of the latter kind are subsumed under the term 'Carbon Dioxide Removal' (CDR) and include, for example, the fertilisation of oceans with naturally scarce nutrients. In this case biological productivity is enhanced and blooming phytoplankton can bind carbon, which gets partially stored when plankton die and sink to the sea floor. Other CDR-methods directly influence the carbon cycle, like the deployment of 'Direct Air Capture', which would sequestrate carbon from ambient air. These technologies would therefore turn the same dials that were used since the industrial revolution – but the other way round.

On the other hand, Solar Radiation Management (SRM) works very differently. These methods aim to influence the energy flow either by decreasing the amount of short wave radiation reaching the Earth or by enhancing the surface albedo. They leave the (increasing) concentration of carbon-dioxide in the atmosphere unaffected. Proposals of this kind include the enhancement of marine cloud reflectivity; the injection of sulphate aerosols into the atmosphere; the placement of shields or deflectors in space to reduce the amount of solar energy reaching the Earth.

The risks associated with these technologies vary (Royal Society, 2009, p. 58). If we inject aerosols into the stratosphere to decrease short wave radiation while continuing to emit greenhouse gases and thereby affecting the carbon cycle, we are influencing two potent regulating screws at the same time. This creates new risks, because the complexity of anthropogenic climate change is increased significantly. Risks also vary with the amount of experience we have in interfering with a certain part of the Earth system. This, too, speaks against SRM-proposals because we have not yet *directly* influenced the amount of short wave radiation on a large scale, whereas we have already altered the carbon cycle.[8]

[5] A slightly higher degree of incoming short-wave radiation is reflected back into space by the CO^2-layer, and – more relevantly – a higher degree of long-wave radiation is reflected back to earth and thus stays within the Earth system. This constitutes a shift in the Earth's radiation balance.

[6] This account is of course a heavy simplification. We do not claim to describe the whole climate system, but instead try to focus on aspects relevant for our further survey. A detailed analysis is given in IPCC, 2013.

[7] For an overview of different GE proposals see, for example, Oxford Geoengineering Programme, 2015; Royal Society, 2009.

[8] Sometimes the effects of volcanic eruptions are seen as being an evidence for the effectivity of SRM. Note that this analogy is "imperfect" (Rasch et al., 2008, p. 4022) and further research concerning this issue is necessary (cf. Gardiner, 2010, fn 8; Robock, 2008, p. 15). Also note that no experience can be gained before the implementation, because field tests would have to be at a range similarly to an implementation of the technology (Robock et al., 2010).

4.1 Hubris and Solar Radiation Management (SRM)

We will now show why the accusation of hubris speaks strongly against SRM. The accusation of hubris is justified if persons display an arrogant ignorance of their own fallibility and former failures. This attitude is particularly fatal if passing over important information and refusing to learn from former mistakes lead to a situation in which new faults are committed in order to eliminate the aftermath of old ones. We can exemplify this by imagining a gambler. Imagine he has large gambling debts because he lost over and over again. Now he asks a friend for another loan in order to regain the money he lost. His friend is hesitant and points to the gambler's past, but the latter cuts him off and insists that he is an exceptionally gifted player and now everything will be different because it is only misfortune that was to be blamed for the losses. Instead of self-critically reflecting about the reasons that brought him into this awkward situation, he is repeating the very mistakes that brought him into trouble in the first place.

The deployment of technologies like SRM, which aim at solving the problems caused by anthropogenic influence on a certain part of the Earth system by tempering with another part are likely to lead to a situation similar to that of the gambler. James Lovelock (2008, p. 3888) vividly outlines the possible consequences: "Consider what might happen if we start by using a stratospheric aerosol to ameliorate global heating; even if it succeeds, it would not be long before we face the additional problem of ocean acidification. This would need another medicine, and so on." And, in a more general way, Clive Hamilton (2013, p. 199) rightly states that "there is something increasingly desperate about placing more faith in technological cleverness when it is the unrelenting desire to command the natural world that has brought us to this point."

The gambler with a long history of losing money nevertheless insists that the answer to his trouble is to do more of the same and stick to his old behavioural patterns. SRM geoengineers are like the gambler in that they expand anthropogenic interference. Humans started to emit carbon-dioxide while not thinking that this would cause serious problems. After a while confidence rose that the opposite is the case. But at this point humans were already too "addicted" to just stop. Now that we are increasingly troubled by the consequences, a response strategy involving SRM is likely to repeat history.

Like the imaginary gambler, we should ask ourselves self-critically which underlying behavioural structures are responsible for the present situation. We have greatly interfered with natural systems to meet our demands and this anthropogenic interference led to serious problems. Dale Jamieson (1996, p. 331) thus warns that "many of our environmental problems flow from attempts to manipulate nature in order to make it conform to our desires rather than forming our desires in response to nature", and Preston (2013, p. 26) reminds us that the failure to change this attitude demonstrates a "culpable arrogance".[9] These aspects obviously suggest a critical assessment of all GE-methods. However, by differentiating between the different GE-technologies, we suggest that the accusation of hubris is less justified with regard to forms of GE that aim to limit anthropogenic influence.

But even the weak volcano-analogue "actually argues against geoengineering because of ozone depletion and regional hydrologic and temperature responses" (Robock et al., 2008; see also Fleming, 2007, p. 59).

[9] The claim to fight causes not symptoms and change human's behavior instead of trying to shape nature is widely articulated in the context of GE. See e.g. Hamilton, 2013; Lovelock, 2008; Schneider, 2008; Kiehl, 2006; Keith, 2000; Jamieson, 1996. The necessity of a fundamental transformation of policies and institutions as well as human behavior patterns has also been stressed by the IPCC (2014b, ch. 1. and 5.).

The large-scale intervention into the Earth system has caused (and will cause) severe and unforeseeable harm. Assuming that we will not stop interfering altogether we should at least stick to the one kind of interference we have some experience with – the carbon cycle. In order to be mindful of our past and to avoid a situation in which new faults are continuously made in order to eliminate aftermaths of old ones, we should avoid directly influencing other parts of the Earth system.

4.2 Hubris and Carbon Dioxide Removal (CDR)

Many CDR methods seem to be preferable to SRM because they address the physical root of the problem, which is the concentration of carbon-dioxide in the atmosphere. Hubris seems to be less likely to occur with CDR and less likely to yield severe consequences. This is because resorting to CDR displays at least a slightly higher degree of self-critical reflection and appreciation of the causes of the problem. Since anthropogenic interference is exactly what brought us into the dramatic situation we are now confronted with, the best solution does not seem to be *more* interference. For similar reasons, however, we hold the interference with the oceanic system to be an unacceptable proposal. Here, one would gravely interfere with the oceanic ecosystem with far-reaching consequences for human-environment systems.[10]

Other CDR-proposals like Direct Air Capture or BECCS[11] do not seem to be immediately concerned by this line of criticism. In this case we would alleviate or even reverse a process that we have already started and that is at the core of our problems. The hope is that we could do so without starting a categorically new sort of intervention into natural processes, and without thereby heightening the complexity of anthropogenic interference and creating new risks. However, there are also deep worries regarding the storage of carbon-dioxide. Fractures could occur in the storage sites, leaking stored carbon-dioxide, and earthquakes could increase this risk (Bachu, 2008; Bohnhoff & Zoback, 2010). Storing the carbon in many small decentralised deposits would at least limit the negative effects in case of occasional failures. Furthermore, reasons for failure can be explored and the knowledge gained can be used to improve other deposits. This could counteract a hubristic attitude, since the awareness of possible failures and the willingness to learn indicates humility.

Moreover, the limitation of anthropogenic intervention also indicates humility. Afforestation thus seems to be preferable to the other measures discussed as a way to bind carbon.[12] Nevertheless we should be aware, that even ecosystem based CDR methods could produce unintended ecosystem impacts, and have substantial land-use demands that may conflict with other mitigation strategies and the delivery of other ecosystem services such as food production (Royal Society, 2009, p. 58; IPCC 2014b, ch. 6.9.3.; IPCC, 2013,

[10] For a critique and the side-effects of this technique see Strong et al., 2009. Cf. also Royal Society, 2009, pp. 17-18 and 58, where ocean fertilization is considered among “the least promising“ CDR-methods. The IPCC (2014b, ch. 6.) stresses that “[t]echniques requiring large-scale interventions in the earth system, such as ocean fertilization or stratospheric aerosol injections, carry significant risks.” By means of this method it becomes obvious that no sharp line can be drawn between CDR and SRM concerning the moral assessment and other relevant evaluative aspects (cf. also IPCC, 2014b, ch. 3.3.7.).

[11] 'Biomass energy with carbon capture and storage' is a combination of using biomass for energy production and carbon capture and storage. Cf. IPCC, 2014b, ch.6.

[12] The Royal Society (2009, p. 10) defines afforestation as a form of CDR, but states at the same time that “such interventions are not normally considered to be geoengineering”. The IPCC (2013, p. 686; 2014b, ch. 6.9.1.1.) goes along with this conception. The Oxford Geoengineering Programme (2015) subsumes afforestation under GE. Diverging classifications may stem from the fact that the distinction between CDR and mitigation is not clear (see also IPCC, 2013, p. 546).

p. 633). Thus, whatever technique is implemented, it has to be accompanied by a focus on mitigation and adaptation since these approaches fight the actual causes of climate change, reduce risks and acknowledge that humans need to live within Earth's limits.[13]

5. Conclusion

The concept of hubris points to an overestimation of our abilities. Hubristic persons could have avoided an overestimation of their abilities if they developed a more critical stance towards their own weaknesses and former failures. We argued that the concept of hubris is indeed valuable in the discourse about geoengineering. It also seems to be capable of evaluating different kinds of GE technologies. The worries about hubris become even more appropriate when a proposal is aimed at influencing previously untouched parts of the Earth system.

If GE fails and even worsens the situation, this would be a result of overestimating our technical and epistemic abilities. It would originate in a reluctance to face the fact that we are not able to reliably predict the relevant effects of these techniques. In addition, it would be the result of our moral failure to avoid the mistakes that caused the present problem and to respond to the demands of intra- and intergenerational justice by reducing our emissions. We are tempted to pass on the costs of climate change to the poorer and weaker citizens of the world, and the present generation is tempted to pass the problem on to future generations. And we are tempted to overestimate our technical abilities. This seems to be the case especially when we are faced with apparently ingenious technical solutions which promise us avoiding unwelcome, but morally binding alternatives. The accusation of hubris points to these temptations and thereby helps us to prevent further epistemic and moral failures.[14]

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[13] Moreover, in the case of CDR it is a blunt necessity to connect this approach to mitigation efforts, since CDR works only in the long-term and relevant effects will occur only decades after implementation (IPCC, 2013, p. 546). There will also be constraints to how much carbon-dioxide can be stored (IPCC, 2014b, ch. 6.9.1.2.).

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Humboldt-Universität zu Berlin
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