Accepted manuscript

Climate change, uncertainty and ethical superstorms

Jan Kunnas

KEYWORDS

Carbon debt; Climate Change; Climate extremes; Future generations; Greenhouse gas; Maximin; Paris agreement; Theory of Justice; sea-level rise; Uncertainty
Anthropocentric/Anthropocene; Earth system; IPCC; Planetary boundaries; Responsibility

SUMMARY

I argue that one of the most urgent tasks of geoethics is how to deal with climate change in a just and equitable way. Our current path could at worst lead to multi-meter sea-level rise, increases in storms and climate extremes causing devastating social disruption and economic consequences. I present some alternatives on how to handle this alarming prospect, arguing that we cannot condense our decision making on climate change into numerical calculations, but should rather make ethical judgements. The commonly used expected utility maximation can be considered as a gamble on the expense of future generations for the benefit of the current ones. Thus, from a Rawlsian perspective, we will instead choose the maximin principle, which tells us to adopt the alternative whose worst outcome is superior to this of the other alternatives. Justice also requires us to make amendments for past emissions. A calculation of the cumulative cost of carbon dioxide emissions shows that developed countries bear the main responsibility of climate change. A mutual debt cancellation between developed countries' carbon debts versus developing countries' conventional monetary debt would solve past grievances, while unilateral measures to curb climate change would provide examples for others to follow.

Published 24.9.2021 as: Kunnas J. (2021) Climate Change, Uncertainty and Ethical Superstorms. In: Bohle M., Marone E. (eds) Geo-societal Narratives. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-79028-8_12

INTRODUCTION

Geoethics recognizes that humans are a geological force capable of making a significant impact on natural environments and this creates ethical responsibility towards the Earth system [1]. With this is mind, one of the most urgent tasks of geoethics is how to deal with climate change in a just and equitable way. An issue that geoethics has largely abstained from addressing so far [2]. I will use the discussion around a controversial paper warning of potential multi-meter sea-level rise in the near future as a starting point, to show how this could be taken into account. Rather than taking either of the sides in this discussion, I will examine how to deal with the uncertainty from which this controversy arises. I will continue by examining ethical problems emerging from the fact that those who bear the main benefits of fossil fuel use and the costs of abatement are not the same as those who will bear the main costs of proceeding climate change. Finally, I will propose a solution to the uncertainties in the abatement costs.

Climate scientists, Hansen et al. [3] warn that the melting of the Antarctic and Greenland ice sheets will contribute to a sea-level increase far beyond the range seen as plausible in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [4]. Hansen et al. conclude that if greenhouse gas emissions were to continue growing, multi-meter sea-level rise would become practically unavoidable, probably within 50–150 years, adding that "social disruption and economic consequences of such large sea-level rise, and the attendant increases in storms and climate extremes, could be devastating" ([3], p. 3799). This alarming prospect in lack of substantial and rapid emissions reductions is supported by Bamber et al., who find

that a global total sea-level rise exceeding 2 metres by 2100 lies within the 90% uncertainty bounds for a high emission scenario [5].

Hansen et al. had rushed a non-refereed draft of their paper into public view, in the hope of influencing the 2015 United Nations Climate Change Conference in Paris, arguing that an IPCC backed 2°C limit on global warming was not a safe guardrail and that a 1.5 °C target should be adopted instead [3]. This draft was already subject to harsh criticism, not because the events predicted to happen if GHG emmissions continued to grow were not plausible, but because they were unlikely to happen. [6]. For example, Thorne stated in his open review:

> To make this conclusion relies to an uncomfortable extent upon a causal chain of the nature given a then b and because b then c and c means that d shall occur etc. Each link in this chain is certainly plausible based upon the relatively scant evidence to hand, but is not by any stretch determinant. At each link there is a finite probability that that link will not actually be realized… ([7], p. 6090]

According to the always so moderate IPCC, there is medium confidence that the instabilities of the Greenland and Antarctic ice sheets could be triggered at around 1.5°C to 2°C of global warming, which could result in multi-metre rises in sea level on time scales of century to millennia [8] [9]. From an ethical point of view, a potentially longer time scale does not matter, it just gives more time to act.

ETHICS AND UNCERTAINTY

There is now overwhelming evidence for human-caused climate change, the remaining uncertainties are about how severe the warming and its impacts will be.

Mastrandrea and Schneider argue that therefore, the policy task is to manage the uncertainty rather than wait an indefinite period to try mastering it. In other words, the only sound global policy is to act now, based on the evidence we have [10]. The longer we wait to take action, the larger the humanitarian and economic costs of climate change will be.

Harsanyi proposes the use of *expected utility maximization* as the decision rule under uncertainty [11]. This is also the theory that most of the literature on optimal climate change policy is based on [12] [13]. In this case, it would mean a counterbalancing between the abatement and adaption costs versus the expected damage due to climate change. If the decision-maker would be risk-neutral this would mean minimizing:

(1) Abatement costs + (Adaption costs + Damage costs) * probability IPCC is right + (Adaption costs + Damage costs) * probability Hansen et al. is right

Unfortunately, climate change is not a textbook example, with a certain number of black and white marbles allowing us to know the actual probability of these outcomes and their costs. Following Thorne's [7] critique, we might however assume that the probability of Hansen et al.'s [3] scenario to unfold to be less likely than the IPCC's "consensus scenarios". For argument's sake, we assume that we have enough information available to make a weighted calculation on how to maximise the utility. If we consider the IPCC more likely to be right than Hansen et al. [3], the outcome of such maximisation could well be in line with the Paris agreement's main aim to keep

a global temperature rise this century well below 2 degrees Celsius, but nowhere near that required for 1.5 °C [14].

This result is largely due to the assumption of risk neutrality. This is a gamble that is easy for us to take, as we know for sure that we are living in the current generation bearing the costs of abatement, while the cost of climate change will largely be borne by future generations. It as a gamble on the expense of future generations for the benefit of the current ones; even if we would lose the gamble, we won´t be bearing the main loss.

However, according to Dietz [15] (see also [12]), economists have realized that it might be unrealistic to assign discrete probability estimates (e.g., There is an X % chance of Y occurring) to the impacts of climate change. On the contrary, climate change is affected by what economists describe as "uncertainty", where the probabilities of the consequences of actions are not precisely known. This uncertainty stems from three main sources:

1) uncertainty about the effect of increases in greenhouse gas concentrations on global climate,

2) uncertainty about the damage function, how temperature changes translate into economic impacts, and

3) uncertainty about the costs of abatement.

Dietz concludes that, in this context of uncertainty, extra precaution is required when setting global carbon emissions targetsto make them more ambitious, and suggests that more than half of society's total willingness to pay to cut carbon emissions stems from an aversion to ambiguity about the impacts of climate change [15].

According to Rawls, a genuine ethical discussion is possible only if, at least for a moment, we forget our own advantage and commit ourselves to consider matters merely from a general point of view. To achieve this, he presents a thought experiment, where the parties are situated behind a *veil of ignorance*. They do not know how the various alternatives will affect them and they are obliged to evaluate principles solely on the basis of general considerations. They must choose the principles of which they are prepared to bear the consequences, whatever generation they turn out to belong to ([16], p. 118-119).

I claim that the participants behind this hypothetical veil of ignorance would not choose the principle of utility maximation as the decision rule in the presence of large uncertainties regarding the future, as they could turn out to be in the generation bearing the main costs of climate change. Following Barnett and Adger [17], and Kunnas [18], I suggest they would choose the maximin rule as the decision rule. According to Rawls ([16], p. 133):

> The maximin rule tells us to rank alternatives by their worst possible outcomes: we are to adopt the alternative the worst outcome of which is superior to the worst outcomes of the others.

Following the maximin rule, we do not need to know the probability of different scenarios, as long as we know that the probability of any scenario does not approach zero. The worst outcomes here would be that:

> 1) we do abatement accordingly to the IPCC scenarios and the Paris agreement [14] and Hansen et al. [3] proves right, or
>
> 2) we do abatement accordingly to the Hansen et al. scenario [3], and IPCC proves right.

In the first outcome, we could face devastating social disruption and economic consequences, and in the second we spend "too much" money on abatement. In the words of Meyer: "If we follow IPCC and they have underestimated risk, we find out too late to do anything about it. If we follow Hansen et al. [3] and they have over-estimated risk, we find out in time and can relax a bit" ([19], p. 54279).

It could be argued that the universal agreement by 195 nations at the United Nations Climate Change Conference in Paris on 12 December 2015 lies somewhere between these two alternatives. The agreements' main aim "Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels" is in accordance with the IPCC recommendations, while the "and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" addition is in line with the Hansen et al. scenario ([14], 2:1a).

After adopting the Paris agreement, governments commissioned the IPCC to prepare a Special Report on the impacts of global warming of 1.5°C. The report found that significant climate impacts already occur at 1.5˚C, especially concerning low-lying areas, human health and oceans, but risks associated with warming are substantially lower at 1.5˚C than at 2˚C. The impacts will hit the poor and most vulnerable the hardest due to loss of livelihoods, food insecurity, population displacement and health effects. The report argued that pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in energy, land, urban and infrastructure and industrial systems. The larger the

overshoot, the higher the need for carbon dioxide removal measures with related ethical problems [20].

ETHICS AND RESPONSIBILITY

It can be argued that the Paris agreement [14, 2:2] evaded one of the main difficulties of the Copenhagen 2009 climate negotiations – the question of responsibility for climate change – through its loose wordings of "common but differentiated responsibilities". Perhaps wisely so, as it was also one of the main reasons for the failure in Copenhagen, where developed countries called for emission reductions also in developing countries, while the latter argued that the developed countries caused this mess in the first place, and should also be responsible for the cleanup [21].

Kunnas et al. suggest that calculating the cumulative cost of carbon dioxide emissions, i.e. the discounted future damage that the total historic emissions up to present, could give new insights into the question of responsibility for climate change. According to their calculations, the United States and the European Union bear the main responsibility of climate change, as they together are responsible for almost half of these cumulative costs. Thus, they support the notion that the main reason for a warming climate is the historical greenhouse-gas emissions of developed countries. On the other hand, China and India together are responsible for around one-seventh of the cumulative costs, leaving over 2/5 to the rest of the world [22]. Therefore, both sides of the Copenhagen trench line were right to some extent.

However, according to Vanderheiden, it can be argued that developed countries had no moral responsibility for greenhouse gas emissions before climate change was

recognized as a problem [23]. But then we stumble into the question of when the problem was recognized. In 1896, Swedish chemist Arrhenius [24] calculated that a doubling of CO_2 in the atmosphere would increase the global surface temperature by an average of five to six Celsius degrees. Arrhenius, however, did not consider this a problem. It would last almost sixty more years before Plass in 1956 warned that the temperature rise from increasing carbon dioxide emissions may be so large in several centuries that: "it will present a serious problem to future generations"[25]. Finally, in 1979, the first World Climate Conference appealed to the nations of the world "to foresee and to prevent potential man-made changes in climate that might be adverse to the well-being of humanity"[26].

Vanderheiden himself proposes the publication of the First Assessment Report from the Intergovernmental Panel on Climate Change in 1990 as the most defensible starting for moral responsibility, as: "By then, most national governments were fully aware of the likely effects of various kinds of human activity on global climate and could have initiated emission abatement programs" ([23], p. 190). But, can ignorance be a defendable reason for the lack of moral responsibility? Modifying the polluter-pays principle, Shue claims that "if whoever makes a mess receives the benefits and does not pay the costs, not only does he have no incentive to avoid making as many messes as he likes, but he is also unfair to whoever does pay the costs" ([27], p. 535).

If developed countries do not take responsibility for the climate debt that fueled their economic growth, why should citizens in developing countries be responsible for their country's foreign loans? We can reasonably ask who has a bigger entitlement to get their loans repaid, especially as people in developing countries seldom have benefitted

themselves from loans taken by their often corrupt leaders. Ndikumana and Boyce found that more than half the money borrowed by 33 sub-Saharan African countries departed the continent in the same year, often ending up in private accounts at the same banks that had provided the loans [28].

Kunnas takes a more tendentious approach, suggesting that: "…the mutual indebtedness—developed countries' carbon debts versus developing countries' conventional monetary debts… provides an opportunity to settle the scores, and start on a clean slate" ([29], p. 434). Considering this mutual indebtedness, he adds that "developing countries joining a global climate treaty should get their debt cancelled." The clean slate that this would provide is of utter importance, as we do not have time to waste on quarrelling on who has the main responsibility.

THE POWER OF EXAMPLE

However, leaving past injustices and following grievances behind does not mean that we should proceed with even steps in the mitigation of climate change after that. On the contrary, if anything general can be learnt from history, it's the power of example. It can be a single person, country or region, but someone must always take the first step, opening up a trail for others to follow, reducing the uncertainty of the followers [30]. I present two examples, showing how even a small country can make a difference.

In 1974, Molina and Rowland showed that the intense *ultraviolet radiation* in the upper atmosphere could, at least in theory, break the chemical bonds of

chlorofluorocarbons (CFCs), releasing free chlorine atoms, which react catalytically with ozone resulting in its significant depletion [31]. Measured evidence of ozone depletion was, however, not available until 1985, when the discovery of the annual depletion of ozone above the Antarctic was first announced [32]. Sweden did not wait for this measured evidence but announced on January 23, 1978, that it would ban aerosol sprays using CFCs as the propelling agent. The United States followed the example by the end of the year, and Canada, Norway, and Denmark followed within a few years. By showing example, they managed to override the scepticism and unwillingness for legislative actions held by the European Community, the predecessor of the European Union. In the very end, the solution to the problem was much cheaper than predicted, which made it easier for less enthusiastic countries to join the ban on chemicals destructive to the ozonosphere [33] [34].

The big question, for the Earth sciences, is what non-toxic, colourless, odourless, non-flammable and non-corrosive chemicals considered mostly harmless are we now emitting that later on will be considered life-threatening [35]. With the death of Mario Molina on October 7th, 2020, the follow-up question is, are there any new Molina and Rowlands out there, and do they have the needed funding to warn us in time?

In 1987, the US Environmental Protection Agency announced that it had detected *dioxins* in the sewage, in fish caught down streams, and in various bleached paper products such as diapers, coffee filters and milk cartons. They originated from factories producing bleached chemical pulp. It turned out that these extremely toxic, highly chlorinated hydrocarbons could cause various health problems, including cancer. Already in the 1970s, Swedish industrial research organizations had started to

study these reactions and what could be done as it was observed that organic chlorine compounds were formed in the bleaching process. Finally, tightening environmental requirements set forward by the government forced the pulp producers to address the problems of chlorine bleaching. Consequently, Swedish companies were the first ones able to respond to the sudden demand for pulp and paper produced without chlorine bleaching. This turned out to be fortunate for Swedish pulp producers. The managing director of pulp producer Aspa, Bengt Unander-Scharin argues that the company would not have survived the 1992-1993 recession without chlorine-free paper. Simultaneously, market pulp producer Södra Cell hit production records thanks to totally chlorine-free bleaching. Furthermore, Swedish equipment and chemical suppliers benefitted from increasing worldwide export markets thanks to their process know-how and mill retrofitting experience. [36] [37] [38] [39] [40].

The chlorine-free example shows that being on the forefront of environmental issues can also be good for business [30]. Bohle and Preiser argue, however, that the efforts to mitigate the effects and damaging impacts of climate change pose a different challenge, as the required modification of production systems and the de-carbonisation of consumption patterns is much more profound ([41], p. 105-106). Yet the most significant difference between climate change and previous problems is that the latter has been resolved and we can look at them from a rear-view mirror [42]. Future generations bearing the consequences of our inaction will wonder why the problem was never solved, even though all the necessary technology already existed.

But the task ahead is not achievable by technology alone. We must also change our consumption patterns and replace quantity with quality. To achieve this, we must ask ourselves what makes us happy, and pursue that happiness in a way that does not

deprive forthcoming generations from the possibility to pursue their happiness ([18] [30] [43].

DISCUSSION AND CONCLUSIONS

We cannot condense our decision making on climate change to numerical calculations but must make ethical judgements. The commonly used expected utility maximation can be considered as a gamble on the expense of future generations for the benefit of the current ones. Thus, from a Rawlsian perspective, we will instead choose the maximin principle, which tells us to adopt the alternative whose worst outcome is superior to the worst outcomes of the other alternatives.

A calculation of the cumulative cost of carbon dioxide emissions shows that developed countries bear the main responsibility of climate change. A mutual debt cancellation between developed countries' carbon debts versus developing countries' conventional monetary debts would solve past grievances. Thereafter we can focus on finding solutions together. Unilateral measures to curb climate change would provide an example for others to follow. Their eagerness will increase as soon as they realize the competitive advantage that will be brought to first movers by the necessary clean energy revolution. As other countries follow the example of first movers, the development of global GHG gases will be a combination of falling curves stacked upon each other, leading to the necessary and fast emission decline. To conclude, *common but differentiated responsibilities* is the way forward, not only because it's the just way, but also because it is the most effective one.

REFERENCES

1. Peppoloni S, Di Capua G. (2017) Geoethics: Ethical, Social and Cultural Implications in Geosciences. Annals of Geophysics 60. doi:10.4401/ag-7473
2. Bohle M, Di Capua G (2019) Setting the Scence. In: M. Bohle M (ed.) Exploring Geoethics, Ethical Implications, Societal Contexts, and Professional Obligations of the Geosciences. Palgrave MacMillan, Cham, p 1-24
3. Hansen J et al (2016) Ice melt, sea level rise and superstorms: Evidence from paleoclimate data, climate modeling, and modern observations that 2°C global warming could be dangerous. Atmospheric Chemistry and Physics 16(6): 3761-3812
4. Church J A et al (2013) Sea level change. In: Stocker T F, et al (eds) Climate Change 2013: The Physical Basis. Cambridge UK, Cambridge University Press, p 1137-1216
5. Bamber J L et al (2019) Ice sheet contributions to future sea-level rise from structured expert judgment. PNAS June 4, 116(23):11195-11200. doi: 10.1073/pnas.1817205116
6. Revkin A C (2015) Whiplash Warning When Climate Science is Publicized Before Peer Review and Publication. The New York Times July 23, 2015. http://dotearth.blogs.nytimes.com/2015/07/23/whiplash-warning-when-climate-science-is-publicized-before-peer-review-and-publication/;
7. Thorne P (2015) Interactive comment on “Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2°C global warming is highly dangerous by J. Hansen et al. Atmospheric Chemistry and Physics Discuss. 15: C6089–C6100

8. Hoegh-Guldberg O et al (2018) Impacts of 1.5ºC Global Warming on Natural and Human Systems. In: Masson-Delmotte V et al (eds) Global Warming of 1.5°C. Intergovernmental Panel on Climate Change, p 175-311

9. Brysse K, Oreskes N, O'Reilly J et al (2013) Climate change prediction: Erring on the side of least drama? Global Environment Change 23: 327–337

10. Mastrandrea M D, Schneider S H (2010) Preparing for Climate Change. Cambridge, Mass, The MIT Press

11. Harsanyi J C (1976) Essays on ethics, social behaviour, and scientific explanation. Dordrecht, D. Reidel, p 37-63

12. Millner A, Dietz S, Heal G (2013) Scientific Ambiguity and Climate Policy'. Environmental and Resource Economics 55(1): 21-46

13. Barrage L (2019) The Nobel Memorial Prize for William D.Nordhaus. Scandinavian Journal of Economics 121(3):884–924. doi: 10.1111/sjoe.12383

14. Paris Agreement (2015) http://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf Accessed 22 May 2016

15. Dietz S (2014) Climate Change Mitigation as Catastrophic Risk Management. Environment: Science and Policy for Sustainable Development 56(6): 28-36

16. Rawls J (1999) A Theory of Justice, revised edition. Oxford, Oxford University Press

17. Barnett J, Adger W N (2003) Climate Dangers and Atoll Countries. Climatic Change 61(3): 321-37

18. Kunnas J (2012) The Theory of Justice in a Warming Climate - John Rawls' theory applied to Finland. Electronic Green Journal 1(34) doi:10.5070/G313412180

19. Meyer A (2015) Interactive comment on “Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2°C global warming is highly dangerous by J. Hansen et al. Atmospheric Chemistry and Physics Discuss. 15, C5426–C5427
20. Masson-Delmotte V et al (2018) Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways
21. Kunnas J (2011) How to Proceed After Copenhagen’. Electronic Green Journal, 1(31). doi:10.5070/G313110845
22. Kunnas J et al (2014) Counting Carbon: Historic emissions from fossil fuels, long-run measures of sustainable development and carbon debt. Scandinavian Economic History Review 62(3):243-265
23. Vanderheiden S. (2008) Atmospheric Justice. New York, Oxford University Press
24. Arrhenius S (1896) On the influence of carbonic acid in the air upon the temperature of the ground. Philosophical Magazine 41:237-276
25. Plass G (1956) Carbon Dioxide and the Climate. American Scientist 44: 302-316
26. WMO (1979) World Climate Conference, WMO-No. 537. Geneva
27. Shue H (1999) Global Environment and International Inequality. International Affairs 75(3): 531-545
28. Ndikumana L, Boyce J K . (2011) Africa’s Odious Debts. New York, Zed Books
29. Kunnas J (2013) An Outline for Funding Adaptation and Disaster Management Schemes. In: Filho W L (ed) Climate Change and Disaster Risk Management. Berlin, Heidelberg, Springer-Verlag, p 427-436
30. Kunnas J (2020) Trail-Blazer Dependency – A Roadmap for the Sustainability Revolution. Global Environment, 13(2):317-337

31. Molina M. J, Rowland F S (1974) Stratospheric sink for chlorofluoromethanes: chlorine atom-catalysed destruction of ozone. Nature 249: 810 – 812

32. Farman J C, Gardiner B G, Shanklin J D (1985) Large losses of total ozone in Antarctica reveal seasonal ClOx/NOx interaction. Nature 315(6016): 207

33. Andersen S O, Sarma K M (2002) Protecting the Ozone Layer: The United Nations History. Earthscan, London

34. Byrd, D (2015) This date in science: Sweden goes first to ban aerosol sprays, Jan 23. http://earthsky.org/earth/this-date-in-science-sweden-goes-first-to-ban-aerosol-sprays Accessed 23 March 2015

35. Kunnas J (2017) Storytelling: From the Early Anthropocene to the Good or the Bad Anthropocene. Anthropocene Review 4(2):136–150

36. Bergquist A-K, Söderholm K (2015) Transition to greener pulp: Regulation, industry responses and path dependency. Business History 57(6):862-84

37. Håkanson H, Waluszewski A (2003) Managing Technological Development. London and New York, Routledge

38. Jerkeman P (2007) Bokslut: Några lönsamma forskningsresultat. Stockholm, Skogsindustrins forskningsstiftelse

39. Smith A, Rajotte A (2001) When markets meet socio-politics: revisiting the introduction of chlorine free bleaching in the pulp and paper industry. In: Coombs R et al (eds). Technology and the Market: Demands, Users and Innovation. Cheltenham, Edwar Elgar, p 136-55

40. Waluszewski A, Håkanson H (2004) Das Plagiat: Kopian som fick orginalet att anpassa sig. In: Widmalm S (red) Artefakter: industrin, vetenskapen och de tekniska nätverken.Möklinta, Gidlunds förlag. p 219–43

41. Bohle M, Preiser R (2019) Exploring Societal Intersections of Geoethical Thinking. In: Bohle M (ed) Exploring Geoethics, Ethical Implications, Societal Contexts, and Professional Obligations of the Geosciences. Palgrave MacMillan, Cham, p 71-136

42. Kunnas J, Myllyntaus T (2010) Anxiety and Technological Change - Explaining the Inverted U-curve of Sulphur Dioxide Emissions in late 20th century Finland. Ecological Economics, 69(7):1587–1593

43. Bohle M, Marone E (2019) Humanistic Geosciences and the Planetary Human Niche. In: Bohle M (ed) Exploring Geoethics, Ethical Implications, Societal Contexts, and Professional Obligations of the Geosciences. Palgrave MacMillan, Cham, p 137-164