A Perfect Moral Storm: Climate Change, Intergenerational Ethics and the Problem of Moral Corruption[1]

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ABSTRACT

The peculiar features of the climate change problem pose substantial obstacles to our ability to make the hard choices necessary to address it. Climate change involves the convergence of a set of global, intergenerational and theoretical problems. This convergence justifies calling it a 'perfect moral storm'. One consequence of this storm is that, even if the other difficult ethical questions surrounding climate change could be answered, we might still find it difficult to act. For the storm makes us extremely vulnerable to moral corruption.

KEY WORDS

Global warming, tragedy of the commons, game theory, global environment

> *'There's a quiet clamor for hypocrisy and deception; and pragmatic politicians respond with … schemes that seem to promise something for nothing. Please, spare us the truth.'*[2]

The most authoritative scientific report on climate change begins by saying:

> '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 …*'[3]

There are good grounds for this statement. Climate change is a complex problem raising issues across and between a large number of disciplines, including the

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physical and life sciences, political science, economics and psychology, to name just a few. But without wishing for a moment to marginalise the contributions of these disciplines, ethics does seem to play a fundamental role.

Why so? At the most general level, the reason is that we cannot get very far in discussing why climate change is a problem without invoking ethical considerations. If we do not think that our own actions are open to moral assessment, or that various interests (our own, those of our kin and country, those of distant people, future people, animals and nature) matter, then it is hard to see why climate change (or much else) poses a problem. But once we see this, then we appear to need some account of moral responsibility, morally important interests and what to do about both. And this puts us squarely in the domain of ethics.

At a more practical level, ethical questions are fundamental to the main policy decisions that must be made, such as where to set a global ceiling for greenhouse gas emissions, and how to distribute the emissions allowed by such a ceiling. For example, where the global ceiling is set depends on how the interests of the current generation are weighed against those of future generations; and how emissions are distributed under the global gap depends in part on various beliefs about the appropriate role of energy consumption in people's lives, the importance of historical responsibility for the problem, and the current needs and future aspirations of particular societies.

The relevance of ethics to substantive climate policy thus seems clear. But this is not the topic that I wish to take up here.[4] Instead, I want to discuss a further, and to some extent more basic, way in which ethical reflection sheds light on our present predicament. This has nothing much to do with the substance of a defensible climate regime; instead, it concerns the process of making climate policy.

My thesis is this. The peculiar features of the climate change problem pose substantial obstacles to our ability to make the hard choices necessary to address it. Climate change is a perfect moral storm. One consequence of this is that, even if the difficult ethical questions could be answered, we might still find it difficult to act. For the storm makes us extremely vulnerable to moral corruption.[5]

Let us say that a perfect storm is an event constituted by an unusual convergence of independently harmful factors where this convergence is likely to result in substantial, and possibly catastrophic, negative outcomes. The term 'the perfect storm' seems to have become prominent in popular culture through Sebastian Junger's book of that name and the associated Hollywood film.[6] Junger's tale is based on the true story of the *Andrea Gail*, a fishing vessel caught at sea during a convergence of three particularly bad storms.[7] The sense of the analogy is then that climate change appears to be a perfect moral storm because it involves the convergence of a number of factors that threaten our ability to behave ethically.

As climate change is a complex phenomenon, I cannot hope to identify all of the ways in which its features cause problems for ethical behaviour. Instead,

I will identify three especially salient problems – analogous to the three storms that hit the *Andreas Gail* – that converge in the climate change case. These three 'storms' arise in the global, intergenerational and theoretical dimensions, and I will argue that their interaction helps to exacerbate and obscure a lurking problem of moral corruption that may be of greater practical importance than any of them.

I. THE GLOBAL STORM

The first two storms arise out of three important characteristics of the climate change problem. I label these characteristics:

- Dispersion of Causes and Effects
- Fragmentation of Agency
- Institutional Inadequacy

Since these characteristics manifest themselves in two especially salient dimensions – the spatial and the temporal – it is useful to distinguish two distinct but mutually reinforcing components of the climate change problem. I shall call the first 'the Global Storm'. This corresponds to the dominant understanding of the climate change problem; and it emerges from a predominantly spatial interpretation of the three characteristics.

Let us begin with the Dispersion of Causes and Effects. Climate change is a truly global phenomenon. Emissions of greenhouse gases from any geographical location on the Earth's surface travel to the upper atmosphere and then play a role in affecting climate globally. Hence, the impact of any particular emission of greenhouse gases is not realised solely at its source, either individual or geographical; rather impacts are dispersed to other actors and regions of the Earth. Such spatial dispersion has been widely discussed.

The second characteristic is the Fragmentation of Agency. Climate change is not caused by a single agent, but by a vast number of individuals and institutions not unified by a comprehensive structure of agency. This is important because it poses a challenge to humanity's ability to respond.

In the spatial dimension, this feature is usually understood as arising out of the shape of the current international system, as constituted by states. Then the problem is that, given that there is not only no world government but also no less centralised system of global governance (or at least no effective one), it is very difficult to coordinate an effective response to global climate change.

This general argument is generally given more bite through the invocation of a certain familiar theoretical model.[8] For the international situation is usually understood in game theoretic terms as a Prisoner's Dilemma, or what Garrett Hardin calls a 'Tragedy of the Commons'.[9] For the sake of ease of exposition,

let us describe the Prisoner's Dilemma scenario in terms of a paradigm case, that of overpollution.[10] Suppose that a number of distinct agents are trying to decide whether or not to engage in a polluting activity, and that their situation is characterised by the following two claims:

(PD1) It is *collectively rational* to cooperate and restrict overall pollution: each agent prefers the outcome produced by everyone restricting their individual pollution over the outcome produced by no one doing so.

(PD2) It is *individually rational* not to restrict one's own pollution: when each agent has the power to decide whether or not she will restrict her pollution, each (rationally) prefers not to do so, whatever the others do.

Agents in such a situation find themselves in a paradoxical position. On the one hand, given (PD1), they understand that it would be better for everyone if every agent cooperated; but, on the other hand, given (PD2), they also know that they should all choose to defect. This is paradoxical because it implies that if individual agents act rationally in terms of their own interests, then they collectively undermine those interests.

A Tragedy of the Commons is essentially a Prisoner's Dilemma involving a common resource. This has become the standard analytical model for understanding regional and global environmental problems in general, and climate change is no exception. Typically, the reasoning goes as follows. Imagine climate change as an international problem and conceive of the relevant parties as individual countries, who represent the interests of their citizens in perpetuity. Then, (PD1) and (PD2) appear to hold. On the one hand, no one wants serious climate change. Hence, each country prefers the outcome produced by everyone restricting their individual emissions over the outcome produced by no one doing so, and so it is collectively rational to cooperate and restrict global emissions. But, on the other hand, each country prefers to free ride on the actions of others. Hence, when each country has the power to decide whether or not she will restrict her emissions, each prefers not to do so, whatever the others do.

From this perspective, it appears that climate change is a normal tragedy of the commons. Still, there is a sense in which this turns out to be encouraging news; for, in the real world, commons problems are often resolvable under certain circumstances, and climate change seems to fill these desiderata.[11] In particular, it is widely said that parties facing a commons problem can resolve it if they benefit from a wider context of interaction; and this appears to be the case with climate change, since countries interact with each other on a number of broader issues, such as trade and security.

This brings us to the third characteristic of the climate change problem, institutional inadequacy. There is wide agreement that the appropriate means for resolving commons problems under the favourable conditions just mentioned is for the parties to agree to change the existing incentive structure through the introduction of a system of enforceable sanctions. (Hardin calls this 'mutual

coercion, mutually agreed upon'.) This transforms the decision situation by foreclosing the option of free riding, so that the collectively rational action also becomes individually rational. Theoretically, then, matters seem simple; but in practice things are different. For the need for enforceable sanctions poses a challenge at the global level because of the limits of our current, largely national, institutions and the lack of an effective system of global governance. In essence, addressing climate change appears to require global regulation of greenhouse gas emissions, where this includes establishing a reliable enforcement mechanism; but the current global system – or lack of it – makes this difficult, if not impossible.

The implication of this familiar analysis, then, is that the main thing that is needed to solve the global warming problem is an effective system of global governance (at least for this issue). And there is a sense in which this is still good news. For, in principle at least, it should be possible to motivate countries to establish such a regime, since they ought to recognise that it is in their best interests to eliminate the possibility of free riding and so make genuine cooperation the rational strategy at the individual as well as collective level.

Unfortunately, however, this is not the end of the story. For there are other features of the climate change case that make the necessary global agreement more difficult, and so exacerbate the basic Global Storm.[12] Prominent amongst these is scientific uncertainty about the precise magnitude and distribution of effects, particularly at the national level.[13] One reason for this is that the lack of trustworthy data about the costs and benefits of climate change at the national level casts doubt on the truth of (PD1). Perhaps, some nations wonder, we might be better off with climate change than without it. More importantly, some countries might wonder whether they will at least be relatively better off than other countries, and so might get away with paying less to avoid the associated costs.[14] Such factors complicate the game theoretic situation, and so make agreement more difficult.

In other contexts, the problem of scientific uncertainty might not be so serious. But a second characteristic of the climate change problem exacerbates matters in this setting. The source of climate change is located deep in the infrastructure of current human civilisations; hence, attempts to combat it may have substantial ramifications for human social life. Climate change is caused by human emissions of greenhouse gases, primarily carbon dioxide. Such emissions are brought about by the burning of fossil fuels for energy. But it is this energy that supports existing economies. Hence, given that halting climate change will require deep cuts in projected global emissions over time, we can expect that such action will have profound effects on the basic economic organisation of the developed countries and on the aspirations of the developing countries.

This has several salient implications. First, it suggests that those with vested interests in the continuation of the current system – e.g., many of those with substantial political and economic power – will resist such action. Second, unless

ready substitutes are found, real mitigation can be expected to have profound impacts on how humans live and how human societies evolve. Hence, action on climate change is likely to raise serious, and perhaps uncomfortable, questions about who we are and what we want to be. Third, this suggests a *status quo* bias in the face of uncertainty. Contemplating change is often uncomfortable; contemplating basic change may be unnerving, even distressing. Since the social ramifications of action appear to be large, perspicuous and concrete, but those of inaction appear uncertain, elusive and indeterminate, it is easy to see why uncertainty might exacerbate social inertia.[15]

The third feature of the climate change problem that exacerbates the basic Global Storm is that of skewed vulnerabilities. The climate change problem interacts in some unfortunate ways with the present global power structure. For one thing, the responsibility for historical and current emissions lies predominantly with the richer, more powerful nations, and the poor nations are badly situated to hold them accountable. For another, the limited evidence on regional impacts suggests that it is the poorer nations that are most vulnerable to the worst impacts of climate change.[16] Finally, action on climate change creates a moral risk for the developed nations. It embodies a recognition that there are international norms of ethics and responsibility, and reinforces the idea that international cooperation on issues involving such norms is both possible and necessary. Hence, it may encourage attention to other moral defects of the current global system, such as global poverty, human rights violations and so on.[17]

II. THE INTERGENERATIONAL STORM

We can now return to the three characteristics of the climate change problem identified earlier:

- Dispersion of Causes and Effects
- Fragmentation of Agency
- Institutional Inadequacy

The Global Storm emerges from a spatial reading of these characteristics; but I would argue that another, even more serious problem arises when we see them from a temporal perspective. I shall call this 'the Intergenerational Storm'.

Consider first the Dispersion of Causes and Effects. Human-induced climate change is a severely lagged phenomenon. This is partly because some of the basic mechanisms set in motion by the greenhouse effect – such as sea level rise – take a very long time to be fully realised. But it also because by far the most important greenhouse gas emitted by human beings is carbon dioxide, and once emitted molecules of carbon dioxide can spend a surprisingly long time in the upper atmosphere.[18]

Let us dwell for a moment on this second factor. The IPCC says that the average time spent by a molecule of carbon dioxide in the upper atmosphere is in the region of 5–200 years. This estimate is long enough to create a serious lagging effect; nevertheless, it obscures the fact that a significant percentage of carbon dioxide molecules remain in the atmosphere for much longer periods of time, of the order of thousands and tens of thousands of years. For instance, in a recent paper, David Archer says:

> The carbon cycle of the biosphere will take a long time to completely neutralize and sequester anthropogenic CO_2. We show a wide range of model forecasts of this effect. For the best-guess cases … we expect that 17–33% of the fossil fuel carbon will still reside in the atmosphere 1kyr from now, decreasing to 10–15% at 10kyr, and 7% at 100 kyr. The mean lifetime of fossil fuel CO_2 is about 30–35 kyr.[19]

This is a fact, he says, which has not yet 'reached general public awareness'.[20] Hence, he suggests that 'a better shorthand for public discussion [than the IPCC estimate] might be that CO_2 sticks around for hundreds of years, plus 25% that sticks around for ever'.[21]

The fact that carbon dioxide is a long-lived greenhouse gas has at least three important implications. The first is that climate change is a *resilient* phenomenon. Given that currently it does not seem practical to remove large quantities of carbon dioxide from the upper atmosphere, or to moderate its climatic effects, the upward trend in atmospheric concentration is not easily reversible. Hence, a goal of stabilising and then reducing carbon dioxide concentrations requires advance planning. Second, climate change impacts are *seriously backloaded*. The climate change that the earth is currently experiencing is primarily the result of emissions from some time in the past, rather than current emissions. As an illustration, it is widely accepted that by 2000 we had already committed ourselves to a rise of at least 0.5 and perhaps more than 1 degree Celsius over the then-observed rise of 0.6°C.[22] Third, backloading implies that the full, cumulative effects of our current emissions will not be realised for some time in the future. So, climate change is a *substantially deferred* phenomenon.

Temporal dispersion creates a number of problems. First, as is widely noted, the resilience of climate change implies that delays in action have serious repercussions for our ability to manage the problem. Second, backloading implies that climate change poses serious epistemic difficulties, especially for normal political actors. For one thing, backloading makes it hard to grasp the connection between causes and effects, and this may undermine the motivation to act;[23] for another, it implies that by the time we realise that things are bad, we will already be committed to much more change, so it undermines the ability to respond. Third, the deferral effect calls into question the ability of standard institutions to deal with the problem. For one thing, democratic political institutions have relatively short time horizons – the next election cycle, a

politician's political career – and it is doubtful whether such institutions have the wherewithal to deal with substantially deferred impacts. Even more seriously, substantial deferral is likely to undermine the will to act. This is because there is an incentive problem: the bad effects of current emissions are likely to fall, or fall disproportionately, on future generations, whereas the benefits of emissions accrue largely to the present.[24]

These last two points already raise the spectre of institutional inadequacy. But to appreciate this problem fully, we must first say something about the temporal fragmentation of agency. There is some reason to think that this might be worse than the spatial fragmentation even considered in isolation. For there is a sense in which temporal fragmentation is more intractable than spatial fragmentation: in principle, spatially fragmented agents may actually become unified and so able really to act as a single agent; but temporally fragmented agents cannot actually become unified, and so may at best only act *as if* they were a single agent.

Interesting as such questions are, they need not detain us here. For temporal fragmentation in the context of the kind of temporal dispersion that characterises climate change is clearly much worse than the associated spatial fragmentation. For the presence of backloading and deferral together brings on a new collective action problem that adds to the tragedy of the commons caused by the Global Storm, and thereby makes matters much worse.

The problem emerges when one relaxes the assumption that countries can be relied upon adequately to represent the interests of both their present and future citizens. Suppose that this is not true. Suppose instead that countries are biased towards the interests of the current generation. Then, since the benefits of carbon dioxide emission are felt primarily by the present generation, in the form of cheap energy, whereas the costs – in the form of the risk of severe and perhaps catastrophic climate change – are substantially deferred to future generations, climate change might provide an instance of a severe intergenerational collective action problem. Moreover, this problem will be iterated. Each new generation will face the same incentive structure as soon as it gains the power to decide whether or not to act.[25]

The nature of the intergenerational problem is easiest to see if we compare it to the traditional Prisoner's Dilemma. Suppose we consider a pure version of the intergenerational problem, where the generations do not overlap.[26] (Call this the 'Pure Intergenerational Problem' (PIP).) In that case, the problem can be (roughly) characterised as follows[27]:

(PIP1) It is *collectively rational* for most generations to cooperate: (almost) every generation prefers the outcome produced by everyone restricting pollution over the outcome produced by everyone overpolluting.

(PIP2) It is *individually rational* for all generations not to cooperate: when each generation has the power to decide whether or not it will overpollute, each generation (rationally) prefers to overpollute, whatever the others do.

Now, the PIP is worse than the Prisoner's Dilemma in two main respects. The first respect is that its two constituent claims are worse. On the one hand, (PIP1) is worse than (PD1) because the first generation is not included. This means not only that one generation is not motivated to accept the collectively rational outcome, but also that the problem becomes iterated. Since subsequent generations have no reason to comply if their predecessors do not, noncompliance by the first generation has a domino effect that undermines the collective project. On the other hand, (PIP2) is worse than (PD2) because the reason for it is deeper. Both of these claims hold because the parties lack access to mechanisms (such as enforceable sanctions) that would make defection irrational. But whereas in normal Prisoner's Dilemma-type cases, this obstacle is largely practical, and can be resolved by creating appropriate institutions, in the PIP it arises because the parties do not coexist, and so seem unable to influence each other's behaviour through the creation of appropriate coercive institutions.

This problem of interaction produces the second respect in which the PIP is worse than the Prisoner's Dilemma. This is that the PIP is more difficult to resolve, because the standard solutions to the Prisoner's Dilemma are unavailable: one cannot appeal to a wider context of mutually-beneficial interaction, nor to the usual notions of reciprocity.

The upshot of all this is that in the case of climate change, the intergenerational analysis will be less optimistic about solutions than the tragedy of the commons analysis. For it implies that current populations may not be motivated to establish a fully adequate global regime, since, given the temporal dispersion of effects – and especially backloading and deferral – such a regime is probably not in *their* interests. This is a large moral problem, especially since in my view the intergenerational problem dominates the tragedy of the commons aspect in climate change.

The PIP is bad enough considered in isolation. But in the context of climate change it is also subject to morally relevant multiplier effects. First, climate change is not a static phenomenon. In failing to act appropriately, the current generation does not simply pass an existing problem along to future people, rather it adds to it, making the problem worse. For one thing, it increases the costs of coping with climate change: failing to act now increases the magnitude of future climate change and so its effects. For another, it increases mitigation costs: failing to act now makes it more difficult to change because it allows additional investment in fossil fuel based infrastructure in developed and especially less developed countries. Hence, inaction raises transition costs, making future change harder than change now. Finally, and perhaps most importantly, the current generation does not add to the problem in a linear way. Rather, it rapidly accelerates the problem, since global emissions are increasing at a substantial rate. For total carbon dioxide emissions have more than quadrupled since 1950 (Figure 1). Moreover, the current growth rate is around 2 per cent per year.[28] Though 2 per cent may not seem like much, the effects of compounding make

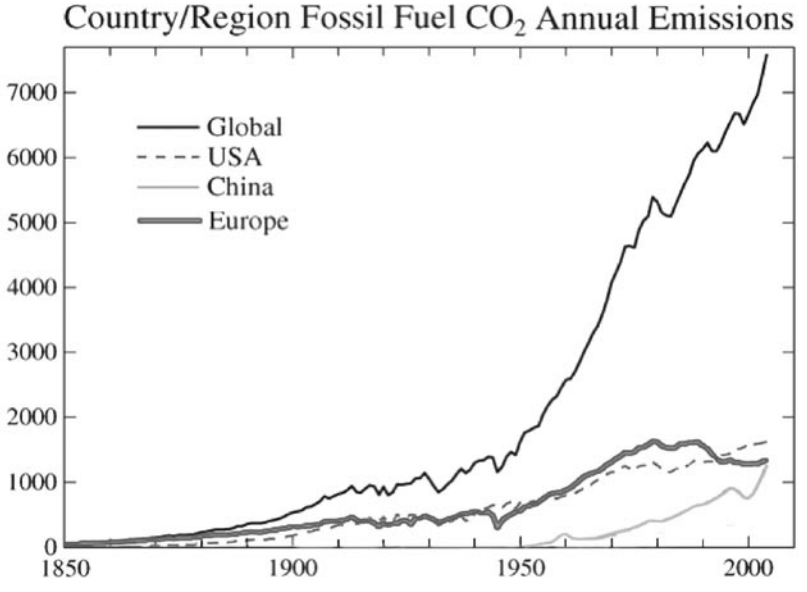

FIGURE 1. Carbon dioxide emissions from fossil fuel burning over the past 150 years.

it significant, even in the near term: 'continued growth of CO_2 emissions at 2% per year would yield a 22% increase of emission rate in 10 years and a 35% increase in 15 years'.[29]

Second, insufficient action may make some generations suffer unnecessarily. Suppose that, at this point in time, climate change seriously affects the prospects of generations A, B and C. Suppose, then, that if generation A refuses to act, the effect will continue for longer, harming generations D and E. This may make generation A's inaction worse in a significant respect. In addition to failing to aid generations B and C (and probably also increasing the magnitude of harm inflicted on them), generation A now harms generations D and E, who otherwise would be spared. On some views, this might count as especially egregious, since it might be said that it violates a fundamental moral principle of 'Do No Harm'.[30]

Third, generation A's inaction may create situations where *tragic choices* must be made. One way in which a generation may act badly is if it puts in place a set of future circumstances that make it morally required for its successors (and perhaps even itself) to make other generations suffer either unnecessarily, or at least more than would otherwise be the case. For example, suppose that generation A could and should take action now in order to limit climate change

such that generation D would be kept below some crucial climate threshold, but delay would mean that they would pass that threshold.[31] If passing the threshold imposes severe costs on generation D, then their situation may be so dire that they are forced to take action that will harm generation F – such as emitting even more greenhouse gases – that they would otherwise not need to consider. What I have in mind if this. Under some circumstances actions that harm innocent others may be morally permissible on grounds of self-defence, and such circumstances may arise in the climate change case.[32] Hence, the claim is that, if there is a self-defence exception on the prohibition on harming innocent others, one way in which generation A might behave badly is by creating a situation such that generation D is forced to call on the self-defence exception and so inflict extra suffering on generation F.[33] Moreover, like the basic PIP, this problem can become iterated: perhaps generation F must call on the self-defence exception too, and so inflict harm on generation H, and so on.

III. THE THEORETICAL STORM

The final storm I want to mention is constituted by our current theoretical ineptitude. We are extremely ill-equipped to deal with many problems characteristic of the long-term future. Even our best theories face basic and often severe difficulties addressing basic issues such as scientific uncertainty, intergenerational equity, contingent persons, nonhuman animals and nature. But climate change involves all of these matters and more.[34]

Now I do not want to discuss any of these difficulties in any detail here. Instead, I want to close by gesturing at how, when they converge with each other and with the Global and Intergenerational Storms, they encourage a new and distinct problem for ethical action on climate change, the problem of moral corruption.

IV. MORAL CORRUPTION

Corruption of the kind I have in mind can be facilitated in a number of ways. Consider the following examples of possible strategies:

- Distraction
- Complacency
- Unreasonable Doubt
- Selective Attention
- Delusion

- Pandering
- False Witness
- Hypocrisy

Now, the mere listing of these strategies is probably enough to make the main point here; and I suspect that close observers of the political debate about climate change will recognise many of these mechanisms as being in play. Still, I would like to pause for a moment to draw particular attention to selective attention.

The problem is this. Since climate change involves a complex convergence of problems, it is easy to engage in *manipulative or self-deceptive* behaviour by applying one's attention selectively, to only some of the considerations that make the situation difficult. At the level of practical politics, such strategies are all too familiar. For example, many political actors emphasise considerations that appear to make inaction excusable, or even desirable (such as uncertainty or simple economic calculations with high discount rates) and action more difficult and contentious (such as the basic lifestyles issue) at the expense of those that seem to impose a clearer and more immediate burden (such as scientific consensus and the Pure Intergenerational Problem).

But selective attention strategies may also manifest themselves more generally. And this prompts a very unpleasant thought: perhaps there is a problem of corruption in the theoretical, as well as the practical, debate. For example, it is possible that the prominence of the Global Storm model is not independent of the existence of the Intergenerational Storm, but rather is encouraged by it. After all, the current generation may find it highly advantageous to focus on the Global Storm. For one thing, such a focus tends to draw attention toward various issues of global politics and scientific uncertainty that seem to problematise action, and away from issues of intergenerational ethics, which tend to demand it. Thus, an emphasis on the Global Storm at the expense of the other problems may *facilitate* a strategy of procrastination and delay. For another, since it presumes that the relevant actors are nation-states who represent the interests of their citizens in perpetuity, the Global Storm analysis has the effect of assuming away the intergenerational aspect of the climate change problem.[35] Thus, an undue emphasis on it may obscure much of what is at stake in making climate policy, and in a way that may benefit present people.[36]

In conclusion, the presence of the problem of moral corruption reveals another sense in which climate change may be a perfect moral storm. This is that its complexity may turn out to be *perfectly convenient* for us, the current generation, and indeed for each successor generation as it comes to occupy our position. For one thing, it provides each generation with the cover under which it can seem to be taking the issue seriously – by negotiating weak and largely substanceless global accords, for example, and then heralding them as great achievements[37] – when really it is simply exploiting its temporal position. For another, all of this can occur without the exploitative generation actually having

to acknowledge that this is what it is doing. By avoiding overtly selfish behaviour, earlier generations can take advantage of the future without the unpleasantness of admitting it – either to others, or, perhaps more importantly, to itself.

NOTES

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[2] Samuelson 2005, 41. Samuelson was talking about another intergenerational issue – social security – but his claims ring true here as well.

[3] Intergovernmental Panel on Climate Change (IPCC) 2001a, p. 2; emphasis added.

[4] For more on such issues, see Gardiner 2004b.

[5] One might wonder why, despite the widespread agreement that climate change involves important ethical questions, there is relatively little overt discussion of them. The answer to this question is no doubt complex. But my thesis may constitute part of that answer.

[6] Junger 1999.

[7] This definition is my own. The term 'perfect storm' is in wide usage. However, it is difficult to find definitions of it. An online dictionary of slang offers the following: 'When three events, usually beyond one's control, converge and create a large inconvenience for an individual. Each event represents one of the storms that collided on the *Andrea Gail* in the book/movie titled the perfect storm.' Urbandictionary.com, 3/25/05.

[8] The appropriateness of this model even to the spatial dimension requires some further specific, but usually undefended, background assumptions about the precise nature of the dispersion of effects and fragmentation of agency. But I shall pass over that issue here.

[9] Hardin 1968. I discuss this in more detail in previous work, especially Gardiner 2001.

[10] Nothing depends on the case being of this form. For a fuller characterisation, see Gardiner 2001.

[11] This implies that, in the real world, commons problems do not strictly-speaking satisfy all the conditions of the prisoner's dilemma paradigm. For relevant discussion, see Shepski 2006 and Ostrom 1990.

[12] There is one fortunate convergence. Several writers have emphasised that the major ethical arguments all point in the same direction: that the developed countries should bear most of the costs of the transition – including those accruing to developing countries – at least in the early stages of mitigation and adaptation. See, for example, Singer 2002 and Shue 1999.

[13] Rado Dimitrov argues that we must distinguish between different kinds of uncertainty when we investigate the effects of scientific uncertainty on international regime building, and that it is uncertainties about national impacts that undermines regime formation. See Dimitrov 2003.

[14] This consideration appears to play a role in U.S. deliberation about climate change, where it is often asserted that the U.S. faces lower marginal costs from climate change than other countries. See, for example, Mendelsohn 2001; Nitze 1994; and, by contrast, National Assessment Synthesis Team 2000.

[15] Much more might be said here. I discuss some of the psychological aspects of political inertia and the role they play independently of scientific uncertainty in Gardiner unpublished.

[16] This is so both because a greater proportion of their economies are in climate-sensitive sectors, and because – being poor – they are worse placed to deal with those impacts. See IPCC 2001b, 8, 16.

[17] Of course, it does not help that the climate change problem arises in an unfortunate geopolitical setting. Current international relations occur against a backdrop of distraction, mistrust and severe inequalities of power. The dominant global actor and lone superpower, the United States, refuses to address climate change, and is in any case distracted by the threat of global terrorism. Moreover, the international community, including many of America's historical allies, distrust its motives, its actions and especially its uses of moral rhetoric; so there is global discord. This unfortunate state of affairs is especially problematic in relation to the developing nations, whose cooperation must be secured if the climate change problem is to be addressed. One issue is the credibility of the developed nations' commitment to solving the climate change problem. (See the next section.) Another is the North's focus on mitigation to the exclusion of adaptation issues. A third concern is the South's fear of an 'abate and switch' strategy on the part of the North. (Note that considered in isolation, these factors do not seem sufficient to explain political inertia. After all, the climate change problem originally became prominent during the 1990s, a decade with a much more promising geopolitical environment.)

[18] For more on both claims, see IPCC 2001a, 16-7.

[19] Archer 2005a, 5. 'kyr' means 'thousand years'.

[20] Archer 2005b.

[21] Archer 2005b; a similar remark occurs in Archer 2005a, 5.

[22] Wigley 2005; Meehl et al. 2005; Wetherald et al., 2001.

[23] This is exacerbated by the fact that the climate is an inherently chaotic system in any case, and that there is no control against which its performance might be compared.

[24] The possibility of nonlinear effects, such as in abrupt climate change, complicates this point, but I do not think it undermines it. See Gardiner unpublished.

[25] Elsewhere, I have argued that it is this background fact that most readily explains the weakness of the Kyoto deal. See Gardiner 2004a.

[26] Generational overlap complicates the picture in some ways, but I do not think that it resolves the basic problem. See Gardiner 2003.

[27] These matters are discussed in more detail in Gardiner 2003, from which the following description is drawn.

[28] Hansen and Soto 2004; Hansen 2006. Graph adapted from Hansen 2006; see also Marland et al. 2005.

[29] Hansen 2006, 9.

[30] I owe this suggestion to Henry Shue.

[31] See O'Neill and Oppenheimer 2002.

[32] Traxler 2002, 107.

[33] Henry Shue considers a related case in a recent paper. Shue 2005, 275-276.

[34] For some discussion of the problems faced by cost benefit analysis in particular, see Broome 1992, Spash 2002 and Gardiner (in press).

[35] In particular, it conceives of the problem as one that self-interested motivation alone should be able to solve, and where failure will result in self-inflicted harm. But the intergenerational analysis makes clear that these claims are not true: current actions will largely harm (innocent) future people, and this suggests that motivations that are not generation-relative must be called upon to protect them.

[36] In particular, once one identifies the Intergenerational Storm, it becomes clear that any given generation confronts two versions of the tragedy of the commons. The first version assumes that nations represent the interests of their citizens in perpetuity, and so is genuinely cross-generational; but the second assumes that nations predominantly represent the interests of their current citizens, and so is merely intragenerational. The problem is then that the collectively rational solutions to these two commons problems may be – and very likely are – different. (For example, in the case of climate change, it is probable that the intragenerational problem calls for much less mitigation of greenhouse gas emissions than the cross-generational problem.) So, we cannot take the fact that a particular generation is motivated to and engages in resolving one (the intragenerational tragedy) as evidence that they are interested in solving the other (the cross-generational version). See Gardiner 2004a.

[37] Gardiner 2004a.

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