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Ozone and climate governance: An implausible path dependence

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ABSTRACT

Many observers and commentators have used the case of ozone science and politics as a role model for climate science and politics. Two crucial assumptions underpin this view: (1) that science drives policymaking, and (2) that a unified, international science assessment is essential to provide "one voice" of science that speaks to policymakers. I will argue that these assumptions are theoretically problematic and empirically questionable. We should realize that both cases, ozone and climate, are profoundly different and only have superficial similarities. Ozone science developed late, but efforts to protect the ozone layer happened swiftly. The relation between carbon dioxide and climate change has been studied for many decades, but efforts to control global warming have failed so far. I will discuss the linear model of the science-policy relationship and use the typology of tame and wicked problems to explain this stark difference.

1. Introduction

Several commentators have emphasized the success of the Montreal Protocol and its significance for other global environmental problems, most notably climate change (e.g., Tolba, 2008). This raises the interesting question to what extent the cases of ozone layer depletion and climate change are similar. Climate change, and greenhouse gases (most notably CO_2) have been a topic of scientific investigation at least since the 19th century. Climate science proper commenced in the 1960s with the merging of two disciplines, carbon cycle research and climate modelling (Hart and Victor, 1993). Observations of global CO_2 concentrations started in 1958, and global average temperatures hundred years before that. Politically, it was put on the international agenda at the United Nations Conference on Environment and Development, held in 1992 in Rio de Janeiro. The United Nations Framework Convention on Climate Change (UNFCCC) was adopted by all member states of the UN. Article 2 of the convention states that its 'ultimate objective' is the 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.' The text continues as follows: 'Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.'.

While this text of the convention was not binding on the signatories, the 1997 Kyoto protocol established as binding goal an average 5% reduction of 'anthropogenic carbon dioxide equivalent emissions of the greenhouse gases below 1990 levels in the commitment period 2008 to 2012.' After a failure to agree on new terms in Copenhagen 2009, the Paris accord of 2015 has agreed that countries should stay within a 1.5–2-degree limit by the end of the century. No CO_2 reduction targets or timetables were announced, and the main mechanism of achieving the target is through 'pledge and review', i.e. voluntary climate policies by individual countries, with a view to make them more stringent over time.

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The ozone layer has been thematised in science since the 1930s, but studies in stratospheric ozone science began only in the early 1970s, starting with Harold Johnsons's works on NO_x emissions from supersonic aircraft, Jim Lovelocks's measurements of CFCs at sea level in the atmosphere and then of course with the publication of the seminal paper by Rowland and Molina (Molina and Rowland, 1974). First in situ measurements in the stratosphere were conducted in the 1930s and some ozone sounding records date back to the 1960s (Hofmann, 2009), but most in situ measurements in the stratosphere were widely undertaken from the 1980s. Measurements of CFCs in the troposphere were first performed by Lovelock in 1971 (Lovelock et al., 1973).

In policy terms, a milestone was reached with the Vienna convention in 1985, which 'urge[d] all States and regional economic integration organizations [...] to control their emissions of CFCs, inter alia in aerosols, by any means at their disposal, including controls on production or use, to the maximum extent practicable.' The Montreal Protocol of 1987 and the subsequent amendments led to a phasing out of ozone-depleting substances (ODS) by the end of the 20th century.

One is bound to ask why ozone layer protection was a latecomer in science and politics, yet led to a swift political response. On the other hand, one asks why climate change and the role of GHGs was a longstanding topic in science, but has not led to a similar effective political resolution to date.

I will begin my paper with an examination of the similarities and differences between the two cases. In order to explain the difference between the two cases, I will then (Section 2) introduce the concept of the linear model of the science policy nexus; and of tame and wicked problems (Section 3). The last section will discuss the political options that were deemed relevant in both cases.

2. Similarities

The similarities between ozone layer depletion and climate change can be summarized as follows.

Ozone-depleting substances and greenhouse gases (GHGs, especially CO_2) have a long lifetime. In both cases, these stretch to several decades. This means that ODPs and GHGs accumulate in the atmosphere, making potential effects worse over time. Any delay in action makes the problem worse in the future.

ODPs and GHGs are emitted locally, but diffuse globally. No matter where on Earth these gases are produced and emitted, they will mix in the air, travel around the globe and cause impacts that will again be felt locally. Both problems therefore have a local and global dimension.

In both cases, societal stakeholders resist regulation. This was evident with the relevant parts of the chemical industry, resisting CFC regulation from the mid-1970s to the mid-1980s. A similar activity can be observed with regard to fossil fuel lobby groups in the case of climate change. However, the range of potential 'veto players' includes many more actors in the case of climate change, because activities that produce GHGs are much more central to the economic functioning of the world's economy.

The role of science is a salient feature in both cases. We distinguish between individual scientists and science as an institutional setting for collecting evidence. Individual scientists have been active in both cases. Rowland, Molina, Crutzen, and others became advocates of the banning of CFCs. Their activities included public appearances in the media and in front of parliamentary committees, giving testimony. Similar activism has emerged in the case of climate change, arguably starting with James Hansen's statement to the US Congress in 1988. These scientists have been vocal and have alerted a worldwide audience to potential dangers.

Science as an institution has provided research results through publications, conferences, and also through assessment reports. In the case of ozone research, these reports were initiated in 1985 by the WMO and UNEP, and provided an assessment of the available knowledge. In 1988, a similar mechanism was established for climate research through the IPCC (Grundmann, 2001; Skodvin, 2000; Weart, 2003). As we shall see, there are different interpretations of the relevance and effectiveness of these assessments for the policy process.

3. Differences

Turning to the difference between both cases, several aspects stand out. In the case of ozone, several drivers of ozone were identified, of which manmade ODS were seen as crucial. Natural drivers were also known, such as large volcanic eruptions that were thought to inject large amounts of chlorine into the atmosphere. But these were seen as sporadic events, and the amount of chlorine rising to the stratosphere was uncertain (WMO, 1985: 114). In policy terms, the framing of the issue was about ODS, and initially nearly exclusively on CFCs.

While CFCs were industrially produced, many climate drivers exist naturally. It is true that much of GHG emissions are by-products of industrial processes, or of human activities, more generally. But the existence of the carbon cycle means that we, as humankind, are always embedded in a process of producing and capturing CO_2. The anthropogenic component can be enhanced or reduced, but not eliminated. Even before the advent of industrialization, human societies were able to affect the carbon cycle via the modification of biomass, for example (Erb et al., 2017).

Drivers of climate change include other processes, such as methane, N_2O, soot, HFCs, and many more. Some of these are relatively short lived, which allows for policy interventions aiming at quick gains in mitigation. Their relative importance is discussed in IPCC AR5 WG1, chapter 8 (Myhre et al., 2013). This shows that CO_2 is the most important one in the long run.

Another important difference is the fact that CFCs were a relatively small part of global economic activity, and their production was located in a small number of countries. As Falkner (2009: 259) put it, 'five chemical firms (DuPont, Allied Chemical, Hoechst, ICI and Atochem) in four countries (the US, Germany, Britain and France) dominated global CFC production'. Only a few developing countries started hosting small CFC plants.

In contrast, climate drivers are associated with the industrial infrastructures of societies, through energy production, housing, manufacturing, agriculture, or transport. All countries are part of these infrastructures and activities. Our way of living depends on activities that impact on climate. Compared to ozone, the challenge for politics is bigger by several orders of magnitude. In the ozone case, substitutes for different applications were becoming available at low cost, and the disruption to economic activities was minimal. Conversely, the cost of decarbonisation is high, especially if climate sensitivity is high (Wagner and Zeckhauser, 2016). There is no agreement on the likely equilibrium climate sensitivity (ECS). The IPCC, in its fifth assessment report, wrote that 'there is *high confidence* that ECS is *extremely unlikely* less than 1 °C and *medium confidence* that the ECS is *likely* between 1.5 °C and 4.5 °C and *very unlikely* greater than 6 °C'. Depending on which value one assumes, the problem could be seen from being minimal to being catastrophic.

The communication of the problem was different in both cases. The endangered ozone layer was initially framed as one of long-term depletion, of a fabric that becomes threadbare. This changed in 1986 when the alarmed discovery of abnormal low ozone over Antarctica led to the reframing of the problem as Ozone Hole, which added urgency to the definition and perception of the problem (Grevsmühl, 2017). The Ozone Hole focussed attention of policymakers, especially as it came completely unexpected. Climate change does not have one focussing device, there are many symbols that are deployed to alert people, such pictures of belching chimneys, floods, draughts, rain forests, or icebears in distress. None of these is unexpected, and the shocks have already been anticipated. Should the West Antarctic ice shelf drift into the sea, this would have been thematised over decades. What is more, climate change has been linked to other, sometimes far-fetched or implausible events, such as volcanic activity, earthquakes, obesity, violent conflict (Koubi, 2017), or migration of refugees from Northern Africa (Missirian and Schlenker, 2017).

4. The linear model of policy making

There is a widespread belief that scientific information will impact policy making and that there is a natural flow from knowledge to action. Countless studies have problematized this 'linear model' (Collingridge and Reeve, 1986; Grundmann and Stehr, 2012; Jasanoff, 1990), but the idea persists. The relation between both is more complicated. In some cases the implementation of knowldge is easier than in others. Engineering solutions based on a technical core are examples which lend themselves to a 'linear' interpretation (Sarewitz and Nelson, 2008). However, our comparator cases show interesting differences when it comes to the role of scientific knowledge in the policy-making process. Let us look at both in turn.

Official accounts of the success in Montreal point to the unified assessments as key explanation. Such accounts suggest that, only because science was able to 'speak with one voice', sceptical voices could be side-lined (Benedick, 1998; Haas, 1992; Tolba, 2008). Some go as far as describing science in the 'driving seat'. Perhaps the most important scientific information about long-term ozone depletion (which was, after all, the remit of the Montreal Protocol) was the report by the Ozone Trends Panel published in 1988, one year after the meeting of the parties in Montreal (WMO, 1988). However, this report presented a consensus about the observation of globally declining ozone concentrations without providing a consensus on the causes (see also Litfin, 1994).

Apart from the scientific insights, pragmatic solutions and technical innovations played a major part on the way to Montreal. First of all, there was a partial ban on CFC use enacted in 1977 in the USA (the so-called 'Spray can ban'). This was advocated early on by scientists like Rowland, and propagated by the press. Consumers followed suit by preferring CFC free products. These were provided by companies based on existing technologies (roll-on deodorants, pump spray cans, butane spray cans, etc., see also Parson, 2003).

The USA spray can ban, enacted through the Clean Air Act, had an impact on the CFC producers in the US that led to complaints by the US industry. Their argument was that European producers gained an unfair advantage on the world market and that a level-playing field needed to be restored. This was an important argument in the negotiating process towards Montreal. The US government, and its industry, wanted to turn this early disadvantage into a competitive advantage. This may explain why US CFC producers came to reassess their position towards CFC controls from 1986 onwards, whereas European CFC producers were still resisting regulations, citing scientific uncertainties.

In the case of climate change, something different can be seen. First of all, there is more scientific activity and more measurements of critical substances have been carried out. We do have long-term time series of CO_2 concentrations and global average temperature levels, and efforts at quantifying the role of the former on the latter. However, despite the IPCC and its efforts at mobilizing the science consensus, dissonant voices have not disappeared, and the consensus pertains to minimalist statements such as those that observed temperature increases are most likely the result of human activities (Cook et al., 2013; Pearce et al., 2017). There is no consensus on the likely climate sensitivity which would be an important piece of information in order to calculate future costs and benefits. The potential impacts of warming, and of climate change, are wide-ranging. It seems to be fair to say that science, and the IPCC, have been successful in putting the problem on the political agenda, without being able or willing to design policy. After all, the IPCC, according to its own description, is providing policy relevant knowledge, without being policy prescriptive (IPCC, 2010).

Meanwhile, the policy process had developed so-called no-regret policies ever since the oil crisis of the 1970s, at least in some European countries. This has led to more fuel-efficient cars and more energy efficient infrastructures and housing. But such efforts were not enough to keep temperatures below 2 degrees Celsius in the long run.

Other policies have been added, and numeric mitigation targets have been established, mainly in Europe.

In recent years, some fast-developing countries have been emitting more GHGs than developed countries. China has overtaken the US in total annual emissions of CO_2 (but not in historic emissions, and not per capita). This poses problems in international negotiations. Unlike the ozone treaty, where developing countries did not play a role, with climate we see an involvement of all countries, which makes agreement more difficult.

Many actors apart from science have shaped the definition of the problem, and the potential strategies to address it. Issues of economic burden sharing are prominent, among others, both on the domestic and international level.

5. Tame and wicked problems

Apart from the difficulties posed at the level of international negotiations, there is a more fundamental issue we need to address. This is the question of what kind of problem we are facing in the case of ozone depletion, and in the case of climate change. Are both problems amenable to change? Much of the language used to describe ozone and climate is the same in that it employs the figure of 'solving the problem'. Scholars have alerted us to the fact that there are some problems, mainly in social policy, that are resistant to solution. Rittel and Webber (1973) distinguish between tame and wicked problems. Tame problems are problems that have a unique, and clearly identifiable solution. Think of solving an equation, or of achieving checkmate in five moves against your opponent. In such cases, we know what the solution looks like, and if we have solved the problem. Engineering provides a paradigm for this approach. Wicked problems are problems that escape this logic. Success criteria are unclear, contested, and subject to change over time. Examples include crime, education, health, economy, employment, and so on. Policies are developed to manage the problem, but there is no hope that we could solve these issues, once and for all. What we try to do is to manage these problems. A lot of political dispute is about the definition, and re-definition of these problems. There is no expectation that science can provide a solution. Steps are taken incrementally and pragmatically.

The distinction between tame and wicked problems lends itself to a straightforward application to our two cases (Grundmann, 2016). Put simply, and somewhat provocatively, ozone layer protection is a tame problem, climate change a wicked problem. In the ozone case, there were two political options from the outset: do nothing (wait and see); or regulate ODS. The benchmark of success was a return to pre-industrial levels of chlorine loading in the atmosphere. The Montreal Protocol has provided the roadmap to achieve this. Part of the regulatory framework is the Technology and Economic Assessment Panel (TEAP) which "provides [...] technical information related to the alternative technologies that have been investigated and employed to make it possible to virtually eliminate use of Ozone-Depleting Substances (such as CFCs and Halons), that harm the ozone layer". (UNEP Ozone Secretariat, n.d.). This was made possible through the availability of a technical core (Sarewitz and Nelson 2008).

The ozone layer shows signs of recovery, but the job is not done (Solomon et al., 2016). It is an open question when this will be achieved. Should the recovery come to a halt or go into reverse, this would be an indication that other factors are at play, that the chlorine chemistry of the atmosphere is not well understood, and the tame problem could unravel into a wicked one.

Contrast this case to climate change. There are different metrics that could be used to gauge success. Three important metrics are: (1) limiting warming to under 2 degrees Celsius (or even to under 1.5 degrees) by the end of the century. This would require (2) to keep CO_2 concentrations below a certain threshold, and to (3) emit only a specified amount of CO_2 over this period (Aykut and Dahan, 2011). In order to achieve these goals, global carbon budgets have been calculated (Rogelj et al., 2016). The size of the budget varies by large amounts depending on the methods and scenarios on which calculations are based (Millar et al., 2017; Rogelj et al., 2014).

A sign of success would be that the temperature rise over the coming decades will be limited to a specified amount. Likewise, we would expect a stabilization of CO_2 concentrations in the atmosphere at some safe level. In order to get there, we would need a radical reduction in CO_2 emissions. Unlike the ozone case where a phase out of, and a ban on CFCs was feasible, no such option exists in climate change. Trying to reduce CO_2 emissions radically, and quickly, runs counter to resistance from societal stakeholders, since CO_2 has a central place in the economic structure of society (Pielke Jr., 2010).

It is noteworthy that no one in the climate change debate has suggested the policy goal of reversing back to pre-industrial levels of CO_2. Ambitious plans aim at stabilizing CO_2 concentrations to between 400 and 500 ppm, compared to 280 ppm concentrations before the industrial era. The most 'radical' positions talk about 'getting below' 350 ppm (Hansen et al., 2008; https://350.org). Some commentators perceive the crossing of this level as a 'tipping point' (Rockström et al., 2009). There is no agreement on what level of CO_2 concentration is a safe one.

There is the distinct possibility that the target of 1.5-degree or 2-degree warming will be missed (Geden, 2016). Would this mean that we have failed to solve the problem of (anthropogenic) climate change? From our present position, it certainly would. However, by 2100, scientists or policy makers might well argue that despite the warming we have seen, this is far from dangerous, or that the dangers can be addressed. And even an overshoot that had been deemed dangerous would not necessarily mean that we will give up on the problem. One might expect people saying that certain attempts have failed, but that there are still other policies available. The problem would be re-defined. As before, we would make choices between options that appear better or worse. These policies could include more radical approaches, as discussed in the next section.

There are two aspects arising from the previous discussion that need highlighting. One is that in the ozone case scientific and technical knowledge was available, and able, to prescribe policy, once the question of ODS controls had been resolved. With a regulatory framework in place, all policy efforts could be channelled in the direction of reducing manmade chemicals that harm stratospheric ozone, as far and as quickly as possible. Secondly, in the of case climate change, several attempts and metrics of dealing with the problem exist, but none can be seen as a solution in the strict sense. There is no technical core on which climate policies could rest. Climate change is a problem that will stay with us. This is not to say that nothing can be done to make the impacts of climate change less serious. But such attempts do not amount to a solution of the problem in the strict sense of the term.

6. Policy options

The above assumes that scientifically defined benchmarks, goals or targets are useful for policy-making. But achieving these goals means to change social, economic, and technological practices. Staying within certain carbon budgets will lead to political disputes about how best to achieve them (and to disputes about the veracity of the underlying science). The suggested carbon metrics is not apt to solve political disagreement, or to sidestep it. Such disagreement becomes obvious when considering strategies to address causes and impacts of climate change. Consider the following list of twelve policy options:

1) rolling out nuclear power plants across the globe;
2) switching all energy supply to solar, wind, or biofuels;
3) taxing carbon (or energy) with a) low or b) high rates;
4) implementing emission-trading systems;
5) developing carbon-capture and storage technologies;
6) develop new zero-carbon energy systems;
7) taking adaptation more seriously;
8) developing geo-engineering projects;
9) adopting vegetarian or vegan diets and lifestyles;
10) restricting population growth;
11) abolishing capitalism;
12) abolishing democracy.

Some of the suggestions go together, many contradict each other. Observers have pointed out that some of these solutions might be worse than the problem (Biello, 2010; full disclosure: the author of this paper is on record of recommending a combination of 3a and 6, see Prins et al., 2010).

The green movement has split over the issue if nuclear is the best option we have, given that a massive expansion of renewable energy technologies would occupy a lot of land (Porritt, 2011; Shellenberger, 2017).

Direct carbon-capture technologies are unproven at scale, solar radiation management poses numerous legal, ethical, and political problems (Hulme, 2014; Keith, 2013; Ming et al., 2014). Likewise, land use changes under BECCS scenarios could have problematic effects (Erb et al., 2017).

Carbon taxes are a simple tool, yet politically divisive. Especially hopes in high taxes are misplaced. Making carbon unaffordable for significant parts of the electorate will not be achievable. Policies that increase fuel (and energy) poverty are politically regressive (Giddens, 2009).

Emission-trading systems have a poor record so far. There are massive problems with setting an efficient carbon price, and the trading systems are being used for fraudulent activities (Berta et al., 2017).

Developing zero-carbon energy systems would provide an obvious technological platform that would help achieving GHG reductions. They would do nothing about other climate drivers (such as those in agriculture and forestry) and do not come about on their own. Radically new technologies need huge upfront investment and need time to develop, both drawbacks on their appeal. The state would need to play a major role, as has been documented in other cases (Mazzucato, 2011). In its way stand 40 years of neo-liberal political rhetoric.

Adaptation has been neglected for a long time as it does not, by definition, address mitigation. Many scientists and policy makers seem to assume that we should prevent radiative forcing from happening instead of dealing with the consequences (Pielke et al., 2007). But global temperatures have been increasing already, and climate impacts are manifesting themselves. Impacts vary regionally and locally, and adaptation measures need to be taken accordingly. If mitigation efforts are not introduced timely and at the necessary level, such adaptation efforts will have to be accelerated.

The contribution of agriculture to climate change is recognized, inter alia, in the call for lifestyle changes such as adopting vegetarian or vegan diets. While they could make a reduction in climate forcing they are not enough to change the overall picture (McMichael et al., 2007). These are unlikely become dominant voluntarily in a short time span; they will be rejected if imposed.

Restrictions on population growth poses all sorts of ethical and political problems. While it is true that more people on the planet will have a greater impact on the natural environment, and increase drivers of climate change, there are various ways of achieving people's needs and desires. When focussing on carbon dioxide as a driver, the carbon intensity of the energy used to produce goods and services seems crucial, as expressed in the Kaya Identity (Lima et al., 2016; Raftery et al., 2017; Raupach et al., 2007).

It is true that capitalist societies have an in-built mechanism that leads to increasing economic activity, with potential harm to the environment in general (Klein, 2014). Actors who decide to make energy-related savings, or decide to have fewer children, will invest these savings in the hope to increase returns on investment. However, such investments will go into areas that are likely to have impacts on climate (Wapner and Willoughby, 2005). Nevertheless, the task of abolishing capitalism is arguably even more demanding (or unlikely) compared to the task of mitigating climate change. Many on the political left see the fight against climate change, and the fight for political reform of capitalism, as equally important, and interlinked. However, using climate change as political 'wedge' could be politically counterproductive. Developing successful mitigation strategies requires the support of broad parts of the electorate. Polarization has been a problem in this regard (Kahan et al., 2012).

Finally, the hope is that authoritarian regimes are more efficient modes of planning a low-carbon economy (Beeson, 2010). But their disregard for citizen's rights, human rights and democratic participation is legend, as is their even worse record in environmental matters (Stehr, 2015). The argument has a rational kernel, however, in that more veto points in a political system will slow down decisions (Tsebelis, 2002). But democracy as a system is more flexible in the long run, which is what we need with climate change. Decisions taken today may turn out problematic tomorrow. The electorate needs to be supportive of the taken route. Authoritarian regimes might have an advantage only under the assumption that they hit upon the 'best solution' (whatever that may mean, given the above caveats) and carry it through, with minimal undesirable side effects (again, a highly problematic assumption). In the long run, the inevitable popular resistance against authoritarian rulers will lead to political upheaval and instability.

As this discussion shows, there is no agreement between the proposed policies. Instead, the political arena harbours controversies about all, or most of them. There is no prospect that a scientific advisory process could solve these controversies.

How can we deal more effectively with climate change, given the complexities listed above? I have argued that climate change as a wicked problem resists a solution. There is no obvious stopping rule for climate policies. An alternative is, of course, to separate different aspects of the problem and deal with them separately. This is what we observe in day-to-day politics. Decomposing the large climate problem into many smaller problems could be tantamount to transforming the wicked problem of climate change into a number of tame problems. The advantage is that we can establish for each of those metrics and success criteria, given specific timescales. For example, one could address industrial sectors such as cement or steel making, electricity, different agricultural sectors, and so on. Progress can be monitored and enhanced in jurisdictions that have the power to do so. However, co-ordinating these manifold activities on a national and global level will be a challenge, given that such solutions will not only be different across industrial sectors and human activities, but also across national jurisdictions. The overall narrative of solving the problem of climate change through global climate policy will lose its meaning as a myriad of disconnected activity mushrooms across the globe.

7. Conclusion

Comparing the cases of ozone layer protection and climate change, we have identified some similarities. These pale in comparison to the differences which have to do with the different problem structure of both issues. Ozone-depleting substances could be dealt with in a process where scientific definitions and metrics led to a technical solution that was economically palatable to the main stakeholders. The issue was discussed at a relatively low level of public involvement, it was quickly addressed, and it was solved within a reasonable timeframe. I explain this success through the fact that the problem was a tame problem. In as far as it relies on scientific models and theories that could still be proven wrong, a less than full recovery of the ozone layer might lead to an unravelling of the problem, making it wicked.

Climate change, by contrast, resists such an approach. There is no unique solution, and the problem is intractable. Many practical steps can be taken towards partial solutions, but these differ in nature and time. What would count as success, at what point in time, is unclear. So far science has not been able to provide guidance with regard to two important metrics for policy making: climate sensitivity and carbon budgets. This type of uncertainty is well known from other wicked problems, which have been defined as social problems, or problems of planning (Rittel and Webber, 1973).

Because the two problems are so different, we should abandon loose talk about 'learning from Montreal.' Instead, we should focus the attention on the practical steps that are possible to address climate change, in a process where political compromise and practical effectiveness are the hallmarks. 'Muddling through' in the search for pragmatic solutions is the name of the game (Lindblom, 1959; Verweij et al., 2006).

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