The geopolitics of climate change

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A B S T R A C T

In his 2012 Political Geography plenary at the 2012 Royal Geographical Society meeting, Stuart Elden posed the possibilities of a “geopolitics” that engages the earth, the air and volumetric understandings as an alternative to geopolitics as a synonym for global politics with its two dimensional cartographic imagination. More is needed than political geography writ large: a material sensibility is necessary to think about security and geography but one that is not linked to traditional determinist formulations. Climate change has a long connection to geopolitics, but now humanity is determining the future of the planetary climate. Picking up Elden’s themes, this paper explores how taking the physicality of climate change seriously requires a rethinking of politics in the face of numerous transformations in what is becoming the more obviously artificial planet in the Anthropocene epoch. The geometrics now needed in security analysis include the volumes of global carbon dioxide and Arctic ice. Geopolitical discourse needs a fundamental overhaul to deal with the new circumstances and incorporate climate change as a production problem in the making of a new world, not as a deterministic phenomenon shaping human life in coming decades.

“... If we really care deeply about the climate and other socio-environmental conditions, our theoretical gaze and political passions have to shift from a concern with the environment per se to a concern and passion for the construction of a different politics.” Erik Swyngedouw (2013: 2)

Geopolitics

Geopolitics is a word that invokes many things simultaneously. Struggles for political dominance is the most obvious meaning of the term and one that comes with the implicit suggestion that this is a matter that is to be understood at the global scale. The “geo” here is both a matter of the world and a matter of the geographical arrangements the shapes the contests for power over that world. It is about the spaces of politics, the geographies of rule, authority and frequently violence. It is nearly always about attempts to make, organize, dominate and control particular spaces, most notably now the spaces of the global neo-liberal economy (Panitch & Gindin, 2012).

As a generation of critical geopolitics scholarship has made clear, geopolitics is also about the modes of knowledge, of ways of representing the world that have political consequences (Dodds, Kuus, & Sharp, 2013). In this sense geopolitics is quite literally about how the world is made known. The geographical terms in the scripts used by politicians, the images conjured up by those who represent foreign places, and their specification in terms of having attributes requiring certain forms of policy are ubiquitous modern political practices (Agnew, 2003). These are obviously literary practices where geopolitical discourse is routine. But more than textual matters structure the practices of global politics even if the other forms of knowledge — numerical and computational — discussed below, are rendered back into text in the key practices of decision-makers and in the justifications used in policy documents, political speeches and media punditry.

Popular imaginations are shaped by multiple modes of political discourse, and in the case of climate change in particular, by numerous invocations of nature, threat and most recently severe storms and unusual droughts and heat waves in contemporary media (Boykoff, 2011). How these are known and interpreted matter in political terms as the huge amounts of money spent by “conservative” institutions in the United States to cast doubt on the realities of climate change show very clearly. How science relates to politics, and how various types of knowledge become politically useful is unavoidable in all this (Hulme, 2009), as it has long been in discussions of geopolitics.

The ability to establish a context remains a particularly useful capability in politics, a practice properly deserving the term...
geopolitics. But the context in which climate and geopolitics might be linked has changed dramatically over the last century in particular. In no small measure this is due to the rapid expansion of technical capabilities and the engineering of whole new urban spaces, production systems, commodity chains as well as the rapid transformation of “rural” landscapes into zones of agricultural extraction. The green revolution and the relationships between weather and crop yields are not unrelated to the calculations of geopolitics (Perkins, 1999); cold war scholars will remember the importance of satellite-based estimates of the Soviet harvest. North Korea watchers do similar calculations today. Drought is, contemporary commentators have suggested, related to the “Arab Spring” (Mabey, Schultz, Dimsdale, Bergamaschi, & Amal-Lee, 2013). These technologies are also modes of knowing, charting, measuring and calculating the earth as it is transformed; this relationship is key to climate change geopolitics, but while it’s not a new matter, the recent focus on anthropogenic climate change adds important new twists to an old story.

Climate has become once again a matter for explicit geopolitical deliberation, but in very different terms than it was in the previous manifestations of what have become known as classical geopolitics. The emergence of climate change as a matter of increasing urgency in global politics requires us to engage with some of these themes again it seems (Webersik, 2010). This paper starts there. Subsequent sections deal with how the atmosphere was a key arena for the cold war, how climate science is tied into geopolitics through this period and how contemporary climate fears have become part of security discourse. The latter half of the paper suggests that both this history of cold war geopolitics, and the contemporary specifications of ecological spaces extend Stuart Elden (2013) concerns with volumes and geometrics. The text ends with some reflections on future trajectories and how climate is changing governance, both through markets and potentially through geo-engineering projects, suggesting that old determinist arguments have now been reversed in the ‘great acceleration’ period in the Anthropocene.

**Determinism, climate and geopolitics**

Theories that reduce human history to uni-causal mechanisms are rightly regarded with scholarly suspicion. Much of the early work of the twentieth century on these themes of environmental causation and the influence of climate on the course of human history have been dismissed as being determinist if not racist or imperialist myopia. The latter point is particularly important, as Mike Davis (2001) makes so clear in his *Late Victorian Holocausts*. There remains a very powerful politics to natural explanations of social phenomena that allow the rich and powerful to evade their responsibilities while attributing human suffering to natural causes. Nonetheless to argue that all discussions of climate as a constraint, if not a cause of human history should be dismissed is to fly in the face of much research in environmental history that has of late richly added to the understandings of earlier phases of the human condition (Hornborg, McNeill, & Martinez-Alier, 2007).

While care has to be taken with dismissals of earlier scholarship, not least because of the unavoidable oversimplifications of disciplinary history, and the institutional advantages of distancing new scholarship from the supposedly inferior or tainted practices of the past, simple arguments that climate causes things were frequently simply badly off the mark. Preston E. James’ (1972: 376) summary comment on Elsworth Huntington’s work will have to suffice in place of a more detailed exposition here: “Huntington worked on subjects for which objectively defined data were lacking and in a period before the methods for collecting such data had been worked out’. More recent environmental history emphasizes the complexity of climate and other factors in ways that reinforce James’ evaluation. This is all important because of the popularity of Malthusian environmental scarcity formulations as the cause of all sorts of contemporary insecurities (Dalby, 2009). As Christian Parenti (2011) emphasizes, contemporary climate changes are impacting on landscapes already restructured profoundly by the processes of neoliberal agriculture.

Rendering earlier theories in terms of possibilism rather than determinism is an altogether safer intellectual strategy, not least because there are environmental constraints on many human activities, only perhaps most obviously such things as particular modes of agriculture that can be undertaken in what parts of the world due to rainfall availability and the constraints of nutrient availability and the numbers of degree days needed for crop maturation. Likewise disease prevalence is related in some ways to ecological conditions necessary for vectors to flourish; tropical diseases are mostly so called for obvious reasons. Indeed it seems that Jared Diamond’s (1997, 2005) major work in Guns, Germs and Steel, and Collapse is better understood as sophisticated re-articulations of possibilism, rather than as matters of environmental determinism, not least because of the key point in Collapse that humanity could now learn its way out of ecological difficulties.

Determinist arguments are nonetheless remarkably persistent in political discourse, not least because of their overly simplistic geographies. Attributing causal logics to specific contexts, and in the process imputing natural explanations on the grounds that either that’s the way things are ‘there’, or that there are no choices because of how things are ‘there’, is routine geopolitical discourse. It has long been key to invoking environmental causation to conflicts (Dalby, 2002). As geographers have been arguing for a long time these convenient naturalizations of artificial cartographic convention (Fall, 2010) work well to obscure social and economic matters that flow across the boundaries demarcated on maps. In the process the responsibilities that go with those cross boundary activities are elided in favour of simple specifications of ‘here’ and ‘there’, and usually virtuous proximity and threatening or morally flawed others elsewhere.

All this is especially dangerous when, as is sometimes the case, it now feeds into the geopolitical discussions related to contemporary climate matters. It is dangerous, as the rest of this paper argues, mostly because it so dramatically misconstrues the nature of contemporary transformations. This misconstrual can be very politically useful to those who either wish to proceed on present trajectories or those who warn of the need for coercive preparations to deal with what is coming. Whatever the merits of earlier arguments about the climate’s shaping influence on human history might have been, it is no longer that case that this matters much in terms of geopolitics. What now matters is the opposite argument. The rich industrial carbon fuelled part of humanity is now determining the future course of the climate not the other way round! This is why, according to a growing number of earth system scientists, we now live in the Anthropocene, not the Holocene.

**Anthropocene geopolitics**

The transformation wrought in the last few generations by global capitalism, and especially in the period since the middle of the twentieth century, the period of ‘the great acceleration’ in the terms of the earth system scientists, now means that it is human action that is shaping the future of the earth’s climate system (Steffen, Crutzen, & McNeill, 2011). Decisions made by those who determine what gets made where, and how the terrestrial surface of the planet is used, now matter directly in terms of the future climate configuration. Climate matters in human affairs now, particularly in terms of the likely impacts more severe storms and more extreme weather events will have on unprepared...
populations in coming decades. These are less and less “natural” events because carboniferous capitalism is changing the planet rapidly; the weather is on steroids these days (Trenberth, 2012). These changes are coming much more rapidly, it needs to be emphasized, than many of the previous shifts from one geological epoch to another (Barnosky et al., 2012).

The emergence of this new condition, of life in the Anthropocene, requires us to recognize that the modern assumptions of nature as separate from humanity, of environment as an external element, determining or not, of the human condition were never a very accurate portrayal of life in the biosphere. The argument in what follows is that these distinctions have to be transcended if we are to collectively think about the future, and how to shape it, in effective ways.

While geographers have been looking to the small scale to understand how genetics and biological sciences in particular can be understood in terms of hybrids and new assemblages of life (Braun, 2007), as a discipline we have been slow to recognize that the biosphere itself is now, in Latour’s terms, effectively a hybrid of the artificial and the natural. The environmentalist tropes frequently used to discuss the iconic ‘blue marble’ NASA image of the whole earth now need to be supplemented with a much more explicit recognition that through our production systems humanity is deciding whether and for how long the ice cap that dominates the lower part of that image will remain. What we will “compose” in coming decades matters greatly (Latour, 2011). How we came to this pass, and how we now know what we do know about our new condition, this matter of life in the Anthropocene, is intimately interconnected with geopolitics, both in terms of how cultural representations of the earth have been generated, and in terms of how our technical practices have produced and enabled knowledge of the world in the process of trying to dominate and control it.

Crucially, we also need to look to the emergence of artificial biomes as the geographical mapping of the planet that sets the stage for discussions of both mitigation and adaptation measures to climate change (Ellis, Goldewijk, Siebert, Lightman, & Ramankutty, 2010). The Anthropocene has a geography. Indeed contrasting the formulations of contemporary cartographic representations with traditional geographic discussions of natural areas of the world is a useful corrective to assumptions that humanity is a recent superimposition on a prior “natural world”. It also powerfully undercuts residual claims to determinism by emphasizing that the geographical contexts that matter to humans are not natural, but, in terms of species mix in particular, hybrid constructions of artificial migrations and impositions. These ‘anthromes’ as opposed to biomes, are the mappings that now matter in considering the appropriate contextualizations for understanding geopolitics in the twenty first century.

In the previous Political Geography lecture in this series Stuart Elden (2013) posed questions of securing volume as a geopolitical practice that, he argued, was a three dimensional view of the practices that was more appropriate than the largely two dimensional focus on “securing the area” which is a standard policing and military tactic, as well as the “flat” surface assumed in much international relations thinking. Territoriality, to use Sack’s (1986) formulation, involves the demarcation of areas, the policing of boundaries, and the control of who and what enters the “secured area”, and is a powerful tool in the armoury of power. However, Elden suggests that it needs a vertical dimension to reflect the contemporary geometries of power. This is both a matter of vertical geopolitics in terms of urban landscapes, buildings and structures, aerial surveillance and controlling “airspace” as well as a matter of subterranean systems, tunnels and infrastructure. How all this is to be measured and surveilled is a matter of geometrics in Elden’s terms.

Picking up these themes this paper suggests both that “volumetric geopolitics” has been an important matter through the cold war period, both in terms of controlling airspace, and orbital space, but also in terms of the geophysics of the atmosphere. In Neil Smith’s (2008) terms, making space is also about making nature. Controlling this volume in a number of ways, and understanding its materiality, were important parts of cold war geopolitics, and ones interlinked with climate. Now, as climate becomes a more high profile concern for global governance, the crucial measurements of the earth, its geometrics, are key to geopolitical considerations.

**Cold war: geophysics and geopolitics**

In his study of the early years of the Cold War Matt Farish (2010) shows how various scientific and technological practices changed how power worked in the United States, and how the representations of the world that structured the geopolitical discourses of the time were shaped by a variety of emergent knowledges only most obviously nuclear physics, remote sensing and operations research. These were the decades of the physicist and the behavioural scientist. The cold war was shaped to a very substantial extent by these knowledges and the genre of nuclear strategy, written by those who, Australian strategist Peter Kaplan so pithily termed the ‘obliterration’, was the pinnacle of technical knowledge linked to a frequently very crude realpolitik that endangered civilization profoundly. Although it is frequently forgotten, some of the geopolitical specifications of the Russian context and the supposedly ‘universally’ expansionist nature of the Soviet Union went back directly to Ratzel’s environmental determinist writings (Dalby, 1990). The simple binary logics of a world of two superpowers fed rhetoric of confrontation, a zero-sum world where superpower rivalry determined the fate of civilization.

Nuclear strategy was in part a very quantitative enterprise, the measurements of missile throw-weights; kilotons and megatons of destructive power; the circular error probabilities of missile accuracy populated the texts and calculations of the ‘Wizards of Armageddon’ (Kaplan, 1983). Radiation was also a matter of quantitative measurements, exposure levels and supposedly safe doses. Where Halford Mackinder had been concerned about the manpower for great power rivalries, now nuclear weapons, long-range bombers and missile numbers were more important to the calculations of scenarios of confrontation. Physics and operations research provided the intellectual tools for “the soldiers of reason” (Abella, 2008). The engineering of bunkers as well as the drafting of codes and protocols for controlling the weapons were numerical technical matters. The metrics that sometimes seemed to matter least were the very crude estimates of the number of immediate fatalities. As Farish (2010) makes clear, these knowledges were derived from Second World War experiences with scientific warfare, the practices of logistics and the technical calculations of bombing missions, troop movements and massive industrial production systems that produced war materiel so copiously.

The war produced missile technology too, and the resultant space race in the 1960s pushed intercontinental missile technology into orbit and then to the moon and further afield. Science, and initially physics, was key to this and to such things as the International Geophysical Year in the late 1950s where study of the physical parameters of a globe understood as such (Jones, 1955) were part of the attempts to know and appropriate the planet, frequently for military purposes. The post-war sciences of geophysics and meteorology in the United States included serious discussions of the possibilities of local weather modification as a weapon of war (Edwards, 2010). Geophysical research also generated attempts to measure trace gases in the atmosphere, efforts
that eventually resulted in the iconic graph of our times, the Keeling curve of atmospheric CO₂ concentrations.

All this geophysics research mattered in part because understanding the physical functions of the atmosphere, the radio properties of the ionosphere, not to mention the dispersal patterns for radiation from nuclear explosions, or the potential disruptions to ozone layers or electronic communications from high altitude weapons detonations, were part of war planning. At least in terms of radioactive contamination, the partial test ban treaty of the early 1960s was an attempt to reduce atmospheric pollution amid growing realization of the large scale impacts of a nuclear war (Sorens, 1997). Concern about changing the planet’s overall climate arose as part of this investigation of geophysics, and a scientific assessment of the potential for human alterations of the global climate landed on President Johnson’s desk in 1965 (Schneider, 1989).

The growing realization about the potential damage of a nuclear war and the Cuban Missile Crisis led gradually to attempts to constrain the nuclear arms build up and SALT and ABM treaties. The physical realities of nuclear war made mutual restraint a necessity where the possibilities of further towards what Daniel Deudney (2007) calls negarchy, a perpower competition, the international system was nudged and subsequently morphed into the world of ‘computati’ at the pinnacle of big science (Edwards, 2010). The big science of the cold war was of physics and attempts to know the world to control it in the rivalry of superpowers; its spinoffs include climate models and the devices now used to monitor earth systems. It is a metropolitan ‘big science’ view of a world to be known, monitored and now ‘managed’.

While there is much more to climate science than the investigations of nuclear winter, the discussion of nuclear winter spurred on the science of climate modelling and by the end of the 1980s it was clear that human actions were causing discernable climate shifts as James Hansen famously stated in congressional testimony in the hot summer of 1988 (Schneider, 1989). What wasn’t clear, and what has generated much ‘big science’ since, is what the projections of increased carbon dioxide in the atmosphere will mean for the future configuration of the biosphere. Modelling climate change became a big project in the 1990s and although numerous additional models have been added, the details of what is coming, and when, remain unclear despite huge efforts and the sequence of IPCC assessment reports since 1990.

The rapid reduction in Arctic Ocean ice cover makes especially clear that linear extrapolations of trends into the future seem unlikely. In human terms heat waves, floods and drought in Russia, Pakistan and the US respectively in the last few years have suggested that unpredictability is the new norm. Where nuclear winter threatened rapid onset climate cooling, the relentless expansion of carboniferous capitalism is promising climate change as a result of atmospheric warming. This in turn has raised numerous concerns about the geopolitical consequences of climate change.

**Rapid onset climate change**

By the early 1980s the ecological effects of a nuclear war had become a major argument for disarmament. In particular the destruction of the ozone layer was of concern; high altitude nuclear explosions had made this an issue much earlier. While there were concerns in the 1970s that air pollution was actually cooling the planet — sulphate aerosols being a major issue both in cooling and acid rain — the connection to geopolitics and specifically warfare came to a head in 1983 when theories of nuclear winter appeared in print (Turco, Toon, Ackerman, Pollack, & Sagan, 1983). These suggested that hot nuclear wars would quickly turn very cold as clouds of debris and smoke lofted into the atmosphere would bring on very rapid onset climate change. In colloquial terms, nuclear winter arguments suggested that the hell of a post nuclear war world would quickly freeze over.

Historical analogies with the detonation of Tamboro in 1815 and Krakatoa in 1883 suggested debris in the upper atmosphere might provide for at least a year without summer. Agricultural collapse due to a combination of the destruction of industrial and fuel supply facilities as well as “nuclear winter” might, the scenarios suggested, finish off civilization as it had come to be known (Sagan & Turco, 1990). All of this added greatly to the arguments in the 1980s for the end of cold war. From anxiety and unrestrained superpower competition, the international system was nuced further towards what Daniel Deudney (2007) calls negarchy, a matter of bounding power, a necessity where the possibilities of civilization termination loomed in the shape of mushroom clouds and subsequently a climate changed to a much cooler temporary configuration.

This link between concerns of nuclear warfare and climate change brought the physics of modelling directly into the discussion of climate. While there were doubts over the calculations of severity of nuclear war, which cities had high enough fuel loading densities to generate firestorms, how many weapons targeted on what would be necessary to trigger full scale nuclear winter, how long it would last and related questions, what was clear from then on was that humanity had the ability to drastically change the earth’s climate. From the physics of cold war, the knowledge of the ‘numeri’ subsequently morphed into the world of climate modelling using ever more sophisticated computers, a world of ‘computati’ at the pinnacle of big science (Edwards, 2010). The big science of the cold war was of physics and attempts to know the world to control it in the rivalry of superpowers; its spinoffs include climate models and the devices now used to monitor earth systems. It is a metropolitan ‘big science’ view of a world to be known, monitored and now ‘managed’.

After September 11th 2001, the war on terror was the Bush administration political agenda; attempts to get climate change onto the security agenda were resisted by the White House. Media coverage of a scenario exercise on global warming and conflict (Schwartz & Randall, 2003), that suggested that the Bush administration’s security priorities were misplaced, did generate some attention. While this document suggested that war might result from rapid climate change, it was not at all clear how this might occur; disruptions were simply assumed to lead to conflict. By 2007 the bureaucratic logjam in Washington was overcome and military analyses suggesting that climate change was an important matter for geopolitical consideration appeared (Campbell et al., 2007; CNA, 2007; Pumphrey, 2008). The military, concerned to think ahead and make plans for future eventualities, is taking the changing climate seriously even if politicians in Washington, many in thrill to fossil fuel funds and the confusion spread by the climate denial campaigns, are not. In part this is related to the growing realization that climate change is unlikely to be a matter of gradual change in the future, and is a matter of more immediate concern with potentially disruptive non-linear phenomena that likely will need to be dealt with by the military (Mayer, 2012).

Crucially most of the reports from the American military think tanks focus on the political instabilities in peripheral areas, and the possible spillover effects these may have for metropolitan societies. Environmental shortages ‘there’ may cause disruptions, wars and
migration that will cause security concerns 'here', we are repeatedly told, despite social science research that suggests such fears are misplaced (Thiesen, Holtermann, & Buhaug, 2011). This imperial optic is clear in the admittedly preliminary policies for dealing with environmental security in NATO and OSCE planning documents. Zones of instability on the fringes of Europe are of concern; possible political instabilities there require interventions to deal with environmental difficulties now prior to their causing spillover conflicts later (Moran, 2011). Many of these practical efforts might make sense regardless of the geopolitical optics, but it is worth emphasizing that in many of these documents peripheral symptoms get attention rather than the metropolitan causes of climate change, a geography that is dangerously misleading if tackling global environmental insecurities is to be taken seriously (Dalby, 2009).

Daniel Deudney (1990) long ago warned that linking environmental change to matters of national security may produce policies that are counter productive. Viewing climate change through the lenses of specifically U.S. national security suggests that he had very good reason to be worried. There are important exceptions to this generalization, some of which are discussed below, but frequently it is worth emphasizing that in many of these documents peripheral symptoms are insidiously emerging in a similar fashion.

Second, and following from this is the related point drawn from the literature in political ecology and trenchantly restated by Christian Parenti (2011). He reminds readers that the landscapes in question are frequently portrayed as threats once they show up at the borders of metropolitan action, are insidiously emerging in a similar fashion.

Climate geometrics

Nearly simultaneous with Elden’s positing the importance of securing the volume in his Edinburgh IBG lecture in July 2012, prominent climate activist Bill McKibben published an article in Rolling Stone magazine that suggested that the most important geometrics of our time relate to basic aspects of the climate system. Reflecting on the dangerous new math of climate change he emphasized three numbers that mattered most in thinking about climate change. First is 2°C, Celsius that is, the widely agreed temperature increase that climate activists and some scientists argue cannot be exceeded if the planetary system is to remain in more or less the configuration that humanity has known for the last ten thousand years.

The United Nations Framework Convention on Climate Change (UNFCCC) commits all parties to the prevention of dangerous anthropogenic interference with the climate system. The original agreement did not however specify how much climate change might be considered dangerous. A consensus grew in the mid 1990s that 2°C average global warming above pre-industrial levels was the upper limit of what should be considered. The figure was widely accepted as the benchmark at the Copenhagen climate conference in late 2009. There was no obvious scientific origin to this figure; it emerged as a European Union compromise figure in the mid 1990s climate change negotiating sessions but nonetheless it has become the “guardrail” beyond which climate change negotiators are agreed humanity must not go. It is a political number, not a serious scientific calculation.

McKibben’s (2012) second metric is the matter of the number of gigatons of carbon dioxide that can be safely emitted to ensure that the planet does not exceed this supposedly reasonably safe level of 2°C of warming. According to the calculations he cites, humanity can...
emit another 656 gigatons of carbon (on top of what it has already burnt) and still stay within the 2 °C range. But the third geo-metric, the one that truly worries McKibben, is the reserves of fossil fuels already in the inventory of energy production companies. That number stands at 2795 gigatons according to his sources. The implications are very simple; if all these current reserves are burned the planet will blow right past the 656-gigaton limit and dramatic climate change is assured (See Anderson & Bows, 2011). It is noteworthy that McKibben's source here is Carbon Trackers, an entity that combines data from environmentalists and from the financial industry, and who warned in 2012 that climate change was a serious danger to investment portfolios. It would become even more so if all those reserves of fuel are extracted and used in coming decades.

McKibben (2012) did not include the most widespread metric from the climate debate, the measurement of parts per million of carbon dioxide in the atmosphere. The Keeling curve, the measurement of carbon dioxide concentration in the atmosphere, has become an iconic symbol of our age. In May it registered the highest average day of greater than 400 ppmv CO2 in the atmosphere. The contested history of this measurement, and the battles to maintain funding for the Mauna Loa measuring station following its initial establishment during the International Geophysical Year, only emphasize how scientific knowledge is part of the larger cold war geopolitical assemblage. Bill McKibben’s campaigning organization is called 350.org to emphasize the need to reduce CO2 levels to something close to 350 ppmv to ensure that the climate system remains in a state loosely similar to the Holocene conditions that gave rise to human civilization. These geometrics are key to the climate change discussion, and to the political strategies advocating a change of course to leave those fossil fuels in the ground.

How to represent this volume of carbon dioxide and visualize just how much gas is involved is not easy, a matter that has a long history in human attempts to understand air (Adey, 2014). The difficulty with carbon dioxide is that while it is ubiquitous we exhale it all the time — it is odourless and invisible and a matter for technical measurement, not a sensuous matter of direct human experience. As with the earlier case of stratospheric ozone depletion, another matter of invisible gases requiring technical definitions beyond human senses, the politics of these measurements require a reliance on technical scientific practices that further imbricate technical matters with political ones (Lifton, 1994).

Another geometric that is a matter of volume is the rising ocean levels as a result of warming waters. While this too is not without measurement difficulties given both matters of isostatic adjustments of land and the uncertainties concerning data sets collected in coastal locations, clearly the volume of the oceans is growing enough to be highly noticeable in low lying areas, especially in the case of island states facing inundation (Ulan, 2013). Beyond that, another crucial measure of oceanic change that is of concern is the changing pH measure of seawater. As carbon dioxide is absorbed the resultant rise in pH is a very worrisome matter for life in the oceans. This too is a geometric that matters in charting the new geophysical circumstances humanity is making. Likewise ocean temperature rises, and current changes too.

Shrinking ocean ice cover in the Arctic in particular has gained attention in terms of geopolitics. The volume of ice has shrunk dramatically in the last few decades as the summers of 2007 and 2012 showed very clearly. This too is a volumetric measurement that matters in terms of the geopolitical transformation of the colder parts of the planet (Dodds, 2008). The imminent disappearance of summer ice in the Arctic suggests that one other major geophysical phenomenon that has been part of the earth system for millions of years may shortly be a thing of the past. Current trajectories suggest that the planet is heading for one permanent polar ice cap, not two. The ocean ice cover over the North Pole has been rapidly retreating in recent years. (Greenland is well south of the pole, it may indeed melt in coming centuries with all the volumetric consequences for rising sea levels and enhanced storm activities (Hansen, 2009).) While there are many unknowns concerning rates of melting, including whether the albedo change due to loss of ice cover has already set a positive feedback process in motion or not, clearly this too is an important geometric that is tied directly into political discussions of the future configuration of the planet.

Elden’s (2013) formulation of volume, while a very useful corrective to the frequently two-dimensional representations of global politics in cartographic terms, needs to be extended to deal with climate. Climate geopolitics requires an historical retrospective to consider the importance of the atmosphere and outer space in the cold war and an extension to grapple more directly with the materialities of the volumes that are to be secured. The climate discussion now emphasizes the importance of atmospheric as well as hydrospherical volumes. Neil Smith’s (2008) crucial argument that capitalism simultaneously produces nature and space provides the necessary link; the materialities of spaces matter, not just the volume. Securing the volume in climate discussions might well be read as securing an upper limit to the volume of CO2 in the atmosphere; how to do it is now key to contemporary geopolitics, and it works its way through numerous geographical specifications of reality as well as the contemporary political economy of financialisation and securitization in both the monetary and political senses.

Neoliberal geometrics

These measurements are not quite what Elden (2013) had in mind in his discussion of geometrics and the necessity of securing the volume. However the logic of his argument fits into the new mathematics of global security, and the market logics of carbon measurement now rapidly populating the growing financial industry buying and selling carbon credits, and evaluating, calibrating and certifying ecosystem services in many parts of the world (Newell & Paterson, 2010). Entirely consistent with Smith’s (2008) point about the production of nature and space, these geometric measurements are now calling all sorts of new ecological entities into existence as matters for geopolitical calculation.

As Lansing’s (2010) examination of this in the case of carbon sinks in Costa Rica makes clear, these calculations are not always easy, not least because of the difficulty of specifying exactly where the forests that count in the calculations actually are. Complicated geo-referenced polygons are key to the allocation of appropriate credit for carbon sink services. The new geometries of sinks may not coincide with prior administrative areas either, all of which generates complicated new modes of governance and requirements that technical procedures for certifying that ecosystem services are actually doing what they supposedly should under the financial arrangements of the clean development mechanism.

In some senses these are new; carbon sinks per se are unprecedented. What is not so new are some of the practices involved in establishing and managing the new ecological entities (Lohmann, 2006). Forestry plantations are an old mode of colonial resource management. If they are now to sink carbon rather than produce fibre or fruit, there may be little practical difference as far as local populations of forest dwellers are concerned. The reduction of forests to sinks and the payments to national governments may have little to do with the indigenous populations outside the formal calculations of financial payments. The poor, often the most vulnerable to both climate variability and their inability to resist the encroachment of modern managerial schemes on traditional subsistence territories, frequently do not enter into these global
calculations of carbon trading and the logics of global agricultural change at all (Cuppers, 2012). These highly technical evaluations of resources are now also part of the global calculations of geopolitics related to climate change in so far as states make arguments about their relative importance as sinks in the global carbon economy.

More than this, the complicated geographies of carbon sinks suggest that these practices are linking metropolitan and peripheral areas in complicated ways that in Saskia Sassen’s (2013) terms disassemble the territorial state. If adaptive measures for geopolitical powers involve changing the rural economies at great distances, then the globalization of adaptation is also part of the new geopolitical calculus of climate. This is not just a matter of carbon sinks, but also of securing land for food production in the face of growing concerns about food insecurity. While care needs to be taken in simplistically blaming Northern elites for the process, and property market bubbles have perverse local effects, nonetheless it is important to note that climate adaptation measures may themselves cause disruptions and conflict as well as further insecurities. This is not just a North—South issue either as the 2013 accounts of Ethiopian people dispossessed of their land by Indian investors makes very clear (Vidal, 2013). But this point emphasizes the rise in the power of urban elites, the reassertion of financial power, and hence in David Harvey’s (2005) terms it is important to emphasize the class power of the neo-liberal project that now largely controls how the climate crisis will be addressed.

The vulnerabilities of states and economies to storms and extreme events likewise factor into the new financial arrangements for managing a climate-changed world. Kevin Grove’s (2010) investigations of Caribbean vulnerabilities and the financialisation of risk management in schemes for catastrophe bonds show that while central government and financial institutions may find some protection, or rather the potential to rebuild after a hurricane, the poorer and marginal peoples in these societies are excluded from the calculations of human security. Once again, as Roberts (2010) emphasizes, the most vulnerable are too poor to factor into the market logics of neoliberalism, logics that simply ignore epidemiological measurements in particular. That said the larger literature on human security and climate change has been using precisely these epidemiological statistics to emphasize the dangers presented by more extreme weather patterns and rising sea levels (Scheffran, Brzoska, Brauch, Link, & Schilling, 2012), to little practical effect it seems, given the financial metrics used in many policy responses.

In discussing the various phases of carbon democracy, the political ecology of coal and oil and the possibilities that these opened up for extending political rights in the case of coal, and frequently restricting them in the case of petroleum, Timothy Mitchell (2011) posits first the economy, and then subsequently the market as the overarching entities that required governance. The gradual ascendance of the market over the economy parallels the rise of globalization, or in earth system terms, the period of the great acceleration, powered by the rise of petroleum fuels. The rapidity of international action in the face of the global economic crisis of 2008, in comparison to the manifest failure to grapple seriously with climate matters, suggests that the market remains key.

While it is premature to suggest that climate is yet anywhere close to the most important entity for governance, the seriousness of what is coming implies that climate might become the next overarching principle. The rapid rise of carbon markets and the commodification of hot air in the form of carbon credits, offsets and increasingly complicated derivative style financial instruments suggests such a shift may be beginning. The planet is now not only a matter for measurement as an object to be known through the practices of remote sensing, but much more obviously now a matter of calculation and computation wherein ecological phenomena are divided up, surveyed, demarcated and marketed, bought and sold in the complicated computations of carbon markets. Given the disruptions of the financial crisis of 2008, and the simultaneous changes wrought by climate change, the more vulnerable are so as a matter of ‘double exposure’ in Leichenko and O’Brien (2008) terms. But it remains to be seen if these innovations in market rules will curtail, much less reduce, carbon dioxide concentrations in the atmosphere in coming decades.

Geoeengineering

If they don’t, and disasters increase, food supplies become constrained and political conflict results, the next thing on the geopolitical agenda is clearly geoengineering (Royal Society, 2009). While cloud seeding and other weather modification measures are being experimented with to deal with small-scale meteorological manipulations, the larger question of adjusting climate on either regional or global scales is being discussed with increasing urgency (Humphreys, 2011). Solar radiation management, controlling the amount of sunlight reaching the planet’s surface is but an extension of earlier engineering concerns with managing the atmosphere and securing airspace from unwanted interlopers, is it not?!

Among the numerous technical possibilities are injections of sulfate aerosols into the upper atmosphere to effectively shade the planet (Vaughan & Lenton, 2011). While aerosol pollution of this nature at lower altitudes has been cursed, largely to deal with acid rain problems, the possibilities of mimicking volcanic action are within the bounds of existing technologies; high flying planes could do the job on a budget that is feasible; stratospheric balloons could in theory disperse aerosols too, although the British SPICE project, a small scale test of such theories, was abandoned in 2012 amidst controversy concerning relevant patents and in the face of environmentalist opposition (Cressy, 2012).

While such solar radiation management technologies might temporarily reduce insulation, they do not deal with the larger problem of accumulating carbon dioxide in the atmosphere. Carbon dioxide reduction mechanisms are urgently needed, but most of the existing proposals work too slowly to deal with the looming crisis. In the face of growing disasters, including the disruption of weather patterns that cause food insecurities for a major state or group of states, it seems likely that the temptations to try geoengineering in the face of a global emergency will be very considerable. It is once again a matter of engineering and security; the discussion of global security has moved on from concerns about disrupting atmospheric matters in terms of ozone holes and nuclear winters to thinking about how some similar techniques might now be used to deliberately manipulate the climate.

Given the interest being shown in such things by billionaire entrepreneurs it may be a Hobson’s choice as to whether it is better to have militaries or private sector actors doing these things. In either case it seems essential to have transparency and public oversight, but as yet there is no regulatory agency in existence that might begin to think about who should adjust the temperature of the planet, how and where. Doing so in ways that do not foreclose “softer”, smaller scale ecological innovations is going to be important (Olson, 2012), especially so as to allow rural peoples the flexibilities to try innovative adaptations that will buffer ecosystems against meteorological extremes while sinking carbon in ways that facilitate local livelihood security.

Unpalatable though such considerations may be they are the next stage of geopolitics and as such deserve critical attention from geographers. But such a discussion raises impossible questions of geometrics. How hot should it get? Who decides? Should the planet have two ice covered poles, or only one? Is 350 ppm of CO₂ the goal, in which case what kind of land use planning is needed to sink large
quantities of carbon? If not on land then why not seed the oceans to facilitate plankton blooms and carbon uptake there. Never mind the unknowable ecological effects this might have. Who should decide how much plankton is needed? Such questions now go on endlessly, all tied into the new geometrics of planetary system stability. These are the political questions for our time, but how to engage them is a fraught matter that the political left has frequently been slow to address (Klein, 2011).

As Erik Swyngedouw (2010) warns, putting climate change into the terms of security and engineering can easily lead to a post-political populism wherein technical measures are decided by some political agency without any kind of serious political discussion. Technical discussions of various geo-metrics can all too easily slip into the constitution of CO₂ as a Latourian quasi object that we are at war against. ‘We’ implies universality and an agent beyond political contestation with a dangerous fetishization of carbon if security narratives come to dominate discussion and technical solutions are all that is on offer. Obviously the political order that gave rise to the problem isn’t in question, merely what technical fix is most appropriate. One can practically see the engineering companies lining up for the contracts! What is clear is that carbon has become big business in addition to becoming a matter of security things now.

In the absence of a sudden appearance of political sanity and the implementation of programs, such as James Hansen’s (2009) fee and dividend scheme for the United States to rapidly change matters away from fossil fuels, how climate change is governed is likely to be a combination of both security and financial calculations of ‘ecosystem’ services, offsets, and related matters in a series of new productions of nature. Facing the possibility of crossing tipping points into a period of abrupt change, the prospect of unilateral attempts at geoengineering loom. Conflict over competing schemes, accusations that one state’s geoengineering is worsening agricultural conditions in another, and disagreements on what level of temperature is appropriate, are easy to project (Urpelainen, 2012). If these happen in times of political nationalism and the temptations to unilateral action prove irresistible to politicians then all bets are off. The atmosphere then becomes not only a volume to be secured, but also one to be competed for directly. Climate wars indeed! The early cold war research on local weather modification as a method of war may end up being tragically prophetic.

Such considerations emphasize the importance of Deudney’s (2007) notions of negarchy and self-restraint as a model for a future geopolitics. So far much of the negotiation activity related to climate change has been in the mode of competitive inter-state rivalries with states thinking in terms of attempting to dominate a divided world in a series of zero-sum games. Hence bargaining strategies presuppose a competitive situation where emissions reductions are understood as a cost, and relative losses seen as a problem rather than there being a common interest in reducing carbon emissions rapidly. The standard realist assumption that economic progress leads to more power in the international system, and that power is the key to peace and prosperity, is now hopelessly ill fitted to shaping the future of the Anthropocene (Dalby, 2013b).

But despite all the attempts on the part of climate change science to explain these simple facts, the political process continues to replicate the state practices of the past while sporadically, but increasingly, supporting the innovative climate market mechanisms despite the obvious consequences for ‘development’ that may be anything but sustainable for local peoples in the ‘South’. Nonetheless this shift in geopolitical vision, coupled with such things as the disassembly of national spaces that Sassen (2013) implies is a crucial part of climate governance, is what we have to work with now.

The territories that are being disassembled, bought, measured, decided about, and reshaped by new technical practices are the anthromes made by agriculture, urbanization and deforestation (Ellis et al., 2010). They are now increasingly artificial entities, and it is these entities that now matter in the calculus of power and the designs of new living arrangements in the next phase of the Anthropocene, when the earth system scholars hope humanity will try to make a sustainable system for all our species. To do so is going to require above all a recognition that the old geopolitical premises inherited from modernity are no longer useful, not least because in the new artificial circumstances of the Anthropocene climate change is much more obviously a production problem than it is one understood in traditional environmental terms.

**Conclusion**

The Anthropocene means that the deterministic arguments about climate shaping human destiny are no longer relevant to the geopolitics of the twenty first century.

While state boundaries may be relatively fixed, the landscapes within and across them are not. Focussing on the Anthropocene emphasizes the point that colonial, or at least metropolitan views of the world are not enough to understand the geopolitics of climate. The long-standing assumptions that global politics is necessarily a competitive arrangement of “flat” territorial states has, as Elden (2013) argued, failed to grapple with some of the most important volumetric dimensions of state power. Extending that argument to suggest that the volumes that matter most now are some of the key geometrics related to the atmosphere and the ocean, and the struggles to secure them are the next phase of geopolitics, also emphasizes both the continuity of climate as a matter in geopolitical thinking and the importance of taking seriously the reversal of the assumed relationship between climate and humanity in the most recent stage of the Anthropocene.

The literature on world order and United Nations reform is littered with good ideas based on notions of a universal humanity and calls for equality and justice for all. Since at least the 1972 Stockholm conference on the Human Environment, there has been awareness that we only have one earth, to borrow the title from Barbara Ward and Rene Dubos’s (1972) conference report. The long forgotten Earth Charter and Agenda 21 schemes from the 1992 Earth Summit sketched out cooperative arrangements based on a recognition that humanity ought to operate on the assumption that there is only one planet, and how we use it matters in terms of the future prospects for humanity as well as other life forms. Now the climate science modellers and the formulation of the Anthropocene have confirmed what appeared obvious to environmentalists of earlier eras; the interconnections between humanity and planet are unavoidable and as such the rich industrial portion of humanity has taken the fate of the earth into its own hands, and in the process has unleashed a transformation unprecedented in the history of the planet.

Given this new recognition of the urgency of tackling the changes set in motion if some semblance of the ecological circumstances that gave rise to humanity is to be maintained for future generations, the political and academic question for geopoliticians is how a rapid transition from the patterns of present negotiations, and the assumptions of relative gains problems, not to mention the basic assumption that the neo-liberal market order of the present is most important, can be changed. New thinking and a new politics are indeed needed to challenge the competitive assumptions of state negotiations. The extension of market logics into carbon credits, and the logics of offsets does not effectively tackle the root causes of climate change in terms of carboniferous capitalism. While these logics may operate to ameliorate some of the
symptoms of climate change, they have so far failed to tackle climate change in terms of a production problem. Given the ecological limits of "sinks", the rapid extension of such markets will, it seems, inevitably lead to the construction of new geo-engineering products and governance mechanisms for what is an increasingly artificial biosphere.

This requires a clear understanding of the Anthropocene as the context that now matters most. Flat geopolitics isn't the appropriate contextualization; sovereignty in ecological terms is irrelevant to the problems at hand (Smith, 2009). How to facilitate rapid social change is a key task for social scientists and not only geographers (Vinthagen, 2013). This geopolitical contextualization means that competitive state rivalries in a flat world is the problem to be tackled, not the given implicit context for the human drama. The geo-metrics that now matter are volumetric ones concerning sea levels and Arctic ice, carbon dioxide concentrations and degrees of warming, not the flat two dimensional boundary demarcations of states.

Climate change adds great urgency to the task of changing the current implicit contextualizations in geopolitical discourse that structure how the world is made known to its political subjects, and hence how those subjects might act politically. The formulation of the Anthropocene is part of this puzzle, not least because it makes clear: climate-change is a production problem, not an environmental one. Humanity is literally making its future, not protecting a given context. The task now for social scientists, not least geographers, is nothing less than trying to work out how to shift politicians and policy makers from a focus on trying to dominate a divided world to learning how to share a crowded one.

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