

Rethinking geopolitics in an era of climate change

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Abstract This article examines the disconnect between predictions about climate change and dominant geopolitical framings of the future. To begin, we introduce four popular geopolitical models of the world. We then show how climate change is a critical variable when considering the future of international politics. Focusing on the specific issues of water availability, agricultural productivity, coastal impacts, and shipping routes, we discuss the implications of predicted changes in the wake of climate change for the assumptions on which these scenarios are built. We show that work linking climate change and geopolitics has clear implications for the ways in which the future geopolitical (dis)order is conceptualized, and we argue that the failure to incorporate this work into geopolitical scenario-planning represents a significant limitation to their utility. We offer some direction for a re-conceptualization of the future based on a more dynamic and flexible approach to geopolitics that recognizes the disruptions posed by climatic and other environmental changes.

Keywords Geopolitics · Climate change · Scenario planning · Environmental security

Despite the appearance of a variety of recent studies pointing to the strategic ramifications of climate change (e.g. NIC 2008, 2004; CNA 2007; Halden 2007; MAB 2006; Fraser et al. 2003; CIA 2000), most assessments of the geopolitical landscape of the twenty-first century ignore the potential disruptions of climatic and other environmental changes, focusing instead on political, economic, cultural, and technological circumstances that affect power relations across the globe. These assessments share the assumption that the physical world will remain static—that environmental variables will not significantly alter the global geopolitical picture. Yet this assumption is deeply problematic given current and potential challenges posed by climatic changes. This article examines the nature and significance of the disconnect that exists between climate science and the geopolitical thinking of journalists, policy makers, and the like. Through an analysis of how climate changes may affect current geopolitical models, we seek to encourage comprehensive, cross-disciplinary efforts to better understand the relationship between the physical and political world.

Our approach is rather different from recent scholarly literature on geopolitics, which “deals with discourses, codes, visions, representations, narratives, and other concepts pertaining to the importance of

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language in geopolitical practices” (Mamadouh and Dijkink 2006: 349). Such studies have helped illuminate how “little things” matter (Thrift 2000), and have identified some of the key ways social and institutional arrangements influence geopolitical ideas and practices. We are concerned with the more traditional, broad-scale geopolitical narratives common in policy circles and popular discourse. While partial, limited, and the product of myriad smaller-scale processes, these framings inevitably shape geopolitical thinking and are worthy of consideration as they can tell us much about popular conceptualizations of the world, as well as the ideological assumptions that shape policy proposals and government practices. By identifying several key climate-driven environmental and territorial challenges to a few popular geopolitical scenarios, we illustrate how common worldviews that underpin policy and security strategy miss a critically important variable: the changing physical environment.

To begin, we introduce four popular geopolitical scenarios—examples that capture many of the basic assumptions commonly used by the intelligence community, economists, political scientists, and the popular media—and consider their underlying spatial-territorial assumptions. We show that these scenarios generally assume that the natural environment is not an influential variable, even though a variety of environmental changes, especially climate change, have significant implications for the underlying assumptions on which these frameworks are built. Focusing on the specific issues of water availability, agricultural productivity, coastal impacts, and shipping routes, we consider some of the challenges they present. We argue that the failure to incorporate climate change represents a significant limitation to geopolitical scenario-planning. By bringing climatic and other environmental changes into dialog with applied geopolitics, this paper encourages thinking across different intellectual traditions and seeks to create space for a broadened consideration of the links between politics and the environment at many levels.

Current approaches to assessing the geopolitical future

There is currently no consensus about the future shape of the world political-territorial order. Instead, different scenarios are commonly developed in an effort to

capture the overarching trajectory that international relations is likely to take in the years to come. These scenarios can be generally understood as attempts to draw on current and past conditions to predict how geopolitical relationships might unfold.

Scenario planning helps us anticipate developments in a variety of fields and provides opportunities to evaluate strategies for responding to conditions through an exploration of alternative futures. Scenario exercises are different from forecasting and risk assessment in that scenarios are used in situations where the variables are highly uncertain and largely uncontrollable. Rather than attempting to predict the future, scenarios are attempts to define the possible; they consider a variety of plausible futures rather than try to predict a single outcome with accuracy (Biggs et al. 2007; Bennett et al. 2003; Clark et al. 2001). Although scenario planning came under scrutiny in the 1980s and 1990s due to the frequent resort to deterministic assumptions, such exercises have more recently been used to understand organizational flexibility and resilience rather than to identify or predict a definitive future (see Biggs et al. 2007).

Since international relations among territories and peoples can have enormous political, social, and environmental consequences, it is not surprising that geopolitics is the focus of major efforts at scenario planning. Much like similar exercises in economics, geopolitical scenarios have been built from questions about how and in what ways uncertainties may define the future of the international system. Samuel Huntington wrote that these scenarios:

...are intended to be roadmaps or paradigms that impose a sense of order on the reality we confront and guide our behavior. Although they are abstractions that neither comprehend the totality of the world nor mirror it objectively, without some blueprint we will have a hard time discriminating between what we judge to be central versus peripheral to our purposes and what will advance as opposed to impede our objectives (cited in De Santis 2002: 62).

We should expect, then, that these scenarios may influence public debate and policy making, and by extension the on-going human construction of international relations.

While it may be impossible to generate a definitive list of influential geopolitical scenarios at any given time, four scenarios currently attracting considerable

attention embody common assumptions about the future spatial configuration of power. One of these foresees the emergence of a new multi-polar world order centered on a few competing states (NIC 2008). Another anticipates the solidification of a world order based on US political and ideological norms (Krauthammer 2002, 2003). A third posits a fragmentation of the world along civilizational lines, with interstate tensions being overshadowed by conflicts between different communities sharing broad historical and/or religious ties (Huntington 1998). Still another focuses on the possibility of a set of political-economic blocs acting as key players in a new international order (Hettne 2004). While these are only a selection of the many possible imaginaries of the future, they are illustrative of conceptions of the world that currently help shape political perception. Consideration of the territorial assumptions upon which each is based provides a framework for analyzing how predicted climate change may impact these scenarios.

Scenario 1: a multi-polar world order

Multi-polar world order scenarios often envision a rise of several key states or superpowers that share a balance of international power and influence. As an example, the “2025 Project” from the National Intelligence Council suggests the likely emergence of China and India as new major global players—similar to the rise of Germany in the 19th century and the United States in the early twentieth century. These new players will transform the geopolitical landscape, with impacts potentially as dramatic as those of the previous two centuries (NIC 2008). Proponents of the multi-polar thesis typically adopt a state-based view of the world and assume that individual states will remain the principal loci of power, but that no one state will be able to dominate the world system. They often argue, for example, that the United States’ position of dominance is already being undermined by rapid population growth and economic expansion in other parts of the world, as well as by the expanding reach of economic globalization. As a result, they predict the emergence of a few increasingly powerful states that will rival the US and the European Union (EU) in power and influence.

Not surprisingly, China and India figure large in the thinking of those who see a coming multi-polar world order, but countries such as Indonesia, Brazil, South Africa, and Russia are sometimes considered to be

potentially important nodes as well. Few suggest that the United States will fall out of the global power picture altogether, but multi-polar-world proponents argue that the growing demographic and economic weight of other states will make it increasingly difficult for the US to sustain a position of global dominance.

A small set of territorial assumptions lie at the heart of the multi-polar world order scenario:

- China, India, and perhaps a few other states or state-like entities will expand their global influence, even as the United States maintains a position of significant power.
- No regional alliances or other types of power blocs will emerge to fundamentally challenge these key geopolitical nodes.
- Destabilizing circumstances in other world regions will not challenge the positions of the key players.

These assumptions are predicated on an extrapolation of current economic and demographic trends. Proponents of this scenario assume that disruptions will likely come from unexpected political or social developments. Given that Brazil, Russia, India and China (The “BRIC countries”) have been discussing alternatives to the use of the US Dollar as a reserve currency and the future admission of India and Brazil into the UN Security Council as permanent members (Alden and Viera 2005), this scenario is increasingly viewed as plausible.

Scenario 2: a uni-polar world order

Although quickly fading in the wake of the recent financial meltdown and the ongoing and unpopular wars in Afghanistan and Iraq, some geopolitical theorists suggest, or at least hope, that the US could retain a lone superpower position. One of the most forceful proponents of this uni-polar world order scenario is the American journalist Charles Krauthammer, who writes a syndicated column for the *Washington Post*. Krauthammer (2002, 1990/1991) argues that the US has become a dominant single power “unlike anything ever seen”—with a military, economic, and cultural reach that completely overshadows other countries. He sees American unipolarity as potentially vulnerable, but not for decades, and not unless political power in the US falls into the hands of what he apparently regards as misguided

multilateralists. His position is one of advocacy, but of a geopolitical scenario that he clearly sees as attainable. In Krauthammer's (2002/2003: 17) words:

The new unilateralism argues explicitly and unashamedly for maintaining unipolarity, for sustaining America's unrivaled dominance for the foreseeable future. It could be a long future, assuming we successfully manage the single greatest threat, namely, weapons of mass destruction in the hands of rogue states. This in itself will require the aggressive and confident application of unipolar power rather than falling back, as we did in the 1990s, on paralyzing multilateralism.

While this vision has lost much support in recent years, many still consider US dominance a viable possibility, especially given the extraordinary "investment" the US makes in its military, as seen, for example, in its maintenance of more than 700 military bases on foreign soil (DOD 2010). Although other single states could challenge US hegemony, Freidman writes, "The concept of American decline is casually tossed about, but for America to decline, some other power must surpass it. There are no candidates" (2009).

Like its multi-polar counterpart, the uni-polar thesis views geopolitics primarily in state-based terms; however, the focus is on the dominance of one state and a set of closely aligned allies. The superpower derives control from a set of unique political and economic strengths that may be sustained as long as it does not lose its ability to counter those that would undermine it.

Once again a small group of territorial assumptions lie at the heart of the uni-polar geopolitical scenario. These are:

- The United States will be able to consolidate its position as global geopolitical hegemon.
- No competing major power will be able to emerge.
- The United States, cooperating with a set of close allies, will be able to keep destabilizing tendencies in other parts of the world from fundamentally undermining its position of dominance.

These assumptions are predicated on an extrapolation of military and economic trends that allow the US to hold, or regain, its dominance. Krauthammer and other advocates of this perspective assume that

dominance, once achieved, will continue unless the US loses the economic and political will to capitalize on its position.

Scenario 3: clash of civilizations

Samuel Huntington has been the most visible spokesperson for the clash of civilizations scenario, which raises the prospect of a growing divide between societies with fundamentally different religious traditions and historical experiences (Western, Islamic, Latin American, etc.) (1993, 1998, 2006). The key to these differences is that they carry with them contrasting views of such core matters as the meaning of progress, the nature of truth, and the place of humans in the larger order. According to Huntington, these differing visions are coming into ever-greater conflict in an increasingly globalizing world.

In this vision, the relations between states and groups from different civilizations will not be close and will often be antagonistic. Yet some inter-civilization relations are more conflict-prone than others. At the micro level, the most violent fault lines are argued to be between Islam and its Orthodox, Hindu, African, and Western Christian neighbors. At the macro level, the dominant division is between "the West and the rest," with the most intense conflicts occurring between Muslim and Asian societies on the one hand, and the West on the other. According to Huntington, the dangerous clashes of the future are likely to arise from the interaction of Western arrogance, Islamic intolerance, and Sinic assertiveness (Huntington 1996: 183).

The clash of civilizations scenario accords a significant position to states, but it is not strictly a state-based conceptualization as it acknowledges that civilization divides exist within states and can cut across state boundaries (Huntington 1998: 155–179). Indeed, the increasing salience of inter-civilization conflict is thought to be a product, at least in part, of the declining power of individual states in an era of economic globalization and institutional multilateralism. In a world of clashing civilizations, the key challenge for individual civilizations is to maintain a degree of political-ideological unity and avoid moral and cultural decline (Huntington 1998: 304).¹

¹ Huntington expresses significant concerns about the ability of the West to meet these challenges.

The territorial assumptions at the heart of the clash of civilizations scenario are:

- Current divisions within civilizational blocs will not increase.
- The interests of civilizational blocs will increasingly trump those of individual states.
- Interdependence among civilizational blocs will diminish.

These assumptions are predicated on an extrapolation of current patterns of conflict and cooperation. Proponents of the clash of civilizations thesis take the position that the major challenge to these assumptions will come from the ideological splintering of key civilizations into competing groups based on differing values, religious orthodoxy, cultural conceptions, and political orientations.

Scenario 4: interregionalism

Interregionalism is an umbrella term for a set of geopolitical ideas that are aligned with the multi-polar-world scenario, but that views world regions as potential key power nodes. Björn Hettne's (2004) paper on "interregionalism and world order" provides a useful overview of this way of thinking (see also Rusi 1997). According to Hettne:

A more appropriate form for the return of 'the political' in today's globalized world would be a post-Westphalian order, where the locus of power moves up the ladder to the transnational level by the voluntary pooling of state sovereignties.... However, from a realist perspective it needs institutionalization. The most likely candidate for such a role, although it does not appear to be imminent, is the interregional organization pursued by the EU, facilitating multiregional governance as the major alternative to unilateralism (2004: 2).

As the preceding quotation makes clear, this scenario is the most idealist of the four, but proponents such as Hettne see it as a realistic alternative—both because they view unipolarity as unsustainable and because they believe the EU has forged a model of "multidimensional, horizontal institutional arrangements" (Hettne 2004: 13) that has much broader potential appeal and applicability.

The interregionalism scenario moves beyond states as key power nodes, although it is still rooted in

regions that are assumed to be collections of states. The key issue for interregionalists is the capacity of strong regional blocs to provide some check on the unequal power relations that can come from unfettered neoliberalism. At the same time, interregionalists readily recognize that the EU is the only regional bloc that comes even close to functioning as a reasonably integrated economic actor, despite recent setbacks. They also recognize that making interregionalism the foundation for a new geopolitical order will be a long and difficult task. Those who see interregionalism as a realistic possibility, however, make the following territorial assumptions:

- The world can be divided into relatively discrete political-economic blocs.
- The EU model can provide a viable alternative to state-dominated regions and is exportable to other parts of the globe.
- Political-economic regional blocs will be able to confront major internal social and political divisions.

These assumptions focus attention on the institutional problems with integration in different world regions. The major challenges to interregionalism are seen as coming from the economic and political spheres.

Why climate change matters

While there is still disagreement over the role of humans in fostering climate change in the US—half of the incoming republican national legislators in 2010 were outspoken climate change deniers—there is general recognition in the scientific community that human-induced changes are already having far-reaching social and economic implications (IPCC 2001, 2007; Gleick et al. 2010; NRC 2002; Arrow et al. 1995). Several studies indicate that global average surface temperatures have increased at least 0.6°C over the twentieth century, snow and ice cover has decreased, global average sea-level has risen, and the heat content and acidity of the oceans have increased as a result of anthropogenic inputs (Gleick et al. 2008; IPCC 2007; US CCSP 2006). Beyond climate change, there is little dispute that a variety of human-caused environmental changes—land degradation and soil erosion, deforestation, pollution, and others—are

having a measurable impact on political and economic systems around the globe (McMichael 2009; Steffen et al. 2007; Stern 2007; Steffen et al. 2004; Crutzen 2002; Handmer et al. 1999; Odum 1989). If these issues have implications for the future of international political relations, then the far-reaching nature of potential changes in climate is surely worthy of consideration.²

Although forecasting tools for determining just how climate changes will affect human systems are in their infancy, global climate models are becoming increasingly refined and are giving us a clearer picture of where we are headed: global average temperature and sea level are projected to rise and the average global surface temperature is expected to increase from 1.1 to 6.4°C over the period 1990–2100, with continental interiors subject to more dramatic changes (IPCC 2007).³ Additionally, global precipitation is projected to increase during the twenty-first century, although some places will become drier even as others become wetter. Temperature shifts will likely alter El Niño and monsoon cycles, and foster more extreme weather events, including hurricanes and typhoons, floods and droughts (IPCC 2007). Climate change may also trigger additional natural greenhouse gas emissions, which could amplify warming (IPCC 2007). Moreover, most climate models show that these trends will be amplified during the coming decades, particularly since recent observations are confirming the worst-case scenarios projected by the Intergovernmental Panel on Climate Change (IPCC) (Richardson et al. 2009). While there is still tremendous uncertainty, or “unknown unknowns” in the climate system, we should expect to live in a warmer world, one where changes in rainfall, increasing storm severity and extreme events combine with rising sea levels, droughts, floods, acidifying oceans, changes in patterns of disease, and an overall loss of biodiversity to present new challenges for human adaptation

(Wilbanks and Kates 2010; Steffen et al. 2007; Stott et al. 2004).

Though climatic changes are inevitable in the long term, the risk of reaching tipping points that speed up or increase warming has become a core concern of recent studies (IPCC 2007; NRC 2010). There is growing worry that once certain thresholds are reached—lack of ice cover for example—warming may happen much more quickly, compounding the effects of increasing atmospheric concentrations of CO₂ and making intervention all but impossible. Recent attention has focused on the potential for catastrophic changes to follow in the wake of the thawing of huge areas of permafrost in the high latitudes that are capable of releasing massive amounts of methane into the atmosphere (Rockstrom 2009). Some estimates suggest that such “positive feedbacks” may increase warming an additional 1–2°C by 2060 (Füssel 2010), which could have dramatic and unpredictable consequences. Though there is disagreement in the scientific community about how quickly current and future emissions may contribute to climatic changes, a 4°C rise in temperature—which could be reached as soon as 2060 based on current rates of pollution and growth—has the potential to set in motion events that could seriously challenge future political and economic stability (Anderson and Bows 2008).

We know from recent studies of past civilizations that climatic shifts can have dramatic social and economic consequences (NAS 2010; Linden 2006; Burroughs 2005; Diamond 2005; Davis 2001; Fagan 1999; Ponting 1993), and scientists are fairly certain that changes can occur rapidly under certain circumstances (van der Leeuw 2008; NRC 2002). It would be naive to assume we are immune from the effects of these changes. Although firm conclusions about the future of the climate system must necessarily be limited and partial, it is clear that major alterations could create and aggravate insecurities for human societies worldwide (MEA 2005; Steffen et al. 2009; Steffen et al. 2004; O’Brien and Leichenko 2000). Climate change is predicted to have serious implications for economic growth and development, for example (Stern 2007; O’Brien and Leichenko 2000). The International Institute of Environment and Development concluded that when the full range of climate impacts is considered, the cost of adaptation could reach \$1,240 trillion (Parry et al. 2009). Places

² We rely on the distinction between the effects of climate change (sea-level rise, increases in storm severity, changes in weather patterns, etc.) and other environmental changes (deforestation, soil erosion, pollution, etc.), though many issues are invariably inter-related.

³ More recent studies suggest that Arctic ice is melting faster than expected and sea levels are likely to rise more than was predicted in the 2007 report (see e.g., Fussler 2009; Lenton et al. 2008).

far removed from the more direct negative effects of climactic changes will likely be affected due to the interconnectedness of social, political and economic systems.

To gain some understanding of the nature and scale of the political implications of climate change, it is instructive to consider the potential geographic impacts of a changing climate. Assessing these impacts is no easy task, as the effects of climate change are both difficult to predict and are associated with multiple overlapping processes, encompassing a wide variety of other environmental changes, including land degradation, soil erosion, and deforestation to name just a few (Karas 2003). Further, changes in climate are not exclusively territorial and may affect patterns and processes far removed from any local or regional alteration. There will certainly also be different effects at different scales—communities and individuals within a state, for example, will certainly experience climate change impacts in diverse ways. Yet some insights into the more general geopolitical implications of climate change can be gained by considering the potential geographical impacts of climate change on four matters of central importance to human society: the availability of fresh water, agricultural productivity, the viability of coastal areas in the wake of sea-level rise, and changes in shipping routes. Though certainly not the only issues of significance, changes in these specific factors are suggestive of the ways in which climate and other environmental changes could alter the foundations on which the geopolitical structures of the mid-to-late twenty-first century will be built.

Water availability

Increased global warming and the greenhouse effect are likely to alter the hydrological cycle in significant ways (IPCC 2007). The IPCC and other scientific bodies have concluded that global warming will likely increase both floods and droughts and alter the cycles of wet and dry seasons in certain areas of the world (2007: 32). These reports also show that parts of the globe are already facing freshwater shortages due to human-induced warming (IPCC 2007). Although global average precipitation is predicted to increase under conditions of warming, much of this increase will occur over the oceans, whereas large parts of the land surface will likely experience an overall

reduction in precipitation. In fact, recent studies suggest major and sustained periods of seasonal variability and drought for continental interiors under modest warming scenarios (IPCC 2007; Karl 2009). Combined with the increase in evaporation associated with higher temperatures, we can expect river runoff to decrease across continental areas in the mid-latitudes, threatening aquifer resources and accentuating the competition between human and ecological water needs (Nohara et al. 2006; see also Loa'iciga 2003). Looking at these shifts alongside other human-induced environmental changes such as deforestation and land-cover change, pollution loading, and urbanization, has led some analyst to estimate that, by 2025, 64% of the world's population will live in water-stressed basins or in areas experiencing water stress and shortages (Arnell 1999).

Over the next few decades, increasing human population and growing water use will put additional pressure on water resources in the drier inhabited regions of Africa, southern Asia, and the Middle East. Importantly, parts of the Middle East and Eastern South Africa are currently facing water-related demographic stress due to a variety of factors (e.g. arid conditions, high population growth rates, and environmental degradation) (IPCC 2007; Alcamo et al. 2007). While political and socio-economic variables may complicate the relationship between climate changes and resource use, changes in hydrological systems in water-stressed areas have the potential to disrupt economic development and strain social and political institutions (Dai 2011; Peluso and Watts 2001). When these disruptions are considered alongside other variables (environmental degradation and pollution, population growth, migration, resource conflicts within river basins, and so on), it becomes clear that changes in weather patterns leading to water stress could have significant geopolitical implications.

Recent research also suggests that if Earth's temperature rises by 7°F over the rest of this century, a billion people or more would have to be relocated and another three billion could suffer from inadequate access to water (Anderson and Bows 2008). Even though water has not always been a direct source of conflict in the past (see Wolf 1998), the implementation of response strategies (e.g., expansion of facilities, water-pricing policies, innovative technology, and informed management) could well be a vital element in attempts to mitigate future political instability

(Gleick 1998; Homer-Dixon 1994). Otherwise, significant areas could face economic depression, mass out-migration, and conflict over international borders and water rights. It follows that water-related issues are a tremendously important component of the geopolitical picture, and of course water is naturally tied to other spheres of human concern as well.

Agricultural systems

Many agricultural systems may face enormous adaptation challenges in the face of climate and other environmental changes, with large areas of cropland becoming unsuitable for cultivation or experiencing declining agricultural yields (Thornton et al. 2011). While it is difficult to know what, precisely, to attribute to climate change, and while agriculture is a dynamic, diverse, and adaptive sphere of human behavior, long-term studies of the relationship between climate and vegetation patterns provide a good indication of the potential impacts of warming and cooling on the ability to grow crops in different parts of the world (see Halweil 2005; Ager 1997; Reilly 1995). As an example, the US National Academy of Sciences suggests that for every rise of 1.8°F (1°C) above the norm, wheat, rice and corn yields will fall by ten percent globally (NAS 2010). Areas where agricultural vulnerability coincides with high levels of demographic stress (i.e., north coastal South America, northwest Africa, and parts of eastern China) are likely to face particularly acute challenges from warming and other climate-related changes.

One of the most serious impacts of rising temperatures on agriculture is the projected increase in extreme weather events, including heightened variability of rainfall and prolonged drought. Changes in precipitation patterns under modest warming scenarios would increase the proportion of the globe experiencing drought at any one time from today's one percent to thirty per cent by the end of the twenty-first century (Dai 2011; Anderson and Bows 2008). If current emissions paths continue, drought and desertification could become widespread, especially in the continental plains, where much of the world's grain is produced (Thornton et al. 2011). Droughts are not the only consequence of extreme weather, however. Floods can be equally destructive of agricultural systems (AIACC 2007).

At the same time, rising surface temperatures are what Lester Brown calls "the most pervasive

environmental threat to food security" (2009: 44). Increased weather variability and a greater frequency and intensity of extreme weather events may force large-scale shifts in agricultural practices (Anderson and Bows 2008). Coupled with the decline of healthy forests, wetlands, mangroves and salt marshes, and an acidified and potentially dysfunctional marine ecosystem, the global agricultural picture gets even bleaker (Dyer 2010). According to the IPCC, fifteen percent of the land currently suitable for cultivation globally would become unsuitable by the end of the century under current emissions scenarios, although this figure is more than balanced by the ability to cultivate areas that are currently too cold to support cultivation becoming suitable (IPCC 2007; see also Thornton et al. 2011).

There are certainly other agricultural challenges that are related to a changing climate, including loss of biodiversity, increased incidents of pests and vector-borne diseases, and changes in fish stocks and aquaculture. At the same time, some studies suggest that areas in the lower latitudes may actually improve in terms of agricultural productivity—for example, the Indonesian Archipelago as well as parts of South Asia actually may benefit agriculturally—at least initially—from climate changes (IPCC 2007). These studies suggest that the Midwestern US, parts of Eastern Europe, and some parts of the Amazon Basin are likely to see a decrease in overall productivity, but the consequences may be less severe as these areas are not under high demographic stress.

Nevertheless, the future relationship between climate and agriculture is clearly an important issue, particularly when considering predictions that half the world's population may face climate-driven food shortages by 2050 (Battisti and Naylor 2009). As Brown notes, "food shortages resulting from severe crop losses will occur more frequently and take longer to recover from as more people become vulnerable to extreme weather events like the droughts and flooding we see today in Russia and Pakistan" (Brown 2009: 19). As a result of food shortages, some estimates suggest that as many as fifty million new environmental refugees may be created by 2020 (Brown 2011a, b, 2009).

Even without climate change, some scholars believe food shortages are going to become a more common occurrence as human populations expand into areas without the capacity to meet growing

demand (Richardson et al. 2011; Brown 2011a, b, 2009). Recent unrest in the Middle East, which was triggered in part by rising food prices, provides insight into the types of challenges that can result from changes in agriculture (Brown 2011a, b). Areas likely to be hardest hit by changing weather patterns are those places that are already politically unstable and economically troubled (NRC 2010). The World Bank, for example, suggests that developing countries will need \$75–\$100 billion a year for the next 40 years to adapt to the effects of climate change on agricultural productivity, infrastructure, and disease in order to avoid large-scale catastrophes (2010: 47). The cost of climate impacts on agriculture alone may seriously overwhelm capacities and adaptation in other spheres. As Masters (2011:12) notes:

When we also consider the world's expanding population and the possibility that peak oil will make fertilizers and agriculture much more expensive, we have the potential for a perfect storm of events aligning in the near future, with droughts made significantly worse by climate change contributing to events that will cause disruption of the global economy, intense political turmoil, and war.

Summarizing the state of the future of human agriculture, Brown (2009: 50) argues that “Our continuing failure to deal with the environmental declines that are undermining the world food economy—most important, falling water tables, eroding soils and rising temperatures—forces me to conclude that such a collapse [of human societies] is possible.” While agricultural challenges are no doubt tied to issues beyond climatic changes, warming alone may have serious consequences for food security in many parts of the world and scenarios that fail to consider the impact of these large-scale shifts are notably deficient.

Coastal impacts

Meanwhile, global sea-level rise could produce significant impacts on populations living along or near coastlines and could cause chain reactions of migration and shortages that affect other areas. Recent work on the melting of the Greenland and Antarctic ice sheets (Pfeffer et al. 2008; Rapley 2006; Lowe et al. 2006) suggests that if current trends continue, a substantial rise in sea level is highly likely. In fact,

some studies indicate that as ice sheets melt, sea level changes will begin to increase at an accelerated rate (Steig et al. 2009). Moreover, there is considerable scientific evidence showing that an increase in ocean temperature could enhance cyclone intensity and frequency, contributing to increased storm surges and flooding (IPCC 2007; Kirshen et al. 2008; Henderson-Sellers et al. 1998), further affecting coastal communities.

As coastal mega-cities emerge in developing regions of the world, these areas will likely be fundamentally affected by sea-level rise. When one considers the coastal zones that lie in areas with relatively low levels of socio-economic development, it becomes clear that the potential impacts of sea-level rise could be devastating, particularly in parts of East Africa, Southeast Asia, and Central America. Such a development could have disastrous consequences for countries such as Bangladesh, much of which is barely above sea-level: the potential impact of a 1.5 meter sea-level rise on Bangladesh suggests that as many as 17 million people could be negatively affected (Mertz et al. 2009; Patz et al. 2005; see also Ali 1996). However, a series of studies found the largest number of people exposed to sea level rise live in China and the Philippines, with 64 million people inhabiting areas of flooding risk (IPCC 2007; see also Alcamo and Henrichs 2002; Vorosmarty et al. 2000).

Sea-level rise will not be an issue solely for less well-off parts of the world. One in-depth study on the effects of predicted climate change on freight transportation and shipping in the US concluded that coastal flooding would be the most serious and costly water-related impact of climate change (Colten 2009). Hurricane Katrina's devastation of New Orleans, Louisiana, in 2005 showed the potential consequences of coastal flooding, with implications that continue to plague the Gulf Coast years later. The consequences of similar events in parts of the world with higher coastal population densities and weaker coping mechanisms may be even more serious (Li 2003). Global sea-level rise will pose a special set of challenges for small island developing states (SIDS), many of which are no more than a few meters above sea-level (see IPCC 2007) As Pelling and Uittob (2001: 56) note:

Even modest rises in sea level are likely to result in significant erosion and submersion of land, increased flood hazard, salinization of

freshwater aquifers, and the loss of protective coral reefs and sand beaches, which will increase exposure to hurricanes and storm surges in the coastal zone where much biological diversity and most of the population, agricultural land and capital assets are located.

Not surprisingly, then, global warming has emerged as a particularly critical focus of concern for countries in this position, leading them to form the Alliance of Small Island States—an organization with a geopolitical agenda that unites the leaders of island states around the globe. Several island states are already considered “water scarce nations” (e.g. Barbados and the West African Islands) (Pelling and Uittob 2001), and the Maldives has become the first carbon-zero state. Economies centered on natural resource exploitation (agriculture, fisheries, tourism, etc.) put small island states in a position in which climate change will not only increase hazard risk but also erode the economic, resource, and even territorial basis of these states. Further, the implications of absorbing populations, or even entire states, forced to move because of rising tides, could have profound implications for the contemporary geopolitical calculus.

Shipping routes and polar resources

The primary shipping routes in the world today are in the mid and low latitudes. However, recent years have seen a steady decrease in the amount of Arctic sea ice—contributing to the possibility that the waters off the north coasts of Canada and Russia could become avenues for shipping raw materials (notably oil) in the summer months. The National Snow and Ice Data Center has predicted a seasonally ice-free Arctic by 2060; more current research suggests the date could be as soon as 2013 (Maslowski and Clement Kinney 2009), or perhaps somewhere in the middle at 2030 (Overland and Wang 2009). The two most important implications of an opening Arctic are improved access to vast energy and mineral resources and shorter maritime shipping routes.

Shorter shipping routes can dramatically alter resource flows and contribute to a shift in economic and political power. Transiting the Northern Sea Route above Russia between the North Atlantic and the North Pacific would trim some 5,000 nautical miles and a week’s sailing time off a trip compared with the

use of the Suez Canal. Traveling between Europe and Asia through Canada’s Northwest Passage would trim roughly 4,000 nautical miles off a trip that made use of the Panama Canal. Further decreases could have an impact on the relative position and stature of Canada and Russia in relation to global movements of commodities. The route from the North Sea to Alaska is the longest and among the most costly under current Arctic conditions, yet it is potentially the shortest and least costly under predicted warming scenarios. Since today’s shipping routes are fundamental to current geopolitical configurations, changes in these routes could significantly alter current models.

The implications of melting Arctic ice go beyond the movement of vessels on the world’s oceans. The US Geological Survey has estimated that a quarter of the world’s oil and natural gas reserves lie beneath the Arctic Ocean (Bethge 2006), and a recent issue of *Science* updated these numbers to 30% of the natural gas and 13% of oil (Gautier et al. 2009). If the thaw continues at current rates, excavation and drilling could soon become financially viable.

In the current geopolitical environment, Norway and Russia are already at odds over drilling rights in the Barents Sea. According to several studies, Arctic resource benefits are likely to begin to materialize by 2025 (NIC 2008) and the US National Petroleum Council has said that some of the technology to exploit oil from the heart of the Arctic region may be ready by 2050 (Parsons 2010). The size of the Russian Shtokman gas field alone is estimated at 3.2 trillion cubic meters, making it one of the largest known deposits in the world (Bethge 2006). The region’s gas could soon be processed in the northern hemisphere and transported to Europe and North America, fundamentally altering power balances in relation to current oil-rich regions in Asia and the Middle East. Nonetheless, these potential riches and advantages are already perceptible to the United States, Canada, Russia, Denmark, and Norway, as evidenced by the emergence of competing territorial claims, such as those between Russia and Norway, and Canada and Denmark (NIC 2008; Berkman and Young 2009).

Although serious near-term tensions could result in small-scale confrontations over contested claims, we should not assume the Arctic would be a site of major armed conflict. Circumpolar states share a common interest in regulating access to the Arctic by hostile powers, states of concern, or dangerous non-state

actors, as well as by their shared need for assistance to exploit the Arctic's resources. The greatest strategic consequence over the next couple of decades may be that relatively large, wealthy, resource-deficient trading states such as Japan, South Korea, and even China will benefit from increased energy resources provided by an opening of the Arctic and by shorter shipping distances (NIC 2008: 53). As with changes to any of these spheres of interest, there are likely to be both costs and benefits. A key issue for the future, then, is how the international system will respond to these fluctuations.

Implications for geopolitical scenario-planning

What, then, are the specific implications of climate changes for the dominant geopolitical scenarios outlined above? The relevance of such a question comes into focus when one considers how many of the territorial assumptions underlying the major competing scenarios could be altered if the current trends continue. While predicted changes in climate are largely from the burning of fossil fuels and other activities globally, the effects of these changes will likely be felt nationally, regionally, and at more local and individual levels—with implications for each of the geopolitical scenarios set forth above. Consider, for example, the following assumptions, which either are leading propositions behind one of the scenarios reviewed earlier in this article, or are ideas that cut across more than one of those scenarios:

1. China and India will expand their global influence (the multi-polar order scenario)
2. The US or another state will dominate (the uni-polar order scenario)
3. No major regional destabilizations will disrupt expected trends (all of the scenarios)
4. No new major power centers will emerge (the uni-polar order and clash of civilization scenarios)
5. Divisions within major regions will diminish (the clash of civilizations and interregionalism scenarios)

1. The assumption that China and India will continue to move ahead is premised on an extrapolation of current economic and demographic developments. If we continue on our present emissions output, scientists predict more flooding and more droughts,

which would increase malaria transmission and potentially cripple the agricultural sector, a key source of livelihood for India's 1.3 billion people (Smith et al. 2007). Both China and India could face significant agricultural challenges in their agriculturally productive plains as a consequence of climate change. And climate changes may well interact with other variables that are increasingly the vulnerability of agricultural areas in India, China and other parts of the world (Leichenko and O'Brien 2008).

The impacts of climate change on fragile livelihoods in newly industrializing economies may be particularly dramatic, where demographics alone—the size and concentrations of population centers in China and India, for example—may present serious problems if agricultural sectors fail. One recent UN report estimated that 350 million people will move from rural to urban areas globally in the next two decades (UNFPA 2007), two-thirds within China and India. Migration on that scale could impede economic growth, heighten internal tensions, and interfere with efforts to extend the political and economic reach of these countries in ways that are unanticipated by the multi-polar-order geopolitical scenario.

Further, a report by the World Bank predicts “catastrophic consequences for future generations” in China unless water use and supply can quickly be brought back into balance.

China's grain production has already begun falling due to minor climatic changes, and some suggest that massive grain imports may be inevitable to sustain the population (Brown 2011a, b). At the same time, farmers in India are potentially even more vulnerable. A World Bank study reported that 15 percent of India's food supply is produced by mining groundwater, which is being depleted rapidly and is already gone from nearly half the wells in many states (INCCA 2011). As the Indian Climate Change Assessment report suggests, “175 million Indians consume grain produced with water from irrigation wells that will soon be exhausted. The continued shrinking of water supplies could lead to unmanageable food shortages and social conflict” (ibid.). These climate-related issues raise broader questions about the stability of China and India within multi-polar scenarios, and about the stability of other individual states in most other scenarios.

2. The assumption that the United States can maintain its position of dominance is premised on

the idea that it can regain its international economic primacy and continue to finance its large military. Yet climate change scenarios suggest the US could face significant agricultural challenges in the Midwest as a consequence of global warming, and the combination of sea-level rise and storm intensification could produce significant and costly coastal flooding problems in the East and Southeast. A recent study suggests the US Gulf Coast could lose \$350 billion dollars if it fails to address the effects of climate change by 2030 (USGS/WDD 2010). Furthermore, the American Medical Association recently released a statement pointing to the large-scale challenges already affecting public health, including changes in patterns of disease and extreme temperatures as a consequence of climatic changes (USGRP—United States Global change Research Group). This report suggests that future changes in climate may cripple an already ineffective health system. Internal challenges of this sort may already be undermining any potential for the unilateral projection of American power. Combined with climatic and other environmental changes, the dominance of the US or any other single unilateral state power is in question. Instead, we may have entered a period requiring multi-lateralism due to the sheer complexity and interconnectedness of environmental, economic and political issues, making uni-polar scenarios effectively untenable.

3. Many geopolitical scenarios focus on economic, political, and ideological trends, with little consideration given to the potential impacts that large-scale regional crises might have outside the projected power centers. Yet models of the effects of global warming suggest that agriculture, water, and coastal flooding problems could overlap to produce serious destabilizations in North and East Africa, Central America and Southwest Asia. Because of interdependencies built into the global system, these could spill over into other territories and regions, and may already be adding to uneven development trajectories in a manner that could fundamentally challenge all of the geopolitical scenarios outlined above. Additional water stress in conflict-prone areas, such as Kashmir for example, may further complicate diplomatic processes and add additional challenges to peaceful resolution of disputed boundaries in South Asia. While large-scale predictions are necessarily speculative, climate and other environmental changes may indeed have major implications for the spatiality of global politics

broadly through a destabilization of entire regions. Put differently, if the worst-case predictions for climate change become a reality, the impact on social and political institutions make geopolitical stability in any scenario much more difficult to predict.

4. The uni-polar and clash of civilizations scenarios pay relatively little attention to evolving potential nodes of power; instead they are sketched against the backdrop of current or rapidly emerging power centers and geopolitical fault lines. Yet the combination of agricultural expansion and the development of new shipping lanes in the Arctic, for example, could significantly benefit Russian agriculture while facilitating the export of that country's rich mineral and fossil fuel wealth from its northern and eastern reaches (Borgerson 2008). Such a development could markedly alter Russia's current position in the global geopolitical matrix—potentially returning it to a position that is largely unanticipated in any of the geopolitical scenarios currently competing for attention. Other unforeseen benefits of climatic changes—longer growing seasons, additional rainfall and transportation routes opening due to lack of ice cover in certain areas may all contribute to shifts in power not currently recognized in current geopolitical imaginations. Further, emerging blocs that result as states or regions fail or succeed could force a re-invention of current geopolitical circumstances. Events that inspire major geopolitical shifts, such as the fall of the Soviet Union in 1991 or the attacks on the World Trade Center in 2001, or even the recent uprisings across the Middle East, are often difficult to predict. Indeed all of the scenarios mentioned above may turn out to be seriously flawed given significant changes in the international system resulting, in part, from a dynamic physical environment.

5. The two geopolitical scenarios focused on the potential primacy of large-scale regional blocs in international affairs (the clash of civilizations and the interregionalism scenarios) foresee a global dynamic in which inter-regional differences trump intra-regional differences. Yet when one looks at several of the key regional nodes in either scenario—notably Sub-Saharan Africa, South Asia, and East Asia—it becomes clear that a changing climate could introduce significant intra-regional challenges. Can non-Islamic Sub-Saharan Africa maintain any kind of meaningful unity in the face of significant environmental stresses? A recent study focusing specifically on the effects of

climate change in Sub-Saharan Africa (SSA) concluded that:

Already today, the number of people at risk from hunger has never been higher: it increased from 300 million in 1990–700 million in 2007, and it is estimated that it may exceed 1 billion in 2010... Croppers and livestock keepers in SSA have in the past shown themselves to be highly adaptable to short- and long-term variations in climate, but the kind of changes that would occur in a 4°C+ world would be way beyond anything experienced in recent times... it is not difficult to envisage a situation where the adaptive capacity and resilience of hundreds of millions of people in SSA could simply be overwhelmed by events (Thornton et al. 2011).

Moreover, how will South Asia deal with water shortages that affect part, but not all, of the region? Questions such as these have important implications for assumptions of intra-regional unity that underlie the clash of civilizations and interregionalism scenarios. The point is that predicted changes in stability due to climate and other environmental stressors may make regional unification in parts of the world considerably less likely.

Analysis: geopolitical futures

The previous discussion highlights some of the key challenges that are likely to follow if current emissions trends and resulting climate changes continue. The combination of a growing global population, rapidly expanding industrialization in parts of the world, and little international consensus on how to reduce greenhouse gasses makes such a continuation distinctly possible. Moreover, the release of increasing levels of greenhouse gasses into the atmosphere could produce changes in environmental systems that create multidimensional, interconnected disruptions (Nordås and Gleditsch 2007). Much like the thresholds or tipping points that are present in most physical systems, human cultural, economic and political systems may also be susceptible to nonlinear, overlapping effects or “double exposures” (Lenton et al. 2008; O’Brien and Leichenko 2000) that lead to compounding insecurities. Droughts, flooding, increasing storm severity, rising sea levels, and

changing rainfall patterns are some of the alterations that could have multiple, synergistic impacts on agriculture, public health, disease prevalence and ecosystem services. Under the circumstances, a conception of geopolitics built on assumptions of a static physical environment no longer makes sense.

Even leaving aside the implications of worst-case scenarios, the potential geographical implications of future disruptions demonstrate the need for a new approach to geopolitical planning and scenario-making. We are likely headed into an era in which new questions of responsibility, liability and justice will be raised—questions that will blur traditional foreign/domestic policy distinctions resulting from new or dynamic geopolitical instabilities (Dalby 2003, 2006; Halden 2007). Even individuals spatially removed from areas experiencing the greatest vulnerabilities may be susceptible to disruptions to networks of trade and communication on a global level (Suhrke 1997). Estimates of human migration from sea-level rise alone could result in regional or even global destabilizations: there already may be as many as twenty million climate refugees around the world, and that number could well rise to more than 200 million in the next several decades (Pascal 2010; McLeman and Smit 2006).

Studies in the field of “Environmental Security” have shown that conflict and environmental issues are interrelated. Research in this field suggests that changes in climate specifically may degrade ecosystems to the point where the resource base of those communities, or even entire societies, is threatened (Swart 1996; Homer-Dixon 1991; Duedney and Matthews 1999; Alker and Haas 1993; Dalby 2002; Schwartz et al. 2000; Peluso and Watts 2001). Homer-Dixon’s examination of the links between conflict and environmental degradation shows that, while not responsible for full-scale wars, resource shortages can promote destabilizing levels of social unrest, ethnic violence and economic turmoil (see e.g., 1991; 1994; 1998; 2003). Lack of food, water and/or shelter has precipitated social unrest, leading to political upheaval in particular cases—a point reinforced by a recent study (Hsiang et al. 2011) demonstrating a statistical relationship between civil conflict and global climate change. Correlation does not equal causation, of course, and we should be suspicious of single-variable explanations of social unrest—even climate stress does not necessarily translate directly into political instability—but to dismiss climate

change as a variable is to ignore a set of important, diverse and overlapping threats that will likely put pressure on human societies globally (Purvis and Busby 2004; Young and Steffen 2009).

At the same time, focusing on the destabilizing implications of climate change should not blind us to the possibility that parts of the world may benefit from a changing climate. Some areas may gain significantly from improved agricultural productivity or the opening of the Arctic due to a loss of ice. It follows that the geopolitics-climate change relationship should not be oversimplified. Indeed, the implications of climate changes on the geography of power are inevitably mediated by economic, political, and demographic factors at multiple levels (Tol 2002). Moreover, the task of considering the consequences of climate change is complicated by many uncertainties on both sides of the equation. Framing the effects of climate change in broad geopolitical terms may hide specifics, such as the influence of the local environment and adaptive strategies of individuals, households, communities and actors at other levels of intervention and engagement.

Yet these complexities should not keep us from bringing the changing physical environment into our geopolitical assessments. In a world inhabited by nearly seven billion people, more than one billion of whom are impoverished (Collier 2008), we no longer have the luxury of pushing questions of the global effects of environmental change to the side. Environmental changes—including fluctuations in climate—are clearly important to the future global affairs. At the very least they point to a more complicated and unpredictable geopolitical environment than is often imagined.

What is needed, in short, is a new approach to scenario-planning in geopolitics—one that treats the changing environment as a central concern rather than as an exogenous, unchanging variable. Efforts to anticipate or predict how the future of international relations might unfold must consider what a majority of climate scientists and security experts already know—that we are entering a world of greater unpredictability and uncertainty as a result of human-induced changes. While climatic changes will certainly affect individuals and communities differently, the sheer range and scale of the potential consequences of a changing climate demands attention in any serious effort to imagine the geopolitical future. In a recent speech, the UK Secretary for Climate and Energy stated that,

“Climate change will affect our way of life—and the way we order our society. It threatens to rip out the foundations on which our security rests” (Huhne 2011). Huhne’s point is increasingly echoed by those looking at how climate change may affect international security. It provides a specific example of Dalby’s (2007) larger suggestion that since we are now in the “Anthropocene”—an era of human dominance over the environment—we need to consider the effects of our manipulation of the natural world on our systems and institutions, including our imaginations of the future (im)balance of world political power. Linking climatic change predictions with widely deployed geopolitical frameworks represents one important step toward addressing that challenge.

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