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The Strategic Implications of Climate Change

Alan Dupont

On 17 April 2007, the United Nations Security Council deliberated on the political and security implications of climate change, a geophysical phenomenon far removed from the traditional preoccupations of international security. Sceptics branded the debate as an unwarranted diversion from more urgent matters and argued that climate change ought to remain the preserve of environmental agencies.[1] But this view is not shared by an increasing number of influential policymakers and practitioners, who accept that unmitigated climate change will have profound consequences for global security. They include Nobel Prize winner and former US Vice President Al Gore, French President Nicolas Sarkozy, German Foreign Minister Frank-Walter Steinmeier, Australian Prime Minister Kevin Rudd and the former and current British prime ministers Tony Blair and Gordon Brown. While still in office, Blair observed that 'there will be no genuine security if the planet is ravaged by climate change'. His chief climate-change adviser, Sir John Houghton, believes that climate change is 'a weapon of mass destruction' and at least as dangerous as international terrorism,[2] a view shared by Rudd's Federal Police Commissioner Mick Keelty, who sees climate change as 'the security issue of the 21st century'.[3] Underlining this shift in sentiment, the European Union's Commissioner for External Affairs, Benita Ferrero-Waldner, declared that global warming has moved to the heart of Europe's foreign policy, while Steinmeier characterised climate change as 'a

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threat to world-wide peace and security', warning that as the polar ice melts rival territorial claims in the Arctic could turn into a 'cold war'.[4]

Hard-headed military and intelligence analysts around the world are also beginning to focus on climate change as a serious strategic issue. In 2002, Andrew Marshall, the long-time head of the US Department of Defense's Office of Net Assessments and arguably the most influential thinker in the Pentagon over the past three decades, commissioned a report by two consultants to explore the security implications of an abrupt-climate-change event.[5] Although shelved by climate-change sceptics in the George W. Bush White House, this path-breaking analysis was followed by a 2007 study reflecting the views of a dozen retired senior US military officers which found that climate change is both a 'threat multiplier' and 'a serious threat to America's national security'.[6] Both the US Central Intelligence Agency and Australia's main intelligence assessment agency, the Office of National Assessment, completed classified reviews of the climate-change threat to national and international security in 2008.

Why has climate change suddenly metamorphosed from a boutique environmental concern to a first-order foreign-policy and national-security problem that is now being ranked alongside terrorism and the proliferation of weapons of mass destruction? The answer is that sceptics have lost the argument about the significance and consequences of global warming. Policymakers around the world now accept there is sufficient scientific data to conclude that the speed and magnitude of climate change in the twenty-first century will be unprecedented in human experience, posing daunting challenges of adaptation and mitigation for all life forms on the planet. Climate scientists overwhelmingly agree that the world's glaciers and northern ice cap are melting at accelerating rates and that sea-level rise will threaten many coastal and low-lying areas. And they regard as virtually certain that there will be a doubling of carbon dioxide (CO_2) concentrations over pre-industrial levels this century regardless of what we do to contain or reduce greenhouse-gas emissions.[7]

As a result, sea-levels are projected to rise by between 0.18 and 0.59 metres this century and the Earth's surface will almost certainly warm by more than 2.0°C, which is widely accepted as the threshold above which managing the

risks becomes progressively more difficult and the consequences more dangerous.[8] The central problem is the rate at which temperatures are increasing rather than the absolute size of differential warming. Spread over several centuries, or a millennium, temperature rises of several degrees could probably be managed without political instability or major threats to commerce, agriculture and infrastructure. Compressed within the space of a single century, global warming will present formidable problems of human and biological adaptation, especially for natural ecosystems which typically evolve over hundreds of thousands to millions of years. Without effective mitigation and adaptation strategies, a rapidly warming planet presents palpable geopolitical risks for all countries, increasing national vulnerabilities, exacerbating inter-state tensions and threatening the very survival of some societies.

Climate change has always been linked to security. There are many historical examples of climatic shifts or extremes of weather triggering conflict and even contributing to the rise and fall of civilisations and nations.[9] Growing aridity and frigid temperatures from a prolonged cold snap caused Huns and German tribes to surge across the Volga and Rhine into the Roman Empire during the fourth and fifth centuries CE, eventually leading to the sack of Rome by Visigoths. Muslim expansion into the Mediterranean and southern Europe in the eighth century was to some extent driven by persistent drought in the Middle East. The Viking community in Greenland died out in the fifteenth century partly because of a sudden cooling of temperatures across northern Europe known as the 'Little Ice Age'.[10] And a changing climate may have been responsible for the collapse of China's Tang dynasty and the disappearance of the Mayan world in Central America a thousand years ago.[11] For the most part, however, these climatic shifts were relatively short lived and far less significant than those in prospect. In a world already populated by 6.5 billion people, a figure projected to reach 9bn by 2050, large deviations from global or regional weather norms, particularly if they occur within the span of a single human generation, would be far more dangerous.[12]

Food and water scarcity

Weather extremes and greater fluctuations in rainfall and temperatures have the capacity to refashion the world's productive landscape, especially at a

time of rising populations in the developing world and concerns that the green revolution of the twentieth century may have largely run its course. Crop yield increases have levelled off since the 1990s and increases in the frequency of extreme weather events, such as cyclones, riverine flooding, hail and drought will disrupt agriculture and put pressure on prices.

If the gap between global supply and demand for a range of primary foods narrows, price volatility on world markets is likely to increase and will be exacerbated by the reduction in food stockpiles mandated by the implementation of the 1994 World Trade Organisation's Uruguay Round agreement. The world's food stocks are already at historical lows due to a combination of rising demand and crop substitution. Much corn is now converted to ethanol for biofuels, rather than being used for human and animal consumption, and productive farmland is being lost due to environmental degradation and urbanisation. Without the moderating influence of substantial grain stocks, a confluence of unfavourable political and economic influences, aggravated by climate change, could create local scarcities, sparking food riots and domestic unrest. If sustained, reduced crop yields could seriously undermine political and economic stability, especially in the developing world.

The world's food stocks are already at historical lows

Of course, doomsayers have long warned of an approaching food deficit and been proved wrong. Most food economists believe that global supply will be able to keep ahead of rising demand. But their assumptions have not adequately factored in the impact of climate change, especially the shift in rainfall distribution, rising temperatures and the probable increase in extreme weather events. Nor have they accounted for the fact that agricultural yields are heavily dependent on high fertiliser use, which links food production to climate change through the energy cycle. The need to achieve greenhouse-gas reductions will increase energy costs, making it more difficult to maintain the per capita food yield gains of the previous century.

Rising sea levels will inundate and make unusable fertile coastal land, and potential changes in the strength and seasonality of ocean currents will cause fish species to migrate and disrupt breeding grounds. Non-

commercial fisheries are likely to decline as coral bleaching takes hold, and the movement of deep-water fish may become more unpredictable, compounding the problem of over-fishing and diminishing global supplies of wild fish. Oceans have already absorbed about half the 800bn tonnes of carbon dioxide humans have pumped into the atmosphere since industrialisation, which over time has increased ocean acidity and further degraded the marine ecosystem.[13] As carbonate ions in the seas disappear because of increased acidity, tiny marine snails and krill at the bottom of the food chain that are the primary source of food for whales and fish could be decimated, possibly within decades.[14]

Changes in the variability and distribution of rainfall could also exacerbate fresh-water scarcity in water-deficient states. In a world where over 2bn people already live in countries suffering moderate to high water stress, and half the population is without adequate sanitation or drinking water, relatively small shifts in rainfall patterns could push countries and whole regions into deficit, leading to a series of water crises with global implications. In Asia, per capita water availability has already declined by between 40% and 65% since 1950.[15] By 2025, some 5bn people globally could be suffering from serious water shortages, half a billion of them due to climate change.[16] It is not yet possible to accurately forecast detailed precipitation changes at the national and sub-national level. However, it is clear that countries which are already water deficient will be most at risk, as rainfall patterns shift and become more variable.

The melting of the Tibetan glaciers illustrates the nexus between climate change, water scarcity and geopolitics. By China's own estimates, the glaciers on the Tibetan plateau are melting at a rate of about 7% a year.[17] Hundreds of millions of people are dependent on the flow of glacier-fed rivers for most of their food and water needs, as well as transportation and energy from hydroelectricity. Initially, flows may increase, as glacial run-off accelerates, causing widespread flooding. Within a few decades, however, water levels are expected to decline, jeopardising food production and causing widespread water and power shortages with potentially adverse consequences for India, Bangladesh, China, Myanmar, Thailand, Laos, Cambodia and Vietnam.

With less fresh water available to slake the thirst of its booming population and economy, China has redoubled its efforts to redirect the southward flow of rivers from the water-rich Tibetan plateau to water-deficient areas of northern China. The problem is that rivers like the Mekong, Ganges, Brahmaputra and Salween flow through multiple states. China's efforts to rectify its own emerging water and energy problems indirectly threaten the livelihoods of many millions of people in downstream, riparian states. Chinese dams on the Mekong are already reducing flows to Myanmar, Thailand, Laos, Cambodia and Vietnam. India is concerned about Chinese plans to channel the waters of the Brahmaputra to the over-used and increasingly desiccated Yellow River. Should China go ahead with this ambitious plan, tensions with India and Bangladesh are likely to rise, as existing political and territorial disputes[18] are aggravated by concerns over water security.

Heightened energy insecurity

In addition to its negative impact on food and water, climate change is heightening concerns about future supplies of energy, complicating energy choices by adding to the costs of production and usage. Coal, for example, is relatively abundant but also highly polluting. Fossil fuels are responsible for nearly 80% of the anthropogenic greenhouse gases that are the major cause of planetary warming.[19] Even if emissions from fossil fuels are stabilised at 1990 levels, as required by the Kyoto Protocol, greenhouse gases will continue to rise for the rest of this century, further heating up the planet. We know this because the increase in greenhouse gases can be extrapolated from current fossil-fuel usage and rates of deforestation.

In 1990, global emissions of carbon dioxide, the main greenhouse gas, totalled 5.8bn tonnes of carbon equivalent, which in a business-as-usual scenario will rise 34% to 7.8bn tonnes by 2010. If every signatory to the Kyoto Protocol reaches its pledged target, an unlikely eventuality since only two countries, the United Kingdom and Sweden, are within their agreed targets, the increase would still be the equivalent of 7.3bn tonnes.[20] This small reduction would be more than offset by the rise in emissions from developing countries, notably China and India, which are exempt from emissions

targets under Kyoto but have been reluctant to endorse a successor agreement for fear that signing up to mandatory targets would set back their economic growth. Almost all nations anticipate growth in energy usage in the coming decades. The International Energy Agency forecasts that the world's primary energy needs will grow by 55% between 2005 and 2030 with fossil fuels accounting for 84% of the increase, which will dramatically push up greenhouse-gas emissions in the absence of mitigating strategies.[21] Thus, at the very time the world's appetite for energy is growing exponentially, the environmental cost of using fossil fuels may be a greater, long-term constraint than their availability.

Climate change is also forcing a major reassessment of the utility of nuclear power, once seen as the energy choice of last resort because of its tarnished public image as a dangerous and dirty fuel. Since nuclear power only emits about 25 grams of carbon dioxide equivalent per kilowatt hour, compared with around 450–1,250g for fossil fuels, it is the one source of virtual carbon-free energy that can make a substantial difference to energy supply in the short to medium term.[22] Critics maintain that switching to nuclear power in order to reduce greenhouse-gas emissions is misguided and merely replaces one problem with an even more serious one: the proliferation of plutonium and enriched uranium which can be used for manufacturing nuclear weapons. They contend that safely storing and protecting this material from terrorists and criminal groups intent on acquiring weapons-grade material for use or profit is problematic, and the political and security risks too high.

The world is already awash in nuclear material

But the security consequences of unmitigated climate change outweigh the risk of terrorists or rogue states acquiring nuclear material from expanded global stockpiles. The world is already awash in nuclear material, much of it stored in unsafe temporary storage sites located near nuclear reactors. Even if all the nuclear power plants in the world were to be shut down tomorrow and every nuclear weapon dismantled, the accumulated waste of half a century would still have to be isolated, safeguarded and eventually disposed of, either in underground repositories or, less desirably, by reprocessing. Arguing against nuclear power on the grounds of safety does little to

address existing problems of waste disposal or proliferation, and even less the issue of climate change.

One aspect of the interrelationship between climate change and energy security that has received scant attention is the impact the submergence of small atolls, rocks and low-lying islands due to sea-level rise could have on the Exclusive Economic Zones (EEZs) of maritime states and disputed seabed resources, including oil and gas. This is a critically important issue since small rocks and islets are commonly used to delineate maritime boundaries and to claim vast tracts of ocean which would otherwise fall outside the EEZs of contiguous states or be designated high seas, opening them up to exploration and exploitation by other nations. International law currently provides no answer to the question of what would happen to sovereignty and EEZ claims should an island, or even a country, be submerged.[23] In the event of significant sea-level rise, the low-water marks from which EEZs are measured would shift, raising the real possibility of serious, new maritime disputes as states argued about the criteria for resetting base lines and re-designating EEZs as high seas.

In Asia, rising oceans could make more difficult the resolution of disputed sovereignty claims in the Spratly Islands, a group of low-lying atolls in the South China Sea which sit astride potentially rich deposits of oil and have already been the scene of military tensions between and among China, Vietnam and the Philippines. Some of these islands are already partially submerged and the highest (Southwest Cay) is only 4m above sea level.[24] Beijing has challenged the island status of Okinotorishima, a small offshore islet claimed by Japan at the southernmost part of the archipelago that is uninhabited and slowly sinking, and is the basis for Japan's claim to an extended EEZ. Under Article 121 of the United Nations Law of the Sea Convention, islands classified as 'rocks' are not entitled to a 200 nautical mile EEZ, unless they are capable of sustaining human habitation and economic life. Japan has already attempted to increase the size and height of Okinotorishima by planting coral around the islet, while some of the claimants to the Spratlys have built large concrete structures grafted onto submerged, naturally occurring coral, which house small military garrisons.[25]

Warming seas, as a consequence of climate change, are also making it possible to exploit previously inaccessible energy resources under the polar ice caps, threatening what has been characterised as a new 'gold rush', with claimant states jostling for the rights to exploit potentially rich deposits of oil, gas and minerals on the seabed. The potential for conflict was dramatically brought home by Russia's successful and highly publicised planting of its national flag on the Arctic seabed on 2 August 2007 by two small submersibles, an act that was lauded as 'heroic' by Moscow but condemned by other claimants, notably Canada, which compared the Russian action to a fifteenth-century land grab.[26] Many climate scientists believe that late-summer Arctic ice could disappear entirely by 2060, which would make the exploitation of Arctic resources technically feasible and therefore more likely, unless the five claimant states – Russia, the United States, Canada, Denmark and Norway – can reach an accommodation.[27]

Infectious disease

Climate change will have a number of serious health-related impacts, including illness and death directly attributable to temperature increases, extreme weather, air pollution, water diseases, vector- and rodent-borne diseases and food and water shortages. 1.7m people die prematurely every year because they do not have access to safe drinking water, and the situation will worsen if waterborne pathogens multiply as a result of rising temperatures.[28] But the greatest security risk is from infectious disease. Temperature is the key factor in the spread of some infectious diseases, especially where mosquitoes are a vector, as with Ross River fever, malaria and dengue fever. As the planet heats up, mosquitoes will move into previously inhospitable areas and higher altitudes, while disease transmission seasons may last longer. A study by the World Health Organisation has estimated that 154,000 deaths annually are attributable to the ancillary effects of global warming due mainly to malaria and malnutrition. This number could nearly double by 2020.[29] Currently, some 40% of the world's population lives in areas affected by endemic malaria.[30]

Extreme weather events and climate-related disasters could lead to short-term disease spikes because of the damage to food production, popu-

lation displacement and reductions in the availability of fresh water. Poorer nations with limited public health services will be especially vulnerable.[31] Health problems can quickly metamorphose into a national-security crisis if sufficient numbers of people are affected and there are serious economic and social consequences, as occurred during the devastating flu pandemic of 1918–19 which killed from 40–100m people.[32] Climate change does not automatically or always provide a more favourable environment for the spread of infectious diseases, since transmission rates and lethality are a function of many interrelated social, environmental, demographic and political factors, including the level of public health, population density, housing conditions, access to clean water and the state of sewage and waste-management systems, as well as human behaviour. All these factors affect the transmission dynamics of a disease and determine whether or not it becomes an epidemic. But where climate is a consideration, temperature, relative humidity and precipitation will affect the intensity of transmission. Temperature can influence the maturation, reproductive rate and survivability of the disease agent within a vector, or carrier.[33] So climate change will alter the distribution of the animals and insects which are host to dangerous pathogens, increasing or decreasing the range of their habitats and breeding places.

More frequent severe natural disasters

Natural disasters seem set to climb in line with the warming of the planet. To be sure, the impact of natural disasters may rise for reasons other than climate change: population growth, higher levels of capital investment and migration to more disaster-prone areas. But the insurance industry is adamant that the rise in the number of extreme and damaging climatic events is a significant driver of the upward trend.[34] Around 188m people were adversely affected by natural disasters in the 1990s, six times more than the 31m directly or indirectly affected by war.[35] While such statistics must be treated with caution since they are not yet sufficiently robust to enable definitive judgements about cause and effect, they do suggest an upward trend in extreme weather events. Scientists are divided about whether this change is due to natural fluctuations or global warming, although the differ-

ences are partly explicable by the rigorous scientific tradition which requires a higher level of certainty than do intelligence and national-security analysis when considering risk. However, there is clearly a strong correlation between the steady rise in ocean temperatures attributable to anthropogenic greenhouse-gas emissions and the demonstrable increase in storm frequency and intensity.[36]

Hurricanes feed off warm water as trade winds blow over the ocean surface, pulling heat from the water as energy. Typically, large storms require ocean temperatures of 27°C, conditions which are now occurring much more regularly as tropical waters heat up. The strength of category 4 and 5 storms is a direct consequence of these warmer ocean temperatures. Storms of this magnitude have a clear security dimension because of the death and destruction they bring in their wake and the political, economic and social stresses they place on even the most developed states.

Storms of this magnitude have a clear security dimension

Defence forces often bear the brunt of major emergency and humanitarian operations as they are usually the only organisations with the resources and skilled personnel necessary to respond quickly and effectively to natural disasters. When Hurricane Katrina devastated New Orleans in August 2005, a full US Army division, the famed 82nd Airborne, was called in to restore order and assist in emergency relief. The devastation was described by Mississippi Governor Haley Barbour as akin to the detonation of a nuclear weapon and President Bush compared its impact with the terrorist attacks on the United States in September 2001.[37]

The Australian, Japanese and New Zealand defence forces were crucial to the success of early efforts to provide humanitarian relief and the restoration of essential services in Indonesia's province of Aceh, the area worst hit by the December 2005 tsunami. And in one of its largest-ever peacetime deployments, tens of thousands of soldiers from the People's Liberation Army performed a similar task during the disastrous floods of 1998 which inundated large areas of northern China, while a million security personnel were deployed to assist the civil authorities during the severe winter storms of early 2008.[38] The involvement of defence forces in emergency-

relief operations will almost certainly grow as the scale and frequency of climate-induced disasters increase, transforming militaries into multi-skilled institutions in which disaster relief will become a core task – if, indeed, it has not already become so.

Natural disasters linked to climate change may prove an even greater security challenge for developing states, displacing affected populations, calling into question the legitimacy or competence of national governments and feeding into existing ethnic or inter-communal conflicts. In extreme cases, the survival of the nation itself may be in question. For example, the 1998 monsoon season brought with it the worst flood in living memory to Bangladesh, inundating some 65% of the country, devastating its infrastructure and agricultural base and raising fears about Bangladesh's long-term future in a world of higher ocean levels and more intense cyclones. In the absence of effective mitigation strategies, a 1m rise in sea level would flood about 17.5% of Bangladesh and much of the Ganges river delta which is the country's food basket.[39]

Environmental refugees

In a grimly ironic scene from the Hollywood blockbuster *The Day After Tomorrow*, thousands of starving, dislocated North Americans stream south across the border to sanctuary in Mexico fleeing from the frigid winter descending on the continent as the great ocean conveyor, or thermohaline circulation, collapses.[40] Although the film is predictably dramatic in its depiction of this high-impact but low-probability scenario, the possibility that climate change might cause mass migrations of environmental refugees and displaced persons, with serious consequences for international security, is certainly plausible and should not be dismissed as a figment of Hollywood's imagination.

We already know that refugee flows and unregulated population movements can destabilise states internally, aggravate trans-border conflicts, create political tensions between sending and receiving states and jeopardise human security.[41] One of the defining features of the post-Cold War security environment has been the rapid rise in unregulated population movements around the globe. The causes of these movements are complex and intercon-

nected, but there is growing evidence to suggest that environmental decline is a contributing cause and that, in future, climate change may play a significant ancillary role. Some contend that climate or environmental refugees are now the fastest-growing proportion of refugees globally and that by 2050 up to 150m people may be displaced by the impact of global warming.[42]

Climate-induced migration is set to play out in three distinct ways. First, people will move in response to a deteriorating environment, creating new or repetitive patterns of migration, especially in developing states. Secondly, there will be increasing short-term population dislocations due to particular climate stimuli such as severe cyclones or major flooding. Thirdly, larger-scale population movements that build more slowly but gain momentum as adverse shifts in climate interact with other migration drivers such as political disturbances, military conflict, ecological stress and socio-economic change are possible.[43] Even the beneficial effects of climate change could lead to conflict. In China's Xingiang province, for example, a projected increase in rainfall is likely to attract an influx of Han migrants into the Muslim Uighur ancestral lands, further inflaming ethnic tensions between the two communities where a low-level insurgency is already festering.

Wild cards

These are some of the security consequences we can reasonably anticipate based on the available scientific data. But what if the speed and extent of temperature increases is greater than projected? Could it be that we have underestimated the threat? After all, climate researchers have identified several episodes of large-scale, abrupt climate change over the past 100,000 years both prior to, and after, the last ice age. In some instances rapid warming (as great as 16°C) took place over spans as short as a decade, although there is still substantial debate over how global these changes were.[44] So what could trigger abrupt, accelerated or runaway climate change, and what strategic consequences might we expect?

There are several potential wild cards in the climate-change deck. As greenhouse-gas emissions increased during the latter half of the twentieth century there was, at least for a time, an accompanying growth in airborne aerosols – primarily sulphate particles resulting from combustion processes

– which mitigated the warming that might otherwise have occurred. These particulates scatter solar radiation, releasing more energy to space, cooling the earth's surface and producing an effect known as 'aerosol masking' or 'global dimming'. Initially, the effect was confined to Europe and North America, as manufacturing surged and airborne pollution worsened in the immediate decades after the Second World War. But towards the end of the century, the concentration of particulates began to increase in Asia as first Japan, followed by the Asian tiger economies and then China and India emulated Europe and North America.

The so called 'Asian brown haze', which has become a semi-permanent feature of the region stretching from the northern Indian Ocean to China and much of Southeast Asia during summer, is graphic evidence of the rise in airborne aerosols in the developing world. The haze has global implications because it can travel half-way around the world depending on the strength and direction of the prevailing winds. And it is getting worse.[45] It is conceivable that the real rate of global warming has been masked by the presence of these aerosols, in which case cleaning up the haze by moving towards alternative fuels and cleaner energy might paradoxically accelerate the rate of climate change.[46] Another possibility is that deforestation will reach the point that the global biosphere will no longer act as a carbon 'sink' but instead become a net source of carbon, warming the planet by a third more than scientists have projected.

Warming may push the climate to a decisive tipping point

Peter Schwartz and Doug Randall, authors of the Pentagon report commissioned by Andrew Marshall, identified a sudden collapse of the thermohaline circulation as the climate-change event most likely to endanger international security. In their scenario, the warm Gulf Stream cools or shuts down altogether, perhaps irreversibly, creating winters of great severity in the northern hemisphere and triggering catastrophic weather. Rather than causing a gradual heating of the atmosphere over the span of a century, the global warming which has already taken place may suddenly push the climate to a decisive tipping point in which the system that controls the planet's ocean–atmosphere system suddenly flips to an alternative

state. North America would then become much colder and the European hinterland might have a climate more like Siberia, precipitating crop losses and population movements.

Schwartz and Randall postulate that as water, food and energy shortages develop, age-old patterns of conflict quickly re-emerge as nations fight for control over diminishing natural resources. Initially, countries attempt to deal diplomatically and collegially with the food, water and energy shortages that develop, along with an upsurge of environmental refugees. But as the decade progresses, international order breaks down because the scale and speed of climate change overwhelms the coping capacities of even the most wealthy and technologically advanced states. Drawing on the findings of Harvard archaeologist Steven LeBlanc, Schwartz and Randall observe that 'humans fight when they outstrip the carrying capacity of their natural environment. Every time there is a choice between starving and raiding, humans raid.'[47]

With these pessimistic assumptions informing their security scenarios, Schwartz and Randall imagine refugees from the Caribbean flooding into the United States and Mexico and struggles over diminishing supplies of oil as demand skyrockets, bringing the US and Chinese navies into confrontation in the Persian Gulf. With fossil fuels unable to meet demand, nuclear power becomes the alternative energy of choice and further nuclear proliferation becomes inevitable as energy-deficient countries develop enrichment and reprocessing capabilities. Japan, South Korea and Germany develop nuclear weapons, as do Iran, Egypt and North Korea. In Asia, energy-hungry Japan, already suffering from coastal flooding and contamination of its water supply, contemplates seizing Russian oil and gas reserves on nearby Sakhalin Island to power desalination plants and energy-intensive agriculture. Pakistan, India and China skirmish on their borders over refugees and access to shared rivers and arable land. States suffering from famine, pestilence, water and energy shortfalls strike out with 'offensive aggression in order to reclaim balance', thereby jeopardising their neighbours' security in pursuit of their own.[48]

Many of these projections are highly speculative or simply misleading, betraying the authors' lack of specialised knowledge of the realities of inter-

national security. A case in point is the mischaracterisation of LeBlanc's position. In fact, LeBlanc made a much more sophisticated and in some places contrary argument – that when people live in states they will often starve rather than fight, 'because the government won't allow them to fight'.[49] Similarly, the proposition that South Korea and Japan would develop nuclear weapons as they diversify away from fossil fuels to nuclear power is highly questionable because it ignores the very real domestic and international constraints on either country going nuclear.[50] South Korea and Japan have eschewed nuclear weapons despite the fact that they have long produced much of their electricity from nuclear power plants. It is drawing a long bow indeed to suggest that abrupt climate change alone would lead either to reconsider their long-standing aversion to nuclear weapons.

Nevertheless, Schwartz and Randall should be given credit for thinking the unthinkable and identifying how an abrupt-climate-change scenario might impact on international security. Even if the probability is low, it is far from zero and, as the potential impact could be very high indeed, policymakers ought to factor them into their security calculations and alternative-futures planning. While most climatologists assess as unlikely a complete failure of the thermohaline circulation this century, others are less sanguine. A 2005 scientific symposium looking at the impact of greenhouse gases concluded that

> there is a greater than 50% likelihood of an ATHC *(Atlantic Thermohaline Circulation)* collapse, absent any climate policy. This likelihood can be reduced by the policy interventions *(carbon tax on fossil fuels)*, but still exceeds 25% even with maximal policy interventions. It would therefore seem that the risk of an ATHC collapse is unacceptably large.[51]

Another risk factor is the stability of high-latitude permafrost. There is clear evidence that ground which was once frozen all year round is melting at higher and higher latitudes. Although there are no definitive estimates of the volume of gases trapped under the permafrost, their carbon content is thought to be considerable – perhaps as much as 500bn tonnes, the equivalent of 70% of all carbon currently present in the atmosphere.[52] Its release

could be quite rapid and widespread, as warming progresses, and would include a significant amount of methane gas, which is one of the most damaging of the main greenhouse gases. Should this occur, the authoritative Intergovernmental Panel on Climate Change (IPCC) predictions of future global warming would have to be revised upward by a substantial margin, since IPCC calculations only take account of emissions from fossil-fuel combustion.

Of all the potential climate wild cards, perhaps the greatest strategic risk is from a larger and more rapid than expected reduction of polar ice, which could dramatically increase sea levels, especially if parts of the Greenland and West Antarctic ice caps disappear. If the Greenland ice cap were to melt entirely it would contribute about 7.3m to sea-level rise, which would flood many coastal cities and low-lying areas, causing enormous economic damage, forced population displacements and loss of agricultural land.[53] While this seems unlikely, scientists are concerned by new evidence of ice loss. The US National Snow and Ice Data Centre has concluded that human-induced warming is at least partially responsible for the shrinking of the Arctic ice cap. We know from a variety of independent studies that sea levels have risen by around 10cm globally over the past 55 years, essentially because of the thermal expansion of water and the melting of terrestrial snow and ice.[54] Satellite data released in January 2008 indicate that West Antarctica is losing more ice that previously thought, with ice-sheet loss along the Bellingshausen and Amundsen seas increasing by 59% over the past decade. If this trend continues, then Antarctic melt may also contribute to the expansion of our seas and the inundation of coastal and low-lying areas.[55]

Scientists are concerned by new evidence of ice loss

Sea-level rise may have particularly dire consequences for low-lying atoll countries in the Pacific such as Kiribati, the Marshall Islands, Tokelau and Tuvalu. Ultimately, human habitation may not be possible on them even with moderate climate change. If temperature and sea-level rises are at the high end of those projected, then the sea will either eventually submerge the coral atolls or ground water will become so contaminated by salt-water

intrusion that agricultural activities will cease.[56] Most of Asia's densest aggregations of people and productive lands are on, or near, the coast, as are many large cities in Europe, the Americas and Africa, so if sea-level rise is at the upper end of the projections, flooding, loss of agricultural land and population displacements will become a serious global problem.

* * *

War has customarily been considered the main threat to international security because of the large number of deaths it causes and the threat it poses to the functioning and survival of the state. Judged by these criteria, it is clear that climate change is potentially as detrimental to human life and economic and political order as traditional military threats.[57] Environmental dangers, such as climate change, stem not from competition between states or shifts in the balance of power; rather, they are human-induced disturbances to the fragile balance of nature. But the consequences of these disturbances may be just as injurious to the integrity and functioning of the state and its people as those resulting from military conflict. They may also be more difficult to reverse or repair.

Protecting and stabilising our climate is a legitimate long-term objective of security policy, since human survival is dependent on the health of the biosphere and the coupled ocean–atmosphere. Climate change of the magnitude and time frames projected by climate scientists poses fundamental questions of human security, survival and the stability of nation-states which necessitate judgements about political and strategic risk as well as economic and environmental cost. Based on the evidence to date, it is difficult to see climate change alone compelling a major reconfiguration of the global balance of power in the foreseeable future. Shifts of this order presuppose substantial redistributions of the relative productive capacities of nation-states, but current climate models are still not accurate enough to describe in detail how most individual states will be affected.

While state weakness and destabilising internal conflicts are a more likely outcome than inter-state war, climate change acts as a stress multiplier on all societies and states. In assessing the long-term consequences of climate

change for international security we should be mindful of Jared Diamond's warning that in many historical cases a society that was depleting its environmental stocks could absorb losses as long as the climate was benign, but when it became more variable or harsh these societies were pushed over the edge and even collapsed. It was the combination of environmental impact and climate change that proved fatal.[58] Whether or not Diamond's observations are germane to our milieu remains to be seen, but can we afford to ignore the risk? It is sobering that on four out of five previous occasions of mass extinction in the Earth's history, at least half of all animal and plant species are estimated to have been wiped out during periods of warming that are comparable to those in prospect.[59]

In the security domain, strategic doctrines and defence budgets are frequently justified on the basis of far less observable evidence than we have about the climate future which awaits us. Yet very little has been done to research, address or even conceptualise the potential security implications of climate change internationally. Prudence and sensible risk management suggest that policymakers need to take this issue far more seriously. And our strategic planners ought to include worst-case climate-change scenarios in their contingency planning as they do for terrorism, infectious diseases and conventional military challenges to national security. For climate change may well be the threshold event that pushes our already stressed planet past an environmental tipping point from which there will be no return.

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