Climate Change and Security: A Coherent Framework for Analysis

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Abstract

The international political environment will change substantially as the Earth enters a period of rapid bio-physical transition driven by climate change. While it is true that climate change will have considerable impact on the national security of states around the world, the link between climate change hazards and security threats is not direct. The academic literature has been haphazard in presenting a theoretically consistent paradigm for assessing the security implications of climate change. Because of the global scale of climate change and the regional variation of specific climate change hazards, the traditional, human and environmental security paradigms can and should be reconciled to ascertain how conflict develops from climate change hazards and predict the probability of conflict scenarios developing at a given location. This paper attempts to redress this through a four-step framework for mapping how climate change hazards can lead to human and traditional security problems at a specific location and in surrounding areas.

Introduction

The international political environment will change substantially as the Earth enters a period of rapid bio-physical transition driven by climate change. While it is true that climate change will have considerable impact on the national security of states around the world, the link between climate change hazards and security threats is not direct. The academic literature has been haphazard in presenting a theoretically consistent paradigm for assessing the security implications of climate change. Because of its global scale and the regional variation of specific climate change hazards, the traditional, human and environmental security paradigms need to be reconciled to ascertain how conflict develops from climate change hazards and predict the probability of conflict scenarios developing at a given location. The generalised focus of many previous studies of the security implications of climate change failed to take into account that while climate change is a global phenomenon, specific climate change hazards are more likely to manifest within a bounded geographical region. The challenge for analysts of international relations therefore is to compile security analyses that are location-specific and practical for policy implementation. This paper presents a four-step framework for mapping how climate change hazards can lead to human, environmental and national security problems at specific locations. The paper will demonstrate the framework by analysing three case studies: south-eastern Australia, north-eastern China, and Darfur in western Sudan. In each case the primary climate hazard is decreased rainfall and drought, though each is characterised by remarkably different political systems, economic capacities, social cleavages and institutional strengths.

Defining an Appropriate Security Paradigm

For an environmental problem to be classified as a traditional security threat, it must have some demonstrable connection to a vital national interest, which can be enhanced or defended through the application of military, economic and political power (Matthew *et al.* 2009, 7; Gleick 1991, 18). In the past, few environmental problems have satisfied that criteria because they tended to be localised or manifest as cumulative problems over distant time horizons, neither of which posed a threat to the core interests of states. Climate change, however, presents a complicated challenge to the traditional security paradigm. It is a global problem, creating hazard phenomena that spread beyond local areas and even state boundaries, which will manifest at a higher frequency and intensity than in the past.

These hazards are likely to challenge the vital interests of many states and for some, even their very survival, yet because of their global scope they do not conform to the state-centric conceptions of security that divide the world into mutually-exclusive territorial entities and do not challenge the structure of economic and military power relations between states (Homer-Dixon 1991, 83). The impacts of climate change will be felt at the local level and experienced differently by people according to their position in the social hierarchy and the institutional capacities of the region in which they live. Because citizens within countries do not enjoy equality in this regard, change the assumption that national security equates to security for all citizens of a state does not hold (Foster 2001, 381).

Proponents of the human security paradigm therefore argue that the appropriate reference point for security analysis should be the individual human being and not the state. Harmful disruptions to human wellbeing and the patterns of daily life for individuals in vulnerable areas are said to lie at the heart of the underlying reasons why conflict occurs. Conflict is more likely where physical safety and secure access to food, water, housing, employment and health care are not available (Matthew *et al.* 2009, 377-8; Myers 1993, 31-2). The provision of these goods is usually the jurisdiction of civilian institutions, the weakness, failure of absence of which can determine the probability of conflict in a given context. The challenge of climate change adaptation is therefore unlikely to be something for which military forces are ideally suited. Oli Brown *et al* (2007, 1153-4) warn against the definition of climate as a traditional security issue because of the danger that securitisation will push states toward costly and inappropriate measures that may actually harm their adaptive responses to climate change. Indeed the appropriate responses for many socio-economic impacts of climate change hazards will lie in realm of public policy.

Environmental security was a natural outgrowth of the human security paradigm (Barnett 2007, 5).[1] Lester Brown (1977, 37) pioneered work in this area, arguing that unfolding stresses in the relationship between human societies and the Earth's natural systems initially manifest as ecological problems and resource scarcities, which create economic instabilities that ultimately translate into social unrest and political volatility. However, direct causal relationships between environmental variables alone and threats to national interest were not easy to demonstrate. To address this dilemma, Thomas Homer-Dixon (1991, 85-6) proposed a framework for charting the development of conflict from environmental problems, identifying population pressures and human activities *in combination* with ecosystem vulnerability as the drivers of environmental degradation, that in turn generate negative social outcomes culminating in different types of conflict. The framework put forward in this paper attempts to expand on the idea that security implications arise when environmental degradation interacts with pre-existing problems in human systems.

Nevertheless, many climate security studies focused on the resource scarcity aspect of climate change as the primary driver of security threats. In a 2003 report commissioned by the Pentagon, Peter Schwartz and Doug Randall (2003) postulated that climate change would produce security threats by reducing the carrying capacity of states throughout the world through declining availability of food, water and energy. According to this model, when scarcity pressures arise, competition may emerge between rival claimants of scarce resources, resulting in violence if cooperative and conflict resolution mechanisms fail. Violence acts as a negative feedback on resource scarcity, as conflicting parties increase their resource consumption to prosecute armed campaigns and refugees fleeing conflict zones create new resource pressures in the regions in which they settle (Brown *et al.* 2007, 1148). Schwartz and Randall's (2003, 2) finding that climate change could potentially destabilize the geopolitical environment through increasing resource constraints is based on the Malthusian assumption that the responses of human societies to scarcity pressures automatically lead to violence, which does not however accord with the evidence for environment and scarcity-based conflict (Michel 2009, 77; Yoffe *et al.* 2003).[2]

Later studies have moved beyond the linear relationship between climate change, resource scarcity and conflict. For Alan Dupont (2008) and Jon Barnett and Neil Adger (2007), climate change is expected to become a stress multiplier for all countries, with heightened risk of civil conflict in those states already at risk from internal instability and economic weakness. Climate change hazards are likely to catalyse the development of conflict

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[1] Jon Barnett has defined environmental security as the ability of individuals to exist free from direct violence by avoiding or adapting to environmental change so that the variables determining their wellbeing—those identified in the human security literature—are not substantially undermined.

[2] For example, in instances of water-related disputes between riparian states sharing trans-boundary river basins, cooperation has far outweighed conflict as the means of dispute resolution.

scenarios through interaction with other problems such as poverty, the availability of weapons, ethnic tensions, external indebtedness, weak institutional capacity and state legitimacy. The risk that a given location will be vulnerable to civil disturbance will be determined by its adaptive capacity. The adaptive capacity of human systems in a given location describes their ability to reduce exposure to and recover from damage caused by climate change hazards (Garg and Halsnaes 2007, 19). When adaptive capacity is high, public policy responses will be sufficient to manage crises, however, where adaptive capacity is low, responses will be inadequate, increasing the risk of adverse security developments.

Clearly then, violent conflict triggered by climate change will proliferate overwhelmingly within vulnerable states. This is the point of view of developing countries, which see climate change as a direct threat to their national survival through domestic societal implosion. Because they generally have low adaptive capacity, developing countries often lack the institutional capabilities to respond to climate change hazards with appropriate public policy responses. Developed nations have a different conception of the security implications of climate change because they are generally better able to adapt to climate change hazards and thus will be less prone to internal unrest. They typically see climate change as a threat to their national security through international instability, as climate hazards in one country create problems that spread risk to others, generating political friction and possibly violent conflict (Michel 2009, 84-5; Barnett 2007, 1364-5). For developed countries, climate change is a national security issue in the traditional sense because it is likely to necessitate military deployments in the form of disaster relief operations, humanitarian intervention, policing and stabilisation missions. Because of this dichotomy of perspectives, the challenge for academic community is to reconcile traditional, environmental and human security paradigms into an analytical framework that can identify the security implications of climate change hazards specific to any given location. By making the analysis location-specific, the tension between the competing security discourses can be overcome.

Climate Security Analysis: A Four-step Framework

This paper sets out a four-step conceptual framework within which sense can be made of the complex relationship between climate change and national security. First, it isolates a specific location for study and the climate change hazards that will affect that location. Second, it identifies vulnerable human systems at that location, documents past damage and estimates the risk of future damage caused by exposure to climate change hazards. Third, it evaluates the adaptive capacity of affected human systems and uses this assessment to pinpoint past and future socio-economic consequences of climate hazard exposure. Environmental and human security issues occur at this level. Finally, traditional security implications are distinguished at the local, state and international levels that may be caused by socio-economic weaknesses at the location in question. By applying this framework to any given location, it will be possible to identify climate-related security threats without over-generalisation due to lack of specificity.

(1) Climate Change Hazard

The first step of the climate security framework will classify one, many or all climate change hazards affecting *a specific location*. A climate change hazard is a process or event that has the potential to create loss in human social, economic and political systems through its transformative effect on the biosphere (Füssel 2007, 157-8). The three key factors to consider here are: (1) the location for analysis, (2) the specific climate change hazards that will impact on that location, and (3) the expected level of hazard exposure. The greater the exposure to climate change hazards, the greater the damage and disruption sustained by human systems, leading to an increased stress on the adaptive capacity of the location in question (Schneider *et al.* 2007, 791).

Any analysis of the security implications of climate change must be made on a location-specific basis because the nature of hazard risk differs according to the unique characteristics of ecological and social systems (Barnett 2007, 2). Different localities will be subject to different types of climate hazards, at varying levels of risk. Some regions, for example, are sensitive to variations in rainfall, some are susceptible to changes in temperature and others more vulnerable to sea-level rise. Given that ecological and social environments are usually diverse even within the confines of individual states, the "location" in this context must refer to a specific, bounded geographic region. While considerable ambiguity exists over the precise future impacts of climate change hazards, this location-specific framework allows the analyst to prepare a more realistic risk assessment of possible security issues for a given locality than can otherwise be deduced from general summations of the climate-security nexus. Without such specificity, any study of climate-security risk becomes too vague and diffuse to be of any practical value.

(2) Impact of Climate Hazard on Human Systems

A climate hazard or confluence of hazards cannot be considered a political issue without causing some kind of direct negative impact on a human system, such as a city, a farming region, key node of infrastructure, or referred damage to ecosystems that support them. The key variables here are: (1) the vulnerability to climate hazard damage of the human systems in question, and (2) the level of damage they are likely to sustain. The human systems most vulnerable to climate-related shocks will be those who are already working at capacity, poorly managed or constrained by lack of resources. The most severe impacts will come when high systemic vulnerability combines with high hazard exposure.

(3) Socio-economic Consequences of Hazard Impact

Any damage to human systems from climate change hazards will have flow-on socio-economic consequences, the nature and severity of which will depend on the adaptive capacity of the location in question. The *adaptive capacity* of human systems describes their ability to reduce exposure to climate hazards, recover from losses incurred and cope with the consequences of the post-shock environment (Garg and Halsnaes 2007, 19; Gallopin 2006, 300-1). The relationship between adaptive capacity and the risk of harmful socio-economic consequences is inversely proportional: risk is a product of the probability of climate hazard exposure and its expected consequences, which will vary according to local adaptive capacity (Dewar 2003, 3). Therefore, poorly adaptive human systems have a higher risk of experiencing deleterious consequences as a result of climate change hazards.

Generally, regions located within countries with high adaptive capacity will be more resilient to external climate shocks. Such countries share a number of characteristics: first, they have adequate economic resources to fund buffering capacities and adaptive responses, along with equitable access to maximise public welfare and minimise social disruption. A prosperous country is more likely than a poor one to withstand external shocks. Clearly, wealth provides options in responding to crises and those most able to harness market forces are best disposed to cope (Campbell and Parthemore 2008, 14; McKeown 2008, 101). Second, resilient countries possess appropriate technologies for buffering and response. Third, such countries are able to widely disseminate crisis-relevant information to at-risk groups and employ skilled professionals to implement adaptive strategies. Fourth, they have appropriate infrastructure in place to facilitate rapid reaction. Finally, a state with high adaptive capacity usually has good governance and capable institutions to maintain social stability (Munasinghe and Swart 2005, 187). Countries with low adaptive capacity tend to be deficient in each of these attributes.

However, adaptive capacity is rarely uniform across the breadth of a state, even in states that possess all of the attributes listed above. Because this climate security framework is location-specific, these regional and demographic differences in adaptive capacity within states can be accounted for. Within states, the distribution of capacities often follows home-grown social and class cleavages, leaving certain social groups better prepared to absorb shocks than others. States that discriminate against social groups through violence or denial of entitlements tend to marginalise such groups, making them more vulnerable to adverse outcomes from environmental stress (Barnett 2007, 8; Schneider *et al.* 2007,791).

Where adaptive capacity is low, climate change hazards are likely to exacerbate problems that already exist, especially if pre-existing human security issues include over-population, demographic imbalance, poor governance, endemic poverty and lack of infrastructure (Matthew *et al.* 2009, 6; Brown *et al.* 2007, 1148-9). Ordinarily, these concerns are best addressed through appropriate public policy decisions, diplomatic negotiations or other cooperative mechanisms, as well as non-government groups, communities, families, and individuals (Brown *et al.* 2007,1153-4; Schneider *et al.* 2007, 791). Conflict scenarios manifest when interventions at all of these levels fail or are non-existent. The risk of such outcomes is greater in poorly adaptive locations than in locations of high adaptive capacity, where the probability of traditional security threats arising will be minimal.

(4) Security Implications for the Location Under Study

The adaptive responses chosen by governments and the efforts of non-government entities will determine whether adaptation remains in the realm of public policy or deteriorates into violent conflict. For poorly adaptive states, security is best defined using the human security paradigm because conflict is likely to be a product of internal problems catalysed by climate change hazards. For states with high adaptive capacity, security is still likely to be conceptualized through the traditional security lens as problems emanating from other states. Therefore, to properly identify the full spectrum of security issues the framework will identify (1) security threats at the location under study; (2) threats to the state in which the location under study is based; and (3) threats from the location under study that are exported to neighouring states.

Case Studies

Three case studies are analysed in this paper to demonstrate the utility of the climate security framework: south-eastern Australia, north-eastern China and the Darfur region of Sudan. They have been selected because they provide an interesting basis for comparison given that they are increasingly being influenced by a similar suite of climate change hazards, most notably decreased annual rainfall. The root cause of many climate change hazards is the impact of climate change on the Earth's hydrological cycle, resulting in greater extremes and frequency of heat waves and droughts, as well as floods and storms (Barnett 2007, 1362).

Each of the regions analysed in this paper has succumbed to extended periods of drought owing to long-term declines in annual rainfall, a trend that is predicted to continue in each case due to climate change. Yet each case presents different security implications despite the similar hazard profile, resulting from differences in the hazard vulnerability and adaptive capacities governments and communities. The case studies show that while the relationship between environmental degradation and conflict does exist, the relationship is not direct and is dependent on a number of other variables. Using the climate security framework, we can identify the human and traditional security implications that arise in each case.

Case Study 1: South-eastern Australia

Climate Hazards

South-eastern Australia is a good example of a region where substantial climate-related stress has not resulted in substantial human, environmental and traditional insecurity. The most important ecological system within this area is the Murray-Darling river basin, which encompasses water systems from Queensland, New South Wales, Victoria and South Australia, eventually flowing into the Southern Ocean south of Adelaide. Seventy-five percent of Australia's total irrigated land lies within the basin, which produces more than forty percent of the country's gross agricultural output and consumes approximately seventy percent of its irrigation water (Garnaut 2008, 129). Much of the basin experiences a Mediterranean-type climate with hot, dry summers and mild, wet winters, punctuated by periodic droughts that occur within the natural cycle of climate variability. Climate change is predicted to increase annual average temperatures, leading to decreases in rainfall and increasingly intense and frequent drought events, a trend that is already visible throughout the basin. Between 1910 to 2004, the average maximum temperature in Australia rose 0.6°C, which the IPCC predicts will continue to rise into the future, with south-eastern Australia suffering up to twenty percent more droughts by 2030 (Hennessy *et al.* 2007, 511; Lucas *et al.* 2007, 1).

By definition, a drought is a prolonged period of abnormally dry weather where lack of precipitation causes extreme hydrological imbalance in an affected area, creating deficiencies in surface and groundwater resources (Mpelasoka *et al.* 2008, 1283-7).[3] In South-eastern Australia episodes of drought are thought to correlate with El Niño events driven by the El Niño Southern Oscillation (ENSO), the Pacific Ocean-wide climate system driven by variations in water temperature and ocean currents. As climate change is predicted to increase the amplitude of ENSO, drought events in south-eastern Australia are predicted to become more frequent and intense, thus increasing the exposure of human systems within this region to ravages of drought (Lenton *et al.* 2008, 1790). The altered hydrological regime will reduce stream flows through the river system and reduce soil moisture is surrounding land areas. The risk of bushfire will also increase as region dries out. The number of 'very high' and 'extreme' fire danger days could increase by between 4 - 25 percent by 2020 and 15 - 70 percent by 2050 (Lucas *et al.* 2007,1, 39). The Black Saturday bushfires beginning on 7 February 2009 starkly illustrated the impact of bushfires on human systems, in which entire townships were destroyed, farmland lain waste and important infrastructure was disabled.

[3] There is a significant time lag between prolonged precipitation shortfall and the onset of a hydrological drought, as groundwater reserves and surface water bodies may contain enough water to maintain ecological systems and human activities during the period rainfall deficit. This also means that hydrological drought can continue well beyond the period of rainfall deficit, creating damage impacts well after precipitation levels have stabilized.

Impact on Human Systems

Water scarcity will in turn accelerate land degradation as drought-effected areas lose soil moisture. In agricultural regions, drought-related reductions in evapo-transpiration will increase the risk of soil moisture moving below the root zone of crops, leading to problems such as soil acidification, dry land salinity and water logging (when rain does fall) (Hennessy *et al.* 2007, 518). Poor quality soils diminish the productivity return of fertilizers and reduce the health crops, leaving them vulnerable to pests and disease (Bi and Parton 2008, 2-3). The pastoral industry will be affected by reductions in the quantity and quality of available pastureland (Garnaut 2008, 129). As this process accelerates, changes in land use will occur as farming on marginal land in drier regions becomes unsustainable. Where agriculture persists, rising temperatures, water scarcity, land degradation and periodic bushfires are likely to combine to reduce crop yields, causing fluctuations in both the supply and price of produce.

The impact of decreased average rainfall on human systems in the Murray-Darling basin will become more severe as water supply and consumption trends converge (Mpelasoka *et al.* 2008, 1283-4). Water diverted from the basin for human usage has far exceeded the replenishment capacity of the system, increasing with the expansion of agriculture and urban settlements that are dependent on the basin for water. Over-allocation of water rights and inefficient water usage has combined with increasing demand, driven by population growth and development, to place considerable stress on supply capacity. The IPCC predicts that annual stream flow in the basin will fall within the range of 10-25 percent by 2050, and 16-48 percent by 2100 (Hennessy *et al.* 2007, 512, 517).[4] Because water allocation is already stretched beyond capacity, many water users within the system will not be able to tolerate further degradation of water supply. If the drying trend continues into the future as predicted, the number of water users acutely vulnerable to water stress will increase, along with competition for water rights among agricultural, industrial and urban users. This will also exacerbate the tension between human usage and the environmental flows required to maintain the health of the river system (CSIRO 2008, 5).

Socio-Economic Consequences

As a developed country, Australia is fortunate to have excellent adaptive capabilities. It enjoys a high level of economic development by global standards, an educated population, stable government and well-resourced institutions, which augur well for high-quality climate hazard responses. The rapid and decisive responses of national and state governments to disaster events including the Black Saturday bushfires in February 2009 and Cyclone Larry in March 2006 are evidence of this. Governments are attempting to manage water demand in rural areas though water license buy-backs and expansion of water trading markets, as well as augmenting water supplies in capital cities through recycling, storm water catchment and desalination (Hennessy *et al.* 2007, 525). This adaptation effort could be improved by the expansion of linkages between the local, state and federal strata of government, which as relics of Australia's federal system of government remain weak. Decision-making and policy implementation is often dissipated across a range of institutions and special-interest sectors,

[4] The IPCC predicts a 50% chance that the average salinity of the lower Murray River will exceed the 800 EC threshold set for desirable drinking and irrigation water by 2020 (Hennessy *et al.* 2007, 517).

which inhibits the creation of sufficient impetus for confronting the more difficult adaptation challenges (Behm 2009, 10).

There are segments of Australian society that are more vulnerable than others. Rural Australians are more vulnerable to climate change hazards because of unequal access to health care nodes, which are for the most part located in capital cities and a few large population centres (Bi and Parton 2008, 3). In such communities in south-eastern Australia, economic hardship (unemployment, bankruptcy, farm foreclosures) brought on by ongoing drought has led to increased rates of suicide, particularly among young men, a problem exacerbated by a scarcity of mental health services in these communities. Indigenous Australians are also at greater risk from exposure to climate change hazards as a result of endemic economic disadvantage and poor access to health services and employment (Hennessy *et al.* 2007, 522).

The economic impacts for drought-affected communities in south-eastern Australia, which are already considerable, are likely to worsen into the future. There is a high probability that irrigated agricultural production in the Murray-Darling basin will decline as a result of climate change-driven water shortages (Garnaut 2008, 126).[5] Rural communities within the basin are likely to contract as agricultural production declines, leading to rising unemployment and migration of residents to larger population centres in search of work. Damage from extreme events such as bushfires is also likely to be substantial, placing an economic burden on government for reconstruction efforts (Hennessy *et al.* 2007, 509). Health care costs are also predicted to increase with a rise in the number of heat-related deaths in large population centres predicted to double by 2020 and triple by 2050 (Hennessy *et al.* 2007, 524).

Political & Security Implications

The security challenges posed by exposure to climate change hazards in South-eastern Australia are likely to be quite benign by international standards, posing little threat of domestic conflict or destabilisation for neighbouring states. The biggest problem in the near term is likely to be migration away from rural communities as unemployment rises and regional economies struggle under the weight of agricultural downturn. Nevertheless, because the rate and scale of population displacement is not likely to be large, any problems associated with the resettlement of internal migrants in larger population centres should be manageable.

In terms of traditional security concerns, the military is likely to be deployed more often in response to more frequent and severe disaster events, as it was in the wake of the Black Saturday bushfires in February 2009. Deployment of the Australian Defence Force (ADF) in response to homegrown disaster events, as well as interventions in Indonesia, East Timor and the Solomon Islands has given it substantial experience in responding to disaster events effectively. Should such deployments be required more often in the future, a greater proportion of the ADF's budget will be devoted to domestic disaster response instead of national security and could reduced its capacity to meet external security demands (Behm 2009, 8); (Bergin and Townsend 2007, 2).

[5] The *Garnaut Climate Change Review* has predicted that irrigated agricultural production in sections of the Murray-Darling basin in New South Wales will decline by up to 92 percent, wheat production in Victoria by 25 percent, as well as a 33 percent fall in livestock productivity in South Australia.

Case Study 2: Northern China

Climate Hazards

The impact of drought on north-eastern China will lead to a different set of security outcomes, based on the geographic, political and economic characteristics of that region. The municipalities of Beijing and Tianjin, two of China's largest cities, are located within this area. The region lies near the boundary between temperate and semi-arid climate zones, which are dominated by continental polar air masses for much of the year. Rainfall occurs predominantly in the summer as a result of the East Asian monsoon, though annual precipitation rates can vary widely (Chen 2005, 369). This area has experienced a consistent increase in average temperature over the last half-century, bringing with it decreasing annual rainfall (Xu *et al.* 2006, 85). The IPCC predicts more frequent and persistent droughts as the warming trend continues (Cruz *et al.* 2007, 475).

Impact on Human Systems

North-eastern China is vulnerable to drought and water scarcity because of a geographic mismatch between water resources and areas of high population and development. A large majority of China's water reserves are located in the south of the country, in the sub-tropical climate zone where precipitation is abundant. North-eastern China accounts for over forty-five percent of China's population, contains almost half of the country's agricultural land and produces a third of its GDP, but has only nineteen percent of its water resources (Jiang 2009, 5). Rising average temperatures are predicted to depress crop yields, with grain crops particularly susceptible to climate variations. A 3-4^{o} Celsius rise in temperature above 1990 levels is likely to reduce maize and rice production in East Asia by 10-20 percent by 2100 (Cruz *et al.* 2007, 483). The direct impact on the temperature tolerance of crops is compounded by changes to precipitation patterns, length of the growing season, the intensity and timing of extreme weather events, and increased exposure to plant pests, weeds and diseases. Also, the agriculture-pasture land transition that signifies a climate zone boundary is pushed southward, decreasing the stock of arable farmland and leaving new grassland areas vulnerable to desertification in combination with human-induced degradation (Chen 2005, 371).

River basins are by definition water-stressed if per capita water availability falls below the internationally accepted standard of 1,000 m^3 per year. In north-eastern China, for example, annual per capita water availability in the Hai River basin stood at 470 m^3, due to a combination of climate-related constraints on supply as well as unsustainable demand cause by over-consumption.[6] Water demand has increased by approximately eight percent since 1997 and is projected to rise by 20 percent by 2030 (Bates *et al.* 2008, 8; Cai 2008, 14-6). Already, up to 90 percent of stream flows in the basin are diverted for human use, well above the figure of 30-40 percent stream flow diversion that is the safe limit for maintenance of healthy aquatic ecosystems (Jiang 2009, 3; Kendy *et al.* 2003, 2). Because of this major imbalance between demand and supply, irrigation from surface and ground water reserves in the region are projected to meet only 70 percent of water requirements for agricultural production (Bates *et al.* 2008, 88). As development has advanced, groundwater reserves have

[6] The Hai River (Haihe) basin incorporates water systems in Hebei Province that drain from the east in Shanzi and south in Henan into the Bohai Gulf near Tianjin.

been mined voraciously, leading to land subsidence as aquifers are depleted, while forest and grassland replaced by farm land and industrial development projects have decreased the water storage capacity of the soil and thus exacerbating flooding events (Cai 2008,15; Economy 2007, 42).[7] Moreover, the advance of urban and industrial development has led to the pollution of water sources, with 78 percent of monitored water courses in the Hai River basin recording a quality so poor that they could not support any human use (Jiang 2009, 3-4).

Socio-Economic Consequences

The adaptive responses of government institutions and communities in north-eastern China will be shaped by a number of factors. Huge losses in agricultural production and industrial output have been recorded as a result of water shortages. Approximately 25-30 million tons of food production and about 200 billion RMB (~US$ 29 billion) in industrial output is lost annually (Cai 2008, 20). Attempts are underway to reduce surface and groundwater consumption by placing restrictions on land use, though often regulations are poorly enforced or simply ignored (Cai 2008, 18). The heavy-lifting of China's government institutions occurs at the provincial and county levels, which exert considerable autonomy from the central bureaucracy in Beijing. Local officials rarely enforce Beijing's environmental mandates if they conflict with projects that advance economic growth and by extension enrich the local officials themselves (Economy 2007, 39). This results in poor water resource management across China’s patchwork of government institutions, characterised by ineffective inter-agency coordination at different levels of government that hinders the implementation of any local-level adaptation measures (Jiang 2009, 6).

Because bureaucratic coordination is so difficult, the central government’s responses to water scarcity have often centred on grand geo-engineering projects to boost supply, which are easier to establish because they do not offend any important political constituencies by constraining water consumption. The best current example of this practice is the south-north water transfer project, which will bring water via pipeline form the Yangtze River to supply urban and industrial centres in the Hai River basin (Schiller 2008-2009, 124). Like any geo-engineering project of this magnitude, the cost of supplying water to end users will increase along with the distance or depth that water must be piped or pumped from its original source (Bates *et al.* 2008, 70).

The other demand-side obstacle is the long-running failure of the Chinese government to price water, which encourages free riding and gives water users no economic incentives to conserve water and prevent waste (Schiller 2008-2009, 124). The government has trialled water trading markets in several locations and is working on a bolder national scheme, though this has yet to be implemented (Liu 2008). Farmers will be most affected by water pricing; as their economic position is already marginal, being forced to pay for water will likely destroy their livelihoods (Cai 2008, 20-2; Kendy *et al.* 2003, 28). Climate-related water scarcity will make it difficult for the Chinese government to allocate water without withdrawing water entitlements from other users.

[7] In the Haihe basin, the cities of Beijing and Tianjin have both experienced land subsidence of approximately six feet over the past decade.

Political & Security Implications

The combination of water scarcity and inequitable access to water resources is rapidly becoming a source of political disquiet in north-eastern China. Water use conflicts cut across many axes, illustrated by competition between upstream and downstream users, as well as sectoral competition between agricultural, industrial and urban water consumers. It is the role of the Chinese government to adjudicate between competing claims and allocate water in a fair and equitable manner, allowing scarcity stress to be borne equally by all users (Cai 2008, 15). Yet as has been shown above, access to water is highly unequal, causing considerable public unhappiness with the central government, culminating in an alarming rise in social unrest linked to water and environmental grievances in recent years. Often this has resulted when local level officials have catered to entrepreneurial interests by allowing over-extraction and pollution, while shutting down all channels for public grievance. Pent-up grievances have exploded into violent anger-venting riots, numbering as many as 1,000 a week across China (Yu 2008, 75-6; Economy 2007, 47).

The proliferation of widespread social unrest related to water allocation and environmental issues represents a serious challenge to the Chinese government's nation-building strategy of maintaining social harmony through economic development, which could undermine the authority of the Communist Party (Economy 2007, 46). The Beijing government has increasingly viewed this kind of social unrest as a security threat, to which it has often responded by violent crackdown. However, by framing environmental complaints through the mindset of security, the government is closing off opportunities for dialogue, the development of transparency and institutional reform, which would improve the water allocation process and help to prevent major protests over water issues from erupting (Ma 2008-2009, 33). By taking a hard line, the government is ensuring that the underlying problem of water scarcity will get worse and lead to more of the very protests that it is attempting to suppress.

The wider trend of aridity and desertification in north-eastern China is also likely to encourage people to flee unviable rural communities, with up to fifty million people predicted to be internally displaced China-wide by 2010. These people often move to cities such as Beijing and Tianjin where their presence adds to pressure on water resources and infrastructure (Schiller 2008-2009, 123; Cruz *et al.* 2007, 488). The fear of climate-related migration also extends to neighbouring states. Officials in Russia have long feared a mass migration of Chinese into the Russian Far East, leading to Sinification of the region and its economic, demographic and military incorporation into China's sphere of influence (Alexseev and Hofstetter 2006, 1; Menon and Ziegler 2002, 36). Russia controls 30 percent of the world's fresh water resources, mostly in places east of the Ural Mountains such as Lake Baikal. Many planners in Moscow fear that these resources could become a target of predation for water-stressed China as the effects of climate change exacerbate its water scarcity (Muraviev 2009).

Water scarcity is likely to impact on China's ability to produce sufficient food for its large and growing population. In the event of widespread food insecurity within China, demand in China for food imports will divert food supplies from other countries and may drive up global cost of food, pricing vulnerable poor people in other countries out of the market (Jiang 2009, 1; New Agriculturalist 2002). This will in turn have serious impacts on the human security of vulnerable citizens in other net food-importing countries, leading to social unrest and possibly malnutrition in extreme cases. In effect, China would be exporting the social and political problems of water scarcity and food insecurity to other more vulnerable nations.

Case Study 3: Darfur

Climate Hazards

Of the three case studies, the Darfur example exhibits the most tangible human, environmental and traditional security concerns stemming from the combination of environmental degradation and societal factors. The Darfur region itself is roughly the size of France and because of its size, it occupies four different climatic zones, grading northward from rich savanna in the south, through poor savanna, an arid zone and finally desert in the north. Annual rainfall ranges from 400-800 milimetres per year in the savanna zone to zero annual rainfall in the desert zone (Fadul 2004, 34). Darfur has suffered from numerous long droughts over the past half-century due to a long-term warming trend that has seen the desert climate zone shift southward up to 200 kilometres since records were first kept in the 1930s. The IPCC predicts that declining annual precipitation rates will see climates zone boundaries continue to migrate southward, placing the region's pastoral grasslands and agricultural areas in the savannah at risk of desertification (Boko *et al.* 2007, 439).

Impact on Human Systems

Agriculture is the main economic activity for more than eighty percent of Darfur's population, essential for the food supply and economic well-being of the population. Millet and sorghum are the staple crops for most of Darfur's population, the productivity of which is wholly dependent on rainfall and the natural fertility of the soil (Fadul 2004, 36). Because of this, local food systems and economies are particularly vulnerable to changes in the regional climate regime. Food production is predicted to fall by approximately 20 percent due to endemic drought caused by changes to the regional climate system (UNEP 2007, 7).

Darfur's ethnic and cultural heterogeneity is itself heavily influenced by climate zone boundaries, which shape the lifestyles and socio-economic organisation of the groups within each zone. In the arid north, Arab and non-Arab groups such as the Zayyadiyya, Northern Rizayqat' and Irayqat exist as camel nomads. Non-Arab sedentary farmers such as the Fur, Masalit, Tama, Qimr, Mima occupy the central area of Darfur, while the south is populated by a series of Arab-speaking cattle nomad groups including the Baqqara, the Bani Halba, Habbaniyya, Rizayqat and Taaisha (O'Fahey 2004, 24). Each of these groups perceive themselves as quite distinct and have developed elaborate ideologies of ethnicity around this differentiation (Murphey 2008, 243).

Creeping desertification from the north and persistent drought throughout Darfur are pushing these groups together as traditional lands become unviable, forcing them to compete over scarce resources in remaining viable areas. Population growth and density in Darfur has accelerated rapidly over the last fifty years, exacerbating the problems that arise as climatic conditions force diverse ethnic groups into close geographic proximity (Fadul 2004, 35). In the sedentary agricultural areas this has led to pressure for greater food production and increased demand for wood fuel for brick making, contributing to land degradation through over-cultivation of soils and removal of vegetation cover, as well as increased exploitation of water resources (Boko *et al.* 2007, 441-2; Al Mangouri 2004, 46). In pastoral areas, population pressure and drought have led grazing nomads to maximise the size of livestock herds. The increased animal population has itself led to the degradation of grazing lands, accelerating the pace of desertification in these areas (UNEP 2007, 7-8; Fadul 2004, 38).

Socio-Economic Consequences

The political situation in Darfur and Sudan as a whole is a major constraint on the adaptive capacity of communities in the region. The Sudanese state has a limited institutional capacity because of protracted civil warfare and the tangled web of inter-communal conflict that permeates political relations throughout the country. Because government institutions have not facilitated human security in Darfur, ethnic groups have come to rely on communal institutions to maintain well-being, resolve conflict and defend against attack from rival groups. Not surprisingly in the context of extreme land and resource competition, relations between local communities have been characterised by distrust and a predisposition toward violence. Local communities do have mechanisms to create crosscutting ties to help mitigate inter-communal conflict (Mohamed 2004, 68-70).[8] However, these piecemeal measures have proven insufficient to overcome the deep ecological and political problems that drive inter-communal fighting.

Local communities are beginning to adopt practical measures to adapt to environmental degradation and climatic stress. Adaptation measures include water harvesting and efficient irrigation techniques; expanded food storage facilities to buffer against poor harvests; improved rangeland management to reduce over-grazing; livestock substitution (replacing heavy-grazing goats with sheep, which have less impact on grassland); establishment and maintenance of tree line shelter belts to protect against wind-driven soil erosion; backyard gardens to supplement family food supplies; and education and training to help communities maintain these interventions (Osman-Elasha 2009, 92). If successfully implemented, they will increase community resiliency and reduce the need for groups to engage in coping strategies that lead to violence and further degrade the environmental capacity of their surrounds.

Unfortunately, however, community adaptation remains trapped in the cycle of competition and conflict. The decreased productivity of rain-fed crops has forced farmers to compensate for declining output by expanding the land area under cultivation. Expansion of plot sizes has occurred at the same time as substantial population growth, leading to the expansion of farms from cropland into the pasturelands used by nomad groups to graze livestock. It was inevitable that in the absence of state institutions, the issue of land use and distribution would lead to conflict between farmers and nomads, as well as between farmers themselves, who were all competing for a slice of a diminishing productive land base (Salih 2008, 3; (Mohamed 2004, 68).

Political & Security Implications

Climate stress and resource scarcity has been the context within which contemporary violence in Darfur has taken place. However, the situation in Darfur is itself nested in the politics of the two decades-long civil war between the central government in Khartoum and the Sudan People's Liberation Army (SPLA) that ended in January 2005 (UNEP 2007, 4). During the mid-1980s Sudanese Prime Minister Sadiq al-Mahdi took the strategic decision to

[8] Such mechanisms include the Sufi Order (*Tariqa*), the Quranic school (*khalwa*), mediation (*judiyya*), tribal festivals, inter-marriage, exchange of gifts, and naming children after friends from other groups.

arm the Baqqara people of southern Darfur ostensibly to defend themselves from the SPLA. However, in the midst of a crippling drought, the newly armed Baqqara took the opportunity to instead attack their northern neighbours, the Fur and Masalit peoples. The SPLA responded to the central government's attempt to open a southern front in the war by supporting the first Arab tribal militias, or *murahaleen*, who subsequently began attacks on non-Arab groups in central Darfur (Murphey 2008, 233, 255).[9] After the peace agreement was signed to end the civil war in January 2005, the central government co-opted the *janjawid*, whom they used to maintain control over Darfur against a rebellion nationalist groups (O'Fahey 2004, 26-7; Salih 2008, 9). The coalescence of ethnic groups in limited geographic proximity due to drought and the southward march of desertification has provided fertile conditions for the perpetuation of inter-communal violence.

Because of its long history of war, Sudan has the largest population of internally displaced persons in the world at over five million people. Internal displacement in Darfur constitutes a large proportion of this figure, with over 2.4 million people affected since 2003. Of these people, about one third have congregated in large refugee camps where their existence is one of constant insecurity, punctuated by human rights abuses and conflict over food and water (UNEP 2007, 6). Many refugee camps have also become bases for members of rebel groups fighting against the central government and the *janjawid*. Because of this, *janjawid* militias attack any refugees who stray outside of the camps and regularly harass the camps themselves (Kahn 2008, 15). The remaining two-thirds of the displaced population live in smaller camps and share land and resources with nearby towns and villages, while some live within towns and villages with the local population (Kahn 2008, 11). Because of the scale of people movements, the complexity of ongoing warfare and the particular vulnerability of the water-scarce landscape of Darfur, the human suffering involved have had few parallels in the world today.

The refugee problem has spilled over into neighbouring Chad, where refugee camps on both sides of the Chad-Sudan border have become bases for parties fighting in Chad's civil war. Approximatley 230,000 thousand refugees from Darfur are currently housed in camps in Chad, which serve as rear bases for recruitment and cross-border incursions deeper into Chad itself (Kahn 2008, 11, 15). In response, the government of Chad has launched its own military raids into Sudan on the pretext of chasing Chadian rebels. In one incident, the Chadian army clashed with Sudanese military forces inside the Sudanese border, a skirmish which left 17 Sudanese personnel killed (Salih 2008, 17).

The international community has focused on military responses to the Darfur conflict. The United Nations has proclaimed the need to send a peacekeeping force to Darfur, though none has been deployed due to conflicting interests within the UN Security Council based on China's energy partnership with the Khartoum government and the relationship of the United States with the SPLA, arrayed in competition over Sudan's oil reserves (Salih 2008, 15-6). A small African Union peace-keeping force of up to 7,000 personnel has been operating in Darfur since 2004. Its impact has been minimal due to its small size, lack of logistical support and limited mandate, along with suspicions in Khartoum over the role of the United States in supporting the African Union intervention (Salih 2008, 13-4). Given the vast size of the Darfur region however, it seems impossible that any international force, regardless of its

[9] It is often said that the *janjawid* militias that have terrorized Darfur since 2003 were a remnant of the *murahaleen*, however, this is not quite true, as the *janjawid* were predominantly recruited from the rival Rizayqat group and other hostile clans.

size, could provide effective physical security in such a complex political environment (Kahn 2008, 13).

Conclusion

The three case studies considered here illustrate how similar climate change hazards can lead to a very different suite of human, environmental and traditional security implications, depending on the economic and political conditions in each location. In south-eastern Australia, high exposure to drought has increased water scarcity and heightened potentiality for more intense bushfires. Because governments and communities have high adaptive capacity and the level of pre-existing socio-economic problems is relatively low, the security implications of climate hazard exposure are relatively minor for both individuals and the state, in spite of continued over-extraction of water resources. In north-eastern China, exposure to similar drought hazards is having a more pronounced effect due to extreme imbalance between water demand and supply, limited institutional capacity and social marked inequality. For vulnerable individuals, climate-driven environmental degradation is increasingly heightening their economic insecurity and harming their health. The Chinese government is concerned that the insecurity felt by vulnerable citizens will generate internal migration to already stressed urban centres and translate into social unrest which could delegitimise Communist Party rule. In Darfur, climate-driven drought and desertification has combined with ethnic cleavages, non-existent institutional capacity and endemic inter-group conflict to produce extraordinary pressures toward continued inter-communal violence and high levels of population displacement. This in turn exacerbates the cycle of environmental degradation and conflict within Darfur and creates flow-on problems for neighbouring states and the international community.

The link between climate change and security is a complicated one. Using the four-step climate security framework, the three competing security paradigms can be reconciled; they are not mutually exclusive, as the former is often a precursor to the latter. This paper has employed the climate security framework comparatively in order to demonstrate its validity. In future studies however, the framework should be utilised to analyse individual locations to determine security risks for all climate change hazards affecting the region under study. Nonetheless, the relationship between climate change and security can thus be summarised in this way: the more extreme the pre-existing political and socio-economic problems, the more pronounced would be the effect that climate-driven environmental degradation will have on a given location.

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