Climate Change, National Security, and the *Quadrennial Defense Review*

Avoiding the Perfect Storm

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The Emergence of harmful nonlinear, long-term, cumulative, anthropogenically generated changes to the Earth's climate and natural environment pose a "serious threat to America's national security."[1] The changes are increasing risks and vulnerabilities across the strategic foundation identified by the 2006 *Quadrennial Defense Review* (*QDR*). Irregular, disruptive, traditional, and catastrophic challenges are surfacing as a result of global climate change and could merge into a "perfect storm" with disastrous consequences. In response, the Department of Defense (DoD) must blend the sustainability tenets of environmental security, ecological economics, and social/environmental equity with the pillars of the democratic peace theory. The conflict ameliorating powers of democracy, economic interdependence, and international organizations operating within the finite environmental, economic, and social limits of the sustainability tenets will enable the DoD to mitigate and adapt to the multiple challenges from climate change and build for the United States and for all other democratic states sustainable security. Importantly, US leadership toward sustainable security will enhance "freedom, justice, and human dignity" around the Earth; "grow the community of democracies";[2] sustain stability, prosperity, and security; and make it possible for the global community to "avoid the unmanageable and manage the unavoidable" consequences of global climate change.[3]

The 6 February 2006 *QDR* explains the current position and future direction for the DoD as the department fulfills its responsibilities to the people of the United States. The essence of the document is "a roadmap

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for change, leading to victory" in the long war against global terrorism.[4] The *QDR* focuses on how America will defeat "violent extremists who use terrorism as their weapon of choice, and who seek to destroy our free way of life."[5] While the *QDR* rightly seeks to identify capabilities required to defeat terrorism, another more potent threat to national security is emerging. The challenge to national security created by global climate change is based on threats, vulnerabilities, and risks across the spectrum of strategic, operational, and even tactical challenges[6] identified within the *QDR*. Military experts contend that "the consequences of climate change can affect the organization, training, equipping, and planning of the military services."[7] In response, and parallel to the challenges identified in the *QDR*, the United States must recognize this long-term threat, operationalize a new strategy, reorient capabilities and forces, reshape the defense enterprise, develop a twenty-first-century total force, achieve unity of effort, and create a roadmap to victory[8] aimed at coping with climate change.

Introduction

Global climate change can be an irregular, asymmetric challenge or a traditional, symmetric challenge. Global warming can also "act as a threat multiplier for instability in some of the volatile regions of the world."[9] The abilities of traditional military forces to mitigate or help states adapt to climate change will be severely tested in the coming decades as the United States encounters global warming challenges. The strategies the United States must adopt will be direct and conventional as well as indirect and unconventional. It must also prepare for abrupt surprises and deal effectively with the uncertainty embedded in Earth's complex and chaotic climate system.[10] Proper preparation will increase the options for US decision makers; these preparations must be based on "the principles of transparency, constructive competition to encourage innovation, agility and adaptability, collaboration and partnership" that guide the current *QDR*.[11] Importantly, a "model of continuous change and reassessment" must guide the effort to protect US national interests.[12] Inherent in this effort are reforms to defense activities that will create sustainable security;[13] a focus on building cooperation; transparent communications globally; and gathering actionable social, political, economic, technological, and environmental intelligence. The goal of many of these activities is to enable states to provide sustainable security for themselves and for their neighbors. In addition, the United States must

minimize the costs of climate change domestically and internationally by leading scientific, technological, governmental, and managerial innovation of climate change solutions.[14]

Preparing and shaping the security future of the United States involves focusing on traditional, irregular, disruptive, and catastrophic threats that global warming can create. Operationalizing the strategy should encompass two main priorities: mitigating the effects of climate change and adapting to climate change consequences within a sustainable security plan. As the current *QDR* notes, there is no "one size fits all" approach to many security threats,[15] and there is no one best way to tackle climate change.[16] The key to success lies in understanding the threats, vulnerabilities, and risks associated with global warming and creating capabilities for responding across a spectrum of challenges.

The Long-Term Threat

The 2006 *QDR* states that our way of life is threatened: "The enemies we face are not nation-states but rather dispersed non-state networks."[17] Today, we also face another emerging threat to our way of life that will harm our natural resources, wildlife, economy, and health.[18] This peril, global climate change, threatens not only the United States but all nations around the world.

The industrial revolution brought widespread improvements to the length and quality of human life. However, the accompanying extensive deforestation and reliance on fossil fuels increased the concentration of greenhouse gases in the atmosphere. In fact, the concentration of a major greenhouse gas in the atmosphere, carbon dioxide (CO_2), was measured using Antarctic ice cores extending back 650,000 years. The concentration is greater today than at any other period recorded before.[19] Importantly, this increased concentration of greenhouse gases along with other human activities is unequivocally warming Earth's climate system. The consequences of this change appear in "increases in global average air and sea temperatures, widespread melting of snow and ice, and rising global average sea level."[20] In fact, the effect of climate change on natural systems in particular has been varied and extensive.

Long-term continental, regional, and ocean basin scale changes have been observed.[21] For example, in the last 100 years average Arctic temperatures have increased almost twice as fast as the previous average global rate. Also, Arctic sea ice is dramatically shrinking, permafrost layers are

melting, precipitation patterns are changing globally, droughts are longer and more severe, heavy rainfall events are increasing in frequency, and tropical cyclones are more intense.[22] In general, Earth now experiences fewer cold days and nights and less frost, while the number of hot days and nights—as well as heat waves—occur more often than in the past.[23] The oceans are also warming. Measurements indicate that not only are sea surface temperatures increasing but that the heat has also penetrated as far as 750 meters below the surface.[24] The predominant cause of these global changes has also been identified.

The increase in average global temperatures since 1950 is "very likely" due to the increase in human-produced greenhouse gas emissions.[25] Specifically, a human fingerprint has been found on the warming of the oceans, increases in continental temperatures, temperature extremes, and changes in wind patterns. Earth will continue to warm and sea levels will rise even if greenhouse gas emissions stopped today, but the overall temperature increase would be substantially less if emissions stabilized.[26] Interestingly, this means that climate change has become a threat to national security not unlike current security threats.

The *QDR* describes operational lessons from the war on terrorism. These broad experiences offer insight into the long-term threat of global climate change. Specifically, the *QDR* notes that the DoD needs more authority and resources to build "partnership capacity."[27] The challenge of global climate change will also require that the DoD has the authority, ability, and resources necessary to "work with and through others and of shifting the emphasis from performing tasks ourselves to enabling others."[28] This process is essential for tackling global warming as other states must organize and prepare for climate change while conducting efforts to reduce greenhouse emissions from all sources.[29] The second lesson asserts that the United States must take early precautionary measures to "prevent problems from becoming conflicts and conflicts from becoming crises."[30] Again, the tasks required for mitigating and adapting to global warming will be less expensive, less conflictual, and less encompassing if early preventive actions are taken.[31] The third operational lesson involves increasing the freedom to act against the threats.[32] The United States must aggressively lead the effort to tackle climate change by assembling partnerships and building trust and cooperation.[33] Trust and cooperation can be enhanced by "cooperative engagement" using all elements of national power, not just the military.[34] The final operational lesson contends that the United States must make the cost

of terrorism much greater for our enemies than for us.[35] In the struggle to mitigate and adapt to climate change, the United States must shift the costs of greenhouse emissions to the emitters, assist their transition to carbon-free processes, and encourage carbon-free technological and sustainable development.[36] Ultimately, the DoD can help shift the balance and leverage US power by "accelerating the adoption of improved business processes and innovative technologies" that increase fuel efficiency, decrease fuel consumption, and reduce greenhouse gas emissions.[37] Obviously, climate change is a long-term threat to US national security in broad areas—but where and how specifically does this threat manifest itself?

Operationalizing the Strategy

A strategic foundation similar to the one described in the 2006 *QDR* can be created to counteract the challenge of global warming. Two priority responses for overcoming this challenge have been identified: mitigation and adaptation.[38] The 2006 *QDR* also presents four focal areas that can be used to coordinate DoD efforts in response to near-term and long-term risks.[39] Although these focus areas were designed primarily for focusing military capabilities, they can be used to identify strategic threats, vulnerabilities, and risks that the United States must address to sustain national security in other areas as well. Specifically, strengthening US "capabilities in these areas" will "improve the versatility of the force to perform a wider range of"[40] security operations in the future. The report identifies four types of challenges—traditional, irregular, disruptive, and catastrophic—that the United States must address to protect national interests.

Traditional Challenges

Traditional challenges to US interests require employing military forces in conventional activities to prevent military competition and conflict.[41] In the climate change threat domain, traditional forces would be employed to prevent conventional conflicts driven by climatic and environmental changes. Three relevant examples of traditional challenges to US security interests that could develop as a result of global climate change are droughts, floods, and heat waves. While droughts and floods have occurred many times in US and world history, climate change could magnify the scale, intensity, and duration of future ones. Heat waves already occur around the world, killing

thousands, but global warming may increase the areas affected and make the heat waves longer and more intense, leading to thousands more deaths and mass unrest. In other words, adverse climatological effects may have direct and negative political consequences that threaten local and regional stability and long-term US security.

Climate change is altering global hydrological cycles. The warming process is having a direct effect on the quantity and quality of fresh water available both for human uses and for natural ecosystems. "The hydrologic cycle has accelerated, with more evaporation and precipitation overall and a larger proportion of the precipitation occurring in downpours."[42] In many regions of the world, increased temperatures have also changed the timing of mountain snowfall melt.[43] The accelerated cycle can cause too much or too little rain or snow to fall, often at the wrong time of the year and in the wrong place. For example, the Amazon Basin is in the grip of a record drought that has been linked to climate-change-induced warming of the sea surface.[44] Also, hydrological cycles in the western United States, the Rhine River Valley in Europe, the Hindu-Kush region in Asia, and the Andes highlands of South America are negatively affected by climate change. As a consequence, snowmelt occurs earlier and earlier each year. The increasing unpredictability and intensity of the hydrological cycle is having direct impacts on the human and natural systems that depend upon stable hydrological cycles for reliable water quality and quantity.

The Intergovernmental Panel on Climate Change (IPCC) predicts that the extent of drought-affected areas globally will likely increase and that this increase will be most deleterious to subsistence farmers. Globally, drought will reduce water availability, hydropower potential, summer tourism, and overall crop productivity.[45] Scientists have also compared data from western US fires against hydro-climatic and land-surface data and found the number of western wildfires has quadrupled, and the area burned from 1987 through 2003 is 6.5 times greater compared to that burned from 1970 through 1986. During this period, the typical wildfire season increased by 78 days (64 percent), and the average burn duration of large fires increased from 7.5 to 37.1 days. Changes in climate particularly caused an increase in spring and summer temperatures and an earlier spring snowmelt, driving up wildfire frequency across the western United States.[46]

Changes in snowmelt have significant ramifications for human populations as well. Most importantly, over one-sixth of the world's population relies on snow and glacial melt for water supplies. If temperatures continue

to increase, peak river runoffs that previously occurred when demand was highest in summer and autumn may shift to winter and early spring, when demand is much less. In addition, winter river runoffs could be lost to the oceans in countries with insufficient water storage capacities.[47] Unfortunately, one face of the climate-change-enhanced hydrological coin is drought from too little water, while the other is flooding from too much water.

Overall, extreme precipitation events are predicted to affect natural ecosystems, therefore increasing the probabilities for extinction, invasion by nonnative species, and spread of exotic diseases.[48] In addition, climate-change-driven sea level rise will flood important coastal wetland breeding grounds for both aquatic life and many bird species. Sea surge will drive salt waters deeper into estuaries, changing the delicate balance between salt and fresh water and hastening more erosion.[49] Global warming will also lengthen the cyclone season. Researchers conclude that atmospheric water vapor concentrations are on the rise, leading to stronger cyclones producing more rainfall and more destructive storms overall. More rainfall will also lead to more severe flooding; more powerful winds will result in higher storm surges, bigger waves, and more erosion.[50] As a result, "the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g., land use change, pollution, over-exploitation of resources)."[51]

Floods are the United States' most costly and destructive natural disaster—over 160 million acres (7 percent) of US land are flood plains.[52] A one-meter rise in sea level would inundate 35,000 square kilometers (km^2) of US land, and a 0.5 meter rise would inundate 18,000 km^2.[53] The mid-Atlantic and south-Atlantic states and the states along the Gulf Coast would be most vulnerable. Coastal islands in New England would also be at risk. The western coast of the United States would be at a lower risk, but the San Francisco Bay area and the Puget Sound region would be exceptions. Obviously, major US cities like New Orleans, Tampa, Miami, Baltimore, Philadelphia, New York, Boston, and Washington, DC, would be severely affected.[54] Protective measures such as dikes, levees, seawalls, and bulkheads range in cost from $150 to $4,000 per linear foot. Overall, studies indicate the cumulative costs in defensive and emergency response measures alone of a one meter rise in sea level by 2100 would be between $20 and $150

billion.[55] DoD planners, in particular, should be cognizant that rising sea levels will inundate several major, irreplaceable DoD facilities.[56] Droughts and floods have been traditional threats to humans for millennia, but the amplification of global temperatures will increase the frequency and intensity of another conventional threat, heat waves.

If average daily temperatures shift because of climate change, then the distribution of daily conditions also shift. This generally leads to a much greater probability of exceeding human health-threshold temperatures for a day or sequence of days. For example, higher temperatures lead to higher absolute humidity and, consequently, to a much higher heat index. In addition, an increase in the frequency of high temperatures can create increased stress levels that weaken and kill off susceptible flora and fauna. For example, coral cannot readily relocate to cooler waters because of geological and biogeochemical conditions; consequently, higher ocean water temperatures are increasing the occurrence of coral bleaching and coral reef die-offs.[57] The IPCC concludes that "approximately 20–30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5–2.5°C."[58]

NASA confirms that the last 10 years were the warmest on record; 2005 is tied with 1998 as the hottest year on record globally. In fact, 1998 received a 0.2°C boost in temperature from El Niño, and 2005 was not an El Niño year.[59] In the United States, 2006 was the fourth warmest year on record. Climate researchers also found that the number of extreme heat events in the twentieth century increased in frequency.[60] Some predict that all US regions will experience more extreme heat events and that the number of extremely hot days—defined as daily temperatures greater than 95 percent of daily temperatures currently—will double. The southwest region would be most affected, with people living in this area experiencing up to 100 additional extremely hot days each year.[61] Increased temperatures as a result of global warming will also aid the development of the deadly air pollutant ozone (commonly called smog) and increase the number of heat-related deaths.

As heat and smog increase, the number of summertime healthy air days in 15 large eastern US cities will be significantly reduced. Unhealthy "red alert" days would double; on average people in these cities would experience nearly 20 percent fewer clean air days in the summer.[62] Additionally, "cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the

course of the century, with potential for adverse health impacts. The growing number of the elderly population is most at risk."[63] Specifically, "heat waves in temperate countries induce heat stroke and circulatory ailments that result in increased morbidity and mortality."[64] Finally, the 2003 European heat wave that killed over 35,000 people is an example of how higher temperatures lead to higher absolute humidity and, consequently, a much higher and deadlier heat index.

Irregular Challenges

Today, irregular challenges to national security can come from state and nonstate actors employing asymmetric tactics to counter US strengths. For example, nonstate actors may employ terrorism or instigate an insurgency to counter US strengths.[65] In a similar vein, many researchers consider global climate change a cumulative and potentially nonlinear, irregular process.

Many evolutionary processes are characterized by nonlinear, punctuated equilibrium;[66] irregular climate change occurs with similar evolutionary characteristics.[67] For instance, the disintegration of saltwater fishing industries due to ocean acidification could spark inter- and intrastate conflict as numerous environmental refugees migrate from their seaside homelands that suffer devastation induced by a climate-change-induced fisheries collapse. In response to such calamities, global societies may resort to radical geo-engineering projects to mitigate climate change. However, unexpected side effects created by international geo-engineering projects designed to alleviate global warming could generate unforeseen, unbalanced threats to national security and US interests. At a minimum, the security implications of mass migration will challenge the economic and security resources of states that receive the migrating populations.

Increasing concentrations of CO_2 in the atmosphere also increase the acidification of the oceans. In a 2007 IPCC report, scenario projections forecast an average reduction in global surface ocean pH (the lower the pH the greater the acidity) of between 0.14 and 0.35 units by 2100 that will be added to the present decrease of 0.1 units since preindustrial times.[68] Scientists contend that "in colder waters, a larger decrease (in pH) will occur. Because the change is occurring so rapidly (in geological terms), natural buffering is not able to moderate the changes. As a result, calcifying organisms are expected to be severely stressed or be unable to survive."[69] In sum, higher acid levels could extinguish many forms of valuable, life-

supporting marine life by preventing the formation of calcium shells and coral reefs—the nurseries of the seas—which will be increasingly vulnerable.[70] Even though the oceans have an almost infinite ability to absorb atmospheric CO_2, any change to the pH of the oceans has dramatic negative effects on the oceanic web of life and, consequently, on human societies that depend on the oceans for sustenance and for economic well-being.

The marine web of life relies on calcifying organisms, such as corals, crustaceans, some mollusks, and many organisms lower on the food chain. What specifically will happen to the ocean ecosystems as the seas become more acidic is unknown; however, scientists conclude that there is little mankind can do to stop the deleterious near-term increased acidification of our seas.[71] IPCC scientists assert that "the progressive acidification of oceans due to increasing atmospheric carbon dioxide is expected to have negative impacts on marine shell forming organisms (e.g., corals) and their dependent species."[72] Ultimately, ocean acidification could degrade or destroy many marine food supplies around the globe. The irregular security challenge presented by the loss of these major food chains could induce massive movements of environmental refugees.

Global warming will have varying effects on populations across the regions of the world. On average, a 13°C increase in temperature will decrease water availability in mid-latitudes and semiarid low latitudes. As a consequence, up to 30 percent of all species could face extinction.[73] Large movements of people in response to climate change will inevitably degrade environmental conditions in areas that receive the refugees. Population expansions in many parts of the world have already contributed to the degradation and unsustainable use of 60 percent of the world's assessed ecosystem services.[74] Conflict in the Darfur region of Sudan is an example in which marginal environmental conditions exacerbated by climate change and other geopolitical factors forced groups to migrate to areas with better environmental services. Unfortunately, the areas where these environmental refugees moved to were already occupied—the result was violent conflict that continues despite increasing international attention.[75] Global warming could provoke environmental refugees through a variety of climatological processes.

Deserts are expanding in China, Morocco, Tunisia, and Libya. In Egypt, half the irrigated croplands are degraded by salinization, while in Turkey over 160,000 km^2 of farmlands are less productive because of soil erosion. In the United States, Louisiana loses approximately 65 km^2 per year to the

sea, while in Alaska over 200 communities may soon be inundated by the ocean. Internationally, Tuvalu and other low-lying Pacific island states could disappear if sea levels continue to rise. In central, south, east, and southeast Asia, declining freshwater availability in large river basins could adversely affect over one billion people by 2050.[76] In the aggregate, ecological and social degradation by erosion, salinization, desertification, deforestation, drought, floods, heat waves, and other climatically induced environmental problems could produce millions—perhaps billions—of environmental refugees.[77] The enormous pressure to mitigate climate change intensified by massive refugee movements could force states to apply extreme measures, such as geo-engineering, in response.

Geo-engineering occurred for thousands of years, resulting in many unexpected side effects. For example,

> the increased reflectivity of the Earth's surface caused by human-induced changes in vegetative cover dating back thousands of years has exerted a cooling effect on global climate. The largest [of] such effects ha[s] been the replacement of forests by croplands and of croplands and grasslands by deserts (each having the effect of making Earth's surface more reflective to incident sunlight). Further transformations in these directions will probably occur over the century ahead, even though they are not generally considered desirable from an ecological standpoint.[78]

Unforeseen and perhaps undesirable, nonlinear consequences of any prospective climatic geo-engineering process are likely, and some researchers contend that "climate engineers wildly exaggerate what is possible and scarcely consider political, military, and ethical implications of attempting to manage the world's climate." Advocates of such projects seldom consider the potential degradation or destruction of natural ecosystems.[79] One such proposal designed to offset the warming influence of man-made greenhouse gases is a floating Styrofoam raft on the ocean the size of a continent that would reflect sunlight back to space. Several unwanted side effects on both climate and marine life would surely result, and this effort would do nothing to "offset the impact of the human-caused buildup of atmospheric CO_2 on the acidity of the oceans."[80] Another approach aims to decrease global warming by "increasing the reflectivity of the upper atmosphere or by directing some of the solar beam away from the Earth before it reaches the top of the atmosphere."[81] Such radical efforts could be realized by injecting particulate matter into the stratosphere using large cannons; but the secondary effects of this process would likely destroy the protective ozone layer. A third geo-engineering example involves constructing enormous "sunlight deflec-

tors above the atmosphere" built by "launching into Earth orbit roughly 50,000 reflective mirrors, each roughly 10 km by 10 km, or, after building a manufacturing plant on the Moon, the lofting of an 1,800-km diameter solar deflector to an altitude roughly five times the distance of the Moon from the Earth."[82] Unfortunately, unforeseen secondary and tertiary side effects, huge potential costs, and overall effectiveness are totally unknown at this time.

Disruptive Challenges

Disruptive challenges include situations where competitors employ revolutionary technologies or methods that might counter or negate current US military advantages.[83] While not dependent on revolutionary technologies or methods, climatic or environmental changes that run counter to or cancel current US and developed state advantages include famines, changes in water quality and quantity, or pandemics, which could pose disruptive threats to US security and interests. These events, intensified and expanded by disruptive climatic changes such as alterations in rainfall patterns affecting agricultural productivity, declining runoff from glaciers or other rain-/snow-fed water systems, and spread of vector-borne tropical diseases to previously disease-free temperate regions will have dire and unsettling consequences.

The great "breadbasket" of agricultural zones around the world is expected to be particularly affected by global warming—but scientists disagree on what form the effects will take. For example, some researchers predict monsoon rains and flooding will increase. Conversely, other scientists think that air pollution will reduce the amount of solar radiation warming the surface and cause a weakening of the monsoons. For most tropical and subtropical regions, "monsoon rainfall provides most of the water and soil moisture needed by agriculture. Significantly heavier rains would make the fields too muddy, whereas significantly less would make the fields too dry."[84] Scholars have also noted that "societies in the region are structured based on past experience with the monsoons, so altered conditions would create disruption until adjustments were made. Larger year-to-year fluctuations in intensity would be likely to stress available systems. Worldwide, monsoons provide water for billions of people, and monsoons redirect atmospheric circulation, affecting global weather."[85]

Researchers contend that global food production should "increase with increases in local average temperature over a range of 1–3°C."[86] However,

if global average temperatures exceed 1.5–2.5°C, scientists predict "major changes in ecosystem structure and function, species' ecological interactions, and species' geographic ranges, with predominantly negative consequences for biodiversity and ecosystem goods and services, e.g., water and food supply."[87] Scientists note that "poor communities can be especially vulnerable, in particular those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies."[88] Africa is especially vulnerable to climate change, with many African states already suffering varying degrees of famine and food scarcity. Climatic changes could push these states toward failure and collapse.[89] Climate change will not only disrupt global food supplies but may also affect the quality and quantity of both fresh and saltwater.

Climate scientists predict that "by mid-century, annual average river runoff and water availability are projected to increase by 10–40% at high latitudes and in some wet tropical areas, and decrease by 10–30% over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water stressed areas. In some places and in particular seasons, changes differ from these annual figures."[90]

Furthermore, many lakes and rivers worldwide will likely "experience changes in their thermal structure and water quality."[91] Researchers determined that "changes in the timing of snowmelt are leading to earlier runoff, changing the temperature and flows of rivers and streams, and, in the summer, causing warmer temperatures and lower flow rates. All of these changes will disrupt aquatic ecosystems, fish, and wildlife."[92] Field researchers have also found that "snowmelt is a vital contributor to water resources for many regions around the world, especially for those depending on rivers originating in high mountain regions and for water systems relying on seasonal snowpack to refill reservoirs in spring and summer. Relatively little warming can, in some situations, cause very large changes in water availability."[93] Scientists also predict that this century water supplies stored in glaciers and snow cover will decline and the decline will substantially reduce water availability in those regions supplied by meltwater from major mountain ranges, where more than one-sixth of the world's population currently lives.[94] In Africa alone, by 2020 between 75 and 250 million people will be exposed to an increase of water stress because of climate change.

Climatically-driven changes in freshwater and marine biological systems could include decreases in ice cover accompanied by alteration of salinity,

oxygen levels, and circulation. The effects on living organisms include "shifts in ranges and changes in algal, plankton and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier migrations of fish in rivers."[95] Climate-change-related famine and water stresses could disrupt societies, thus weakening their ability to respond to additional climate-change-driven threats such as pandemics.

The effects of disease vectors on natural ecosystems are not well studied, but some empirical evidence is emerging. Researchers conclude that an increase in global temperatures will increase survival rates of many different disease vectors, possibly leading to increases in the frequency and intensity of vector-borne disease and pandemics.[96] For example, the temperature increase of about 1°C per decade since 1970 in Alaska has caused permafrost thawing and allowed the overwintering of spruce bark beetles and the influx of additional forest disease vectors. These disease attacks weakened spruce forests, resulting in 9,000 km^2 of dead trees on the Kenai Peninsula, making forests on the peninsula more prone to frequent and extensive wildfires.[97] Clearly, pandemics can have broad and complex ecological, security, and social ramifications for humans.

Scientists conclude that the spread of diseases among populations already weakened by global warming will threaten plant, animal, and human health. The spread of vector-borne diseases (for example malaria, dengue, yellow fever, and encephalitis) and nonvector-borne diseases (such as cholera and salmonellosis) could pose a serious threat to human health.[98] In sum, the potential for societal disruption from climate-change-induced famine, water stress, and pandemics is equal to, and possibly greater than, the threat from adversaries introducing revolutionary new technologies or methods designed to counter US capabilities. Specifically, "endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and Southeast Asia due to projected changes in hydrological cycles associated with global warming. Increases in coastal water temperature would exacerbate the abundance and/or toxicity of cholera in South Asia."[99]

Catastrophic Challenges

The US strategic view of catastrophic challenges focuses on terrorists or rogue states employing weapons of mass destruction (WMD) or methods producing WMD-like effects against US interests.[100] Climatic and environmental changes producing WMD-like effects against US interests could

occur from a one- to eight-meter sea level rise resulting from some or all of the polar ice caps melting. In addition, mass extinctions of animal and plant species caused by degradation of natural habitats and niches driven by sea level rise and/or global warming would be disastrous for all of mankind. Security specialists also contend that "projected climate change will seriously exacerbate already marginal living standards in many Asian, African, and Middle Eastern nations, causing widespread political instability and the likelihood of failed states."[101] Climate change may have an additive feature that could simultaneously induce failures in both natural and human systems, resulting in global calamity.

Research on warming at both poles indicates that changes in the ice system may be approaching catastrophic levels; changes appear to be occurring more rapidly than previously observed or expected.[102] In Greenland and in the Antarctic, ice sheets are melting and thinning more rapidly than in the past.[103] In the Arctic, researchers found that the loss of mass from the Greenland ice sheet doubled between 1996 and 2005 to 224 ± 41 cubic kilometers (54 ± 10 cubic miles) per year.[104] Climate models project that by 2100 the high northern latitudes will be as warm, or warmer, than they were during the last interglacial period. Paleoclimatological researchers have determined that during the last interglacial period, approximately 127,000 to 130,000 years ago, sea levels were four to six meters higher than today.[105] Loss of the southern half of the Greenland Ice Sheet alone would raise global sea level by two to three meters, and full melting of the sheet would raise sea levels roughly seven meters. Finally, if the Western Antarctic Ice Sheet (WAIS) were to melt, sea levels would rise about six meters,[106] and the "retreat of Antarctic Sea ice and even partial loss of the WAIS will alter ocean circulation, weather, and the survivability of key species."[107]

The Arctic is warming almost twice as fast as the rest of the world, and significant challenges to arctic communities are apparent today. Scientists determined that average winter temperatures increased as much as two to four degrees Celsius in the past 50 years in Alaska, western Canada, and eastern Russia. Alaskan Inuit elders report unpredictable sea-ice conditions have made hunting more difficult and hazardous. Conservative estimates project a 50 percent decline in sea ice during the Arctic summer by the end of this century. Less conservative models show the "complete disappearance of summer sea ice. Because ringed seals and polar bears are unlikely to survive in the absence of summer sea ice, the impact on

indigenous communities that depend upon these species is likely to be enormous."[108]

Today, 21 percent of the world's population lives within 30 km of the coast, and the coastal population is growing at twice the average rate of global population.[109] Some researchers have ascertained that a sea level rise of one to five meters by 2100 would displace roughly between 130 and 410 million people.[110] Consequently, large-scale polar ice cap melting would undoubtedly have calamitous global repercussions. One of these repercussions could involve global die-offs of plants and animals.

Ecosystem experts conclude that climate change already affects global biodiversity. Global warming has already pushed the arrival of springtime on every continent forward by not just a few days but by weeks. In addition, many species are migrating poleward, the natural ranges of some species are contracting, predator-prey relationships are being altered, and abundance and ranges of parasites and disease vectors are changing—all contributing to the extinction of individual species.[111] Flora and fauna experts argue that "ecosystems are generally attuned to the prevailing weather regimes, and shifts in the location of these regimes will lead to shifts in ecosystem locations as the warm edges contract and poleward edges become more conducive to growth. The differing pace of movement will likely cause significant disruption of ecosystems and their important services."[112] As mentioned before, approximately 20 to 30 percent of all plant and animal species surveyed will be at increased risk of extinction if global average temperature increases exceed 1.5–2.5°C.[113] Furthermore, scientists conclude that "projected decreases in rainfall in the tropics would lead to an extensive die-back of tropical forests and the ecosystem changes could occur in a less than a century. Forest death would lead to loss of many ecosystems rich in biodiversity and would significantly reduce carbon storage amplifying global warming."[114] If tropical forests die back as predicted, this would "result in loss of a very productive ecosystem and diminution of water storage globally, greater warming and significant loss of biodiversity."[115] Other eco-regions of the world will also be significantly threatened with a severe loss of biodiversity through species extinction due to global warming. Latin America is particularly vulnerable to species loss from climate-induced habitat changes.[116]

IPCC models project that if global average temperatures exceed 1.5–2.5°C, then "major changes in ecosystem structure and function, species' ecological interactions, and species' geographic ranges [will occur], with predominantly

negative consequences for biodiversity, and ecosystem goods and services, e.g., water and food supply."[117] As a corollary, researchers conclude that "in regions where weather regimes shift, societal tuning to particular types of conditions will be upset, possibly requiring adjustments to buildings, infrastructure, transportation, health care, and community lifestyle. Globally, the weather and its seasonal patterns in each region will become more like that hundreds of kilometers toward the equator, necessitating a wide range of adjustments."[118] These adjustments required to mitigate or adapt to climate change will tax the resources and capabilities of developed states and are beyond the capabilities of poor or unstable states. Consequently, mass extinctions will destroy biodiversity, amplify global warming, debase the quality of life for humans, and threaten the stability and security of many states.

Climate change may provoke a large-scale breakdown of natural ecosystems. It may also induce state failure as key natural ecosystems collapse. Conversely, the failure of certain states may also threaten the survival of key natural ecosystems. The deleterious circular, additive attributes inherent in many of the challenges created by climate change infuse substantial pressures on natural ecosystems and state infrastructures. The Scientific Expert Group on Climate Change and Sustainable Development warns of the dangerous additive quality of global warming, noting that

> climate change during the 21st century is likely to entail increased frequency and intensity of extreme weather, increases in sea level and the acidity of the oceans that will not be reversible for centuries to millennia, large-scale shifts in vegetation that cause major losses of sensitive plant and animal species, and significant shifts in the geographic ranges of disease vectors and pathogens. These changes have the potential to lead to large local-to-regional disruptions in ecosystems and to adverse impacts on food security, fresh water resources, human health, and settlements, resulting in increased loss of life and property. Some sectors in some locations may benefit from the initial changes in climate. Most impacts are expected to be negative, however, with the social and economic consequences disproportionately affecting the poorest nations, those in water-scarce regions, and vulnerable coastal communities in affluent countries.[119]

As a result of the cumulative characteristics of climate change, the degradation and outright destruction of life-supporting ecosystems could have nonlinear environmental consequences with catastrophic global effects. The loss of environmental services provided by these natural ecosystems could force large populations to exploit other less stable environmental services in an attempt to replace lost services. If climate change induces environ-

mental refugees and these migrants move into areas of marginal ecological and social stability, the vulnerable state may be pushed over the edge and become a failed state. For example, in northern Africa, "natural droughts, compounded by poor agricultural practices and land-tenure policies, have contributed to severe famines, such as those in the Sahelian zone of Africa in the early 1970s and 1980s, which in turn led to the displacement of large numbers of people."[120] The displacement of massive numbers of poor, starving people into states that already have difficulty supporting their own indigenous populations is a recipe for more environmental degradation and, eventually, state failure. Multiply these deadly circular events across the globe and the end result could be cataclysmic failure of both ecological and human social systems.

National security experts assert that "when climates change significantly or environmental conditions deteriorate to the point that necessary resources are not available, societies can become stressed, sometimes to the point of collapse."[121] An analysis of the impact of climate change on international security by national security experts concludes that

> unlike most conventional security threats that involve a single entity acting in specific ways and points in time, climate change has the potential to result in multiple chronic conditions, occurring globally within the same time frame. Economic and environmental conditions in already fragile areas will further erode as food production declines, diseases increase, clean water becomes increasingly scarce, and large populations move in search of resources. Weakened and failing governments, with an already thin margin for survival, foster the conditions for internal conflicts, extremism, and movement toward increased authoritarianism and radical ideologies.[122]

Attacks on state support systems could come from diverse sectors. Currently many states have impaired access to food and water; climate change will only exacerbate these vulnerabilities. In addition, "violent weather, and perhaps land loss due to rising sea levels and increased storm surges, can damage infrastructure and uproot large numbers of people."[123] As discussed before, many negative effects of climate change could create large numbers of refugees who will undoubtedly cross borders in search of resources, bringing large-scale violent conflicts in their wake. The massive migrations of people from Bangladesh to India in the second half of the last century were attributed, among other environmental factors, to the degradation of arable land in Bangladesh. The migration severely degraded economic and political conditions in India, and violence ensued between the locals and the new

migrants.[124] Less recent history also provides vivid examples of state collapse as a result of changing environmental factors.

Human-induced devastation of environmental conditions and climate change directly contributed to the disintegration of the Easter Island, Mayan, and Anaszai Indian societies.[125] Societal collapse can be one major outcome of such catastrophic challenges, but, unfortunately, "when governments are ineffective, extremism can gain a foothold. While the developed world will be far better equipped to deal with the effects of climate change, some of the poorest regions may be affected most. This gap can potentially provide an avenue for extremist ideologies and create the conditions for terrorism."[126]

The catastrophes that could ensue from the melting of the polar ice caps, mass die-offs of plants and animals, and the climate-change-induced failure of states to provide basic services threaten US security and national interests. However, the convergence of these traditional, irregular, disruptive, and catastrophic challenges presents the gravest threats, risks, and vulnerabilities that any sustainable security must address.

The Perfect Storm

Overall, a variety of forcings that control climate add and subtract from the overall global average temperature. Researchers have found that positive forcings (forces that increase temperature, such as rising greenhouse gas emissions levels or polar ice melting) currently may be underestimated. Temperature increases predicted in the coming decades may greatly augment ongoing positive forcings as soils, oceans, and forests may release more CO_2 and methane. Additional greenhouse gases could amplify predicted temperature ranges from 1.5–4.5°C to 1.6–6.0°C[127] or further enhance warming by an additional 15–78 percent.[128] Consequently, warming could be much greater than anticipated by the IPCC with the accompanying magnification of climate change effects. Unfortunately, scientists still do not understand how the feedback mechanisms that control climate interact, but the potential for "dangerous" climate change that raises sea levels and drives species to extinction may only be less than 1°C away from current global averages.[129] As a result, climate change could result in "multiple chronic conditions, occurring globally within the same time frame" acting as a "threat multiplier for instability in some of the most volatile regions of the world."[130] Therefore, the threats are clear, the scale is global, the solutions are within reach, and the alternative to no action may be a "perfect storm":

> Climate change is expected to have a widespread negative effect on water resources, natural ecosystems, coastal communities and infrastructure, air and water quality, biodiversity, coastal fisheries, parks and preserves, forestry, human health, agriculture and food production, and other factors that support economic performance and human well-being around the world. The impacts on society are expected to differ greatly depending on regional and local cultural practices, engineering infrastructure, farming resources, governments, natural resources, population, public health conditions, financial resources, scientific and technological capability, and socioeconomic systems. . . . Only by mitigating the effects of climate change and finding new, achievable ways to adapt to them can the world find stability and prosperity. . . . The challenge now is to keep climate change from becoming a catastrophe.[131]

The simultaneous occurrence of several climate change threats, the "perfect storm," would overwhelm the ability of US forces to respond in a timely and effective manner. Consequently, the potential of a global warming "perfect storm" will force US defense planners toward a sustainable security strategy (see fig. 1).

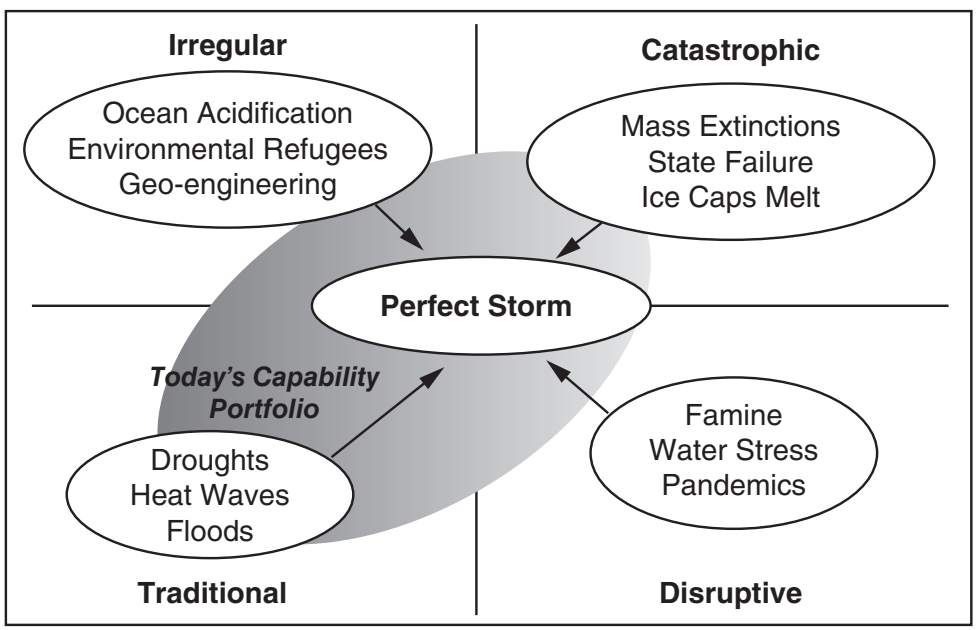

Figure 1. Climate Change Security Challenges: The Perfect Storm. (Modified by John T. Ackerman from "Quadrennial Defense Review Results" [Washington, DC: Office of the Secretary of Defense, 3 February 2006], transcript of press briefing slides.)

Reorienting Capabilities and Forces

The adjustments necessary for the US military and the DoD to counter a looming "Perfect Storm" of traditional, disruptive, irregular, and catastrophic challenges created by global climate change are multifaceted. The process will require that the defense establishment embrace a broader conception of security that incorporates environmental and climate concerns, focuses on the long-term, and emphasizes sustainability. The process will also require that all activities using US instruments of power be unified to create sustainable security by peacefully spreading democracy, encouraging economic cooperation, and leveraging the cooperative functions of international organizations. Sustainable security for the United States and every state in the international system is possible, in spite of the challenges posed by global warming. It does not require a hegemon, seeking empire, to create sustainable security. It does not require a superpower to placate the power of anarchy and security dilemmas. It requires US foresight, planning, and leadership to develop a sustainable security strategy.

First, a sustainable security strategy must be based on clear definitions of the critical elements of sustainability. The strategy should focus on enhancing human well-being as a national and international security objective. Specifically, human well-being must encompass environmental security for all states, global application of the principles of ecological economics, and equal access to the resources for living, good health, and high-quality social relations.[132] However, sustainability alone lacks a system to foster social cohesion and drive the necessary political, economic, social, and environmental changes that will ease implementation of the elements of sustainability. The missing catalyst is the capability for political action or governance. Consequently, sustainable security requires combining two relatively new international relations theories that are approaching ideological status—the sustainability paradigm and democratic peace theory.[133]

A new national sustainable security strategy will buttress traditional precepts found in the *National Security Strategy 2006* of "freedom, democracy, and human dignity"[134] by recognizing the wisdom of acting within the inherent limits of our natural environment and the power of fully accountable free markets, and by acknowledging the innate right of all people to free, equitable, and secure lives. Sustainability has become "the tool for obtaining political consensus. Today there are no political alternatives to sustainable development,"[135] and all of these processes can be enabled by democratic regimes.

Specifically, the democratic peace theory has been called "the closest the field of international relations has come to producing an empirical law," and importantly, democracies themselves have been described as creating a " 'near-perfect' sufficient condition for peace."[136] Therefore, intertwining democracy, sustainability, and security processes will enable the United States to respond to the threat from global warming through strategies that mitigate environmental and climatic changes and encourage adaptation to the consequences. The response requires reshaping the defense enterprise around a sustainable security strategy.[137]

The US Army has been a leader in DoD efforts to incorporate sustainability concepts into security operations. In particular, the Army has created its own "triple bottom line" for sustainability based on the principles of "mission, community, and environment."[138] A similar civilian triple bottom line for sustainability of "economics, equity, and environment" (the "three Es") was the model for the Army's principles.[139]

The civilian "three Es" incorporate the "diverse, worldwide, multi-cultural, and multi-perspective" process that has been called the "sustainability revolution."[140] This broad approach offers the possibility for positive change both within and among societies in a context that does not pit opposing parties against each other in no-win situations.[141] Creativity, cooperation, and context are core issues in which the three Es operate and produce sustainability.

The environment portion of the three Es is built around three critical ecological subtenets. First, environmental sustainability requires a long-term perspective as opposed to a short-term view. Second, ecosystems are not separate entities but are linked to the larger biosphere system that secures and anchors human life, the essence of environmental security. Finally, ecosystems have built-in sustainability checks and balances that humans must be aware of at all times.[142]

Economic sustainability departs from neoclassical economic perspectives in several ways.[143] Most importantly, sustainable or ecological economics recognizes the significance of natural capital as being indispensable for human life.[144] Unfortunately, natural capital in the past has been treated as an unlimited common, free to all, and consequently, subject to overuse and abuse.[145] Whereas neoclassical economists consider sustainability to be a fad, ecological economists recognize the limits to a finite biosphere.[146]

The third subtenet of sustainability answers social, political, and environmental appeals for universal justice. A multilevel approach to sustainability is inherent in this concept. At the individual level, equitable

sustainability ensures that resources are fairly distributed; at the community level, sustainability encourages "cooperation and concern for one's neighbor"; and at the state level, sustainability places responsibility for an equivalent quality of life in the hands of just and fair governments.[147] Implicit in this argument is the assertion that the long-term viability and security of global society is predicated on the fair and balanced distribution of resources and power.

However, the Army's version of the triple bottom line and the civilian three Es need a few refinements if mitigation and adaptation to climate change and, eventually, sustainable security are to become feasible. Nevertheless, the Army's sustainability efforts can become a model for the effort to reshape the defense enterprise if defense leaders alter the bottom line to incorporate ecological economics, social/environmental equity, and environmental security.[148] In the new construct, the "mission" of the military would add providing sustainable security enabled by environmental security, ecological economics, and social/environmental equity blended with the democratic peace to traditional interest-based security concepts.

The Army's replacement of the economic principle with mission obscures one of the dominant factors involved in unsustainable, climate unfriendly processes in the United States and around the world. In the United States, the DoD is a power player in the economy and is responsible for the largest share of the national budget, with expenditures exceeding $500 billion per year. If sustainable ecological economic principles are not incorporated into DoD energy production, distribution, and consumption practices, the entire system for operating, training, and equipping US forces will be unsustainable. Energy production, distribution, and consumption processes are the lifeblood of national defense and are also some of the primary drivers of global warming. The DoD is the largest energy consumer in the US government, but less than 10 percent of the energy it uses comes from renewable sources. Consequently, reshaping the defense enterprise to prepare for the challenges anticipated from climate change will primarily revolve around making energy processes sustainable by applying ecological economic principles.

Energy processes within the DoD must become sustainable within natural, environmental, and climatic limits. In essence, current DoD energy processes must evolve toward those that are carbon free, climate friendly, and environmentally benign if US national security is to become sustainable. Unfortunately, current sustainability efforts—such as complying

with environmental regulations, purchasing more green energy, and developing and deploying more-energy-efficient combat systems—have only been partially successful.[149] The department must do more to lengthen product/system lifetimes, reduce resource throughput, increase the use of renewable energy, decrease or capture greenhouse gas emissions, apply true ecological cost accounting procedures, and leverage DoD procurement policies as part of an integrated sustainable security strategy.

The DoD must integrate processes that increase the lifetimes of military products and combat systems so that they are more durable, thus decreasing energy and resource consumption rates.[150] Military equipment or services leased from providers, responsible for maintaining, reclaiming, and recycling equipment at the end of its lifespan would optimize cradle-to-cradle processes.[151] Leasing products and services can also reduce ownership costs associated with military systems, facilities, and operations. Leasing will allow the DoD to stipulate that the production of products and services are at least carbon neutral and, thus, climate friendly.

The resource base (primarily fossil fuels and minerals) of the US economy is finite, as is the global base. Decreasing the total resource throughput in the DoD economy and overall in the US economy has multiple benefits. Reducing resource throughput would diminish the total ecological and atmospheric footprint from resource extraction, energy use, and pollution. Concurrently, reduction will encourage development of creative and innovative efficiency, conservation, and carbon-neutral solutions to production, distribution, and consumption challenges.

As mentioned before, the DoD is the single largest energy consumer in the United States; numerous opportunities currently exist to reduce demand, incorporate renewable energy technologies, and mitigate negative environmental side effects (air, land, and water pollution).[152] Specifically, new solar, wind, geothermal, and biomass energy technologies have the potential to answer the call to reduce ecological flows while serving unique DoD needs. Solar and wind energy production rely on renewable resources, require no additional fuels, create no pollution, are transportable, and can be installed close to the power consumer.[153] Thus, these alternatives are perfect for mobile, agile military forces. The US Air Force leads all federal agencies in purchasing renewable sources of energy, buying over 40 percent of all green energy purchased by the federal government.[154] However, current purchases of green energy are part of a less focused plan to reduce energy consumption. Purchasing green energy should be part

of a wide-ranging sustainable security strategy that reduces emissions and resource throughput force-wide.

Climate specialists and ecological economists would recommend the DoD use the most advanced building designs, equipment, and appliances that reduce energy consumption, resources use, and emissions. The new, environmentally friendly designs and processes also improve working conditions and worker performance. Purchases or leases from green manufacturers also create negligible or even zero waste streams and toxic materials and employ the most energy-efficient processes.[155] All DoD power plants should implement carbon capture and storage procedures and consume renewable biomass for fuel whenever possible.[156] In addition, all DoD military ranges should begin a process to reforest deforested areas and replenish degraded soils.[157] These processes will limit the release of greenhouse gases, capture carbon, and reduce dependence on nonrenewable fossil fuels. If the DoD reduces its dependency on fossil fuels, billions of dollars in subsidies paid to fossil fuel companies will become available for other defense-related purposes. The savings could spur development of more renewable, climate-benign energy sources like solar, wind, and biomass.[158] Again, applying true cost accounting standards and using energy-efficient vehicles and processes can increase overall sustainability while maintaining current security capabilities.

One direct method that can reduce resource flow (extraction, consumption, production, or reuse) and deleterious climate changes is to tax the DoD on the amount of resources and energy used, waste created, or pollution produced. The process of shifting taxes away from income toward environmentally destructive processes has been endorsed by many economists.[159] This would create additional incentives for more resource efficiency and conservation. Using market forces to indicate the real environmental, climatic, economic, and social consequences of DoD activities is a profound way to "tell the ecological truth"[160] about national security efforts. Simply put, reducing energy throughput will free funds for more "teeth" and reduce the burdensome "tails" that inhibit agile deployment, maneuver, and engagement of forces.[161] If US forces become more self-sufficient in energy by utilizing local renewable sources (biomass, solar, wind, or geothermal), then the logistics requirements will be greatly reduced.

The procurement process is a major fulcrum for institutionalizing environmental sustainability and security change—specifically the DoD's substantial national and international purchasing leverage that can encourage

firms and industries to incorporate sustainable, climate-friendly principles into their production, distribution, and consumption activities. The leverage could be even more effective if the DoD became "an early adopter of innovative technologies and could stimulate others to follow."[162] Transportation is another activity that produces substantial greenhouse gases and is an inviting target where the department can leverage its procurement muscle.

The DoD should aggressively develop and purchase highly fuel efficient vehicles, ships, and planes.[163] Current testing of hybrid, plug-in hybrid, and hydrogen vehicles and equipment by the services is a step in the right direction. Also, alternative fuel vehicles have been introduced into the department's vehicle fleet; however, purchases have been limited because of the relatively high initial costs of the vehicles and the lack of a support infrastructure.[164] Unfortunately, most of these efforts are piecemeal, uncoordinated, and not part of an overall plan to reduce emissions and resource throughput. The DoD's purchasing leverage and market economies of scale should be applied to these programs to reduce overall costs as part of a broad and encompassing sustainable security strategy. Additionally, the DoD should create performance metrics for energy use in general rather than just for transportation energy. Flexible policies, measures, and approaches that reduce energy use or emissions should be rewarded and inefficient energy efforts taxed.[165] Overall, this would reduce the environmental and climate footprint that the DoD creates, save taxpayer dollars, drive new innovations, sustain natural capital for future generations, and increase combat power. Sustainable change that would implement the elements of sustainability also involves the Army's triple-bottom-line principle of community.

The Army focuses on being "an active citizen within our communities as well as a good neighbor"[166] but does not overtly address the issue of equity. Sustaining security and mitigating climate change requires rebalancing national and international political, social, and environmental inequities. As a good neighbor, the DoD in general must work through democratic processes to eliminate discrimination, bigotry, and unequal distribution and use of resources and energy wherever the department operates, domestically and internationally. This equity principle especially applies to operations in other countries, and equity may be the unappreciated factor that exacerbates international conflict.[167]

Equitable treatment leads to constructive engagement. This should be a cornerstone for security, stability, transition, and reconstruction (SSTR) operations. Importantly, focusing the combatant commander's Theater Security Cooperation Plans (TSCP) on equitable mitigation and adaptation processes will build host-nation capacities, promote stability, and ensure greater trust and cooperation.[168] Trust and cooperation can generate goodwill towards the United States, a vital element of current security cooperation plans and a central counter to global terrorist operations.[169] Equity is also at the heart of the climate change challenge.

The powerful influence of equity in global climate change negotiations has been widely studied.[170] The disequilibrium between the most vulnerable states and the least vulnerable states can be framed using many different qualifiers.[171] For example, the climate change discussions often break down into conflict between less vulnerable, rich, developed states that are most responsible for climate change and the very vulnerable, poor, less developed states that have little responsibility for global warming. Also, perceptions of the developed states as "Western," "colonial," "capitalist," "Northern," or "first tier" continue to infuse the climate debate with ideologies, passions, and assumptions seen through the lens of political history.[172] In particular, less developed states argue that they must have help to cope with global warming and its consequences, and yet many of these states are wary of US or Western diplomatic initiatives they suspect as covert attempts at exploitation and subjugation.[173] Nevertheless, an opportunity exists in the form of technology transfers and economic assistance to help less developed countries field cleaner sources of energy and transportation that produce little or no greenhouse gases.[174]

Just how urgent these transfers/assistance needs are is exemplified by the question of Malawi's minister of forestry, fisheries, and environmental affairs at the 1997 Kyoto Conference: "How can we devote our precious resources toward reducing emissions when we are struggling every day just to feed, clothe, and house our citizens?"[175] As a result, many policy makers believe that climate change is the greatest challenge to North-South cooperation the world has ever seen.[176] Strengthening capacity, stability, and equity within vulnerable states is a tremendous opportunity for the DoD to build positive, cooperative relationships, similar to what occurred after the 2005 tsunami in Southeast Asia.[177] Unfortunately, many developing countries suffer from internal resource distribution inequalities that are sources for popular grievances that cause nonviolent and violent conflict

and stimulate terrorism.[178] Fair, equitable, respectful treatment of allies and enemies are core values of American forces and are essential for victory in the war against terror and for the creation of long-term security and sustainability.

The DoD's existing approach to the natural environment is shallow and unremarkable. DoD policies reflect perceptions of environmental issues more in the realm of pollution prevention, toxic waste cleanup, base closures, and worker safety.[179] This approach lacks concentrated research into the relationships between environmental/climatic change and conflict and into how to sustain environmental security. Comprehending these processes requires investigating how altering environmental and atmospheric conditions creates environmental deprivation, which can then lead to insecurity and threats to US national security and interests.[180] Researchers must also examine the historical roots of the "pervasive conflict and security implications of complex nature-society relationships."[181] In essence, comprehending how to secure the environment from catastrophic change is a vital national interest.

First, the environmental security of military areas of operations (AOR) and the consequences of DoD operations on the local environment must be understood and planned for, and all negative environmental and atmospheric results eliminated or mitigated. The negative economic externalities of production and consumption in the form of pollution, waste, and climatic and environmental degradation also have to be incorporated into economic and mission-oriented accounting procedures to determine the actual bottom line before acting on procurement and operational decisions.[182] Specifically, combatant commanders' TSCPs should identify in an AOR who controls access to water, food, and energy. Also, plans must account for the basic environmental context surrounding the water, food, and energy situation, with an eye toward developing ways to mitigate or improve basic environmental conditions. These efforts will build trust, cooperation, partnership, and goodwill. Additionally, these activities will improve host-nation capacity and capability to deal with climate change and other national security threats.[183]

Second, the DoD must accomplish a holistic, futuristic, threat-based, causation-oriented, proactive, and ethical examination of environment-security linkages.[184] This involves working through domestic and international climate change/environmental regimes to create partnerships that reduce emissions, resource use, and environmental degradation.[185]

The goal should be to enhance sustainable security—defined as providing for security in a manner that at the very least does not diminish or compromise, and at very best actually enhances, an environmentally, socially, and economically sustainable quality of life for future generations worldwide.[186] The military/civilian force needed to accomplish this goal should be a "self-contained, self-sufficient, full-service enterprise capable of being projected over great distances and sustained for long periods of time to deal effectively with a full range of complex emergencies (on their own terms)."[187] Recent environmental security research[188] has made vital contributions to our understanding of environment-security issues, globalization ramifications, and transnational security threats, but more research is still needed into the threat, risks, and vulnerabilities created by climate change.[189]

The real bottom line is that the DoD must become the leader—the driving force within the United States and globally—in creating a sustainable security strategy. The strategy should be based on ecological economic principles, social/environmental justice tenets, and environmental security concepts that are interwoven with the principles of democratic peace. The development of a twenty-first-century force capable of executing a sustainable security strategy is the next challenge, and it will definitely require unity of effort.[190]

Achieving Unity of Effort

The United States, and in particular the DoD, cannot prevent climate-induced catastrophes alone. Successful mitigation and adaptation require integration of all instruments of power and greater cooperation between the United States and all germane international organizations and states. In particular, interagency efforts must expand information collection capabilities to plan and conduct climatic and environmental SSTR operations. Also, the US government must create the concepts and doctrine for a sustainable security initiative that expands security obligations beyond traditional state-centric security issues into economic, environmental, technological, and social domains. The international consequences of climate change should be a focal point. In particular, the global degradation of natural ecosystems such as forests, soils, oceans, freshwater systems, and anthropogenic processes (e.g., resource/energy procurement and consumption) have to be considered when planning, synchronizing, and executing sustainable security policies. Additionally, the DoD should have

more latitude in building mechanisms for developing, training, equipping, and advising host-nation sustainable security forces. These mechanisms must be culturally, environmentally, economically, and politically specific to the host nation.

A prime policy vehicle for sustainable security against climate change must be the development of national sustainable security planning guidance and a national sustainable homeland security plan. A key enabler for these policies will be the creation of a sustainable security corps of military and civilian professionals, trained to respond to security, climate, and environmental challenges. In addition, the US government and the DoD must "overhaul traditional foreign assistance and export control activities and laws"[191] with a new focus toward facilitating sustainable security. A critical buttress to policy development and the study of climate change/sustainable security could be the creation of a national sustainable security university.[192]

Generally, the DoD must "transform itself into an enterprise whose organizations and processes support . . . agile"[193] sustainable security forces that can conduct operations without degradation to the environment, economy, or society. These forces must also be able to work with other states to "build the capacity and resiliency to better manage climate impacts."[194] Management processes within the DoD must also shift from a threat-based approach to a capabilities-based approach.[195] These capabilities must sustain national security against the threats created by global warming and by the unsustainable resource and energy consumption processes currently used within the DoD. The key to any transformation within the DoD are people.

The strength of the DoD has always been the high quality and dedication of the personnel who serve the United States. To increase their capabilities to address the challenges created by climate change, department members must improve their language proficiencies, cultural knowledge, and environmental awareness. Today, the stress on the force is enormous, and if that stress is to be effectively managed, the whole force must be organized, trained, and equipped for the fight against global warming and for the mission of contributing to sustainable security. If the whole force is to be brought to bear, the Active/Reserve component mix and civilian/contractor workforce must be rebalanced, the Reserve component must become more operationally competent, and, overall, the skill sets necessary to build sustainable security must be identified, trained, and institutionalized.[196]

The future forces of sustainable security will have to be shaped and reshaped to counter an ever-changing strategic environment. Sustainable security forces must be ready for both "steady-state and surge operations"[197] in response to climate-induced traditional, irregular, disruptive, and catastrophic threats. For example, these forces must be able to respond quickly to conventional state-on-state security challenges induced by societal, political, economic, environmental, or climatic pressures. Simultaneously, additional sustainable security forces must be prepared to provide flexible deterrence to or to respond to abrupt environmental changes, failed states, insecurity entrepreneurs, or even terrorists who see climate-mitigated chaos as an opportunity for aggression or coercion.[198] In sum, the new breed of US defense forces should be able to react to a variety of security, climate, and environmental challenges flexibly, rapidly, and sustainably. Democracy is the catalyst that will power the transformation and unify the efforts of US defense forces as well as the defense forces of other states. I do not mean a plain vanilla, Western-style democracy, but a new form of "green democracy" that supports the three pillars of sustainability: environmental security, ecological economics, and social/environmental equity.

Green Democracy and Kant's Three Pillars

Immanuel Kant was the most famous scholar to propose three pillars supporting liberal progress toward peace, prosperity, and security: Kant's "republican constitutions" equate to today's representative democracies, "cosmopolitan law" is nowadays represented by global commerce and free trade, and Kant's "pacific union" corresponds to modern international law and organization.[199] Scholars have investigated the pillars for relevance and accuracy and have slightly modified Kant's concepts for modern application. Consequently, a "virtuous" triangular relationship was identified in which democracy, economic interdependence, and international organizations interact to enable, enhance, and increase peaceful relations, security, and nonviolent conflict resolution globally.[200] These three liberal pillars, separately and especially synergistically, have enormous implications for sustainable security if integrated with the remodeled three Es of sustainability: environmental security, ecological economics, and environmental/social equity.[201]

Democratic processes and international organizations can implement the difficult, expansive, and complex policies needed to mitigate or adapt to global climate change. Democratic processes will ensure the necessary policies

are the will of the people, are transparent, and are perceived as legitimate. International organizations reduce transaction costs and uncertainty and provide a structure that can establish accountability and reliability, as well as ensure accurate, honest monitoring, verification, compliance, and enforcement of climate change and sustainability agreements. Free, open, and competitive trade ensures supply and demand processes are applied to a greenhouse gas emissions trading or tax regime to generate the most cost-effective and cost-efficient prices. Additionally, free trade should induce technological innovation and diffusion of climate-friendly, resource-conserving products and services.

Democracy will be the driving political ideology required to achieve sustainable security. Democratic ideals account for pluralistic consent, openness, inclusiveness, and legitimacy. International organizations will be the framework and foundation for efforts to institutionalize equitable reconciliation among people and between people and nature. Specifically, free trade and the market represent the economic vehicles used to transform, improve, and diffuse policies and programs required for long-term maintenance of natural and human-made capital. Importantly, the equitable, effective, and sustainable application of the Kantian principles represent the best hope for countering global climate change and ensuring sustainable security. In this "virtuous circle" all of the actors, concepts, and processes align, preserving the freedom, economic well-being, progress, and equity of natural ecosystems and human civilization, using sustainable security as the overarching principle (see fig. 2).[202]

Conclusions

"The increasing risks from climate change should be addressed now because they will almost certainly get worse if we delay."[203] The DoD can lead the efforts to address these risks. Because of its existing environmental footprint and because of the connections between traditional security and environmental security concepts, the DoD must show the way forward to sustainable security not only for the United States but also for other nations. The effort will require the DoD to increase environmental security efforts, to broadly apply ecological economic principles, and to inculcate equity considerations into all defense strategies. The templates into which these processes must be forged are the three pillars of the democratic peace theory.

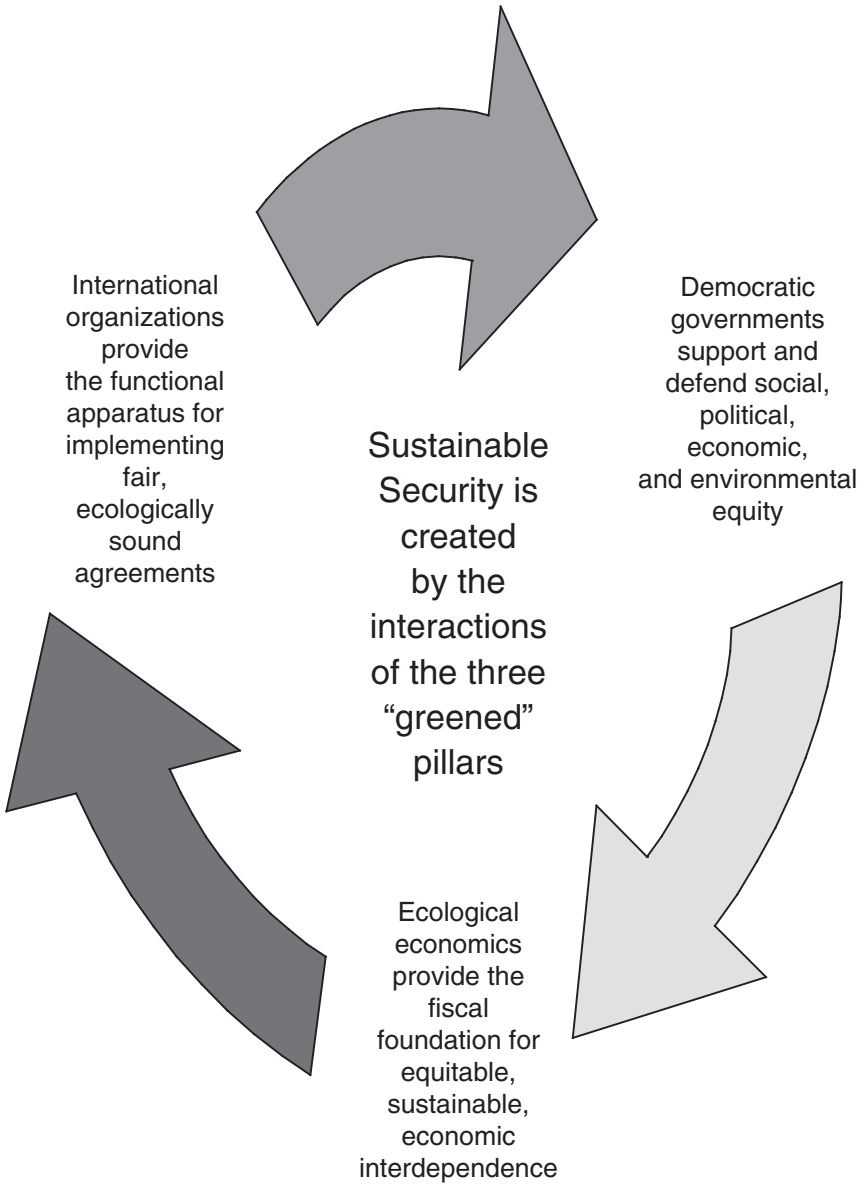

Figure 2. Sustainable Security. (John T. Ackerman's adaptation of fig. 1, "Climate Change Security Challenges: The Perfect Storm.")

The global forces of democracy must unite to counter climate change by leveraging the confidence and cooperation generating powers of free and fair elections, economic interdependence, and international organizations. These three bulwarks of peace will become sustainable by international acknowledgement and protection of the finite characteristics and resources

of the natural ecosystems that provision, regulate, support, and secure our future. In essence, the DoD must become "greener" in order to become leaner, agile, effective, and sustainable. The DoD must lead efforts to extend democracy, encourage ecologically sound economic interdependence, and promote international organizations that produce climate change solutions and expand global sustainable security. In sum, democracy, prosperity, and security cannot counter the long-term threat of climate change without environmental sustainability and social justice.[204] SSQ

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