Environmental and Energy Issues for the Military

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II. Executive Summary:

Acknowledging that environmental and energy issues have the potential to affect regional military resiliency and readiness, the United States Southern Command (USSOUTHCOM) has hosted a series of annual events with partners in the Region, which have increased awareness about these defense related challenges. Collaboration during the 2012 event resulted in the formation of the Environmental and Energy Collaboration Group (EECG) — a voluntary group established to examine how regional militaries are currently being impacted by environmental and energy challenges. The EECG is comprised of subject matter expert military officials from a set of hemispheric states, specifically; Chile, Colombia, El Salvador, Trinidad and Tobago and the United States of America. The group examined reference information on impacts of a variety of environmental and energy factors, focusing the research and scope to those challenges that may degrade the capacities of military organizations to execute their core missions. The group also assessed the potential consequence of new or expanded military missions in support of civilian authorities.

This report outlines how military organizations throughout the hemisphere might be affected by environmental and energy factors with particular focus on potential disruptions to Western Hemisphere states' militaries, to include military installations, force health, and general operational readiness.

It is important to note that the authors of this report did not aspire to conduct a comprehensive country-by-country study of all states in this hemisphere. Rather, they endeavored to conduct a well-researched reference review of environmental reports and relate the information to challenges that participating countries' respective militaries may face. Based on this analysis the authors compiled a list of general impacts that are likely to affect military organizations throughout the hemisphere.

This report reveals that there are environmental and energy challenges currently affecting regional militaries' facilities and operational readiness. It posits that environmental factors such as; natural resources scarcity (e.g. clean water), environmental degradation (e.g. deforestation), energy sustainability, extreme weather/catastrophic events (e.g. tornados and hurricanes), sea level rise, and infectious diseases (i.e. disease outbreaks) must be understood by military leadership as potential threats that may challenge military readiness. The report also touches on energy challenges for the military and suggested actions to address operational needs.
The instances and severity of these challenges are detailed in the following pages, including the group's key findings, conclusions and recommendations outlined on pages 16-18.

The authors are confident that through country-specific and collective mitigation and adaptation actions, the Western Hemisphere member states can reduce the potential effects of environmental and energy challenges to military resiliency and readiness.

III. Background:

On October 28, 2003, the Organization of American States (OAS) adopted the 'Declaration on Security in the Americas' establishing that environmental deterioration affects the quality of life of our peoples and may constitute a threat, concern, or challenge to the security of states in the Hemisphere.[1] Through this declaration, the Organization's Secretariat for Multidimensional Security called for action by all member states to strengthen our national capabilities in the face of environmental degradation. Understanding the challenge, several member states military representatives voluntarily established an EECG to explore this matter in greater depth.

Origins of the Study: The group was established at a USSOUTHCOM defense-related environmental and energy security cooperation event held in August 2012. The working group decided that their first collaborative project would be this multilateral report. The findings revealed in this report are a result of numerous collaborative sessions over a period of several months.

> "The security threats, concerns, and other challenges in the hemispheric context are of diverse nature and multidimensional scope, and the traditional concept and approach must be expanded to encompass new and nontraditional threats, which include political, economic, social, health, and environmental aspects."
>
> -- **Organization of American States** [1]

IV. Summary of General Environmental Effects by Sub-Region

Central America – Many physical and environmental factors affecting human populations are rooted in settlement and urban expansion, as well as agricultural activities. As an example, El Salvador reports degradation of critical resources like mangrove wetlands and gallery forests as one of their main environmental challenges with second and third tier effects on coastal and riparian resources. They also report issues with surface water pollution from agricultural activities and storm water discharges, groundwater pollution from saline intrusion, soil erosion, and deforestation. Due to its location between two great oceans, Central America is extremely vulnerable to hydrological systems. There is ample evidence of climatic variability—both intra-seasonal and long-term—that have caused an increase in the intensity of events linked to the hydro-meteorological phenomena. Further, countries in the region depend heavily on fossil fuels for transportation and energy generation to include firewood for cooking. This reliance on fossil fuels result in elevated greenhouse gas emissions, deterioration in the quality of air and water, as well as other detrimental effects on human security.

South America (Equatorial Region) – Increased intensity of hurricanes in the Caribbean, changes in precipitation distribution patterns and more frequent droughts are likely linked to a general warming trend in the region. The Intergovernmental Panel on Climate Change (IPCC) estimates that there will likely be increases in mean sea level, climate variability and extreme

[1] Declaration on Security in the Americas. Adopted at the third plenary session of October 28, 2003, http://portal.oas.org/en/sedi/dsd/ELPG/resources/decSecurityAmericas.asp

hydrological events that may adversely impact low-lying coastal areas[2]. Further, exploitation of hydrocarbons is closely related to environmental deterioration, leading some experts to believe that current trends in energy management are unsustainable and that alternative approaches need to be formulated to avoid further energy challenges.

South America (Southern Cone) – Increased mean sea level rise in coastal areas of South Atlantic countries, melting glaciers in Patagonia and the Andes, and ice sheet losses in West Antarctica will present long term challenges to the region. In Chile current and future impacts related to climate change are expected. For example, in relation to shifts in rainfall patterns, a general decline has been identified, which coincides with the climatic tendencies observed for that region. In the case of sea level rise, these changes can lead to changes in the location of fish stocks in the southeastern Pacific. Related to agriculture, there are future declines projected for a number of crops, to include corn and wheat. In more arid areas like Northern and Central Chile, climate change may lead to salinization and desertification of agricultural lands. In addition, high impacts are expected to the availability of energy, as well as restrictions to water availability and irrigation demands in Central Chile as result of anomalies associated with El Niño and La Niña climate phenomena.

Caribbean - Environmental degradation is expected to further exacerbate existing social, environmental and economic vulnerabilities that exist in the region with the possibility of new vulnerabilities being created. One of the most consequential impacts of environmental variability is the mean sea level rise and the increased number of storm surge events due to more frequent and intense storms. Some experts suggest that sea level rise in the Southern Caribbean significantly exceeds the average global mean. This is evident on the island of Trinidad where the relative sea level has risen by 20 cm in the past century and is projected to increase by approximately 6 cm per decade. In addition, the destructive power of hydrological phenomena (e.g. hurricanes) has been identified as a threat to national security since hurricanes have the proven potential to disrupt energy supplies, and severely damage infrastructure and tourism facilities, which several Caribbean nations depend on for their Gross Domestic Product. The energy sector is also of significant importance to Caribbean nations like Trinidad and Tobago which rely heavily on oil and gas exports.

North America - In the recent past, Canada, the United States and Mexico have all experienced economic damage plus substantial ecosystem, social and cultural disruption from weather-related extreme events to include hurricanes, floods, droughts, heat waves and extreme winters. Further, economic damage from severe weather has increased dramatically, due largely to the increased value of the infrastructure at risk. For example, annual costs in North America have now reached tens of billions of dollars in damaged property and economic productivity, as well as lives disrupted and lost. Extreme events may become increasingly more common, requiring that sustainability and resilience become essential elements of national security strategy of North American states.

[2] UNEP, Geo Lac 3, Latin America and the Caribbean: Environmental Outlook 2010

V. Environmental and Energy Issues for the Military

TABLE: Environmental and Energy Issues for Operations, Facilities and Readiness

General Effects	Impacts on Military **Operations**	Impacts on Military **Facilities**	Impacts on Military **Readiness**
• Sea level rise, increased intensity of hydro-meteorological events (i.e. tropical cyclones), floods, avalanches, landslides • Large episodic weather anomalies to include El Niño and La Niña phenomena • Surface water contamination and scarcity of clean water due to saline intrusion into aquifers • Increasing instances/outbreak of vector-borne diseases such as malaria, dengue fever and tick-borne disease and pulmonary syndrome cause by the Hanta virus • Disruption in energy supplies (i.e. fossil fuels and hydro-electricity)	• Increased requirement for Search and Rescue (SAR) capabilities and diversion of resources from traditional missions to humanitarian assistance operations • Prolonged disruption of operations due to increased storm intensity (e.g. disrupts anti-narcotics and anti-terrorism operations) • Increase cost of logistical support • Military forces clean water supply stressed during operations • Disease outbreaks affects force health disrupting operations • Disruption in operational energy supplies in case of disasters	• Sea level rise and storms adversely affect installations' drainage leading to flooding and causing erosion of coastal facilities • Damage to coastal riverine squadron facilities' due to combined effects of sea level rise and increasing inundations • Adverse impact on facilities' clean water supplies • Disruption in electricity supplies to installations due to loss in energy production from hydroelectric dams or resulting from extreme weather events	• Increasing intensity of hydrological events impacts routine training and exercises (e.g. lost training days) • Acquisition planning affected by new environmental degradation imperatives (e.g. requirement for more SAR, and fire-fighting equipment) • Possible adverse impacts on force heath due to lack of clean water • Requirement for environmental related military professional education/training • Increasing frequency of disease outbreaks (e.g. malaria and dengue) due to vector borne diseases decrease readiness • Energy disruption leads to lost training days

Central America (El Salvador) –

El Salvador has the second highest population density in the hemisphere (second to Haiti) as well as highly deforested areas. This increases the potential impact of extreme weather events with almost 90% of the population is estimated to be vulnerable, 95% of the national territory exposed and 90% of the Gross Domestic Product (GDP) at risk. In addition, along the coast of El Salvador, there have been significant environmental shifts associated with climate change.[3]

Recent scientific studies also point to an increase in the duration, intensity, and changes in the distribution of climatic phenomena linked to changes in the Pacific and Atlantic oceanic systems. The vulnerability of El Salvador to the impacts of climate variability covers a wide range of domains to include: the mobility of people, health, food security, development of urban spaces, rural settlements, and physical infrastructure to include road connectivity.

Furthermore, due to the increase in climate variability, the shifting patterns of temporal and spatial rainfall tend to cause anomalies which can lead to an increase in hydro-meteorological phenomena. Below is a summary of observed impacts:

- ✓ More intense extreme hydro-meteorological events
- ✓ Changes to spatial and temporal distribution of precipitation
- ✓ Significant changes in the intensity, trajectory, and number of cyclonic systems originating in the Pacific and Atlantic Oceans which are increasing in intensity in some circumstances

Due to these ongoing environmental shifts that are already adversely affecting the country, it is not viable for El Salvador to attempt to sustain growth and economic development without a practical vision of climate change adaptation. It is critical that changes be made to traditional practices through the implementation of actions and measures designed to minimize the risk to the population, health and productive infrastructure.

Effects on El Salvador Military Forces

The Military Forces of El Salvador offers assistance to the population when disasters occur. In addition, Salvadorian forces help to reverse the effects of climate change by the establishment and maintenance of forest nurseries in military units, executing reforestation campaigns, and donating plants to public and private institutions. The military also conducts staff training on adaptation and mitigation to the effects of climate change and to also support various forest fire prevention and suppression activities.

Training - It is necessary to train constantly to improve readiness to confront the aftermath of extreme weather events. It is critical that personnel at all levels be trained to improve their capability to assist populations affected by climate related events especially since the country is vulnerable to effects such as; floods, earthquakes, hurricanes and other events.

Material and equipment - In order to better support the population, the acquisition of materials and special equipment to be used by the military for search, rescue and evacuation of affected populations is necessary, including environmentally friendly technologies.

[3] Pascual, Carlos and Elkind Johnathan. *Energy Security Economics, Politics, Strategies, and Implications*. Brookings Institution Press, 2010.

Impact of the environment on military installations - To date, a direct impact on facilities caused by an extreme weather event has not happened. However, vulnerabilities to infrastructure have been identified, which should be reinforced or renewed as appropriate.

It is well understood by the Salvadorian military that environmental degradation can affect personnel, weapons, material and equipment to varying degrees. For the reasons previously stated, the military planning process should start to factor in climate change as a threat to energy resource access as well as supplies.

Implications of Environmental Degradation on Central American Military Forces -

Impacts on Operations	Impacts on Facilities	Impacts on Force Readiness
• Increased requirements for search and rescue (SAR) capabilities • Diversion of resources away from traditional missions to address humanitarian needs induced by environmentally linked events • Increasing intensity of hydrological events disrupts and erodes operational effectiveness	• Sea level rise and storms could adversely affect installations' drainage networks leading to flooding • Sea level rise adversely affects coastal bases (i.e. erosion and flooding) • Adverse impact on facilities' clean water supplies	• Increased intensity of hydrological events impacts training and exercises (i.e. lost training days) • Adverse impact on force heath due to disease outbreaks (e.g. malaria and dengue) leading to requirement for preventive measures • Increased requirement for training to improve readiness to respond to natural disasters • Acquisition planning affected by new environmental degradation imperatives (i.e. special equipment, and materials)

Caribbean Region (Trinidad and Tobago)

The South West region of Trinidad is of significant importance to the nation's economy—an economy that hinges principally on oil and gas exports. Trinidad's state owned *Petroleum Company of Trinidad and Tobago Limited* (PETROTRIN) which conducts most of its core operations in South West Trinidad, commissioned a vulnerability assessment covering the period 2004 to 2007, as well as a storm impact survey of the South West coast. The purpose of the survey was to identify the impacts of climate driven sea level rise and extreme storm surge events on the company's infrastructure and operations.[4] The results revealed that the company's assets would be at considerable risk of inundation and erosion due to the effects of sea level rise and storm surges. These results could be extrapolated to military facilities located in South West Trinidad. Other major companies such as *Atlantic*, the seventh largest Liquefied Natural Gas (LNG) exporter in the world, responsible for processing approximately half of the country's

[4] Singh, B., A El Foulandi & K. Ramnath. Vulnerability assessment survey of oil and gas facilities to climate-driven sea level rises and storm surges on the west coast of Trinidad. WIT Transactions on Information and Communication. Risk Analysis IV, 39: 389-398, 2008.

natural gas production, are also located in the South Western peninsular of Trinidad.[5]

While efforts are now underway to diversify the country's economic activities away from the South West coast and to *Galeota* in the South East, the challenges presented by erosion and storm surges still exist.[6] This already precarious situation is coupled with an additional threat as it has been suggested that the South West coast is also subsiding as a result of extensive offshore drilling for oil.[7]

Due to more frequent storm related surges and other degrading natural factors, Trinidad and Tobago (T&T), and other countries throughout the Caribbean basin, should assess how military installations and operations might be affected. From such assessments, adjustments can be made to both mitigate and adapt to the degrading impacts of these effects. Below is a description of how the military forces of T&T, and countries throughout the broader Caribbean, are likely to be affected by environmental and energy supply related factors.

Effects on Trinidad and Tobago Military Forces

Regional President of British Petroleum (BP) Trinidad and Tobago (bpTT), Norman Christie, acknowledged that most of the company's large discoveries in shallow waters around T&T have already been produced or are at the tail end of their lifecycle. He suggested that the new prospects that the company is developing to meet the industry's demand for gas in the short- to medium-term are now in much more complex geology (i.e. deeper waters) and are more costly developments[8]. This has serious implications for the energy security of the island state whose economy is still heavily dependent on the revenues from the energy sector. It will also mean that there is an elevated risk to the country's environment and ecology as well as the need by the nation's Coast Guard to possess appropriate naval assets that will be capable of patrolling for long periods to ensure that security of personnel and oil and gas assets in these areas.

This is of concern since the Caribbean Sea has an extremely high level of shipping activity and low levels of maritime policing. Further, Serena Joseph-Harris, former High Commissioner of T&T to the United Kingdom (U.K.) lamented that apart from the need to secure offshore petroleum installations, the immediate challenge confronting Caribbean governments is the securing of their territorial waters from the insidious passage of illegal cargo, including drugs and firearms[9]. T&T is one Caribbean nation that lies in the *corridors* between drug producers in South America and markets in the North. This challenge should not go unaddressed since the security of not only T&T, but also other small nations, depend on individual and regional capacities to stem this threat.

[5] International Energy Agency (EIA). "Energy security". Accessed on October 26th, 2013. http://www.iea.org/topics/energysecurity/, 2013
[6] Lal, Vijai. 2013. "Facilitating the activities of exploration and production (E&P) companies." National Energy Company of Trinidad and Tobago, http://ngc.co.tt/latest-news/galeota-port-development-project/ Accessed 14th October, 2013.
[7] Kanithi and Rosano, Seventh Latin American and Caribbean Conference for Engineering and Technology Latin American and Caribbean Conference for Engineering and Technology, Energy and Technology for the Americas: Education, Innovation, Technology, and Practice, 2009.
[8] John-Lall, Rafael. J. bpTT president: Fiscal incentives key to T&T investment decisions. Trinidad Guardian. Accessed 25th October 2013. http://guardian.co.tt/business-guardian/2013-07-17/bptt%E2%80%88president-fiscal-incentives-key-tt-investment-decisions, 2013
[9] Brock, Hannah. "Competition over resources: Drivers of Insecurity and the Global South." Oxford Research Group, 2011

Implications of Environmental Degradation on Caribbean Military Forces -

Impacts on Operations	Impacts on Facilities	Impacts on Readiness
• Increased requirement for local and regional search and rescue (SAR) capabilities • Diversion of resources away from traditional mission sets to address more frequent humanitarian needs (i.e. SAR) and to support critical national infrastructure security operations • Increasing intensity of hydrological events disrupts operations (e.g. force movement) and disrupts operational energy supplies	• Sea level rise and more intense storms leads to destructive inundation and erosion of coastal facilities • Adverse impact on facilities' clean water supplies • More frequent storms and rains damage infrastructure increasing maintenance costs	• Increasing intensity of hydrological events impacts routine training and exercises (e.g. lost training days) • Acquisition planning affected by new environmental degradation imperatives

South America Equatorial Region (Colombia)

A diverse set of climate phenomena indicate the effects of global warming in the region, including an increased intensity of hurricanes in the Caribbean, changes in distribution and intensity of precipitation patterns, changes in temperature levels, more droughts, and increased sea level rise in coastal areas.[10] The region's vulnerability is not only due to more frequent climatic events but also due to the population's greater exposure to threats that affect agriculture, fisheries, and the tourism industry[11]. Data from the Intergovernmental Panel on Climate Change (IPCC) predicts more worrisome future situations. In 2007, it was projected that sea levels could rise between 18 cm and 59 cm in this century. Many researchers now believe that the increase will be even greater (between 0.8 and 1.5 meters) in part as a result of new assessments of the physical potential of ice sheets fracture in Greenland and Antarctica.[12]

Climate change may cause displacement, both at a national and international scale, due to the increase of natural disasters, and environmental and social repercussions. For Colombia, climate degradation will be a threat multiplier exacerbating existing problems, for example; drug trafficking, crime, natural disasters, migration and forced displacement.

Below is a description of how the Colombian Military Forces are likely to be affected by environmental related factors.

[10] UNEP & Semarnat, Geo Lac 3, Latin America and the Caribbean: Environmental Outlook 2006.
[11] Comunidad Andina, 2008
[12] UNEP, Geo Lac 3, Latin America and the Caribbean: Environmental Outlook 2010

Effects on Colombian Military Forces -

National security challenges arise due to several factors including increase in the intensity of natural disasters (i.e. floods, droughts, forest fires and tropical storms that affect the Caribbean coastline). These impacts would overlap with the potential to result in serious humanitarian and economic effects, creating a more permissive environment for illegal activities, exacerbating crime and violence at the national level.

Illegally armed groups and criminal organizations will benefit from the disorder caused by climate change and social unrest. They will have some advantages due to the relative flexibility of their operations against the government and the military, who will need to confront the impacts of the climate on infrastructure as resource availability.

There will be increased pressure on military resources and operations as the Colombian military forces will have to adapt its units, installations and operations to climate change, as well as guarantee the security. Likely, the military mission will be affected by flooding since many Colombian military installations are located along the river banks. In addition, as result of sea level rise, military units located in coastal areas will be affected. Resultant damages to infrastructure and the increase in complexity of the humanitarian missions will affect the military forces in terms of resource allocation for other missions and operations[13]. Addressing these challenges will require skills and resources from the government, communities and security forces in order to effectively respond to these and other associated threats.

Implications of Environmental Degradation on South American Equatorial Region Military Forces –

Impacts on Operations	Impacts on Facilities	Impacts on Readiness
• Decrease in operational tempo due to weather related challenges—adversely affecting counter-narcotics and counter-terrorism operations • Diversion of resources away from traditional mission sets to address humanitarian needs • Military forces clean water supply stressed due to changes in precipitation distribution patterns	• Increasing need to adapt facilities for ongoing effects of environmental degradation • Damage to coastal and riverine squadron facilities' due to combined effects of sea level rise and increasing inundations	• Increasing intensity of hydrological events adversely impacts training and exercises (e.g. lost training days) • Acquisition planning affected by new environmental degradation imperatives • Adverse impact on force heath due to disease outbreaks (e.g. malaria and dengue) leading to requirement for preventive measures

[13] Catarious, David M. Espach, Ralph H. "Impactos del Cambio Climático en la Seguridad Nacional y Regional de Colombia". CNA, 2009

South America Southern Cone Region (Chile)

According to the latest scientific report issued by United Nations climate change experts, a series of impacts associated with climate change are evident in Chile.[14] For example, a decline in precipitation in the south of Chile has been identified as a trend, similar to the climate shifts observed for that zone. In the case of variations in sea level, the report notes that this shift can also lead to changes in the location of fish stocks in the southeastern Pacific. Related to agriculture, declines are expected in the future for crops such as corn and wheat; and in more arid areas such as northern and central Chile, climate change may lead to salinization and desertification of traditional agricultural lands.

In terms of water resources, a high vulnerability to extreme events is expected. In addition, a high impact on energy availability in the country is expected due to anomalies associated with El Niño and La Niña, as well as restrictions on water availability and the demands of irrigation in central Chile. In addition, recent studies point to Chile as being potentially impacted by scarcity of water, sanitation issues in coastal cities, and contamination of underground aquifers due to saline intrusion. A dramatic decrease in glacier volume continues to be observed in recent decades, with southern Chile being most affected area.

For human health, it has been reported an increase in outbreaks of a pulmonary syndrome caused by the Hanta virus after prolonged droughts and subsequent heavy rains and floods, that in turn increases the availability of food sources for domestic rodents. In the north, conditions are more favorable for the development of vector-borne diseases such as malaria, dengue fever (not currently present in Chile) as well as tick-borne diseases. While it is not expected that climate change will produce new diseases, it could, however, increase the occurrence of some diseases and exacerbate the effects of variables on environmental health.

Finally, it is believed that air pollution will be exacerbated due to the burning of fossil fuels to meet citizens' transportation needs in urban areas such as Santiago. There is also the distinct risk of forest fires that will be exacerbated by climate change.

Due to the ongoing impacts caused by increased temperatures, changes in commercial, industrial and residential energy consumption are expected, primarily related to air conditioning systems. This, paired with the reduced hydroelectric generation, would cause increase in use of other energy sources.

With regards to drought effects, since 2008 the country has been affected by one of the most serious droughts registered in the last 80 years. The water reservoirs are in the lowest levels, groundwater wells are dry and the terrain breaks due to dryness. Zone IV of Coquimbo is one of the most affected.

The Effects on Chilean Military Forces –

Effects such as melting glaciers, climate change induced health impacts, the energy system and the effects of drought will continue to affect the military just as they affect the civilian population. These effects are present because the military facilities are distributed throughout the national territory and are part of society as a whole.

[14] IPCC. Intergovernmental Panel on Climate Change, Climate Change Synthesis Report: Summary to Policymakers, 2007.

Lastly, the impacts described above must be transformed into opportunities to create and implement the most appropriate adaptation measures in order to avoid or minimize the negative climate impacts and bring positive changes that adequately utilizing all available capacities.

Implications of Environmental Degradation on South American Southern Cone Region Military Forces

Impacts on Operations	Impacts on Facilities	Impacts on Readiness
• Increased requirement for Search and Rescue (SAR) capabilities due to extreme events such as floods, drought, heat or cold waves • Diversion of resources away from traditional mission sets to address new environmentally induced challenges (e.g. forest fires) and associated humanitarian needs • Clean water supply stressed due to shifts in precipitation patterns, sea level rise and droughts in some regions • Possible prolonged disruption of operations due to increased storm intensity	• Damage to infrastructure due to sea level rise, floods, and increased intensity of hydrological events • Adverse impact on facilities' clean water supplies • Sea level rise adversely affects coastal bases and facilities • Disruption in electricity supply to bases and installations due to loss in energy production through hydraulic dams	• Possible adverse impacts on force heath due to increasing frequency of disease outbreaks (e.g. hanta virus) • Higher mean temperatures increase in some regions adversely impacts force health due to increased instances of heat exhaustion • Acquisition planning affected by new environmental degradation imperatives (e.g. requirement for more fire-fighting equipment)

North America (United States of America)

Extreme natural disasters may become increasingly more common requiring environmental sustainability and resilience to become near-term imperatives. Some of the impacts of environmental variability that have been observed include sea level rise, increase in inundations, and shoreline erosion. Shifts in weather patterns are also leading to harmful impacts such as heat waves and extreme winters. Water scarcity has also become a, issue in some states due to diminishing snowfields among other factors.

Further, in January 2014, Canada and the U.S. experienced extreme low temperatures throughout their respective territories due to a weather condition known as the *Polar Vortex*. A U.S. Science and Technology government official recently stated that "A growing body of evidence suggests that the extreme cold being experienced by much of the U.S. is a pattern that we can expect to see with increasing frequency as global warming continues." [15]

[15] Director of the White House Office of Science and Technology, Dr. John Holdren, 2014

"Climate change does not directly cause conflict, but it can significantly add to the challenges of global instability, hunger, poverty, and conflict. Food and water shortages; pandemic diseases; disputes over refugees and resources; more severe natural disasters – all place additional burdens on economies, societies, and institutions around the world."

U.S. Secretary of Defense Chuck Hagel,
Halifax, Nova Scotia, November 22, 2013

Annual costs to American states because of these impacts are now in the tens of billions of dollars due to damaged property and economic productivity loss, and have even resulted in the disruption of livelihood and the loss of life. It is expected that extreme events ranging from natural disasters to severe droughts, will become increasingly more common requiring environmental sustainability and resilience to become core elements of the American national security strategy.[16]

Due to the ongoing impacts of the aforementioned effects, it is important that the country's military forces prepare to adapt to a diverse set of challenges that will vary in severity and across time scales. The U.S. has already initiated efforts aimed at increasing force resiliency and improving the sustainability of bases and installations to face the long term degradation induced by environmental factors.

The U.S. Department of Defense (DoD) commissioned a study via the Strategic Environmental Research and Development Program (SERDP) to assess how climate change and sea level rise might affect a coastal military installation using an Air Force base situated on the north-west Florida coast as a representative example[17]. The focus of the assessment was on how the base's infrastructure could be affected by sea-level rise and changes in the intensity of tropical cyclones over the next century. Studies like this serve to inform military facility managers of the short, mid and long term challenges for which they need to plan. These challenges include coastal erosion mitigation measures like beach nourishment projects, flood mitigation measures for facilities prone to coastal flooding, and well water pumping management to reduce the risk of salinity intrusion.

The Effects on the military of the United States of America -

DoD continues to evaluate various aspects of environmental and energy issues and their potential effects on U.S. military facilities, operations, training and missions. Over the last five years, U.S. national security and defense guidance have highlighted the potential effects of environmental stressors in the future security environment. Physical pressures such as population, resources, energy, climate and environment, could combine with rapid social, cultural, technological and geopolitical change to create greater uncertainty.[18] Environmental factors have the potential to directly affect the military forces as they depend upon the physical environment in which they operate.

[16] The Concept of Environmental Security, By Kent Hughes Butts, Sherri Goodman, Nancy Nugent (2012)
[17] http://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/Vulnerability-and-Impact-Assessment/RC-1700
[18] 2008 US National Defense Strategy

In 2010, the U.S. military consumed more than five billion gallons of fuel in military operations[19]. The military demand for energy is growing, while global and operational energy supplies are under pressure. Also, at the operational and tactical levels, fuel logistics have proven vulnerable to attack in recent operations. As long as U.S. forces rely on large volumes of energy, particularly petroleum-based fuels, the vulnerability and volatility of supplies will continue to raise risks and costs for the armed forces. Below are some examples of environmental and energy factors that the DoD is looking into from a risks/vulnerabilities assessment perspective.[20]

Implications of Environmental Degradation on North American Military Forces -

Impacts on Operations	Impacts on Facilities	Impacts on Readiness
• Extreme weather events may lead to increased demand for defense support to civil authorities for humanitarian assistance or disaster response[21] • Increase storm intensity may cause temporary or prolonged disruption of operations • Coastal flooding and storm surge may have impacts on supply chain from potential shipping interruptions • Higher temperatures increase operational health risks	• Storm intensity and flooding increase maintenance costs for roads, utilities and runways • Sea level rise and more frequent storms lead to destructive inundation and erosion of coastal facilities • Rising temperatures increase energy costs for building and industrial base operations	• Increased intensity of extreme weather events impacts routine training and exercises (i.e. lost training days) • Mission equipment acquisition planning affected by new environmental degradation imperatives

[19] DOD Operation Energy Strategy, http://energy.defense.gov/Reports/tabid/3018/Article/3507/operational-energy-strategy.aspx
[20] 2012 Strategic Sustainability Performance Plan, Appendix 2
[21] Quadrennial Defense Review 2010

VI. Conclusion

The impacts revealed in this report show little known/understated vulnerabilities of military forces—organizations subject to shifts in the natural environmental to an equal or greater degree than other state institutions. Furthermore, it provided a synopsis of emerging non-traditional challenges that most military organizations are ill-prepared and under-resourced to effectively address. These impacts on operations, facilities and readiness are most efficiently and effectively addressed through transnational mechanisms and approaches to take advantage of the benefits inherent in collective actions.

The authors believe that environmental and energy related challenges are significant enough to warrant collective action through defense regional organizations like the Conference of Defense Ministers of the Americas (CDMA) and the Inter American Defense Board (IADB), as appropriate. Factors such as resource scarcity (i.e. clean water), energy supply disruptions, extreme weather impacts (i.e. tornadoes and hurricanes) and infectious diseases (i.e. pandemic outbreaks) should be understood by military leadership throughout the hemisphere as matters that directly and indirectly adversely impact military facilities, operations and readiness.

Why a Regional Approach

Country specific impacts *are* regional impacts. The tables above serve to illustrate that different regions face similar challenges, reminding us that the environment does not recognize man-made borders. For example, most military forces in the region operate sea or river side outposts or stations. Sea level rise, and the increased intensity of hydrological events, will adversely affect all such installations albeit in uneven ways. These slow, moderate or rapid onset effects will all cause varying severities of degradation (to personnel, assets, and budgets) if not addressed through effective adaptation and mitigation plans in the short term.

Though individual counter-effect approaches may be taken by each country's military, the authors recommend that the starting point for mitigating actions be intra-hemispheric cooperation. There exist varying degrees of expertise and experience among hemispheric states on each of the environmentally induced effects discussed in the paper. Pooling of expertise, technology resources, and the sharing of lessons learned would lead to an economization of effort and resources. Through online knowledge sharing activities, professional education programs, the sharing of environmental mitigation measures, and climate modeling technology, all participating militaries can more rapidly close knowledge gaps as result of unilateral approaches.

Why Take Action Now

It is the authors' belief that without near term mitigating and adaptation actions, many military organizations in the hemisphere may not be able to maintain operational readiness for traditional mission sets. From sea level rise along coastlines adversely affecting military installations in countries like El Salvador and Colombia, to extreme storm events requiring the unplanned utilization of military forces to assist affected communities recover in the United States and Mexico, all represent non-traditional challenges to military forces. Further, the increasing possibility of insufficient supplies of operational energy for military training and traditional operations should spur military planning that leads to initiatives that mitigate the threat of this disruptive and rapidly emerging challenge.

It is with this appreciation of the growing severity of the effects discussed in this report that the authors supply the below recommendations. It is envisioned that organization delegates will assess the findings outlined in this report along with the below recommendations to create appropriate mechanisms to facilitate intra-hemispheric collaboration on the effects previously discussed.

VII. Recommendations:

It is recommended that the appropriate regional organizations (e.g. CDMA, IADB) establish mechanisms for security cooperation on defense-related environmental issues with the purpose of:

i. Reviewing the conclusions and recommendations from this report
ii. Scheduling additional Subject Matter Experts (SME) briefings to gather further information
iii. Developing a charter and road map to address mission sustainability, military resiliency and readiness to face environmental and energy challenges

Once a strategic framework for cooperation on this matter has been formalized, it is envisioned that the following capacity building tasks and activities will be undertaken in the near to mid-term.

- Leverage and strengthen existing collaboration mechanisms, including the Environmental and Energy Collaboration Group that prepared this report, to continue to increase awareness of the effects of environmental and energy challenges into military resiliency and readiness.

- Incorporate defense-related environmental and energy issues into the curriculum for military organizations like the Inter-American Defense College (IADC) and the Western Hemisphere Institute for Security Cooperation (WHINSEC). Facilitate training/education and the building of awareness about environmental and energy challenges promote military resiliency, and environmental stewardship at all levels in the military organizations.

- Conduct further security cooperation subject matter expert exchanges, workshops and training to help member states obtain the expertise required to develop risk assessments and studies for military units. Training may also be necessary, for example, to capacitate service members on the application of prediction models to estimate flooding risk on military installations.

- Conduct applicable training for environmental management systems to promote environmental stewardship and compliance for interoperability.

- Promote outreach to foster local communities' support to the military as well as military integration into the communities. Military facilities could serve as test beds to demonstrate sustainability measures for energy, water and waste management.

- Promote collaboration in science and technology to enable important new formulation of solutions and approaches issues.

- Assemble a team of subject matter experts and delegates from member states' military forces to develop defense-related environmental policies.

- Form issues specific/sub-regional working groups (e.g. coastal facilities working group) which would leverage the advanced capabilities and knowledge of participating member countries—broadening the knowledge of the collective while minimizing cost to each participating state.

- Serve as advocate and expert advisors to other regional military organizations to assess the effects of environmental and energy challenges to regional militaries' resiliency and readiness. Reach out to the Conference of the American Armies, Conference of Central American Armed Forces, Inter American Naval Conference, the System for Cooperation Among the American Air Forces ("*SICOFAA*"), CARICOM and others, to channel regional expertise to address these defense-related challenges.

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