The Strategic Implications of Climate Change in Central America: An Assessment

A Monograph

by

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In the last ten years, climate change research has made considerable progress. Climate change continues to be a politically-charged issue, but in the scientific community, scientists universally agree that the earth's climate is shifting. The change in climate will stress existing systems, infrastructure, social and economic stability, and natural resources. The United States will have to assess the country's vulnerability in relation to climate change, as well as the secondary impacts on regional partners. In the Northern Hemisphere, Central America is particularly vulnerable to the effects of climate change. From a national security standpoint, the United States will need to be prepared to address or respond to new drivers of conflict caused by climate change, including mass migration and natural resources scarcity in Central America. Additionally, great power competition presented by China's involvement in Central America will challenge the US perspective and the necessity of regional involvement. However, addressing the source of push factors, including socioeconomic opportunity, stability, and violence in Central America, can assist with alleviating factors for migration.

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Abstract

Implications of Climate Change in Central America. By Kelly J. Buckner, 42 pages.

In the last ten years, climate change research has made considerable progress. Climate change continues to be a politically-charged issue, but in the scientific community, scientists universally agree that the earth's climate is shifting. The change in climate will stress existing systems, infrastructure, social and economic stability, and natural resources. The United States will have to assess the country's vulnerability in relation to climate change, as well as the secondary impacts on regional partners. In the Northern Hemisphere, Central America is particularly vulnerable to the effects of climate change. From a national security standpoint, the United States will need to be prepared to address or respond to new drivers of conflict caused by climate change, including mass migration and natural resources scarcity in Central America. Additionally, great power competition presented by China's involvement in Central America will challenge the US perspective and the necessity of regional involvement. However, addressing the source of push factors, including socioeconomic opportunity, stability, and violence in Central America, can assist with alleviating factors for migration.

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Abbreviations

C	Celsius
CADC	Central American Dry Corridor
DoS	Department of State
ENSO	El Niño-Southern Oscillation
EPWP	East Pacific Warm Pool
IPCC	Intergovernmental Panel on Climate Change
JRS	Joint Regional Strategy
JSP	Joint Strategic Plan
USAID	United States Agency for International Development

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Introduction: The Status of Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science and producing the most up to date reports on the status of global climate change. The IPCC's 2018 *Global Warming of 1.5° Celsius* assesses the threats and mitigation mechanisms for the potential warming of the climate by 1.5 degrees Celsius (C) above pre-industrial levels.[1] The report argues that climate change is happening, projecting that temperatures will rise between 0.1 degrees C and 0.3 degrees C per decade. The report asserts that human activities are likely to have initiated warming of 1.0 degrees C above preindustrial levels.[2] Forecasting potential impacts and risks of climate change diverge greatly by region, and the extent of warming will depend on the implementation of mitigation options.[3] However, earlier IPCC reports estimate that the greatest single impact of climate change could be on human migration, with the possibility of millions displaced as climate refugees.[4] The IPCC report bases its recommendations on limiting warming to 1.5 degrees C, which requires the aggressive implementation of already recommended mitigation efforts. However, warming above 2 degrees C will inflict dire consequences on health, livelihoods, food security, water supply, and human economic growth. For the purpose of this monograph, research will focus on the current and future impacts of climate change on Central America, acknowledging that warming above 2 degrees C will intensify the assessed impacts to the region.

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[1] Intergovernmental Panel on Climate Change, *Special Report on the Impacts of Global Warming of 1.5°C: Summary for Policymakers* (Geneva, Switzerland: Intergovernmental Panel on Climate Change, 2019), 6, accessed October 19, 2019, https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf.

[2] Ibid., 6.

[3] Ibid., 7.

[4] International Organization for Migration, *Migration and Climate Change* (Geneva, Switzerland: International Organization for Migration, 2008), 9, accessed 15 March 2020, https://www.ipcc.ch/apps/njlite/srex/njlite_download.php?id=5866.

Understanding the intensity of climate change is essential for the planning and implementation of mitigation options. Mitigation options require a whole of government approach both domestically and as part of US foreign policy to ensure efforts are encompassing and capable of addressing climate change induced events. However, military planners must also prepare to respond to the impacts of climate change by formulating options that will better prepare regions to absorb the social and political consequences. The United States, for example, must prepare to respond to the internal effects of climate change as well as the external factors that may drive regional instability and migration. Climate change projections forecast Central America to be one of the most adversely-impacted regions because of climate change, which is likely to create mass migration events. It behooves the US military to fully understand the interconnectedness of climate change and the push versus pull factors that drive mass migration events. Indeed, an initial analysis of Central America reveals a high probability of instability escalated by climate change, creating a push factor for migration. Push factors include socioeconomic instability which will contribute to higher levels of both legal and illegal migration from Central America, creating challenges for border security and US national security.

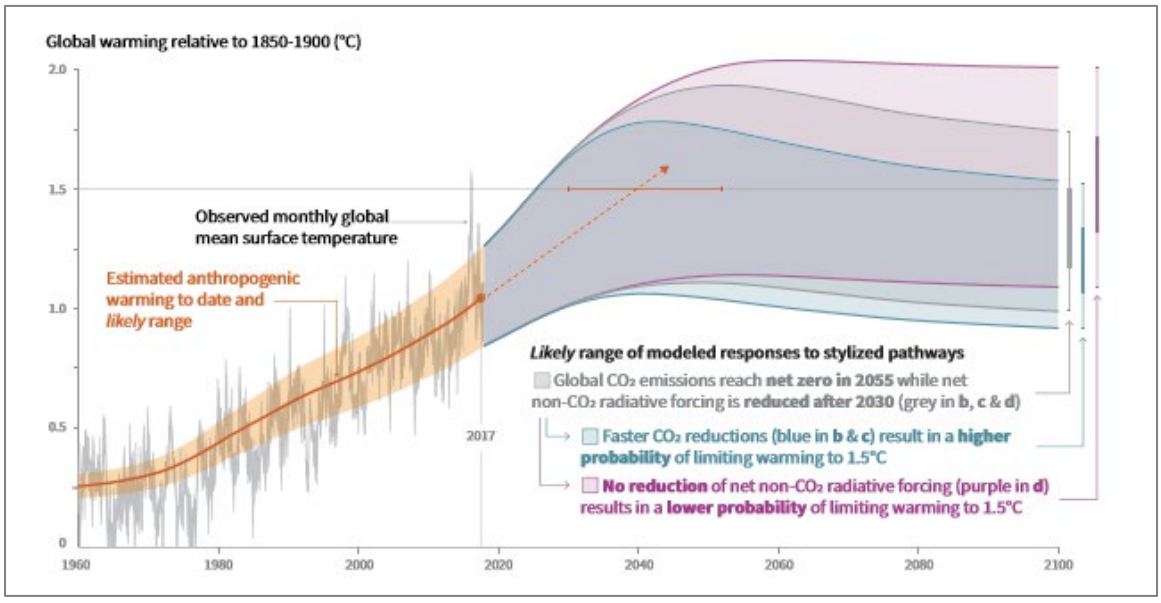

Figure 1. Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways. Intergovernmental Panel on Climate Change, *Special Report on the Impacts of Global Warming of 1.5°C: Summary for Policymakers* (Geneva, Switzerland:

Intergovernmental Panel on Climate Change, 2019), accessed October 19, 2019, https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf.

Climate Change and the Homeland

During fiscal year 2019, the United States Border Patrol apprehended 851,508 individuals between ports of entry along the Southwest Border.[5] The events at the border have quickly become politically charged talking points about how to deal with the "migration crisis." However, many of the proposed solutions for the migration crisis fail to address one of the root causes of current migration trends. Research continues to demonstrate a correlation between climate change and socioeconomic drivers of migration, especially in Central America. From a national security perspective, the US Department of Defense will need to prepare to respond to climate change driven events. As United States policymakers debate how to address the threat of climate change, if at all, the IPCC is updating reports showing clear evidence of the changing climate. For US national security, climate change poses the largest threats to infrastructure, the economy, and most of all regional instability attributable to the effects of climate change.[6]

In the background of the 2018-2019 migration crisis at the US southern border was the idea of climate-induced migration. Climate-induced migration includes climate migration, environmental migration, and climate refugees.[7] Researchers often attempt to postmortem migration events to understand the root cause, especially when analyzing mass migration. This monograph will focus on the drivers of migration in Central America, and the connections between these factors and climate change. One of the more popular understandings of migration is the "push-pull" model, which describes the push to emigrate or "factors of expulsion" as

[5] US Customs and Border Protection, "Southwest Border Migration FY2020," US Department of Homeland Defense, updated December 5, 2019, accessed December 8, 2019, https://www.cbp.gov/newsroom/stats/sw-border-migration.

[6] Climate and Security Advisory Group, *A Climate Security Plan for America* (Washington, DC: The Center for Climate and Security, 2019), 9.

[7] Gregory White, *Climate Change and Migration* (New York: Oxford University Press, 2011), 4.

economic, social, and political hardships in the poorest regions.[8] Conversely, "factors of attraction" describe the comparative economic advantage that migrants seek when looking for a place to relocate.[9] Scholars often use the push-pull model to describe why historic migration events occur. Critics counter this modeling approach misses the micro-structural determinants of migration in favor of using "obvious" factors to attempt to explain migration flows.[10] However, the push-pull model does help explain macro factors that can initiate migration. By using the push-pull model, military planners can explore factors in Central America that could trigger mass migration and identify the micro determinants, validating observations that a large migration event may occur in the future.

United States Strategy in Central America

From a US perspective, the impact of climate change on Central America is already visible. Regional instability is a known push factor for migration. In December 2002, border apprehensions had decreased to around forty-thousand people apprehended.[11] However, during the peak of the migration crisis, authorities apprehended some 144,000 people in the month of May 2019, at the southern border.[12] At the strategic level, the United States continues to take a whole of government approach to Central America. While policy varies by country, the United States engages Central America through trade agreements, humanitarian aid, and Department of Defense (DOD) programs, alongside various non-governmental and intergovernmental organizations. The 2017 National Security Strategy (NSS) outlines these efforts as a principle necessity, stating: "Stable, friendly, and prosperous states in the Western Hemisphere enhance

[8] Sergio Diaz-Briquets, *Determinants of Emigration from Mexico, Central America, and the Caribbean* (New York: Routledge, 2018), 76.

[9] Ibid., 76.

[10] Ibid., 76.

[11] US Customs and Border Protection, "Southwest Border Migration FY2020."

[12] Ibid.

our security and benefit our economy."[13] However, Central America, like any region of the world, comprises a complex system with numerous interests, cultures, ideas, and governance.

On March 15, 2019, President Donald J. Trump declared a National Emergency on the southern border because of the overwhelming number of migrants seeking refuge from instability and violence in Central America.[14] The declaration states that the southern border is a major entry point for criminals, gang members, and illicit narcotics, making this sort of large-scale migration a risk to national security. Many argue that the porous US border has created a pull factor for migration, and better border security measures constitute the only way of discouraging illegal migration. However, in recent years there have been sharp increases in family units and unaccompanied minors entering and seeking asylum.[15] Prior to 2014, most migrants seeking asylum in the United States were adult men from Mexico seeking work opportunities.[16] In 2016, the number of Central American asylum seekers surpassed those asylum seekers from Mexico.[17] While the United States presents opportunities that could pull migration, the drastic shift in the origin of asylum seekers suggests that regional push factors are likely a large contributor. Policy changes in the United States, as well as additional enforcement by the Mexican government, is beginning to discourage migration. However, evidence reveals that the desire to emigrate remains strong. Therefore, addressing the source of push factors, including socioeconomic opportunity, stability, and violence, in Central American can assist with alleviating factors for migration. However, planners must also understand the complex systems and interconnectedness of factors

[13] Donald J. Trump, *National Security Strategy* (Washington, DC: Government Printing Office, 2017), 51.

[14] Donald J. Trump, "Presidential Proclamation on Declaring a National Emergency Concerning the Southern Border of the United States," *The Whitehouse*, March 15, 2019, accessed February 18, 2020, https://www.whitehouse.gov/presidential-actions/presidential-proclamation-declaring-national-emergency-concerning-southern-border-united-states/.

[15] Trump, "Presidential Proclamation."

[16] Sigelmann, 1.

[17] Ibid., 1.

for migration, as well as how climate change is exasperating these factors, resulting in climate-induced migration.

The NSS provides the President's national security vision and the roadmap for protecting vital US national interests. While the current NSS does not directly address climate change, it is not hard to extrapolate how working to ensure stability in the Western Hemisphere constitutes a strategic aim. Specifically, the NSS states that "Democratic states connected by shared values and economic interests will reduce the violence, drug trafficking, and illegal immigration that threaten our common security, and will limit opportunities for adversaries to operate from areas of close proximity to us."[18] Evidence does suggest that increased governance and economic opportunity is essential to climate change adaption strategies. Therefore, the NSS does hit on a regional necessity for robust adaptions strategies by encouraging "market-based economic reforms" and by encouraging "transparency to create conditions for sustained prosperity."[19]

Critics often condemn the current NSS for not directly addressing climate change as did past national security strategies. However, addressing climate change is complex. Indeed, addressing the environmental variables associated with the phenomenon is only one approach, and it is not the only way to create antifragility within the system. Mitigation and adaption strategies for climate change must also address socioeconomic factors that are exacerbated by climate change. These include developing strong diverse economic markets and strong governance. Managing the risk associated with climate change as a contributing factor of regional instability will require coordination, collaboration, and continued analysis to understand the interconnectedness of environmental and socio-economic factors. Central America remains a complex system, interwoven with seven different governments, diverse yet interconnected social

[18] Trump, *National Security Strategy*, 51.

[19] Trump, *National Security Strategy*, 51.

structures, and an assortment of donors contributing humanitarian aid, research, and training programs.

United States Strategic Planning

The US Government's higher-level planning documents and strategies include the NSS, the United States Agency for International Development (USAID) Joint Strategic Plan (JSP), State Department Joint Regional Strategy (JRS), Functional Bureau Strategies, and the Integrated Country Strategies. Additionally, the NSS informs the National Defense Strategy (NDS), which provides guidance for DoD strategy and enables the department to provide combat-credible military forces to deter war and protect US national security of the United States.[20] The JSP supports policy set by the President in the NSS, and presents how the Department of State (DoS) and USAID will implement US foreign policy and development assistance.[21] These strategic documents inform the DoS Integrated Country Strategies and the Department of Defense's NDS.[22] The strategic level documents help to provide a roadmap for the instruments of national power, guiding engagement strategies as well as priorities for funding. The programs and funding nest with the strategy, policies, and priorities identified in the strategic documents. With relation to Central America, the NSS and JSP take different approaches, but have similar overarching strategic goals focused on stability, countering transnational crime, and addressing corruption.

[20] US Department of Defense, Joint Chiefs of Staff, *National Military Strategy of the United States of America* (Washington, DC: Joint Chiefs of Staff, 2018), 1, accessed February 16, 2020, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

[21] US Department of State and US Agency for International Development, *Joint Strategic Plan FY 2018-2019* (Washington, DC: US Department of State, 2018), 15, accessed 19 January 2020, https://www.state.gov/joint-strategic-plan/.

[22] US Department of State, Foreign Assistance Resource Library, "Integrated Country Strategies," 2020, accessed, January 19, 2020, https://www.state.gov/integrated-country-strategies/#wha.

United States State Department

The JSP provides the strategic framework for both the US DoS and USAID. The DoS is the lead US foreign affairs agency within the Executive Branch, as well as the lead institution in conducting American diplomacy.[23] In coordination with DoS, USAID is the US Government's lead international development and humanitarian assistance agency.[24] Unlike the NSS, the JSP FY 2018-2019 does not provide goals by region, but outlines four strategic goals similar to the NSS: 1) protect America's security at home and abroad; 2) renew America's competitive advantage for sustained economic growth and job creation; 3) promote American leadership through balanced engagement; and 4) ensure effectiveness and accountability to the American taxpayer.[25]

Under the DoS, there are various levels of the planning process (see figure 5). Once the JSP provides a framework, the DOS produces the nested Functional Bureau Strategy (FBS) and the Joint Regional Strategy (JSR). These are four-year plans designed to articulate priorities within a region, aligning resources for the highest potential for impact.[26] The JSR for Central America falls within the Bureau of Western Hemisphere Affairs and Bureau for Latin America and the Caribbean. Approved in January of 2019, the JRS strategy outlines four goals for action: 1) a secure hemisphere; 2) a prosperous hemisphere; 3) a democratic hemisphere; and 4) a hemisphere receptive to US leadership and values.[27] While the JSR does not directly discuss

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[23] US Department of State and US Agency for International Development, *Joint Strategic Plan FY 2018-2019*.

[24] US Department of State and US Agency for International Development, *Joint Strategic Plan FY 2018-2019*, 15.

[25] Ibid., 23.

[26] US Department of State, "Joint Regional Strategies" 2020. Accessed January 20, 2020. https://www.state.gov/joint-regional-strategies/.

[27] US Department of State, *Joint Regional Strategy: Bureau of Western Hemisphere Affairs and Bureau of Latin America and the Caribbean* (Washington, DC: US Department of State, January 3, 2019), accessed January 20, 2020, https://www.state.gov/wp-content/uploads/2019/06/JRS_WHA-LAC_UNCLASS-508.pdf.

climate change, it identifies natural disasters as a risk to regional stability. In terms of ongoing climate change, there is a direct connection between the phenomenon and increased vulnerability and frequency of extreme weather events in Central America.

Figure 2. The State Department conducts strategic planning at the department, bureau, and country levels. Department of State, "Joint Regional Strategies," 2020, accessed January 20, 2020, https://www.state.gov/joint-regional-strategies/. Development of the FBS and JSR fall into the second tier of planning, called Bureau Strategic Planning, indicated on the figure by the red circle. The budgeting for all department activities, including foreign assistance, is developed based on these strategies.

Under the JSP, USAID's regional strategies are the Regional Development Cooperation Strategies (RDCS) and the Country Development Cooperation Strategies (CDCS). The CDCS are generally five year plans that define a mission's chosen approach in a country, describes the self-reliance trajectory, and lays out the expected results.[28] The most recent RDCS for Central America and Mexico (CAM) is the 2015-2019 plan, which describes USAID's regional

[28] US Agency for International Development, "Country Development Cooperation Strategies (CDCS)," updated May 7, 2019, accessed January 20, 2020, https://www.usaid.gov/results-and-data/planning/country-strategies-cdcs.

presence.[29] The CAM RDCS outlines foreign policy priorities in Central America and Mexico, including: ineffective governance, pervasive crime and violence affecting the Northern Triangle, slow economic growth, climate change and high vulnerability of disasters, and HIV/AIDS.[30] The CAM development objectives include: 1) regional economic integration increased; 2) regional climate-smart economic growth enhanced; 3) regional human rights and citizen security improved; HIV prevalence in Central America contained.

The CAM explains that the development objectives are in strategic alignment with the Central America bilateral missions' work and support the key pillars of the US Strategy for Engagement in Central America (CEN Strategy) and the Alliance for Prosperity.[31] The CEN Strategy includes a prosperity pillar, which RDCS nests efforts within by seeking to improve trade facilitation and agricultural value chains, in turn, building resiliency to climate change impacts.[32] The CAM outlines various Developmental Objectives (DO) for Central America, as seen in figure 6. Only one of these lines of effort, "DO2: Regional climate-smart economic growth enhanced," mentions climate change. This is not an oversight by the DOS but a comprehensive approach to addressing the additional vulnerabilities related to at risk populations. Climate change vulnerability is not just about addressing immediate climate variables but also socioeconomic conditions like poverty and access to education. The other lines of effort all include efforts that contribute to Central America being more resilient to and adapting to climate change challenges. The objectives are in coordination with the mutual security and economic

[29] US Agency for International Development, "Central America and Mexico (CAM) RDCS," updated March 3, 2016, accessed January 20, 2020, https://www.usaid.gov/cam/cdcs.

[30] US Agency for International Development, *Central America and Mexico (CAM) Regional Development Cooperation Strategy, 2015-2019* (Washington, DC: US Agency for International Development, 2020), 3, accessed January 20, 2020, https://www.usaid.gov/sites/default/files/documents/1862/FINAL-CAM-RDCS_public_0.pdf.

[31] Ibid., 3.

[32] Ibid., 3.

interests of the United States and Central America to mitigate the effects of global climate change, aiming a more inclusive, prosperous, transparent, and safe Central American region.[33]

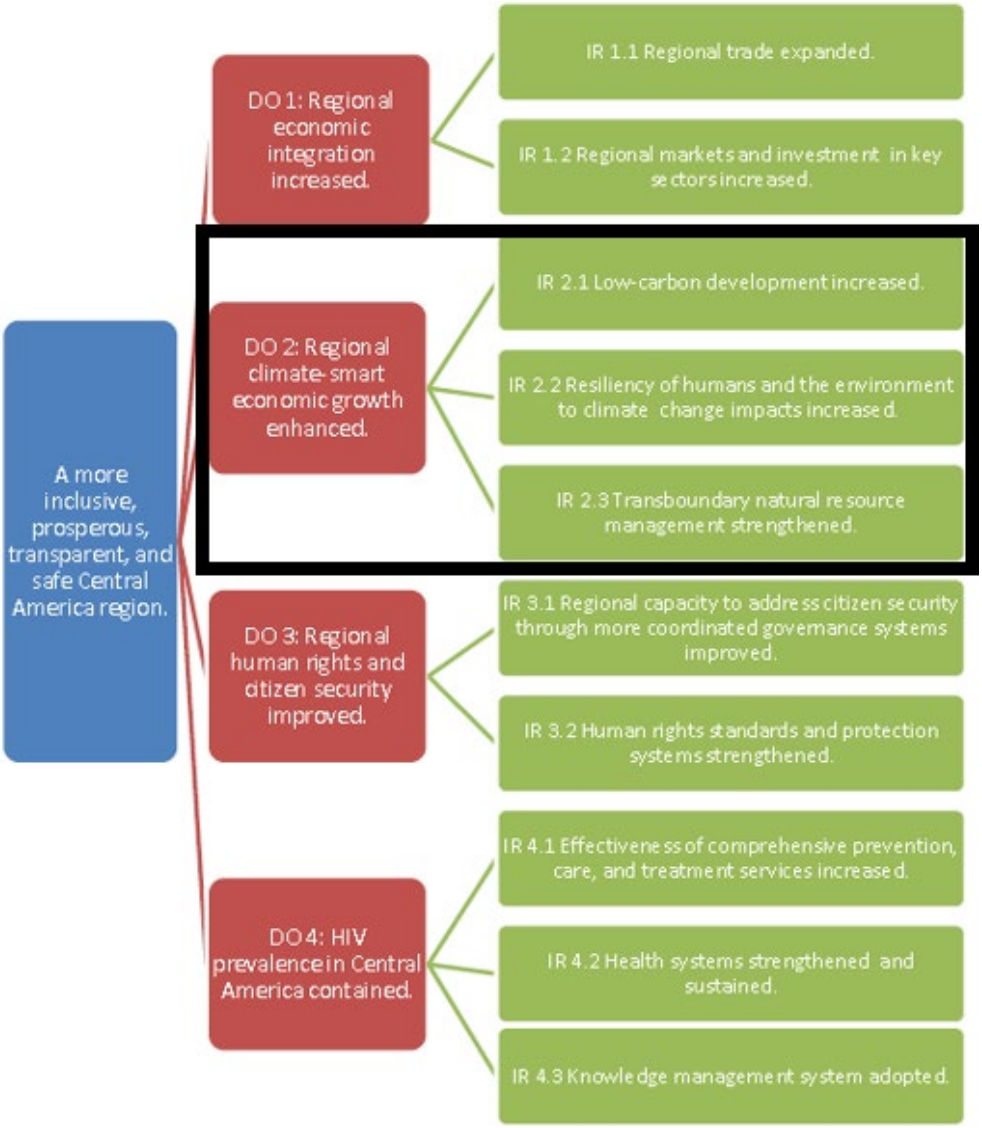

Figure 3. Illustration of the CAM four Development Objectives to work towards the goal of a more inclusive, prosperous, transparent, and safe Central American region. US Agency for International Development, *Central America and Mexico (CAM) Regional Development Cooperation Strategy, 2015-2019* (Washington, DC: US Agency for International Development, 2020), 12, accessed February 15, 2020, https://www.usaid.gov/sites/default/files/documents/1862/FINAL-CAM-RDCS_public_0.pdf. Outlined in black is DO2, which most directly addresses climate change.

[33] Ibid., 12.

One of the most important aspects of any engagement strategy is monitoring and quantitative assessment. With a complex system like Central America, unforeseen variables or misunderstanding secondary and tertiary impacts can derail even the best-intentioned program. However, the CAM does address the need for monitoring and, most importantly, the need to learn from ongoing assessment to reframe programs and inform future projects. The CAM outlines the need to track progress toward goals through identified illustrative indicators. For example, "DO2: Regional climate-smart economic growth enhanced," is measured through "SUB IR 2.2.2: Evidence-based climate-resilient practiced adopted" and quantified through the indicator of "Custom number of stakeholders implementing risk reduction practices as a result of USG assistance."[34] The CAM approach to identify goals, quantify impacts through illustrative indicators, and then learn and adapt programs shows a comprehensive, informed approach. Furthermore, by systematically reviewing the RDCS, USAID can maximize development results and ensure programs as suitable, desirable, feasible, and acceptable for Central America, while also reframing assumptions and emergent variables.[35]

Department of Defense

A critical part of US foreign policy is its ability to nest regional strategies across agencies. The DoD actions the NSS through the NDS and the NMS. Broadly, the NDS states that the central challenge to US prosperity and security is the reemergence of long-term, strategic competition by revisionist powers. More specifically, the NDS identifies Russian and Chinese influence through interference in other nations' economic, diplomatic, and security decisions. In the realm of international relations, China's expanding presence in the region is an example of

[34] US Agency for International Development, *Central America and Mexico*, 34.

[35] Ibid., 39.

competition.[36] Competition along the defined competition continuum allows the United States to compete for strategic advantage while remaining below the level of armed conflict through a mixture of cooperation applying all instruments of national power.[37] However, the popular approach to dealing with these outside influences is generally strengthening alliances and encouraging strong governance with regional actors. As the NSS guides the NDS, the NDS influences the strategies of the Combatant Commands. Most relevant for this monograph is the US Southern Command's (USSOUTHCOM) nested regional strategy.

In his USSOUTHCOM 2020 posture statement to Congress, Admiral Craig Faller, Commander of USSOUTHCOM, states that USSOUTHCOM is focusing on sustaining "advantages in the Western Hemisphere – the most important of which are strong partnerships founded on shared democratic values."[38] The posture statement identifies current trends with Chinese involvement in the region as well as the vicious circle of threats that erode stability and challenge young governments.[39] While it may seem that this statement marginalizes the security challenges that climate change will impose on the region, stability and governance through alliances and partnerships is essential. The posture statement focuses on strengthening regional partnerships to counter threats and supporting interagency efforts. The strategic documents suggest that USSOUTHCOM and the DOS synchronize their efforts to ensure regional stability, leveraging a whole of government approach.

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[36] US Department of Defense, Joint Staff, Joint Doctrine Note (JDN) 1-19, *Competition Continuum* (Washington, DC: Government Publishing Directorate, June 3, 2019), 1, accessed March 12, 2020, https://www.jcs.mil/Portals/36/Documents/Doctrine/jdn_jg/jdn1_19.pdf?ver=2019-06-03-133547-197.

[37] US Joint Staff, JDN 1-19, 2.

[38] Craig S. Faller, "Posture Statement of Admiral Craig S. Faller, Commander, United States Southern Command, Before 116 Congress, Senate Armed Services Committee," January 30, 2020, 1, accessed February 16, 2020, https://www.southcom.mil/Portals/7/Documents/Posture%20Statements/SASC%20SOUTHCOM%20Posture%20Statement_FINAL.pdf?ver=2020-01-30-081357-560.

[39] Ibid., 2.

China is rapidly expanding its influence into Latin America. Nineteen nations in Latin American and the Caribbean are now participating in the One Belt One Road initiative.[40] With more than $150 billion in loans, China is now the region's largest investor and creditor. Much of the Chinese investment focuses on infrastructure projects, including military significant infrastructure like deep water ports, but also critical infrastructure like roads and energy projects. Critical infrastructure is vital to building resiliency and implementing comprehensive climate change adaption strategies. However, Chinese predatory investment can directly challenge US influence in the region. In Central America, Ecuador is one of the biggest borrowers of Chinese loans, amassing $18.4 billion in debt to China.[41] Infrastructure projects in Ecuador include: $1.7 billion for the Coca-Codo Sinclair hydroelectric dam, $571 million for Sopladora hydroelectric dam, $2 billion for renewable energy development, $312 million for Minas-San Francisco hydroelectric dam, and $509 million to finance the Coca-Codo dam transmission system, just to name a few. Energy security is one factor that can help to ensure economic stability and quality of life improvements for Ecuador. However, water management in the Dry Corridor, as well as and the impact of dams, can complicate international relations and put populations downstream at risk if not managed properly. While hydroelectric power is often met with criticism due to its inimical environmental impact, this is compounded in Ecuador as there is no modern hydrological monitoring network to evaluate river flows.[42] Furthermore, traditional financing sources, such as

[40] Ibid., 4.

[41] Kevin P. Gallagher and Margaret Myers, "China-Latin America Finance Database," Inter-American Dialogue, 2019, accessed February 16, 2020, https://www.thedialogue.org/map_list/.

[42] Matt Terry, "Ecuador's Water Crisis: Damming the Water Capital of the World, Ecuadorian Rivers Institute," December 15, 2007, accessed February 16, 2020, https://www.international rivers.org/resources/ecuador-s-water-crisis-damming-the-water-capital-of-the-world-1895.

the World bank, publish formal social and environmental safeguard assessments.[43] There is often no such requirement associated with Chinese funding.

There is often debate about humanitarian assistance and whether the assistance is helping, hurting, or creating further problems in a target region. With China funding development projects in Central America, there is similar controversy. For example, while energy independence is important, hydroelectric projects can cause further difficulty if done in isolation without proper regulatory oversight. Negative impacts of hydroelectric infrastructure can include damaging and even collapsing ecosystems by changing river flows and changing watersheds. Additionally, hydroelectric infrastructure can reduce and even stop water flow, creating conflict between upstream verses downstream communities. Climate change amplifies the negative impacts of hydroelectric infrastructure as the region faces difficulties from extended droughts to severe flooding. Policymakers must weigh the impacts of energy security against the possible negative impacts and future impacts as the region responds to climate change. The question for US national security is whether Chinese sway and infrastructure projects reduce US influence and present a potential risk to destabilizing the region. USSOUTHCOM's posture statement indicates that China's infrastructure projects have future military potential and have inflicted insurmountable, long-term environmental damage. Even worse, telecommunication projects provide a backdoor for the Chinese government to monitor official information shared with US partners.

USSOUTHCOM is countering the risks presented by malign actors, as directed by the NDS, by deepening relation with "regional countries that export military capabilities and regional

[43] Maria Cristina Vallejo, Betty Espinosa, Francisco Venes, Victor Lopes, Susana Anda, "Evading sustainable development standards: Case studies on hydroelectric projects in Ecuador," Boston University, Global Development Policy Center, October 2018, 9, accessed February 16, 2020, https://www.semanticscholar.org/paper/Evading-sustainable-development-standards-%3A-Case-on-López/ea9cbb8fc1bdeb31333b2e62b9b1c59504785cbe.

and global security challenges."[44] This approach is fitting for the DoD's limited enduring US military presence in Central America. Conversely, building infrastructure and doing long-term governance projects is a more fitting approach for DoS. The DoD achieves its objectives through reoccurring rotations of small teams to help strengthen partnerships and exchange critical expertise.[45] Furthermore, the National Guard maintains enduring relationships through the State Partnership Program (SPP), while Joint Task Force-Bravo (JTF-B) and Marine Corps Special Purpose Marine Air-Ground Task Force (SPMAGTF) build collective response and security capability. As seen in figure 7, JTF-B, as the only forward JTF in the area of operations, plays a critical role by maintaining an enduring presence. Again, while their efforts do not mention climate change or the environmental risks present in the region, JTF-B specifically addresses countering malign actors, weak governance, and developing economies.

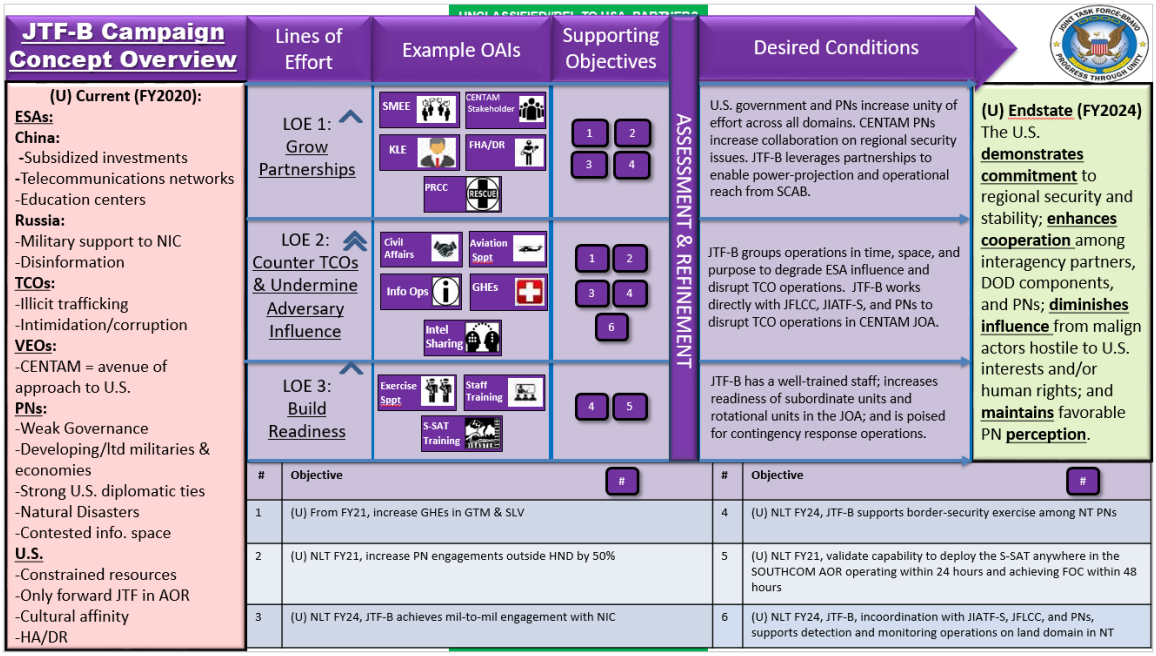

Figure 4. Illustration of JTF-B Campaign Overview. US Army Southern Command, Joint Task Force–Bravo, *Capabilities Brief* (Soto Cano Airbase, Honduras, 2019). The diagram demonstrates how the priorities nest with lines of effort, and supporting objectives, which undergo routine analysis to reframe and refine objectives to achieve desired conditions.

[44] Faller, "Posture Statement," 4.

[45] Ibid., 7.

USSOUTHCOM boasts a relatively small footprint in Central America. However, the importance of this region for US national security interests are clear. State actors like China are expanding influence while non-state actors and gang violence threaten overall regional stability. Climate change does present a direct threat to stability in the region through resource competition, economic hardship resulting from dwindling crop yields, and humanitarian crisis resulting from food insecurity. Research suggests that development and adaption strategies, especially in developing countries, must focus on efforts to reduce vulnerability, building governmental capacity to deal with crises in governance and strengthening economic opportunities. USSOUTHCOM should continue to engage to strengthen its close cooperation with Central American militaries and governments. While these efforts are not overtly addressing climate change, it is the proper mission for USSOUTHCOM to undertake to strengthen national security and ensure regional stability.

Status of Climate Change in Central America

Central America consists of seven countries: Panama, Costa Rica, Nicaragua, Honduras, El Salvador, Guatemala, and Belize. The region is also known as one of the world's richest and highly threatened biodiversity regions.[46] In an assessment of countries most threatened by climate change according to the global climate risk index, several Central American countries were ranked within the top ten most 1996-2015.[47] The impacts of climate change likely will be considerably more severe in Central America than the United States because of weak governance,

[46] Aline Chiabai, ed., *Climate Change Impacts on Tropical Forests in Central America: An Ecosystem Service Perspective* (New York: Routledge, 2015), 17.

[47] Sonke Kreft, David Eckstein, and Inga Melchior, *Global climate risk index 2017: Who suffers most from Extreme weather events? Weather-related loss events in 2015 and 1996 to 2015* (Bonn, Germany: Germanwatch e.V., 2016), 10, accessed December 10, 2019, https://germanwatch.org/sites/germanwatch.org/files/publication/16411.pdf.

reliance on an agricultural-based economy, resource competition, and the socio-economic impacts compounded by drought, increased survivability of disease vectors, and food scarcity.

The "Dry Corridor"

The Central American Dry Corridor (CADC) is a tropical dry forest region that runs along the western coast of Central America from Guatemala to western Costa Rica.[48] The CADC encompasses territory ranging from Guatemala, Honduras, El Salvador, Nicaragua, Panama, and Costa Rica.[49] The Dry Corridor consists of a group of dry tropical forest ecosystems in Central America, running from Chiapas, Mexico, to the low-lying areas of the Pacific slope of the central region, including Guatemala, El Salvador, Honduras, Nicaragua, and part of Costa Rica.[50] Of the CADC countries, the United Nations identifies Guatemala, Honduras, El Salvador, and Nicaragua as the most vulnerable to drought.[51] Additionally, a 2015 risk assessment analyzing threats, vulnerability, and responsiveness found El Salvador, Honduras, and Nicaragua highly at risk, and especially Guatemala at a very high risk for a crisis or humanitarian disaster.[52] Inhabitants of the Dry Corridor are familiar with the region's known irregular rainfall. However, while known irregular rainfall causes alternating periods of flooding and drought, creating challenges for

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[48] Jordi Vaque, *Chronology of the Dry Corridor: The impetus for resilience in Central America* (Rome, Italy: Food and Agriculture Organization of the United Nations, 2017), 1 accessed December 10, 2019, http://www.fao.org/in-action/agronoticias/detail/en/c/1024539/.

[49] Ibid., 1.

[50] Lino Naranjo, Michael H. Glantz, Sayat Temirbekov, and Ivan J. Ramírez, "El Niño and the Köppen-Geiger Classification: A Prototype Concept and Methodology for Mapping Impacts in Central America and the Circum-Caribbean," *International Journal of Disaster Risk Science* 9, no. 2 (2018), 233 accessed December 10, 2019, https://link.springer.com/article/10.1007/s13753-018-0176-7#citeas.

[51] Naranjo et al., 233.

[52] Food and Agriculture Organization of the United Nations, *Disaster Risk Programme to strengthen resilience in the Dry Corridor in Central America: El Salvador-Guatemala, Honduras-Nicaragua, 2015-2018* (Rome, Italy: Food and Agriculture Organization of the United Nations, September 2015), 2, accessed December 11, 2019, http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/330164/.

farmers, new research shows that the corridor is one of the most susceptible regions in the world to the impacts of climate change.[53]

The corridor is also home to 25 percent of the region's population, with an estimated one million people who depend on the land as subsistence farmers.[54] In Honduras, the corridor has nearly tripled in size over the past thirty years, now encompassing almost 45 percent of national territory.[55] The expansion of the Dry Corridor threatens the livelihoods of small subsistence farmers. Climate change-related drought will likely place rural communities at high risk because of limited access to drinking water and reduced agricultural productivity. These risks intensify as the seasonal temperatures rise and the drought season lengthens. As these climate trends intensify, rural communities will be at greater risk of depleting food stocks.[56] Climate change will fundamentally impact the region through increased temperatures and decreased rainfall, resulting in cascading resource competition, socio-economic impacts, and driving regional instability.

[53] Ibid., 1.

[54] Federica Ravera, David Tarrasón, and Elisabeth Simelton, "Envisioning Adaptive Strategies to Change: Participatory Scenarios for Agropastoral Semiarid Systems in Nicaragua," *Ecology and Society* 16, no. 1 (2011): 20, accessed January 17, 2020, https://doi.org/10.5751/es-03764-160120.

[55] John R. Wennersten and Denise Robbins*, Rising Tides: Climate Refugees in the Twenty-First Century* (Bloomington, IN: University Press of Scholarly Publishing, 2017), 110.

[56] Food and Agriculture Organization, *Disaster Risk Programme*, 3.

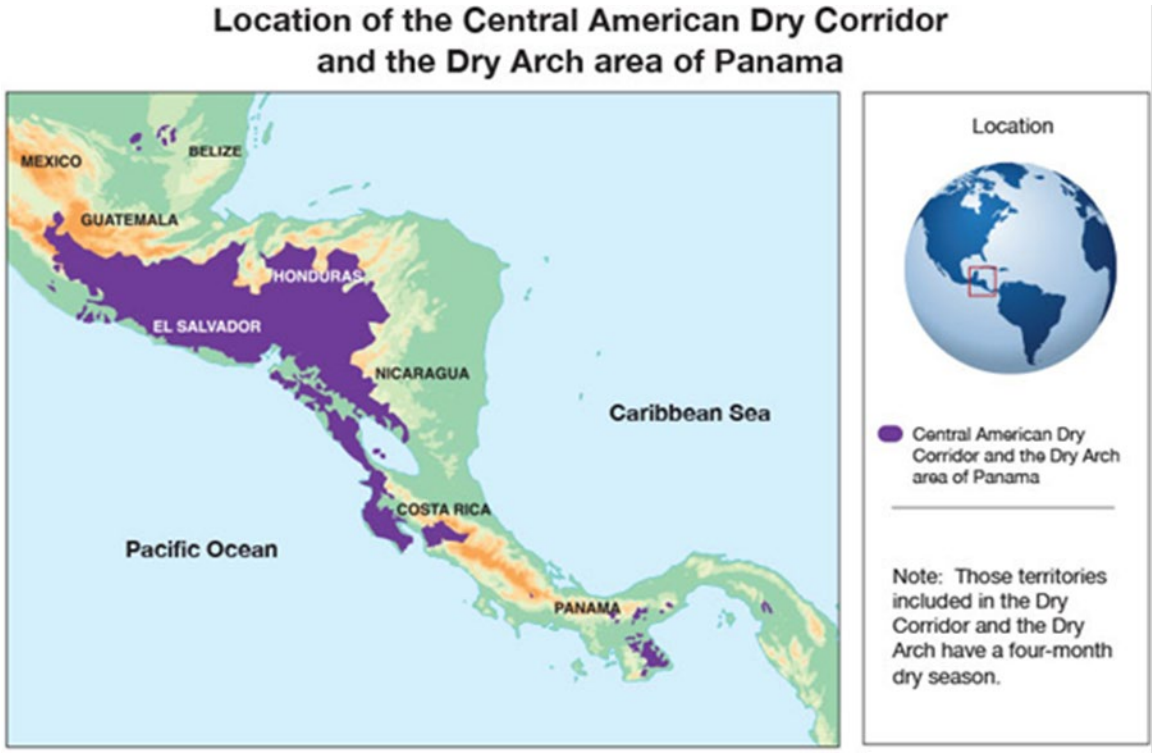

Figure 5. Location of the Central American Dry Corridor and the Dry Arch area of Panama. Food and Agriculture Organization of the United Nations, *Disaster Risk Programme to strengthen resilience in the Dry Corridor in Central America: El Salvador-Guatemala, Honduras-Nicaragua, 2015-2018* (Rome, Italy: Food and Agriculture Organization of the United Nations, September 2015), 1, accessed January 17, 2020, http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/330164/.

Climate Trends

Since the mid-1970s, IPCC reports reveal warming temperatures of nearly 0.7 degrees C to 1.0 degrees C throughout Central America, with the greatest extreme temperature fluctuations occurring in tropical regions.[57] By 2100, modeling suggests that temperatures in Central America could increase by 1.6 to 4 degrees C, triggering increased dryness as a result of evaporation and a

[57] Graciela O. Magrin, José A. Marengo, Jean-Phillipe Boulanger, Marcos S. Buckeridge, Edwin Castellanos, Germán Poveda, Fabio R. Scarano, and Sebastián Vicuña, "Central and South America," in *AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability*, ed. Christopher B. Field, 1502 (New York: Cambridge University Press, 2014), 1502, accessed December 21, 2019, https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap27_FINAL.pdf.

reduction in soil moisture.[58] The 2016 Paris accords was an agreement to strengthen the global response to climate change by seeking to limit warming to only 2 degrees C.[59] However, with few to no countries on track to meet emissions goals of the Paris Agreement, warming to 2 degrees C is likely a best-case scenario. The significance being that much of the predictable impacts of climate change, according to the IPCC, are likely to be exceptionally worse as the globe warms past the 2-degree C mark.[60] As tropical regions are the most vulnerable to climate change, the warmer, dryer climate is likely to change the ecological biomes of Central America and prompt wider weather fluctuations as a result of seasonal events, such as El Niño and La Niña.

Current modeling scenarios reflect Central America as the region with the largest expected changes in climate among tropical areas.[61] The impact to seasonal weather is also likely to cause dramatic changes in vegetation types. One analysis of potential ecoregion transformation predicts a reduction of canopy cover between 2070-2100 that could result in the transition of tropical rainforests to seasonal or dry forests, while also increasing bushlands and pastures.[62] If climate change increases temperatures rapidly in tropical ecoregions, the likelihood for plants to adapt greatly diminishes. Limited adaption, compounded by habitat fragmentation and limited seed dispersal sources, will further exacerbate climate-induced ecosystem transformation.[63]

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[58] Laura Sigelmann, *The Hidden Driver: Climate Change and Migration in Central America's Northern Triangle* (Washington, DC: American Security Project, 2019), 7, accessed November 25, 2019, https://www.americansecurityproject.org/perspective-climate-change-and-migration-in-central-americas-northern-triangle/.

[59] David Wallace-Wells, *The Uninhabitable Earth* (New York: Penguin Random House, 2019) 9.

[60] Ibid., 9.

[61] Chiabai, 32.

[62] Ibid., 32.

[63] Ibid., 33.

Central America is located between the warm waters of the eastern tropical Pacific Ocean, Caribbean Sea, and Gulf of Mexico.[64] As a result of the region's ecosystem geographic location and coastal disposition, the El Niño-Southern Oscillation (ENSO) influences Central America's seasonal weather. Furthermore, the region is impacted by the East Pacific Warm Pool (EPWP).[65] Directly adjacent to Central America, the EPWP constitutes the warmest water in the eastern Pacific Ocean and the rainiest place on earth during the summer season.[66] Warming sea surface temperature, in correlation with an El Niño event in the EPWP, could trigger rainfall anomalies in Central America.[67] Historically, extreme El Niño events happen once every twenty years. However, with climate change, the likelihood of extreme El Niño events increases to once every ten years.[68]

El Niño and La Niña are periodic weather patterns that act as opposing phases of the ENSO cycle.[69] During an El Niño year, the Pacific coasts of Central America remains dry while the Caribbean coasts receive excessive rainfall.[70] El Niño events frequently correlate with drought in Central America. While these events are normal, occurring every three to six years, climate change aggravates the intensity of these events. The 2019 El Niño reduced cumulative rainfall in Central America to 60 percent below the long-term average.[71] ENSO events are

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[64] Kristopher B. Karnauskas and Antonio J. Busalacchi, "The Role of SST in the East Pacific Warm Pool in the Interannual Variability of Central American Rainfall," *Journal of Climate* 22, no. 10 (2009): 2605, accessed December 12, 2019, https://doi.org/10.1175/2008jcli2468.1.

[65] Ibid., 2605.

[66] Ibid., 2606.

[67] Ibid., 2606.

[68] Wennersten and Robbins, 113.

[69] National Oceanic and Atmospheric Administration, "What are El Niño and La Niña?" 2019, accessed November 25, 2019, https://oceanservice.noaa.gov/facts/ninonina.html.

[70] Viktor Noviko, "Climate Impacts of El Niño Phenomenon in Latin America and the Caribbean," GRID-Arendal, 2005, accessed November 25, 2019, https://www.grida.no/resources/6517.

[71] Food and Agriculture Organization of the United Nations, "GIEWS – Global Information and Early Warning System: GIEWS Updates," 2019, accessed November 25, 2019, http://www.fao.org/giews/reports/giews-updates/en/.

difficult to forecast, complicating efforts to prepare for the impacts these events produce. Furthermore, there is disagreement in the scientific community about whether El Niño's generate anomalous weather events or if persistent ENSO events temporarily change the seasonality of the climate for that specific year.[72] For example, during an El Niño year, Central America experiences dry conditions (during dry season from November-April) followed by a higher than usual rainy reason (May-September). However, the midsummer drought (July-August) will generally be stronger and last longer.[73] The impacts of the El Niño event then proceed until the following year, causing the region's regular seasonality to suffer. These events would tend to lead to rainforest ecosystems shifting to tropical savannah conditions due to the rapid rainfall deficit following El Niño.[74]

Climate patterns occur during a calendar year when climate shifts are characterized by the weather before or after ENSO events.[75] ENSO events become so impactful because they modify the normal flow of seasons in regions like Central America.[76] In turn, the modified seasons then hasten definable climate shifts with the potential for cascading effects depending on how populations respond and prepare.[77] Currently, research showing distinct correlations or even causation between a warming climate and more intense ENSO events is limited. The IPCC reports state with high confidence that ENSO events will continue to be the dominant driver of seasonal variability in Central America. However, increased moisture availability in the

[72] Naranjo et al., 225.

[73] Ibid., 230.

[74] Ibid., 233.

[75] Ibid., 233.

[76] Ibid., 234.

[77] Ibid., 234.

atmosphere will likely intensify ENSO-induced rainfall.[78] Despite limitations in research which correlates ENSO and climate change, ENSO events will influence Central America's social and political environments. Farmers throughout Central America, who depend on seasonal crop production, will have to prepare for varying climate patterns and, more importantly, climate shifts, which have the potential to disrupt normal planting and harvesting timetables.

Decreased Rainfall

Central America's geography and topography create high exposure to geo-climatic hazards.[79] Since around 1950, IPCC research has shown evidence that the rainy season in Central America begins later and precipitation has become more irregular.[80] Research predicting future climate scenarios in the region are increasingly dire due to economic dependence on agriculture and hydropower.[81] Furthermore, Central America has seen a steady increase in extreme weather events, including storms, floods, and droughts.[82] One extreme storm event can have lasting impacts, such as Hurricane Mitch in 1998, which killed approximately 10,000 people in Nicaragua and Honduras and decimated infrastructure estimated at around 40 percent of Honduras's Gross Domestic Product (GDP).[83] Research suggests future seasonal variations

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[78] Thomas F. Stocker, Dahe Qin, Gian Kasper Plattner, Melinda M. B. Tignor, Simon K. Allen, Judith Boschung, Alexander Nauels, Yu Xia, Vincent Bex and Pauline M. Midgley, eds., "Climate Phenomena and their Relevance for Future Regional Climate Change," in *Climate Change 2013: The Physical Science Basis*, 1217-1308 (New York: Cambridge University Press, 2013), 1243, accessed December 15, 2019, https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter14_FINAL.pdf.

[79] Magrin et al., 1508.

[80] Ibid., 1506.

[81] Pablo Imbach, Sin Chan Chou, André Lyra, Daniela Rodrigues, Daniel Rodriguez, Dragan Latinovic, Gracielle Siqueira, Adan Silva, Lucas Garofolo, and Selena Georgiou, "Future Climate Change Scenarios in Central America at High Spatial Resolution," *Plos One* 13, no. 4 (2018): 2, accessed November 18, 2019, https://doi.org/10.1371/journal.pone.0193570.

[82] Magrin et al., 1508.

[83] Emilio Sempris, "Freshwater in Latin America and the Caribbean," *UN Chronicle* 46, no. 4 (2012): 1, accessed January 17, 2020, http://blogs.worldbank.org/latinamerica/guaranteeing-water-security-priority-central-america.

(outside of ENSO events) will include precipitation reduction for the rainy season and a strengthening of annual midsummer droughts.[84]

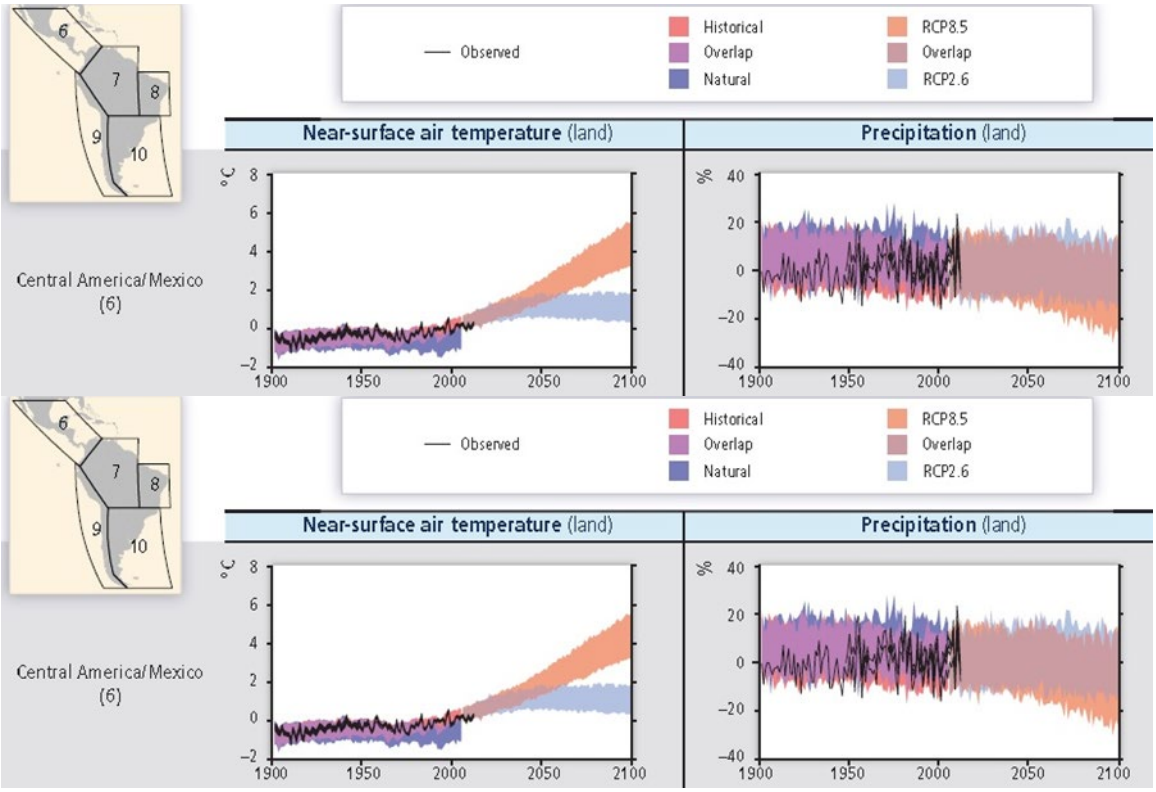

Figure 6. Observed and predicted variations in annual average temperature over Central America and Mexico defined in IPCC's 2012 Summary for Policymakers. Thomas F. Stocker, Dahe Qin, Gian Kasper Plattner, Melinda M. B. Tignor, Simon K. Allen, Judith Boschung, Alexander Nauels, Yu Xia, Vincent Bex and Pauline M. Midgley, eds., "Climate Phenomena and their Relevance for Future Regional Climate Change," in *Climate Change 2013: The Physical Science Basis*, 1217-1308 (New York: Cambridge University Press, 2013), 1-19, accessed December 15, 2019, https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter14_FINAL.pdf. Black lines show various estimates from observational measurements. Shading denotes the 5th to 95th percentile range of climate model simulations driven with "historical" changes in anthropogenic and natural drivers.

Central America's wet season generally runs from May through October.[85] Current trends depict a shorter wet season with increasing amounts and intensity of rainfall.[86] From 1960 to 2000, records show no evidence of increased total annual precipitation in Central America, but

[84] Imbach et al., 7.

[85] Karnauskas and Busalacchi, 2608.

[86] Magrin et al., 1506.

there is increased proportion of precipitation occurring during extreme events.[87] However, some studies show that warmer oceanic surface temperatures to the east could increase precipitation in Central America as a result of increased evaporation off the warmer sea surface.[88] Furthermore, increased sea surface temperature could also lead to a longer and more intense tropical cyclone season.[89] The impact of shorter but more severe wet seasons will have dire impacts on those living in Central America. Farmers will need to mitigate the impacts of extreme rainfall events to maintain crop production levels. Frequent extreme rainfall events will also likely increase the occurrence of landslides and flash floods, which have the potential to wash out roads, damage crops, and destroy farming land, further contributing to food insecurity.[90]

Central America's dry season usually runs from November to March, with an additional dry period occurring from July to August.[91] While El Niño causes the most severe drought events, Central America also experiences annual seasonal droughts. Climate change is likely to increase the intensity of seasonal drought as well as lengthen the drought season. From 1950 to 2008, annual rainfall has already decreased about 1 millimeter per day for every fifty years.[92] More intense drought in Central America will intensify food insecurity and decreases economic

[87] Claudia Bouroncle, Pablo Imbach, Beatriz Rodríguez-Sánchez, Claudia Medellín, Armando Martinez-Valle, and Peter Läderach, "Mapping climate change adaptive capacity and vulnerability of smallholder agricultural livelihoods in Central America: Ranking and descriptive approaches to support adaptation strategies," *Climatic Change* 141, no. 1 (2017): 123-137, accessed December 15, 2019, https://link.springer.com/article/10.1007/s10584-016-1792-0#citeas.

[88] E. Aguilar, T. C. Peterson, P. Ramírez Obando, R. Frutos, J. A. Retana, M. Solera, J. Soley, I. González García, R. M. Araujo, A. Rosa Santos, V. E. Valle, M. Brunet, L. Aguilar, L. Álvarez, M. Bautista, C. Castañón, L. Herrera, E. Ruano, J. J. Sinay, E. Sánchez, G. I. Hernández Oviedo, F. Obed, J. E. Salgado, J. L. Vázquez, M. Baca, M. Gutiérrez, C. Centella, J. Espinosa, D. Martínez, B. Olmedo, C. E. Ojeda Espinoza, R. Núñez, M. Haylock, H. Benavides, R. Mayorga, "Changes in precipitation and temperature extremes in Central America and northern South America, 1961-2003," *Journal of Geophysical Research* 110, no. D23 (2005): 12, accessed December 12, 2019, https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2005JD006119.

[89] Ibid., 12.

[90] Magrin et al., 1502.

[91] Imbach et al., 13.

[92] Sigelmann, 7.

productivity. Estimates suggest that droughts contributed to 27 million USD in losses between 1972 and 2010.[93] In addition to food scarcity, climate change will lead to water shortages. Predicting future water scarcity can be difficult, but most modeling efforts show a general trend of decreasing water availability in Central America.[94] Water availability will have varying impacts on the region, but studies show water scarcity will have the biggest impact on the northern part of Central America as well as regions with high population density, such as capital cities.[95]

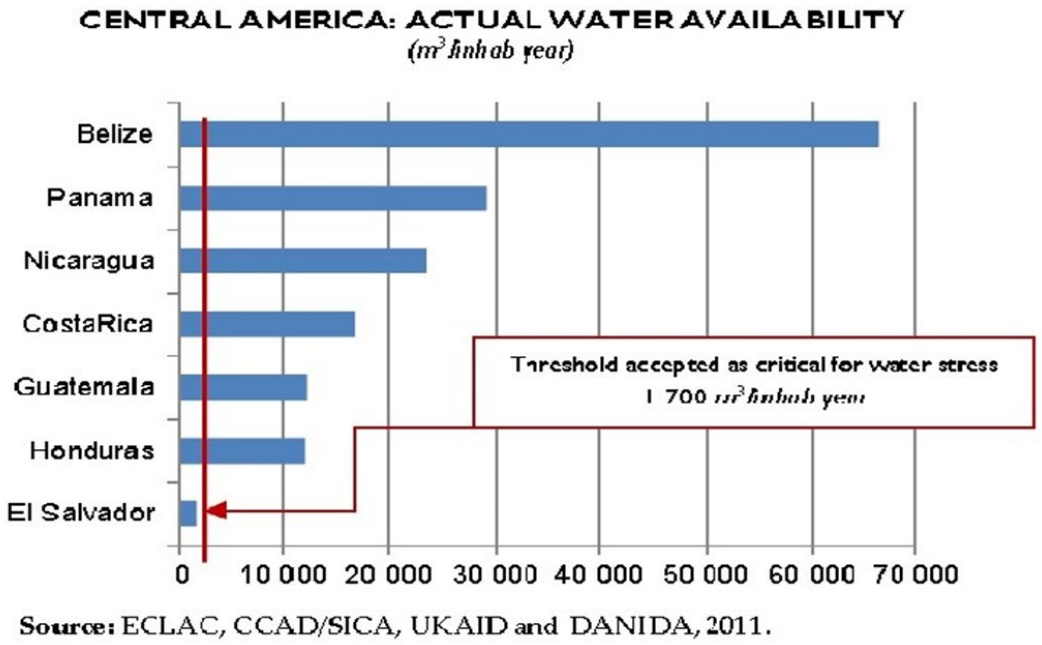

Figure 7. Central America has high water availability in some countries and water scarcity in others. United Nations Economic Commission for Latin America and the Caribbean, *Climate Change in Central America: Potential Impacts and Public Policy Options* (Mexico City, Mexico: United Nations Publication, 2015), 63, accessed December 15, 2019, https://www.cepal.org/en/publications/39150-climate-change-central-america-potential-impacts-and-public-policy-options. Belize has 66,400 cubic meters per year while El Salvador has 1,752 cubic meters per year, a value close to the water stress value. Central America's ability to respond to water scarcity will depend on management practices and countries ability participate in cross-border cooperation and management.

[93] Naranjo et al., 233.

[94] Chiabai, 82.

[95] Ibid., 85.

Climate change is directly and indirectly influencing three main drivers of migration in Central America: socioeconomic conditions, food security, and violence.[96] Changes in climatic trends is one of the largest influences to food security and socioeconomic drivers that exacerbate instability and violence. However, understanding the impacts of climate change on the climatic trends in the region is essential to understanding, mitigating, and implementing policies to respond. Central America will experience increased temperatures, longer dry seasons, more intense wet seasons, and possibly more intense and more frequent ENSO events as a result of climate change. While researchers cannot predict how extreme these impacts will be, it would be irresponsible to not attempt to anticipate these potential events.

Resource Competition

Agriculture plays a large role in the Central American economies. In the Dry Corridor region, at least one million families survive as subsistence farmers.[97] As climate change creates longer drought seasons, access to arable land and freshwater will become even more critical. As warming intensifies, the wet season becomes shorter, and more intense weather events occur, evaporation rates will increase.[98] Increased evaporation will likely result in declining soil moisture, decreasing the arability and viability of existing farmland.[99] The social and economic vulnerability of subsistence farmers will become a major issue intrinsically tied to food security. Access to fresh water and arable land also influences all three of the main drivers of migration in Central America: socioeconomic conditions and food security by creating negative impacts on agriculture, and violence as a secondary symptom of socioeconomic instability.

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[96] Sigelmann, 5.

[97] Food and Agriculture Organization, *Disaster Risk Programme*, 2.

[98] Sharon Gourdjia, Peter, Läderach, Armando Martinez Valle, Carlos Zelaya Martinez, David Lobell, "Historical Climate Trends, Deforestation, and Maize and Bean Yields in Nicaragua," *Agricultural and Forest Meteorology* 200 (2015): 270, accessed December 17, 2019, https://www.sciencedirect.com/science/article/pii/S0168192314002536?via%3Dihub.

[99] Ibid., 270.

Access to fresh water varies by country in Central America. Additionally, there is a disparity between rural and urban populations with direct access to piped fresh water. In El Salvador, 94 percent of urban populations have piped water, compared to only 75 percent of rural populations.[100] Furthermore, piped water is not always managed safe drinking water. In Costa Rica, 90 percent of the population have access to safely managed drinking water, while only 61 percent in Guatemala and 59 percent in Nicaragua.[101]

While the Dry Corridor crosses international borders, it presents similar challenges in multiple countries. In the Dry Corridor, 33 percent of residents require humanitarian assistance due to food shortages and loss of production resulting from lack of water.[102] In 2014-2015, Guatemala, Panama, and Honduras declared states of emergency because of the unprecedented drought.[103] These declarations promoted water restrictions and increased funding for humanitarian aid, but the drought impacted some 3.5 million people and left two million in dire need for food.[104] Climate change has the potential to contribute to a 70 percent rise in the estimated number of people who will struggle to access clean water by 2025.[105] Further studies estimate that a temperature raise of 2 degrees C will result in one to four billion people experiencing growing water shortages globally, with Central America being one of the four most effected regions.[106]

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[100] United Nations Children's Fund and World Health Organization, "Progress on household drinking water, sanitation and hygiene 2000-2017: Special focus on inequalities," 2019, accessed January 17, 2020, https://data.unicef.org/resources/progress-drinking-water-sanitation-hygiene-2019/.

[101] Ibid.

[102] Seynabou Sakho and Marco Antonio Aguero, "Guaranteeing Water Security, a Priority for Central America," *World Bank Blogs*, 2019, accessed January 17, 2020, http://blogs.worldbank.org/latinamerica/guaranteeing-water-security-priority-central-america.

[103] Wennerstern and Robbins, 109.

[104] Ibid., 109.

[105] Stern, 121.

[106] Ibid., 76.

Access to water as the result of drought drastically impacts subsistence farming. In Belize, agriculture comprises only 10 percent of economy; Guatemala, 31 percent; El Salvador, 21 percent; Honduras, 39.2 percent; Nicaragua, 31 percent; Costa Rica, 5.5 percent; and Panama, 17 percent.[107] Less developed countries, like El Salvador and Guatemala, will struggle the most with the impacts of climate change.[108] As countries attempt to prepare and implement adaption strategies, those countries with the economic resources to transition farming methods, install irrigation systems, and diversify crops will have a better chance to maintain crop yields.[109] Central America will need to prepare for fluctuation in production and the economic variability of lower crop yields as even slight warming will negatively impact farming across the region. However, while extremely unlikely, if warming remains below 1.5 degrees C, estimates show a considerable decrease in impacts to cereal crops in Central America.[110]

Some governments in Central America are responding to water shortages by placing massive restrictions on water usage. However, restricting water usage is a short-term solution to an enduring problem.[111] When weather events or natural disasters unexpectedly destroy harvests, it forces rural farmers to utilize coping mechanisms. The World Food Program (WFP) found that residents in the Dry Corridor often reduce food consumption, adjust finances, and sell off land before eventually migrating.[112] As farming continues to become a less viable livelihood, estimates show that people will continue to move to urban areas. Urbanization will introduce yet another challenge to the Central American region, water, and sanitation requirements. Across the

[107] Central Intelligence Agency, "The World Factbook 2019," 2019, accessed December 17, 2019, https://www.cia.gov/library/publications/resources/the-world-factbook/index.html.

[108] Stern, 83.

[109] Ibid., 83.

[110] Intergovernmental Panel on Climate Change, *Special Report on the Impacts of Global Warming*, 11.

[111] Wennersten and Robbins, 106.

[112] Sigelmann, 5.

region, 59 percent of the population resides in urban areas.[113] Estimates show that within the next generation, seven out of ten people will live in cities. Attempts to mitigate climate change will fall on government's ability to manage and distribute limited resources, like food and water, across their populations. To be successful, Central American governments must balance the needs of the population and the increased burdens that climate change places on the already limited availability of natural resources.

Risk Mitigation

Ongoing climate change will put considerable pressure on Central America by intensifying the risk of instability driven by food scarcity, reduced access to freshwater, and extreme weather events. Compounding these challenges, almost half of the population live in poverty, and approximately one-third live in extreme poverty.[114] Even with considerable financing, adaption strategies need to account for the fact that some losses, including infrastructure and crop production, will occur. Therefore, adaption strategies must also include poverty and inequality reduction.[115] However, studies suggest that policymakers in Central America often lack access to scientific research on climate change, which leads to poorly informed policy decisions in support of climate change adaption strategies.[116] Regional stability depends on the resiliency of the Central American governments as well as their ability to

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[113] Augustin Maria, Jose Luis Acero, Ana I. Aguilera, and Marisa Garcia Lozano, eds. *Central America Urbanization Review: Making Cities Work for Central America* (Washington, DC: World Bank, 2017), 1, accessed February 4, 2020, http://documentos.bancomundial.org/curated/es/370521489645120053/Central-America-urbanization-review-making-cities-work-for-Central-America.

[114] United Nations Economic Commission for Latin America and the Caribbean, *Climate Change in Central America: Potential Impacts and Public Policy Options* (Mexico City, Mexico: United Nations Publication, 2015), 18, accessed February 7, 2020, https://www.cepal.org/en/publications/39150-climate-change-central-america-potential-impacts-and-public-policy-options.

[115] Ibid., 23.

[116] Camila I. Donatti, Celia A. Harvey, M. Ruth Martinez-Rodriguez, Raffaele Vignola, and Carlos Manuel Rodriguez, "What information do policy makers need to develop climate adaptation plans for smallholder farmers? The case of Central America and Mexico," *Climatic Change* 141 (2017): 107-121, accessed February 14, 2020, https://link.springer.com/article/10.1007/s10584-016-1787-x.

implement comprehensive policy to mitigate the impacts of climate change. Adaption strategies to manage and mitigate water shortages, food scarcity, and disease will be essential to prevent instability and deter further emigration from the region.

Forecasts anticipate that climate change will increase the frequency of extreme regional drought. This risk has the potential to reduce annual crops yields and trigger migration to urban regions, causing water and food shortages that local governments must be able to address. In April 2019, the price of white maize in the Dry Corridor averaged 10 to 40 percent higher than normal due to below-average rainfall caused by El Niño.[117] Exacerbated by limited access to irrigation systems, extended periods of drought will directly impact the rural population's access to food.[118] Efforts to mitigate the risk of extended drought will require coordination to create a system to distribute water from the transnational river basins that comprise 40 percent of the region.[119] The current approach to risk mitigation is largely unilateral. However, due to the interconnectedness of the water basins that cross-national borders, water allocation and appropriation create complex relationships between countries.[120] However, poor management of hydroelectric dam projects have the potential to further complicate cooperation among nations, triggering competition and conflict. Population growth and increasing climate change without implementing any water saving measures could lead to a 300 percent increase in water demand by 2050.[121] Managing water at the regional level must become a priority for policymakers.

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[117] Food and Agriculture Organization of the United Nations, "GIEWS."

[118] Ibid., 2.

[119] United Nations Economic Commission for Latin America and the Caribbean, *Climate Change in Central America*, 63.

[120] Ibid., 65.

[121] Ibid., 66.

Furthermore, to prevent future humanitarian crises, management and access for the most impoverished populations must increase.[122]

Soil management also plays a key role in mitigating the impacts of climate change on sustainable farming to ensure food security. Modeling scenarios show that soil considerable practices can positively impact yield rates.[123] However, modeling scenarios reflecting a continuation of poor soil management suggests drastic decreases in maize yields across multiple test countries in Central America. For example, the scenario implies Honduras will suffer the largest loss in crop yield with almost a 30 percent reduction under the worst-case conditions. However, modeling reflexing better soil management infers improved crop yield by almost 20 percent. Water resource management is paramount to successful soil management. To maximize water retention throughout the soil profile, smart farming practices such as zero till and crop rotation implementation is necessary. Additionally, water management to reduce unnecessary water run-off and evaporation, which is necessary for soil management, is an essential part of the overall hydrological capacities' assessment for policymakers. Policymakers must be able to make decisions and implement best use practices to balance water management requirements for both agriculture and drinking water. The implementation of water planning and distribution is a delicate balance and, if poorly done, can result in social conflict or humanitarian crisis.[124]

One of the limiting factors with risk mitigation is cost. As research and modeling attempt to anticipate the future environment, governments will need to invest in adaption strategies.

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[122] United Nations Economic Commission for Latin America and the Caribbean, *Climate Change in Central America*, 67.

[123] Axel Schmidt, Anton Eitzinger, Kai Sonder, and Gustavo Sain, *Tortillas on the roaster (ToR) Central American maize-bean systems and the changing climate: full technical report* (Baltimore, Maryland, Cali, Colombia, Mexico-Distrito Federal, Mexico: Catholic Relief Services, Centro Internacional de Agricultura Tropical, International Maize and Wheat Improvement Center, 2012), 123, accessed February 08, 2020, https://www.researchgate.net/publication/276099395_Tortillas_on_the_roaster_ToR_Central_American_maize-bean_systems_and_the_changing_climate_full_technical_report.

[124] Ibid., 102.

However, modeling suggests that the potential impacts of climate change will intensify with ongoing delays in mitigation and adaption strategies.[125] Moreover, the cost of mitigation and adaptions strategies will increase further if efforts to stabilize emissions fail, resulting in more dire climate change.[126] As countries develop adaption strategies to address the environmental impacts, the best strategies must include coordination to maximize benefits and integrate sustainability strategies into national and regional development agendas.[127] Taking into account the extreme poverty of the Central American region, many responses to climate change will need to encompass poverty reduction.

Poverty is another factor aggravating climate change challenges in Central America. Research shows that climate variability increases in regions where the population lives in poverty. In many cases, adaption strategies focus on a single resource such as water management or specific crop yields. However, costly programs burden local governments and lack of employment leaves those living in poverty with few options. Comprehensive, whole-of-government approaches, which include addressing poverty, can help to ensure vulnerable populations become more resilient in the face of climate change. For example, increasing household income can reduce the risk of food insecurity during times of increased drought, and increasing access to education can expand economic opportunities.[128] Conversely, many infrastructure projects that seek to alleviate poverty, including improving transportation infrastructure, market access, and access to potable water and energy sources, are themselves

[125] United Nations Economic Commission for Latin America and the Caribbean, *Climate Change in Central America*, 16.

[126] Ibid., 16.

[127] United Nations Economic Commission for Latin America and the Caribbean, *Climate Change in Central America*, 17.

[128] Shixiong Cao and Heran Zheng, "Climate change adaptation to escape the poverty trap: role of the private sector," *Ecosystem Health and Sustainability*, 2, no. 10 (2016), 2, accessed February 14, 2020, https://www.tandfonline.com/doi/full/10.1002/ehs2.1244

vulnerable to climate change.[129] The connection between poverty and climate change adaption strategies are complex. Nevertheless, they will be paramount in breaking the cycle of vulnerable populations being unable to build resiliency in the face of climate change.[130]

Conclusions and Recommendations

Research suggests that lack of political commitment, gaps in scientific knowledge, and institutional weakness hamper adaption strategies in Central America.[131] However, understanding the risks of climate change helps to build the operational framework to develop comprehensive adaption strategies. From a US perspective, instability in Central America presents challenges for national security. Migration, violence, economic collapse, and great power competition are all symptoms of the social and political instability that climate change fuels. China's involvement in the region presents competition below armed conflict while lack of effective governance provides freedom of maneuver for criminal organizations. It is in the interest of the United States to understand the drivers of instability and address those drivers whenever possible. Understanding the operating environment means understanding resource competition and the impacts of extreme weather events to develop comprehensive engagement, enabling adaption strategies to include water and soil management and socioeconomic opportunity in the region. The American engagement in Central America is currently being done and must endure as a whole of government approach. However, engagement strategies—including diplomatic, information, military, and economic approaches—must ensure synchronization and appropriate deconfliction between departments. Specifically, the DOD and DOS strategies must ensure the department's goals are achievable, measurable, and nested.

[129] Cao and Zheng. "Climate change adaptation," 2.

[130] Ibid., 2.

[131] Magrin et al., 1502.

Even as the world tries to reduce carbon emissions, the climate will continue to warm. Central America will experience challenges, to include agricultural losses and water shortages, due to seasonal weather shifts and more extreme weather events. Accepting that these events are likely to happen sets in motion efforts to build resiliency within the system. Direct mitigation approaches, which decrease the effects of drought and increase the resilience in food security are essential, but so is comprehensive infrastructure planning and resource management.[132] Building infrastructure is an important component of robust planning but governments of Central America also need institutional capacity to manage projects and international assistance efficiently.[133] Regions of Central America are water rich, but supply management and dramatic infrastructure investment is necessary.[134] According to a 2014 World Bank report, Central American countries must invest at least 0.41 percent of their annual GDP to meet the commitments made within Sustainable Development Goals (SDGs).[135] The governments of Central America will have to address resources management, food scarcity, resilient infrastructure projects, create economic opportunities to diversify the market, and prepare to respond to natural disasters and extreme weather events. Preparing for climate change is no small task, and it will take strong governance to keep the region stable in the face of such adversity.

Central America's desperate need for infrastructure provides opportunities for nations like China to introduce economic and infrastructure projects. The NSS identifies China's investments as an attempt to expand influence and gain competitive advantages against the

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[132] Secretaría De Seguridad Alimentaria Y Nutricional De La Presidencia De La República [Secretariat of Food and Nutrition Security of the Presidency of the Republic], "Seasonal Hunger Care Plan is presented at CONASAN," March 5, 2019, accessed February 7, 2020, https://translate.google.com/translate?hl=en&sl=es&u=http://www.sesan.gob.gt/wordpress/2019/03/05/plan-para-la-atencion-del-hambre-estacional-es-presentado-en-conasan/&prev=search.

[133] Sakho and Aguero.

[134] Ibid.

[135] Ibid.

United States.[136] Furthermore, Chinese loans are known for having disadvantageous terms in developing countries. Admiral Fuller stated "We've seen what China's done with port-leasing agreements in other parts of the [world], where they've essentially created a situation where there's limited host-nation access and little host-nation involvement."[137] As climate change creates additional challenges for Central America and exacerbates already existing socioeconomic challenges, the region will be left with no choice but to rely on international assistance and loans. However, in the long term, assistance from China is likely to create secondary problems that are not yet evident. Planning to campaign through competition requires a long-term approach that can react to rapid changes in the political, diplomatic, and strategic environment.[138] Understanding the long-term impacts of climate change, and the risks the phenomenon presents to US national security, is essential to developing campaign plans that position the United States in a position of relative advantage in a strategic environment of great power competition.

Building resiliency into adaption strategies in Central America is important. Many authorities address climate-related hazards through disaster risk management while limiting proactive planning for land use and economic development.[139] Studies continue to identify poverty and vulnerability as risk factors. Climate adaption strategies must also address the determinants of vulnerability including access to education, health care, and infrastructure as part of broader development policy.[140] Furthermore, infrastructure projects must also include climate change projections. The production of energy from sources such as hydroelectric power depends greatly on climate conditions.[141] As Central America invests in large hydroelectric projects,

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[136] Trump, *National Security Strategy*, 38.

[137] Christopher Woody, "4 ways China is gaining ground in Latin America, according to the US's top military commander in the region," *Business Insider*, December 18, 2019, accessed March 15, 2020, https://www.businessinsider.com/southcom-4-ways-china-is-growing-influence-in-latin-america-2019-12.

[138] US Joint Staff, JDN 1-19, 2.

[139] Magrin et al., 1502.

[140] Ibid., 1533.

[141] Ibid., 1533.

failure to include long-term climate modeling can negatively affect energy projection and reliability. Poor management and shortsighted projects can be costly for already fragile systems, increasing vulnerability to instability. Furthermore, the secondary impacts of diverting or damming rivers, has the potential to deplete necessary water access and cause regional conflict.

Regional stability in Central America is vital for US national interests. US foreign policy prioritizes instability by setting policy priorities and correlated developmental challenges through the CAM RDCS. The CAM RDCS does directly prioritize climate change and Central America's high vulnerability to natural disasters.[142] However, CAM RDCS also prioritizes addressing ineffective governance and slow economic growth, which is arguably equal, if not more important, to building an antifragile system that can manage climate change and extreme weather events.[143] Coordination and collaboration between DOS and DOD is essential to furthering US foreign policy. However, the DOS mission is more appropriate to engage over the long-term and to be the lead department for countering strategic regional stability and competition. Persistent partnership and engagement help to maintain essential relationships necessary to further policy and contribute to regional stability and security. Addressing push factors of migration, at the source; including socioeconomic opportunity, stability, and violence in Central American can alleviate factors for migration, which in turn, increases US national security.

[142] US Agency for International Development, "Country Development Cooperation Strategies."

[143] Ibid.

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