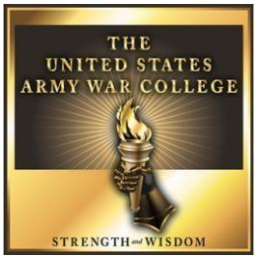
Strategy Research Project

Changing Army Preventive Medicine for a Changing Climate

by

Colonel Scott Mower
United States Army

Under the Direction of:
Dr. Richard Meinhart



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Global climate change is expected to worsen the medical threat landscape both domestically and abroad. The Army's Preventive Medicine community will play a crucial role in countering those global climate change-linked threats that imperil health within the garrison and contingency operating environments. Unfortunately, organizational, training, resourcing, and posturing shortcomings could undermine the Preventive Medicine community's abilities to provide essential preventive medicine services to beneficiaries, perform core force health protection functions, and support severe weather event-triggered Defense Support to Civil Authority or Foreign Humanitarian Assistance missions. This research paper evaluates the Preventive Medicine community's preparedness to address five emerging global climate change-related challenges and offers recommendations to overcome identified shortcomings. The five challenges evaluated relate to preventive medicine workforce staffing processes, vector-borne disease prevention readiness, post-hurricane support postures, medical research mindsets, and medical intelligence production. The time to confront these global climate change challenges is now before public health calamities befall the Total Army family and mission success is jeopardized.

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Changing Army Preventive Medicine for a Changing Climate

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Abstract

Global climate change is expected to worsen the medical threat landscape both domestically and abroad. The Army's Preventive Medicine community will play a crucial role in countering those global climate change-linked threats that imperil health within the garrison and contingency operating environments. Unfortunately, organizational, training, resourcing, and posturing shortcomings could undermine the Preventive Medicine community's abilities to provide essential preventive medicine services to beneficiaries, perform core force health protection functions, and support severe weather event-triggered Defense Support to Civil Authority or Foreign Humanitarian Assistance missions. This research paper evaluates the Preventive Medicine community's preparedness to address five emerging global climate change-related challenges and offers recommendations to overcome identified shortcomings. The five challenges evaluated relate to preventive medicine workforce staffing processes, vector-borne disease prevention readiness, post-hurricane support postures, medical research mindsets, and medical intelligence production. The time to confront these global climate change challenges is now before public health calamities befall the Total Army family and mission success is jeopardized.

Changing Army Preventive Medicine for a Changing Climate

Since the 2010 Department of Defense Quadrennial Defense Review (QDR) was published, global climate change (GCC) has emerged as a key concern for forward-looking strategic planners. The QDR mandated all installations to "assess the potential impacts on its missions and adapt as required" from a changing climate and predicted GCC will cause significant impacts on DOD [Department of Defense] operations and missions both domestically and abroad.[1] The chairman of the Defense Science Board Task Force (DSBTF) on Trends and Implications of Climate Change on National and International Security, Dr. Paul G. Kaminski, asserted in 2011 that "climate change will only grow in concern for the United States and its security interests."[2] The DSBTF's report concluded that the DOD "will inevitably be part of the approaches to adapt and respond to the climate changes in the United States and key areas of the globe" and urged DOD to adopt a forward-thinking approach on climate change security matters.[3]

The subject of GCC is a controversial topic within the United States (U.S.) today. There is heated debate on whether man-caused GCC exists and, if it does exist, how serious of a threat it poses to U.S. national security interests. During President Obama's administration, GCC was viewed as an urgent and imminent threat requiring a whole-of-government approach to resolve and mitigate.[4] President Trump's administration has differing perspectives on GCC and has removed it as a "national security threat" within the new *National Security Strategy* unveiled in December 2017.[5] Despite its removal, the DOD still acknowledges a changing climate poses risks to national security, and Secretary of Defense, James Mattis, in written responses to a U.S. Senate panel in March 2017 wrote, "Climate change is impacting stability in areas of the world where our troops are operating today."[6]

The U.S. Global Change Research Program (USGCRP) in a 2016 scientific assessment titled, *The Impacts of Climate Change on Human Health in the United States,* concluded "climate change impacts will endanger our health by affecting our food and water sources, the air we breathe, the weather we experience, and our interactions with the built and natural environments."[7] This assessment further predicted public health threats from GCC "to worsen" with more personnel suffering from heat stress and respiratory ailments caused from poorer ambient air quality conditions and increasing probabilities of food-, water-, and vector-borne disease outbreaks.[8] Though the predictions made by the USGCRP were specifically for the United States, the consensus among the international scientific community is that climate change is a global phenomenon.[9]

Given the interdependencies between climate and health, the medical departments within the DOD military services must be ready to confront the health threats forecasted to result from GCC. Before taking decisive actions, senior medical leaders must understand the relationships between a changing climate and health, predict future mission requirements based on emerging GCC-linked health trends, and complete capability and capacity gap assessments to identify potential resource shortfalls. These actions are especially relevant for the leaders and professionals within the Army Preventive Medicine (PM) community, who are charged with preventing disease and non-battle injuries (DNBIs), assisting local authorities in the provision of public health services during civil support or foreign humanitarian assistance (FHA) operations, and actively participating in medical planning activities for military missions.[10]

This strategic research paper identifies that the Army PM community is not optimally organized, trained, resourced, and positioned to provide the essential garrison public health services or fulfill contingency operation mission requirements should dire predictions about GCC come to fruition. This perspective is based on an evaluation of the Army PM community's preparedness to address five emerging GCC-related challenges. These challenges are: staffing the installation medical treatment facility's (MTFs) PM workforce to counter growing health threats; executing increased garrison vector-borne disease outbreak response and mosquito surveillance missions; providing PM support domestically and abroad to areas devastated by severer hurricanes; maintaining a medically ready force; and expanding medical intelligence production capacities to provide timely intelligence under more rapidly changing climatic conditions.[11]

Anticipating Demand Growth for Army Preventive Medicine Services (PMS)

Army Regulation (AR) 40-5 is the Army's governing document on the delivery, implementation, and execution of disease DNBI prevention and health promotion measures. The regulation defines PM as "one of the functional areas of Army health care delivery for which The Surgeon General (TSG) is the Army functional component."[12] The goals of PM are to anticipate, predict, identify, survey, evaluate, prevent, and control disease and injuries.[13] Specific diseases and injuries targeted for prevention are communicable diseases; vector-, food-, air-, and water-borne diseases; occupational and environmental health diseases and injuries; disease and non-battle injuries; and training injuries.[14]

The PM practitioners providing public health services are assigned to medical organizations with either tables of distribution and allowances (TDAs) or tables of

organization and equipment (TOEs), which respectively corresponds with unit types that either non-deploy or deploy.[15] Examples of TDA organizations are the Preventive Medicine Services (PVNTMED SVC) – abbreviated as PMS within this paper - embedded within U.S. Army MTFs, the U.S. Army Public Health Center (USAPHC), Regional Public Health Commands (RPHCs), and Public Health Service Activities. Examples of TOE organizations include Medical Detachments (Preventive Medicine) and Medical Detachments (Veterinary Services), Army Medical Laboratories, and PM subject matter experts assigned to slotted positions within Medical Brigades, Multifunctional Medical Battalions, Brigade Combat Teams (BCTs), Military Police Brigades, Special Forces Groups, Divisions, Corps, and Theater Support Commands.[16] Excluding the BCTs, the personnel assigned to the TOE slotted positions are usually found within the organization's surgeon section where they deliver and/or coordinate force health protection (FHP) services to subordinate units.[17] At the BCTs, the PM personnel are commonly assigned to the medical company within the BCT's forward support battalion.

The specific types of mission services executed by PM personnel fall within nine functional areas. All nine functional areas have mission services with demand growth potential because of countering emergent climate change health threats. The degree of potential growth depends on local conditions and the health disparities (ex. age, socioeconomic status, health education level, etc.) found within beneficiary populations.[18] The demand for mission services directly affected by climatic factors such as climatic injury prevention services are almost certain to grow. Likewise, services such as hearing and vision conservation, health physics, and preventive dentistry with

no discernable relationships to climatic factors are unlikely to grow. Those mission services with demand growth potential along with the corresponding mission service functional areas are shown in Table 1 below.

Table 1. PM Mission Services with Demand Growth Potential[19]

Functional Area	Mission Service
Disease Prevention and Control	Screening and monitoring procedures for early detection of disease
	Immunizations to prevent disease
	Travel Medicine
	Acute respiratory disease treatment and consultations
Field Preventive Medicine	Combat stress control
	Advising, training, and assessing readiness of unit level field sanitation teams (FSTs)
	Field ration and bottled water sanitary audits and product shelf-life extension assessments
	Military working dog (MWD) physicals, treatment and care
Environmental Health	Recreational water quality monitoring
	Climatic injury prevention training and temperature monitoring
	Climatic injury diagnosis and treatment
	Pest and disease vector surveillance, prevention and control
	Air quality monitoring
	Drinking water quality monitoring and testing
	Food service sanitation
	Waste management guidance
Occupational Health	Health hazard education and injury prevention and control
	Medical surveillance examinations and screening
	Industrial hygiene services
	Ergonomics
	Personal protective equipment
	Workers compensation
Health Surveillance and Epidemiology	Collect, analyze, report, and archive information pertaining to Army personnel health statuses and exposures
	Implement appropriate PM measures
	Identify and characterize morbidity and mortality statistics
Soldier, Family, Community Health, and Health Promotion	Communicable and chronic disease prevention and control
	Health of school-age children
	Child and youth services
Toxicology and Laboratory Services	Air and water quality sample analysis
	Communicable and infectious disease specimen analysis
	Heat Injury – related patient laboratory testing
Health Risk Assessment	Health risk assessment
Health Risk Communication	Health risk communication

The Army employs a wide variety of technical experts to execute PM mission services and treat patients suffering ill health effects that could be linked to GCC. These

experts are military personnel in deployed settings, while a combination of military and Department of the Army (DA) civilians are the norm at MTFs and in deployed settings when highly specialized expertise is required.[20] Contract labor is also an option used under certain circumstances. Based on the anticipated health threats linked to GCC identified by public health experts, one can reasonably predict those technical expert types or specialties with greater potentials to bear higher workloads. For example, medical entomology has a stronger growth potential due to the preponderance of evidence tying GCC to the spread of vector-borne diseases and the important role medical entomology plays in protecting the force from pest threats.[21]

Though recognized as a primary care rather than a PM discipline, pulmonology is another medical specialty with growth potential. This projected growth is due to expected increases in the incidence of respiratory ailments caused by degrading air quality conditions and longer allergy seasons.[22] Table 2 identifies medical specialties with stronger growth potential along with their associated area of concentration designation. Table 3 lists the AOCs and provides an example of potential mission requirements linked to anticipated effects from GCC that the AOC is suited to perform.

Table 2. Stronger Growth Potential Specialties[23]

Specialty Name	Area of Concentration
Preventive Medicine Officers	60C
Occupational Medicine Officers	60D
Pulmonologist	60F
Army Public Health Nurses	66B
Environmental Science and Engineering Officers (ESEO)	72D
Preventive Medicine Specialists	68S
Medical Entomologists	72B
Psychiatrist	60W
Clinical Psychologists	73B
Mental Health Specialist	68X

Table 3. AOCs with GCC Examples[24]

Area of Concentration	Example
60C	Tracking of diseases and trends related to GCC[25]
60D	Prevention of exertional heat injuries among DA employees[26]
60F	Diagnosis and treatment of respiratory ailments caused by more frequent exposure to forest fire smoke, photochemical smog, and longer pollen seasons[27]
66B	Educating beneficiary population about health impacts of GCC[28]
72D	Investigation of infectious water-, food-, and vector-borne disease outbreaks[29]
68S	
72B	Improving integrated pest management plans to control arthropod vectors[30]
60W	Provision of mental health services to populations traumatized by natural disasters (ex. tornadoes, floods, hurricanes, forest fires, etc.)[31]
73B	
68X	

The specialty listings with growth potential listed in the tables above are not all inclusive. There are certainly other medical specialties lying outside the PM disciplines, like pulmonology, with growth potential associated with GCC.[32] Those medical specialties where research shows stronger associations between GCC and adverse health effects will have better arguments for manpower increases and, at a minimum, stronger justifications to avoid staff reductions, when future manning decisions are made. Translating these associations into concrete work hour estimates will prove extremely difficult given the complex relationships between climate change and health effects.[33]

Adding staff to a PMS within a MTF may prove infeasible since most of the mission services performed by public health professionals within the MTF lack the reimbursement mechanisms afforded direct or primary care health service providers.[34] This means the MTF's executive leaders charged with approving hiring actions are hard pressed to find funding sources to pay for more PM staff. The most viable options for

shaping the future PM workforce; therefore, will be those options which do not increase a MTF's overall payroll expenses.

At least six options are available for enhancing the GCC-preparedness of the PMS in a fiscally responsible manner.[35] First, the executive leadership at the MTF could identify "bill-payer" positions from within the PMS or elsewhere for elimination to bring on board needed PM expertise. Second, fundamental training courses attended by civilian and military PM practitioners could be revamped or developed to better cover emerging health challenges tied to GCC. Examples of courses that could be revamped include the 9-week Principles of Military Preventive Medicine, the 5-day Public Health Emergency Management, and the 5-day Operational Clinical Infectious Disease Courses.[36]

Third, the distribution of PM practitioners throughout the entire Army Medical Command's (MEDCOM) Heath Service enterprise could be examined through a composite risk management lens where the probability and severity of GCC-related health threats are assessed.[37] Those MTFs supporting installations determined to be at lesser risk for significant adverse public health impacts would face staff reductions. MTFs on the opposite side of the spectrum would see commensurate increases to their PM staffing levels.

Fourth, MEDCOM could redistribute the military end strengths of its PM and even primary care specialties to match expertise against predicted emerging requirements. An example within the PM specialty arena would be to decrease the number of ESEOs, while simultaneously boosting the corresponding number of military entomologists. A fifth option would be to expand the scopes of practice of the PM specialists and make

them PM generalists. An example for this approach would be training ESEOs to master essential military entomology core functions.

A final option is to separate the PMS from an MTF's health care delivery functional area altogether. A major advantage of this approach is that the PMS would no longer have to compete against the primary care departments for payroll funds. For command and control (C2) purposes, the PMS could be placed underneath a RPHC. Since the RHPCs often have a firmer grasp on PMS mission services and corresponding resourcing requirements than an MTF command team, this C2 arrangement could lead to an overall improvement in PM efficiency and effectiveness.

An alternate C2 arrangement could be adopting the model used by large U.S. metropolitan cities such as New York City, where the public health department falls underneath the Mayor's office.[38] Since U.S. Army installations do not have mayors, the PMSs would answer to either the senior mission or the garrison commanders. Advantages potentially derived from this approach would be improved integration into installation emergency planning endeavors and greater senior level leader visibility of, endorsement for, and resourcing of health promotion initiatives designed to mitigate GCC health threats. Regardless of what C2 arrangement was enacted, the PMS would still have to maintain close communications with the resident MTF on patient care matters and rely heavily on it for medical logistics and information technology support.[39]

Vector-borne Disease Prevention

The GCC could elevate the risks of vector-borne disease outbreaks.[40] Warmer temperatures can allow disease transmitting insects to expand their range into areas previously too cold to support their populations. Shorter winters can extend the period throughout the year when insects competent to transmit diseases are present. Hotter

day and night temperatures can increase insect activity levels causing more bites and corresponding disease transmission. Higher rainfall patterns can enlarge aquatic breeding habitats for mosquitoes. In the case of West Nile Virus, the seasonal alterations from GCC could change the migration patterns of the birds serving as the natural host for the mosquito-transmitted virus.[41] Warming temperatures associated with climate change may already be affecting the continental U.S. as medically important mosquito species and disease transmitting tick species are expanding their ranges northward.[42] Countering any emerging vector-borne disease threats will require the Army to dedicate greater resources towards garrison and expeditionary vector-borne disease prevention efforts.

An examination of the Army's ongoing efforts towards stopping the Zika virus spread provides a timely example of the resource challenges associated with vector-borne disease prevention. On April 18, 2016, MEDCOM issued a Zika Virus Response Order (ZVRO) shortly after the U.S. Centers of Disease Control and Prevention (CDC) confirmed that local transmission of the disease had occurred in Florida. The ZVRO expanded clinical and laboratory diagnosis requirements at MTFs to "evaluate at-risk patients for signs and symptoms of Zika virus infection and provide laboratory diagnosis to confirm."[43] The ZVRO also boosted the frequency and intensity of routine mosquito surveillance activities performed by PMSs. These surveillance activities included: mosquito trapping (i.e. specimen collection); searching areas for mosquito breeding sites; speciating collected specimens; prepping and shipping specimens to laboratories; performing laboratory viral testing; and submitting regular reports on testing results.[44]

The PMSs executing the field surveillance work and the Army public health laboratories processing the *Aedes* mosquitoes – the genus of mosquito able to transmit the Zika virus – specimens experienced an upsurge in labor requirements from the ZVRO.[45] The ZVRO also sparked additional labor demands at the USAPHC and MTF Public Affairs Offices, where health risk communication strategies and public health informational products were developed.[46] A MTF notably impacted was the Tripler Army Medical Center (TAMC) in Hawaii. Prior to the ZVRO, the medical entomology mission there was performed by one civilian entomologist with occasional assistance by one PM specialist. Following the ZVRO, the medical entomology mission required three full-time employees. The Tripler PMS augmented the medical entomology section by shifting two PM specialists from elsewhere within the service, but at the expense of reducing the service's overall capacity to perform other public health missions.[47] Though TAMC's situation represents an extreme case, since the tropical climate of Hawaii necessitates a year-round mosquito surveillance program, other PMSs will presumably have to lengthen their mosquito surveillance periods due to milder winters caused by GCC and absorb additional labor burdens to comply with ZVRO requirements.

Countering the Zika virus threat has introduced the essential task of conducting mosquito surveys at the outdoor locations visited by individuals either confirmed or suspected of acquiring the virus. An early step in these surveys is to interview the patient to determine their travel history and outdoor visitation habits. The outdoor locations visited by the patient are then surveyed to identify mosquito habitat, assess the threat of transmission to others in the area, guide health risk communication messaging activities, and aid in the development of control strategies to reduce

mosquito populations in those areas.[48] Examples of outdoor locations frequently visited by patients requiring surveys on installations could include military housing areas, playgrounds, outdoor eateries, and dog parks. Preventive Medicine Services personnel are only authorized to survey on DOD properties. Local health authorities survey the off-post locations visited by the patient after notification from the PMS.[49] Since mosquitoes do not respect fence lines, the results from the on-post surveys should be shared to the maximum extent possible with local health authorities.

Due to the successful eradication of many epidemic mosquito transmitted diseases in the past century, PMSs are relatively inexperienced in post-outbreak response activities.[50] A way to overcome medical entomology gaps is to seek out the entomological science experts found at the U.S. Army Public Health Command Regions and request technical assistance visits (TAV). As part of the TAVs, these experts can also help the installation's emergency management officers develop emergency vector control plans (EVCP) and orchestrate exercises to test the efficacy of those plans.[51]

Countering the burgeoning mosquito-borne disease threat is not a mission for Army TDA organizations alone. The PM TOE units, especially the Medical Detachments (Preventive Medicine), will have a crucial role to play in battling this health threat. As the Army's most capable and largest stand-alone PM unit, the Medical Detachments PM can perform pest surveillance and pesticide application tasks to support state, territorial, and local authorities in quelling outbreaks during defense support to civilian authorities (DSCA) missions. Such a DSCA mission was recently considered, but not ultimately enacted, during a highly publicized mosquito-transmitted dengue outbreak on Hawaii's Big Island between December 2016 and February 2017.[52] A past example of an actual

mosquito control and surveillance DSCA mission performed by a DOD asset occurred in the aftermath of Hurricane Andrew, when personnel from the U.S. Navy Disease Vector Ecology and Control Center stationed at Naval Air Station Jacksonville deployed to South Florida to assist the Dade County Mosquito Control Division.[53]

During a serious vector-borne disease outbreak in a garrison setting, the installation could tap into resident Army PM TOE organizations to augment vector control and surveillance efforts.[54] If the installation's leadership wishes to pursue this contingency action, the PM TOE organizations should be notified in advance that the contingency exists, given clearly defined employment parameters, issued a formal tasking from the Senior Mission Commander, and afforded an opportunity to participate in a practice exercise.[55] Those writing the EVCP should not over rely on PM TOE unit participation for emergency response, since these assets could be mobilized, deployed, or otherwise unavailable when the plan must be activated.

The Armed Forces Pest Management Board has identified the enormous labor requirements in sustaining control efforts and lack of area control tools as key shortcomings in preventing *Aedes* mosquito transmitted diseases.[56] The trend to downsize installation pest management shops and transition towards less costly contractor-provided services, the obstacles for complying with stringent pesticide storage and mixing facility requirements, and the difficulty in obtaining and keeping currency with DOD Pesticide Applicator credentials have contributed to diminishing an installation's overall capacity and capability to support emergency vector control operations using organic assets alone.[57] Though the PM specialists, ESEOs, and medical entomologists assigned to the PMSs are licensed pesticide applicators, they

are not resourced to purchase or legally store bulk quantities of the commercial grade pesticides used in large area mosquito control application equipment or perform area treatments. This mission is the responsibility of the installation pest control services working with contracted pest controllers under the review of the pest management coordinator.[58]

There are numerous ways for surmounting garrison vector-control capability and capacity gaps. Larvicide control teams consisting of borrowed military manpower and under the supervision of DOD licensed applicators could be created to treat standing water sources and empty water-holding containers in residential, billeting, and training areas during an outbreak.[59] Other recommendations include: developing better adulticides and adulticide pesticide application methods; appropriately resourcing pest management services to fulfill their missions; establishing memorandums of agreements with local mosquito control districts for external support; and modifying pest management contracts to include area control capabilities.[60] Identifying the best solutions to overcome gaps will require additional analysis by DOD pest management experts and will differ for each installation.

During a mosquito-borne disease emergency, PMS personnel could also augment DA civilian and contracted pesticide application efforts if this mission took precedence over other outbreak response public health missions and applicable regulatory requirements were satisfied. These augmenters would require refresher training on pesticide application processes and access to both pesticides and application equipment. In addition, the pesticide applicators must be issued personnel protective equipment to include respirators, medically cleared by the Occupational

Health clinic, and fitted for respirators by the Industrial Hygiene Service or a properly trained fitter prior to performing the application work.[61] Just as for PM TOE units, the mechanisms for proper employment of PMS personnel should also be detailed within the EVCP and rehearsed prior to an actual outbreak event.

Department of Defense Manual Number 4150.07 specifies that DOD *Federal Insecticide*, *Fungicide and Rodenticide Act* - certified applicators or persons working under their direct supervision are the only DOD employees who may apply pesticides on DOD property.[62] Licensing requires passing a three-week DOD Certified Pesticide Applicator Course and subsequent passage of a five-day refresher course once every three years.[63] DOD regulation does permit contractors to apply pesticides on DOD property if they are properly certified by the State.[64]

For off-post pesticide application, the DOD regulation specifies that DOD applicators "will work under the supervision of appropriately certified State or federal personnel."[65] The regulation does not define the term "supervision." The general practice for when DOD certified applicators supervise non- DOD certified applicators is line of sight (LOS) supervision.[66] This practice can be circumvented if the state or territorial governments have a reciprocity agreement whereby they automatically accept the DOD certification in matching categories. Even with a reciprocity agreement, the jurisdictional authority may want to talk with the applicators and observe them once before approving applications.[67]

Mandating LOS supervision in a DSCA response situation could prove untenable and retard vital application efforts should the local government lack qualified supervisors or require the services of their supervisors elsewhere. Prior to the advent of any DSCA

pesticide application missions, it is recommended that Army PM units receive clear and specific instructions as to where, when, and how to apply pesticides. In addition, they should fully understand the processes for recording and reporting those applications to the supported civil authorities.

Hurricane Response

An expected outcome from GCC is more frequent and intense hurricane activity.[68] The 2017 hurricane season with three devastating hurricanes striking the United States and its territories could be a harbinger of weather disasters to come. The destruction and devastation from these hurricanes overwhelmed local governments prompting mobilization of National Guard, Army Reserve and Army Active Component units for disaster response and recovery operations. Army PM units and personnel were part of the mobilization and sent to Texas, Florida, Puerto Rico, and the U.S. Virgin Islands. Their missions were two-fold consisting of providing FHP support to DOD personnel and assisting civilian authorities in protecting the public's health in devastated areas.

The level of DSCA support provided by PM assets depended on the extent of devastation and the local government's post-disaster public health capacities. The states of Texas and Florida were able to draw upon resources from unaffected areas of their massive states to support the restoration of public health services. Therefore, the military PM efforts were directed towards conventional FHP and health surveillance missions to prevent DNBI among the deployed Service Members involved with response and recovery operations.[69] The situation was different in Puerto Rico and the U.S. Virgin Islands, which had no areas unaffected by the hurricanes and possessed far less public health capacity before the storms struck. The PM assets deployed to these

territories tested drinking water supplies at public water purification plants and within distribution systems, surveyed emergency food distribution warehouses, and performed mosquito surveillance missions at the behest of the Federal Emergency Management Agency (FEMA) and local public health authorities, while also performing the conventional FHP and health surveillance mission services.[70]

If the predictions of GCC contributing to more severe and frequent hurricanes striking the United States become true, the DOD can expect repeats to the Hurricane 2017 season with PM units increasingly called upon to participate in hurricane response missions. As such, an examination of where PM units are positioned within the Army's force structure and their basing locations for optimizing their hurricane response capabilities makes sense. The most capable expeditionary Army PM unit, the MED DET PM, only resides within the Active Army (Compo 1) or Army Reserve (Compo 3). Compo 1 and Compo 3 units can only be activated for hurricane response deployments after a state or federal governor requests a Federal declaration of disaster status and the President makes the determination that Federal support is required to "supplement the efforts and available resources of the state and local governments."[71] For Hurricanes Harvey, Irma, and Maria in 2017, the deployment authorization processes went quickly with the President approving Federal support in advance of storm landfalls.[72] The process went less smoothly in 2004 during Hurricane Katrina where bureaucratic and communication problems led to widespread and politically-charged dissatisfaction with the authorization processes.[73]

A possible way to accelerate the activation of MED DET (PM) for hurricane response or any other public health emergency is to place a portion of them within the

Army National Guard (ARNG) or create a new type of PM unit within the ARNG (Compo 2) force altogether. This new unit could follow the fielding concept proposed for the pilot Full Spectrum Integrated Vulnerability Assessment Teams (FSIVA) stood up by the National Guard Bureau (NGB) in Fiscal Year 2004, which called for one team per FEMA region, or the more robust model adopted for the Weapons of Mass Destruction-Civil Support Teams (WMD-CSTs) with at least one team in every state and territorial jurisdiction.[74] With highly capable PM units in the ARNG, states could bypass the DSCA process and directly request PM support from other states and territories through emergency management assistance compact (EMAC) agreements.[75]

The FSIVA and WMD-CSTs were staffed with full-time active guard/reserve (AGR) personnel making them costly to maintain, but this staffing model also made them rapidly deployable and highly trained. Many public health disaster responses, where urgent PM assistance from the ARNG might become required, are not likely to originate as a complete surprise, especially those disasters resulting from forecasted severe weather events. In fact, U.S. Northern Command (USNORTHCOM) assumes a three-day notice to execute emergency plans before a major hurricane landfall.[76] Therefore, a staff completely comprised of AGR personnel is unwarranted. Were the unit to assume missions such as assessing the vulnerabilities of critical public health-associated infrastructure (water treatment plants, hazardous waste disposal facilities, sanitary landfills, etc.) to natural disasters or actively participating in local disaster preparedness exercises with public health scenario play, the justification for a full-time staff would be strengthened.

Additional PM unit types meriting consideration for placement within the ARNG due to their utility in natural disaster responses are the Medical Detachments (Combat Operational Stress Control), aka (MED DETs COSC), and MED DETS (Veterinary Service). MED DETs COSC are manned with mental health professionals that can assist local government health authorities with the facilitation of early post-disaster mental health interventions.[77] Such assistance was provided during the aftermath of Hurricane Andrew, when Army mental health teams complemented by a U.S. Navy Special Psychiatric Rapid Intervention Team assessed neighborhoods ravaged by the storm in south Florida.[78] In the aftermath of Hurricane Katrina, a MED DET (Veterinary Service) performed critical class I storage and catered meal inspections, while also coordinating the evacuation of 1,500 abandoned and lost pets in the New Orleans metropolitan area.[79]

Another justification for positioning more PM assets within the ARNG is the provision of essential sanitation and epidemiological surveillance services to disaster intake centers where indigent people left homeless from the hurricane or evacuating from the approaching storm can receive temporary housing and basic medical care. In the recent past, ARNG armories and military reservations have served as intake centers and shelters. The Fort Chafee Maneuver Training Center, an ARNG installation in western Arkansas, processed three waves of refugees totaling over 16,000 evacuees following Hurricanes Katrina and Rita.[80] Fort Chafee and Fort Indiantown Gap, another ARNG installation in central Pennsylvania, have both housed large populations of refugees fleeing political persecution.[81] The plausibility for sites like these to house refugees from GCC-linked disasters is likely to grow. A recent incident highlighting this

possibility occurred when retired Lieutenant General Russell Honore, the former commander of the Joint Task Force-Katrina, called for an evacuation of populous Puerto Rico in September 2017 in the wake of Hurricane Maria.[82]

The lack of Army PM units with robust PM capabilities based within hurricane and tropical disease-prone territorial jurisdictions is another deficiency within the PM force structure.[83] The health threats within the territories are amplified by the territories' small land masses, geographical separation from mainland support, weaker public health institutions, poorer housing and sanitary infrastructure, and diminished critical infrastructure restoration capabilities. These factors combine to make the territories exceptionally vulnerable to the public health repercussions of accelerated GCC.

The Active Army and Reserve Components are naturally inclined to station medical units at or near accessible power projection bases and where other medical units are collocated. The power projection capacities of bases within the territories are lesser than their stateside counterparts. Stationing other medical unit types is also problematic in territories where there are critical shortages of the highly-skilled medical specialists (ex. physicians, nurses, physician assistants, etc.) available in the private sector to join the Reservist ranks.[84] Furthermore, USNORTHCOM uses a planning assumption that local governments can restore basic services (power, potable water, etc.) within ten days following a major hurricane – an assumption invalidated for the post-Hurricane Maria recoveries in Puerto Rico and U.S. Virgin Islands.[85] Overcoming the identified basing obstacles and accounting for the possibility of lengthier DSCA deployments amplifies the justification for expanding PM capabilities and capacities in

the ARNG and stationing ARNG PM units within the territories or their supporting FEMA regions.

An alternative course of action to improve PM unit response to hurricane ravaged territorial areas that does not require growing overall Army personnel end strength would be pre-positioning public health disaster response medical equipment sets within the territories. With this course of action, an active or reserve component medical brigade or multifunctional medical battalion with the appropriate mix of subordinate units such as MED DET PM, MED DET (Veterinary Services), Area Medical Lab, and Combat Operational Stress Control is placed on prepare to deploy orders (PTDOs) to fall in on this equipment in the event of a DSCA activation. The equipment set's configuration would provide a full or tailored complement of the public health and laboratory services reasonably expected to be required for a determined number of days following a major hurricane strike. The unit on PTDO would receive advance notification and undergo a train up and certification process along the lines of what is currently done for the task force medical within the Defense Chemical, Biological, Radiological, Nuclear Response Force.[86]

Four equipment sets would be ideal with one set pre-positioned in the South Pacific Region, one set in Hawaii, one set in the Caribbean Region, and one set state-side to cover the most vulnerable hurricane locations.[87] This placement scheme would ensure sets are readily accessible for use in territories. It would also place sets in closer proximity to natural disaster-prone partner nations such as the Philippines where humanitarian assistance and disaster relief missions may be executed.[88] The medical

unit(s) placed on the PTDOs could access the state-side set for training purposes and deploy with this set for any U.S. mainland responses under FEMA oversight.[89]

Hypothetical Climate Change Impacts on Maintaining a Medically Ready Force

Much of the Army's success depends on recruiting and retaining physically fit and mentally resilient Soldiers. With GCC harshening environmental conditions at training and deployment locations, recruitment, retention and deployment readiness difficulties on the medical front could arise.[90] Medical fitness standards for service entry are designed to ensure today's new recruits are suited to bear today's climatic conditions, but there may be new challenges.

First, tests in the future to measure heat stress coping tolerances and susceptibility to air pollution-induced ailments may become necessary at the Military Entrance Processing Stations should the DOD find the existing standards insufficient. Much of the onus to develop tests and devise recommendations for revising initial entry medical standards would fall upon the Army's medical research and development (R&D) programs under U.S. Army Medical Research and Material Command. Existing R&D programs such as the Military Operational Medicine Research Program and the Military Infectious Disease Research Program are already developing countermeasures and vaccines against physical stressors and infectious diseases that may become more prevalent due to GCC.[91] However, these organizations do not view GCC in the exact same manner as the other hazards currently studied by them. A switch in mindset where GCC-linked physical health threats are a specific focus area would help guide research priorities in a more proactive way.[92]

Second, the published deployment medical standards to support contingency operations issued by Geographical Combatant Commands are also based on the

present-day climatic conditions. The purposes of the Geographical Combatant Commanders' (CCDRs) deployment medical standards are to keep medically vulnerable personnel out of dangerous environments and reduce the strain on expeditionary medical assets by prohibiting personnel with non-waivered medical conditions from deploying.[93] The responsibility for crafting, revising and updating the deployment medical standards rests with the CCDRs Surgeons. The pace for updating the standards will almost certainly hasten since many nations most at risk of suffering destabilizing climate change effects are also likely to become deployment destinations. Therefore, the surgeon staffs could struggle to maintain the currency of the standards and, if worsening environmental conditions merit tightening the standards, the CCDRs could find themselves without sufficient numbers of medically eligible personnel to deploy to the "hottest" hot spots.

Keeping Medical Intelligence Current in the Face of Accelerated Climate Change

The 2014 not-for-profit Center for Naval Analyses publication, prepared by a 16-member military advisory board of retired Generals and Admirals, titled *National Security and the Accelerating Risks of Climate Change* recommended CCDRs "factor in the impacts of projected climate change across their full spectrum of planning and operations" with the support of National Intelligence estimates.[94] Providing CCDRs with actionable and informative estimates will require maintaining robust intelligence assets. Those assets must be appropriately resourced to collect, process, exploit, analyze, produce, disseminate, integrate, and evaluate climate change-associated intelligence.[95]

The chief asset within the DOD for analyzing medical intelligence is the National Center for Medical Intelligence (NCMI), which is a subcomponent of the Defense Intelligence Agency.[96] This organization, in collaboration with and supporting other

intelligence community (IC) partners, has the scientific experts and medical specialists on staff to prepare intelligence products on emerging environmental health concerns, communicable disease outbreaks, health care infrastructure, and medical research initiatives of strategic FHP import linked with GCC-phenomena.[97] However, resource constraints stemming from sequestration have diminished NCMI's and the entire IC community's capability to produce intelligence products at a speed commensurate with accelerated GCC.[98] Additionally, shifting national security strategy priorities could also retard the production of GCC-associated intelligence products.[99] Consequently, to fill this intelligence void within the FHP realm and fulfill medical intelligence preparation of the operating environment responsibilities, PM officers and medical planners assigned to CCDR staffs must have a basic understanding of the joint intelligence process and rudimentary proficiency in finding, analyzing, and integrating the intelligence sources available to them into planning efforts.[100] Incorporating medical intelligence training into Army Medical Center and School courses or employing mobile training teams comprised of medical intelligence experts to train medical planners at home duty stations are recommendations to enhance the development of these skill sets.[101]

Conclusion

Predicting with absolute certainty the public health impacts and force health implications of climate change are extraordinarily complex problems. However, there is no question that Army PM community must adapt the ways and means by which it counters the health threats most likely to emerge from GCC. Without this adaptation, the PM community will lack the essential Doctrine, Organization, Training, Material, Leadership and Education, Personnel, Facilities and Policy tools to protect the health of medical beneficiaries, Service Members, and, in the case of DSCA missions, the

American public. Absent significant budgetary increases, the PMSs will have to devise creative solutions to maintain the right numbers of personnel with the right skill sets to respond to emergent requirements.

An area of special emphasis is preventing the spread vector-borne disease outbreaks. The medical entomology experts within the PMSs and, to a lesser extent, the TDA PM TOE organizations will have critical vector surveillance, post outbreak investigation, and pesticide application roles to play countering this health threat on Army installations. These roles must be clearly understood; defined within written and rehearsed EVCPs; and performed by properly trained and equipped personnel. The same conditions will hold true, minus the EVCP-related imperatives, if Army PM assets respond to off-post vector-borne disease outbreak situations. During an actual outbreak, the PMSs should maximize sharing surveillance data and keeping the lines of communication open with the local health authorities.

Preventive Medicine units on the TOE side will increasingly deploy to support FHA operations and DSCA missions related to GCC- linked weather events such as hurricanes. The current placement of these units and their equipment sets exclusively within the Compo 1 and Compo 3 forces and their state-side basing locations are not optimal for responding to hurricane emergencies within U.S. territorial jurisdictions. The PM community will also face challenges acquiring and producing timely medical intelligence products at a sufficient speed to reflect actual conditions on the ground, as well as, supporting efforts to recruit, screen, and maintain a medically ready force that can perform under harsher environmental conditions. The moment to prepare for confronting the probable health impacts anticipated from GCC is now before a public

health calamity befalls the Total Army family and jeopardizes the Army's capabilities to execute its world-wide missions.

Endnotes

[1] Robert Gates, *Quadrennial Defense Review* (Washington, DC: U.S. Department of Defense, February 1, 2010, 85.

[2] Howard William et al., *Report of the Defense Science Board Task Force on the Trends and Implications of Climate Change for National and International Security* (Washington, DC: Defense Science Board Task Force, October 2011), cover memo, http://www.dtic.mil/dtic/tr/fulltext/u2/a552760.pdf (accessed on February 9, 2018).

[3] Ibid., xv.

[4] Madison Park, "Obama: No Greater Threat to Future Than Climate Change," *Cable News Network Online*, January 21, 2015, http://www.cnn.com/2015/01/21/us/climate-change-us-obama/index.html (accessed on January 6, 2018).

[5] Sammy Roth, "Trump Omits Key Military Priority From National Security Strategy: Climate Change," *USA Today Online*, December 18, 2017, https://www.usatoday.com/story/news/politics/2017/12/18/trump-omits-key-military-priority-national-security-strategy-climate-change/961769001/ (accessed on December 19, 2017).

[6] Ibid.; Andrew Revkin, "Trump's Defense Secretary Cites Climate Change as National Security Challenge," *ProPublica Online*, March 14, 2017, https://www.propublica.org/article/trumps-defense-secretary-cites-climate-change-national-security-challenge (accessed on December 19, 2017).

[7] A. Crimmins et al., *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (Washington DC: U.S. Global Change Research Program, 2016), summary page, https://health2016.globalchange.gov/ (accessed on December 6, 2017).

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[9] United Nations News Centre, "Climate Change Impacting Entire Planet, Raising Risk of Hunger, Floods, Conflict – UN Report," March 31, 2014, linked from the *UN News Centre Home Page*, http://www.un.org/apps/news/story.asp?NewsID=47471#.WihOrUqnGM8 (accessed on December 6, 2017).

[10] U.S. Department of the Army, *Army Health System,* Army Tactics, Techniques, and Procedures No. 4-02 (Washington DC: U.S. Department of the Army, October 7, 2011), 2-11, https://fas.org/irp/doddir/army/attp4-02.pdf (accessed on January 6, 2018); Health.mil, "Humanitarian and Disaster Relief," linked from the *Military Health System Home Page*, https://health.mil/Military-Health-Topics/Health-Readiness/Global-Health-Engagement/Humanitarian-Assistance-and-Disaster-Relief (accessed on January 6, 2018).

[11] The challenges listed were identified by the author after analyzing and assessing the Army PM community's readiness to confront extreme GCC phenomena. This list should not be considered all inclusive. Other possible capability and capacity gaps may exist. One mission area potentially meriting investigation is the PM community's preparedness to participate in theater security cooperation activities with those partner nations at most risk of suffering serious PH and FHP impacts from GCC.

[12] U.S. Department of the Army, *Medical Services: Preventive Medicine*, Army Regulation 40-5 (Washington, DC: U.S. Department of the Army, May 25, 2007), 2, http://www.apd.army.mil/epubs/DR_pubs/DR_a/pdf/web/r40_5.pdf (accessed on December 7, 2017).

[13] Ibid., 2.

[14] Ibid.

[15] DAMH-FPO, "History of Tables of Distribution Allowances (TDA) units," May 30, 1995, linked from the *U.S. Army Center for Military History Home Page*, https://history.army.mil/html/forcestruc/tda-ip.html (accessed on December 6, 2017).

[16] U.S. Department of the Army, *Preventive Medicine Services*, Field Manual 4-02.17 (Washington, DC: Headquarters Department of the Army, August 28, 2000), 3-1 to 4-1, http://usacac.army.mil/sites/default/files/misc/doctrine/CDG/cdg_resources/manuals/fm/fm4_02x17.pdf (accessed on December 7, 2017).

[17] U.S. Department of the Army, *Army Health System Support Planning*, Army Techniques Publication 4-02.55 (Washington, DC: Headquarters Department of the Army, September 16, 2015), 2-15, http://www.apd.army.mil/epubs/DR_pubs/DR_a/pdf/web/atp4_02x55.pdf (accessed on December 7, 2017).

[18] Howard Frumkin et al., "Climate Change: The Public Health Response," *American Journal of Public Health Online* 98, no. 3 (March 2008): 438, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2253589/ (accessed on December 6, 2017); J. Longstreth, "Public Health Consequences of Global Climate Change in the United States-some regions may suffer disproportionately - Abstract," February 1999, linked from the *PMC Home Page* at "Environmental Health Perspectives," https://www.ncbi.nlm.nih.gov/pubmed/10229716 (accessed on December 6, 2017).

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[20] The deployment of DA civilians with highly specialized PM skills is particularly common during Humanitarian Assistance/Disaster Response activities. For example, the U.S. Army Medical Research Institute of Infectious Disease (USAMRIID) deployed civilian experts to provide onsite laboratory support in Liberia as part of the DoD's assistance to West African nations combatting the Ebola virus in 2014. For more information visit: Caree Vanderlinden, USAMRIID supports Ebola Virus Disease outbreak response in West Africa," October 22, 2014, linked from the *Army Home Page*,

https://www.army.mil/article/136531/usamriid_supports_ebola_virus_disease_outbreak_response_in_west_africa (accessed February 9, 2018).

[21] Stephen B. Berte, "US Army Entomology Support to Deployed Forces," *American Entomology Online*, no. 4 (Winter 2005): 1, https://academic.oup.com/ae/article/51/4/208/2474766 (accessed on December 6, 2017).

[22] Aaron S. Bernstein and Mary B. Race, "Lungs in a Warming World," *CHEST Journal Online* 143, no. 5 (May 2013): 1455-1459, http://journal.chestnet.org/article/S0012-3692(13)60346-3/fulltext (accessed on December 6, 2017); Crimmins et al., *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.*

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[24] Ibid. The author created the table by aligning the areas of concentration specified within the AMEDD's AOC, ASI, and SI chart with examples of potential GCC mission requirements spelled from multiple references. Those references are cited after each example provided within the table.

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[26] Rebekah A. I. Lucas, Yoram Epstein, and Tord Kjellstrom, "Excessive Occupational Heat Exposure: A Significant Ergonomic Challenge and Health Risk for Current and Future Workers," July 23, 2014, linked from the *PMC Home Page* at "Extreme Physiology and Medicine," https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4107471/ (accessed on December 6, 2017).

[27] Crimmins et al., *The Impacts of Climate Change.*

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[29] Crimmins et al, *The Impacts of Climate Change*, summary.

[30] U.S. Department of Defense, *Pest Management Program*, Department of Defense Instruction 4150.7 (Washington, DC: U.S. Department of Defense, April 22, 1996), 21.

[31] Joshua Morganstein and Robin Cooper, "How Climate-Related Natural Disasters Affect Mental Health," linked from *American Psychiatric Association Home Page* at "Patients & Families," https://www.psychiatry.org/patients-families/climate-change-and-mental-health-connections/affects-on-mental-health (accessed December 7, 2017).

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[35] The first four options were solely the author's ideas. The fifth and sixth options were suggested for examination by Mr. John J. Resta, U.S. Army Public Health Center Director. Mr. Resta served as the author's AMEDD advisor. The Office of The Surgeon General directed each AMEDD officer within the U.S. Army War College Class of 2018 to select a General Officer or senior civilian leader advisor for their research paper. Author received two telephone interviews and one email that provided suggestions for improving the content within the Strategic Research Paper. John J. Resta, U.S. Army Public Health Center Director, telephone interview by author, October 19, 2018; John J. Resta, U.S. Army Public Health Center Director, telephone interview by author, December 6, 2017; John J. Resta, U.S. Army Public Health Center Director, e-mail message to author, December 18, 2017.

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[39] A debate on the best place to command, control, budget, and administer the PVNTMED SVCs within the military healthcare system is ongoing as part of the requirements for the DoD to comply with the 2017 *National Defense Authorization Act* (NDAA). Under the NDAA, all MTFs will fall under the direction of the Defense Health Agency (DHA) for "budgetary matters, information technology, health care administration and management, and administrative policy and procedure" associated with the provision of primary health care services at the start of Fiscal Year 2019. A decision on the fate of "military department-directed installation and command support functions separate from direct healthcare activities" which include many of the PVNTMED SVC functions is to be provided to Armed Services Committees of the Senate and House of Representatives by March 1, 2018. For more information on this topic see U.S. Department of Defense, *Report to the Armed Services Committee of the Senate and House of Representatives: Plan to Implement Section 1073c of Title 10, United States Code* (Washington DC: U.S. Department of Defense, June 30, 2017), 6, https://health.mil/Reference-Center/Reports/2017/06/30/Reform-of-Administration-of-the-Defense-Health-Agency-and-Military-MTFs (accessed on December 20, 2017).

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[44] Nadja West, U.S. Army Surgeon General, "Operations Order 16-37 MEDCOM Response to Zika Virus," Fort Sam Houston, TX, U.S. Army Medical Command, April 18, 2016; U.S. Assistant Secretary of Defense (Health Affairs) Jonathon Woodsen and Acting Assistant Secretary of Defense (Energy, Installations, and Environment) Peter Potochny, "Strategy for Control of Zika Virus Transmitting Mosquitos on Installations and Housing Areas," memorandum for Secretaries of the Military Departments and Surgeon Generals, Washington, DC, March 17, 2016.

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[46] Information about USAPHC's role in preparing health risk communication products during the onset of the Zika virus emergency in CONUS was provided by Ms. Roseanne Radavich, Entomological Services Division, U.S. Army Public Health Command, telephone interview with author, October 25, 2017.

[47] The author of this paper was the Deputy Chief of the PVNTMED SVC at Tripler Army Medical Center during the post ZVRO issuance period and oversaw the implementation of the staffing actions to comply with the order.

[48] Division of Communicable Disease Control, *Guidance for Surveillance of and Response to Invasive Aedes Mosquitoes and Dengue, Chikungunya, and Zika in California* (Sacramento, CA: California Department of Public Health, February 2017), 3-6,

https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/InvasiveAedesSurveillanceandResponseinCA2017.pdf (accessed on December 7, 2017).

[49] The Tripler Army Medical Center's Medical Entomologist would typically perform the interviews at the patient's residence. He would contact his counterparts within the Hawaii Department of Health's Vector Control Branch and alert them to off-post locations visited by the patient. The U.S. Army Garrison-Hawaii Pest Management Coordinator would be informed about locations visited by the patient on Army property.

[50] Press Room, "Mosquito-Borne Diseases," linked from the *American Mosquito Control Association Home Page* at "Resource Center," http://www.mosquito.org/page/diseases (accessed on December 7, 2017).

[51] The Navy and Marine Corps mandate that all their installations prepare an Emergency Vector Control Plan, and that this plan be included as an appendix within the Installation's Integrated Pest Management Plan. Army regulations do not identify an EVCP as a specific requirement. More information on the Navy's policy is found at Office of the Chief of Naval Operations, *Navy Pest Management Programs*, OPNAVIST 6250.4c (Washington, DC: Department of the Navy, April 11, 2012), 20, http://www.med.navy.mil/sites/nepmu5/Documents/EDNT/15-OPNAVINST%206250.4C(11APR12).pdf (accessed on December 7, 2017); Navy and Marine Corps Public Health Center, *Aedes Surveillance and Control Plan for U.S. Navy and Marine Corps Installations: Mosquito Vectors of Dengue, Chikungunya, and Zika* (Portsmouth, VA: Navy and Marine Corps Public Health Center, February 2016), 3, http://www.med.navy.mil/sites/nmcphc/Documents/program-and-policy-support/NMCPHC-Aedes-Surveillance-Contro-for-NMC-Installations.pdf (accessed on December 7, 2017).

[52] Big Island Video News, "Declare State of Emergency for Dengue Fever, Gabbard Tells Gov," January 29, 2016, linked from the *Big Island Video News Home Page* at "Regions," http://www.bigislandvideonews.com/2016/01/29/declare-state-of-emergency-for-dengue-fever-gabbard-tells-gov/ (accessed on December 7, 2017); The PMS at the Tripler Army Medical Center (TAMC) sent an entomology surveillance team to the Big Island during the dengue outbreak to perform mosquito surveillance on U.S. Army Garrison-Hawaii installations and at U.S. Army Reserve Center. The survey team did not collect any dengue positive mosquitoes; however, they did trap an *Aedes* aegypti mosquito at one of the surveyed installations. *Aedes* aegypti mosquitoes are the most competent Aedes vector for transmitting dengue. The Hawaii Department of Health (DOH) did not know that Aedes aegypti were present in this surveyed area near the Hilo International Airport. The DOH was appreciative of TAMC's willingness to share surveillance data. Since the dengue outbreak, all the other DoD PM elements in Hawaii are now sharing mosquito surveillance data with the Hawaii DOH and attending joint Mosquito Control Working Group Meetings.

[53] U.S. Centers for Disease Control and Prevention, "Emergency Mosquito Control Associated with Hurricane Andrew—Florida and Louisiana, 1992," *Morbidity and Mortality Weekly Report Online* 42, no. 13 (April 9, 1993): 240-242, https://www.cdc.gov/mmwr/preview/mmwrhtml/00020129.htm (accessed on December 7, 2017)

[54] Berte, "US Army Entomology Support to Deployed Forces," 1.

[55] The author served as the Fort Bragg Senior Mission Commander Force Health Protection Officer from July 2012 – July 2014. While in the position, he coordinated with the Taskings

Branch to issue taskings to PM TDA and TOE organizations for performing public health related mission services at special events.

[56] Mark Carder et al., *Vector Centric Capability Gap Working Group Report* (Silver Spring, MD: Armed Forces Pest Management Board, August 9, 2016), 10. This document was furnished to the author by COL Jaimie Blow, Armed Forces Pest Management Board Director, email message to author, November 15, 2017.

[57] According to Dr. William Miller, the senior entomologist at U.S. Army Environmental Command, virtually all installations are now contracting vector control services. He cites the onerous pesticide storage and mixing facility requirements and cost savings from contracting options among the reasons for eliminating the garrison pest control shops. William Miller, Entomologist, U.S. Army Environmental Command, telephone interview by author, December 1, 2017.

[58] Armed Forces Pest Management Board, *Installation Pest Management Program Guide*, Technical Guide 18 (Silver Spring, MD: Armed Forces Pest Management Board, August 9, 2016), 4, https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg18.pdf (accessed on December 8, 2017).

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[62] U.S. Department of Defense, *DoD Pest Management Training and Certification: The DoD Plan for Pesticide Applicators*, Department of Defense Instruction 4150.07 (Washington, DC: U.S. Department of Defense, May 23, 2013), Enclosure 3, 21. http://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415007m_vol1.pdf (accessed on December 8, 2017).

[63] Ibid., 16-22.

[64] Ibid., 12.

[65] Ibid., 2.

[66] Information about the general practices associated with Line of Sight supervision and the nuances associated with enacting reciprocity agreements with state authorities was provided to the author from an email exchange with Ms. Rosanne Radavich. Ms. Rosanne Radavich, Entomological Sciences Division, U.S. Army Public Health Center, email message to author, November 28, 2017.

[67] Ibid.

[68] J. Walsh et al., "Chapter 8: Changes in Hurricanes" in *2014 National Climate Assessment,* ed. J. M. Melillo, T. C. Richmond, and G. W. Yohe (Washington DC: U.S. Global Change Research Program, 2014), 41, https://nca2014.globalchange.gov/report/our-changing-climate/changes-hurricanes (accessed on December 22, 2017).

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