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Proposal for Funding the Vulnerability Assessment Software Toolkit (VAST)

Under the ERDC Geospatial Research and Engineering Business Area

George W. Calfas and Nicole M. Wayant

December 2017

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Under ERDC Geospatial Research and Engineering Business Area

Abstract

This work responds to stated critical concerns within the U.S. Army that it currently lacks the necessary depth of knowledge about the complex dynamics within megacities or other dense urban environments. Army leaders acknowledge the inevitability that at some point the Army will be asked to operate in a megacity, considered one of the most challenging environments. This document presents a proposal to develop a social power analysis for understanding social systems, work which is fundamental for mission success but has not yet been solved. The proposed research will overcome the Army's use of an inadequate approach to understanding social systems by demonstrating new knowledge, methods, and tools for a problem-oriented, system-of-systems approach. This work goes beyond the topical inventories currently found in Army doctrine and used in practice. Results include a framework and methodology for the assessment of the power dimensions within urban social systems; a software tool for military planners to operationalize the power flows within the social systems; a workflow and methodology to combine network epidemiology and disease hazard mapping for vector-borne disease monitoring, prediction of spread, and intervention; and software plug-ins to assist with geospatial and temporal analysis of a population.

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Contents

Abstract.....	ii
List of Tables.....	iv
Preface	v
Foreword	vi
Funding Proposal and Justification for the VAST Project	1
Purpose	1
Products	1
Payoff	2
Background.....	2
1. What is the problem?.....	5
2. What are the barriers to solving this problem?	7
3. How will you overcome those barriers?	8
4. What is the capability you are developing?	10
Quantitative metrics	12
Transition milestones	13
Endorsements	13
Other work package attributes	14
Scope of work	15
Work breakdown plan	16
<i>Task 1: Conceptual framework for social power analysis</i>	<i>16</i>
<i>Task 2: Social systems impact assessment.....</i>	<i>16</i>
<i>Task 3: Geosocial temporal disease modeling.....</i>	<i>18</i>
<i>Task 4. Demonstrations</i>	<i>19</i>
Cost estimate.....	20
Proposal self-evaluation.....	20
Principal investigators	22
Bibliography.....	27
Appendix A: Endorsements.....	29
Appendix B: Capability Gap Assessments	30
Report Documentation Page	

List of Tables

Table 1. Project metrics.....	13
Table 2. Cost estimate by work unit (in \$K); total in \$M).	20
Table 3. Criteria, self-assessment and justifications for proposed project, “Vulnerability Assessment Software Toolkit.”	21

Preface

This work was done for the Headquarters, Engineer Research and Development Center (ERDC) in Vicksburg, MS, as a funding proposal for 6.2 research under the ERDC Geospatial Research and Engineering Business Area to develop Vulnerability Assessment Software Toolkit to benefit the U.S. Army.

The work was performed by researchers from two Army research laboratories: (1) the Environmental Processes Branch (CNE) of the Installations Division (CN) at U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL); and (2) the Information Generation and Management Branch (IGMB) at the Geospatial Research Laboratory (ERDC-GRL).

At the time of publication, research management for ERDC-CERL included Mr. H. Garth Anderson as Chief, CEERD-CNE; and Mr. Donald K. Hicks as Acting Chief, CEERD-CN. Research management for GRL included Ms. Katlyn Castillo as Chief, CEERD-TRG; and Ms. Martha Kiene as Chief, CEERD-TR.

Mr. Kurt Kinnevan was the Technical Director for Adaptive and Resilient Installations (CEERD-CVT) at ERDC-CERL, and Mr. Ritch Rodebaugh was Technical Director for the Topographic Engineering Center at GRL (CEERD-CZT).

The Interim Deputy Director of ERDC-CERL was Ms. Michelle J. Hanson, and the Interim Director was Dr. Kirankumar V. Topudurti. The Deputy Director of ERDC-GRL was Ms. Valerie Carney, and the Director was Dr. Joseph F. Fontanella.

The Commander of ERDC was COL Bryan S. Green, and the Director was Dr. David W. Pittman.

Foreword

This work was originally presented as a proposal to the Geospatial Research and Engineering business area of the Engineer Research and Development Center (ERDC) for project funding.

This report captures the original proposal's contents, with small editing and formatting changes made to meet ERDC publication style.

JEAN S. NOELLSCH

Writer-Editor (CTR)

Information Science and Knowledge Management (ISKM) Branch

Funding Proposal and Justification for the VAST Project

Purpose

This project will develop a social power framework, identify key social vulnerabilities that result from adverse events in-theater (combat, terror, etc.), monitor changes in power relations that have ramifying effects throughout the social system in urban settings, and consider the likelihood and magnitude of threats to maneuverability, force protection, and the security of the civilian population.

Currently, the U.S. Army acknowledges it does not fully understand the complex dynamics within megacities or other dense urban environments. With rapid global growth, economic disparity, political instability, and the threat of natural disasters and disease epidemics, “It is inevitable that at some point the United States Army will be asked to operate in a megacity and currently the Army is ill-prepared to do so.”¹ In order to operate effectively within a dense urban context, the Army must have a solid understanding of the operational environment (OE), with all its interwoven and shifting complexities. The purpose of this work package is to develop a framework for the assessment of the power dimensions within the social system, to develop an improved means of understanding the spread of vector-borne disease within that system, and to integrate the impacts of both into maneuverability, force protection, and the security of the civilian population. This framework will be operationalized through a software tool that allows military decision makers to assess human impact to military operations within the urban environment during Phase 3 through Phase 5 operations.

Products

- A framework and methodology for the assessment of the “Power Dimensions” within the social systems in urban environments.

¹ U.S. Army Strategic Studies Group, *Megacities and the United States Army: Preparing for a Complex and Uncertain Future*, report to GEN Raymond T. Odierno, Chief of Staff, (Washington, DC: U.S. Army, June 2014).

- A software tool that allows military planners the ability to operationalize the power flows within the social systems.
- A workflow and methodology to combine network epidemiology and disease hazard mapping that is designed and tailored for vector-borne disease monitoring, prediction of spread, and intervention.
- Plug-ins for geospatial and temporal analysis of a population's impact to military operations.

Payoff

This effort will develop a social power framework, design a prototype software plugin that focuses on local populations impacted by adverse events, and develop a software solution that which explore the connections between ecological, constructed, and sociocultural systems. The inclusion of these dynamic systems will enhance the spatio-temporal understanding of rapidly evolving events. This developed software package will do the following:

- Provide a repeatable methodology for social power analysis vulnerability assessment in complex and dense urban environments during the full spectrum of operations.
- Provide analysis tools that facilitate timely decision-making in complex, dynamic environments.
- Quickly provide the Army with a strong situational awareness of the spatial and temporal risk presented by an ongoing or potential vector-borne disease epidemic.

Background

The Army's strategic context of expeditionary capabilities mandates the U.S. Army to promptly deploy combined-arms forces worldwide into any operational environment in order to conduct missions effectively upon arrival. The Army needs to develop a flexible response capacity that allows it to conduct all types of operations in a wide range of environments. Our planet is currently home to more than 20 megacities, each with a population of 10 million or more persons. Additionally, hundreds of cities with fewer than 10 million people have population densities that rival those of their megacity counterparts. It is expected that by the year 2030, 70% of

the world's population will live in urban settings, with the number of megacities increasing to 41.² Given the rapid growth of urban populations, haphazardly constructed infrastructure, economic disparity, political instability, and the threat of natural disasters and disease epidemics across the globe, "it is inevitable that at some point the United States Army will be asked to operate in a megacity..."³ These urban environments are complex, dynamic, systems of systems with ecological, constructed, and sociocultural components.⁴ To compound the difficulties, conflicts within them may well also fall within the so-called Gray Zone.⁵

A key part of the assessment of the battle space is identification of the social systems within it and their vulnerabilities. To operate effectively in the midst of these complex systems, it is important to understand social power relations, whether our operations take place in a rural, urban, or dense urban environment. TRADOC's 2014 pamphlet on engagement makes the importance of social power clear: "Understanding the power residing within human interaction, social constructs, language, culture, behaviors, and other human variables will provide the construct for future Army forces to influence the Operational Environment."⁶ GEN Joseph L. Votel was even more explicit in his March 2015 testimony to the House Armed Services Committee's Subcommittee on Emerging Threats and Capabilities:⁷

Power and influence are now diffusing to a range of actors, both state and non-state, who have not traditionally wielded it. Many governments are struggling to adjust to the new realities...Populations are increasingly challenging the legitimacy of their governments and demanding change on a range of issues. Governments unwilling or unable to accommodate

² United Nations, *World Urbanization Prospects: 2014 Revision*. (New York: United Nations Secretariat, Department of Economic and Social Affairs, Population Division, 2014).

³ U.S. Army Strategic Studies Group, *Megacities and the United States Army*.

⁴ United Nations, *World Urbanization Prospects: 2014 Revision*.

⁵ Gray Zone refers to the space between peace and war where state competition morphs into conflict while staying below the threshold of conventional warfare. Gray Zone operations are characterized by ambiguity and often combine subversion, destabilizing social media influence, and disruptive cyberattacks instead of recognizable armed forces to achieve an advantage.

⁶ U.S. Army TRADOC, *U.S. Army Functional Concept for Engagement*, TRADOC Pamphlet 525-8-5, (Fort Eustis, VA: U.S. Army Training and Doctrine Command, 24 February 2014), para 3-5c2.

⁷ GEN Joseph L. Votel, U.S. Army, Commander United States Special Operations Command, statement before the House Armed Services Committee Subcommittee on Emerging Threats and Capabilities, 18 March 2015, p. 6.

change will face increasing pressure from dissatisfied segments of their populations...

Just as traditional responses of governments to new wielders of social power will prove inadequate, so too will its attempts to understand the operational environment that do not explicitly address social power. If our operations also fall conceptually within the so-called gray zone, where “we are confronted with ambiguity on the nature of the conflict, the parties involved, and the validity of the legal and political claims at stake,”⁸ our efforts to understand the operational environment and the social power relationships therein are challenged by increased complexity. General Votel continues, “These conflicts defy our traditional views of war and require us to invest time and effort in ensuring we prepare ourselves with the proper capabilities, capacities, and authorities to safeguard U.S. interests.”⁹ Clearly, tools that enable the Army to rapidly develop understanding of the social power relationships among urban networks and systems, and the challenges that those networks and systems present, are critical to mission success.

To contribute to the understanding of urban systems and identify key vulnerabilities within them, we propose to develop a Vulnerability Assessment Software Toolkit (VAST)—an integrated, common operating software platform with the capacity to aid planners in understanding complex operating environments and how those environments might be affected by military operations. Among our goals is to provide the Army with a framework that enables assessment of social power relationships in complex operational environments. That framework will enable the Army to develop a scientifically grounded understanding of the social power dynamics in the operational environment, and it will allow decision makers to plan effectively to anticipate risks and mitigate adverse impacts.

⁸ GEN Joseph L. Votel, U.S. Army, Commander United States Special Operations Command, statement before the Senate Armed Services Committee, 26 March 2015, p. 7.

⁹ *ibid.*

The world's burgeoning metropolitan areas (and those who would operate within them) are challenged by poor infrastructure and re-emerging diseases.^{10,11,12} To meet that set of challenges, VAST will also include tools that address the rapid spread of vector-borne disease within urban environments, and the role that social power plays in the production of disease-related impacts within the city itself and the impacts of migration out of it.

1. What is the problem?

The Army increasingly recognizes the importance of the social systems in the conduct of operations abroad. However, the current standard Army frameworks and practices (DIME-FIL, PMESII-PT, METT-TC, SWEAT-MSO, ASCOPE)¹³ do not address the understanding of the social power dimensions of the human domain. The following seminal citations highlight the importance of this ill-defined research area:

Recent and ongoing conflicts reinforce the need to balance the technological focus of Army modernization with a recognition of the limits of technology and an emphasis on the human, cultural, and political continuities of armed conflict. Nations and organizations in the future will fight for the same reasons that the Greek historian Thucydides identified 2,500 years ago: fear, honor, and interest.

TRADOC Pamphlet 525-3-1 (31OCT14, p. 8-9).

Thucydides quote from *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War*. (R. Crawley, Trans; R. B. Strassler, ed.)

¹⁰ Duane J. Gubler. "Dengue, Urbanization and Globalization: The Unholy Trinity of the 21st Century," *Tropical Medicine and Health*, vol. 39 no. 4 (2011): 3–11.

¹¹ T.B.C. Alavo, A.Z. Abagji, M. Accodji, and R. Djouaka, "Unplanned Urbanization Promotes the Proliferation of Disease Vector Mosquitoes (Diptera: culicidae)." *The Open Entomology Journal*, 4 (2010): 1–7.

¹² A.M. Bayer, G.C. Hunter, R.H. Gilman, J.G. Cornejo del Carpio, C. Naquira, C. Bern, and M.Z. Levy, "Chagas Disease, Migration and Community Settlement Patterns in Arequipa, Peru," *PLoS Neglected Tropical Diseases*, vol. 3 no. 12 (2009): e567.

¹³ Spell-outs of terms in parentheses are as follows: Diplomatic, Information, Military, Economic, Financial, Intelligence and Law Enforcement (DIMEFIL); Political, Military, Economic, Social, Infrastructure, Information, Physical Environment, and Time (PMESII-PT); Mission, Enemy, Terrain, Troops available, Time, and Civilian considerations (METT-TC); Sewage, Water, Electricity, Academics, Trash, Medical, Safety, and Other considerations (SWEAT-MSO); Area, Structures, Capabilities, Organizations, People, and Events (ASCOPE).

A megacity is not the only environment where a land force can be tasked to operate, but it is potentially the most challenging...The accelerating migration of humanity to cities is undeniable. They are the centers of gravity for the human domain were drivers of instability converge. In a world made smaller by global connected-ness, threats emanating from distant megacities will have the capability to threaten US interests, its allies and the homeland itself.

Army Chief of Staff

Strategic Studies Group: Megacities and the United States Army
- Preparing for a Complex and Uncertain Future, June 2014

The Joint Concept for Human Aspects of Military Operations (JC-HAMO) focuses the future Joint Force on a critical and enduring challenge in warfare – the need to understanding relevant actors’ motivations and the underpinnings of their will. The concept recognizes that war is fundamentally and primarily a human endeavor.

Gen. Paul J. Selva, U.S. Air Force

Vice Chairman of the Joint Chiefs of Staff
JC-HAMO, 19 Oct 2016

Additionally, as MAJ GEN Robert B. Brown and MAJ Ronald W. Spring are quoted by Steven Metz, “The Human Domain cannot be controlled or managed by technical means or capabilities; it requires human contact – person to person interaction – with duration and persistence over time.”¹⁴ As we found in Iraq and Afghanistan, such person-to-person interaction exposes Soldiers to non-combat injuries, illnesses, and disease. Within areas of conflict, and particularly within the dense urban environment, outbreaks of disease, epidemics, and pandemics are both more likely and particularly problematic. Given that a person’s health and well-being are heavily influenced by their social and material position in society, it seems probable that a solid understanding of social power dynamics will also aid us in our understanding of the outbreak and spread of disease, epidemics, and pandemics.

¹⁴ Steven Metz, *Strategic Landpower Task Force Research Report* (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 3 October, 2013), 11. Online publication: <http://ssi.armywarcollege.edu/index.cfm/articles/STRATEGIC-LANDPOWER-TASK-FORCE/2013/10/3>.

Thus, our research responds to critical concerns addressed within the U.S. Army Functional Concept for Engagement,¹⁵ U.S. Army Operating Concept (AOC),¹⁶ and the Joint Concept for Human Aspects of Military Operations (JC-HAMO).¹⁷ By developing a framework that allows warfighters to identify and analyze the power dimensions of social systems, this project will address a critical gap in the U.S. Army's ability to understand complex sociocultural dynamics that directly impact its ability to maneuver, sustain the initiative, protect the force and noncombatants (from both injury and disease), and engage with the civilian population during combat operations.

2. What are the barriers to solving this problem?

Despite past efforts, the Army remains unable to adequately define and understand social systems. Although the Army has more than 15 years of lessons learned from combat operations in Iraq and Afghanistan, its doctrine writers still struggle with how best to address problems related to social systems. The Army's previous efforts have been constrained by its long tradition of developing inventory-based tools. This approach does little more than list concerns. It does not help Soldiers to make sense of the information they have so carefully compiled.

Further complicating our understanding of social systems is the Army's historical predilection for relying primarily on Western-oriented, First World cognitive psychologists, political scientists, and economists to explain complex sociocultural dynamics within the Third World. Often, in their attempts to understand social systems and convey it convincingly to the Army, scholars in these fields have relied upon measures that can be quantified and ingested into computational models. Unfortunately, these models fall short of being able to characterize the underpinnings of human behavior in a global context. Social scientists from other humanities disciplines, employing qualitative methods and theoretical paradigms associated with their particular field of inquiry, are what the Army needs to better explain social systems.

¹⁵ U.S. Army TRADOC Pamphlet 525-8-5.

¹⁶ U.S. Army TRADOC, U.S. Army Operating Concept, TRADOC Pamphlet 525-3-1 (Fort Eustis, VA: U.S. Army Training and Doctrine Command, 31 October 2014).

¹⁷ Joint Chiefs of Staff, *Joint Concept for Human Aspects of Military Operations* (JC-HAMO), (Washington, DC: Department of Defense, 19 October 2016).

Moreover, political-military intelligence analysis focus on relations between nation-states and the functioning of their institutions and key leaders in their political systems. Military interventions have repercussions in the international political arena. However, military operations occur at the local level and have impacts on local politics. Currently, the Army lacks the methods and tools to understand local politics, which take into account the nature of the relationship between government and the governed as well as the structural foundations for the differential exercise of social power.

Additionally, the integration of social science into geospatial land cover analysis has not been a focus within the Department of Defense (DoD). Social power plays an integral role in production of humans as disease vectors. Powerless people with limited resources are frequently relegated to parcels of land of low value to social elites and that are also prime locations for the emergence of disease. Furthermore, the majority of previous research in vector-borne diseases has focused on the transmission of illness via non-human carriers (e.g., mosquitos, ticks, sand fleas). While this research has been able to pinpoint the loci of disease occurrences based upon the limited travel distance of non-human carriers it does not take into consideration humans play in transmitting a vector-borne disease. Humans are extremely mobile and allow for a much more rapid and much wider dispersion of disease.

3. How will you overcome those barriers?

The VAST effort will overcome the barrier of the Army's use of an inadequate approach to understanding social systems by developing knowledge, methods, and tools that demonstrate a problem-oriented, system-of-systems approach that addresses a significant capabilities gap identified in the development process for Army's requirements. Our focus on social power analysis addresses an Army problem in understanding social systems that is fundamental for mission success but has not yet been solved for the benefit of Army operators. Our proposed approach goes beyond the topical inventories found in doctrine and used in practice; it will contribute to an understanding of the workings of complex social systems that change over time.

Our effort will leverage strengths that reside within the Geospatial Research and Engineering (GRE) business area as well as the greater Engineer Research and Development Center (ERDC). Located at ERDC's Construction Engineering Research Laboratory (ERDC-CERL) is a unique

team of social scientists (anthropologists, sociologist, linguists, and human geographers) with a wealth of experience doing problem-oriented research regarding social systems in non-Western societies. Since the inception of the sociocultural program within ERDC, this team of researchers has been engaged with Army units that specifically require insights into social systems. Based upon their previous endeavors, this team participates on committees that are focused on the 7th Warfighting Function and other Capabilities Needs Analysis working groups.

Our framework and its operationalization with conceptual modeling and spatially integrated social science will enable the understanding of the human domain from the bottom up, i.e., at the level that military units encounter and impact local society. Many of the societies that the Army will encounter in the course of Gray Zone conflicts have decentralized governments, which is to say that the national government has devolved the everyday business of government to lower levels. In addition, weak states may be unable to extend much control to the local level. The foundations of local-level sociopolitics may well differ dramatically from national-level drivers.

Our effort will contribute to a growing interest in the integration of social science and geospatial analysis.¹⁸ We anticipate needing to meet the following challenges as we work toward this integration:

- Identifying scalable geospatial data—Geosocial models will be developed on the basis of robust datasets from countries other than the United States. The learning from this research will then be related to areas with lower fidelity datasets, which will allow for models to be reverse-validated. We will engage with stakeholders at United States Army Special Operations Command (USASOC), Civil Affairs, and regionally aligned forces (RAF) to tap into their knowledge of open-source datasets and to evaluate our models.
- Highly dynamic and spatially disaggregated nature of armed conflict and responses to it in an urban operational environment—We will

¹⁸ See the website of the Center for Spatially Integrated Social Sciences (<http://csiss.org>), which describes the effort funded by the National Science Foundation from 1999–2007 with the mission of developing “unrestricted access to tools and perspectives that will advance the spatial analytic capabilities of researchers throughout the social sciences.” This work continues to be supported by the University of California, Santa Barbara, at the following websites: www.spatial.ucsb.edu; www.gispopsoci.org; www.teachspatial.org.

draw upon our knowledge gained from a decade of evaluating the use of open-source data for geospatial analysis of the sociocultural aspects of the operational environment. We will recommend improvements in data collection that can be made if assets are invested in acquiring data on-site and in near-real time at a local scale.

- Identifying authoritative, continuous data streams for the responses of social actors, communities, and cities to armed conflict—We will use open-source proxy data in order to make inferences about and representations of population behavior that apply at the local scale. We will employ a mixed-media approach with qualitative and quantitative data (which we pioneered in our research for the GRE 6.2 effort Phase Zero Assessment of Urban Security Threats), and we will include explanatory narratives to accompany our visual representations to enable decision-makers to reason from the evidence presented. Information about conditions on the ground can be obtained from investigative reporting, ethnographies, and reports by organizations such as the International Crisis Group, Human Rights Watch, and Médecins Sans Frontières (Doctors Without Borders). We will develop quantitative data that can be used for our spatially-referenced and temporally-sensitive vulnerability analysis from multiple remotely available sources, including geographic data layers for baseline comparisons, and imagery and photos for change detection.
- Identifying extensive disease incident data—To avoid the computational cost and complexity of person-level epidemiological models (taking several hours to several days to run), we will focus on the spatiotemporal behavior of the local population. Using regional population and demographic data, we will build Monte Carlo simulations, which will model the spread of a vector-borne disease across a region. This modeling effort will allow us to estimate what regional factors or infection scenarios the region is most vulnerable to, such as an influx of persons into the region or changes in local susceptibility due to disasters or military operations.

4. What is the capability you are developing?

This project directly addresses the following unpublished capability gaps: Maneuver Support Center of Excellence Capabilities Needs Analysis gaps FY 18–22 (all rated as Extremely-High): 462155 (16-20 Gap#: 461067), 462180, 462270.4, 462270.9 (16-20 Gap#: 203092), 500418, 502176, 502179, 502182, 502184, 550041, Special Operations Center of Excellence Capabilities Needs Analysis gaps FY 18–22 (all rated as Extremely High):

502094, 502100, 502152, and U.S. Army Capabilities Needs Analysis Gaps FY 17–21: three High-Risk, and five Moderate-Risk (see Appendix B).

Future Army engagements will likely be in the gray zone, wherein low-level conflict may threaten or persist, without an official declaration of war between nations. In this gray zone, the Army will encounter complex political situations that involve a range of state and non-state actors with agendas that are less than transparent, whose networks are partially hidden or invisible, and whose alliances may shift as conflict threatens or continues. The capability that VAST is developing is designed to enable Army decision makers to deconstruct, analyze, and anticipate the dimensions of the exercise of social power and its contestation in the operational environment.

An investigation of social power involves identifying the conduits through which actors exercise power and determining how social and cultural systems are reproduced and/or transformed through this exercise of power. Theoretical debates about the nature of power abound.¹⁹ We will use as a benchmark the applied approach to power analysis pioneered by the developers of the Powercube,²⁰ which focuses on understanding the spaces, places, and dynamics of power that undermine and exclude people from political participation. This approach expands a conventional focus on domination (power over) to consider the capacity of actors to wield power by taking social action (power to).

Army operators engaging in complex political situations need a new, comprehensive method to efficiently gain situational understanding that takes into account power relations among the myriad actors, who can be conceptualized as adversaries, neutrals, and supporters. Our method will aid in the characterization of the heterogeneous field of state and non-state actors, who interact at multiple geographic scales, starting with the local perspective and extending to the global perspective, if relevant. It will enable the user to take into account shifts in alliances as low-level conflict persists, and to monitor and interpret changing power relations.

¹⁹ Mark Haugaard, "Power." In *The Encyclopedia of Political Thought*, first edition. Edited by Michael T. Gibbons. (Indianapolis, IN: John Wiley & Sons, Ltd., 2015).

²⁰ See <http://www.powercube.net/>.

Once Army operators achieve understanding of the workings of power relations in the operational environment, they will be able to assess the impacts of power relations on the creation and/or exacerbation of vulnerabilities in the population. For example, the exercise of social power plays a role in making humans into vectors for the transmission and spread of disease. The recent outbreak of the Ebola virus in West Africa is a case in point; the spread of this virus was facilitated by (1) limited access to both education about the disease and health services for treating the disease, and (2) by the inability of the government to control population movement and cultural practices regarding disease treatment and dealing with the dead. VAST's incorporation of the impacts of power relations into ERDC's land cover modeling capability for forecasting disease transmission will produce powerful tools for Army analysis that can strategically inform considerations of force protection, sustainment, building partnerships, and maneuver.

In the complex and rapidly changing operational environments characteristic of gray zone engagements, commanders expect to conduct operations in a decentralized manner. Operators cannot be dependent on information and analyses flowing from the top down. The ability to efficiently understand the changing situation in the operational environment contributes to the ability to cope with adversity, learn, and adapt to change.

Research on sensemaking suggests that experts formulate mental models that aid in the assessment of complex situations. In the process of assessment, they question the adequacy of what they think they know and reflect on new ways to look at the problem or to fill information gaps.²¹ Our method will enable commanders and soldiers to form mental models of power relations that they can deploy in making sense of the operational environment.

Quantitative metrics

This effort will affect the metrics shown in Table 1, although other metrics not listed will certainly be addressed over the life of the project.

²¹ Winston R. Sieck, Gary Klein, Deborah A. Peluso, Jennifer L. Smith, and Danyele Harris-Thompson (Klein Associates Inc.), *FOCUS: A Model of Sensemaking*, Technical Report 1200, (Fort Belvoir, VA: United States Army Research Institute for the Behavioral and Social Sciences, May 2007).

Table 1. Project metrics.

Measure	Current	Effort Objective	Army Objective	TRL or SRL*
Define social power in the OE	None	Develop social power analysis framework	Understand human dynamics	Start level 3 End level 5
Represent social power relations in the OE	None	Identify tipping points that adversely impact population	Identify tipping points that adversely impact population	Start level 3 End level 5
Map infectious habitats and spread of disease	Detect a portion of public health threats.	Predict 100% of potential threats in area of responsibility (AOR)	Detect 100% of potential threats in AOR	Start level 3 End level 5
Computational algorithms for spatial analysis	Provide scalable geospatial data that supports military operations	First data layers < 12 hours	First data layers < 24 hours	Start level 3 End level 5

* TRL = Technology Readiness Level; SRL = System Readiness Level.

Transition milestones

We anticipate that our developed workflow will be transitioned to the parties listed in the endorsement section of this proposal. Currently, Map-Based Planning Services (MBPS), Distributed Common Ground System–Army (DCGS-A), Engineer Site Identification for the Tactical Environment (ENSITE), Instrument Set, Reconnaissance, and Survey (ENFIRE), and the Army’s Medical Research and Materiel Command (MRMC) have expressed interest in having this product transitioned.

Endorsements

The following agencies and organizations have endorsed this project either through verbal or written communication. Appendix A holds emails from the Medical Research and Materiel Command and 130th Theater Engineer Brigade that highlight the value of VAST research.

- Medical Research and Materiel Command (MRMC)
- National Center for Medical Intelligence (NCMI)

- National Geospatial-Intelligence Agency (NGA): InnoVision
- 130th Theater Engineer Brigade, Hawaii
- Civil Affairs Center of Excellence
- TRADOC Capability Manager-Geospatial

Other work package attributes

Novel to this effort would be analyses such as Spatial Nodes of Attraction, which would be used to identify areas vulnerable to isolation caused by combat operations. Spatial Nodes of Attraction can utilize a variety of inputs (open spaces, road intersection classification, etc.) to categorize a wide array of vulnerabilities ranging from areas most vulnerable to violent events to locations most likely to become physically isolated in the event of a break in transportation infrastructure. By using a Social Vulnerability Index (SoVI), a multidimensional understanding of a region's vulnerability and ability to cope with disaster can be provided.

Megacities and dense urban environments are challenging settings for military operations of any sort: kinetic, humanitarian/ disaster relief, and unconventional warfare. Because of the spatial characteristics of urban environments, portions of a city/urban area can become blocked off due to kinetic operations, terror, and disasters. In areas that have become isolated, direct action operations can be severely affected. In those situations, questions arise: What areas can be reached in order to effectively provide resources, and if needed, protection? How many response units are needed to cover reachable areas? Where should units be positioned? How will units get there? With Army Warfighting Challenges/Functions in mind, VAST will utilize open-source and ESRI-based capabilities to determine urban areas that have been negatively impacted by combat operations. The software tasks in VAST will yield methods to consume and geospatially project overlays that represent sociocultural information applicable to infrastructure and critical societal needs. The VAST team will work in conjunction with other ERDC research efforts to stay informed on cutting-edge sensor platforms.

Lastly, as the world's urban population grows, so too do the risks of exposure to infectious disease.²² Focusing on vector-borne diseases (diseases

²² WHO. *Global Report for Research on Infectious Diseases of Poverty: A Summary of the Key Findings*, TDR/GR/EN 12.1, (Geneva, Switzerland: World Health Organization, 2012).

spread by mosquitos, ticks, etc.) VAST proposes to develop a new methodology to map and predict the spread of infectious disease within urban environments that includes all essential elements associated with the growth and spread of disease, such as: land cover, climate, cultural and demographic variables, and the temporal movement and flow of a region's population. Utilizing key aspects of network epidemiology and disease hazard mapping, models will be developed that accurately and efficiently map and predict the spread of disease. This combination of spatial and aspatial theories and algorithms will provide the Army with (a) knowledge of where and how a disease will likely spread, (b) number of people it will impact and potentially infect, and (c) insight into how to lessen the burden of a disease, thus improving the Army's ability to adapt and alter its course of action in the face of a disease outbreak.

Scope of work

Our research goal is to instantiate a social power analysis framework and operational methodology in a prototype decision-support tool for application during the military mission analysis process. Our development effort consists of four major tasks.

For the geosocial and disease vector data outputs, this effort will design and test plug-ins for a desktop software package focused on vulnerability assessment. Using the ArcGIS Engine as the main back-end for analysis software, we are leveraging the full capacity of the ArcGIS program, for which the U.S. Army has over 13,000 licenses. All of the models and tools developed as plug-ins follow our Qualitative Assessment Framework (QAF). The QAF aligns with the Army Geospatial Enterprise (AGE) to advance data interoperability between Army programs. The AGE is an integrated system of technologies, standards, data, organizations and processes that delivers a Standard and Shareable Geospatial Foundation (SSGF) at all echelons. The SSGF ensures that all Army programs can consume the maps, imagery, and additional data produced by other Army programs. Coordination with the staff of the AGE Node will enhance VAST's technical certainty, develop software able to consume data that meets the standards outlined in the SSGF road map; it has the further effect of ensuring that our end users at the tactical to strategic levels are able to leverage data appropriately. Utilizing a plug-in approach, different analyses are packaged as mini-programs and are inserted into the broader code base. Our model of software development extends the capacity of the commercial off-the-shelf (COTS) software to consume products developed for

other research programs. Using a modular approach extends the impact of the software and reduces costs. For example, a plug-in may require a specific software that may not be present on all computers; by using a compartmentalized programming process, only that tool would not work, and a user would be able to access the rest of the functionality of the software.

Work breakdown plan

Task 1: Conceptual framework for social power analysis

We will develop a conceptual framework that provides a scientifically sound basis for a spatially integrated analysis of social power that can be applied to any OE. Our framework will take into account the following: the practice of governance at the local level; the relationship between government and civil society; social actors that support, contest, or replace state-sanctioned governance; and sources of tension in everyday sociopolitical relations that are associated with power and privilege, unequal access to resources, and identity differences in race, class, religion, sect, ethnicity, gender, tribe, caste, etc. We will determine how Army actions influence local power relations, what is likely to deteriorate, and what can be bolstered. When the U.S. Army intervenes, it steps into a complex system of social power relations. Our research will result in a conceptual framework for understanding the landscape of social power prior to our intervention, and it will help the Army to understand and anticipate how our presence will impact and alter power relations. The goal of our research and the framework and tools we will develop is to help the Army avoid discernable pitfalls related to systems of social power within social systems.

We will ground our framework in the results of social science research and case-based reasoning; it will represent those social power relations that are relevant to Army mission analysis.

Task 2: Social systems impact assessment

We will demonstrate how to operationalize the conceptual framework by (a) applying it in a particular case study, and (b) integrating spatiality into social science, which will allow for the production of software plug-ins that support the application of the framework.

Applying the framework

Apply the framework in a particular case study, which enables the determination and anticipation of the impacts of the deployed force on the local exercise of social power during military operations. Population responses to armed conflict that are relevant to Army operations include population displacement from areas that become inhospitable, resettlement of population away from the conflict zone, mobilization of sectors of the population to resist or support U.S. forces, repurposing of spaces (e.g., a playground becomes a cemetery or a school becomes a clinic), and changes in everyday patterns of power relations.

Using plug-ins to support the framework

The research team will establish a methodology for creating geospatially and temporally sensitive plug-ins, a methodology which currently does not exist. Use of the plug-ins will bolster the Army's understanding of population responses to conflict in a way that is relevant to the military decision making process. Our goal is to contribute to geospatial visualizations that support social power analysis. We want to be able to determine which sectors of the population that are engaged in local power relations will remain in, shift locations within, or vacate their homes area during conflict. By using census data, surveys, social media data, geographic landscape characteristics, and remote sensing, we will develop tapestries²³ of the operational environment. These tapestries will provide greater nuances than traditional methods in characterizing neighborhoods, the population's use of space, and the population's mobility during conflict. For example, a tapestry of migrant workers could demonstrate that a location has cyclical expansion and contraction. We also plan to investigate the utility of remotely sensed imagery of night lighting for detecting population mobility in dense urban areas. In addition, an important part of our research will be to determine the nature (i.e., accuracy, reliability, scale) and availability of open-source data appropriate for geospatial and temporal analysis.

²³ ESRI, "Tapestry Segmentation: Methodology," White paper (Redlands, CA: August 2014).
<https://www.esri.com/library/whitepapers/pdfs/esri-data-tapestry-segmentation.pdf>.

Task 3: Geosocial temporal disease modeling

Disease hazard mapping

The tactical scale workflows will use high-resolution commercial multi-spectral satellite imagery (e.g., WorldView-3), ancillary geospatial data layers (e.g., digital elevation models), and various urban landscape features (e.g., roads) to create detailed land cover products with a minimum mapping unit of less than 100 m² for U.S. Army training sites and Korean cities near the demilitarized zone (DMZ), an area plagued by the vector-borne disease, hantavirus. Advanced spatial object characterization metrics (e.g., texture, shape, spatial autocorrelation) will be investigated to enhance the accuracy and precision of the vegetation cover map layers. Species distribution modeling principles will also be utilized in this investigation to delineate mosquito, tick, and other vector and disease reservoir habitats. Ongoing disease risk assessments and vector surveillance activities will provide on-site expertise and ground reference information.

Development of disease propagation network model

The population in a region will be viewed as a discrete population density, modeled from the study site's demographics and cultural characteristics. Each local region will have a population density representing infected and non-infected individuals, and a local population's susceptibility to an increase in infected. This approach will allow us to run Monte Carlo simulations of potential outbreaks and create a "common flow" network, which will be a weighted, complex network representing the most common paths seen during an epidemic's progression. This network can be characterized by complex network measures to test its resilience and stability, as well as its full spatiotemporal spread, meaning that the effect of adverse events or intentional intervention can be measured and tested for statistical significance. Further, this approach allows us to better model the spread of vector-borne diseases, which we can treat as a stochastic process acting on the local population density.²⁴

Using our density-focused framework, a disease's progression will be influenced by any combination of three factors: (1) changes in the population distribution, (2) changes in the demographic and geographical makeup of

²⁴ T. Caraco, M. Duryea, S. Glavanakov, W. Maniatty, and B.K. Szymanski. "Host Spatial Heterogeneity and the Spread of Vector-Borne Infection." *Theoretical Population Biology* 59, no. 3 (2001): 185–206.

a region, and (3) the increase or decrease in the local population of disease vectors such as sandflies or mosquitoes and their hosts. Our particular framework will allow us to examine the effect of changes in land cover, either due to natural effects or man-made ones such as deforestation or resource depletion. This type of analysis can be done for a variety of disease models,²⁵ so as to fully investigate a region's capacity for infectious disease.

Geosocial-temporal workflow development

The workflows developed in the two previous tasks will be integrated into one common workflow prototype. This workflow will be designed around various kinds of input data (raster data, hospital records, cultural information, etc.). The size of the final product's grid cells will be based on the optimal resolution determined in the disease hazard map workflow section. The environmental and climatic data within these grid cells will then be used as weights to help determine to which regions of the study area the disease is most likely to spread.

Task 4. Demonstrations

Technical demonstration

Technical demonstrations, including conferences and journal publications, will be held throughout the life-cycle of the VAST project in order to showcase progress and capability from all work units. Particular emphasis will be placed on the integration of the capabilities developed within the individual work units.

Geospatial enterprise demonstration

The products of this work package will be consistent with the policies and protocols of the Army Common Operating Environment and the Army Geospatial Enterprise. Evaluation and demonstration test beds at AGC/GRL, such as the AGE Node, will allow the tools created in this work package to be evaluated on Army systems. These AGE demonstrations will be critical to the ongoing development and deployment strategy of the work package.

²⁵ J. Minsta, M. Rachdi, and J. Demongeot, J. "Stochastic Approach in Modelling Epidemic Spread." In Proceedings of 2011 IEEE International Conference on Advanced Information Networking and Applications (AINA 2011), held 22–25 March 2011, Biopolis, Singapore.

Stakeholder demonstration

In order to achieve successful transition of VAST's products and capabilities, we will engage regularly with key stakeholders and Army acquisition partners. As the AGE demonstrations progress, we will also demonstrate our technologies and capabilities to all interested parties. Feedback from these demonstrations will be critical to both the strategic direction and model development of the project.

Cost estimate

Table 2 shows the estimate of cost by work unit.

Table 2. Cost estimate by work unit (in \$K); total in \$M).

Work Units/Tasks	FY17	FY18	FY19	FY20
Task 1: Social Power Framework (Labor)	550	600	527	300
Task 2: Population Vulnerability (Labor)	150	650	600	630
Task 3: Population Vector Modeling (Labor)	550	600	600	550
Demonstrations	25	25	25	25
Travel	25	25	25	25
Total (in \$M)	1.3	1.9	1.77	1.53
<i>Funding Source: Army T41</i>				

Proposal self-evaluation

The proposed research project was self-evaluated against a set of ERDC's established portfolio criteria. Table 3 lists these criteria and provides the self-assessed score for each. Scores are provided on a scale of 1–10, where 1 represents low value or uncertain outcomes and 10 represents certain and highly valuable outcomes. Values of 1–4 are generally considered low; values of 5–8 are average; and values of 9 or 10 are exceptional.

Table 3. Criteria, self-assessment and justifications for proposed project, "Vulnerability Assessment Software Toolkit."

Portfolio Criteria	Self-Assessment Score	Justification for Score
<i>Mission Dimension</i>		
Army/Corps Impact	6	Provides ability to plan and respond to population responses to kinetic operations
Unique Niche	7	Provides understanding of the complex urban system dynamics in dense urban environments
Follow Opportunity	7	Effort could result in substantial follow-on from other agencies needing urban and disease model/prediction data
Innovation	6	Innovative aggregation of various discipline methods. DUE geospatial models are leveraging COTS resource and developing techniques currently not utilized
Technical Excellence	8	The team assembled has a unique combination of skills and experience in anthropology, sociology, mathematics, networks, programming, land cover classification, and human geography
Proponency	7	Clear indication of who to approach and from whom to anticipate endorsement; endorsements not made yet
<i>Feasibility Dimension</i>		
Technical Certainty	9	Have learned lessons from previous work to ensure success.
Technical Approach	7	Building on work completed in CB-SITE, the team has strong development experience in various disciplines.
Resources	6	Resources are appropriate and easily obtained.
Transition	8	Good likelihood of transition.
<i>Other Criteria</i>		
Competitive Impact of the Technology	Key	Could be used immediately.

Portfolio Criteria	Self-Assessment Score	Justification for Score
Technical Maturity	Growing	Desire to understand impact military operations have on a dense urban environment is still increasing.
Timing of Impact	Near-Mid	Upon completion, may take time for impact to be felt/seen in acquisition.

Principal investigators

CURRICULUM VITAE

a. **Title:** Research Anthropologist

b. **Name:** George W. Calfas

c. **Current Position, Department and Division:**

- 2013-Present; Research Anthropologist, Environmental Processes Branch, Construction Engineering Research Laboratory-Engineer Research and Development Center (ERDC) – Champaign, IL.

d. **Education:**

- 2013 Ph.D. (Archaeology), University of Illinois, Urbana-Champaign, Illinois, U.S.
- 2010 M.A. (Archaeology), University of Illinois, Urbana-Champaign, Illinois, U.S.
- 2006 B.A. (Mathematics and Anthropology), University of Illinois, Urbana-Champaign, Illinois, U.S.

e. **Relevant Professional Experience or Employment:**

- 2011-2013 Sociocultural/Remote Sensing Analyst
- 2008-2011 Archaeologist focusing in Remote Sensing
- 1992-2006 U.S. Army Infantry Small Unit Operations

f. **Relevant Publications:**

- Integrating Social Science Knowledge into Reconnaissance, Surveillance, and Intelligence, chapter accepted after peer review for an edited volume entitled Sociocultural Analysis in the RSI Paradigm, edited by Charles Ehlschlaeger, Strategic Multilayer Assessment Program, Office of the Secretary of Defense
- Regional Analysis of Historic Plantation and Farmstead Archaeological Site Characteristics on DoD Installations, Department of Defense Legacy Program

- Aerial Thermal Survey of New Philadelphia, Illinois, National Center for Technology and Training, National Park Service Grant No. MT-2210-07-NC-02

g. Invention Disclosures and Patent Applications:

- N/A

h. Research Achievement and Recognition Awards:

- 2012 Historic Charleston Research Award
- 2011 National Endowment for the Humanities
- 2011 National Endowment for the Humanities
- 2010 National Science Foundation
- 2008 National Science Foundation

i. Alphabetized List of Collaborators: (Past 48-months)

- Dr. Ghassan Al-Chaar, Civil Engineer, CERL
- Mr. Mathew Bates, Environmental Engineer, EL
- Mr. Jeffery Burkhalter, Community Planner, CERL
- Chipstone Foundation
- Mr. Lewis Cochrane, Analyst, Maneuver Center of Excellence
- Mr. Thomas Decker, Engineer, CERL
- Dr. Christopher Fennell, Archaeologist, University of Illinois
- Diachronic Research Foundation
- Dr. Susan Enscoe, Geographer, CERL
- MAJ. Bernard Faircloth, U.S. Army, USASOC
- Mr. Noah Garfinkle, Civil Engineer, CERL
- Mr. Dick Gebhart, Soil Scientist, CERL
- Mr. Patrick Guertin, Forester, CERL
- Dr. Michael Hargrave, Archaeologist, CERL
- Mr. William Hedges, Analyst, Intelligence Center of Excellence
- Mr. Mathew Hiett, Urban Planner, CERL
- Historic Charleston Foundation
- LTC Martin Jung, U.S. Army, CERL
- Dr. Anne Koster, Archaeologist, CERL
- Dr. David Krooks, Social Scientist, CERL
- Mr. Igor Linkov, Physical Scientist, EL
- CPT. Michael Mailloux, U.S. Army, GRL
- Ms. Natalie Myers, Community Planner, CERL
- Dr. Dawn Morrison, Geographer, CERL
- Dr. Dustin Nottage, Systems Engineer, CERL
- Dr. Edward Nykaza, Acoustical Engineer, CERL
- Mr. Timothy Perkins, Community Planner, CERL
- Dr. Nathaniel Putnam, Mechanical Engineer, CERL
- Mr. Adam Smith, Geographer, CERL

- South Carolina Department of Natural Resources
- Dr. Ahmet Soylemezoglu, Systems Engineer, CERL
- Ms. Swathi Veeravalli, Physical Scientist, GRL
- Dr. Judith Vondrzyk, Research Sociologist, CERL
- Mr. Mark Wahl, Hydrologist, CHL
- Dr. Lucy Whalley, Anthropologist, CERL
- Ms. Juliana Wilhoit, Urban Planner, CERL

CURRICULUM VITAE

a. Title: Vulnerability Assessment Software Toolkit (VAST)

b. Name: Nicole M. Wayant

c. Current Position, Department and Division: Geographer, USACE-GRL-IGMB

d. Education:

- 2011 M.A. (Geography), University of Nebraska, Lincoln, NE
- 2009 B.S. (Mathematics), Kansas State University, Manhattan, KS
- 2009 B.S. (Geography), Kansas State University, Manhattan, KS

e. Relevant Professional Experience or Employment:

- 2015–Present, sub-team lead for 6.2 project RAPID, investigating community annoyance to military blast noise. USACE ERDC-GRL.
- 2015–Present, team member of 6.1 project Hierarchical Characterization of Community Reactions to Military Training Noise, completed hierarchical statistical analysis for community annoyance to noise. USACE ERDC-GRL.
- 2014–Present, team member of 6.2 project STRIDER. Studied ways to incorporate space into storytelling. USACE ERDC-GRL.
- 2011–2015, Principal Investigator, 6.1 “HiSpan,” basic research project. Created ways to analyze geosocial data. USACE ERDC GRL.
- Summer 2010, SMART program scholar, USACE ERDC GRL.
- Summers 2007–2009, STEP Program, National Geospatial-Intelligence Agency, St. Louis, MO
- August 2007–May 2009, Undergraduate Research Assistant, Kansas State University Remote Sensing Laboratory and GIS Spatial Analysis Laboratory. Studied the spatio-temporal movement of malaria in Paraguay using NDVI and climatic raster data.

- Springs 2007–2009, Undergraduate Researcher, Terry C. Johnson Center for Basic Cancer Research, Manhattan, KS. Investigated spatial clustering of cancer throughout the Midwest.

f. Relevant Publications:

- Croitoru, A., Wayant, N., Crooks, A., Radzikowski, J., and Stefanidis, A. (2015). Linking Cyber and Physical Spaces through Community Detection and Clustering in Social Media Feeds. *Computers, Environment and Urban Systems*. (Pending Publication).
- Croitoru, A., Crooks, A., Radzikowski, J., Stefanidis, A., Vatsavai, R., and Wayant, N. (2013). Geoinformatics and Social Media: A New Big Data Challenge. In: *Big Data Techniques and Technologies in Geoinformatics*, H. Karimi, editor. CRC Press.
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- Wayant, N. Monitoring Tropical Deforestation using Fourier Analysis. (2010). *American Association of Geographers*, Lawrence KS.
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- Wayant, N., Maldonado D., de Arias A., Cousino, B. and Goodin, D. (2009). Spatio-temporal Analysis of Malaria in Paraguay: Correlating Malaria. *American Association of Geographers*, Las Vegas, NV.

g. Research Achievement and Recognition Awards

- Department of the Army Commander's Award for Civilian Service (2015) for completed 6.1 project, HiSpan
- Science Mathematics and Research Transformation Scholar (2009)

h. Previous Research Results:

- PI for ERDC 6.1 project: Hi-Span: Hierarchical Multiscale Structure of Spatiotemporal Neighborhoods in Human Terrain
 - Led project from FY2011-FY2015
 - One peer-reviewed journal publication
 - One book chapter publication
 - Two conference presentations

i. Alphabetized List of Collaborators: (Past 48-months)

- Mr. Chandler Armstrong, ERDC-CERL
- Dr. Arnold Boedihardjo, ERDC-GRL
- Dr. Dawn Morrison, ERDC-CERL
- Dr. Edward Nykaza, ERDC-CERL
- Mr. Timothy Perkins, ERDC-CERL
- Mr. Kevin Tyler, ERDC-GRL
- Dr. Keith Wilson, ERDC-CRREL

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- Minsta, J., M. Rachdi, and J. Demongeot, J. "Stochastic Approach in Modelling Epidemic Spread." Workshop presented at the 2011 IEEE International Conference on Advanced Information Networking and Applications (AINA 2011) held 22–25 March 2011, Biopolis, Singapore.

Sieck, Winston R., Gary Klein, Deborah A. Peluso, Jennifer L. Smith, and Danyele Harris-Thompson (Klein Associates Inc.). *FOCUS: A Model of Sensemaking*. Technical Report 1200. Fort Belvoir, VA: United States Army Research Institute for the Behavioral and Social Sciences, May 2007.

United Nations. *World Urbanization Prospects: 2014 Revision*. New York: United Nations Secretariat—Department of Economic and Social Affairs, Population Division, 2014.

U.S. Army Strategic Studies Group. *Megacities and the United States Army: Preparing for a Complex and Uncertain Future*. Report to GEN Raymond T. Odierno, Chief of Staff. Washington, DC: U.S. Army, June 2014.

U.S. Army TRADOC. *U.S. Army Functional Concept for Engagement*. TRADOC Pamphlet 525-8-5, para 3-5c2. Fort Eustis, VA: U.S. Army Training and Doctrine Command, 24 February 2014.

U.S. Army TRADOC. *U.S. Army Operating Concept: Win in a Complex World, 2020–2040*. TRADOC Pamphlet 525-3-1. Fort Eustis, VA: U.S. Army Training and Doctrine Command, 31 October 2014.

WHO. *Global Report for Research on Infectious Diseases of Poverty: A Summary of the Key Findings*. TDR/GR/EN 12.1. Geneva, Switzerland: World Health Organization, 2012.

Appendix A: Endorsements

Not all endorsements are reproduced here, but a representative two were selected to reproduce below:

Verbal meeting for collaboration

[EXTERNAL] Quick brief on BARDA

Parker, Joshua M ERDC-RDE-GRL-VA CIV

This message was converted to plain text.

Sent: Wed 5/4/2016 10:44 AM

To: Wayant, Nicole M ERDC-TEC-VA

Some of the information about Dr. Lant was taking word for word from BARDA's website, let me know if you need references for them.

Dr. Timothy Lant is the Director of the Division of Analytic Decision Support of the Biomedical Advance Research and Development Authority (BARDA), which provides an integrated, systematic approach to the development and purchase of the necessary vaccines, drugs, therapies, and diagnostic tools for public health medical emergencies for the Office of the Assistant Secretary for Preparedness and Response (under the U.S. Department for Health and Human Services). His division works with Federal, State, Local, and Tribal groups to develop simulation-driven exercises and assessment tools for public health emergency preparedness and decision making.

On Monday, 2 May 2016, Dr. Joshua Parker briefed Dr. Timothy Lant on the project being submitted both to create a dialogue about the capabilities we are planning to develop as well as to discuss potential collaborations. Dr. Lant was supportive of the project, highlighting in our conversation the limits of the current agent-based modeling approach to simulating epidemics, as well as the current lack of ability to include ground cover in their simulations of vector-borne illnesses such as the Zika virus. In particular, he highlighted the lack of geospatial information that techniques such as LIDAR could provide, which GRL has a unique ability to acquire and leverage. He strongly encouraged further communication on the project, and encouraged a partnership with our team to facilitate data and technique sharing, training, and suggested that BARDA is a potential client for future work products that could be generalized to non-military applications.

Email from Major Houston expressing support of reachability concept

Tue 4/26/2016 4:54 PM

Houston, Dion A Sr MAJ USARMY 8 TSC (US)

RE: PP16 Exercise and GeoSHAPE (UNCLASSIFIED)

To: Rodgers, Robin E ERDC-TEC-VA

Cc: Gupta, Vineet ERDC-GRL-VA

Signed By: dion.a.houston.mil@mail.mil

CLASSIFICATION: UNCLASSIFIED

OK, very quick initial response - looks like a VERY good idea. During our exercise, reachability was actually a key consideration. We looked at GMTI data to get an idea of traffic flow, and assessed how that would impact reachability, but we did so in a very ad hoc fashion.

I think that would be tremendous value add to GeoSHAPE.

Got to run to a meeting, but looks good...

Dion A. Houston Sr.
Major, Military Intelligence
130th Engineer Brigade S-2

Appendix B: Capability Gap Assessments

Capability gap assessments are part of the Joint Capabilities Integration and Development System process. The process is a deliberate assessment of the Future Years Defense Program that evaluates alignment of DoD resource investments and other efforts with warfighter needs, joint concepts, and strategic guidance. Initiation of the capability gap assessments is aligned with the annual submittal of Combatant Command integrated priority lists, which represent prioritized issues (capability gaps associated with validated or proposed capability requirements), that limit combatant command ability to successfully achieve assigned roles, functions, and missions. Excerpted below are pertinent capability gaps from the overall Army Capabilities Needs Assessment along with integrated priority lists from Maneuver Support Center of Excellence and Special Operations Center of Excellence.

Army Capabilities Needs Assessment, FY17–21

Protection

High Risk: The Army at Theater level and below lacks the capabilities needed to preform medical surveillance in order to detect and identify 100% of the infectious disease threats during unified land operations.

Moderate Risk: The Army at Theater level and below lacks the capability to establish, coordinate, and conduct joint medical surveillance program operations within 3 days (72 hours) of initiation of operational activities.

Sustainment

Moderate Risk: The Army at Theater level and below lacks a universally shared medical network structure for performing essential consultation services to medical elements, both forward and on an area basis, to meet the 98% standard.

Moderate Risk: The Army at Theater level and below lacks the capability to leverage advances in medical technologies to enhance Soldier performance and resistance to full range of health threats including CBRN in support of unified land operations in order to save 100% of Soldiers with potentially survivable wounds.

Low Risk: The Army at Theater level and below lacks the ability to ensure medical readiness of the force (regardless of component) across the spectrum of home station, pre-deployment, deployment and post-deployment operations to reach 95% medical fitness for duty rate.

Division HQ/Sustainment

High Risk: The Army at division and below lacks the ability to provide uninterrupted ground, lifesaving medical evacuation (and medical treatment on the move) with the same survivability, mobility, and sustainability as the forces supported under unified land operations, including operations in complex or restrictive terrain (e.g., jungle, urban, mountainous) for 100% of all urgent category patients within 60 minutes.

High Risk: The IBCT lack the ability to move to and decisively close with and destroy the enemy under restrictive terrains such as mountains subterranean and urban areas because of excessive physical burdens.

Moderate Risk: Army medical units and forward-deployed medical personnel lack the ability to provide 100% acute and chronic pain management for wounded and injured Soldiers, starting at the point of injury and continuing across the spectrum of care, during unified land operations.

Building Partnerships

Moderate Risk: Army Forces in support of the warfighting function (WfF) Building Partnerships lacks ability to support host nation governance under AFR, EPP, and SSSP scenarios to a standard where our partnerships with local organizations result in 60% or more of the community needs are accommodated and local capacity used to develop and maintain transportation, telecommunications, energy, and information critical infrastructure.

Maneuver Support Center of Excellence: Capabilities Needs Analysis, FY 18–22

Gap #502179

Extremely High Risk

The MP BOE (o), MP BOE (S) and the MP CMD (S), and MEBs lack the lethality, mobility, and survivability to simultaneously execute local, operational, area, base, route, convoy, and facilities security, and conduct host nation police training during operations across the Range of Military Operations (ROMO) in order to respond to threat attacks and unauthorized access attempts against protected assets, facilities, and bases in order to maintain effective local security while also improving governance and rule of law.

Gap #462180

Extremely High Risk

EN BOEs, MEBs, MP units, CBRN BOE, and BEBs have limited capacity during decisive action to overcome obstacles, barriers, and explosive hazards to maintain mobility for the supported force within 30 minutes of notification to maintain freedom of maneuver.

Gap #500418

Extremely High Risk

Engineer Brigades, MEBs, Fires units, and BCTs lack the capability to employ U.S. Policy compliant (man-in-the-loop) obstacles to influence the movement and maneuver of enemy forces or deny enemy forces use or access to key terrain/facilities.

Gap #462270.4

Extremely High Risk

The ENG BOE and TEC lack the capability to produce high resolution 3 dimensional (HR30) geospatial products to provide commanders with detailed situational awareness in complex and urban terrain.

Gap #462270.9
Extremely High Risk

ENG BDEs and TEC lack proficient geospatial intelligence analysts and geospatial engineers to conduct detailed collaborative and comprehensive geospatial analysis and prepare geospatial products, such as mensurated composite products and mosaics, under ULO conditions with an acceptable error of less than 15 percent.

Gap #462155
Extremely High Risk

MP BOE, CMD, and MEB units lack the capability to secure supply routes during decisive action and assure over 90% of combat effectiveness in order to continue combat operations.

Gap #502184
Extremely High Risk

The MP BDE (o), MP BOE (S), and MP CMD (S) lacks the capacity and capability to Conduct Operational Area security under operations across the ROMO to execute all support area functions in order to secure support areas.

Gap #502176
Extremely High Risk

The MP BDE (o) lacks the capacity to execute Straggler movement control under conditions across the ROMO to collect, protect, and redirect stragglers to straggler collection points IOT maintain freedom of movement on MSRs/ASRs.

Gap #550041
Extremely High Risk

MP CMD(S), MP BDE(O), MP BDE(S)and MP CID GRP (S) lacks the capacity to have the available MP units devoted to population and resource control measures in order to conduct Civil Disturbance Operations.

Gap #502182
Extremely High Risk

The MP BDE (o), MP BDE (S), and MP CMD (S) lacks the mobility and lethality under operations across the ROMO to defeat 100% level II threats within 30 minutes of notification and delay level III threats in order to support battle handover.

Special Operations Center of Excellence: Capabilities Needs Analysis, FY 18–22**Gap #502094**
Extremely High Risk

The U.S. Army Civil Affairs Forces lack the ability to integrate relevant information and display civil vulnerabilities of the civil component on a comprehensive Common Operating Picture in order for the commanders to gain situational understanding thus allowing commanders to make decisions that allow forces to maintain the operational tempo

Gap #502100
Extremely High Risk

The Army CA Force lacks the capacity and expertise to leverage Unified Action partners and bring them into a collaborative planning process in order to avoid diverting combat power away from decisive action and enable the consolidation of gains and achievement of U.S. campaign objectives

Gap #502152
Extremely High Risk

The US Army CA Force lacks the capacity to provide functional specialist expertise in rule of law, infrastructure, governance, economic stability, public health and welfare, and public education in order to shape the environment and consolidate gains without relying on UAP, if available.

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