

**WALLACE, RPI**  
**DHS Coastal Resilience Center**  
**Research Project:**  
**Annual Project Performance Report**

Covers reporting period July 1, 2016 – June 30, 2017

**1. Project Title:**

Community Supply Resiliency (COMSURE)

**2. Principal Investigator / Institution:**

William A. Wallace, Yamada Corporation Professor, Industrial & Systems Engineering (ISE), Rensselaer Polytechnic Institute (RPI)

**3. Other Research Participants/Partners:**

John Mitchell, Professor, Mathematical Sciences, RPI; Thomas Sharkey, Associate Professor, ISE, RPI; Richard Little, Research Scholar, ISE, RPI

**4. Short Project Description (“elevator speech”):**

The resilience of a coastal community to an extreme event depends upon the resilience of its critical infrastructures, one of which is the system of supply chains that provide the goods and services that make a community livable – Community Supply Resiliency.

**5. Abstract:**

The capability of communities to withstand and recover from the disruptions of extreme events will determine, to a large extent, the degree to which the social, economic, and psychological impacts of these events can be reduced. It is well recognized that civil infrastructures (e.g., transportation, power, water supply and sewerage, and communications) are critical to the wellbeing of a community; our past work has focused on these systems. However, it is the social infrastructures (e.g., emergency response, banking, and food distribution) that play a crucial role in societal functioning; the availability of these systems following an extreme event is a key element in determining the resilience of a community. Therefore, the objective of the proposed research is to better understand, describe, and portray the supply chains that provide the goods and services needed to respond to and recover from an extreme event, such as a hurricane impacting a coastal community. With this knowledge, models and algorithms will be developed to support emergency management in planning, community development, training and education, thereby enhancing community supply resiliency.

**6. End users:**

We envision the primary end users for our research to be local emergency managers and DHS analysts tasked with providing guidance on policies that effect community resilience to extreme events. We will collect data on the supply chains for the goods and services provided

by the social infrastructures in this county; particularly the pharmaceutical and convenience industries. We will incorporate that information into our artificial coastal community of 500,000 citizens for our research and analyses. We have met with representatives of HealthCare Ready and NACS, the Association for Convenience and Fuel Retailing to discuss possible joint projects and end user activities.

#### **7. Unanticipated Problems:**

Although the research necessary to develop and deploy MUNICIPAL/COMSURE has essentially been completed, this technology is not readily usable by the practitioner community. If the necessary funding were provided, this research could be translated into a readily deployable education and training tool for practitioners that will make the nation and its critical infrastructures more resilient in the face of multiple hazards. Two proposals have been submitted to secure this funding; one to the Critical Infrastructure Resilience Institute at the University of Illinois on in October, 2016 (not selected) and one in response to the NIPP 2017 Security and Resilience Challenge in May 2017 (pending).

#### **8. Project Impact:**

The MUNICIPAL/COMSURE technology has 3 potential levels of application that could be utilized by different cohorts of the EM community.

- An educational application designed for university-level curricula in emergency management that would make use of the CLARC community dataset
- A training application designed for working professionals in emergency management that would make use of the existing technology coupled with the HSIP Gold dataset specific to the location in question
- A field application to be used as a real-time decision-support tool in an actual emergency; it would also utilize the HSIP Gold dataset

All of these applications would produce usable tools for the education and practitioner communities to better understand the complex interactions that occur between interdependent civil and social infrastructures. The educational tool would make students more familiar with the complex interactions that occur between interdependent systems; the training tool would supplement or replace costly “boots on the ground” field exercises; and the decision-support tool would increase understanding of the important role of service restoration priorities in designing effective response and restoration activities.

**9. Research Activity and Milestone Progress:**

**Research Activities and Milestones: Progress to Date**

<b>Reporting Period 7/1/2016 – 6/30/2017</b>			
<b>Research Activity</b>	<b>Proposed Completion Date</b>	<b>% Complete</b>	<b>Explanation of why activity / milestone was not reached, and when completion is expected</b>
Integration of supply chain activity	12/1/16	100%	
Incorporation of data into CLARC	2/1/17	100%	
Analysis of COMSURE	5/1/17	100%	
<b>Research Milestone</b>			
Research paper on modeling and analysis	6/30/17	90%	Paper under review
Dataset for augmented CLARC	6/30/17	90%	Incorporating suggestions form NACS

**10. Transition Activity and Milestone Progress:**

**Research Activities and Milestones: Progress to Date**

<b>Reporting Period 7/1/2016 – 6/30/2017</b>			
<b>Transition Activity</b>	<b>Proposed Completion Date</b>	<b>% Complete</b>	<b>Explanation of why activity / milestone was not reached, and when completion is expected</b>
Meet with NOAA officials at 2016 National Coastal Conference	10/28/16	100%	
Discussions with NIST: Center for Risk-Based Community Resilience Planning, Colorado State University	11/1/16	100%	
	12/1/16	100%	

Investigate transitioning MUNICIPAL to an educational teaching aid for university training courses			
Dataset for augmented CLARC	12/1/16	100%	
Network and associated mathematical representations for COMSURE	12/1/16	100%	
Exercising COMSURE to simulate impact of hurricanes on community supply chains to assess community resilience	4/30/17	100%	
<b>Transition Milestone</b>			
Paper on the role of Critical Commercial Services in Community Resilience	12/1/16	100%	
Paper on COMSURE	6/30/17	90%	Incorporated into research paper

**11. Interactions with education projects:**

Provided a White Paper entitled, “MUNICIPAL for Educators” as a basis for discussion with the CRC Education Leadership.

**12. Publications:**

Little, R.G., R.A. Loggins, J.E. Mitchell, T.C. Sharkey, and W.A. Wallace. “CRISIS: Modeling the Recovery of Interdependent Social Infrastructure Systems after an Extreme Event,” *Natural Hazards Review*, submitted 4/23/2017 (in review).

**13. Tables:**

**Table 1: Documenting CRC Research Project Product Delivery**

<u>Product Name</u>	<u>Product Type</u>	<u>Approx. Delivery Date</u>	<u>Recipient or Anticipated End Users</u>
NA	NA	NA	NA

**Table 2: Documenting External Funding and Leveraged Support**

<u>External Funding</u>			
<u>Title</u>	<u>PI</u>	<u>Total Amount</u>	<u>Source</u>
NA	NA	NA	NA
<u>Leveraged Support</u>			
<u>Description</u>			<u>Estimated Annual Value</u>
10% time for Professor Wallace and R. Little salaries plus fringe benefits			\$30,048

## 14. Metrics:

<b>Metric</b>	<b>Year 1</b> (1/1/16 – 6/30/16)	<b>Year 2</b> (7/1/16 – 6/30/17)
HS-related internships (number)	--	
Undergraduates provided tuition/fee support (number)	--	
Undergraduate students provided stipends (number)	--	
Graduate students provided tuition/fee support (number)	--	
Graduate students provided stipends (number)	1	2
Undergraduates who received HS-related degrees (number)	--	
Graduate students who received HS-related degrees (number)	--	
Graduates who obtained HS-related employment (number)	--	
SUMREX program students hosted (number)	--	
Lectures/presentations/seminars at Center partners (number)	1	1
DHS MSI Summer Research Teams hosted (number)	--	
Journal articles submitted (number)	--	1
Journal articles published (number)	--	
Conference presentations made (number)	--	3
Other presentations, interviews, etc. (number)	2	1
Patent applications filed (number)	--	
Patents awarded (number)	--	
Trademarks/copyrights filed (number)	--	
Requests for assistance/advice from DHS agencies (number)	1	
Requests for assistance/advice from other Federal agencies or state/local governments (number)	1	1
Total milestones for reporting period (number)	3	
Accomplished fully (number)	2	2
Accomplished partially (number)	1	0
Not accomplished (number)	0	0