DAVIDSON, U-DEL
DHS COASTAL RESILIENCE CENTER
RESEARCH PROJECT
YEAR 3 PERFORMANCE REPORT
AND
FINAL PROJECT REPORT

Project Title: An Interdisciplinary Approach to Household Strengthening and Insurance Decisions

Principal Investigator Name/Institution:
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Co-Principal Investigators and Other Partners/Institutions:
- Jamie Kruse, Professor, Economics, East Carolina University
- Linda Nozick, Professor, Civil Engineering, Cornell University
- Joseph Trainor, Associate Professor, Public Policy, University of Delaware

Project Start and End Dates: 1/1/2016 – 6/30-2018

Short Project Description ("elevator speech"):

This interdisciplinary project improved a developing tool to help agencies explore the potential effects of policies related to household hurricane risk reduction. The project specifically focused on better understanding the factors that influence homeowner insurance purchase and retrofit decision-making. The tools and policy briefs created are useful to other researchers working with same goal of supporting the development of policies that lead to household hurricane risk reduction.

Summary Abstract:

Two primary mechanisms to manage natural disaster risk— insurance and retrofit—are presently underutilized, suggesting a need to better understand how homeowners make retrofit and insurance purchase decisions. Future programs and policies intended to reduce coastal natural disaster risk will be more effective if designed to align with how homeowners actually make these choices.

This project helped advance understanding of (1) homeowner insurance purchase and retrofit decision-making and (2) the role it plays within the larger insurer-government-homeowner system of managing natural disaster risk. We leveraged two products from a NIST-funded research project we undertook recently—phone survey data and a holistic framework comprised of interacting mathematical models of hurricane risk, and homeowner and insurer decision-making that can help policy makers consider how specific policy alternatives might affect different stakeholder groups.

The support from this funding led to the following: (1) Improved scientific understanding of insurance and retrofit decisions; (2) advances in modeling of those decisions; (3) improvements in the broader mathematical framework and policy tool; (4) improved alignment in the tools'

design based on end users' concerns. Specifically, we created the following tangible products: (1) A discrete choice model that describes homeowner insurance purchase decisions; (2) two versions of discrete choice models that describe retrofit decisions; (3) policy briefs on insurance purchase decisions, and on the impact of low cost loans, grants, and insurance premium reductions on homeowner retrofit decisions; and (4) an analysis of the role of prior hurricane experience and risk perception on protective action decisions using the theory of planned behavior.

PROJECT NARRATIVE:

1. <u>Research Need:</u>

    In the DHS strategic plan for 2012-2016, *Ensuring Resilience to Disasters* is presented as one of the Department's five missions, and within that mission, one of the nine objectives is to *improve individual, family, and community preparedness* (Objective 5.2). This project directly supported that objective by providing insights into how homeowners make preparedness decisions, what influences their decisions, and how their actions affect the ability of the overall community system to manage coastal risk. One of the nine performance measures highlighted for that mission is to increase the percentage of households that have taken steps to be prepared in the event of a disaster. Improved understanding of how homeowners decide whether or not to undertake such steps is critical to achieving that goal, and this project aimed to help provide that required insight. Further, the NFIP is administered by FEMA within the Department of Homeland Security. Better understanding of the policies that increase acceptance of NFIP provisions and premiums can help support the goal of providing flood insurance at risk-based rates yet address concerns of affordability.

2. <u>Project History:</u>

    This project utilized existing data to improve our understanding of homeowner decisions and to advance a policy decision tool. The initial proposal called for the creation of a number of statistical models and analyses. Initial feedback from reviewers suggested that while the models were of interest and the insights they were designed to develop were of importance, that alone they would not be sufficient to meet the needs of our end users. Over the course of the first two years we focused on three major types of activities: (1) development of the statistical models as promised; (2) integration of the models into the broader decision framework/tool; (3) exploring a number of potential products that would better transition the research results for our partners.

    In terms of the first two task above we delivered as promised on the statistical models and integrated the results of that work into the broader framework. The third set of activities proved more difficult in that different stakeholders expressed alternate visions for how they would have liked to see the tool develop and be applied, many of which would have required resources far beyond that which were available in the current support. For example, some would have liked us to expand the model beyond hurricanes to other hazards; some asked for a broader set of mitigation and/or preparedness activities to be included; others wanted the working prototype expanded to a larger region; others still wanted the model to include a broader set of economic concerns. While the tool has the potential to integrate these desires, they represented improvements well beyond what we were able to deliver within the scope of

this funding. As an interim translation step we provided policy briefs to explain the practical insights from our statistical analyses. We also developed an oral presentation that was delivered to our partners focused on these insights. Finally, we have used the information we gathered from this initial feedback to help guide our continuing development of these tools through other sources. In short, we are taking these lessons forward in hopes that we can develop some of the elements and return when what we have is closer to what is desired.

3. Results:

The details of our scientific research can be found in the publications and documents listed below. Here we have provided a high-level summary of the insights from our analyses. While some of these suggestions might require further analysis and direct implementation will require consideration of a broader set of issues, we propose the following for consideration:

- Premium and deductible are important factors that can be used to predict insurance penetration rates for a region. The results indicate that although homeowners do respond to insurance pricing (premiums and deductibles) they are not highly sensitive to the tradeoff between premium and deductible. Understanding homeowners' relative sensitivity to premiums and deductibles may help to identify premium and deductible combinations that help increase penetration, reduce risk, but not significantly affect insurance profitability.
- Since higher income is shown to be associated with increased insurance purchase, our work provides additional evidence that affordability is an important factor in determining insurance purchase. It is critical to continue exploring affordability and policies that will facilitate risk reduction.
- Given the apparent relationship between insurance purchase and number and recentness of previous hazard experiences, especially for people with damage, one might consider broadly marketing insurance products in a region recently exposed to an event in order to increase penetration.
- Given that prior retrofit actions to strengthen the home are significant predictors of insurance purchase, one might consider programs that link information about one risk reduction method with the other. For example, insurance companies might provide information on retrofitting and/or greater incentives to homeowners that retrofit.
- Government programs designed to increase retrofits that reduce flood and wind damage will be most effective dollar for dollar if incentives are in the form or grants.
- Information and incentive programs should be offered within the first year after a hurricane and be targeted at property relatively close to the coast.
- Government could target information towards first time homebuyers in order to encourage risk reducing retrofits.

Additional detail on these findings and their limits can be found in the following products:

- Published two journal papers, plus one in draft form (see Section 8).
- Three more journal papers would not have been possible without this project, though they were not directly funded by it (see Section 8).
- Conference presentations
  - Society for Risk Analysis Annual Meeting in 2016 (homeowner insurance purchase decision)

- o Society for Risk Analysis Annual Meeting in 2017 (homeowner retrofit decisions).
- o Natural Hazards Workshop poster in 2017
- o Panel presentation at 2018 Natural Hazards Workshop on Private financing of hazard risk
- Theses and dissertations
  - o Slotter R. (2018) Hurricane Mitigation Decision-Making an Application of the Theory of Planned Behavior. Masters Thesis. University of Delaware.
  - o Jasour, Z. (2017) Homeowner Decisions to Retrofit to Reduce Hurricane-Induced Wind and Flood Damage. Masters Thesis. University of Delaware.
  - o Wang, D. (expected 12/18) A Computational Framework to Support Government Decision-making in Regional Natural Disaster Risk Management. PhD dissertation. University of Delaware.
- Policy briefs
  - o *Factors that affect homeowner retrofit decisions to reduce wind and flood damage*, R. A. Davidson, J. E. Trainor, J. B. Kruse and L. K. Nozick
  - o *Factors that affect if homeowners purchase flood and wind insurance*, R. A. Davidson, J. B. Kruse, L. K. Nozick and J. E. Trainor

4. End Users and Transition Partners:

Five primary end users were involved in this project, representing both the mitigation and preparedness directorates of FEMA, state floodplain managers, and the NIST Community Resilience group (Table 1). As Acting Division Director of the Risk Analysis Division, one of the three main divisions of the FEMA Mitigation Directorate, focused on identifying hazards, assessing vulnerabilities, and developing strategies to manage the risks associated with natural hazards in communities. In the FEMA Individual and Community Preparedness Division, the division works to promote preparedness and mitigation activities as adjustments to risk. Chad Berginnis represents the 17,000 members of the ASFPM, an organization dedicated to reducing flood losses nationwide. As a member of the Applied Economics Office and the NIST Community Resilience Group, they work on economic analysis of individual and community resilience. We had multiple conversations with these partners before and during the project through a combination of in-person meetings, conference calls, and email exchanges. Through these interactions we gained a good understanding of the challenges they face and how we can support their efforts to meet those challenges. In our previous NIST-funded research project, we worked with a reinsurance industry representative to gain input from that perspective.

Table 1. Primary end users involved in project

Name	Title	Organization	Role in project
	Acting Division Director	FEMA Federal Insurance and Mitigation Administration, Risk Analysis Division	Advisory Panel
	Senior Policy Advisor	FEMA Individual and Community Preparedness Division, National Preparedness Directorate	Advisory Panel

Chad Berginnis	Executive Director	Association of State Floodplain Managers (ASFPM)	Advisory Panel
	Research Economist	NIST Applied Economics Office/ Community Resilience Group	Advisory Panel
	Lead for Disaster Resilience	Materials and Structural Systems Division	Advisory Panel

5. Project Impact.

Our efforts for this project focused on developing mathematical and statistical tools to support mitigation and insurance decision making. Over the course of the effort it has become clear that a greater distance between the stated goals and the desires of our end users existed than we initially appreciated. We proposed to develop the analysis but users were more focused on what we called future tools. Through engagement and the conversations with our stakeholders we modified our initial approach several times over the course of this project. These interactions have led to important changes to our presentation of the results. We held briefings and developed summary briefs to explain our findings. These products have had modest direct impact on those that have reviewed the policy briefs and participated in our advisory meetings by informing them about the comparative performance of several incentives for mitigation. Given how recently the results were generated, they have not yet led to direct programmatic or policy changes, however our stakeholders were engaged and interested in the implications of the data and results for their programs. As a result of this interest we are hopeful it will inform decisions. It should also be noted that one important tangible gain has been modifications to our scientific approach to the problem in ways that have affected future directions for this work based on the needs and concerns of the stakeholders. We intend to continue developing these tools past the end of the project closing and are actively developing analyses and future modifications to the way our framework is designed to improve usability. For example, we are exploring affordability and considering a broader range of mitigation programs that might be included in the framework. Although beyond this effort's scope, we also have plans to convene a meeting of mitigation specialists to explore new direction in incentives and policy/programs for mitigation. This work has helped us to better align our approach with end user needs and as a result will serve as an important foundation for the next iteration of the project.

6. Student involvement and awards:

- Ms. Zeinab Yahyazadeh Jasour, Dept. of Civil and Environmental Engineering, University of Delaware, M.S. received August 2017. Ms. Jasour wrote a Master's thesis based on this project. She is first author on a journal paper in the *ASCE Journal of Infrastructure Systems*. She began a Ph.D. program at the University of Maryland in September 2017. She was fully funded by this grant.

- Ms. Dong Wang, Dept. of Civil and Environmental Engineering, University of Delaware, Ph.D. expected December 2018. Ms. Wang wrote a chapter of her dissertation based on this project. She is first author on a journal paper in the *Natural Hazards*. The rest of her

dissertation involves research that would not be possible without the work funded by this grant (see win-win paper Section 8). She was partially funded by this grant and partially by an NSF grant.

- Ms. Royan Chen, School of Civil and Environmental Engineering, Cornell University. While an MS student, she performed some data analysis on the data generated through the survey. Her work informed some of the later data analysis on this project. She is currently a Ph.D. student at Cornell. She was funded by this grant.

- Dr. Esther Chiew, School of Civil and Environmental Engineering, Cornell University. She is a post-doc and has developed a series of statistical models on household retrofit choice behavior. She is currently writing a journal paper on this work which we expect to submit by the end of this summer. She was funded by this grant although the grant did not fund collection of the data she analyzed.

- Ms. Rachel Slotter, School of Public Policy and Administration, University of Delaware, Masters 2018. Ms. Slotter's time was not funded by this grant, but her research focused on the analysis using the theory of planned behavior and was directly supported by the work of the summer interns (Section 7).

7. Interactions with education projects:

In the Summer of 2016, we hosted two 8-week summer interns from our CRC partner, Tougaloo College, at the Disaster Research Center at the University of Delaware. The students are Irenia Ball and Taralyn Rowell, both African American Female Seniors. While at UD they contributed to this project by reviewing extant insurance literature and developing an inventory of mitigation programs currently being offered by states. These students also visited the Delaware Legislature, with a group of non-profit leaders in Wilmington, and the State Emergency Management Agency. They also interacted more generally with UD social science and engineering students and faculty interested in disaster studies. We were able to bring the second student by identifying supplemental funds from the University of Delaware to support her. These efforts provided material support to a thesis and developing scholarly publication focused on homeowner intentions to mitigate that were developed at DRC.

8. Publications:

Journal papers
Wang, D., Davidson, R. A., Trainor, J. E., Nozick, L. K., and Kruse, J. 2017. Homeowner purchase of insurance for hurricane-induced wind and flood damage. *Natural Hazards* 88, 221–245.
Jasour, Z., Davidson, R., Trainor, J., Kruse, J., and Nozick, L. 2018. Homeowner decisions to retrofit to reduce hurricane-induced wind and flood damage. *Journal of Infrastructure Systems*, in press.
Chiew, E. Nozick, L., Davidson, R., Trainor, J., and Kruse, J. The effect of grants on hurricane retrofit decisions by homeowners. To be submitted August 2018.

The following papers were not directly funded by this project, but they were only possible because of the research conducted under this grant. Thus, the center grant is acknowledged in each of these papers.

Wang, D., Davidson, R., Nozick, L., Trainor, J., and Kruse, J., A computational framework to support government policy-making for hurricane risk management. To be submitted to *Natural Hazards Review* August 2018. This paper is a modified version of the proposed system win-win paper. It directly makes use of the statistical models developed in this project.

Xu, K., Nozick, L., Kruse, J., Davidson, R., Trainor, J. Dynamic modeling of competition in the natural hazard catastrophe loss insurance market with explicit consideration of homeowner financed mitigation. To be submitted August 2018. This paper directly makes use of the statistical models developed in this project.

Robinson, C., Davidson, R. A., Trainor, J. E., Kruse, J. L., and Nozick, L. K. 2018. Homeowner acceptance of voluntary property acquisition offers. *International Journal of Disaster Risk Reduction* 31, 234-242. This paper relies on the same dataset and use similar modeling approaches as the research in this project.

Theses and dissertations
Jasour, Z. (2017) Homeowner Decisions to Retrofit to Reduce Hurricane-Induced Wind and Flood Damage. Masters Thesis. University of Delaware. (fully funded by this grant)

Slotter R. (2018) Hurricane Mitigation Decision-Making an Application of the Theory of Planned Behavior. Masters Thesis. University of Delaware. (not directly funded by this grant, but related to it and relying on intern work funded by this grant)

Wang, D. (expected 12/18) A Computational Framework to Support Government Decision-making in Regional Natural Disaster Risk Management. PhD dissertation. University of Delaware. (partially funded by this grant)

9. Tables:

Table 1: Documenting CRC Research Project Product Delivery

Product Name	Product Type (e.g., software, guidance document)	Delivery Date	Recipient or End User
Factors that affect homeowner retrofit decisions to reduce wind and flood damage	Policy brief	9/17	Open Access, Advisory Panel
Factors that affect if homeowners purchase flood and wind insurance	Policy brief	1/18	Open Access, Advisory Panel
Homeowner purchase of insurance for hurricane-induced wind and flood damage	Journal paper and dissertation chapter	11/16	Scientific Community
Homeowner decisions to retrofit to reduce hurricane-induced wind and flood damage	Journal paper and M.S. thesis	8/17	Scientific Community
An Interdisciplinary Approach to Household Strengthening and Insurance Decisions: Results	Powerpoint Results Briefing		End User Advisory panel
Hurricane Mitigation Decision-Making an Application of the Theory of Planned Behavior	Master's thesis		Scientific Community
The effect of grants on hurricane retrofit decisions by homeowners	Draft journal paper	8/31/18	Scientific Community

Table 2A: Documenting External Funding

Title	PI	Total Amount	Source
Collaborative Research: An Interdisciplinary Approach to Modeling Multiple Stakeholder Decision-making to Reduce Regional Natural Disaster Risk, National Science Foundation	Davidson	$306,555	NSF
Modeling natural disaster risk management: A stakeholder perspective	Davidson	$797,000	NIST

Table 2B: Documenting Leveraged Support

Description	Estimated Total Value
DRC support of interns	$1,000
UDEL School of Public Policy and Administration support of interns	$1,000
UDEL Vice Provost of Diversity support of interns	$3,000
Support of undergraduate researcher through McNair Scholars program and UDEL summer scholars program	Approx. $5,000

Table 3: Performance Metrics:

DAVIDSON PERFORMANCE METRICS

Metric	Year 1 (1/1/16 – 6/30/16)	Year 2 (7/1/16 – 6/30/17)	Year 3 (7/1/17- 6/30/18)
HS-related internships (number)	0	0	0
Undergraduates provided tuition/fee support (number)	0	0	0
Undergraduate students provided stipends (number)	2	0	0
Graduate students provided tuition/fee support (number)	2	2	1
Graduate students provided stipends (number)	2	2	1
Undergraduates who received HS-related degrees (number)	0	0	1
Graduate students who received HS-related degrees (number)	0	1	1
Graduates who obtained HS-related employment (number)	0	1	
SUMREX program students hosted (number)	2	0	0
Lectures/presentations/seminars at Center partners (number)	0	0	0
DHS MSI Summer Research Teams hosted (number)	0	0	0
Journal articles submitted (number)	1	1	1
Journal articles published (number)	0	1	2
Conference presentations made (number)	0	0	2
Other presentations, interviews, etc. (number)	0	0	1
Patent applications filed (number)	0	0	0
Patents awarded (number)	0	0	0
Trademarks/copyrights filed (number)	0	0	0
Requests for assistance/advice from DHS agencies (number)	0	0	
Requests for assistance/advice from other agencies or governments (number)	0	0	
Total milestones for reporting period (number)	1	3	
Accomplished fully (number)	1	2	
Accomplished partially (number)	0	1	
Not accomplished (number)	0	0	

10. <u>Year 3 Research Activity and Milestone Achievement:</u>

Research Activities and Milestones: Final Status as of 2018
Reporting Period 7/1/2017 – 6/30/2018

Research Activities	Proposed Completion Date	% Completed	Explanation of why activity/ milestone was not reached
Write journal paper about homeowner hurricane-related retrofit decision-making, including consideration of incentives	8/17	100%	
Research Milestones			
Submit manuscript to peer-reviewed journal about homeowner hurricane-related retrofit decision-making for protection against both wind and flood damage, including consideration of incentives.	8/17	100%	

11. <u>Year 3 Transition Activity and Milestone Status:</u>

Transition Activities and Milestones: Final Status as of 2018
Reporting Period 7/1/2017 – 6/30/2018

Transition Activities	Proposed completion date	% completed	Explanation of why activity / milestone was not reached
Group conference call with research team and all end user partners to present progress and get input	7/17	100%	
Write Retrofit incentives policy brief	12/17	100%	
Transition Milestones			
System win-win paper	12/17	100%	A somewhat modified version of this was completed 8/18. Will be submitted for journal publication 8/18.
Policy Brief: Homeowner purchase of insurance for hurricane-induced wind and flood damage	7/17	100%	

Policy Brief: Factors that affect homeowner retrofit decisions to reduce wind and flood damage	12/17	100%	
Policy Brief: Hurricane experience and risk perception policy brief	10/17	90%	Completed in form of MS thesis. In process of being edited into a publication.