

Disaster & Failure Studies Updates on Enhancing the Readiness of Teams

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National Institute of Standards and Technology

U.S. Department of Commerce

NIST's Disaster and Failure Studies Program

Statutory Thrust

- Evaluate hazard events against deployment criteria
- Manage identification, vetting, and onboarding of NCSTAC members
- Develop agenda, manage logistics, and set frequency for NCSTAC meetings
- Create annual NCST reports to Congress
- Coordinate statutory activities across programs related to disasters.
- Conduct field studies under various authorities

Procedures Thrust

- DFS Standard Operating Procedures
- HOT Team membership, training, and credentials
- Field and safety protocols
- Human subjects protocols
- Manage equipment for disaster metrology and personnel protection
- Data preservation, security, and management
- Field tools (NDA's, permissions, survey instruments)
- MOUs with other agencies, academics, and others
- NIST Disaster Working Group

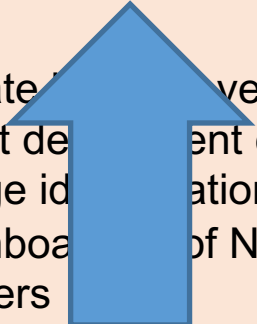
Research Thrust

- Research program focused on disaster metrology, including structural performance and social sciences
- Coordinate research activities with NIST EL Groups, Disaster Statutory Programs, NIST EL Divisions, and other NIST Labs
- Coordination with the Center of Excellence of Risk-Based Community Resilience Planning on field studies
- NSF/NIST Disaster Resilience Research Grants Program
- Outreach and dissemination

NIST's Disaster and Failure Studies Program

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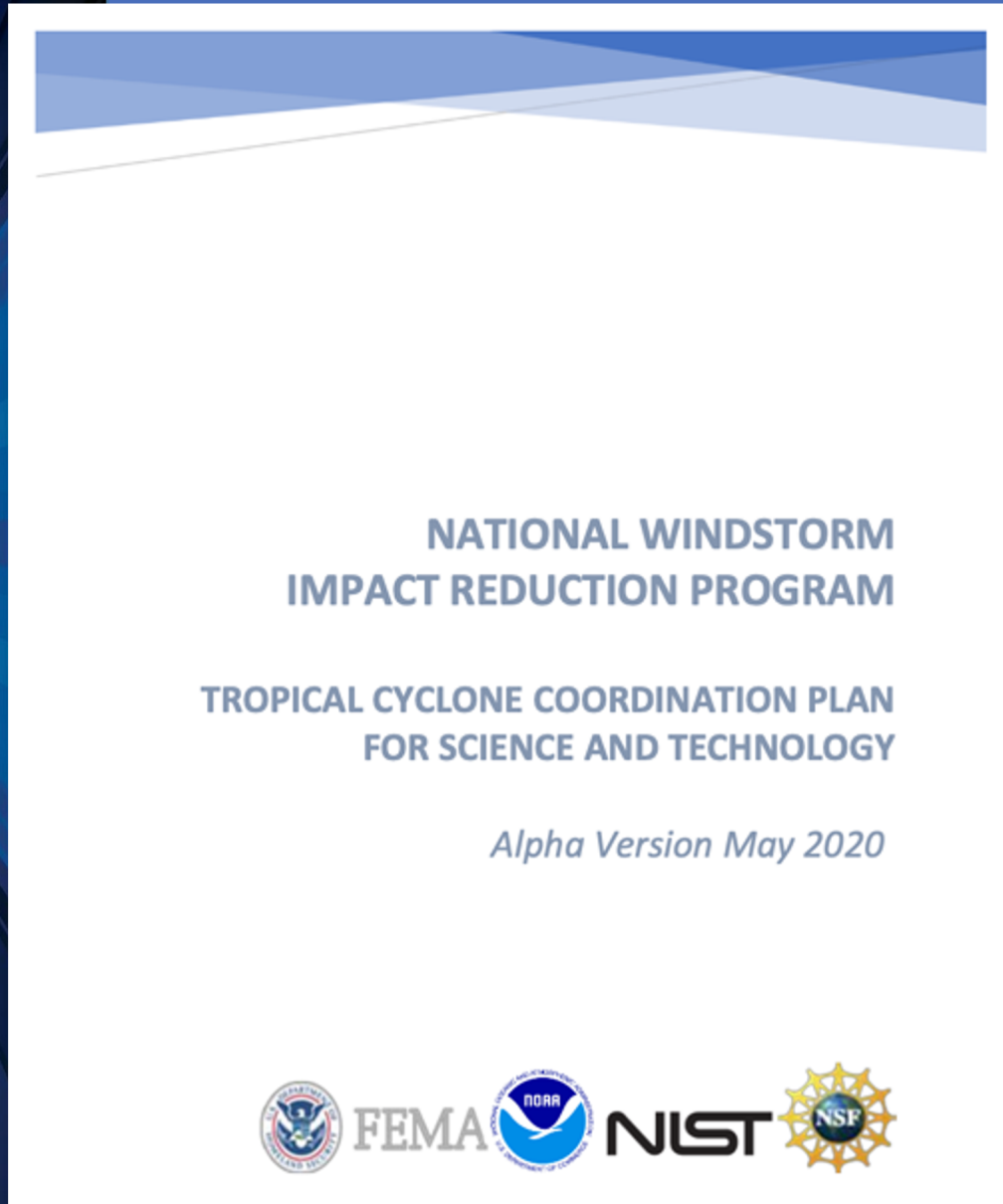
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Events Scoring

<i>*NIST deployed a team</i> Disasters Scored Oct 2020 – June 2021			
Date	Event	Event Consequence Score (max=5.0)	Evacuation & Response Score (max=5.0)
12/17/2020	Arecibo Observatory Collapse	3.0	1.0
1/14/2021	Sulawesi Indonesia Earthquake	3.3	4.0
1/25/2021	Fultondale, Alabama Tornado	2.0	1.5
1/27/2021	Tallahassee, Florida Tornado	0.8	0.5
2/17/2021	Texas Winter Storm	3.4	3.0
3/26/2021	Southeastern US Tornado Outbreak	2.7	1.3

NWIRP Coordination Plan for Tropical Cyclones



- Plan provides an overview of relevant agency activities in the pre and post windstorm space.
- Detailed agency roles and responsibilities for information sharing as a function of temporal phases
 - Phase zero (- 2 weeks to zero hour)
 - Phase 1 (Event Occurrence – Two Weeks)
 - Phase 2 (Two Weeks – Two Months)
 - Phase 3 (> Two Months)
 - *Extent of agency activities are dependent upon phase relevance*
- Data Dissemination
- Plan Revision Process

NIST SciServer: Collaborative Science Platform

NIST-JHU PREP Project

- Project Goal: add computer science capacity to NIST disaster statutory programs via the NIST's Professional Research Experience Program (PREP)
- NIST Associates: Prof. Alex Szalay, Dr. Gerard Lemson, and Dr. Arik Mitschang
- Project Scope: adopt data semantic standards and foster interoperability between other disaster repositories; design a public database that can easily be managed by NIST; combine traditional data management and access services with computing resources (e.g., Python and R).

SciServer is a system allowing scientists and researchers across multiple domains to host and share their datasets and provide query and analysis tools for collaborative work.

SciServer - 2.1.1 Dashboard - 2.1.2

Powered by:

<http://www.sciserver.org/>
(with permission from Prof. Szalay)

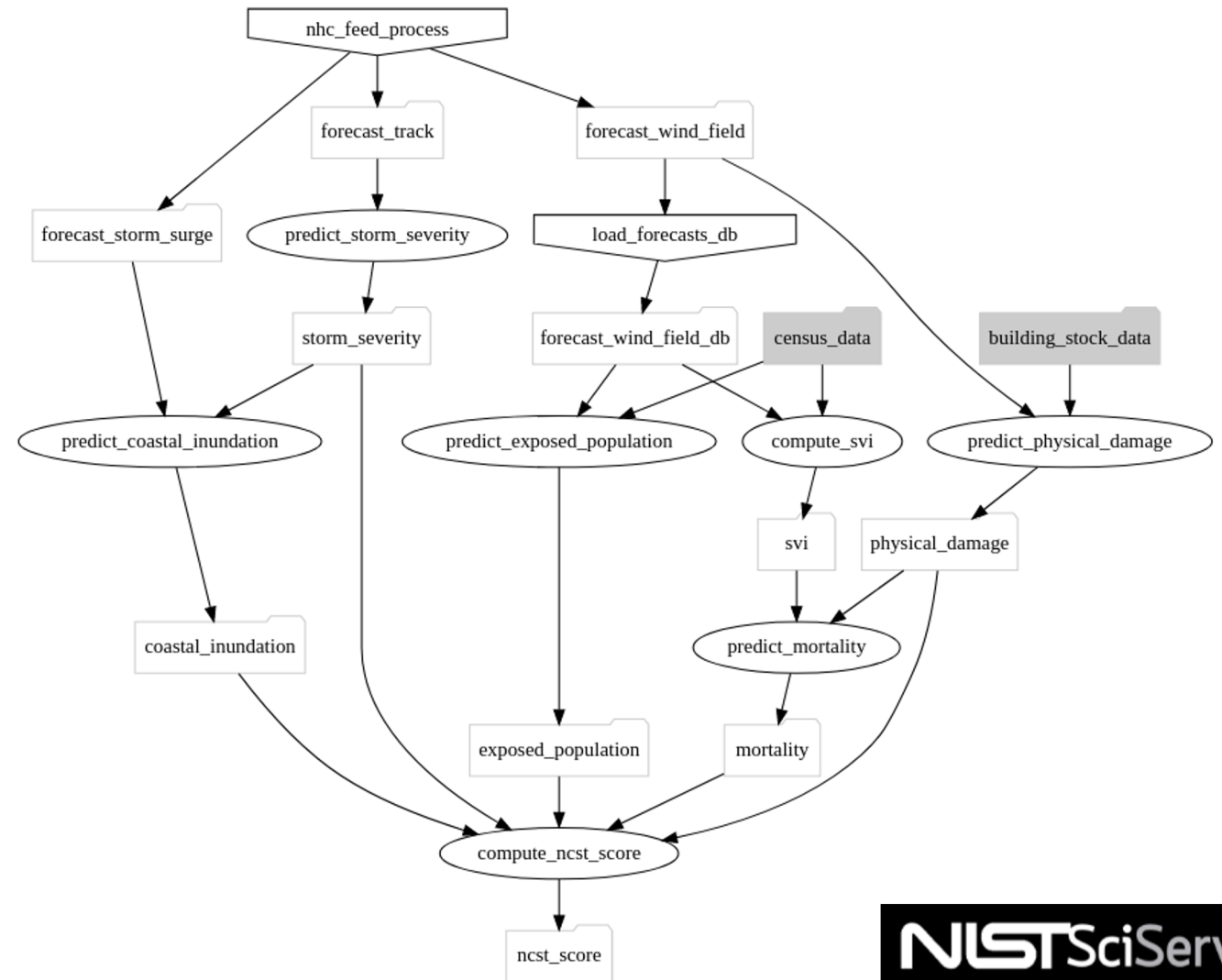

Automated Event Scoring: SciServer example (1/8)

Implementation of coordinated activities across disaster statutory programs for NCST event scoring:
fully automated workflow to calculate “Event Consequence” score during NWIRP’s *phase zero*

**NATIONAL WINDSTORM
IMPACT REDUCTION PROGRAM**

**TROPICAL CYCLONE COORDINATION PLAN
FOR SCIENCE AND TECHNOLOGY**

Alpha Version May 2020

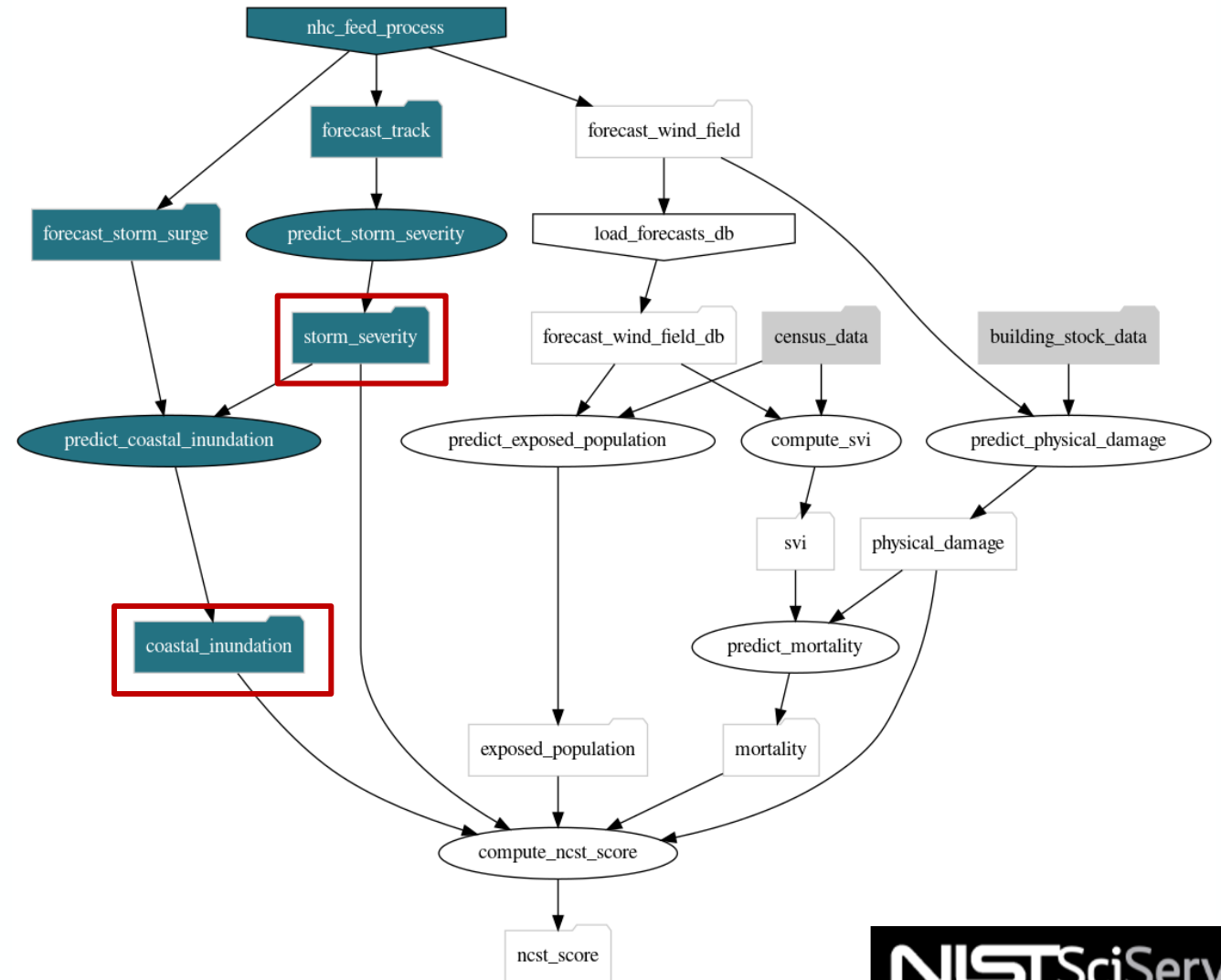


Automated Event Scoring: SciServer example (2/8)

Implementation of coordinated activities across disaster statutory programs for NCST event scoring: fully automated **Hazard and/or Failure Intensity** score during NWIRP's *phase zero*

Hurricane Michael's NCST Score Sheet

1.0 Event Consequence			
	Low	Medium	High
A. Mortality			
Facility context	0	1 to 2	>2
Community context ¹	0 to 3	4 to 9	>10
Regional context ²	0 to 5	6 to 19	>20
B. Exposed Population			
Facility context	<100	100 to 499	≥500
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Count x Weight:	0 x 1 = 0	2 x 3 = 6	5 x 5 = 25
Event Consequence Score:	31/7 = 4.43		

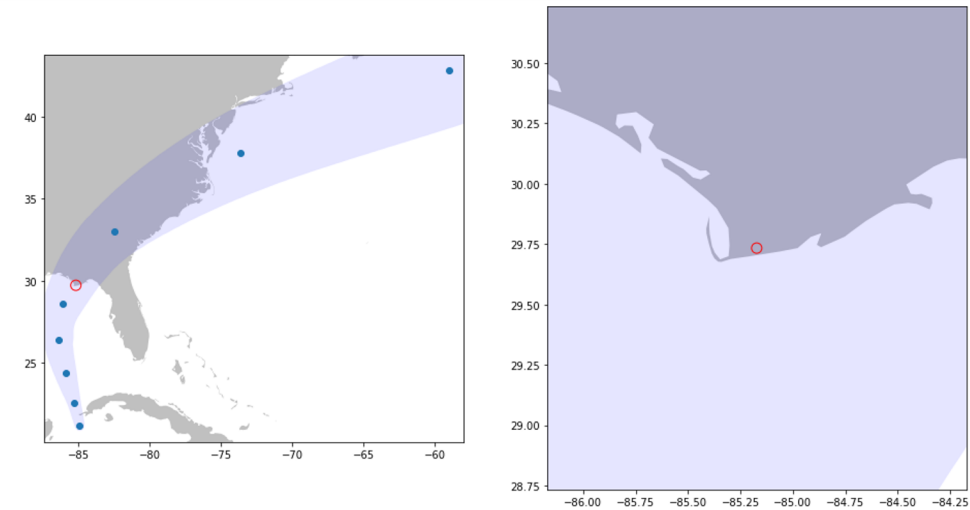


Automated Event Scoring: SciServer example (3/8)

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fully automated **Hazard and/or Failure Intensity** score during NWIRP's *phase zero*

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```
In [31]: ▶ html = ''
if len(points_in_land) != 0:
    from IPython.core.display import HTML
    CAT_MAP = pd.DataFrame({
        'min': [0, 64, 83, 96, 113, 137],
        # 'min': [0, 74, 96, 111, 130, 157], MPH
        'cat': ['Non-Hurricane', 'I', 'II', 'III', 'IV', 'V']
    })
    landfall_time = dt.datetime.utcnow().timestamp(landfall_pt.timestamp)
    cat = CAT_MAP[CAT_MAP['min'] < landfall_pt.wind].iloc[-1]['cat']
    html = (
        f'<h1><span style="color:silver">Estimated Time of Landfall:</span> {landfall_time} UTC </h1>'
        f'<h1><span style="color:silver">Estimated Wind speed at Landfall:</span> {landfall_pt.wind:0.2f} knots '
        f'<span style="color:silver">Gust:</span> {landfall_pt.gust:0.2f} knots</h1>'
        f'<h1><span style="color:silver">Estimated Hurricane Category at Landfall:</span> {cat}'
    )
HTML(html)
```

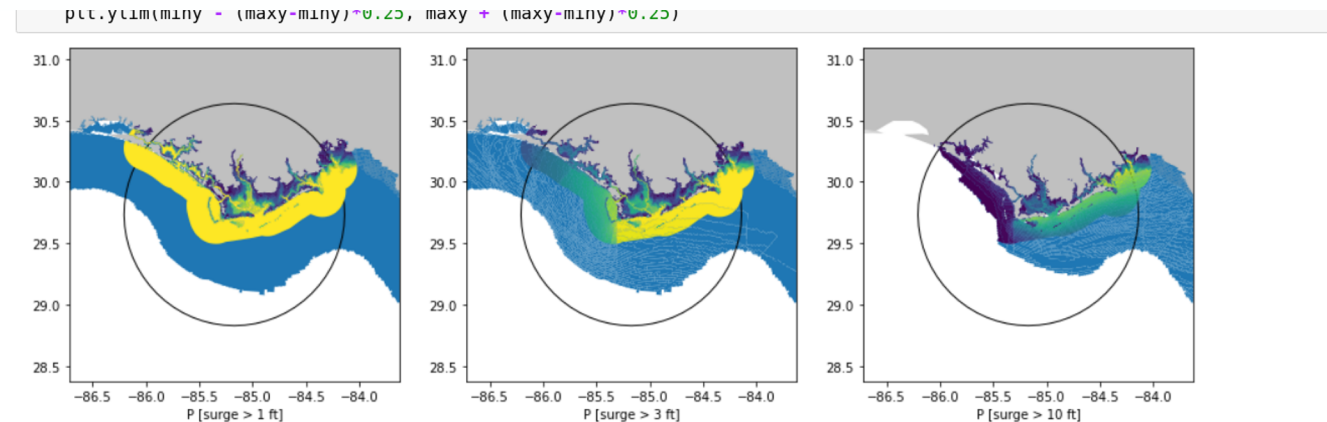
Out[31]:
Estimated Time of Landfall: 2018-10-10 18:11:00.055285 UTC
Estimated Wind speed at Landfall: 89.54 knots Gust: 110.68 knots
Estimated Hurricane Category at Landfall: II

Automated Event Scoring: SciServer example (4/8)

Implementation of coordinated activities across disaster statutory programs for NCST event scoring:
fully automated **Hazard and/or Failure Intensity** score during NWIRP's *phase zero*

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Compute a boolean for if the surge is in regions of interest corresponding to the NCST decision criteria rubric

```
In [13]: passes = [
    surge_prob[surge].query(f'PSurge{surge:02d}c > {MIN_PROB}').to_crs(proj_crs).area.sum() / surge_prob[surge].to_crs(proj_crs).area.sum()
]
```

```
In [14]: smax = 0
    for i in range(len(SURGE_INDEX)):
        if passes[i]:
            if i == 2:
                smax = None
            else:
                smax = SURGE_INDEX[i+1] - 1
    smax
```

Out[14]: 9

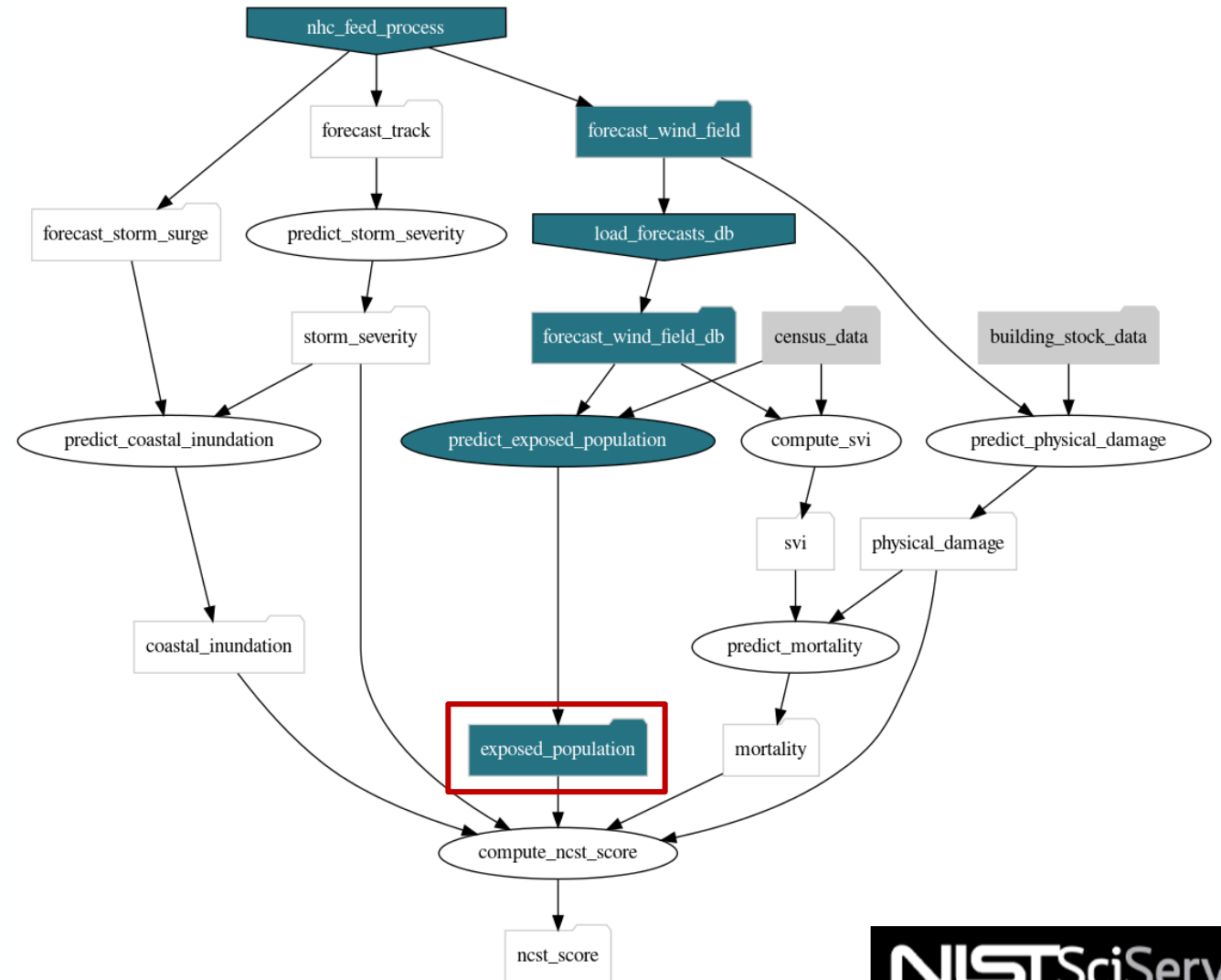
World Imagery Map Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Automated Event Scoring: SciServer example (5/8)

Implementation of coordinated activities across disaster statutory programs for NCST event scoring:
fully automated **Exposed Population** score during NWIRP's *phase zero*

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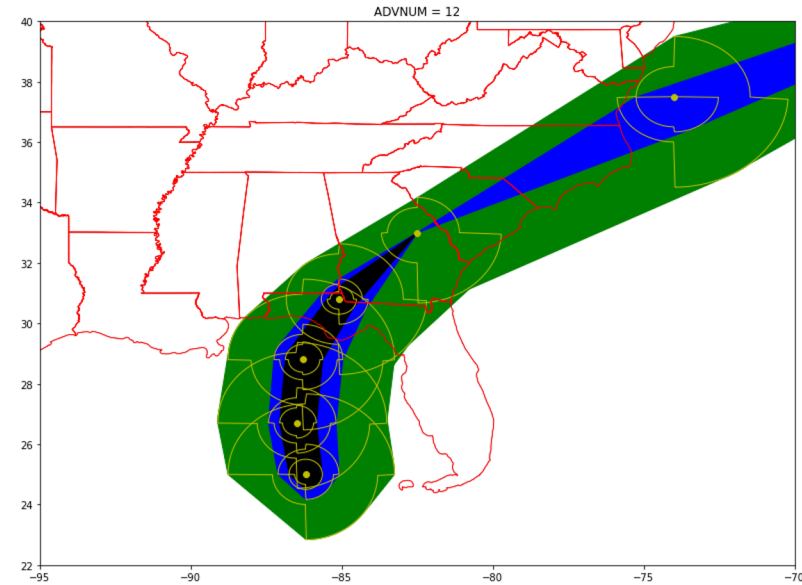


Automated Event Scoring: SciServer example (6/8)

Implementation of coordinated activities across disaster statutory programs for NCST event scoring:
fully automated **Exposed Population** score during NWIRP's *phase zero*

Hurricane Michael's DFS Score Sheet

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Map Source: Census Bureau TIGER/Line Shapefiles

Calculate exposed population

Similar query as above, but only return the exposed population for each wind speed swath and using a Table Valued Function to get the final swaths as union-aggregated polygons.

```
In [4]: %time
sql=f"""
select h.radii
, sum(isnull(t.s0601_c01_001e,0)) as totpop
, count(gt.tractce) as nTract
from dbo.ForecastRadiiHulls({year}, '{code}', '{advnum}') h
join GEO_t1_2018_us_tract gt
on gt.geometry.STIntersects(h.hull) = 1
join census.S0601_tract t
on t.year={year} and t.state=gt.statefp and t.county=gt.countyfp and t.tract=gt.tractce
group by h.radii
"""
df=cj.executeQuery(sql, "NWIRP")
df
```

CPU times: user 25.8 ms, sys: 8.14 ms, total: 34 ms
Wall time: 6.13 s

```
In [5]: from IPython.core.display import HTML
if 64 in df.radii.values:
h=df[df['radii']==64].iloc[0]
message=f'<h1><span style="color:silver">Population predicted to be exposed to Hurricane force winds:</span> {h.totpop} </h1>'
else:
message=f'<h1>No prediction for hurricane winds yet</h1>'
HTML(message)
```

Out[5]: Population predicted to be exposed to Hurricane force winds: 733632

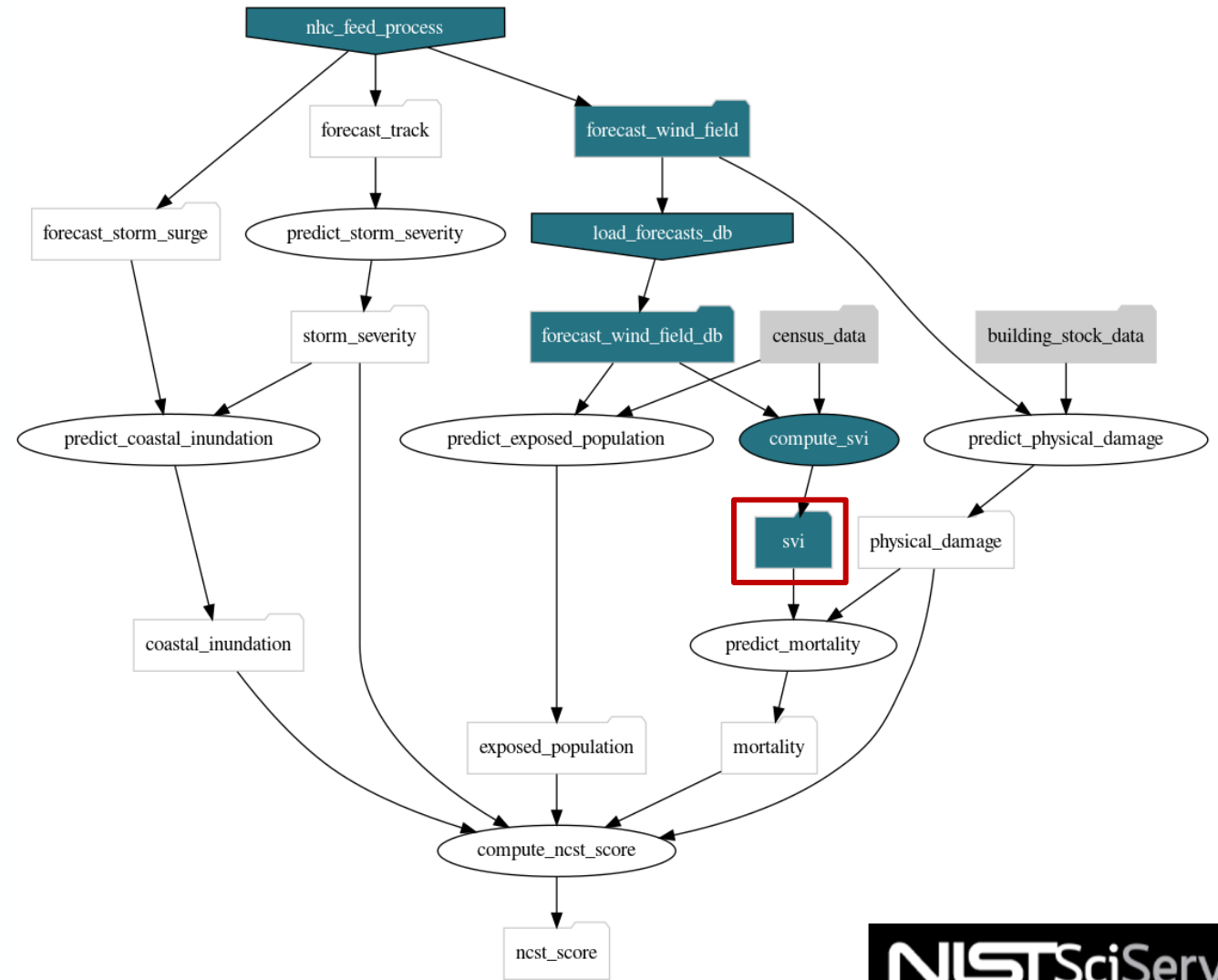


Automated Event Scoring: SciServer example (7/8)

Implementation of coordinated activities across disaster statutory programs for NCST event scoring: fully automated **Mortality** (CDC's Social Vulnerability Index used as proxy) score during NWIRP's *phase zero*

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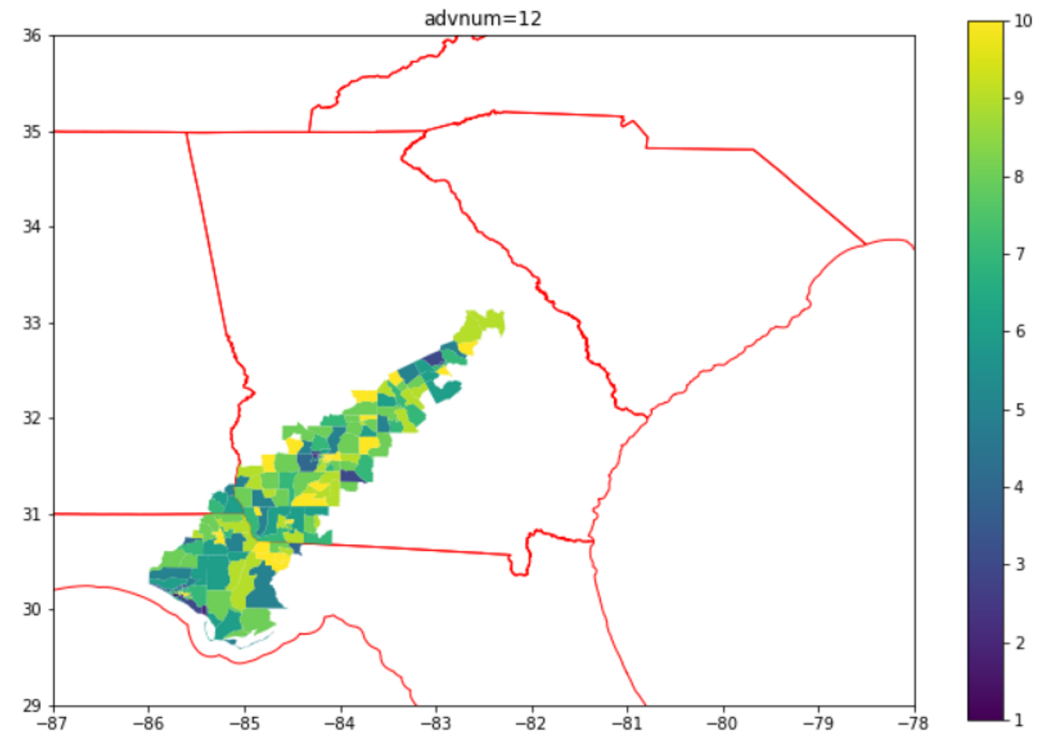
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```
In [12]: ax=states.plot(figsize=(12,8),color='none',edgecolor='r',linewidth=1)
# if len(hull)>0:
#     hull.plot(ax=ax,color='k',edgecolor='k',alpha=.3)
if len(tracts)>0:
    tracts.plot(ax=ax,column='spl_tile',legend=True)#,color='none',edgecolor='b')

plt.xlim(-87,-78)
plt.ylim(29,36)
plt.title(f"advnum={advnum}");
```



Map Source: Census Bureau TIGER/Line Shapefiles

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- NIST Disaster Working Group

Research Thrust

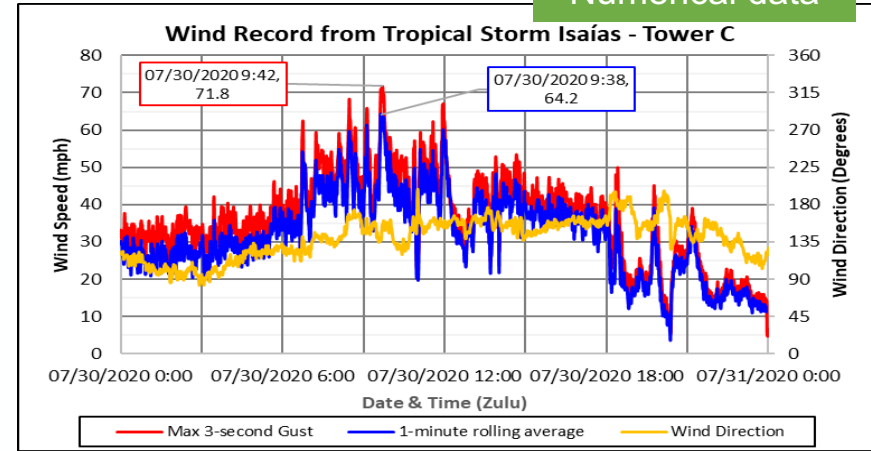
- Research program focused on disaster metrology, including structural performance and social sciences
- Coordinate research activities with NIST EL Groups, Disaster Statutory Programs, NIST EL Divisions, and other NIST Labs
- Coordination with the Center of Excellence of Risk-Based Community Resilience Planning on field studies
- NSF/NIST Disaster Resilience Research Grants Program
- Outreach and dissemination

Investigation Data Procedures

The Challenge:

- Heterogeneous data with different attributes, including:
 - Data type
 - Data owner/Source
 - Level of Sensitivity
 - Restrictions on Access
 - Restrictions on Use

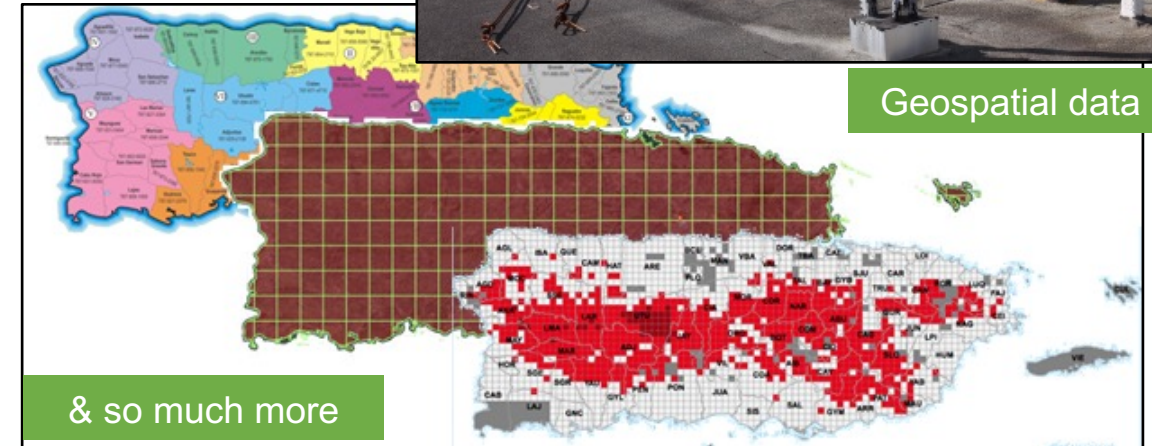
Numerical data



Photos and videos



Geospatial data

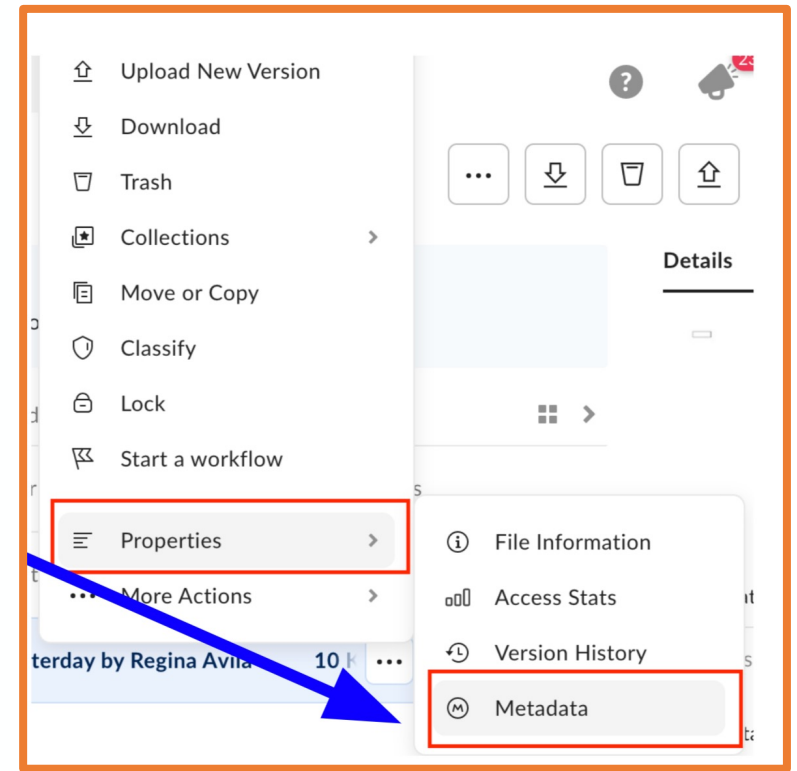


& so much more

Investigation Data Procedures

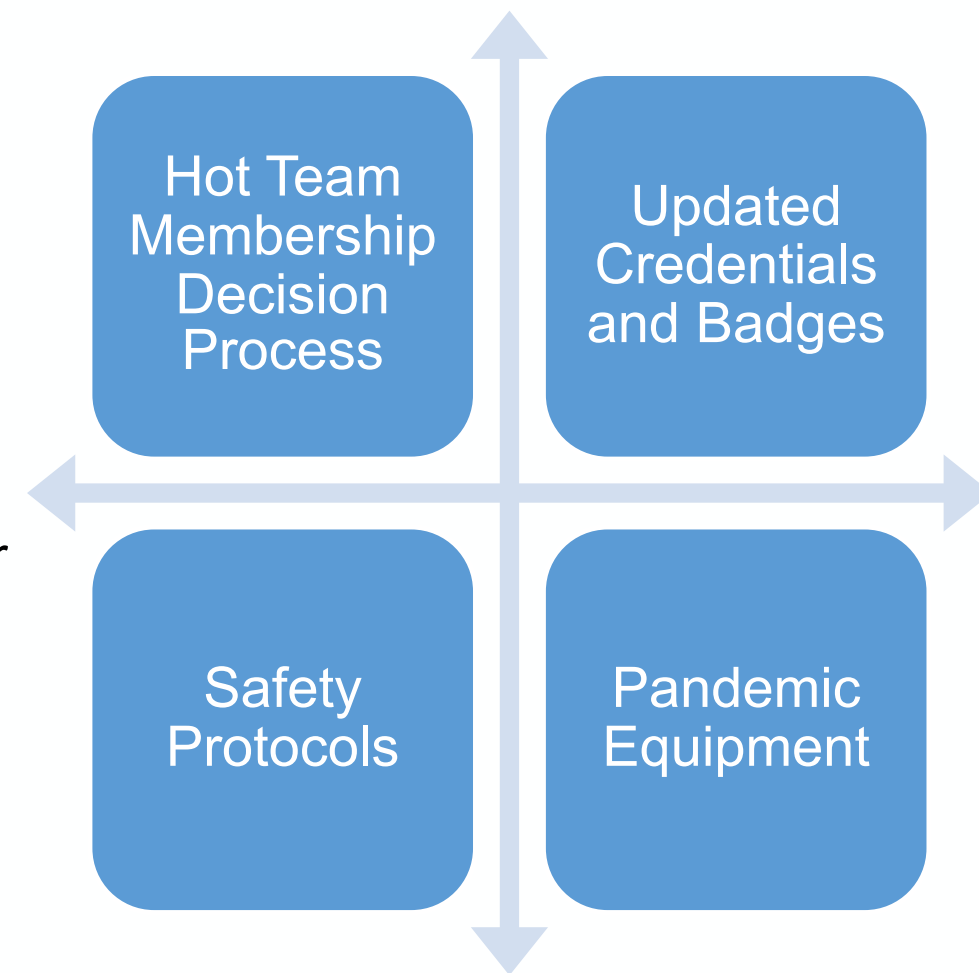
The Solution:

- Steps to ensure data is findable, such as:
 - Organizing data using various platforms for collaboration (e.g., Google Drive, Box, Zotero)
 - Documenting data with metadata templates
 - Creating README files
 - Documenting curation guidelines
- Steps to address data sensitivity, such as:
 - Privacy Impact Assessment of data system
 - Employ platform features, e.g., Classifying data and access permissions in Box
 - Guidance on Tagging/Handling Personally Identifiable Information (PII) in Collected Files



DFS Procedures

- Hot Team Membership Decision Process, enacted in September 2020
- NIST Emergency Services Office and Department of Commerce Office of Security supporting DFS in updating credentials and badges for Hot Team members
- Safety protocols for field teams
 - NIST First Level Hazard Review recognized with a NIST Safety Award in FY21
 - DFS safety procedures referenced in SDR report, *Integrating Science and Technology with Disaster Response* (Science for Disaster Reduction Interagency Coordination Group 2021)
- Necessary field equipment (e.g., PPE, contactless thermometers) in place for upcoming deployments



DATA DEPOT

Find in Data Depot

PRJ-2656 | A Longitudinal Community Resilience Focused Technical Investigation of the Lumberton, North Carolina Flood of 2016

PI: Van De Lindt, John

Project Type: Field Research | Longitudinal Study

Natural Hazard Type: River Flood, Hurricane

Event: Hurricane Matthew | Lumberton, NC | 10-03-2016 — 10-23-2016 | Lat 34.627222 Long -79.011944

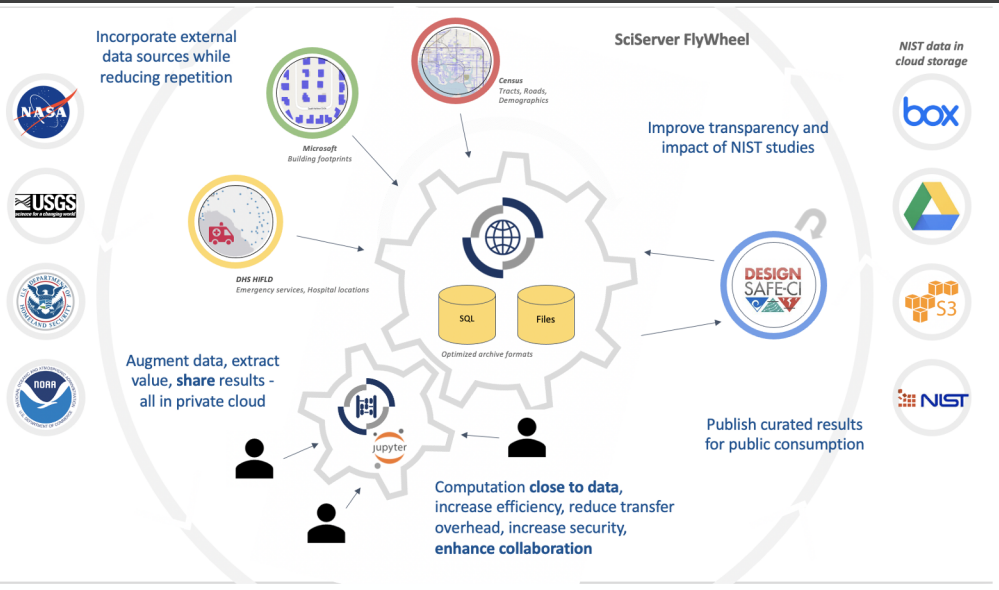
Awards: Center for Risk-Based Community Resilience Planning - NIST-70NANB15H044

DOI(s) in Dataset: 10.17603/ds2-9w11-tn85, 10.17603/ds2-pmt9-1s33, 10.17603/ds2-b1yd-pq98, 10.17603/ds2-db3h-gy28, 10.17603/ds2-t9kt-fm93

Related Work: The Lumberton, North Carolina Flood of 2016: A Community Resilience Focused Technical Investigation of the 2016 Lumberton, North Carolina Flood: An Interdisciplinary Approach, Importance of Households in Business Disaster Recovery, Quantifying post-disaster business recovery through Bayesian methods

Keywords: Field Research Planning, Community Resilience, Longitudinal, Survey Instruments, Sample Frame

- Sharing disaster metrology instruments and protocols



- Interoperability with NIST SciServer

DFS Uses of DesignSafe

DesignSafe-Cl

All unread

Threads

Mentions & reactions

Saved items

Slack Connect

Channels

- # announce_emails
- # general
- # hurricane-delta-2020
- # hurricane-harvey-2017
- # hurricane-laura-2020
- # hurricane-sally-2020
- # nashvilletornado-3-3-2020
- # puerto-rico-eq-1-6-2020
- # sseer-community
- # steer
- + Add channels

Direct messages

- Slackbot
- Maria Dillard you
- Erica Fischer
- Tracy Kijewski-Correa
- + Add teammates

Apps

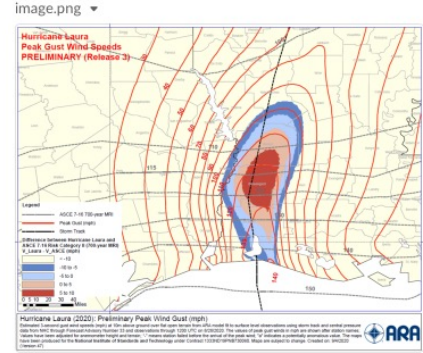
#hurricane-laura-2020

September 6th, 2020

Marc Levitan 2:37 PM

The third release of the Hurricane Laura windfield maps has been completed. The primary changes in this version are: (1) incorporation of mesonet data from the 8 stations comprising the Louisiana Agrilimatic Information System (LAIS); and (2) updates to the windfield model fit to the observed data, including LAIS. These additional observations generally confirmed and helped refine the previously estimated wind speeds on the eastern side of the track (the assistance of Randy Price and Andrew Garcia with the LSU AgCenter in providing this data and metadata is gratefully acknowledged). The model was also adjusted to achieve better fit to the observations closest to landfall, resulting in an increase in the area of estimated 130+ mph winds. The map format and product descriptions in the README file were improved, in part as result from user feedback.

As shown on page 3 (copied below) of the maps file, **Hurricane Laura definitely appears to have been a design-level event.** Peak gust wind speeds across most of Beauregard Parish and much of Vernon Parish were estimated to be as much as 10 mph greater than ASCE 7-16/ IBC 2018 design wind speeds for Risk Category II buildings and other structures (which have a Mean Recurrence Interval of 700 years). Peak gust wind speeds for most of Lake Charles and much of the rest of Calcasieu Parish were estimated to be within +/- 5 mph of ASCE 7-16/ IBC 2018 speeds.



Below is the pdf file with the full set of maps. The complete package of all the pdf, excel and GIS files has been sent to the DesignSafe Slack team for posting on the Recon Portal

- Collaboration during hazard event evaluation via Slack

NIST's Disaster and Failure Studies Program

Statutory Thrust

- Evaluate hazard events against deployment criteria
- Manage identification, vetting, and onboarding of NCSTAC members
- Develop agenda, manage logistics, and set frequency for NCSTAC meetings
- Create annual NCST reports to Congress
- Coordinate statutory activities across programs related to disasters.
- Conduct field studies under various authorities

Procedures Thrust

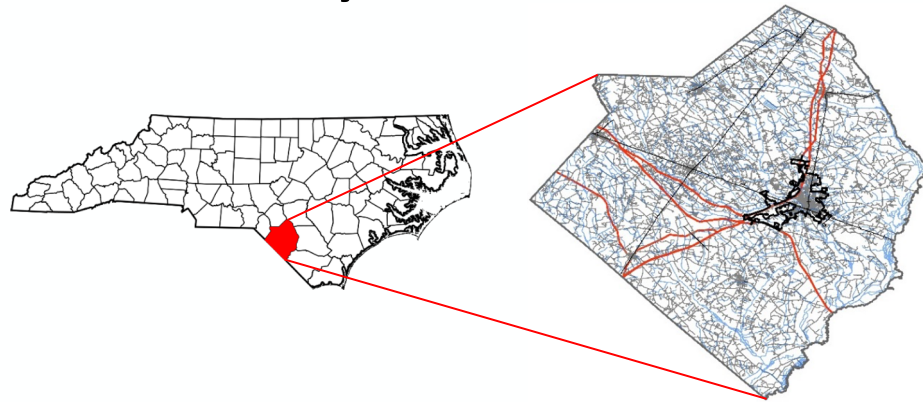
- DFS Standard Operating Procedures
- HOT Team membership, training, and credentials
- Field and safety protocols
- Human subjects protocols
- Manage equipment for disaster metrology and personnel protection
- Data preservation, security, and management
- Field tools (NDA's, permissions, survey instruments)
- MOUs with other agencies, academics, and others
- NIST Disaster Working Group

Research Thrust

- Research focused on disaster metrology, including structural performance and social sciences
- Coordinate research activities with NIST EL Groups, Disaster Statutory Programs, NIST EL Divisions, and other NIST Labs
- Coordination with the Center of Excellence of Risk-Based Community Resilience Planning on field studies
- NSF/NIST Disaster Resilience Research Grants Program
- Outreach and dissemination

NIST/CoE Collaborative Field Study in Lumberton, North Carolina

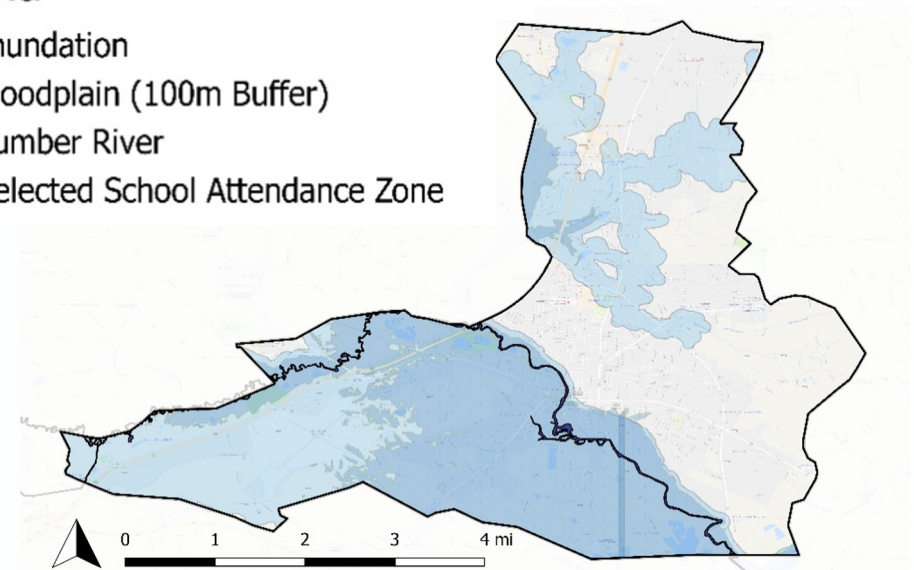
Field Study Area



North Carolina (above left); Robeson County with City of Lumberton in gray (above right) Lumberton Study Area (left)

Legend

- Inundation
- Floodplain (100m Buffer)
- Lumber River
- Selected School Attendance Zone



Field Study Timeline



Standardized Protocols, Instruments, Data Structures for Measuring Hazard Impacts and Community Recovery



Welcome, Maria!

Workspace Learning Center NHERI Facilities NHERI Community News Help

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DATA DEPOT

+ Add

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- My Projects
- Shared with Me
- Box.com
- Dropbox.com
- Google Drive
- Published**
- Published (NEES)
- Community Data

Help ▾

Find in Data Depot

PRJ-2656 | A Longitudinal Community Resilience Focused Technical Investigation of the Lumberton, North Carolina Flood of 2016 [Download Dataset](#)

PI Van De Lindt, John
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[10.17603/ds2-db3h-gy28](#)
[10.17603/ds2-f9kt-fm93](#)
Related Work [The Lumberton, North Carolina Flood of 2016: A Community Resilience Focused Technical Investigation](#)
[Community Resilience-Focused Technical Investigation of the 2016 Lumberton, North Carolina Flood: An Interdisciplinary Approach](#)
[Importance of Households in Business Disaster Recovery](#)
[Quantifying post-disaster](#)
Keywords Field Research Planni

In early October 2016, Hurricane Matthew crossed the state of North Carolina, bringing with it heavy rainfall on already saturated soil. The National Institute of Standards and Technology (NIST) Applied Economics Office, teamed with researchers from NIST's Applied Economics Office) to conduct a quick assessment of the flooding they experienced from unavailability of services, a typical civil infrastructure. The November 2016 field study was the first of a series of studies on Lumberton and its subsequent recovery. They provide data and insight into making U.S. communities more resilient to future engineering-social science field study protocol impacts on ethnicity, income, tenancy status, and education.

[View Data Diagram](#)

PRJ-2656

Documents Institutional Review Board Protocol 2015 - 2020	<input checked="" type="checkbox"/>
Documents Household Survey Instrument, November 26, 2016: Wave 1	<input checked="" type="checkbox"/>
Documents Building Damage Survey Instrument, November 26, 2016: Wave 1	<input checked="" type="checkbox"/>
Documents Household Survey Instrument, January 19, 2018: Wave 2	<input checked="" type="checkbox"/>
Documents Business Survey Instrument, January 19, 2018: Wave 2	<input checked="" type="checkbox"/>

Measuring Hazard Impacts: Damage

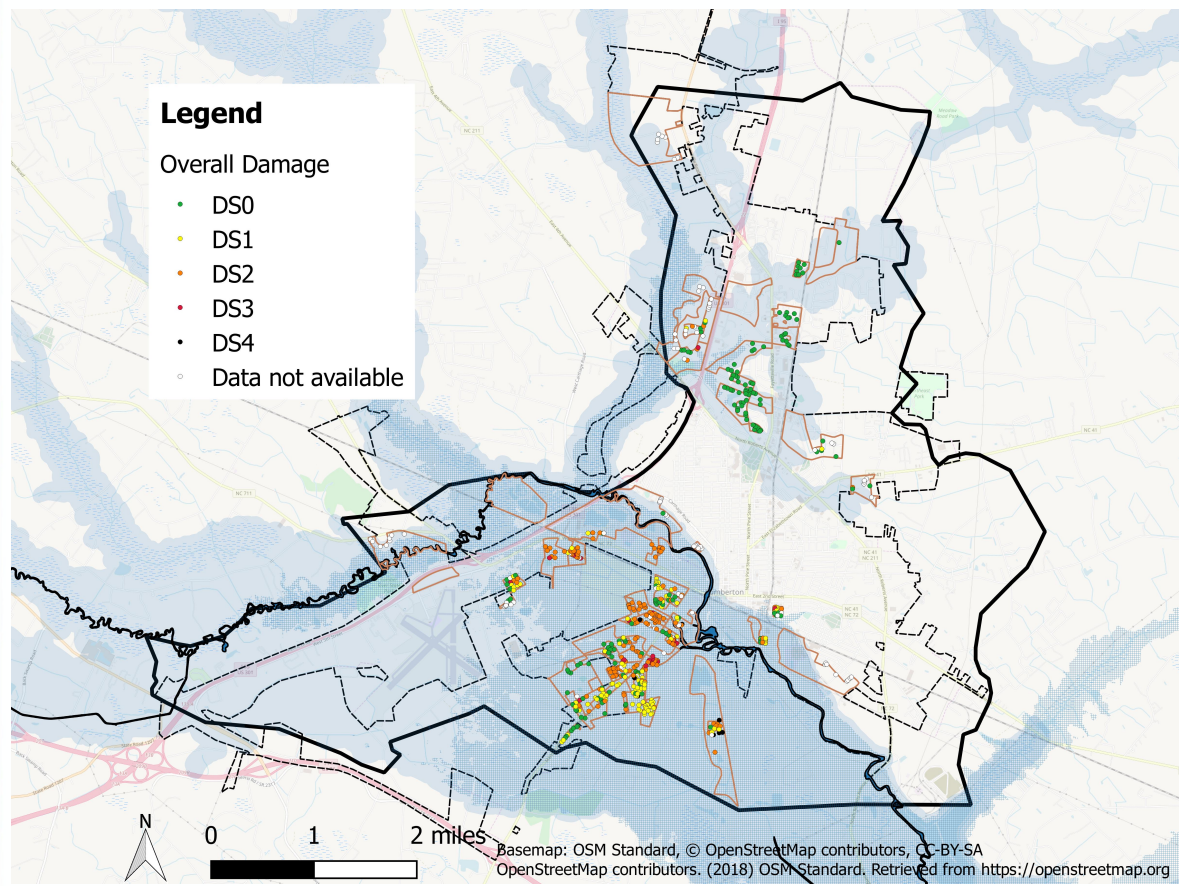


Figure 4-6. Overall damage state rating of residential housing units. [1 mile = 1.61 km]

Figure 4-7. Overall damage state ratings of residential housing units.

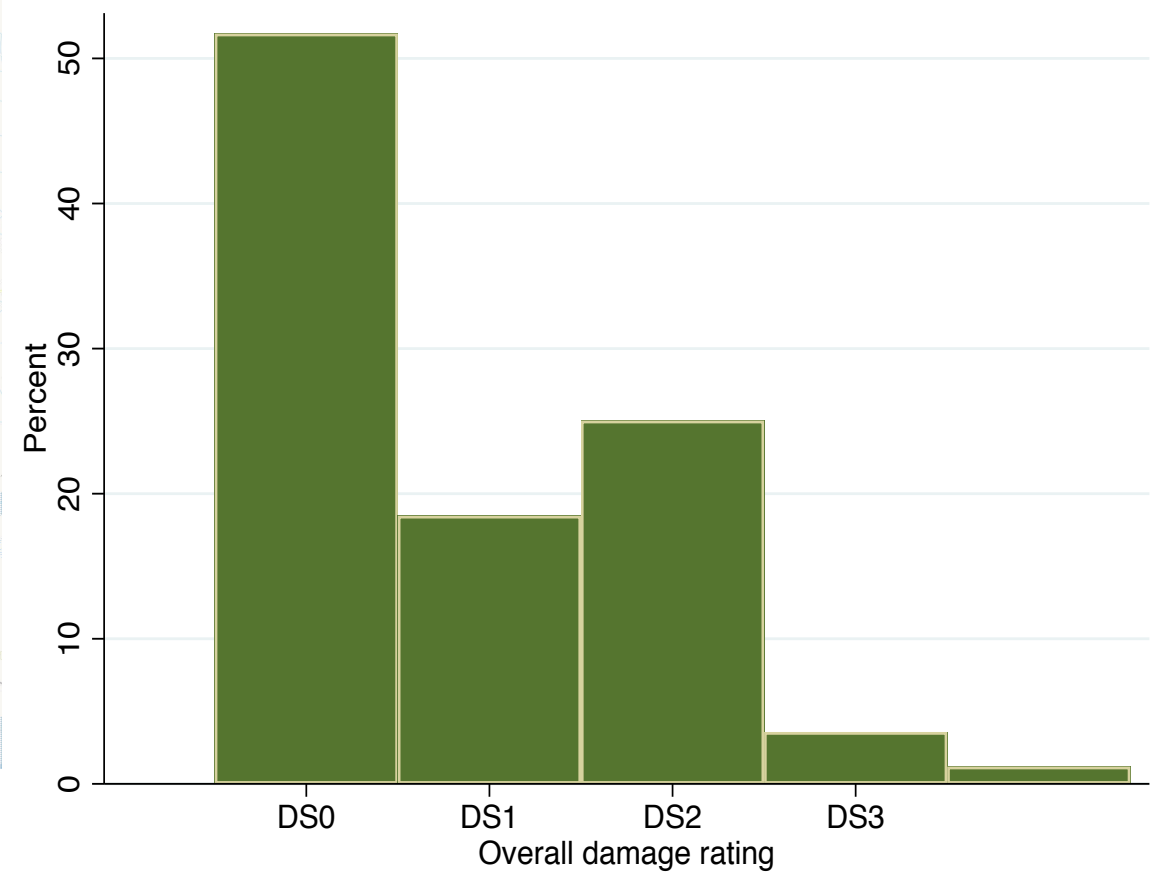


Table 1: Least square linear regression models

Variable	Model 1 Number of Days to Repair Completion	Model 2 Number of Days to Re- Occupancy
Damage State 1	-	-15.5
Damage State 2	96.03	36.5*
Damage State 3	135.93*	173.1***
Not-Hispanic White	-103.28*	-9.4
Has Insurance	115.09	19.2
Received Insurance	-155.81**	-25.6
Received Gov. Funds	65.74	16.3
Received NGO Funds	81.50	113.7***
Income \$20k- \$50k	-130.89*	-32.9
Income \$50k- \$100k	-103.37	-74.8***
Income \$100k+	-107.24	-42*
_constant	293.41***	56.2***
R ²	0.39	0.72

Note: Model1 n = 58; Model2 n=104 from 664 observations

*p≤0.05 (one-tailed)

**p≤0.05 (two-tailed)

***p≤0.01 (two-tailed)

Measuring Recovery: Repairs

Key factors influencing days to repair completion:

- Damage
- Race/ethnicity
- Receipt of insurance
- Income \$20-50k

Key factors influencing days to re-occupancy:

- Damage
- Receipt of NGO funds
- Income \$50-100k
- Income \$100k+

Source: Sutley, E.J., Hamideh, S., Dillard, M.K., Gu, D., Seong, K., van de Lindt, J.W. Integrative Modeling of Housing Recovery as a Physical, Economic, and Social Process. at the 13th International Conference on Applications of Statistics and Probability in Civil Engineering, ICASP13 Seoul, South Korea, May 26-30, 2019.

LONG-TERM NIST COMMUNITY RESILIENCE STUDY RELEASES SECOND REPORT

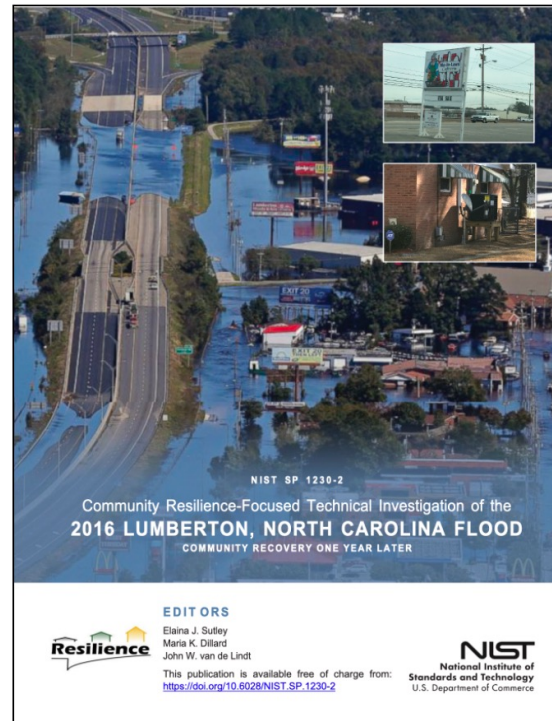
Published on April 26, 2021

In early October 2016, Hurricane Matthew crossed North Carolina as a category 1 storm with some areas receiving 15 in. to 18 in. of rainfall on already saturated soil. The small city of Lumberton, NC, experienced significant flooding from the Lumber River. A group funded by the National Institute of Standards and Technology, NIST, conducted a field study in Lumberton immediately after the flooding. One year later, the group returned to the city to document its recovery — and continue what has become an ongoing, long-term look at community resilience.

This multidisciplinary, longitudinal study is led by the NIST [Center for Risk-Based Community Resilience Planning](#), teaming with researchers from NIST's [Community Resilience](#), [Disaster Failure Studies](#), and [Applied Economics](#) programs.

In April 2021, the team released its second report, [Community Resilience-Focused Technical Investigation of the 2016 Lumberton, North Carolina Flood: Community Recovery One Year Later](#). The report, NIST Special Publication 1230-2, was edited by the field study leadership team: Elaina Sutley at the University of Kansas, Maria Dillard at NIST, and John van de Lindt at Colorado State University.

The Center and NIST team is studying Lumberton's recovery progress with an emphasis on the city's housing, businesses, schools, community and state-level decisions, and the intersection of these sectors in community recovery. This type of investigation is critical for the study of community resilience,



Related Links

[Lumberton Project Survey Instruments](#)

[Lumberton Wave 1 Report](#)

[Lumberton Wave 2 Report](#)

[NIST Center for Risk-Based Community Resilience Planning](#)

Source: <https://www.nist.gov/publications/community-resilience-focused-technical-investigation-2016-lumberton-north-carolina-0>

Maria Dillard

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Judith Mitrani-Reiser*, Scott Weaver*, Alex Szalay^, Gerard
Lemson^, Arik Mitschang^, and NIST Community Resilience Center of
Excellence*

**NIST*

^Johns Hopkins University PREP Associates

Questions?

 **Please 'raise your hand' using the Blue Jeans
Participant window and unmute your audio and video**