

NCST Technical Investigation of Hurricane María (Puerto Rico)

Characterization of Morbidity and Mortality

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Background

- Death certificates often misclassify deaths caused by disasters because of a lack of attribution standards and consistent data collection/reporting.*
- Previous studies^(^,^^,†,††) attempted to characterize the extent of mortality in Puerto Rico after Hurricane María using available data and/or collecting primary data.
- The GW study^{††} concluded that the lack of appropriate death certification practice after the hurricane and the local lack of communication about death certificate reporting prior to the storm limited the count of deaths that were reported as related to Hurricane María.
- The NIST mortality project **will not** produce another death count. Instead, NIST will use rigorous, scientific methods to understand the distribution of causes of death and the injury mechanisms of those that perished due to the storm, within the greater context of the hazards and the building and infrastructure system failures experienced by those individuals.

* Combs D.L., Quenemoen L.E., Parrish R.G., Davis J.H., 2009. "Assessing disaster-attributed mortality: Development and application of a definition and classification matrix." *International Journal of Epidemiology* 28(6): pp. 1124–9.

^ Robles, F., Davis, K., Fink, S., Almkhatar, S., 2017. "Official Toll in Puerto Rico: 64. Actual Deaths May Be 1,052." *The New York Times*. December 9, 2017.

^^ Santos-Lozada AR, Howard JT. Use of Death Counts from Vital Statistics to Calculate Excess Deaths in Puerto Rico Following Hurricane Maria. *JAMA*; Aug. 2, 2018: doi:10.1001/jama.2018.10929.

† Kishore N, Marques D, et al. *Mortality in Puerto Rico after Hurricane Maria*. *NEJM* 2018; 379:162-170

†† George Washington University, in collaboration with the University of Puerto Rico Graduate School of Puerto Rico, 2018. "Ascertainment of the Estimated Excess Mortality from Hurricane Maria in Puerto Rico," a Project Report for the Governor of Puerto Rico, August 28, 2018.

Updates on Mortality Contract

- Contract Modified: Contract awarded to the George Washington University Milken Institute School of Public Health on July 27, 2020 was modified on May 23, 2022 to explore new methods in finding next-of-kin and key informants for VA'SE surveys.

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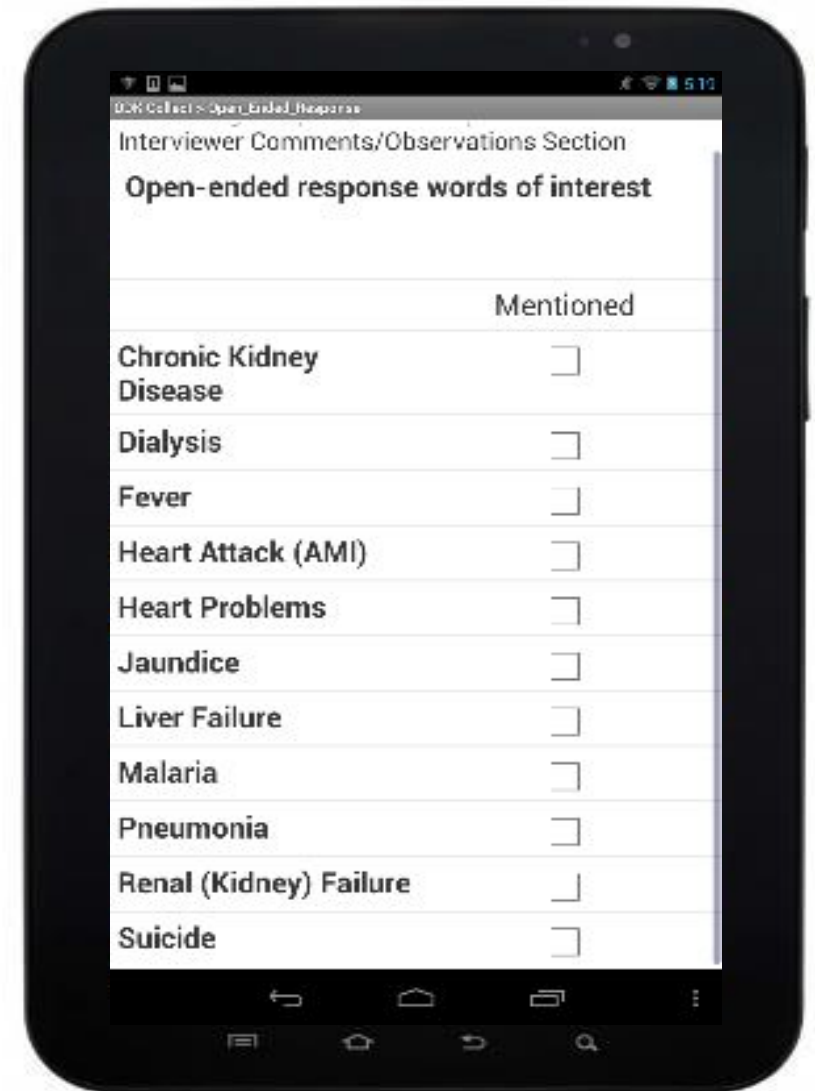
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Project Plans (1/4): Verbal Autopsy (VA) + Social Environmental (S'E) Survey

Foundation for survey with next-of-kin and key informants

- VA+S'E survey marks the beginning of the development of a disaster-centric verbal autopsy, when including the social vulnerability and environmental conditions before, during, and after the event.
- The VA+S'E survey builds on the Institute for Health Metrics and Evaluation (IHME) VA questionnaire
- SmartVA-Analyze is an analysis program used to determine the cause of death and is an open application developed by IHME, University of Washington
- SmartVA-Analyze uses the Tariff *method*^{^^^} to provide most likely underlying cause of death, and the next two or three most likely ones.
- Suggested mode was originally face-to-face; survey mode was adapted to phone due to COVID-19.

^{^^^}James et al., 2011. Performance of the Tariff Method: validation of a simple additive algorithm for analysis of verbal autopsies. *Population Health Metrics*, 9:31.



Source: Bernardo Hernández Prado (with permission)

Project Plans (2/4): Medical Records and Hospital Functions Review

Hospital Medical Records Abstraction

- Retrieve additional data (e.g., medical records, hospital functions data) of the selected hospital deaths to augment key elements required to inform causal path of death and for final determination of the death disease category
- Integrate secondary data to expand the explanatory variables used in analysis
- Confirmation of individual information to help support VA+S'E survey effort

Hospital Management and Clinical Staff Interviews

- Develop structured interview to identify potential operational changes due to storm
- Selection of expert panel with local and national experts

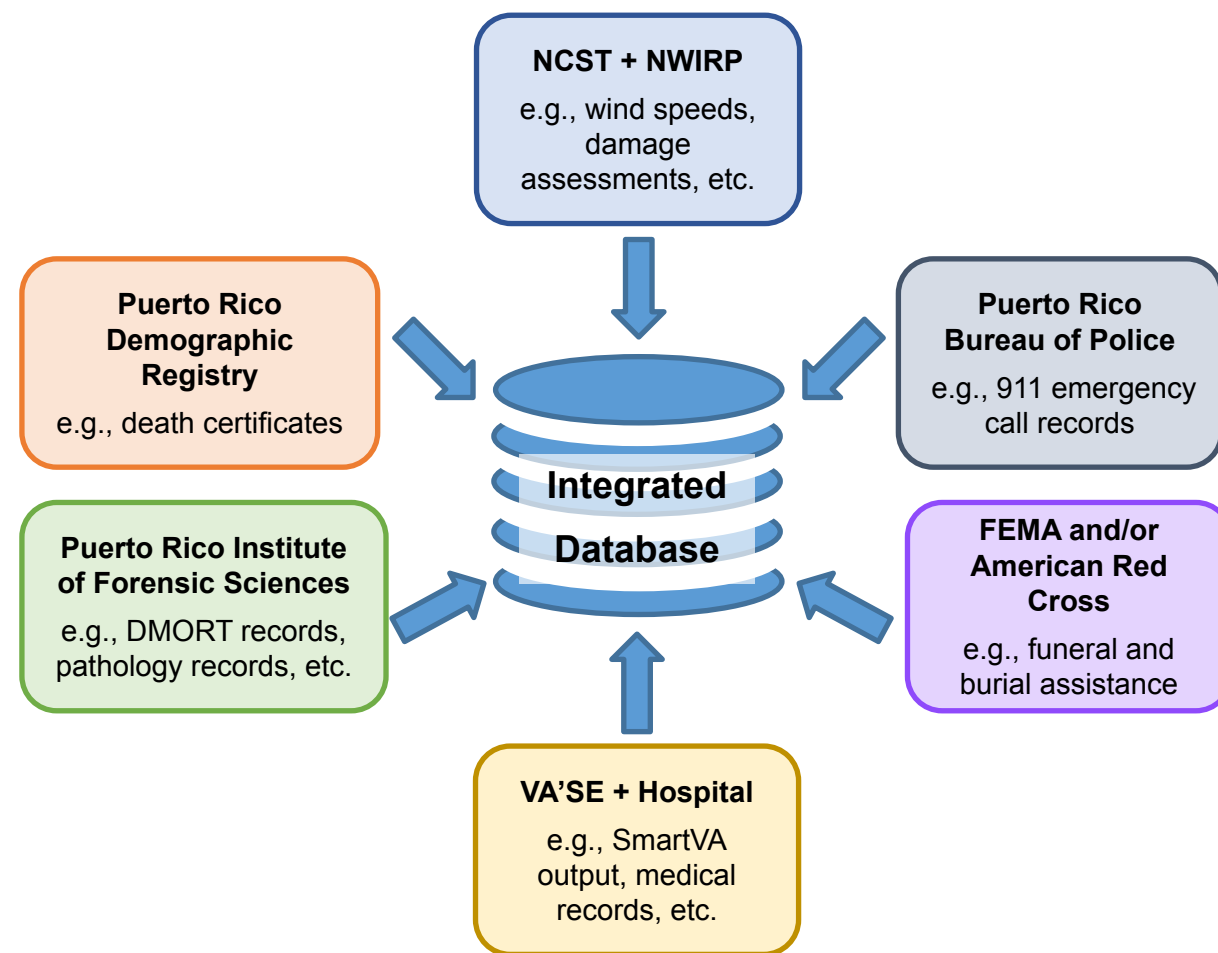
MEDICAL RECORD ABSTRACTION

Q1	Sociodemographic data	<input type="checkbox"/> _____
Q2		<input type="checkbox"/> _____
Q3	Pre-triage (reason for ambulance call, patient status, medications, vitals, prognosis, etc.)	<input type="checkbox"/> _____
Q4		<input type="checkbox"/> _____
Q5		<input type="checkbox"/> _____
Q6		<input type="checkbox"/> _____
Q3	Triage (problem list, level of consciousness, duration of illness, medications, vitals, prognosis, etc.)	<input type="checkbox"/> _____
Q4		<input type="checkbox"/> _____
Q5		<input type="checkbox"/> _____
Q6		<input type="checkbox"/> _____
Q7		<input type="checkbox"/> _____
Q8	Accident Information, ER Notes, Ward Admission Notes, Daily Progress, ICU Notes, Transfer, Death Certificate)	<input type="checkbox"/> _____
Q9		<input type="checkbox"/> _____
Q10		<input type="checkbox"/> _____
Q11		<input type="checkbox"/> _____

Project Plans (3/4): Integrated Database

Develop Integrated Database of Deaths in Puerto Rico

- Collect and merge geocoded data on the deaths occurring in the first 15 days and up to six months after Hurricane María made landfall in Puerto Rico
- Data sources include the Puerto Rico Vital Registration System with available datasets from the Bureau of Forensic Sciences, including DMORT E-Cases records, pathology registry records, case identification, case review, and cremation and institutional death databases.
- Additional data from other projects in the investigation, NWIRP study, and other products from the project



Project Plans (4/4): Spatial & Temporal Analysis

Spatial and Temporal Clustering of Deaths

- Analyze the integrated database to calculate cause-specific mortality rates adjusted for age and gender and compare these to the prior seven years to obtain cause-specific excess mortality.
- Examine groups of causes of death (based on ICD-10 codes) and the causes usually attributed to hurricanes (e.g., drowning, death from a fallen object, etc.) and compare them to the 7 previous years.
- Identify significant increases in death rates from specific causes in the aftermath of the storm; flag all deaths from those causes in the first two weeks after the storm.
- Identify spatial and temporal clusters of deaths occurring up to six months after the storm (entire island), with a separate analysis for the first 14 days after the event

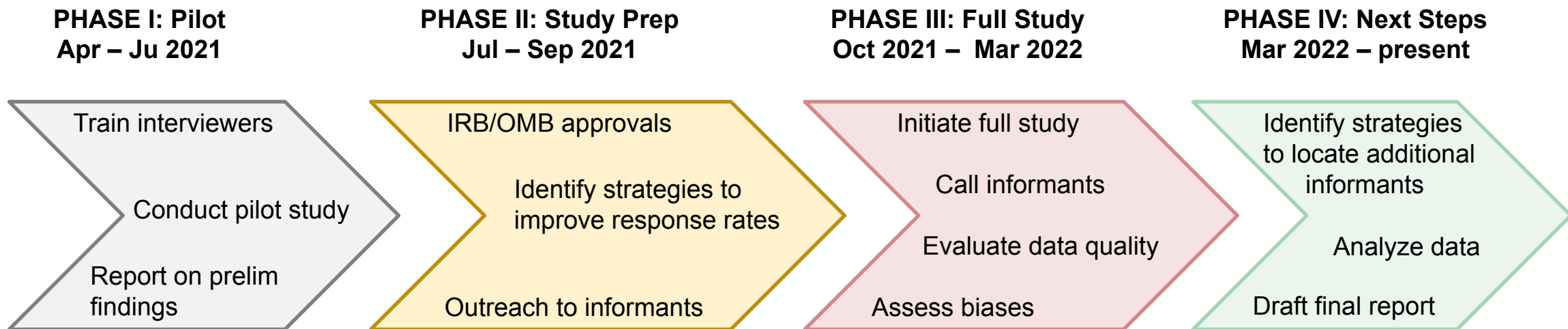
Puerto Rico Hurricane Maria Mortality Study Population, by time-period, sex, age, and socioeconomic development index (SEI*).

Variable	Period	Landfall + 14 days ¹		6 Months ²	
		N	%	N	%
Total		1,772	100%	16,657	100%
sex	Female	812	46%	7,597	46%
	Male	960	54%	9,060	54%
age	Young	74	4%	846	5%
	Mid	320	18%	2,988	18%
	Old	1,378	78%	12,823	77%
SEI	Low	304	17%	2,988	18%
	Middle	537	30%	4,950	30%
	High	931	53%	8,719	52%

*Junta de Planificación. Índice de desarrollo socioeconómico municipal. 2017.

Recent Progress: Verbal Autopsy and Socio-Environmental Survey

- VA+S'E instrument developed with the objectives to: (1) ascertain the cause of deaths within two weeks of the storm making landfall in Puerto Rico, and (2) identify socio-environmental contextual factors that could be related to the occurrence of those deaths.
- Pilot study conducted April - June 2021; instrument was revised and submitted for IRB and PRA approvals July - August 2021; final VA'SE instrument approved by OMB on September 3, 2021.
- Diverse outreach methods (e.g., > 950 letters mailed via USPS, study website, social media, etc.) were implemented to reach next-of-kin and key informants.
- UPR team completed 368 interviews as of May 31, 2022. Of the individuals contacted, 62% agreed to participate. More than 1500 informants remain unreachable.



Recent Progress: Verbal Autopsy and Socio-Environmental Survey

- Non-response analysis completed to assess any biases introduced based on respondents
- The team has been conducting quality control checks to make sure all informants had followed the 3-call protocol, including one call on the weekend.
- A modification was awarded on May 23, 2022 to GW-UPR to use a people finder service to contact more next of kin and key informants.

Characteristics		Interviewed	Non-Interviewed	P-Value*
Gender	Female	171 (47.8%)	652 (45.1%)	0.36
	Male	187 (52.2%)	794 (54.9%)	
Age	0-39 years	13 (3.6%)	63 (4.4%)	0.20
	40-64 years	54 (15.1%)	274 (18.9%)	
	65+ years	291 (81.3%)	1105 (76.4%)	
	Not Available	0 (0.0%)	4 (0.3%)	
Education	Bachelor's degree	41 (11.4%)	121 (8.4%)	0.01
	Associate degree	33 (9.2%)	84 (5.8%)	
	High school diploma or GED	95 (26.5%)	328 (22.7%)	
	Graduate school	15 (4.2%)	41 (2.8%)	
	No high school diploma	167 (46.7%)	783 (54.1%)	
	Not Available	7 (1.9%)	89 (6.2%)	
Marital status	Married	127 (35.5%)	444 (30.7%)	0.02
	Never married	50 (13.9%)	287 (19.8%)	
	Separated	69 (19.3%)	217 (15.0%)	
	Widowed	108 (30.2%)	440 (30.4%)	
	Not Available	4 (1.2%)	58 (4.0%)	
Residence zone	Rural	164 (45.8%)	610 (42.2%)	0.08
	Urban	182 (50.8%)	746 (51.6%)	
	Not Available	12 (3.4%)	90 (6.2%)	

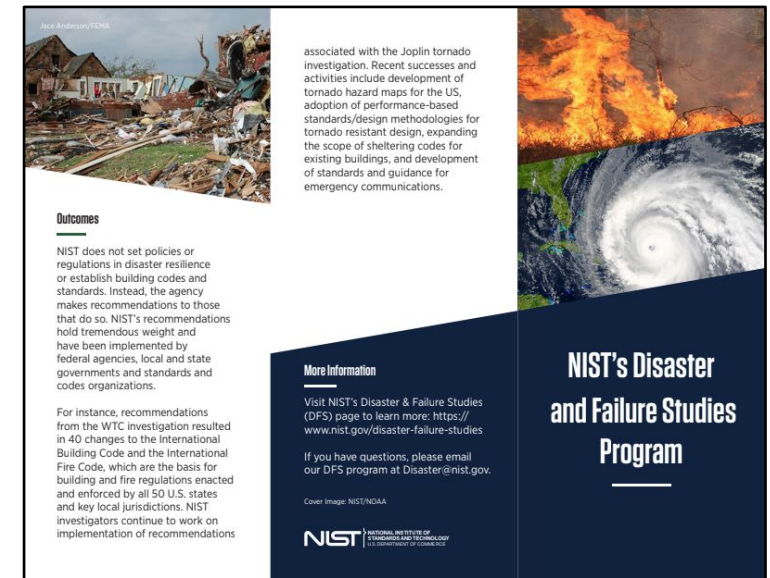
*Pearson Chi-Square

Recent Progress: Medical Records and Hospital Functions Review

- Implemented a non-random, stratified, and paired matched sampling method to select the sample of hospitals (6 hospitals total)
- Data will be extracted from the medical records of each of the deaths that occurred in the sample hospitals within 14 days of the impact of Hurricane María.
- Interviews with 5-6 members of the key administrative and medical-clinical staff who worked in the hospital at the time of Hurricane María's impact. The instrument will cover the following topics, among others:
 - Position (in the hospital) of the person being interviewed
 - Information on pre-existing problems in the hospital prior to Hurricane María
 - Hospital emergency plans and their implementation
 - Hospital operational status
 - Availability of utilities
 - Operation of the hospital's clinical units
 - Impact of these circumstances on hospital operations and patient care

Recent Progress: Medical Records and Hospital Functions Review

- Hospital survey instruments developed with input across HM Program projects, and submitted for OMB approval on May 19, 2022
- Hospital recruitment efforts underway, in collaboration with relevant HM Program projects
- Recruitment efforts include letters of support from the Puerto Rico Department of Health (PRDOH).
- For the medical records abstraction, an electronic form will be utilized to gather the following data:
 - Basic sociodemographic information
 - "Pre-triage" and "triage" information, such as the patient's status, vital signs, main complaints, etc.
 - Injuries information, if applicable
 - Emergency Room Admission Notes
 - Room Admission Notes
 - Daily progress notes for length of hospital stay
 - Patient transfers- last day; DNR order information



associated with the Joplin tornado investigation. Recent successes and activities include development of tornado hazard maps for the US, adoption of performance-based standards/design methodologies for tornado resistant design, expanding the scope of sheltering codes for existing buildings, and development of standards and guidance for emergency communications.

Outcomes

NIST does not set policies or regulations in disaster resilience or establish building codes and standards. Instead, the agency makes recommendations to those that do so. NIST's recommendations hold tremendous weight and have been implemented by federal agencies, local and state governments and standards and codes organizations.

For instance, recommendations from the WTC investigation resulted in 40 changes to the International Building Code and the International Fire Code, which are the basis for building and fire regulations enacted and enforced by all 50 U.S. states and key local jurisdictions. NIST investigators continue to work on implementation of recommendations

More Information

Visit NIST's Disaster & Failure Studies (DFS) page to learn more: <https://www.nist.gov/disaster-failure-studies>

If you have questions, please email our DFS program at Disaster@nist.gov.

Cover Image: NIST/NOAA

NIST's Disaster and Failure Studies Program

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las recomendaciones asociadas con la investigación del tornado de Joplin. Los éxitos y actividades recientes incluyen el desarrollo de mapas de riesgo de tornados para los EE. UU., la adopción de estándares/metodologías de diseño basadas en el desempeño para el diseño resistente a tornados, la ampliación del alcance de los códigos de refugio para edificios existentes y el desarrollo de estándares y guías para comunicaciones de emergencia.

Resultados

El NIST no establece políticas o regulaciones en resiliencia ante desastres o establece códigos y estándares de construcción. En cambio, la agencia hace recomendaciones a quienes lo hacen. Las recomendaciones de NIST tienen un peso tremendo y han sido implementadas por agencias federales, gobiernos locales y estatales y organizaciones de estándares y códigos.

Por ejemplo, las recomendaciones de la investigación del WTC dieron como resultado 40 cambios en el Código Internacional de Construcción y el Código Internacional de Incendios, que son la base para las normas de construcción e incendios promulgadas y aplicadas por los 50 estados de EE. UU. y jurisdicciones locales clave. Los investigadores del NIST continúan trabajando en la implementación de

Más Información

Visite la página de Estudios de fallas y desastres (DFS) del NIST para obtener más información: <https://www.nist.gov/disaster-failure-studies>

Si tiene preguntas, envíe un correo electrónico a nuestro programa DFS a Disaster@nist.gov.

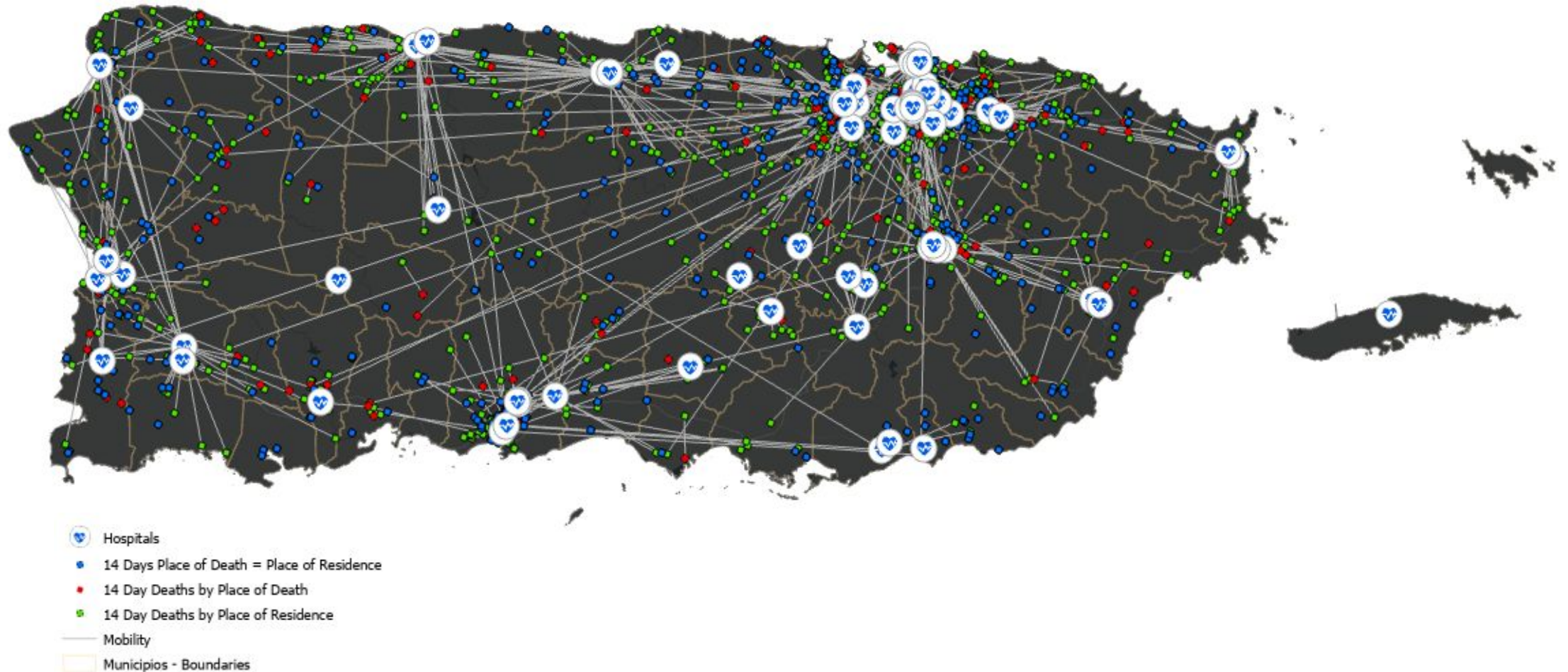
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Recent Progress: Spatial and Temporal Analysis

- NIST HM and GWUPR's GIS staff meet to discuss leveraging data across the HM Program's projects, and support analyses and visualization of hurricane impacts; more than 10 layers of information for analysis.
- Cause-Specific Excess Mortality report submitted to NIST in April 2022 for review and feedback.



Next Steps

Verbal Autopsy and Socio-Environmental Survey:

- Continue survey data collection with additional methods to identify next of kin and key informants
- Employ finalized framework for attribution analysis, including risk factors associated with building failures

Medical Records and Hospital Functions Review:

- Collect medical records from deaths that occurred in the hospital sample
- Interview administrators and clinicians in sample hospitals
- Finalize clinical panel members
- Identify data required for attribution determination by clinical panel

Integrated Database:

- Continue to work with other projects to inform the cause-specific mortality assessment
- Finalize any required MOUs to retrieve secondary data, as needed

Spatial & Temporal Analysis:

- Continue to work with other projects to inform the cause-specific mortality assessment
- Continue adding new layers to dataset and work across projects on data analysis
- Complete analysis for spatial and temporal clustering of deaths

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Characterization of Morbidity and Mortality

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Project Team: Thomas D. Kirsch, MD, MPH (NCDPH), Emina Herovic, PhD (NIST), GW/UPR scientists

**A special thanks to Captain Rebecca Noe (CDC) for sharing her time and expertise so graciously with the Hurricane María NCST investigation, and specifically, with this project!*



Questions?

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