

NCST Technical Investigation of Hurricane Maria (Puerto Rico)

Characterization of Morbidity and Mortality

Project Leader: Judith Mitrani-Reiser, PhD, NIST

Project Team: Thomas D. Kirsch, MD, MPH

Objective: To complete a quantitative morbidity and mortality assessment of Puerto Rico, to better understand how damaged buildings and supporting infrastructure played a role in the injuries and deaths associated with Hurricane Maria. The study results will provide guidance to improve codes, standards and inform future approaches to accurately attribute and predict life loss due to building failure(s) caused by windstorms.

Background

- Death certificates generally underestimate deaths caused by disasters because of a lack of standards and consistent data collection/reporting.*
- A standard for disaster-related mortality attribution was proposed in 1999** but it has not been widely adopted nor applied to a disaster with a long recovery.***
- Previous studies^(^,^^,†,††) attempted to characterize the extent of mortality in Puerto Rico after Hurricane Maria 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 Maria.

* 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.

** Combs DL, Quenemoen LE, Parrish RG, Davis JH. Assessing disaster-attributed mortality: development and application of a definition and classification matrix. *Int J Epidemiol* 1999;28:1124–9.

*** National Center for Health Statistics. A Reference Guide for certification of deaths in the event of a natural, human-induced, or Chemical/Radiological disaster. (Reference guide No. 1). CDC, National Center for Health Statistics 2017. Retrieved from <https://www.cdc.gov/nchs/data/nvss/vsrg/vsrg01.pdf>

^ Robles, F., Davis, K., Fink, S, Almukhtar, 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.

Motivation

- To date, several studies ([^],^{^^},^{††}) have focused on assessing Hurricane Maria's death toll using excess mortality approaches, such as daily and monthly comparisons with previous years.
- Additionally, a single population-based study[†] characterized the predominant reasons associated with deaths in their sample as attributable to a lack of healthcare access.
- The NIST mortality project **will not** produce another death count.
- Instead, NIST will use rigorous, scientific methods to understand 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.

[^] Robles, F., Davis, K., Fink, S, Almukhtar, 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

- ❑ Option Exercised: Option exercised on **April 19, 2021** to the contract awarded to the George Washington University Milken Institute School of Public Health on **July 27, 2020**; subawards to University of Puerto Rico-Graduate School of Public Health and independent external consultants;

George Washington University:

Carlos Santos-Burgoa, MD, MPH, PhD
Project Manager

Ann Goldman, MPH, PhD
Project Coordinator

Ramin Asgary, MD, MPH, MSc
Global Humanitarian Health

Ximena Riesco-Cruzat, MD, MSc, PhD
Health systems

Leslie Zaragoza, MPH (cand)
Epidemiology

Maria Jose Talayero, MD, MSc, DrPH (cand)
Environmental Health

Diane Uschner, PhD
Biostatistics Center

Sharon Edelstein, MS
Biostatistics Center

Jordan Kahn
Biostatistics Center

Michele Santacatterina, PhD
Biostatistics Center

Valerie Donohue
Biostatistics Center

University of Puerto Rico-Medical Sciences:

Pablo Méndez-Lázaro, PhD
Local Project Coordinator

Ralph Rivera-Gutierrez
Health Systems and Policy

Laura Cabrera, Dr.PH (Cand)
Environmental Health

Heriberto Marin
Health Services Analysis

External consultants:

Bernardo Hernandez-Prado, ScD
Lead Verbal Autopsy, IHME, University of Washington

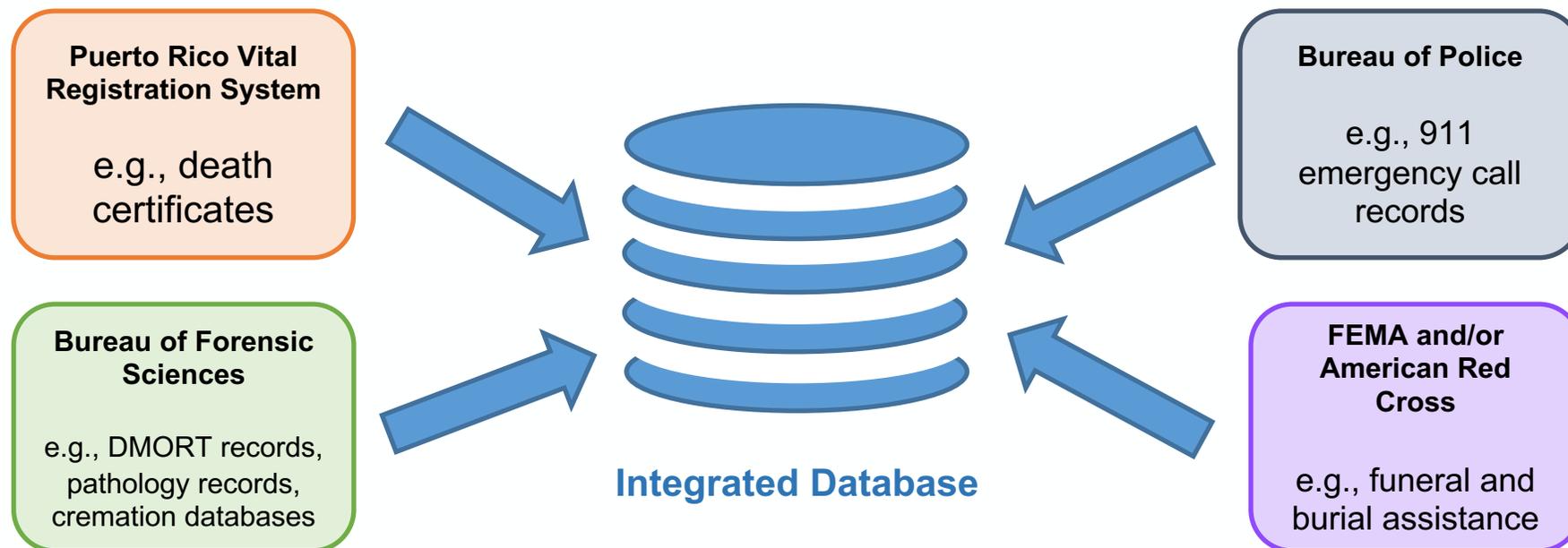
Abraham D. Flaxman, PhD
SmartVA, IHME, University of Washington

Aurelio Castro, MS; Glenda Roman, MS
Geographic Mapping Technologies, Corp., San Juan, PR:
GIS and Remote Sensing

Project Plans (1/4): Integrated Database

Develop Integrated Database of Deaths in Puerto Rico

- Collect and merge geocoded data on the deaths occurring up to six months after Hurricane Maria 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 to consider are 911 emergency calls obtained from the Bureau of Police, and funeral and burial assistance data from FEMA and the American Red Cross.



Project Plans (2/4): 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 years.
- Examine each broad cause of death (i.e. ICD-10 codes) and specific causes of death typically attributed to hurricanes (e.g., drowning, death from a fallen object, etc.) and compare them to previous years. Identify significant increases in death rates from particular causes between the period after the storm and years prior; 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 (4 study regions).*

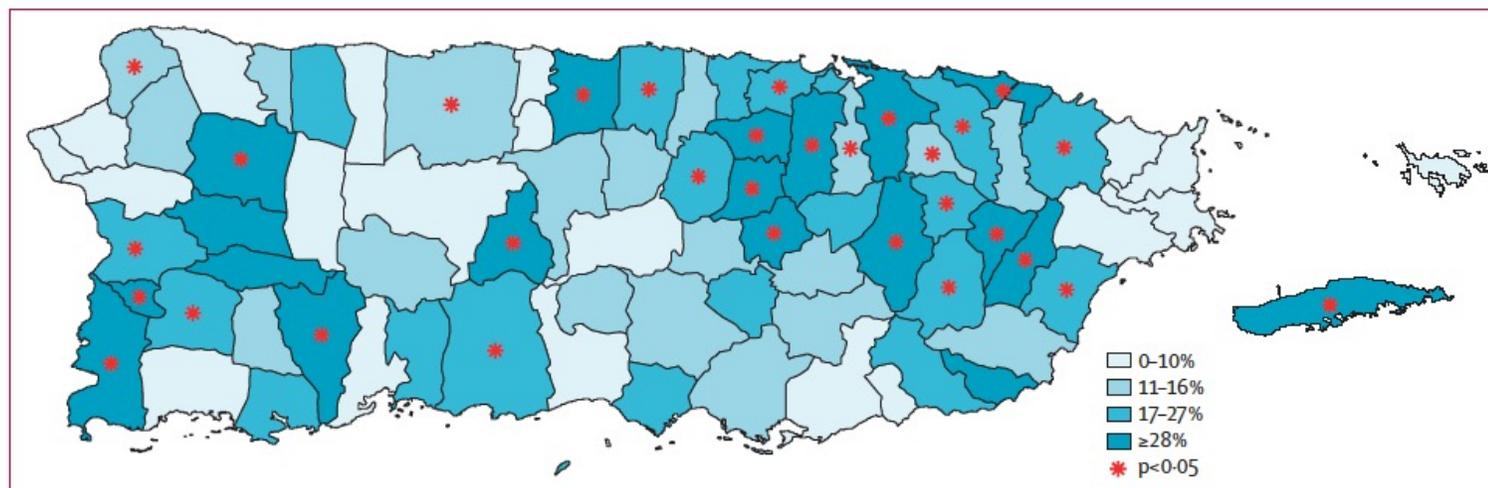


Figure 3: Percentage increase in crude mortality by municipality in Puerto Rico

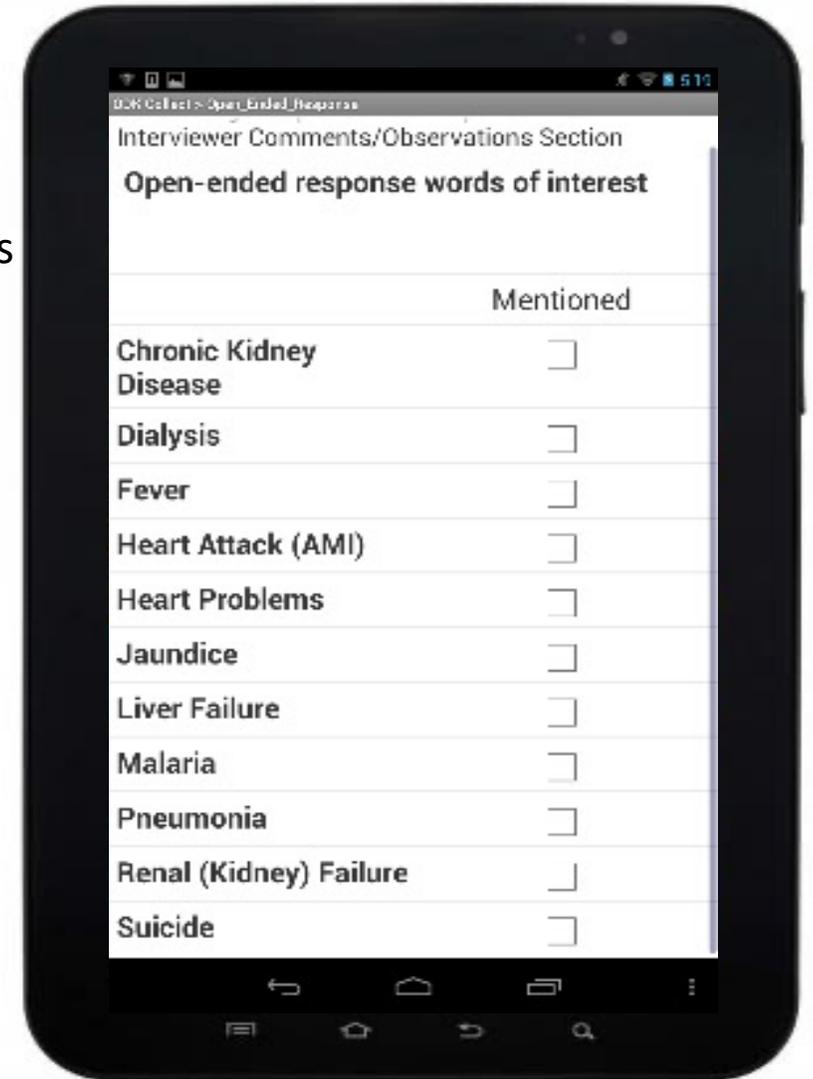
Estimated increase in crude mortality from September, 2017, to February, 2018, relative to mean mortality in the same period in 2015–16 and 2016–17 under the displacement scenario.

Source: Santos-Burgoa et al., 2018 (with permission)

Project Plans (3/4): Verbal Autopsy (VA) + Social Environmental (S'E) Survey

Foundation for survey with Next of Kin and Key Informants

- SmartVA is an application developed by Institute for Health Metrics and Evaluation (IHME), University of Washington).
- SmartVA includes a VA questionnaire, and a module of analysis to ascertain of cause of death.
- Spanish verbal autopsy instruments are also available.
- SmartVA-Analyze uses the *Tariff method*^{^^} to ascertain causes of death from a list of 34 causes for adults, 21 for children and 6 for newborns, excluding stillbirths.
- 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 is being adapted to phone due to COVID-19.
- This VA+ S'E will mark the beginning of the development of a disaster-centric verbal autopsy.

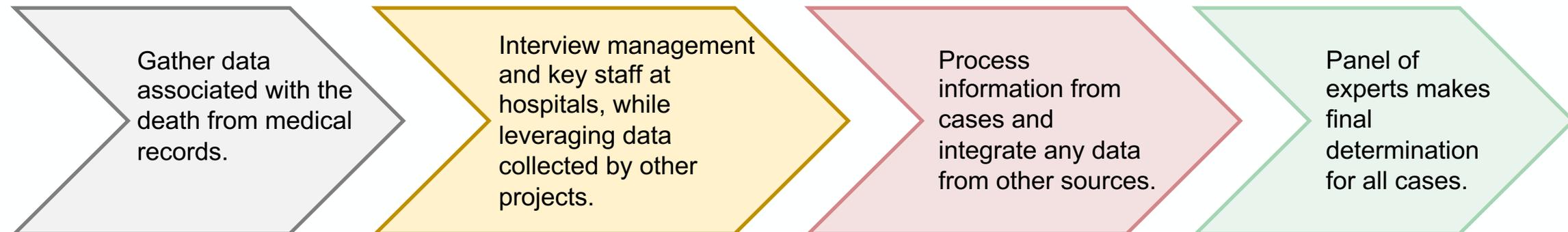


^{^^}James et al., 2011. Performance of the Tariff Method: validation of a simple additive algorithm for analysis of verbal autopsies. *Population Health Metrics*, 9:31.

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

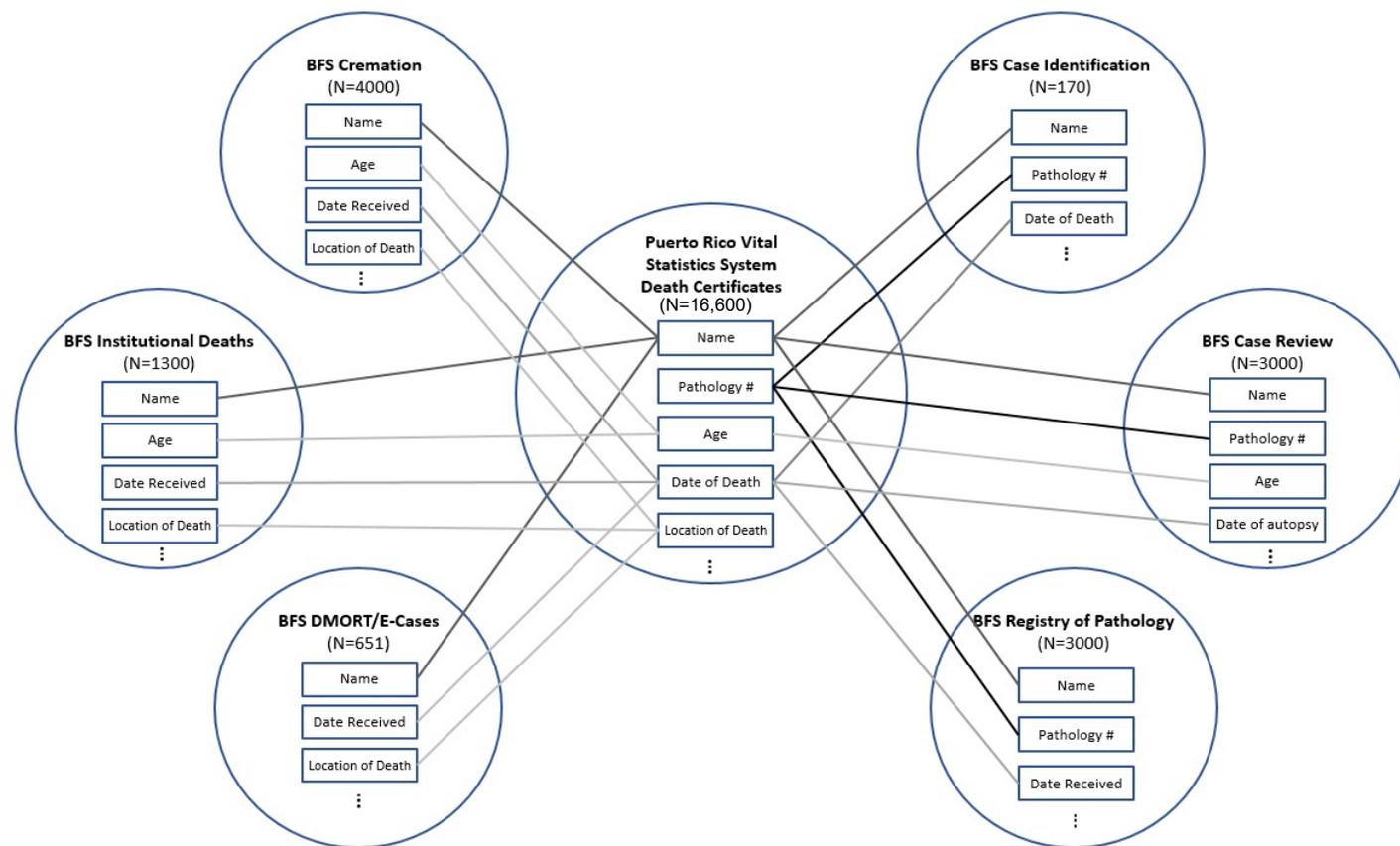
Contract option exercised in April 2021

- Confirmation of individual information to help support VA+S'E survey effort.
- Develop structured interview survey to identify potential operational changes due to storm.
- Selection of expert panel with local and national experts.
- 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.



Recent Progress: Integrated Database

- Data Use Agreements (DUA) with the Demographic Registry at the Puerto Rico Department of Health and the Institute for Forensic Sciences.
- The transfer of updated datasets ensure that the project's analyses contain any additions or corrections to the original 2017-2018 dataset.
- Data for the first 14 days after the storm's landfall used to search/locate next of kin or key informants.
- GWUPR's GIS team is standardizing and geocoding addresses for death place and residence of the deceased.

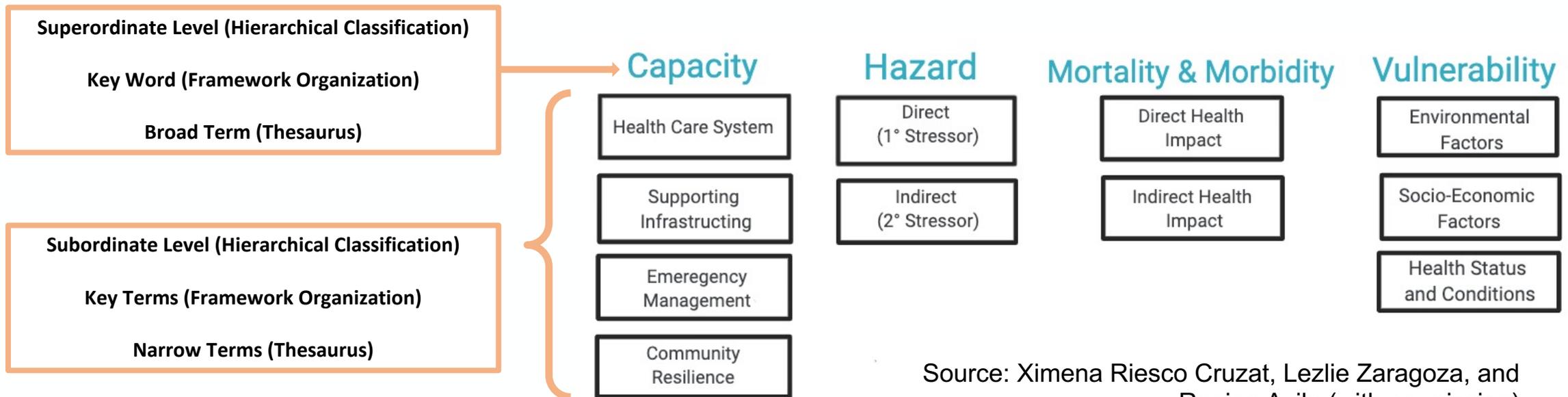


Source: Carlos Santos-Burgoa (with permission)

- NIST HM and GWUPR's GIS staff met to discuss leveraging data across the HM Program's projects, and support analyses and visualization of hurricane impacts.
- Meetings held with FEMA to explore additional MOA(s) for data sharing.

Recent Progress: Morbidity and Mortality Library

- The Hurricane Maria mortality and injury literature review consists of 240 resources, including scientific publications, reports, instruments, and grey literature.
- Every document is available in a *repository* on a shared drive.
- As part of their literature review, GWUPR developed a compendium or compilation of resources with key information (i.e., objective of study or highlights of contents) to assist in navigation.
- The taxonomy for the organization of the resources and the creation of a *Thesaurus* were developed collaboratively by the NIST HM and GWUPR staff.
- Literature review resources into a citation management tool used across the NIST HM Program.



Source: Ximena Riesco Cruzat, Lezlie Zaragoza, and Regina Avila (with permission)

Recent Progress: Verbal Autopsy Pilot Study

- Verbal Autopsy and Socio-Environmental (VA+S'E) instrument developed with the objectives to: (1) ascertain the cause of deaths that took place within two weeks of the storm making landfall in Puerto Rico, and (2) identify the needed socio-environmental contextual factors that could be related to the occurrence of those deaths.
- PRA approval from OMB (March 2021) for the VA+S'E instrument's use in a pilot study.
- Interviewer training took place over 5 half-days, totaling more than 20 hrs and including interactive sessions with the following content:

- 1) background on the NCST investigation and mortality project,
- 2) survey procedures,
- 3) familiarization with the questionnaire and the tablets (see photo),
- 4) emotional containment strategies, and
- 5) an exercise of empathy and self-care.



Photographed (left to right): Lyz Negrón, Miladys Perez, Ambar Meléndez, Tanyaly Rivera, Katherine Torres, Jennifer Acevedo, Guillermo Gorbea, Janet Forestier, Adian Rodriguez, Rocío Rodríguez, Rocío Lamboy, Myrna Del Mar Gonzalez, Genesis Rodriguez, Julian Hernandez, Laura Cabrera, and Pablo A. Méndez Lázaro

Photo Credit: Laura Cabrera (with permission)

- Interviews (a total of 50 expected) for the pilot study began on April 26, 2021.

Next Steps

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.
 - May need to develop contingency plans if some data cannot be acquired.

Spatial & Temporal Analysis:

- Finalize the standardizing and geocoding of location data.
- Continuously adding new layers to dataset and work across projects on data analysis.
- Complete analysis for spatial and temporal clustering of deaths.

Cause Specific Analysis:

- Analysis will use latest mortality data and is expected summer 2021.
- Analysis of excess mortality by groupings of death categories using the International Classification of Diseases⁺⁺⁺.
- Analysis covers: (1) up to 14 days post landfall, and (2) up to 6 months post landfall (Sept 2017 – Feb 2018).

Verbal Autopsy:

- Finalize pilot study and update the survey instrument as required.
- Deployment survey in four study regions (expected by late summer).
 - Concern with accuracy of contact information of next of kin and key informants.
 - Concern with response rates, based on early feedback from pilot study.
 - Develop a public engagement plan with public affairs officers at NIST, GW, and UPR to support interview recruitment.
- Finalize framework for attribution analysis, including risk factors associated with building failures.

Medical Records and Hospital Functions Review:

- Identify data required for attribution determination by clinical panel; finalize clinical panel members; develop survey instrument as needed to acquired additional hospital data.

⁺⁺⁺World Health Organization. (2004). ICD-10 : international statistical classification of diseases and related health problems : tenth revision, 2nd ed. World Health Organization.

NCST Technical Investigation of Hurricane Maria (Puerto Rico)

Characterization of Morbidity and Mortality

Project Leader: Judith Mitrani-Reiser, PhD, NIST

Project Team: Thomas D. Kirsch, MD, MPH

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



Questions?

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