NCST Technical Investigation of Hurricane Maria's Impacts on Puerto Rico:

Goal 1b: Characterize the technical conditions associated with deaths and injuries.

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NCST Advisory
Committee Meeting

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Goal 1: Characterize the Wind Environment and Technical Conditions Associated with Deaths and Injuries

Goal 1b: The Wind Environment and Technical Conditions Associated with Deaths and Injuries

this presentation

Project: Characterization of Morbidity and Mortality

Project Objective: the objective of this project is 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 wind storm building failure(s).

Studies and Estimates of Morbidity and Mortality in Puerto Rico

- Puerto Rico's Department of Public Safety certified **64*** deaths related to the storm*, but later updated this estimate to **1,427**** on June 13, 2018 and to **2,975***** on August 28, 2018.
- The New York Times and other news organizations estimate that the actual death toll could be **over 1,000***, based on analysis of daily mortality data from Puerto Rico's Vital Statistics Record Office.
- Letter to the Editor of JAMA provides an estimate of **1,139****** excess deaths through December 2017, using death counts from vital statistics records and updating a previous estimate.
- Harvard School of Public Health conducted a population-based survey and estimated **4,645******* deaths.
- George Washington University conducted a study of excess mortality, and estimate that there were **2,975******** excess deaths in Puerto Rico from September 2017 through the end of February 2018.

*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.
** Puerto Rican Government, 2018. "Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico," a preliminary report dated July 9, 2018 and released for public comment.
***Darrah, N., 2018. "Puerto Rico governor raises Hurricane Maria death toll from 64 to 2,975." *Fox News*. August 28, 2018.
****Santos-Lozada AR, Howard JT, 2018. "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., 2018. "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.

Puerto Rico's Certified Deaths and Background

- The official death toll by the Puerto Rico's Dept. of Public Safety was initially **64***, but on June 13, the Government of Puerto Rico revealed that there were **1,427**** more deaths in the four months after the hurricanes than normal (based on the previous four years), and updated the official count to **2,975***** based on George Washington University's study.
- It has been challenging to develop guidance/policy to prevent disaster attributed mortality due to the ***lack of standards, consistent data collection and reporting.***********
- There is disagreement on the contribution of indirect exposure to adverse health outcomes.****
- A ***directly-related death*** is a direct result of the forces/energy of the disaster or by the immediate consequences of these forces, such as structural collapse, flying debris, or radiation exposure.****
- An ***indirectly-related disaster*** death occurs when the unsafe or unhealthy conditions present during any disaster phase (i.e., pre-event, during, or post-event during recovery) contribute to a death.****
- Death certificates generally greatly underestimate deaths (both direct and indirect) caused by a disaster event.****
- Population surveys may be more accurate, but can over-estimate.*****

*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.
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***Darrah, N., 2018. "Puerto Rico governor raises Hurricane Maria death toll from 64 to 2,975." *Fox News*. August 28, 2018.
****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.
*****(CDC) Centers for Disease Control and Prevention, 2017. "Vital Statistics Reporting Guidance: A Reference Guide for Certification of Deaths in the Event of a Natural, Human-induced, or Chemical/Radiological Disaster." October 2017

Analysis of Daily Excess Deaths

- ***Summary*:** the New York Times (NYT) and other news organizations estimate that the actual death toll could be over 1,000, based on analysis of daily mortality data from Puerto Rico's Vital Statistics Record Office.*
- ***Methods*:** the NYT analysis compares the number of deaths for each day in 2017 with the average of the number of deaths for the same days in 2015 and 2016.*
- ***Notes*:**
  - The deadliest day was September 25, 2017.
  - In Puerto Rico, medical examiners include direct and indirect deaths to count official storm-related deaths.*
  - The highest spikes in number of deaths after the storm was in deaths from sepsis (47% higher in 2017), pneumonia (45% higher in 2017), and emphysema (43% higher in 2017).*
  - Possible reasons for additional deaths may be related to delayed medical treatment or poor conditions in homes and hospitals, and oxygen tanks that ran out.*

*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.

Analysis of Monthly Excess Deaths

- ***Summary*:** a research letter to the Editor of JAMA describes variance in deaths due to difference in methods and updates their own estimate to 1,139 (95% CI 1006-1272) excess deaths through December 2017, using death counts from vital statistics records and updating a previous estimate.
- ***Methods:*** the researchers compare 2017 monthly death counts in Puerto Rico after Hurricane Maria to mean monthly death counts estimated from vital records from 2010 through 2016.
- ***Notes:***
  - Greatest monthly excess death occurred in October 2017.
  - Estimate is likely 'conservative' because of mean death counts used the upper 95% CI and did not adjust for the population that left the island.

* 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.

Population-Based Survey of Deaths

- ***Summary:*** Harvard School of Public Health lead a community-based survey in Puerto Rico that resulted in an estimate of 793 to 8,498 deaths.*
- ***Methods:*** study includes a representative stratified population-based sample of 3,299 households (of an estimated 1,135,507 total households), using a remoteness index based on travel time to nearest city.*
- ***Notes:***
  - Researchers estimate a 62% increase in mortality rate between September 20 and December 31 in 2017.*
  - Researchers estimate a median *excess* of 4,645 deaths (95% CI range – 793 to 8,498).*
  - One third of the deaths surveyed are related to delayed or interrupted health care.*
  - On average, persons in the survey were older and households were larger than the ACS 2016 baseline.*

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

Statistical Analysis of Death Certificates

- ***Summary:*** George Washington University conducted a study of excess mortality, and estimate that there were 2,975* excess deaths in Puerto Rico from September 2017 through the end of February 2018.
- ***Methods:*** completed an estimate of excess mortality due to Hurricane Maria by analyzing past mortality patterns using mortality registration and population census data from 2010 to 2017, predicting mortality if Hurricane Maria had not occurred, and a comparing actual deaths to predicted deaths.*
- ***Notes:***
  - Researchers estimate a total excess mortality post-hurricane to be 2,975 (95% CI: 2,658-3,290).*
  - Study accounts for trends in population size and distribution over this period in terms of age, sex, seasonality, residence by municipal level of socioeconomic development, and emigration during the prior decade and dramatic population displacement after the hurricane.*
  - Study ran two different scenarios: one assuming population had not changed (census scenario) and one accounting for post-hurricane population displacement from the island (displacement scenario).*
  - Used data for all deaths occurring between September 2017 to February 2018, provided by the Puerto Rico Vital Statistics Records (PRVSR) division of the Puerto Rico Department of Health (DoH).*

* 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.

Background Material on the NCDMPH (National Center for Disaster Medicine and Public Health)

- The NCDMPH was founded in 2008 under HSPD 21 to be *"…an academic center of excellence in disaster medicine and public health…"*, and *"…shall lead Federal efforts to develop and propagate core curricula, training, and research related to medicine and public health in disasters*."
- The *National Center* is listed as an implementing organization in the National Health Security Strategy 2015-18, and has an important role to play in implementing Strategic Objective 4 – Enhance the integration and effectiveness of the public health, healthcare, and emergency management systems.

NCDMPH
National Center for Disaster Medicine and Public Health

Background Material on the NCDMPH (National Center for Disaster Medicine and Public Health)

MISSION

- The mission of the National Center for Disaster Medicine and Public Health is to improve our Nation's disaster health readiness through education and science.

VISION

- The National Center for Disaster Medicine and Public Health will be the Nation's academic center of excellence leading domestic and international disaster Health education and research efforts. In collaboration with partners, we create and translate science and education to improve readiness.

NCDMPH
National Center for Disaster Medicine and Public Health

Background Material on the NCDMPH (National Center for Disaster Medicine and Public Health)

- ***Readiness:*** NCDMPH is charted to build the Nation's readiness to respond to and mitigate the health effects of all types of disasters both domestically and internationally.
- ***Education and Training:*** NCDMPH will identify educational needs and create content to better prepare the Nation.
- **Research and Scholarship:** NCDMPH will conduct, translate and propagate research that changes readiness practice and policy.
- ***Collaboration and Leadership:*** NCDMPH will engage key internal and external partners to coordinate disaster science and education activities across the Federal government.

NCDMPH
National Center for Disaster Medicine and Public Health

Background Material on the NCDMPH (National Center for Disaster Medicine and Public Health)

- **NCDMPH is a unique organization:**
  - Academic and Federal organization
  - Collaboration is the mission
    - Interagency partners
    - Academic partners
    - Other partners include professional organizations; non-government organizations; and subject matter experts

Preliminary Project Plan: (1/4) Mortality Study

In order to recommend changes to or the establishment of evacuation and emergency response procedures and for improvements to building standards, codes, and practice, we need to use scientifically rigorous methods for:

(1) attributing morbidity and mortality to windstorms (directly and indirectly),
(2) examining the health impact associated with building and building system failures in windstorms,
(3) developing a process to integrate epidemiology and engineering methodologies and tools that better determine the risk factors of and predict life loss due to failures in the built environment.

Preliminary Project Plan: (2/4) Mortality Study

- Develop overall project plans, solidify partnerships, and establish contracts, MOUs, and any other means of formalizing relationships for this multidisciplinary project.
- Work closely with hazard characterization and critical building performance teams to characterize the exposure and causes of building failures.
- Identify important data sources for injuries and fatalities directly and indirectly related to the disaster.
- Review data regarding excess mortality, analyze and geocode deaths using death certificates, and identify sample for in-depth analysis related to direct and indirect deaths associated with building damage and supporting infrastructure failures.

Preliminary Project Plan: (3/4) Mortality Study

- Develop two survey tools for in-depth analysis of risk factors for direct and indirect deaths and injuries:
  - (1) work closely with building performance team to develop physical damage assessment tool to be used in the morbidity/mortality studies.
  - (2) develop survey instrument to identify direct and indirect morbidity and mortality related to building failures.
- Use data analysis to assess the association of the injuries and deaths to building and critical infrastructure failures.

Preliminary Project Plan: (4/4) Mortality Study

- Structured surveys with sampled households
- Direct morbidity and mortality:
  - Did the deaths occur during hazard events associated with Hurricane Maria (e.g., damaging winds, landslides, torrential rains, flooding)?**
  - Did the deaths occur due to the secondary hazard events (e.g., structural collapse, flying debris, falling trees, downed power lines, power outage, carbon monoxide exposure)?**
- Indirect morbidity and mortality
  - Were the deaths caused by unsafe or unhealthy conditions created by the hazard events associated with Hurricane Maria (e.g., evacuation, loss of critical infrastructure including health care, repair or cleanup activities, returning to unsafe structures or environments, disaster preparedness)?**

**(CDC) Centers for Disease Control and Prevention, 2017. “Vital Statistics Reporting Guidance: A Reference Guide for Certification of Deaths in the Event of a Natural, Human-induced, or Chemical/Radiological Disaster.” October 2017

Progress Updates (1/2)

- Completed:
  - Executed IAA with USU/NCDMPH
  - Trip to Puerto Rico (Aug 20-24)
  - Hosting a meeting on Sept 6-7, 2018 to to discuss the state-of-the-practice in post-disaster field data, collection methods, including sampling methodologies across multiple disciplines:
    - Engineering, sociology, economics, geography, public health and health experts
    - Assess availability and quality of injury data
    - Identify optimum methods within each field
    - Potentially identify interdisciplinary methods for future post-disaster studies

Progress Updates (2/2)

- Next Steps:
  - PRA/IRB approvals will be obtained for the protocols, as necessary.
  - Develop injury and death-related survey questions for inclusion in the population and institution-based surveys.
  - Review existing health and public health statistics for the island related to direct, indirect and excess deaths and injuries.
  - Complete a literature review related to direct and indirect and short- and long-term hurricane morbidity and mortality.
  - Develop preliminary public health research methods in coordination with proposed NIST data collection.

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Questions?

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