Hurricane Maria: Response Challenges

Hurricane Maria: Response Challenges

AWRA – NCRS Meeting
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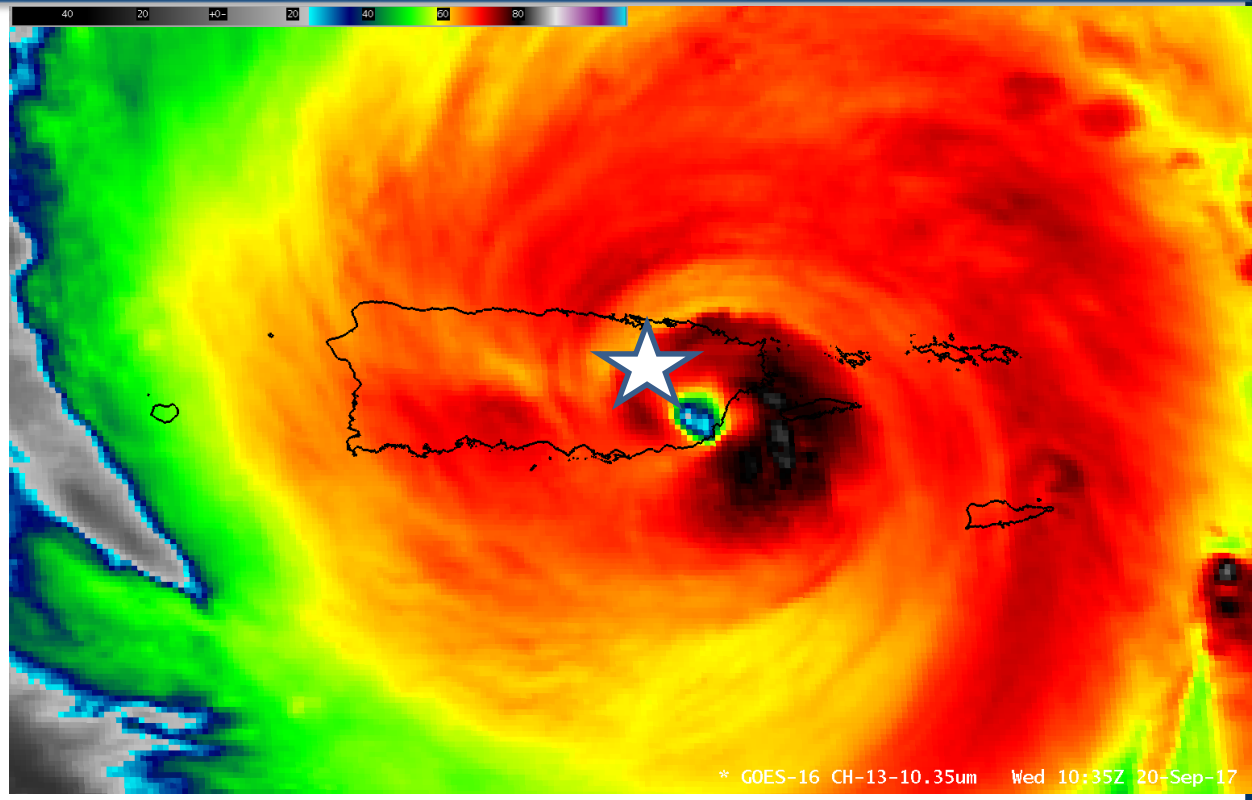
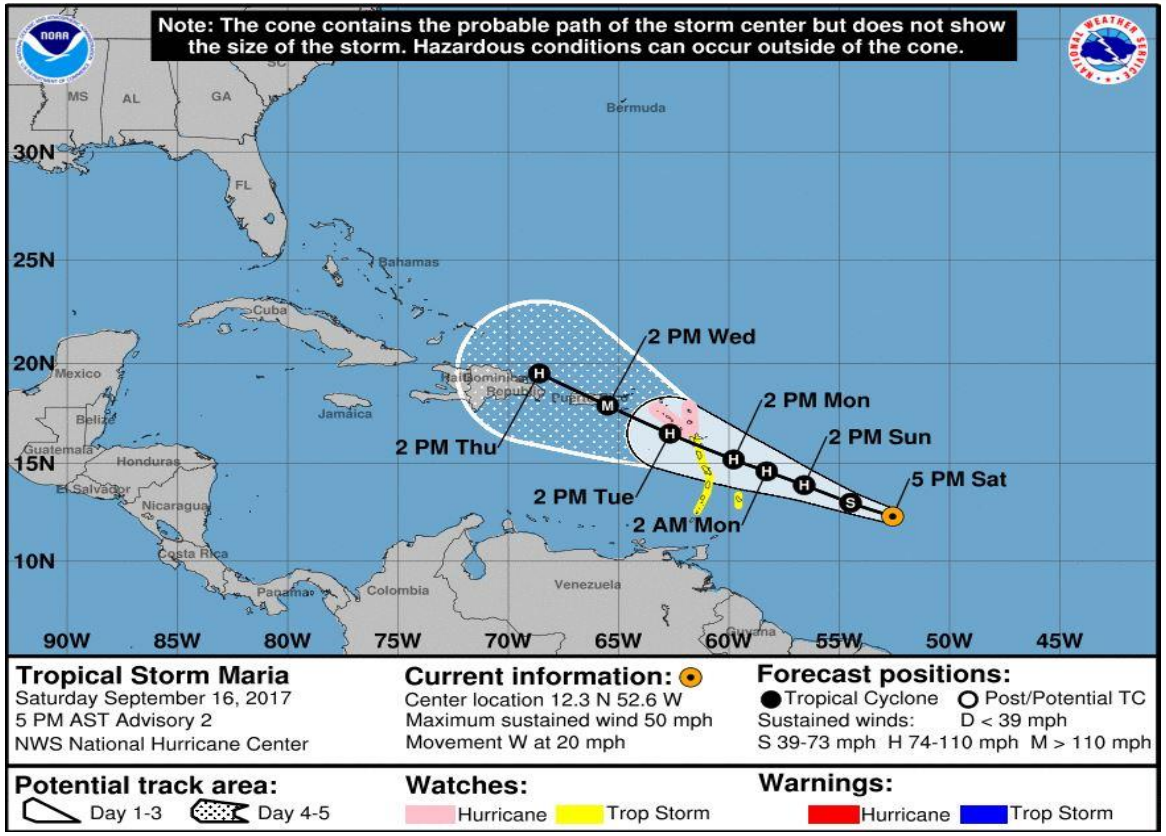


GOES 16 (Now GOES East) Satellite image of Hurricane Maria at landfall on 20 September 2017

Hurricane Maria: Response Challenges

Agenda

- Brief Storm Overview
- Team Deployment
- Post-Storm Communications
- Response Challenges
- Doppler Radar Outages



NHC Forecast Track for Hurricane Maria, issued 5 PM AST 16 September 2017

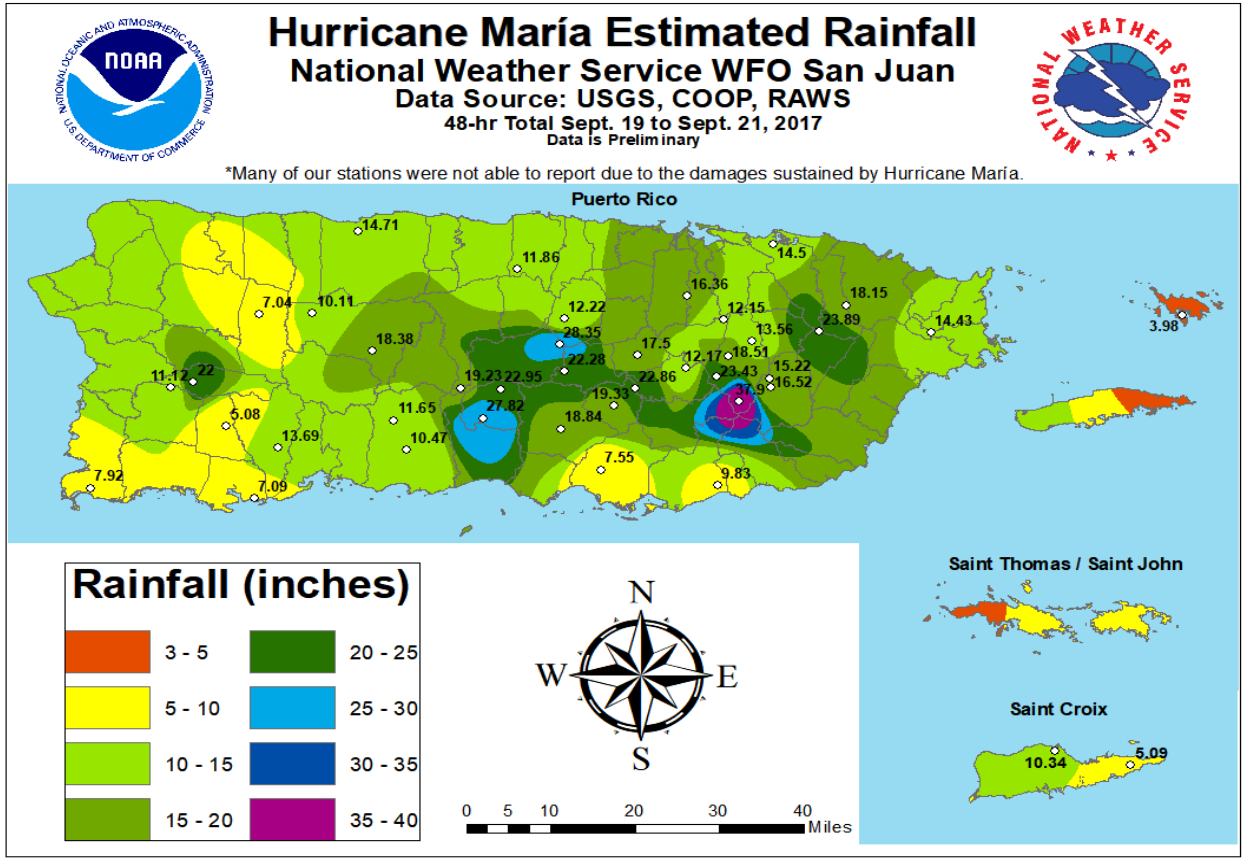
Hurricane Maria: Response Challenges

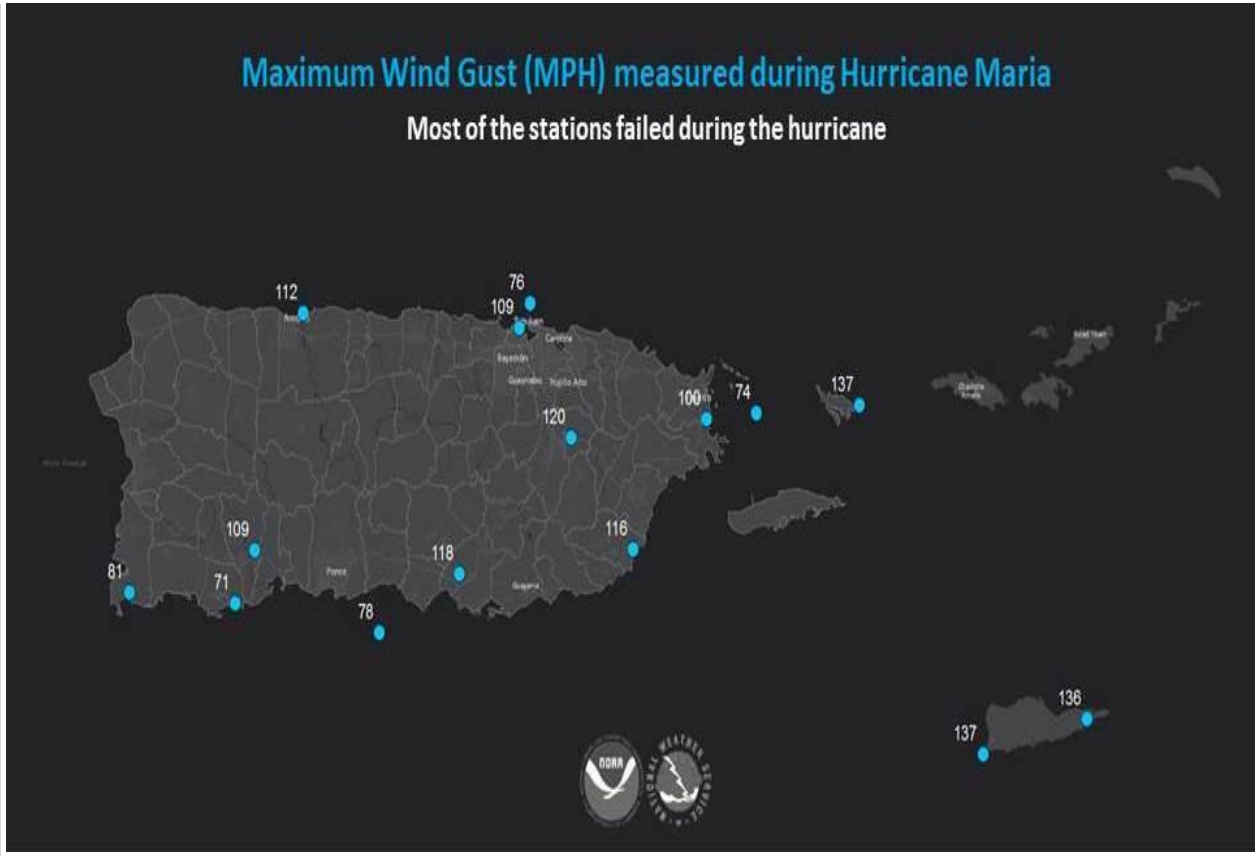
Brief Storm Overview

- Made landfall near Yabucoa, PR 20 September 2017 at 6:15 AM AST
- Maximum Sustained Winds 155 mph at landfall (Category 4)
  - Peak Intensity 175 mph Sustained Winds (Category 5) the evening prior to landfall
- Hurricane-Force Winds and catastrophic flash flooding experienced island-wide
- Most significant storm surge flooding reported along the southeastern coast

HURRICANE MARIA: RESPONSE CHALLENGES

Brief Storm Overview





Estimated Storm Total Rainfall (left) and Maximum Measured Wind Gust (right). Images Courtesy NWS San Juan

***Note: Most rain gauges and wind sensors failed during the storm. Actual values may be higher.**

Hurricane Maria: Response Challenges

Team Deployment

17 Sept.

- Notified 17 September 2017 4 pm EDT of deployment from Florida (Hurricane Irma Response) to Puerto Rico

18 Sept.

- Flew to Puerto Rico; arrived around 3 pm AST

19-21 Sept.

- Reported to FEMA's Distribution Center (DC) Caribbean to work.
- Sheltered-in-Place through 21 September.

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Team Deployment

FEMA's Distribution Center (DC) Caribbean

Air Mattress in Supply Warehouse

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Post-Storm Communications

- Maintained limited internet and cell phone capabilities through around 3 pm on 20 September
  - Cell phone tower ran out of fuel in backup generator
  - Limited number of satellite phones
- 3 days of sporadic to no connectivity depending on exact location

Parked car moved by wind

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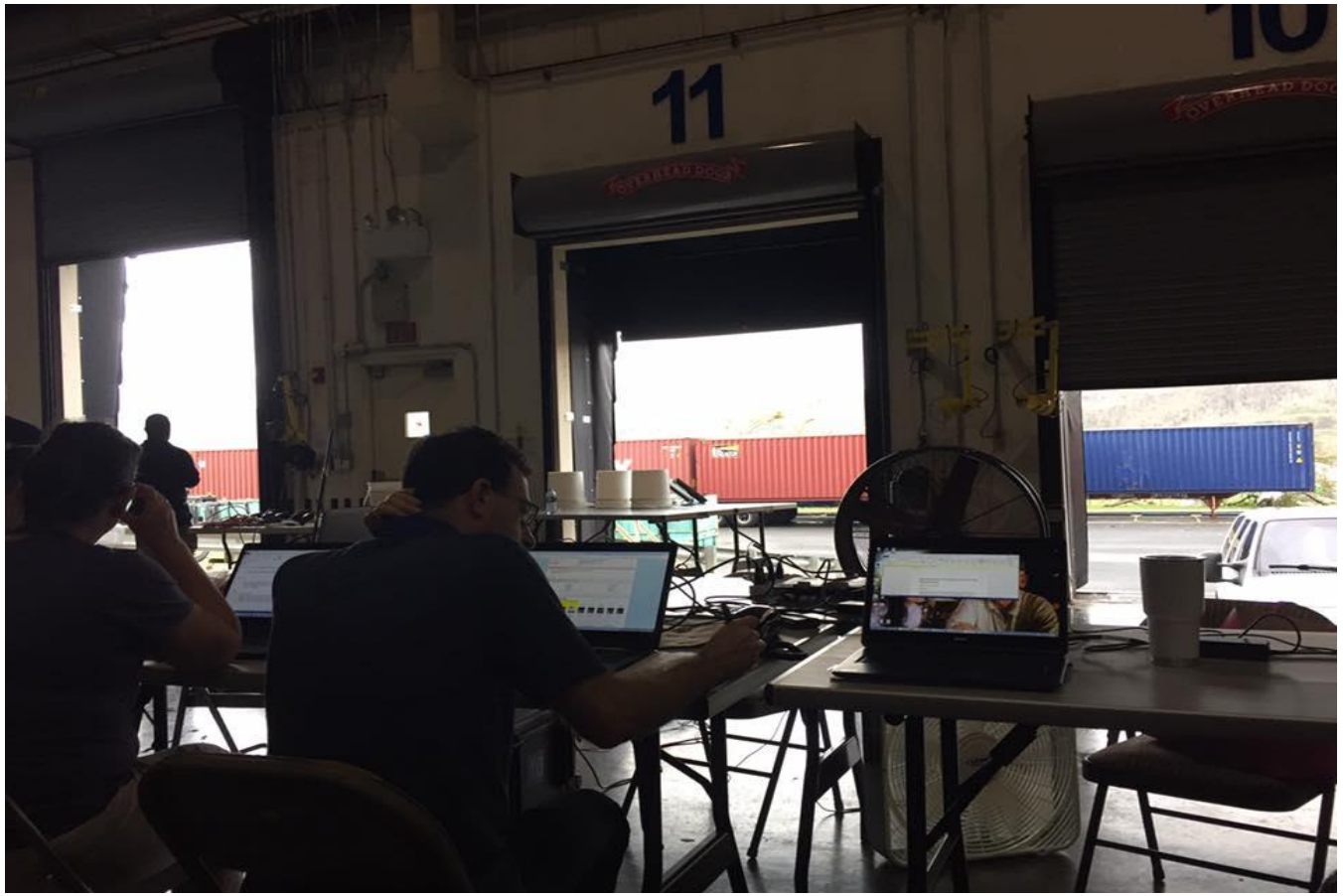
Post-Storm Communications



Using a laptop connected to a BGAN. Photo: Diane Dooley, FEMA

Response Challenges

- Establishing reliable communications
- Obtaining situational awareness
- Flash flooding and landslides
- Guajataca Dam
- Radar Outage

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Concrete power pole snapped by wind. Photo: Diane Dooley, FEMA

Establishing reliable communications

- 100% power loss on the island
- Cell phone towers ran out of backup fuel; some generators taken
- Satellite phones necessary in the field
- Needed in order to obtain situational awareness and determine exact needs (ie, fuel, water, food, USAR, etc.)
- Significant challenge to prepare and produce weather briefings

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Obtaining Situational Awareness

- Communications and power outages made obtaining reliable information nearly impossible for several days to 1 week; often information was conflicting
- No visibility on the ground across the mountains, thus no information
  - Many small mountain towns completely isolated due to washed out bridges and roads
- Difficult to assess specific needs across the island

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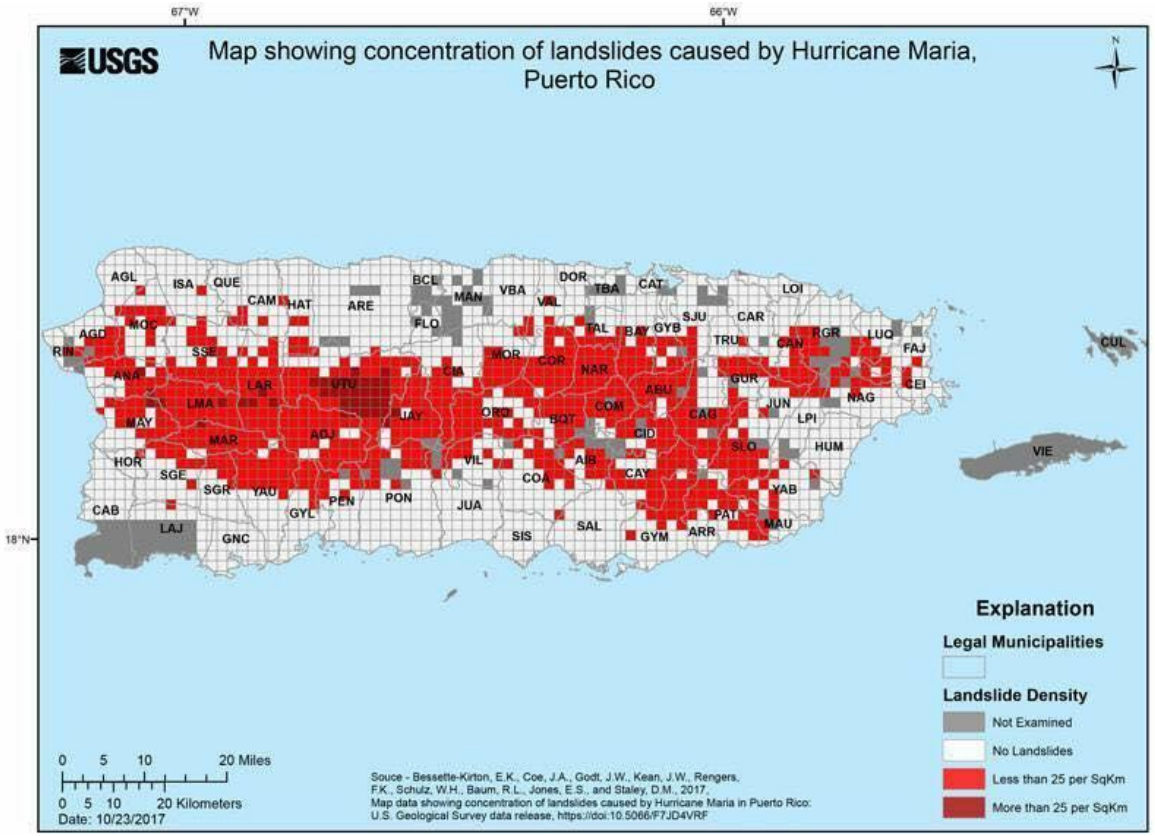
Flash Flooding and Landslides

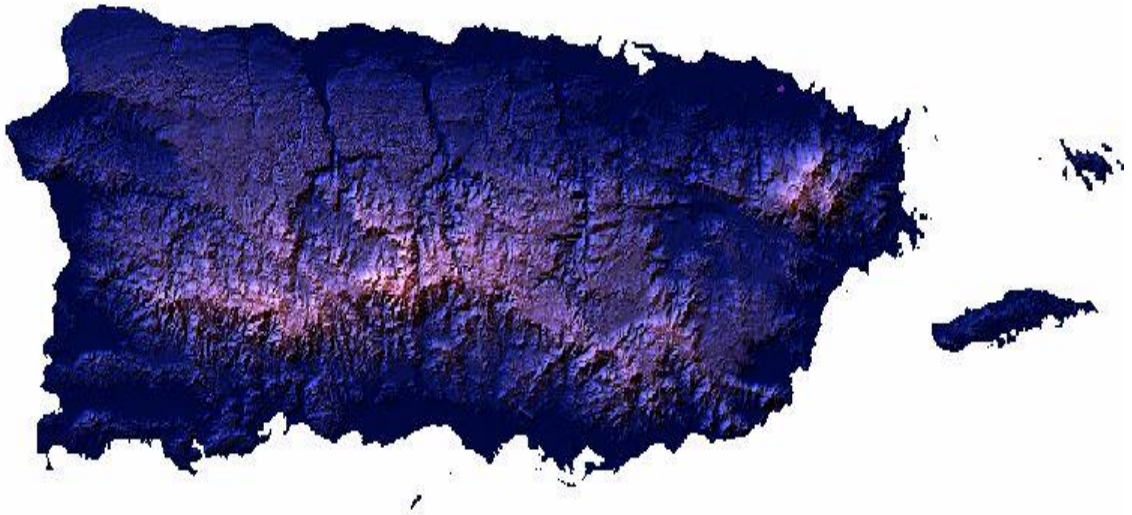
- Heavy rainfall led to significant flash flooding events and landslides for 3 weeks post-storm
- Mountainous areas most frequently impacted
- Additional bridges and roads washed out, further limiting access and supply missions
  - Some roads and bridges that had been repaired were knocked out again
  - Emergency rescues of people on roofs conducted on several days
- Significant impacts on air operations
  - Largest air-supply mission in FEMA's history

HURRICANE MARIA: RESPONSE CHALLENGES

Flash Flooding and Landslides



Concentration of Landslides during Hurricane Maria
(Map courtesy of USGS)



Shaded Digital Elevation Map
(Map courtesy of ESRI)

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Guajataca Dam

- Dam was overtopped/cracked due to heavy rainfall from the hurricane
  - Volume of water flowing over the dam caused significant erosion of the emergency spillway
  - Significant amount of pressure on the dam
  - Limited to no means to expedite water release to lower the lake level for several weeks due to lack of power/equipment
- Initial estimates and media reports of 70,000 people endangered if dam failed
  - Numerous evacuations in the threatened area for several weeks
  - Subsequent modelling efforts determined that only ~150 structures threatened

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Guajataca Dam

- Dam stabilization: daily task force meetings to plan/coordinate efforts
  - PREPA, DoD, USACE, FEMA, NWS, Private contractors/consultants
- PREPA: owners/operators of the dam
- DoD: provided personnel (ie, pilots), trucks, helicopters; facilitated planning
- USACE: dam inspections, remediation recommendations
- FEMA: monetary, logistics and planning support
- NWS: daily weather briefings and real-time notifications of nearby lightning for safety considerations; issuance of Flash Flood Warnings

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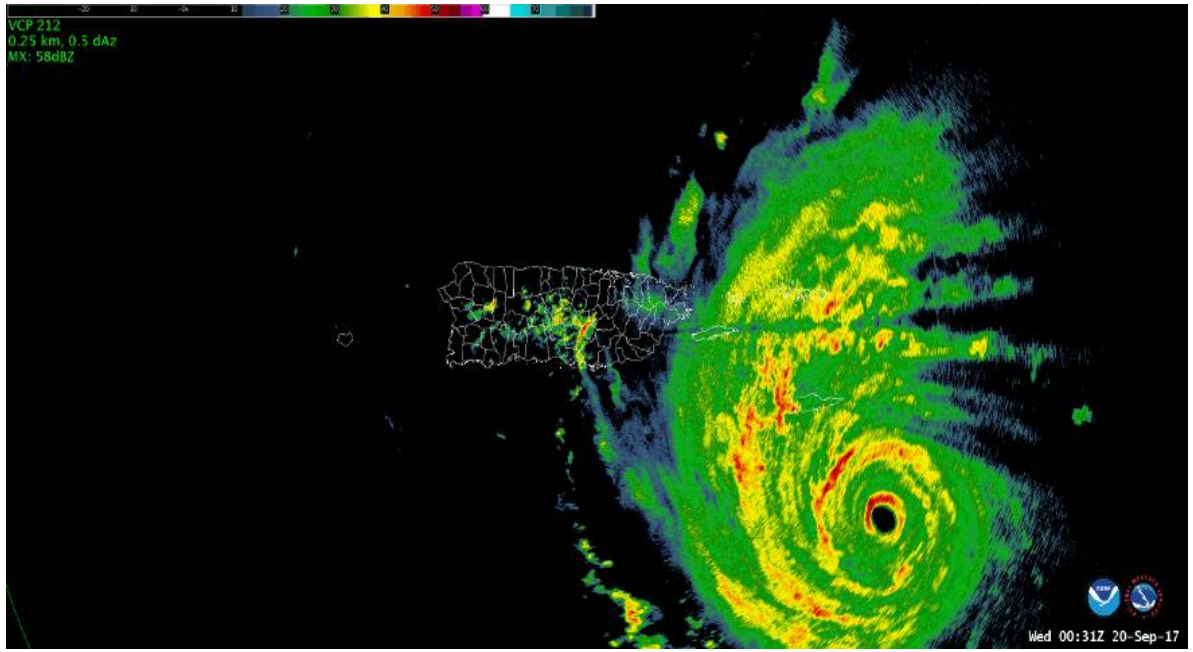

TJUA (WSR-88D) radar loop courtesy of NWS San Juan

Doppler Radar Outages

- FAA's Terminal Doppler Weather Radar (TDWR) lost communications
- TJUA WSR-88D dome and antenna were completely destroyed by winds
  - Radar remains out of service with no estimate of return
- NWS meteorologists relied on GOES-16 (now GOES-East) satellite imagery as well as lightning networks and EM reports to assess flash flooding

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Doppler Radar Outages

- U.S. Marine Corps deployed 2 portable radar units to Puerto Rico to help overcome the radar outages
  - Radar sites established in Rosy Roads and Aguadilla
- Extensive coordination effort between NWS, FEMA and DoD
- DoD will leave radars in place and turn over to NWS control in February until the main Doppler Radar can be rebuilt

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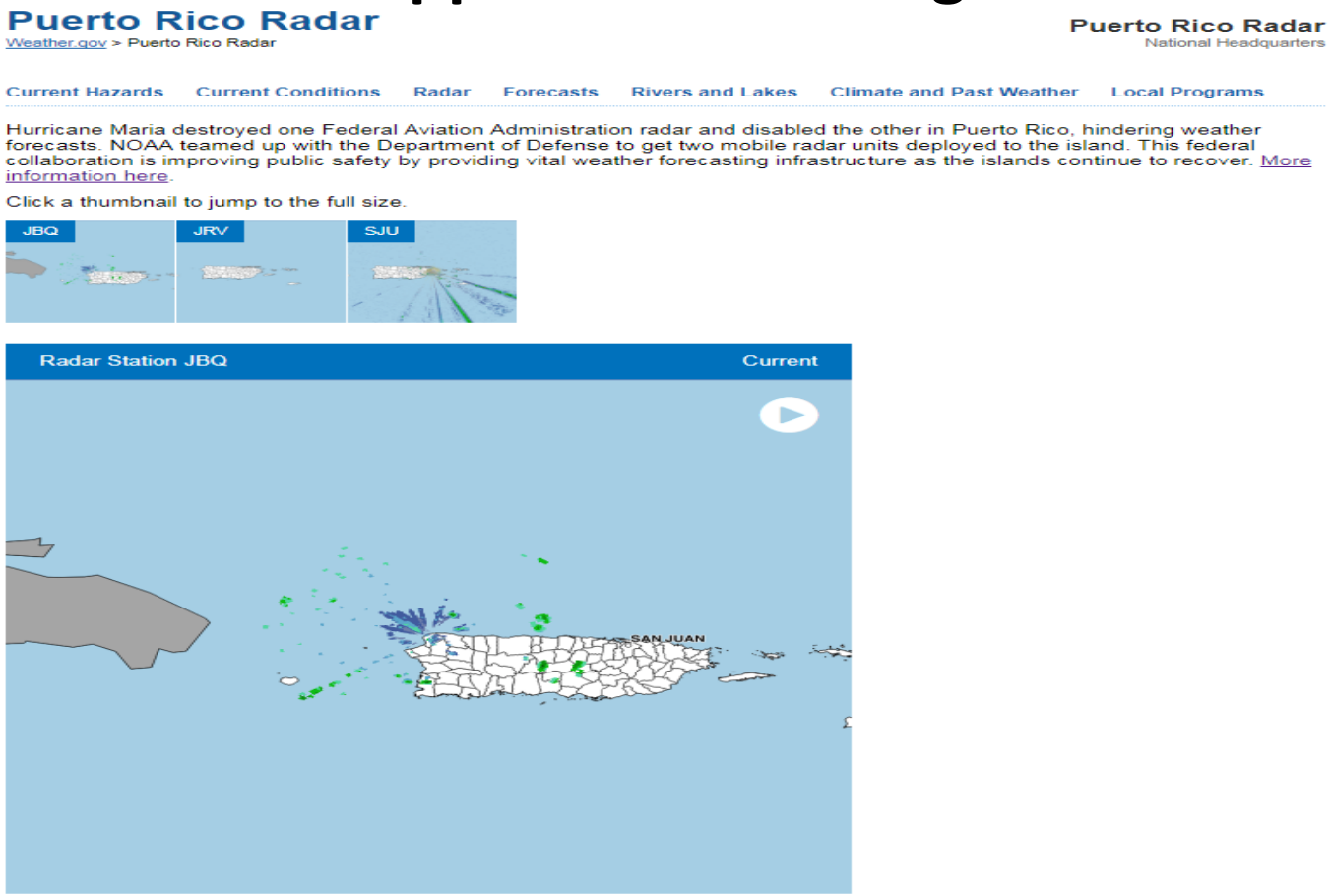
Doppler Radar Outages



DoD radar display at http://www.weather.gov/radar-pr/

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Other Response Challenges

- Logistical challenges/delays in supply arrival from Mainland
  - For example, power poles have to manufactured and shipped to the island
- Safety and security immediately following storm
- Generator installation
- Fuel distribution

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Questions/Comments?

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