



## 8<sup>vo</sup> Simposio de Mantenimiento de Edificios: Lecciones Aprendidas Luego de un Desastre Natural

# Lecciones Aprendidas a Raíz del Paso del Huracán María en la Infraestructura Vial de Puerto Rico

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CATEDRÁTICO UPRM

COLEGIO DE INGENIEROS Y AGRIMENSORES DE PUERTO RICO, HATO REY

VIERNES, 29 DE JUNIO DE 2018

# ¡Buenas Tardes!



PRESENTA

## 8 VO. SIMPOSIO DE MANTENIMIENTO DE EDIFICIOS



### LECCIONES APRENDIDAS LUEGO DE UN DESASTRE NATURAL



Sede CIAPR, Hato Rey  
28 y 29 de Junio de 2018

Co-organización



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*... en solidaridad con  
nuestra gente, en  
particular aquellos que  
sufrieron pérdida de vida  
y familiares a raíz del paso  
del huracán María.*



Source: <http://www.laprensa.hn/>

# Condición de la Infraestructura de Carreteras y Transportación de Puerto Rico

20 de septiembre de 2017

**Landslides**

**Washed-out Pavements**

**Traffic Signals**

**Coastal Erosion**

**Power Grid Reconstruction**

**Reconstruction of Telecommunications**

**Debris clean-up**





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*“It is critical to get the island’s infrastructure **in working condition** as soon as possible so **relief supplies and other assistance** can be delivered to the people of Puerto Rico.”*

**Elaine L. Chao**

**Secretary of the United States Department of Transportation**

Source: <https://www.fhwa.dot.gov/pressroom/fhwa1716.cfm>



*“El Huracán María nos dejó como lección palpable que estamos ante un nuevo paradigma de construcción y que **parte de nuestra infraestructura no estaba ni remotamente lista para un huracán de esta fuerza.** Construir lo mismo, informalmente, sólo nos llevará a tener que repetir el ejercicio de construcción innumerables veces.”*

**Ing. Pablo Vázquez Ruiz  
Presidente CIAPR**



*“La respuesta no es detener el desarrollo, la respuesta es ser capaces de adaptar la manera en que trabajamos en nuestras sociedades, para que sean capaces de anticipar estas tendencias en vez de responder a ellas tardíamente como sucedió en el pasado”*

**António Guterres**  
**Secretario General de la ONU**

Fuente: <https://www.un.org/sustainabledevelopment/es/>



*“Como nación, gastamos cientos de miles de millones de dólares arreglando cosas tras el desastre, en la respuesta y la recuperación, pero solo un pequeño porcentaje en fortalecer (las estructuras) para tormentas futuras. Lo estamos haciendo al revés.”*

**Bryan Koon**

**Ex-director de Manejo de Emergencias de Florida**

# Puerto Rico Highways and Transportation Authority's Mission and Vision

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## MISSION

Lead Puerto Rico towards economic development through an efficient transportation system, safely and in accord with the environment, while procuring the delivery of excellent service

## VISION

Develop and promote an integrated transportation system that, along with a highway infrastructure and service delivery, will facilitate the economic development of Puerto Rico in harmony with the environment

# An Evolving Mission of PRHTA since its creation (PRHA/1965) and during the last 53 years (1965-2018)

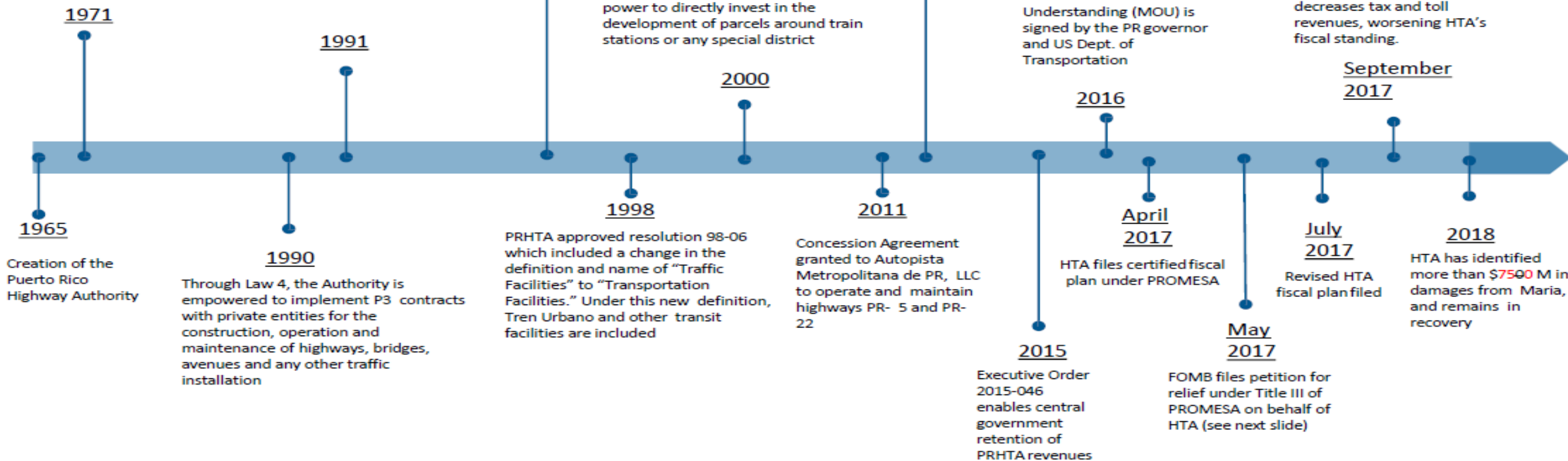
- HTA falls under DTOP's umbrella through the Reorganization Plan Num 6, conceding its powers and duties to the Secretary
- Integration of the mass transportation sector through the successful establishment of exclusive lanes project for AMA buses is put in place

The Secretary of DTOP grants the name Highways and Transportation Authority through Law 1, becoming the principal promoter and administrator of mass transportation public policies

The construction of Teodoro Moscoso Bridge is completed, becoming the first highway privatization project in PR and the US with an investment of \$126M

- Toll Credits were implemented to benefit HTA by using the credits to substitute the required local share on future Federally aided projects
- Law 41-2014 amended the Organic Act of PRHTA to vest its powers in a Board of Directors

- Hurricane Maria hits Puerto Rico, causing widespread damage to infrastructure, including prolonged power outages, damage to toll facilities, roads, and bridges.
- Economic impact of Maria decreases tax and toll revenues, worsening HTA's fiscal standing.





*“Our highways were already in a delicate state, but the damages that occurred would have happened even if they had been in good condition. [...] We had two category 5 hurricanes, back-to-back. We had never experienced this before in Puerto Rico.”*

**Eng. Carlos M. Contreras Aponte**  
**Secretary of the Puerto Rico**  
**Department of Transportation and Public Works**

Fuente: <https://www.elnuevodia.com/>

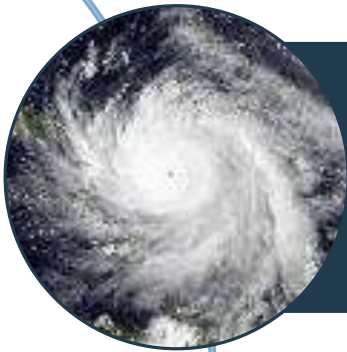
La ACT y el Plan  
Fiscal Certificado por  
PROMESA:2018-  
2023



As Certified by The Financial Oversight and Management Board for Puerto Rico  
April 20, 2018

# Contenido de la presentación

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PARTE 1: Estatus y retos en la infraestructura vial de Puerto Rico a raíz del paso del Huracán María



PARTE 2: Lecciones aprendidas en la resiliencia del sistema de transportación a raíz del paso de desastres naturales extremos

# Contenido de la presentación

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PARTE 3: Iniciativas del programa federal Cada Día Cuenta (EDC) relacionadas a resiliencia y cambio climático



PARTE 4: Propuesta para el Desarrollo de Puerto Rico del CIAPR

# Parte 1

Estatus y retos en la  
infraestructura vial de  
Puerto Rico a raíz del paso  
del Huracán María



Source: Naval Research Laboratory, NOAA

# Datos pertinentes del Huracán María y su paso por Puerto Rico



Source: CNN, National Weather Service

Upon landfall (Sep. 20, 6:15 AM):

- Pressure: 917 mBar (27.08 in Hg)
- 1-Minute sustained winds: 155 mph (250 km/h, Category 4)
- Hurricane strength winds reach 60 miles (100 km) from center

Officially documented deaths: 64 (January 1, 2018)

**Hurricane Maria is the most intense hurricane to landfall in Puerto Rico since 1928**

# Estimated damages caused by Hurricane María (\$114M to HTA's non-highway assets)\*

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- HTA's direct loss assessment to-date indicate that Maria caused \$71M in damages, excluding damage to the highway network.
- At the time received, the assessment (shown to the right) was only complete for 62% of assessed categories.
- Assuming a linear distribution, HTA estimates total costs in the fiscal plan to be \$114M. Additional loss estimates are likely.
- HTA estimates that the vast majority of the direct costs, or \$108M, will be covered by emergency funds and insurance payments, with a local funding need of \$6M. HTA will meet the local share of all additional federal funding it receives.
- Some indirect costs, including lost revenues may not be covered

\*Hurricane Maria damages are almost all covered by Emergency Relief (ER) and insurance coverage

# Estimated damages caused by Hurricane María (\$114M to HTA's non-highway assets)\*



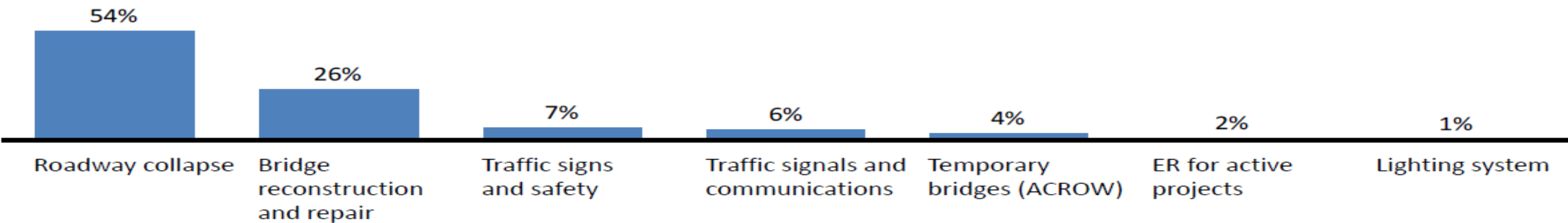
PW Assistance Project - PW Listing  
PR Highway and Transportation Authority (PRHTA)

Category	Sub-Category	Costs
Force Account Labor and Equipment	Force Labor Account Payroll	184,111
	<b>Total</b>	<b>184,111</b>
Emergency Protective Measures	First Transit Buses for Military Personnel	44,686
	First Transit Buses use during Emergency	29,236
	Security Protection for Toll System Facilities	21,392
	Health & Safety Inspections Facilities	3,500
	Provision of Foods, Water and Other Essential Items to COE (Central Operacional de Emergencia )	20,287
	First Transit Security Protection	63,000
	Direct Administrator Cost	17,078
	Temporary Generators Facilities Rental (including Maintenance and Diesel)	346,691
	Vehicle Rentals, Equipment, Parts	213,829
	<b>Total</b>	<b>759,699</b>
Emergency Road Repairs	Emergency Road Repairs	1,800
	<b>Total</b>	<b>1,800</b>
Building and Equipment Damages	PRHTA Offices Damages and Repairs	1,508,049
	PRHTA - Toll System Equipment Damages and Repairs	97,191
	PRHTA- 2% Mapfre Insurance Deductible	958,687
	PRHTA Vehicles Damages and Repairs	18,311
	First Transit Bus Damages	16,142
<b>Total</b>	<b>2,598,380</b>	
Debris, Emergency Protective Measures & Building and Equipment Damages	Debris, Emergency Protective Measures & Building and Equipment Damages	67,668,704
	<b>Total</b>	<b>67,668,704</b>
<b>Total</b>		<b>71,212,694</b>

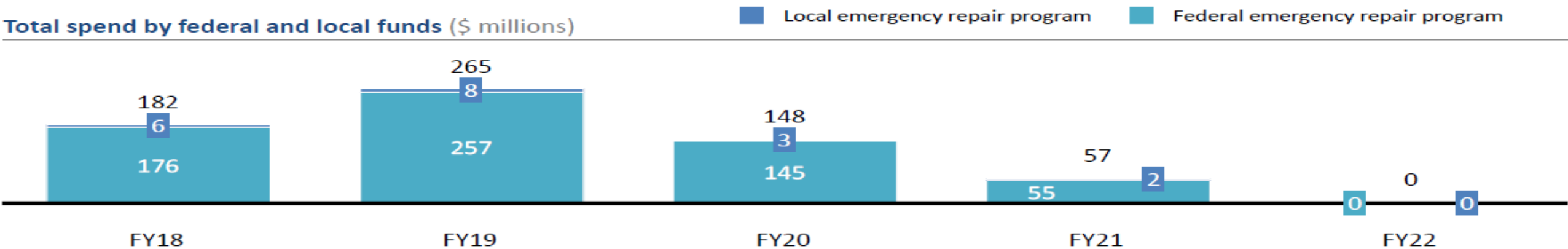
\*Hurricane Maria damages are almost all covered by Em Preliminary Damage Estimates. Subject to Change / Finalization

# Estimated damages caused to the PRHTA Highway Network by Hurricane María (\$652M; 97% covered by Federal Funds/FHWA, etc.)

Percent of budgeted repair cost by category



Total spend by federal and local funds (\$ millions)



1 Bipartisan Budget Act of 2018, 115th Cong., 2d Sess. (2018). Page. 88; line 8.

# Comparación de métricas de comportamiento de la red de carreteras de Puerto Rico con los Estados Unidos antes del paso del Huracán María: Key Performance Indicators (KPIs)

Performance Metric	Description	Metric Results
1 Fatality Rate	Ratio of total number of fatalities to the number of VMT (2015)	<p>PR: 1.96, US: 1.08, National Safety Goal: 1.892</p>
2 % Pavement in Good Condition – Interstate (IS)	Pavement rating with an IRI value of less than 95 or Good condition (2014)	<p>PR: 11%, US: 77%, National goal: 27%</p>
3 % Pavement in Bad Condition - IS	Pavement rating with an IRI value greater than 170 or Bad condition (2014)	<p>PR: 21%, US: 3%, National goal: 22%</p>
4 % Pavement in Good Condition - Non-IS	Pavement rating with an IRI value of less than 95 or Good condition (2014)	<p>PR: 1%, US: 55%, National goal: 18%</p>
5 % Pavement in Bad Condition - Non-IS	Pavement rating with an IRI value greater than 170 or Bad condition (2014)	<p>PR: 68%, US: 10%, National goal: 40%</p>
6 Bridge Area Condition (NHS)	% of total bridge deck area classified as structurally deficient (2016)	<p>PR: 9%, US: 10%, National goal: 0.45%</p>

- National Safety Goal on is to have a significant reduction in the fatality rate, while target is set by state at 1.85 for fatalities by 2018.
- National goal is to maintain the highway infrastructure asset system in a state of good repair.
- HTA will monitor performance against these key metrics, and strive to make improvements in road and bridge conditions and safety within its budgetary constraints.

# Condición de la Infraestructura de Puerto Rico: Antes del Impacto del Huracán María

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## BRIDGES

Inventory: 2,304 bridges (2015)

- National Highway System: 780
- Deficient classification: 1,269
- Functionally obsolete: 968
- Structurally deficient: 301

Design life: 50 years

- 33.1% (762) of bridges are 50 years or older
- 12.5% (287) of bridges are 75 years or older

Source: Eng. Javier Arroyo, PRHTA-DTPW, August 2015

## PAVEMENTS

Approximately 16,694 miles  
(26,860 km) of roads.

Inspected in 2014: 7,467.59 km of  
National Highway System

Pavement network rating:

- 80.4% poor
- 16.7% fair
- 2.9 % good

Source: *Pavement and Bridge Condition, Puerto Rico NHS Network 2014*  
Eng. Cándido Camacho Ayala, ACT

# Impact of Hurricane María on PRHTA Operations and Finances

- **Infrastructure Damage:** Roads, bridges, were damaged in the hurricane, and major projects were delayed due to the temporary realignment of resources towards recovery. HTA was unable to execute planned capital improvements, focusing instead on emergency repairs to bring infrastructure back online.
- **Public Transit Damage:** Several Tren Urbano (TU) stations were damaged by Maria, with limited service returning in late December.



# La importancia de la Infraestructura de Transportación en el Desarrollo Económico de Puerto Rico

Transportation infrastructure is a key asset to the economy

- Access to employment and services
- High value manufacture exports
- Consumer good imports
- Tourism
- Construction
- Government income related to transportation activities
- Economic competitiveness component

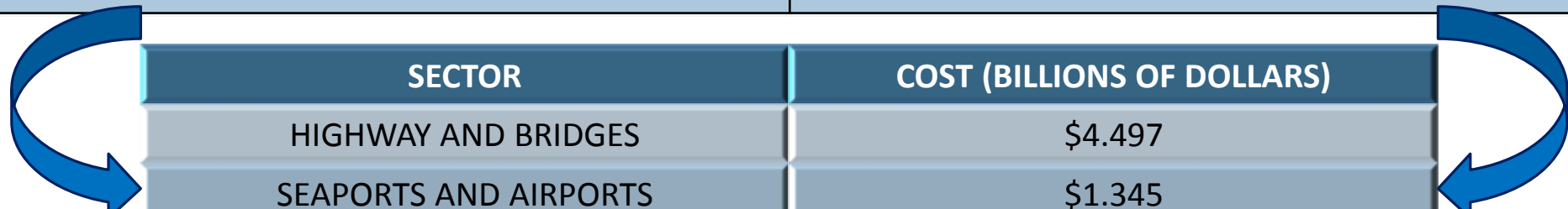
Item	Value in 2016
GDP in transportation and warehousing	\$985 million (1%)
Net income in transportation	\$720 million (0.8%)
Visitor expenditures	\$3,985 million (3.8%)
Federal funding for transportation government agencies and public corporations	\$234 million
Total value of exports	\$71,856 million (68.4%)
Total value of imports	\$43,320 million (41.2%)
Personal expenditure in transportation	\$6,226 million (5.9%)

Source: Statistical Appendix of the Economic Report to the Governor 2016

# Estimado de Costos de Reparación de Puerto Rico subdividido por sectores

**\$94.392 billion**

SECTOR	COST (BILLIONS OF DOLLARS)
HOUSING	\$31.068
POWER GRID	\$17.789
HEALTH	\$14.946
OTHERS	\$30.589



SECTOR	COST (BILLIONS OF DOLLARS)
HIGHWAY AND BRIDGES	\$4.497
SEAPORTS AND AIRPORTS	\$1.345
RESTORATION OF PUBLIC BUILDINGS	\$0.153
DRAINAGE SYSTEMS	\$1.409

Source: Office of the Governor

# Estatus de la Restauración de Servicios Esenciales de la Isla

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- ❑ PREPA: 97.27% generation and 95.93% of customers (April 20, 2018)
- ❑ PRASA: 98.93% of customers, 1,216,159 active water meters (April 14, 2018)
- ❑ Telecommunications: 99% of customers (April 14, 2018)
- ❑ Reopened seaports: 100% (January 24, 2018)
- ❑ Service stations: 88% (December 26, 2017)
- ❑ MBA Routes: 100% (January 24, 2018)
- ❑ Tren Urbano: 14 out of 16 stations reopened (December 2017)
- ❑ Post Offices: 100% (January 24, 2018)

Source: <http://status.pr/>

# SIX MONTHS AFTER MARÍA



## COMMODITIES



POTABLE WATER  
**16.99**  
MILLION GALLONS



BOTTLED WATER  
**72.57**  
MILLION LITERS



MEALS  
**63.16**  
MILLION

## POWER-GENERATORS



**1,969**  
TOTAL GENERATORS INSTALLED

**890**  
TOTAL STILL IN USE

## DEBRIS CLEARED



**6.47**  
MILLION CUBIC YARDS

## HOUSING, PUBLIC ASSISTANCE AND SBA

### INDIVIDUAL AND HOUSEHOLDS PROGRAM



TOTAL REGISTRATIONS  
**1.1** MILLION  
TOTAL DOLLARS APPROVED  
**\$1.15** BILLION

### PUBLIC ASSISTANCE



TOTAL DOLLARS OBLIGATED **\$1.3** BILLION  
DEBRIS REMOVAL **\$69** MILLION  
EMERGENCY PROTECTIVE MEASURES **\$1.23** BILLION

### SMALL BUSINESS ADMINISTRATION



TOTAL LOANS APPROVED **32,839**  
BUSINESS **1,722**  
HOMEOWNERS & RENTERS **31,117**  
TOTAL DOLLARS APPROVED **\$1.2** BILLION

## DISASTER UNEMPLOYMENT ASSISTANCE



APPROVED  
**7,179**  
AMOUNT DISBURSED  
**\$5.3** MILLION

## NUMBERS OF FEDERAL CIVILIAN EMPLOYEES AND MILITARY PERSONNEL

FEMA **2,868**  
INCLUDING PUERTO RICAN EMPLOYEES **1,515**

DEPARTMENT OF DEFENSE **1,827**

TOTAL **4,695**

## TEMPORARY ROOFING



FEMA SELF HELP TARPS  
**125,981**

U.S. ARMY CORPS OF ENGINEERS  
BLUE ROOFS INSTALLED



**59,381**

Numbers as of March 15

Source: Mr. Sonny Beauchamp, FEMA (March 15, 2018)

# Estatus de Restauración del Sistema de Semáforos en Intersecciones

- ❑ 1,224 signalized intersections (February 27, 2018)
  - ❑ 100% of intersections sustained damage
  - ❑ 600 powered and operational
  - ❑ 200 intersections remain with severe damage.
  - ❑ 424 repaired but not operational

## Evaluarán el jueves las intersecciones que serán energizadas primero

La Autoridad de Energía Eléctrica y el Departamento de Transportación y Obras Públicas comenzaron a intercambiar información

martes, 27 de febrero de 2018 - 2:52 PM

Por Javier Colón Dávila



Thursday, March 1, 2018



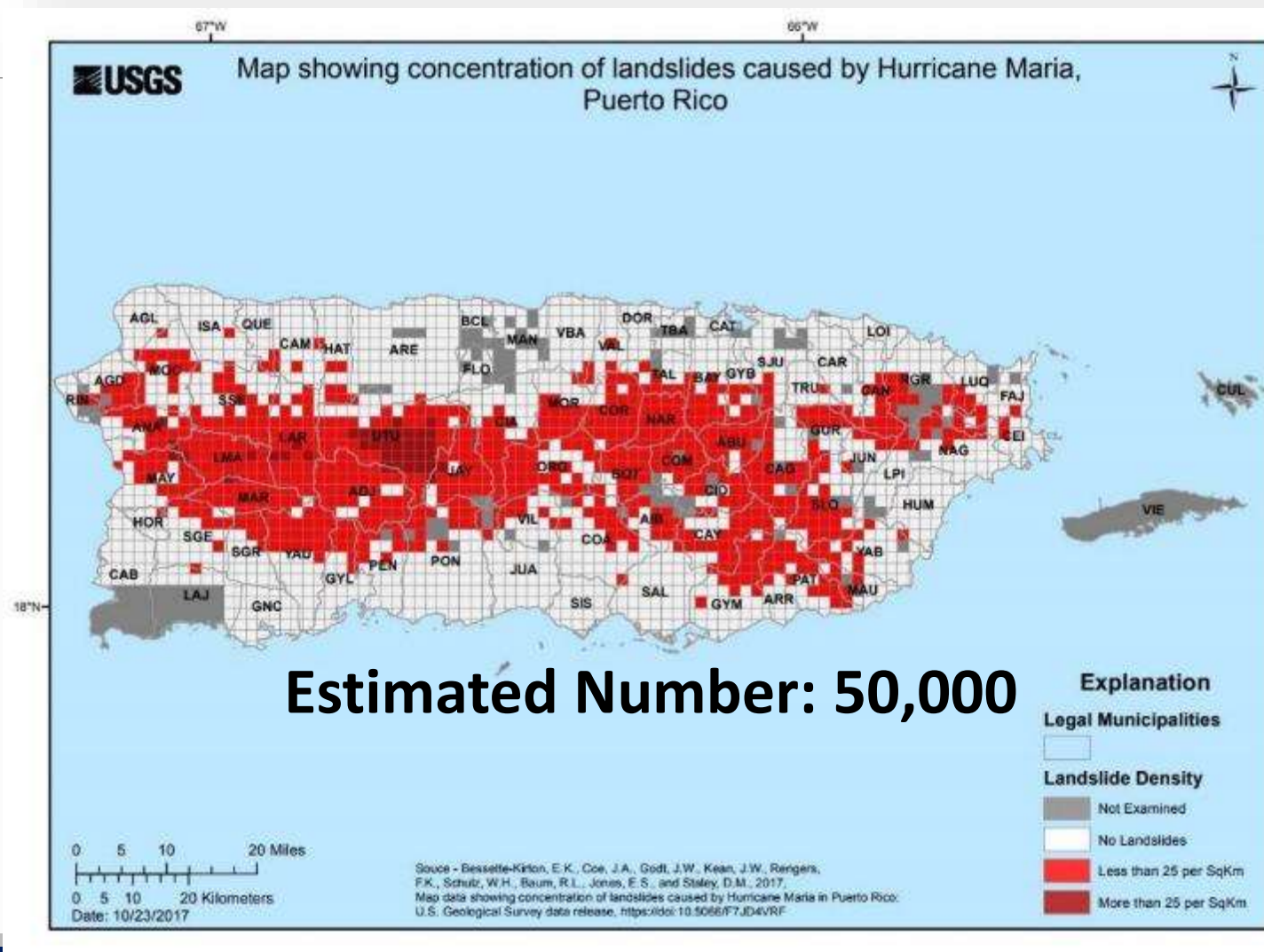
Source: El Nuevo Día

# Efecto del Huracán María en el Inventario de Puentes

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- Bridge Inventory: 2,343 (2017):
  - 1,772 over water bodies (75.6%), 571 over highways and other depressions (24.4%)
- Collapsed bridges: **26 (1.1%)**
- Collapsed bridge approaches (bridge closure): **31 (1.3%)**
- Other damages: **331 (14%)**
- Total number of damaged bridges: **388 (17%)**
  - National Highway System bridges with damage: **42 (1.8%)**
- Average year of construction of collapsed bridges: **1968**
- (Average age: 50 years)

# Estimado de Deslizamientos de Terrenos en la Isla



# Deslizamientos de tierra y derrumbes



OROCOVIS, PUERTO RICO  
Source: Univision Noticias



COROZAL, PUERTO RICO  
Source: Getty Images, Univision Noticias

# Erosión e inundaciones en la Zona Costanera



MAYAGÜEZ, PUERTO RICO  
Source: Authors



PR-64 in MAYAGÜEZ, PUERTO RICO  
Source: Authors

# Inundaciones Urbanas



GURABO, PUERTO RICO  
Source: gfrmedia.com



SAN JUAN, PUERTO RICO  
Source: Getty Images, Univision Noticias

# Inundaciones por desbordamientos de los cauces de ríos



PR-2 in YAUCO, PUERTO RICO

Source: Carlos García Rawlings, REUTERS, Univision



GUAYAMA, PUERTO RICO

Source: Carlos García Rawlings, REUTERS, Univision

# Fallas de Accesos a Puentes



## Destrucción rotulación, mastiles y mobiliario a la orilla de la carretera



# Logística de la cadena de suministro, combustible, cajero automático



## Parte 2:

Lecciones aprendidas en la resiliencia del sistema de transportación a raíz del paso de desastres naturales extremos



Source: <http://www.primerahora.com>

# Puerto Rico Faces the Island-Wide Challenge of Recovery

**Landslides**

**Washed-out Pavements**

**Coastal Erosion**

**Traffic Signals**



**Reconstruction of Telecommunications**

**Debris clean-up**

**Power Grid Reconstruction**



# Post-Disaster Recovery Activities Within the Highway Network

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Repair and reconstruction of highway facilities

- Coastal erosion, landslides
- Bridge erosion and wash-outs

Repair of roadside appurtenances

- Traffic signals and signs
- Utilities (power, water, telecommunications)

Clean-up of rubble and debris

Delivery of disaster relief supplies

**All of these activities affect traffic operations**



Source: play.mobicast.tv

# Hazardous Conditions Requiring Temporary Traffic Control (TTC) In a Post-Hurricane Setting



Source: <http://bahiia.com>



Source: <http://www.utuadohoy.com>

Inoperative traffic signals → police and access management for traffic control

Bridge failures, landslides and debris obstruct or destroy highway segments

- Barriers, channelizing devices and signage to block/restrict passage are essential

# Challenges Affecting Infrastructure Repair in the Face of Climate Change and Extreme Weather Events

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## CHALLENGES

Physical damage to highway network

Limited capacity to sustain deployment of essential goods and services

Generalized need for temporary traffic control for recovery activities

Obsolete designs that do not demonstrate resilience against natural disasters

## RECOVERY ACTIVITIES

Reconstruction, repair and rehabilitation amid a shortage of resources

Logistical support to public and private entities associated to essential goods and services

Judicious application of temporary traffic control and safety protocols

Modernization and/or retrofit of infrastructure assets to increase resilience

# Use of Resilient TTC Equipment



Source: <http://www.roadsafetraffic.com>



Source: <https://www.3m.com>



Source:  
<http://www.bethsbarricades.com>

Solar-powered ITS equipment

Retroreflective elements

Provisional intersection control systems

Benefits

- Minimize dependency on external energy supply
- Reduce exposure of traffic control staff
- Ensures nighttime availability, especially when power outages occur

**Flexible-but-judicious use can save lives!**

# Maritime Terrestrial Zone Infrastructure

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Rigorously enforce laws and regulations in maritime terrestrial zone in the Caribbean

Revise standard drawings of bridge and pavement infrastructure adjacent to coastal areas

Analyze feasibility of applying hard engineering, green engineering and/or planned relocation for protection of critical assets



PR-64 in MAYAGÜEZ, PUERTO RICO

Source: El Nuevo Día

# Bridges with Scouring Potential

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**PR-52 in JUANA DÍAZ, PUERTO RICO**

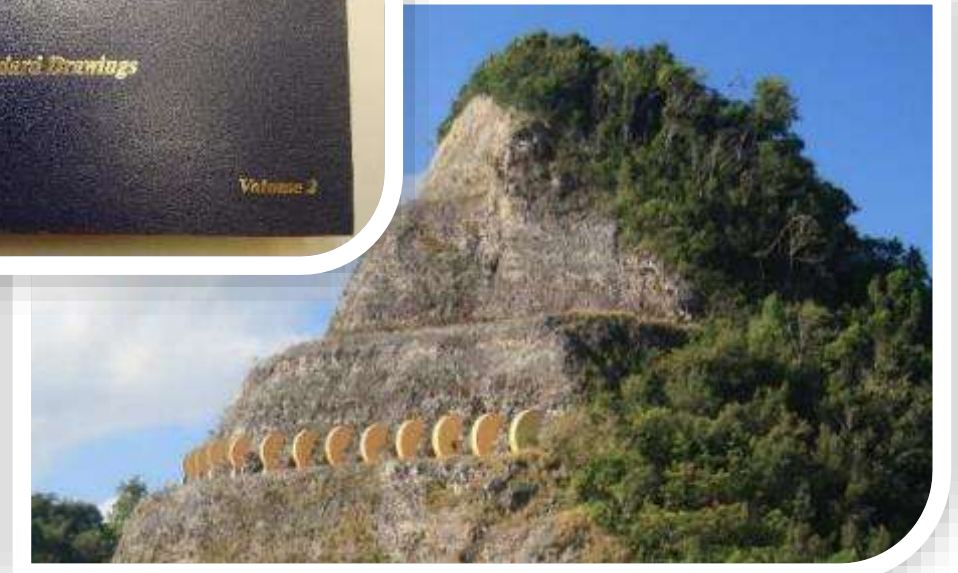
**Source: El Nuevo Día**

The design of bridge abutments requires further review where high speed and turbulent flow are expected in their design life and potential scouring may occur.

# Benching for Stability of Roadside Slopes

Standard Drawings of PRHTA associated with the cut slope sections with clay soils and/or unstable soil rock formation needs to be revisited.

Use of benching in cut sections with the appropriate slopes needs to be incorporated in future designs.



Source: Authors (above), Panoramio.com (below)

# Shotcrete for Stability of Roadside Slopes

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Mesh to contain rock falls in areas where recurrent falls occurred, needs to be reevaluated.

Shotcrete in cut sections in highways can be further evaluated to be implemented in the central mountain range as a potential alternate cost-effective design.



Source: <http://bestsupportunderground.com>

# Benefits of Shoulders

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Shoulders in major highway corridors with cut section in mountains with moderate height (less than 800 feet) minimizes the impact of mud and rock slides, thus allowing roadway reconfiguration with at least one lane open to traffic on both directions.

Shoulders can also accommodate queueing for essential services while minimizing adverse congestion impacts.



Source: <https://upload.wikimedia.org>

# Preventive Maintenance

Preventive maintenance of urban drainage systems is essential to minimize the potential for flooding.



Source: Authors

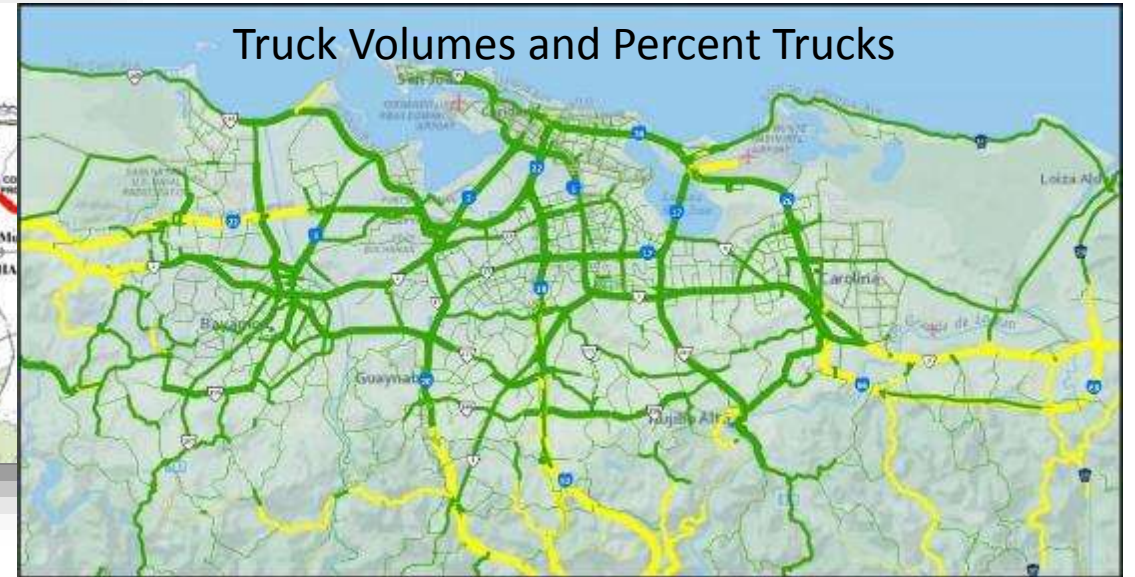


Source: <https://www.montgomerycountymd.gov>

# Redundancy in Strategic Corridors



Source: Puerto Rico Highway and Transportation Authority



The importance of strategic redundancy of principal highway transportation corridors was evident for the mobility of people and goods during the emergency post hurricane María.

Careful planning of redundant routes should take into consideration both traffic volumes and freight, in order to facilitate both emergency response and recovery.

# Lessons learned: Traffic Signal Supports

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The catenary design used in intersections to mount traffic signals needs to be revisited.

The consideration of mast poles to replace catenary designs is pertinent in category 3 and above hurricane alley such as Greater Antilles that include Puerto Rico.

Review design codes for mast poles in the state of Florida, USA after the pass of hurricane Andrew in 1991.



Source: Getty Images, Univision



Source: <http://www.kdlt.com>

# Lessons learned: Traffic Sign Supports



PR-2 km 126.6, AGUADILLA, PUERTO RICO

Source: Authors



BAYAMÓN, PUERTO RICO

Source: Authors

Freeway overhead and roadside guide/directional signs, according to MUTCD with breakaway device in the base that yields on impact, needs to be revisited.

# Lessons learned: Utility and Luminaire Poles

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Utility and luminaire poles of all materials (concrete, wood and steel) that failed in the base and the upper 1/3 of their length need to be evaluated for strength against wind loads.

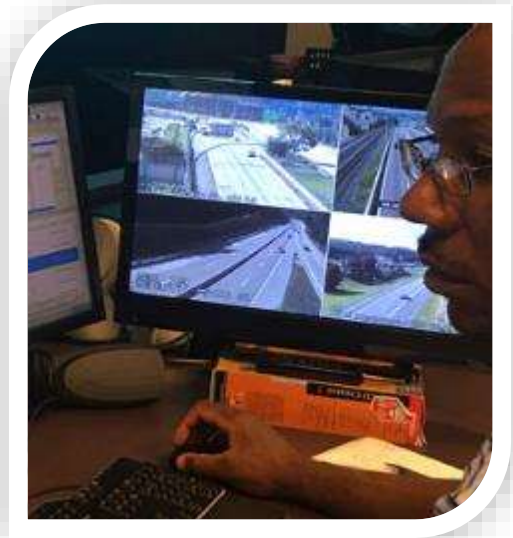
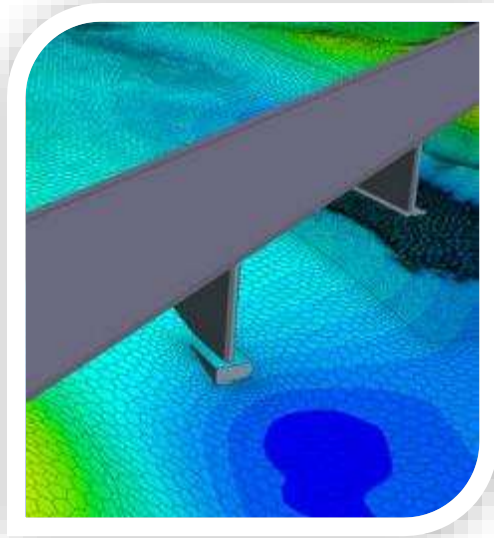
Vegetation control along utility line corridors is essential to minimize the chance of collapse of entire rows.



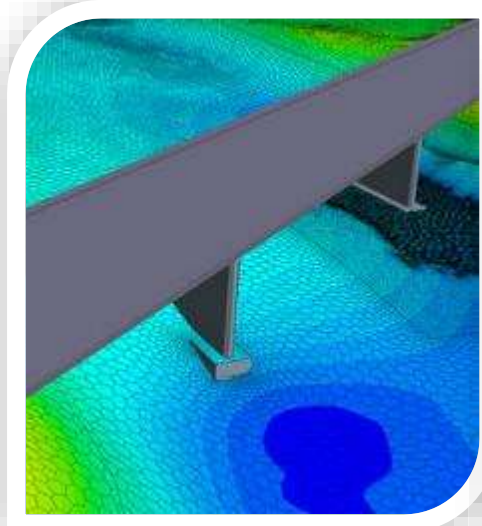
Source: <https://images-cdn.wapa.tv>

# Parte 3:

Iniciativas del Programa Federal Cada Día Cuenta (EDC) relacionadas a resiliencia y cambio climático



# Iniciativas del Programa Federal Cada Día Cuenta (EDC) relacionadas a Resiliencia y cambio climático



Collaborative  
Hydraulics



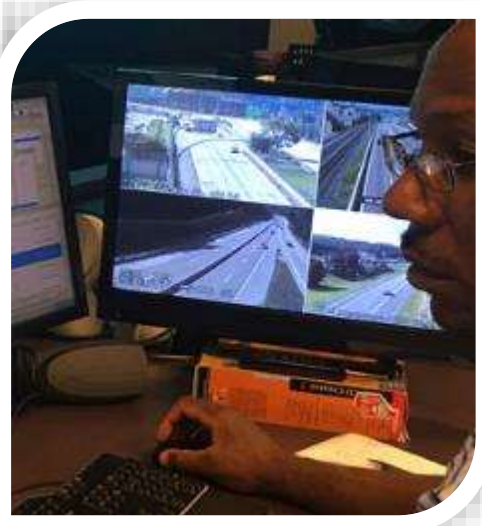
Road Weather  
Management



Advanced Traffic  
Signal Performance  
Measures

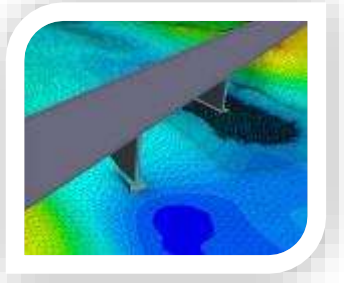


Integration of NEPA  
and Permitting



Using data to  
improve Traffic  
Incident  
Management

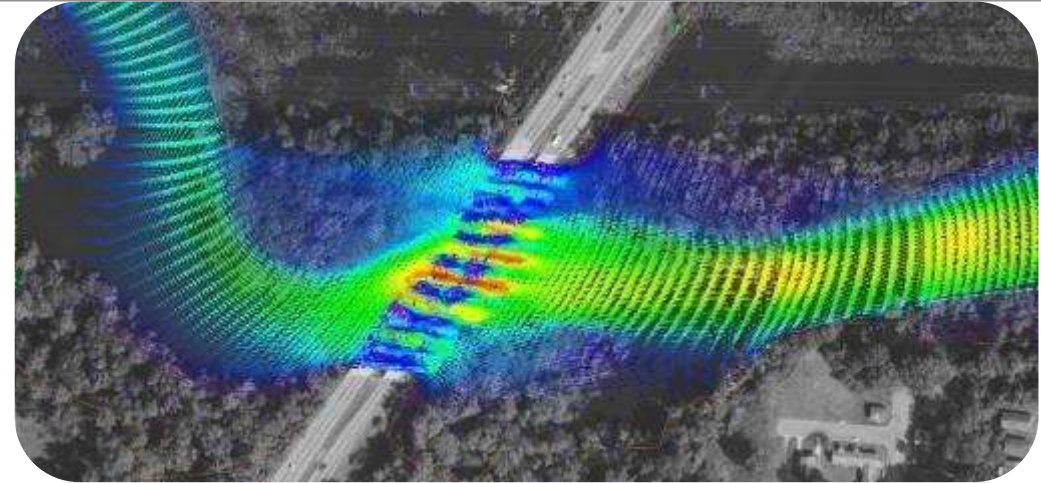
Sources: [https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_4/](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/), El Nuevo Día



# Collaborative Hydraulics



- Use of advanced software for detailed hydraulic models
  - Coastlines
  - Rivers and floodplains
  - Scouring
  - Flood mapping
  - Stability of hydraulic systems
  - Mitigation for natural systems



- Expected benefits
  - Reduction of design uncertainties
  - Effective communication between agencies
  - Adaptation for extreme events

Source: [https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_4/CHANGE.cfm](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/CHANGE.cfm)

<https://nc.water.usgs.gov>

# Road Weather Management



## IMPLEMENTATION OF PATHFINDER

- Multisector collaboration between state government, federal government //and weather companies
- Consistent weather information for the public
- Documenting weather impacts to highways



## INTEGRATED MOBILE OBSERVATIONS

- Instrumented government vehicles and equipment (ex. Maintenance machines) to gather weather data
- Instrumented pavements
- Informed decision-making to determine magnitude of impacts and intervention locations

Source: [https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_4/roadweather.cfm](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/roadweather.cfm)

# Using Data to Improve Traffic Incident Management



- Performance measures

- Time to clear incident
- Time to clear highway
- Incidence of secondary crashes

- Implementation Plan for Puerto Rico

- Staff training at Traffic Management Center
- Integration of crash databases → TraCS and SunGuide
- Digitalization of crash form (PPR-93, Police of Puerto Rico)



Source: [https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_4/timdata.cfm](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/timdata.cfm)  
Puerto Rico Highway and Transportation Authority

# Integrating NEPA and Permitting



## Objectives:

- Reduction of bureaucratic obstacles between permitting and environmental impact statements → duration of process
- Interagency collaboration between highway agencies and permitting agencies (ex. AEE, AAA, DRNA, JP, OGPE, FEMA, USACE, Coast Guard, among others)
- Identification of main problems
  - Exposure to natural hazards related to climate change
  - Adverse effects of interaction between infrastructure and natural systems



# Automated Traffic Signal Performance Measures (ATSPM's)



## Objectives:

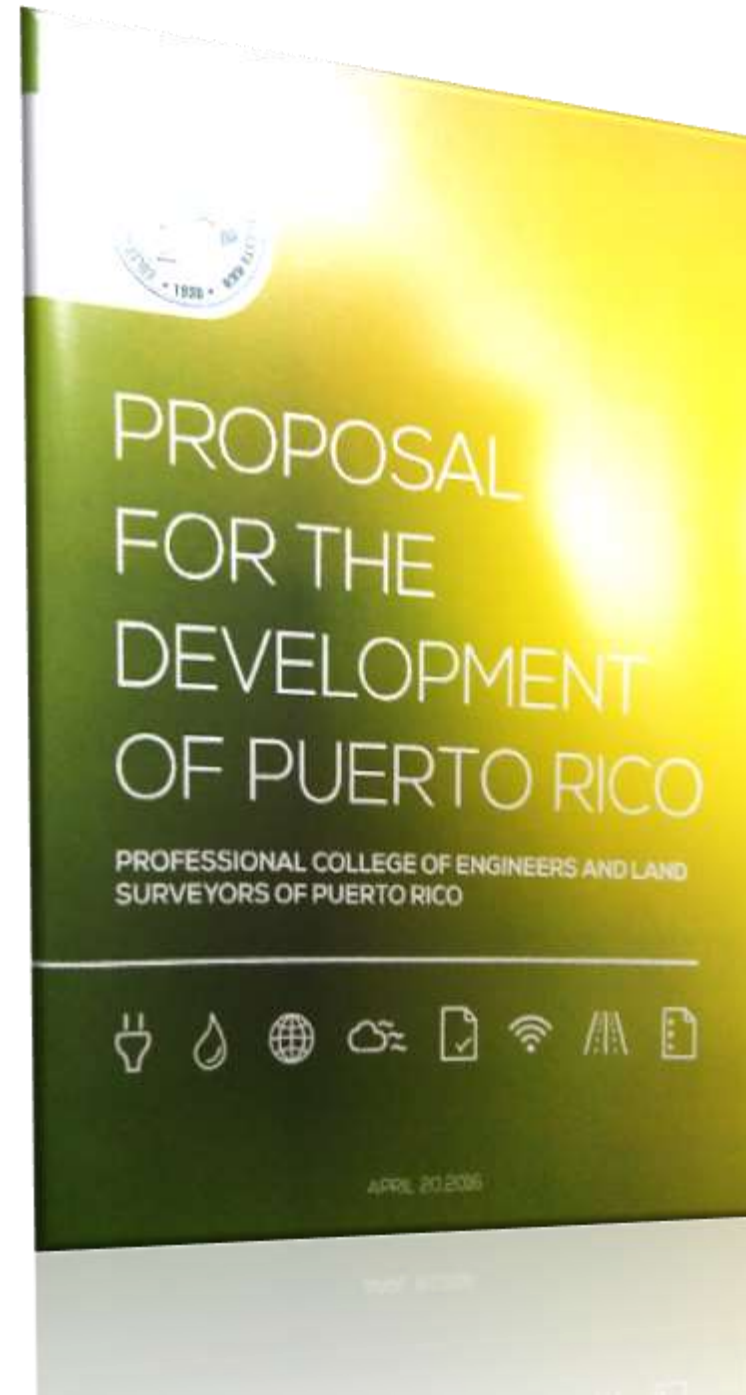
- Direct and continuous monitoring of traffic signal operations → real-time adjustments and for different scenarios
- Reprogramming signals using real data rather than only simulations or citizen complaints
- Cost savings
- Traffic incident management response time reduction
- Contributes to system resilience in coordination with other government agencies (police, medical services, firefighting, among others)



Source: [https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_4/atspm.cfm](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/atspm.cfm)

## Parte 4:

# Propuesta para el Desarrollo de Puerto Rico del CIAPR





# TRANSPORTATION AND HIGHWAYS

**VISION:** PROVIDE A TRANSPORTATION SYSTEM THAT IS EFFICIENT, SAFE, BALANCED, AND SUSTAINABLE TO GUARANTEE THE MOBILITY AND ACCESSIBILITY OF ALL USERS.



## CIAPR

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# Proposal for the Development of Puerto Rico: Transportation and Highway Sector



### RECOMMENDED ACTIONS:

**1. Prioritize rehabilitation, restoration, and optimization of existing infrastructure over new construction.**

Focus efforts on the maintenance and strategic restoration of the land transportation infrastructure and its assets.

**2. Use new materials and technologies.**

Explore the use of new techniques, technologies, and materials (including recycled products) for the development of transportation projects. For example, warm asphalt mix, permeable concrete, accelerated bridge construction, and roller-compacted concrete. Continue promoting initiatives such as “Every Day Counts” (EDC4) and the Strategic Transportation and Innovation Council (STIC).

**3. Promote the development of mass transportation.**

Review the regulations to promote transit-oriented development and mixed uses. Review regulations related to truck overloads and their impact on the premature damage of the road infrastructure and bridges.

#### 4. Revitalize urban areas.

Promote urban revitalization projects in primary urban corridors (such as Piñero, Roosevelt, and Muñoz Rivera avenues) along with the development of business improvement districts. Promote the geometric reconfiguration of main roads to provide better access to businesses, lanes for bicycles, and transform traditional intersections into modern roundabouts and complete streets.

#### 5. Access additional funds.

Identify sources of local matching funds to capitalize on the funds available through the federal FAST Act (Fixing America's Surface Transportation) to strengthen mass transportation service, promoting its efficiency, and expand the operation of the system.

CIAPR

## Proposal for the Development of Puerto Rico: Transportation and Highway Sector



CIAPR

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Proposal for the Development  
of Puerto Rico:  
Transportation and Highway Sector



**6. Foster research.**

Provide local research funds that allow the development of new technologies and techniques to meet the Island's needs, motivate the retention of professionals, and serve as sources of export. These funds could help to research measures for the reuse of elements such as car tires, which today have become a critical issue in Puerto Rico.

**7. Educate citizens.**

Increase awareness campaigns for citizens to foster a culture of road safety, touching subjects such as aggressive driving, security in construction zones, consolidation of agencies, and public aesthetics versus infrastructure.

¡Muchas gracias por la  
oportunidad!

