

# Impact of Hurricanes Irma and Maria on Puerto Rico Maternal and Child Health Research Programs

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UNIVERSITY OF  
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# Presenter Disclosure

Michael Welton

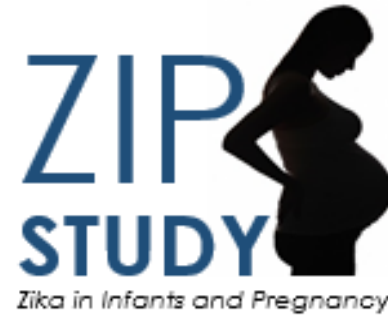
The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

No relationships to disclose

# Outline

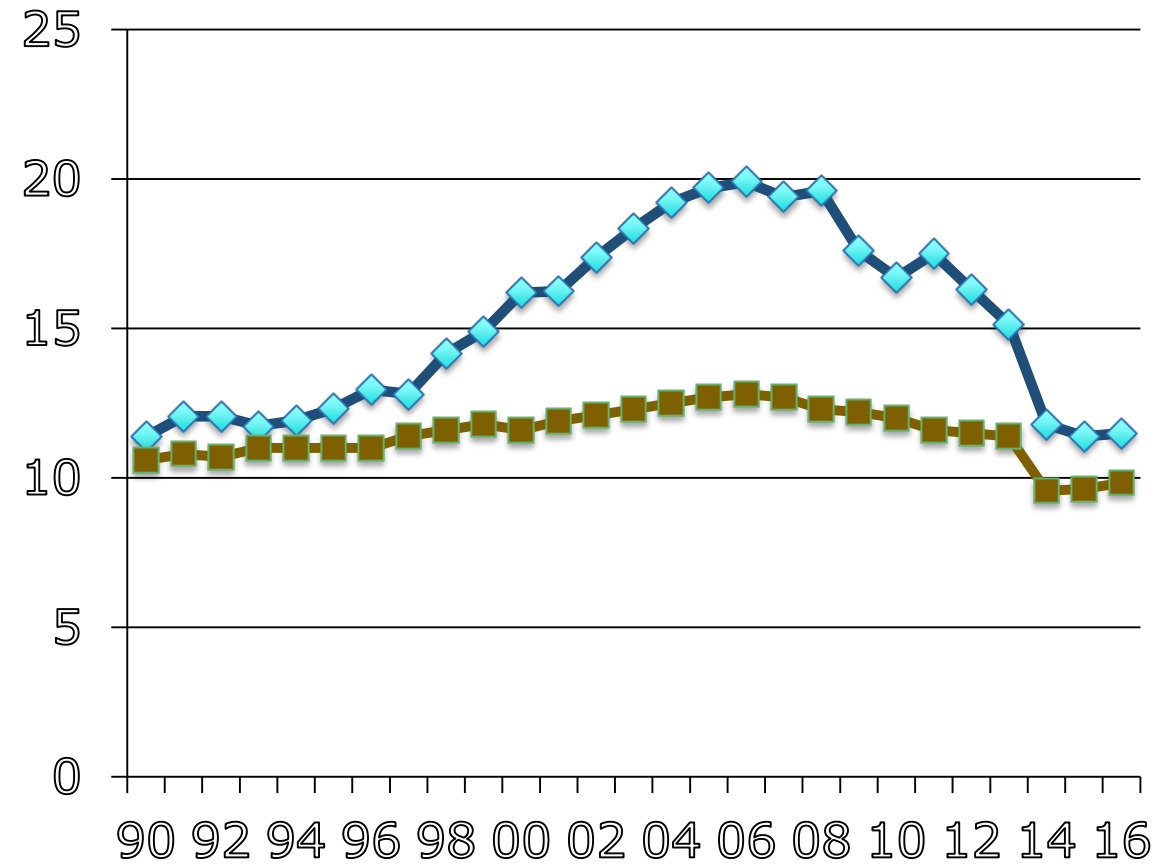
- Intro to our studies
- Hurricane Overview
- Immediate Responses
- Puerto Rico Ecosystems





# Introduction

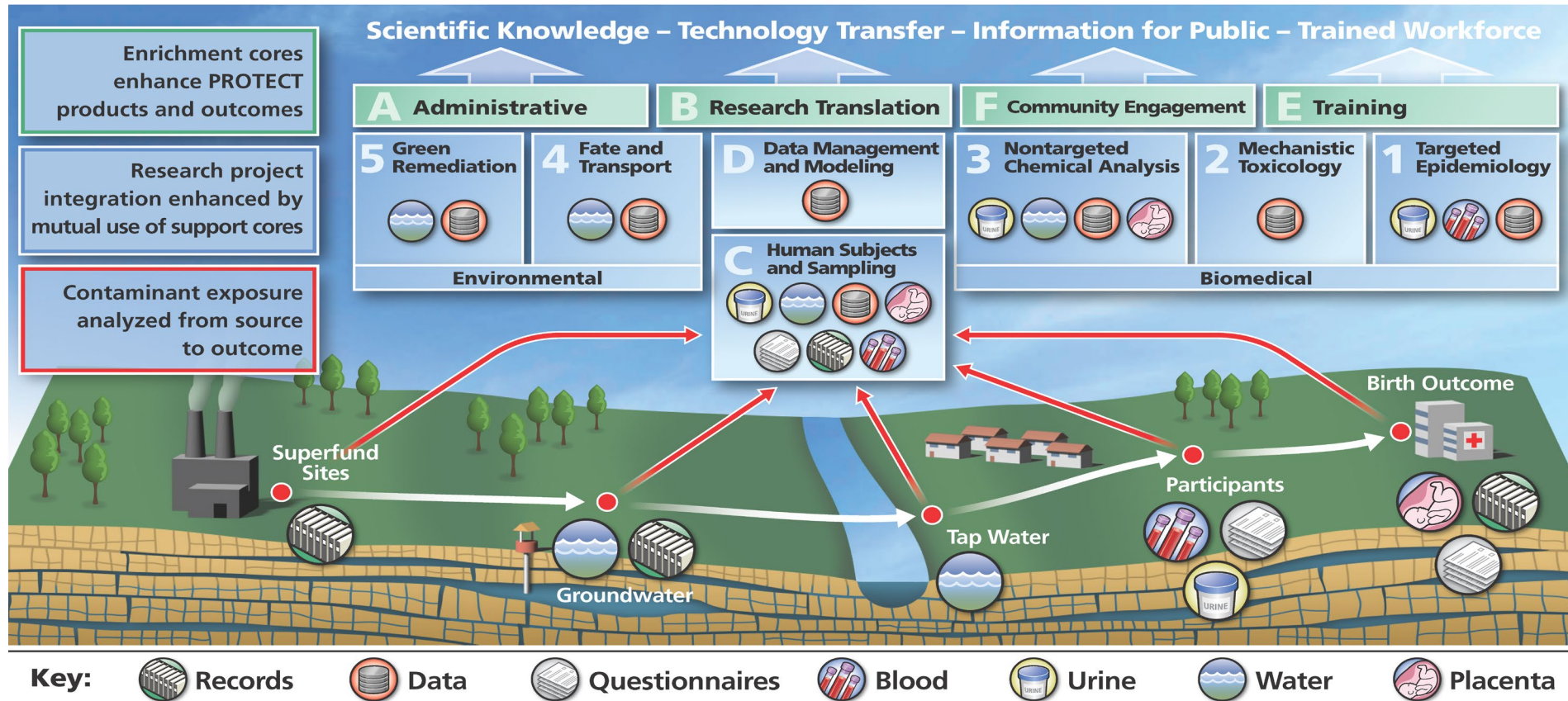
- Puerto Rico is a United States Territory (1898)
- Population about 3.4 M / 3,500 Square miles
- In 2006, Puerto Rico had the highest rate of preterm births of any US jurisdiction (19.9%) and third highest worldwide
- Puerto Rico has the highest density per square mile of toxic waste sites recognized by the US EPA.



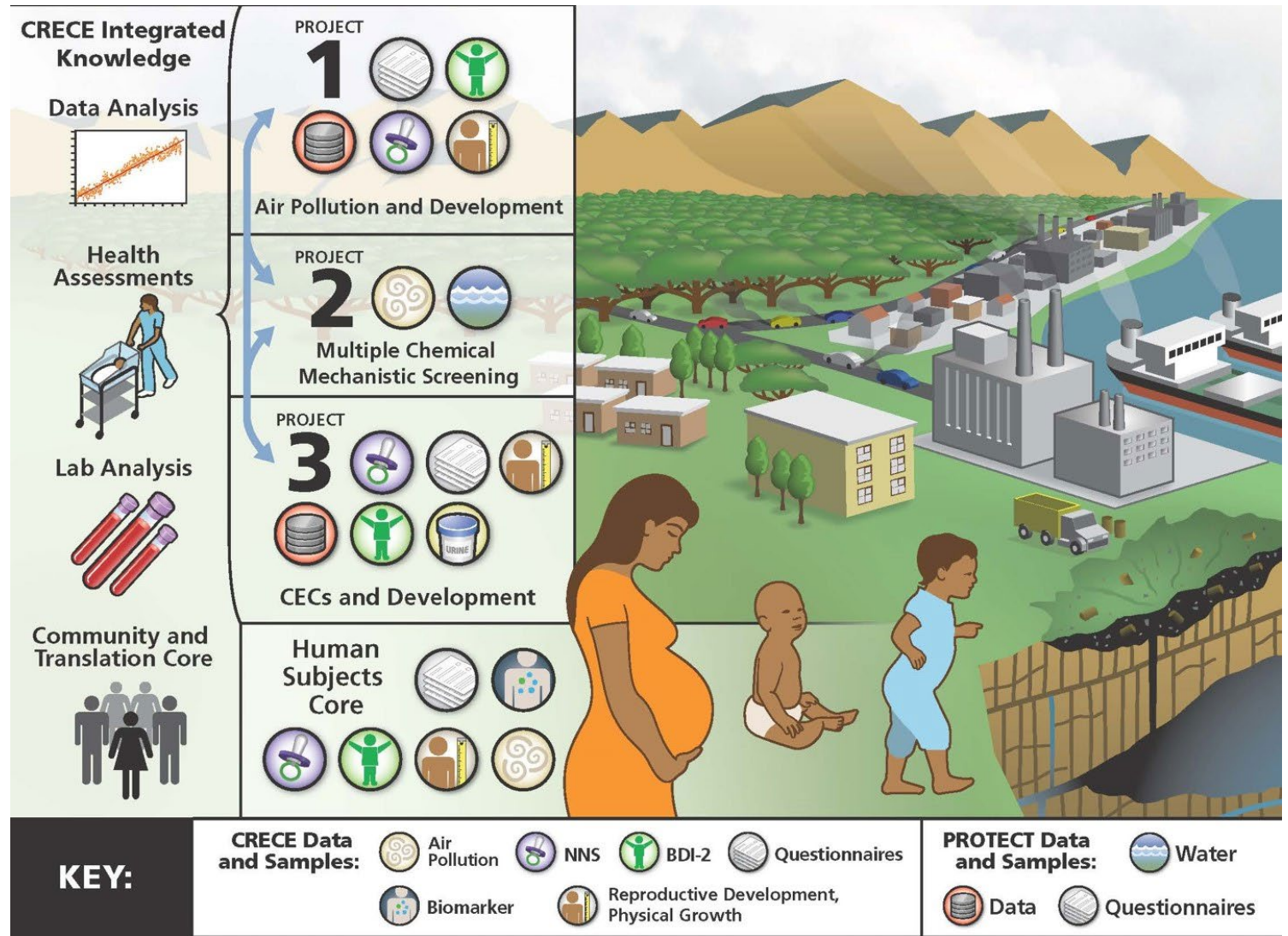


# PROTECT

Puerto Rico Testsite for Exploring Contamination Threats



Supported with funding from the NIEHS Superfund Research program, the PROTECT Center studies exposure to environmental contamination in Puerto Rico and its contribution birth outcomes



Center for Research on Early Childhood Exposure and Development in Puerto Rico: Children’s Environmental Health Center program directed by the EPA and the NIEHS. Investigate mixtures of environmental exposures and other factors affect the health and development of infants and children living in the heavily-contaminated island of Puerto Rico

# Zika in Pregnancy Study (ZIP)

- Began recruitment in summer 2016
- A consortium of six countries and 10 sites
- Prospective Observational Cohort – 2 years
- Intend to recruit 10,000 pregnant women in two years in five countries: Brazil, Colombia, Guatemala, Nicaragua, Puerto Rico, and Peru

Figure 1. Zika in Infants in Pregnancy (ZIP) Study Sites



(1) North Karst, Puerto Rico

(2) San Juan, Puerto Rico

(3) Amatitlan and Mazatenango, Guatemala

(4) Managua, Nicaragua

(5) Cali, Columbia

(6) Lima, Peru

(7) Pernambuco, Brazil

(8) Salvador, Brazil

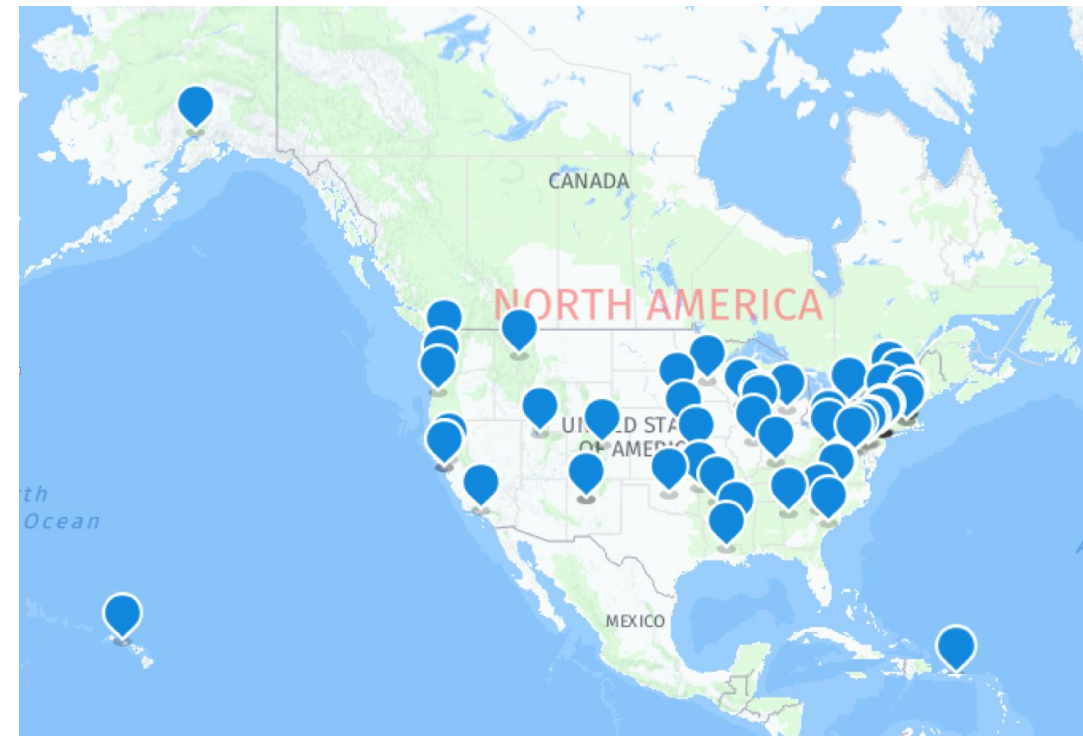
(9) Rio de Janeiro

(10) São Paulo, Brazil



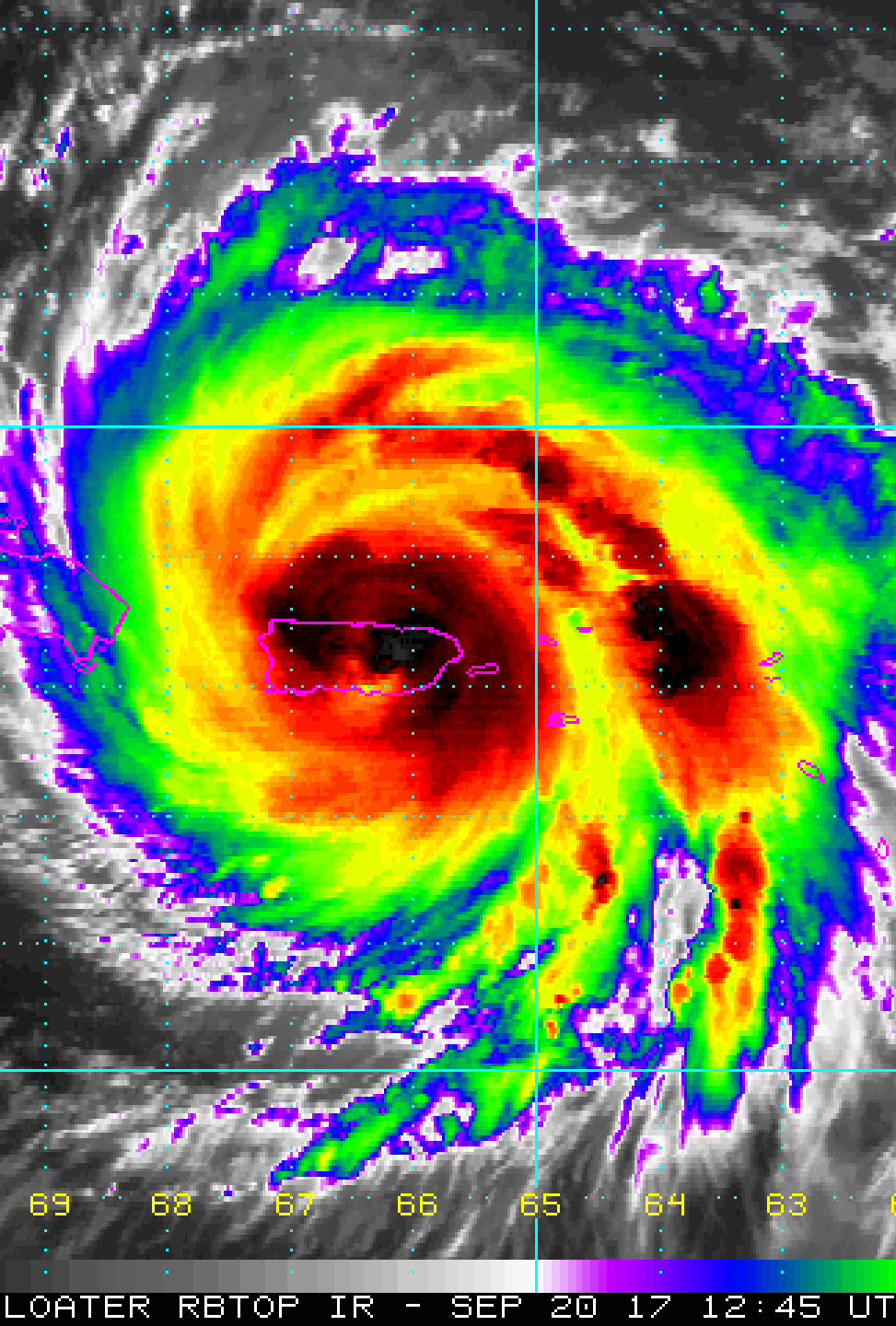
# Environmental Influences on Child Health Outcomes (ECHO)

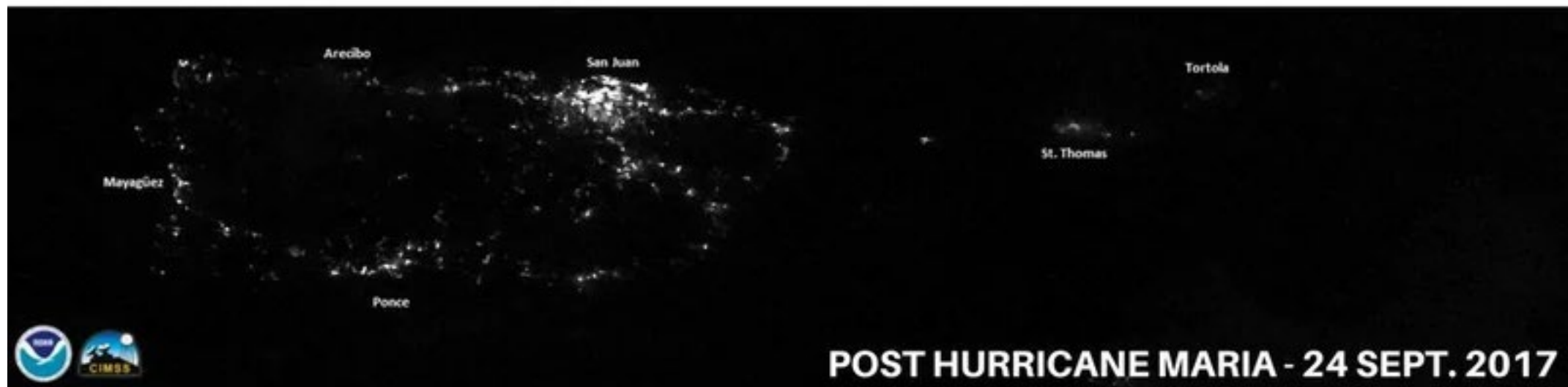
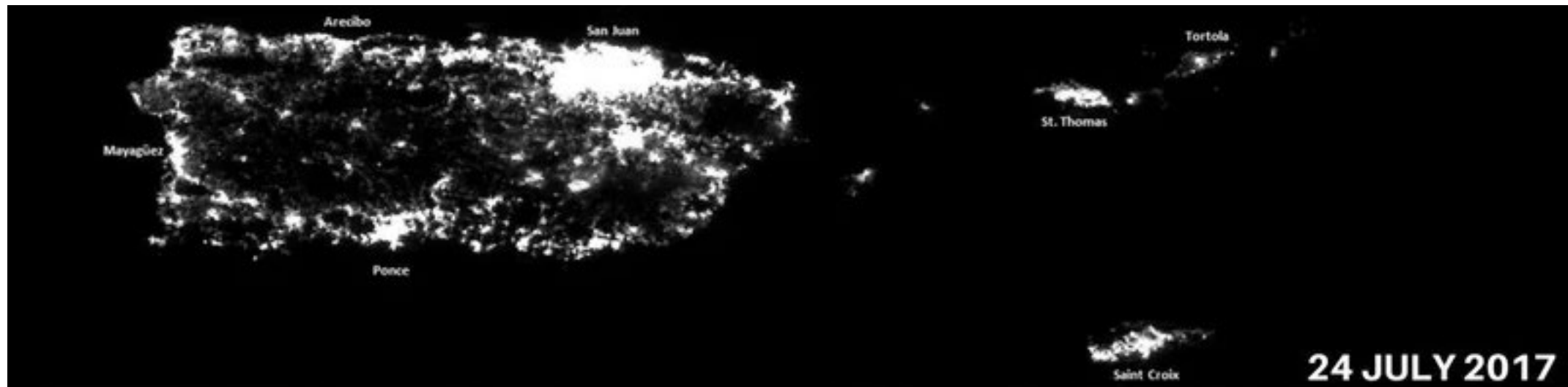
- Began in 2017
- 7 years (5 years of recruitment)
- Will recruit approx. 1000 mothers/infant
- 267 mothers & 293 infants currently
- Through pregnancy and up to 6 years old



# September 20, 2017 Hurricane Maria hits Puerto Rico

- Followed IRMA on Sept 6 – 2 weeks prior
  - ~80,000 people still had not recovered electricity
- 175 mph winds (sustained)
- Collapse of the electric grid, water systems, telecommunications, roads, and many homes destroyed
- Recovery will cost \$139 Billion
- Close to 3,000 fatalities

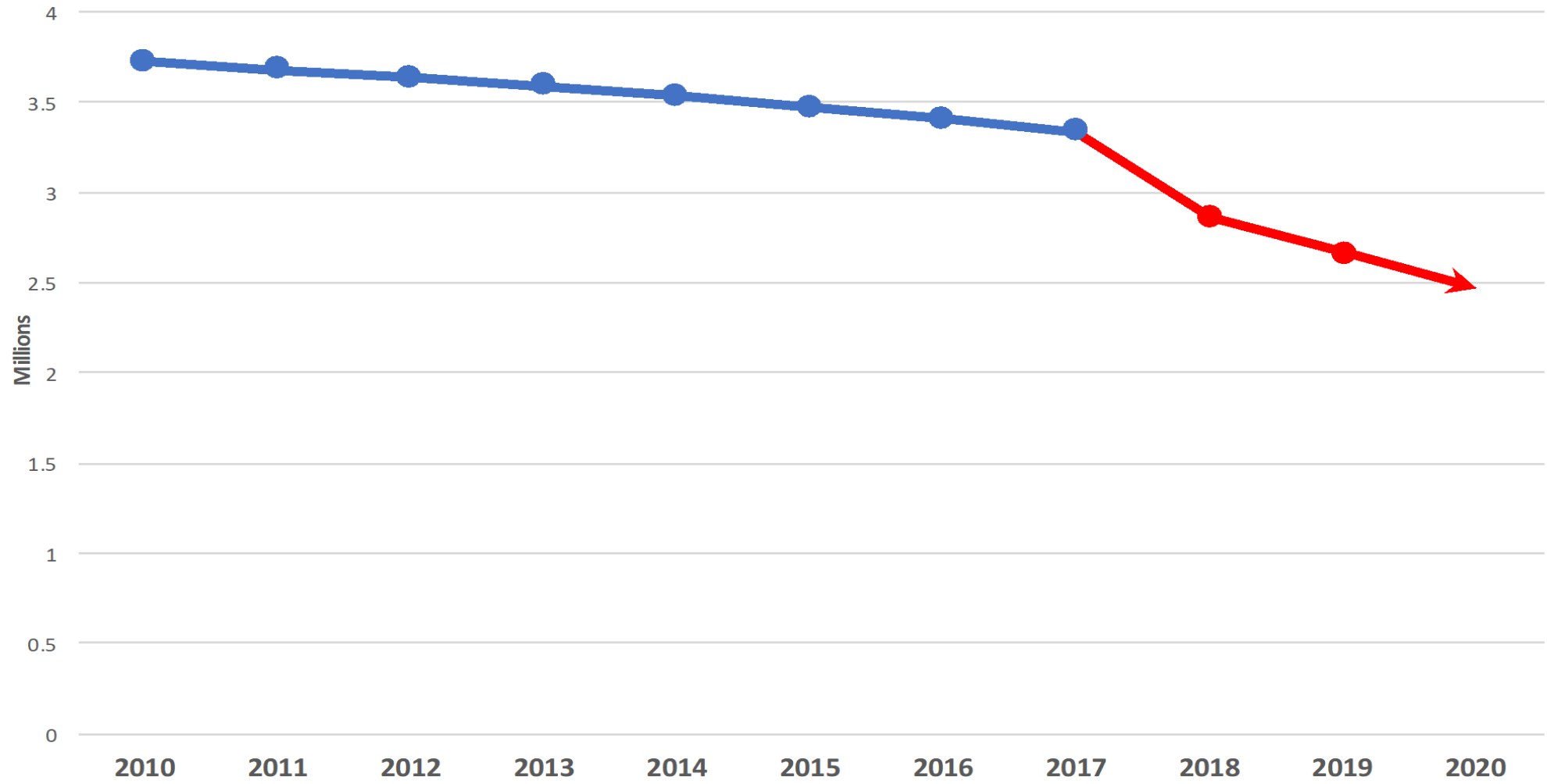






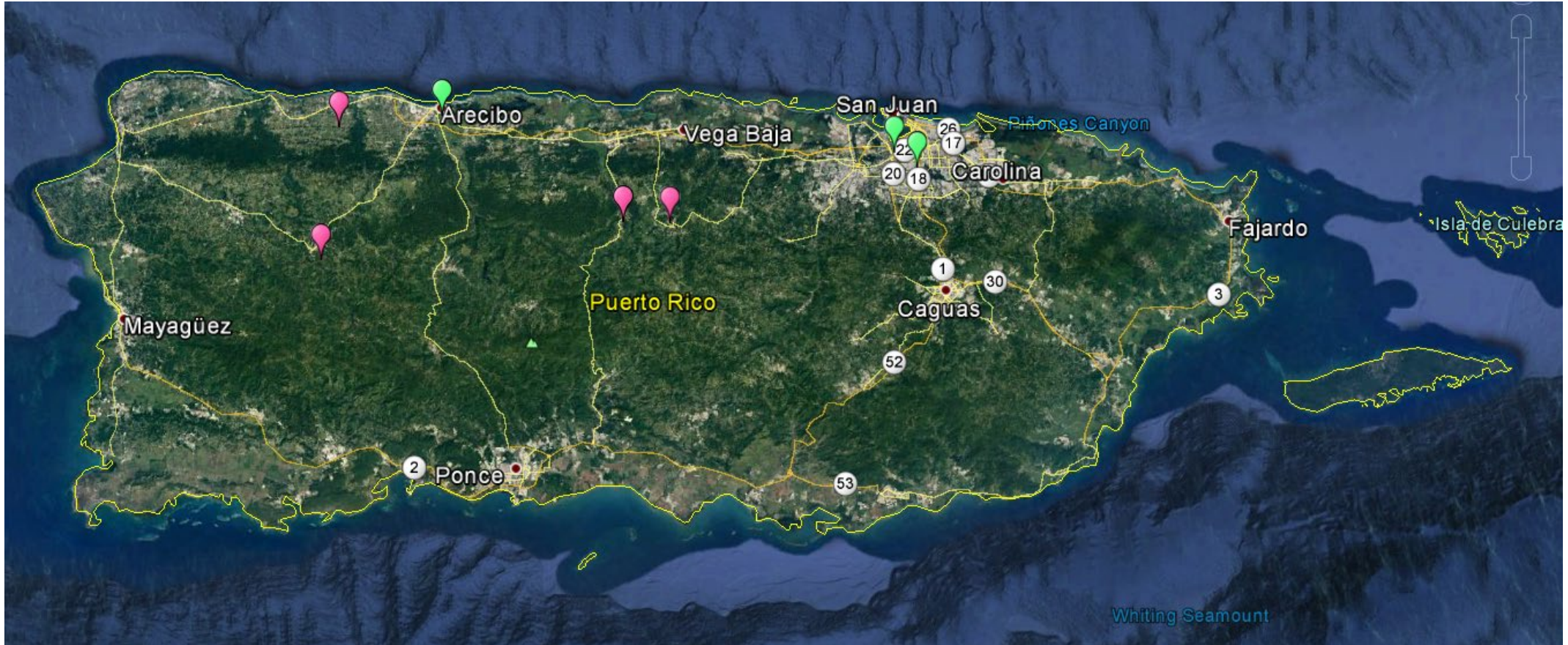


**Puerto Rico Population Estimate Following Hurrigan Maria 2010-2020**

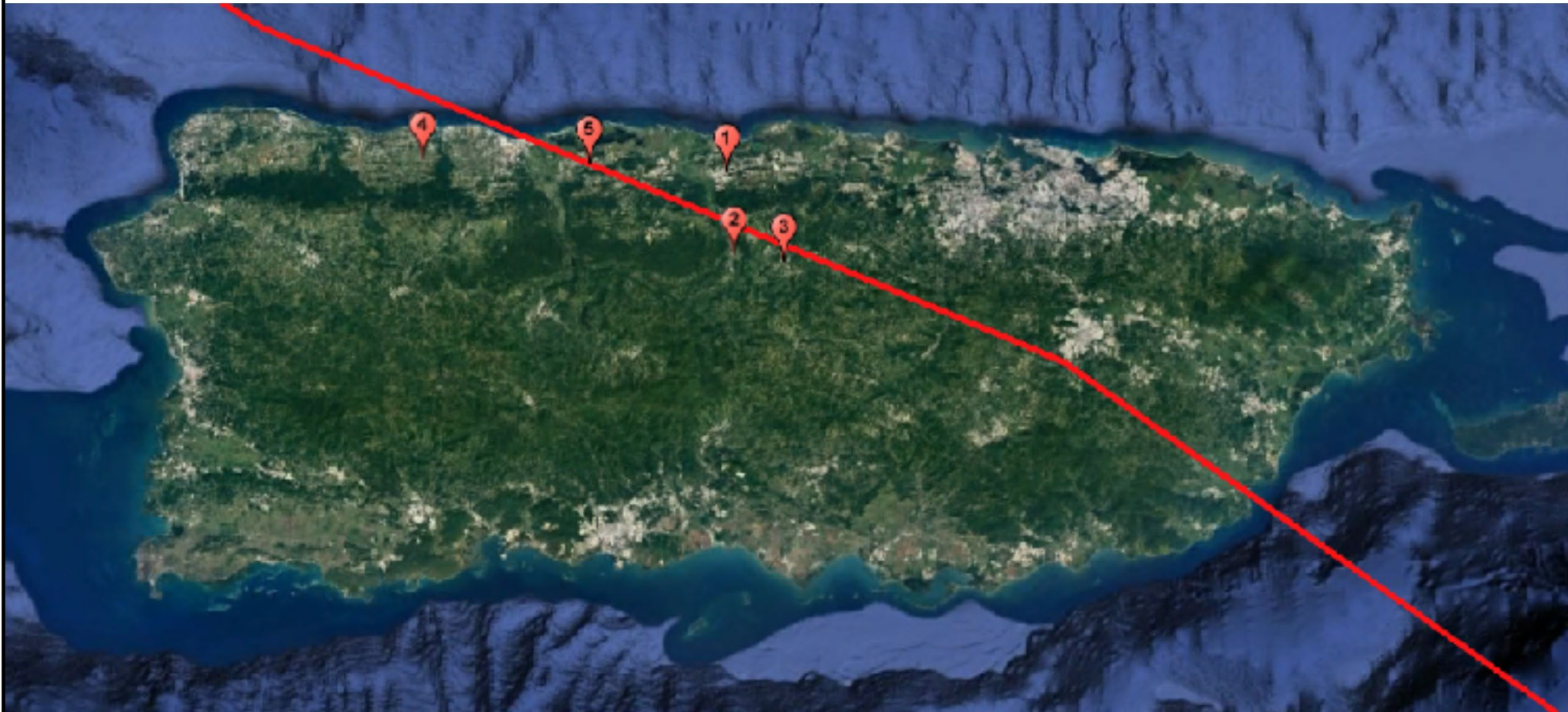


CUNY: [https://centopr.hunter.cuny.edu/sites/default/files/RB2017-01-POST-MARIA%20EXODUS\\_V3.pdf](https://centopr.hunter.cuny.edu/sites/default/files/RB2017-01-POST-MARIA%20EXODUS_V3.pdf)

# PROTECT/CRECE/ZIP/ECHO Study sites



## Figure 1. Hurricane Maria's Path and PROTECT/ZIP Study Clinic and Hospital Sites



1: Manatí Medical Center and PROTECT Clinic, 2: Ciales FQHC, 3: Morovis FQHC, 4: Camuy FQHC, 5: Arecibo Pavia Hospital



# Immediate Response...

- 1<sup>st</sup> priority was our team
- Over 20 staff in Puerto Rico
  - Field Nurses
  - Lab technicians
  - Project managers
  - Data Managers
  - Trainees/students
- 2 team members lost their homes entirely
- ~350 Maternal and close to 300 infant participants



- Followed by meeting participants needs
- Water filtration systems set up in health centers, clinics
- Coordinating donations with local needs
  - Water filters for participants and clinics
  - Personal care items needs
  - Batteries, flashlights, and other needs
  - Diapers, baby food, wipes, etc.



# Science scramble after storm

*Public-health researchers in Puerto Rico are regrouping to study the aftermath of Hurricane Maria.*

**BY SARA REARDON**

**N**ightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have rushed home each night to avoid being in the streets after dark. Many

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. “I thought I was prepared, but I wasn’t,” he says.

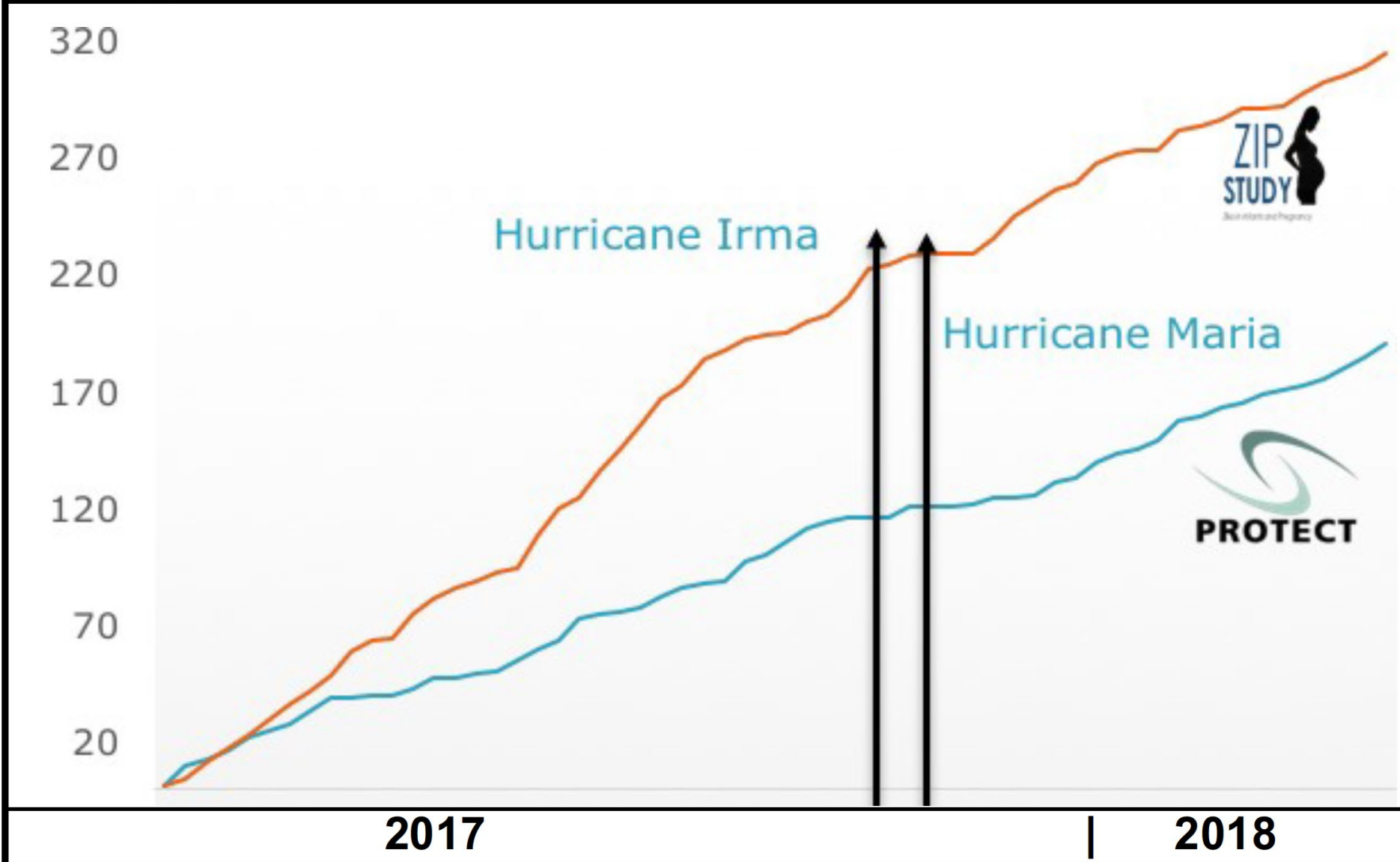
Even before the hurricane, the island’s 18 ‘Superfund’ sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk

# Resuming research activities...

- Strong rapport with community
  - ~96% retention in studies
- Team eager to get back to work
- PROTECT/CRECE/ZIP a resource for participants
  - Information and support
- Continue to identify of major challenges to families and children
  - Mental health and finances
- Transportation and communication were major challenges to research



**Figure 2. PROTECT and ZIP Recruitment 2017-2018**



# Research Projects



- Our team was awarded NIH grants:
  - Environmental Exposures and stress (Spring 2017)
  - Traumatic experiences (Fall 2017)
- Participants from PROTECT, ZIP, and CRECE
- Birth outcomes (Preterm birth, birth weight, and pregnancy loss)
- Included women who were pregnant who were pregnant during the Hurricanes or became pregnant during 6 months after
- Phone surveys, in person questioners, and biologic samples

# Hurricane Damage to Puerto Rico Ecosystem

- Ecosystems

- Sandy Beaches and Rocky Shores
- Rain forest
- Coral Reefs and seagrass beds
- Mangroves and lagoons
- Dry Forests

- 3000 Plant species

- 5300 insects and arthropods

- 1300 mollusks and echinoderm

- 1500 birds, reptiles, amphibians, fish, and mammals



# Sandy Beaches

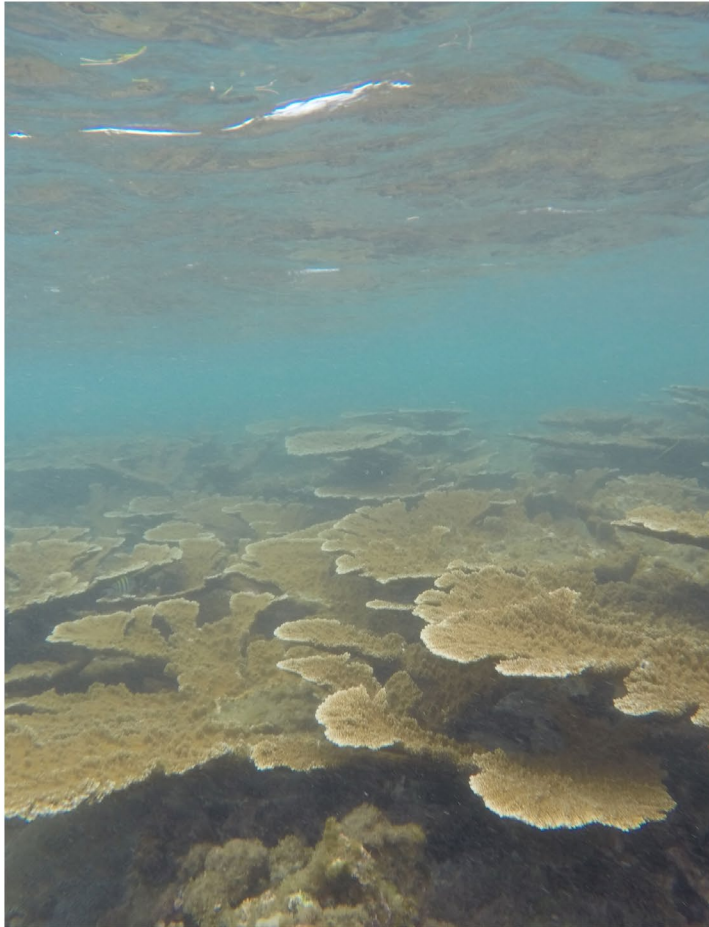




# Rain Forests



# Reefs and Seagrass Beds



# Mangroves and Lagoons



# Saving Puerto



Vital for recovery, the island's bees are searching for food and shelter

Seeking P

January 29, 2018 by Chris Rir

of Hurricane Maria

Community in Crisis After Maria

## Monitoring air pollution after Hurricane Maria

October 31, 2018, American Chemical Society

here at one time the fishing blished... See More

October 6, 2017 by Leila Macor, With Kerry Sheridan In Miami

V.I. Bats Struggle for Hurricanes

## Hurricane María Has Renewed Puerto Rico's Fight Against Coal Ash

The disastrous hurricane spread ash from landfills into the air and groundwater of the island, giving new momentum to groups fighting for a future without coal.

PUERTO RICO AFT

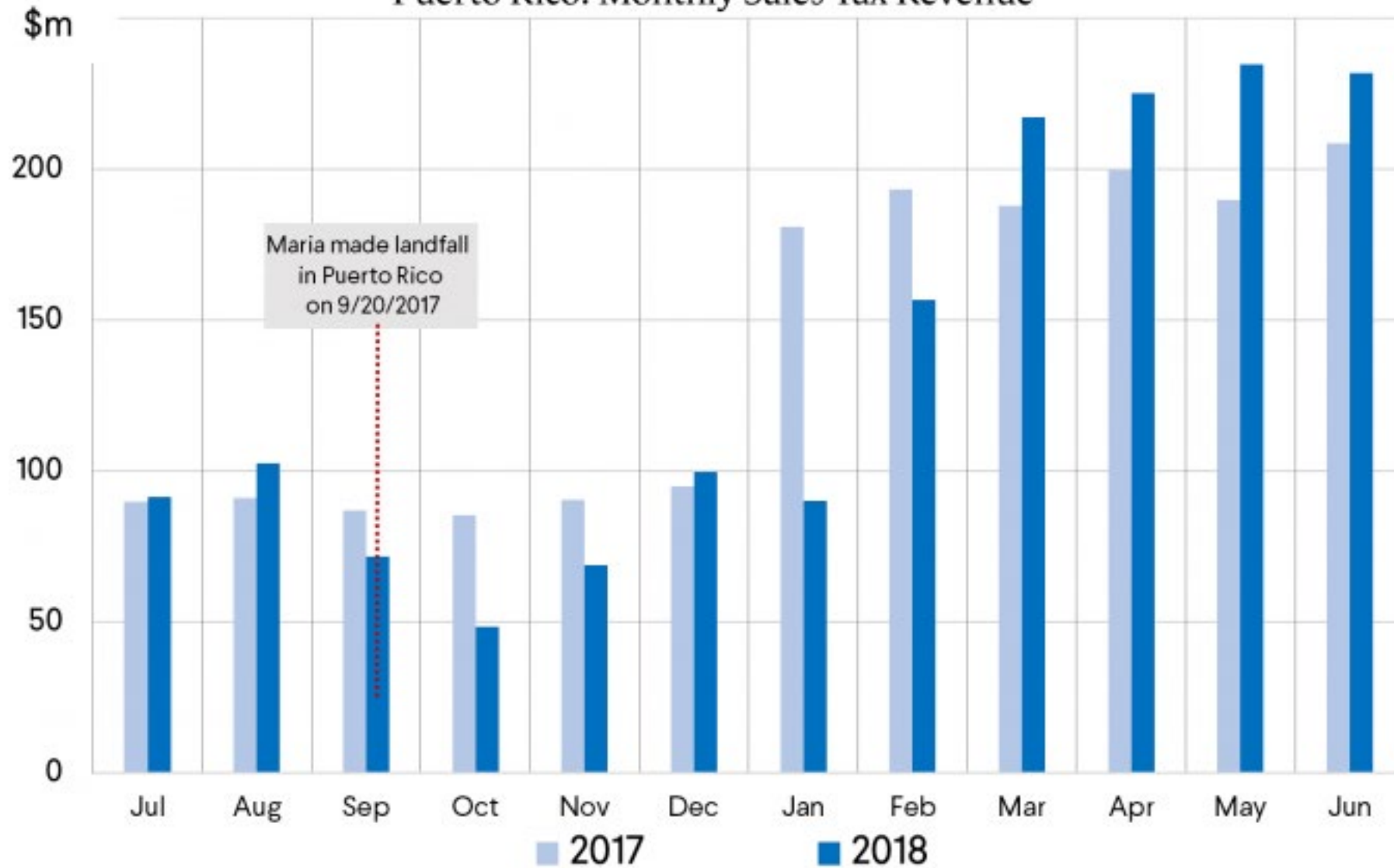
'Water is everyt

FIRST CAME THE HURRICANE. NOW COME THE Mosquitoes.

LINDA POON OCT 3, 2018

Heavy rains and flooding create ideal conditions for swarms. For public health officials, the focus is on curbing the potential for viruses to spread.

## Puerto Rico: Monthly Sales Tax Revenue



Note: The Puerto Rican fiscal year runs July through June.

Sources: Government Development Bank for Puerto Rico.

Brad Setser and Cole Frank  
[cfr.org/blog/Setser](http://cfr.org/blog/Setser)

# Conclusions

- Climate models predict more extreme weather events to come and we need to work now to be prepared.
- The drastic lifestyle changes following a natural disaster constitute a dramatic departure from normality
- Research on the impact of natural disasters on health and environment is needed
- Disentangle the effects of hurricane on health outcomes - stress, trauma, and chemical exposures
- Has implications for populations in all hurricane prone areas in the United States the Atlantic and Pacific regions

Questions?



Email: [mdwelton@uga.edu](mailto:mdwelton@uga.edu)

Looking forward...





# Natural Disasters and Health Outcomes

Research based on Hurricanes Andrew, Katrina, Sandy, etc.

- Long-term physical and psychological health consequences
- Evidence that pregnant women may be at higher risk of preterm birth, low birth weight, and other adverse birth outcomes
- Are associations due to post-traumatic stress, hurricane-related exposure to hazardous substances, or a combination of factors?

Maria is unique...

Prolong recovery

Geographic isolation



# Research Projects

- Our team was awarded NIH grants:
  - Environmental Exposures and stress (Spring 2017)
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- Birth outcomes (Preterm birth, birth weight, and pregnancy loss)
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# Environmental Exposures and Stress

Urinary Phthalate Metabolite Concentrations (ng/mL)													
	<b>PRE-MARIA</b> (n=248 samples, 111 women)						<b>POST-MARIA</b> (n=57 samples, 47 women)						
	GM	25th	50th	75th	95th	MAX	GM	25th	50th	75th	95th	MAX	P for Δ
MEHP	1.82	0.99	1.99	3.47	7.71	61.4	1.87	1.20	1.70	2.66	10.8	13.3	0.71
MECPP	9.49	6.00	8.79	14.1	31.7	467	10.2	7.56	9.90	12.9	37.1	59.2	0.40
MEHHP	5.01	3.14	4.87	7.84	18.1	261	5.61	3.78	5.18	7.08	25.6	33.3	0.33
MEOHP	4.63	2.81	4.34	7.20	16.5	219	5.29	3.73	5.31	6.66	28.6	31.9	0.29
MBzP	1.85	0.94	1.80	3.40	8.68	53.4	2.51	1.00	2.10	5.22	24.3	27.5	<b>0.02</b>
M CPP	0.94	0.51	0.90	1.50	5.49	86.4	1.10	0.60	0.87	1.68	8.10	23.1	0.55
MONP	1.82	0.97	1.63	2.85	10.7	369	2.72	1.20	2.25	4.07	37.8	63.9	<b>0.02</b>
MEP	32.1	10.9	24.6	84.9	467	2143	26.5	9.08	18.9	55.8	734	1136	0.33
MBP	11.8	6.76	11.5	20.1	47.7	147	15.4	8.10	14.4	24.3	82.7	131	<b>0.05</b>
MIBP	7.54	4.31	6.93	13.2	36.5	101	9.32	5.60	9.30	15.5	33.3	40.7	0.19
MHBP	1.23	0.68	1.28	2.21	6.38	12.6	1.65	0.96	1.44	2.87	10.0	19.1	0.07
MECPTP	34.8	13.8	28.5	65.5	381	1609	52.8	17.8	50.0	112	1626	3720	<b>0.03</b>
MEHHTP	5.40	2.23	5.02	11.5	66.4	178	9.73	3.70	7.56	24.2	323	689	<b>0.004</b>

p-values from mixed models accounting for within person correlation across samples

# Hurricane Traumatic Experiences (HURTE)

<b>Part 5. Hurricane Experiences</b>		
<i>This section asks about your experience during the hurricanes and the time immediately after. Please answer YES or NO to the following questions about your experience during hurricane Irma or Maria or during the recovery period following the hurricanes:</i>		
22	Did you feel your life was in danger?	<input type="checkbox"/> Yes <input type="checkbox"/> No
23	Were you injured or did you get sick?	<input type="checkbox"/> Yes <input type="checkbox"/> No
24	Was a member of your family injured or did they get sick?	<input type="checkbox"/> Yes <input type="checkbox"/> No
25	Did you walk through flood waters?	<input type="checkbox"/> Yes <input type="checkbox"/> No
26	Did your home or residence have severe damage?	<input type="checkbox"/> Yes <input type="checkbox"/> No
27	Were you without electricity for more than one week?	<input type="checkbox"/> Yes <input type="checkbox"/> No
28	Did you experience the death of a family member or loved one?	<input type="checkbox"/> Yes <input type="checkbox"/> No
29	Did you witness the death of anyone?	<input type="checkbox"/> Yes <input type="checkbox"/> No

# Traumatic exposure Severity Scale (TESS)

30	During the hurricanes did you have to spend the night somewhere other than in your home?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
31	Did you need food and water aid after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
32	Did you need clothes after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
33	Did you need shelter outside of your home after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
34	Did you suffer financial difficulties because of the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
35	Did you need financial assistance from others because of hardships caused by the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
36	Was your home damaged in the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
37	Did you have to relocate because your house became structurally unsafe to live in?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
38	Did you lose possessions in the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
39	Were you physically injured during the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
40	Did you seek medical attention for any injury or illness as a result of the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
41	Did you become dependent on others because of the physical injuries/losses you suffered?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
42	Were you stranded for period of time during or after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
43	Did any members of your immediate family die during or soon after the hurricanes as a result of the hurricane?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing

44	Were any members of your family or your loved ones physically injured in the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
45	Did any of your loved ones become dependent on you for physical care because of their injuries?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
46	Was a member of your family or someone close to you stranded or lost during or after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
47	Was there a period when you knew your family or someone close to you was stranded or lost during or after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
48	Was there a period when you were uncertain about the welfare of loved ones, when you were unable to establish contact or unable to locate them?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
49	Did you lose any relatives (e.g., aunts, uncles, cousins, grandparents) in the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
50	Were you involved in rescue work?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
51	Did you see any dead bodies or body parts during the rescue and clearing up work period during or soon after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
52	Did you hear sounds and cries for help from individuals during or soon after the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing
53	Did you experience the odor of dead bodies in the days following the hurricanes?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Not at all distressing <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	Extremely distressing