

Redistribution of Environmental Pollutants in the aftermath of Hurricanes and Community Health



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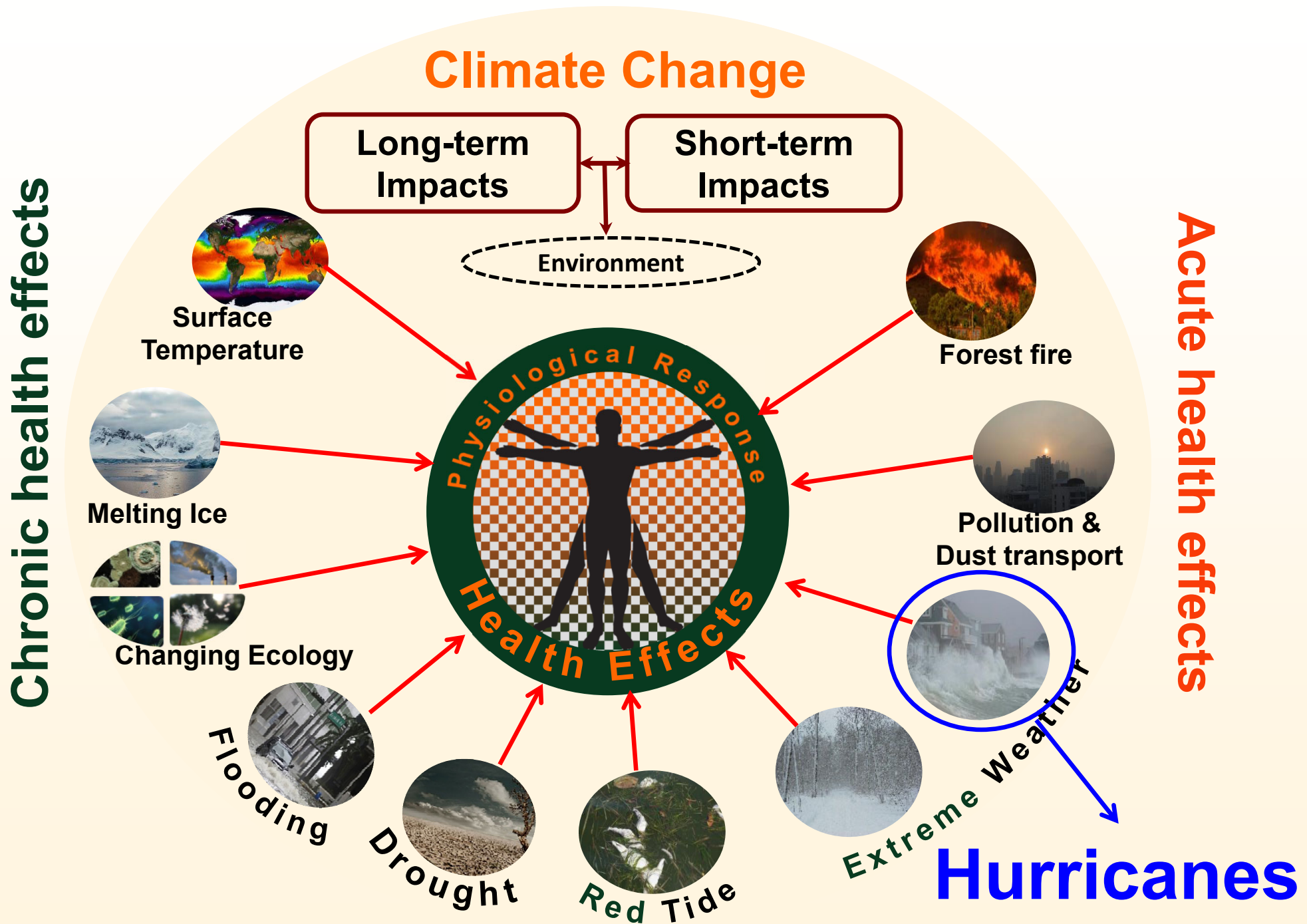
Conflict & acknowledgement

- **No-conflict of interest**
 - Research motivation and conduct of research
 - Data collection, analyses and interpretation
- **Acknowledgement**
 - This work in part was supported by NIH (R21ES029765) and internal support of the University of Miami Department of Public Health Sciences

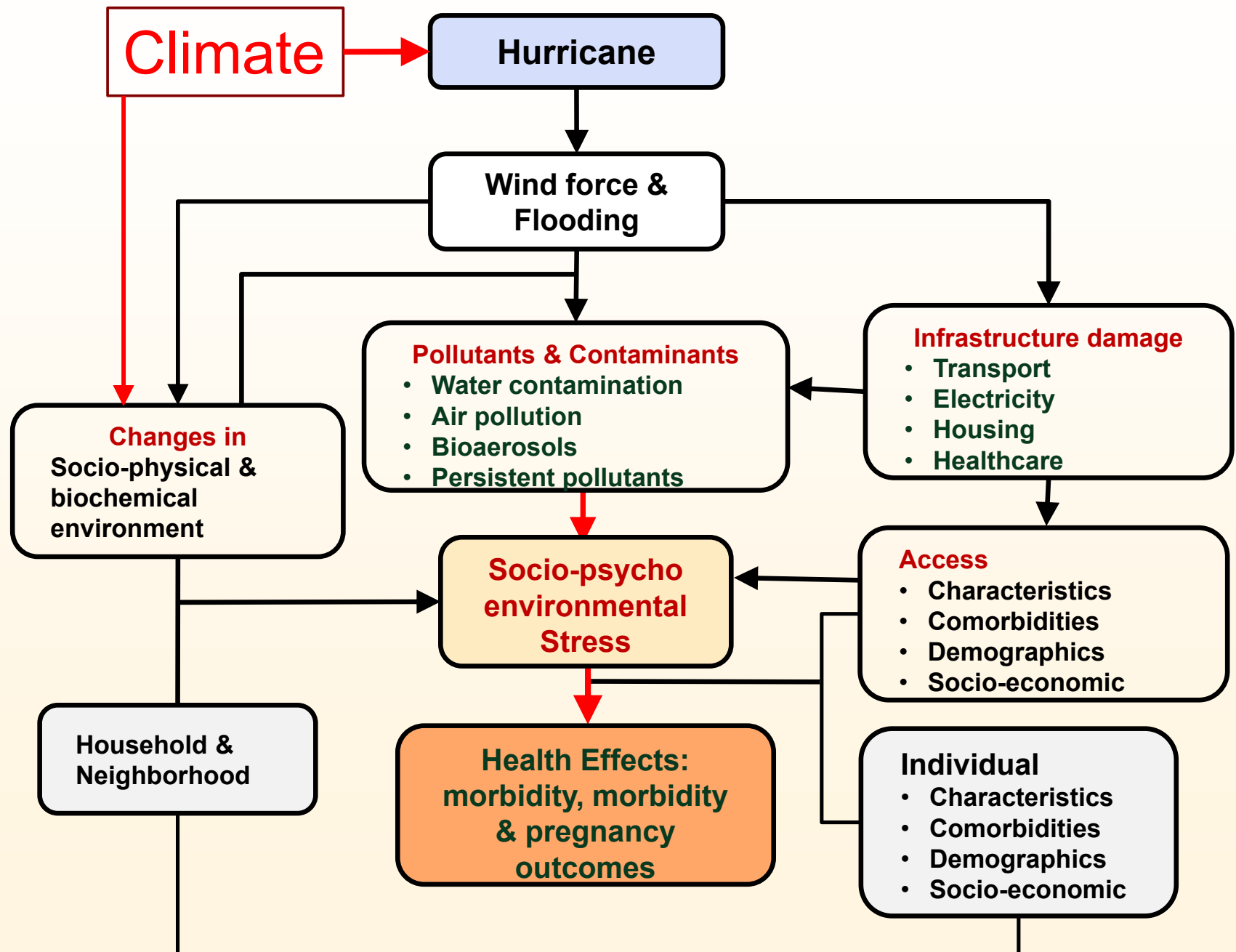
Presentation contents

- **A conceptual framework of the linkages among hurricane, environment and health**
- **Background of Guánica Bay and Municipality (Puerto Rico) and PCBs**
- **Data collection and analyses**
- **Changes in PCB and other pollutants after hurricane Maria**
- **Potential community exposure to PCBs after hurricane Maria**
- **Implications for exposure management**

A. Climate, environment and Health



A1. Hurricane, environment & health



A2. Research questions?

- **Do hurricanes result in the (re)distribution of environmental pollutants?**
- **What are potential health implications of changes in environmental exposures in the aftermath of hurricanes?**



B. Guánica Municipality - Study Site





B1. Guánica Bay



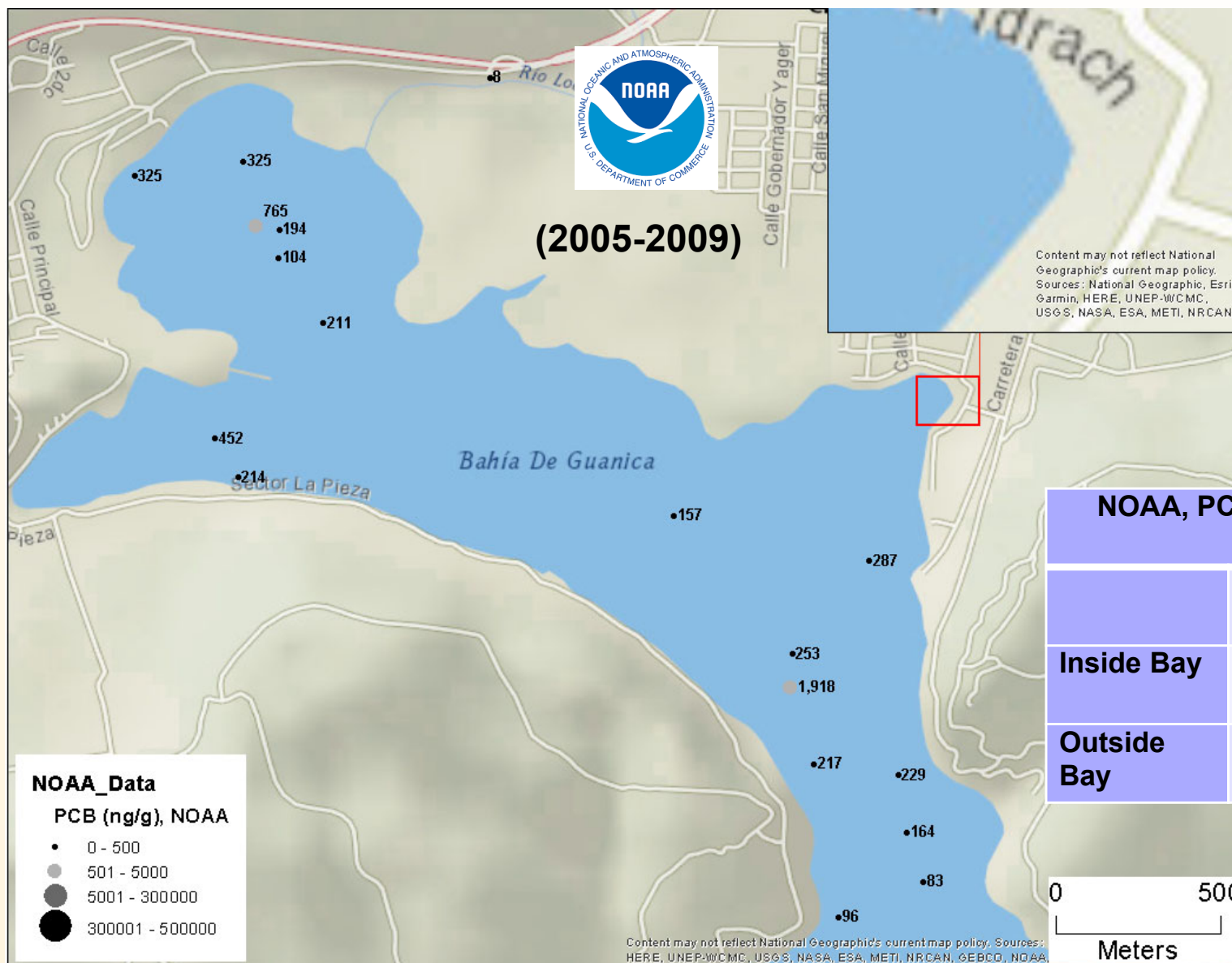


B2. Guánica Bay



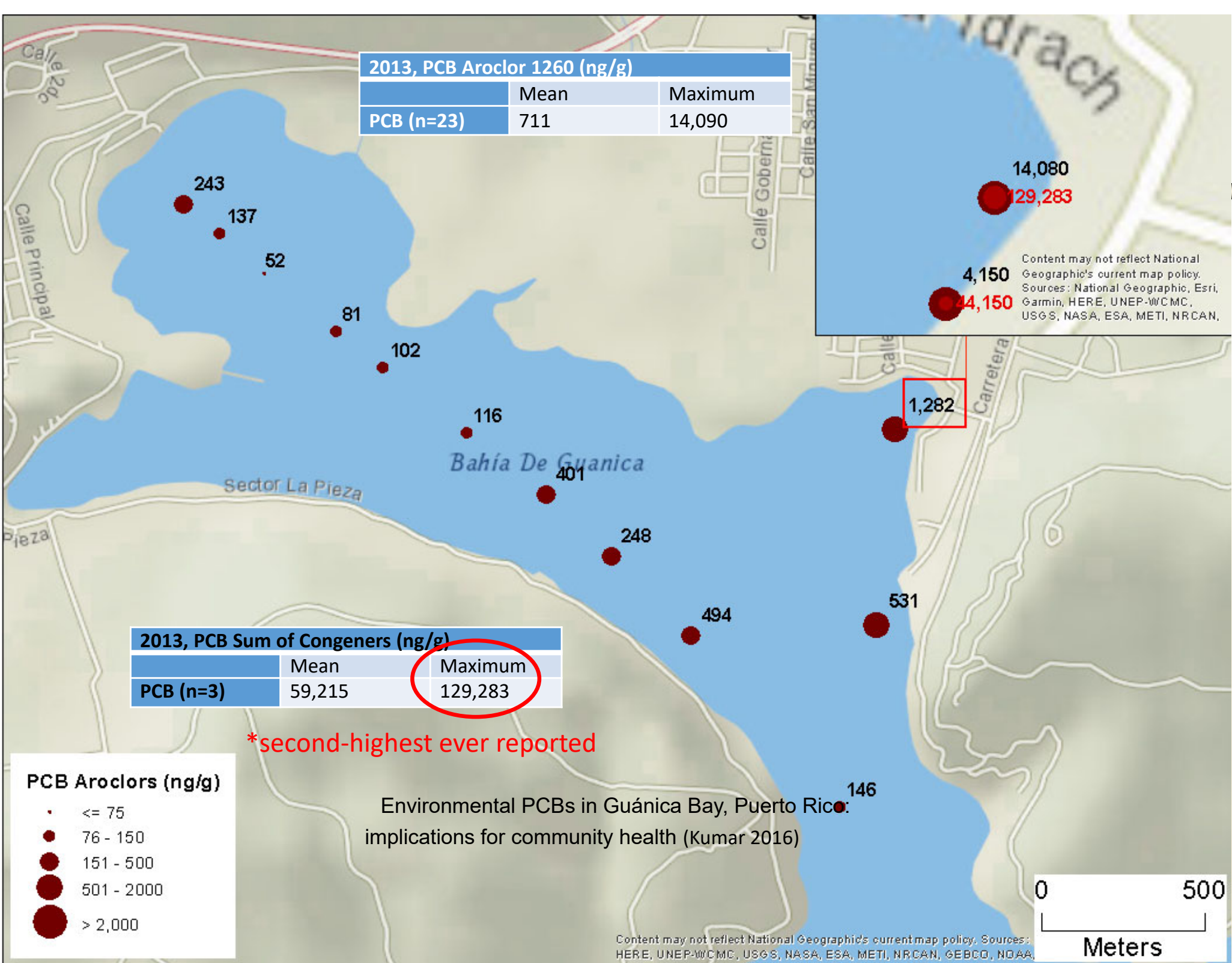
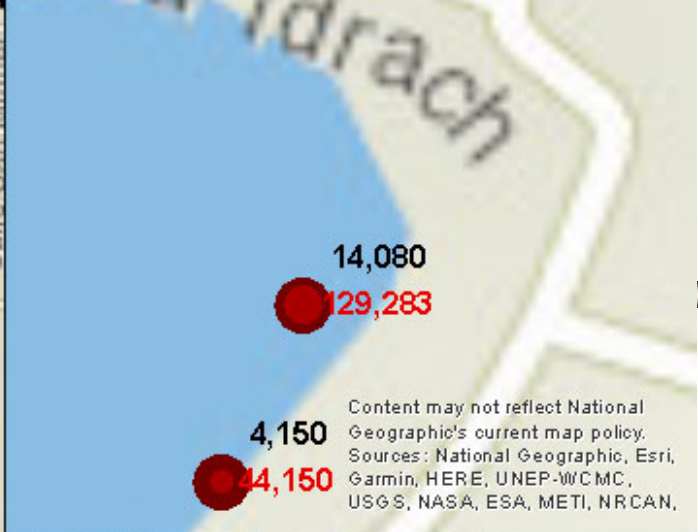


B3. PCBs in Guánica Bay (NOAA)



NOAA, PCB Sum of Congeners (ng/g)		
	Mean	Maximum
Inside Bay	214	1918
Outside Bay	6.69	

2013, PCB Aroclor 1260 (ng/g)		
	Mean	Maximum
PCB (n=23)	711	14,090



2013, PCB Sum of Congeners (ng/g)		
	Mean	Maximum
PCB (n=3)	59,215	129,283

*second-highest ever reported

PCB Aroclors (ng/g)

- ≤ 75
- 76 - 150
- 151 - 500
- 501 - 2000
- > 2,000

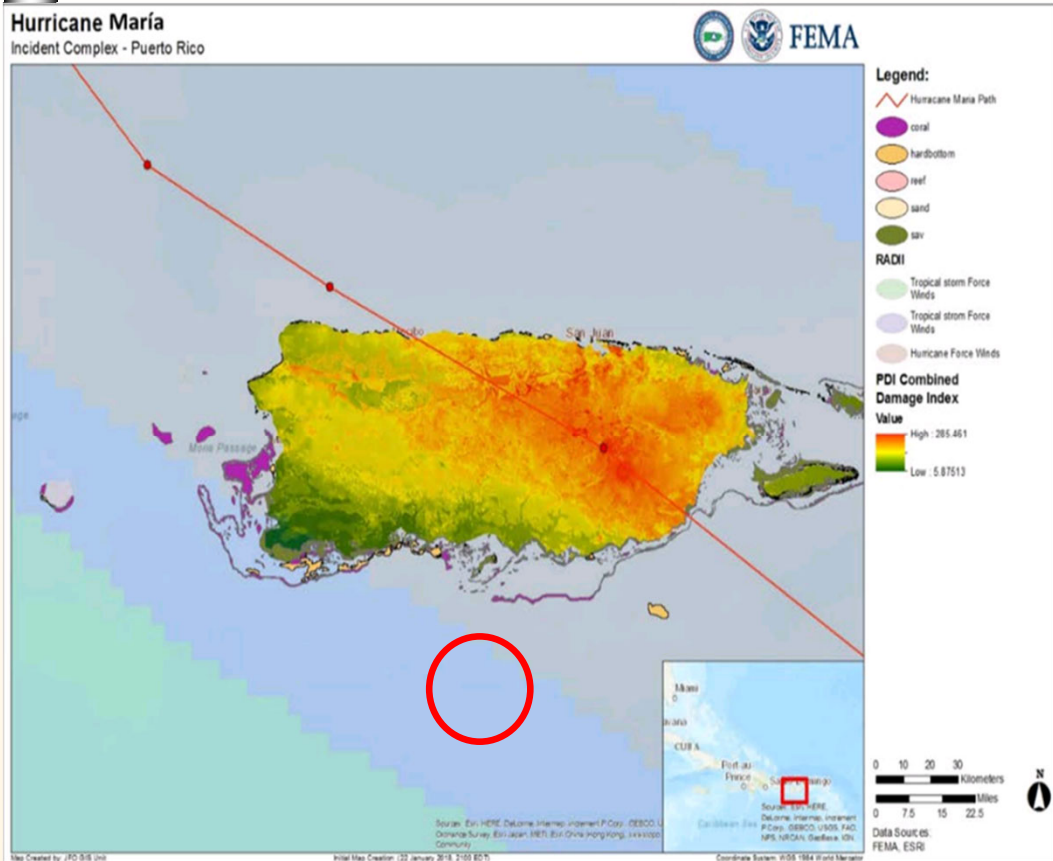
Environmental PCBs in Guánica Bay, Puerto Rico: implications for community health (Kumar 2016)



Content may not reflect National Geographic's current map policy. Sources: HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA,



Hurricane Maria - 2017



C. Data

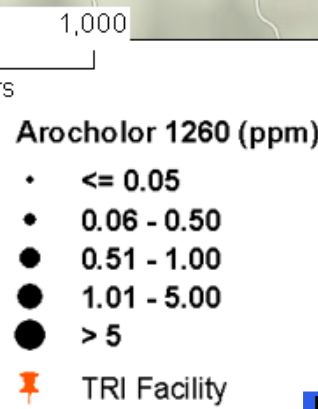
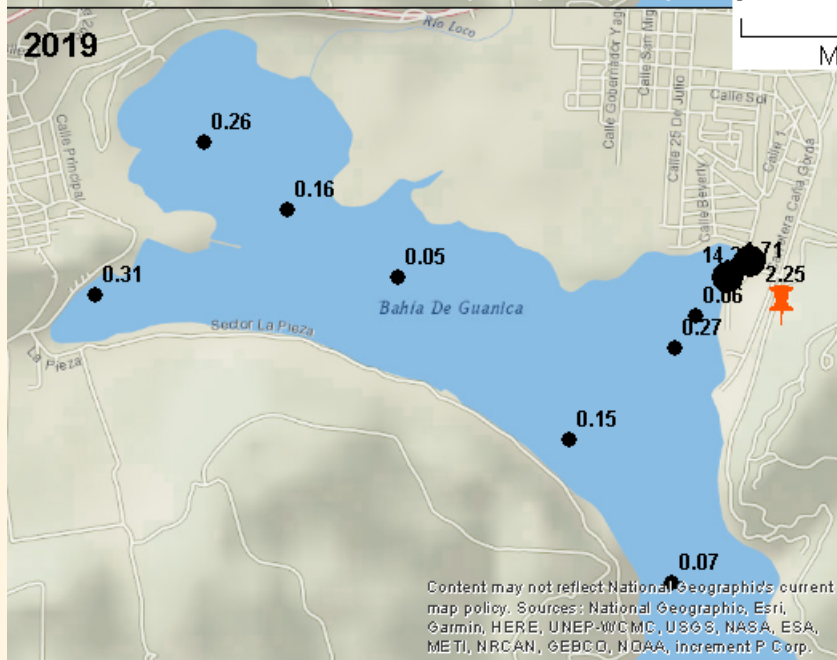
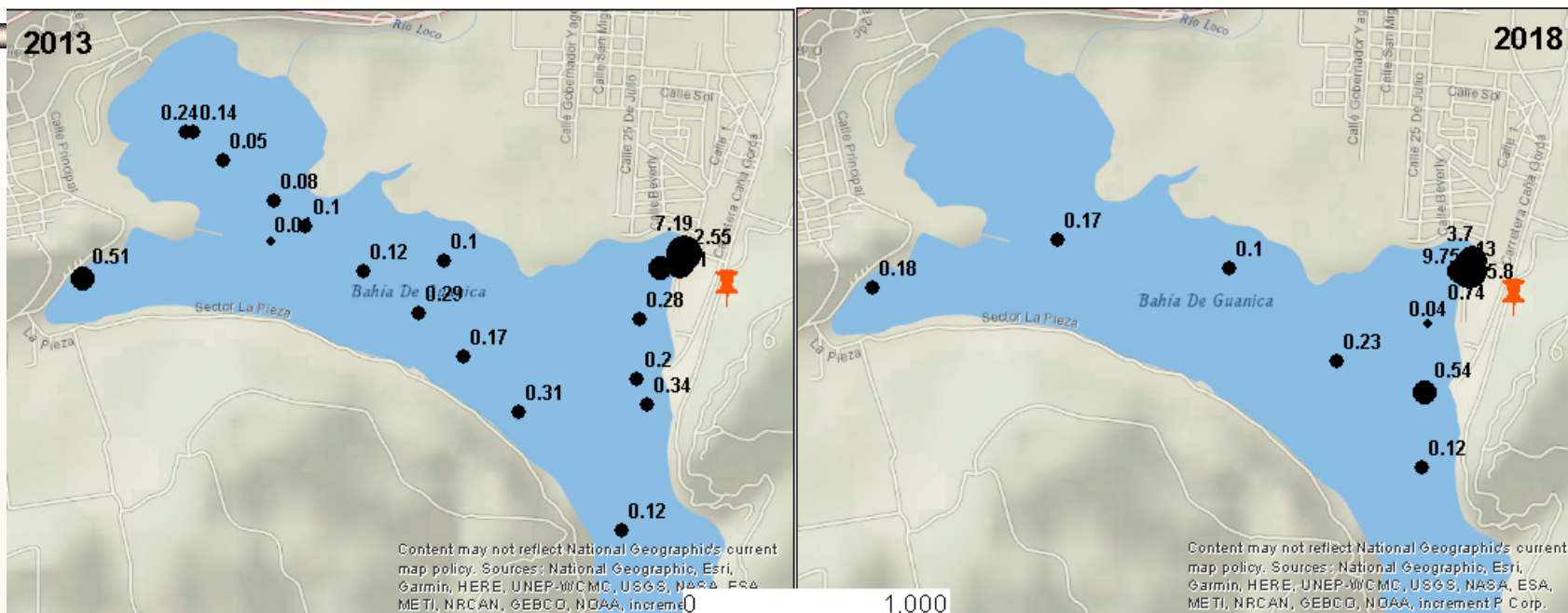
- **Sediment samples**
- **2013 (n=23), 2018 (14) and 2019 (12)**
- **Air samples**
 - **2018 (n = 6)**
- **Biomonitoring**
 - **2018 (n=50), 2019 (n=97)**
- **Survey**
 - **2018, 2019 (n=418)**

C1. Sample analyses

- **PCBs and PAHs in the samples were analyzed using EPA Method EPA 3550C, EPA 3550 C – MS**
- **Duplicate and blank samples were analyzed**
- **PCB 103* & PCB 198 were used as surrogate for sample recovery**
- **Heavy metals were analyzed using ICP-MS**



D1. RESULTS – Aroclor 1260



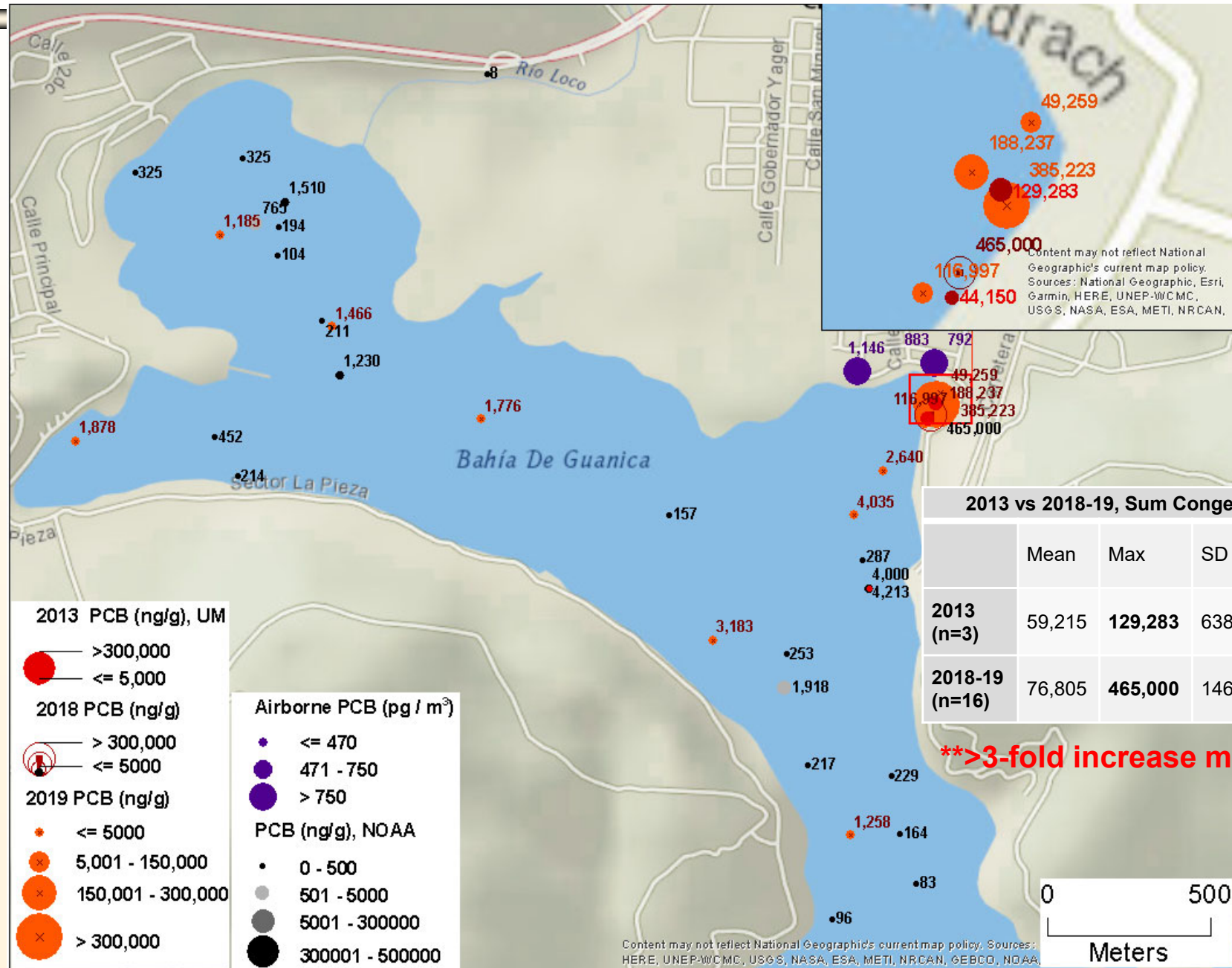
2013 vs 2018-19, Aroclor 1260				
	Mean	Max	SD	p-value
2013 (n=23)	711	7,190	1535	<0.03
2018-19 (n=15)	2,878	13,000	4841	

Bay = **4-fold increase

Hotspot, PRE vs POST: Aroclor 1260				
	Mean	Max	SD	p-value
2013 (n=3)	1,154	2,550	1292	0.1
2018-19 (n=3)	6,310	13,000	6449	

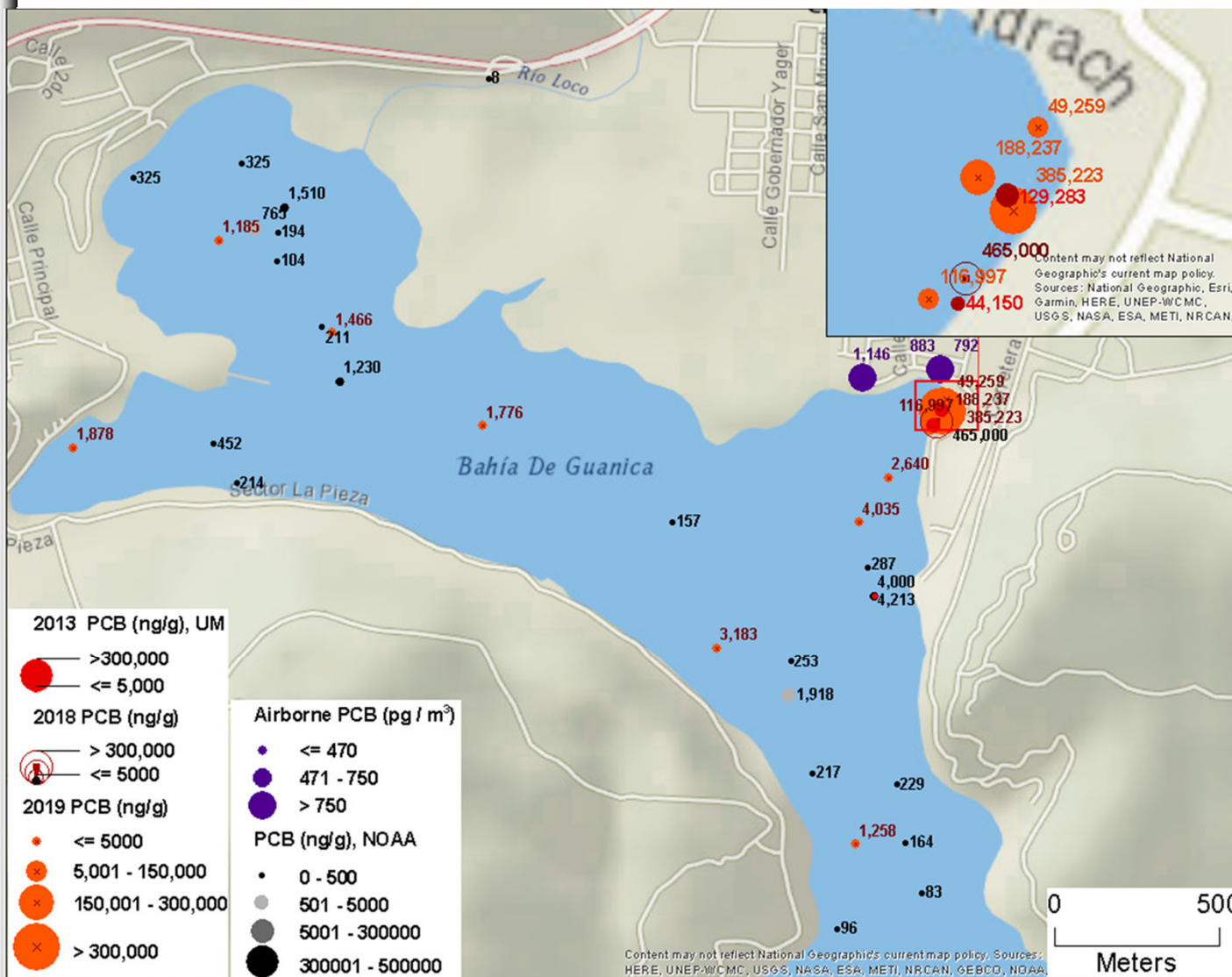
Hotspot = **5-fold increase mean

D2. Sum of PCB congeners





D3. Airborne PCBs: PCB congeners



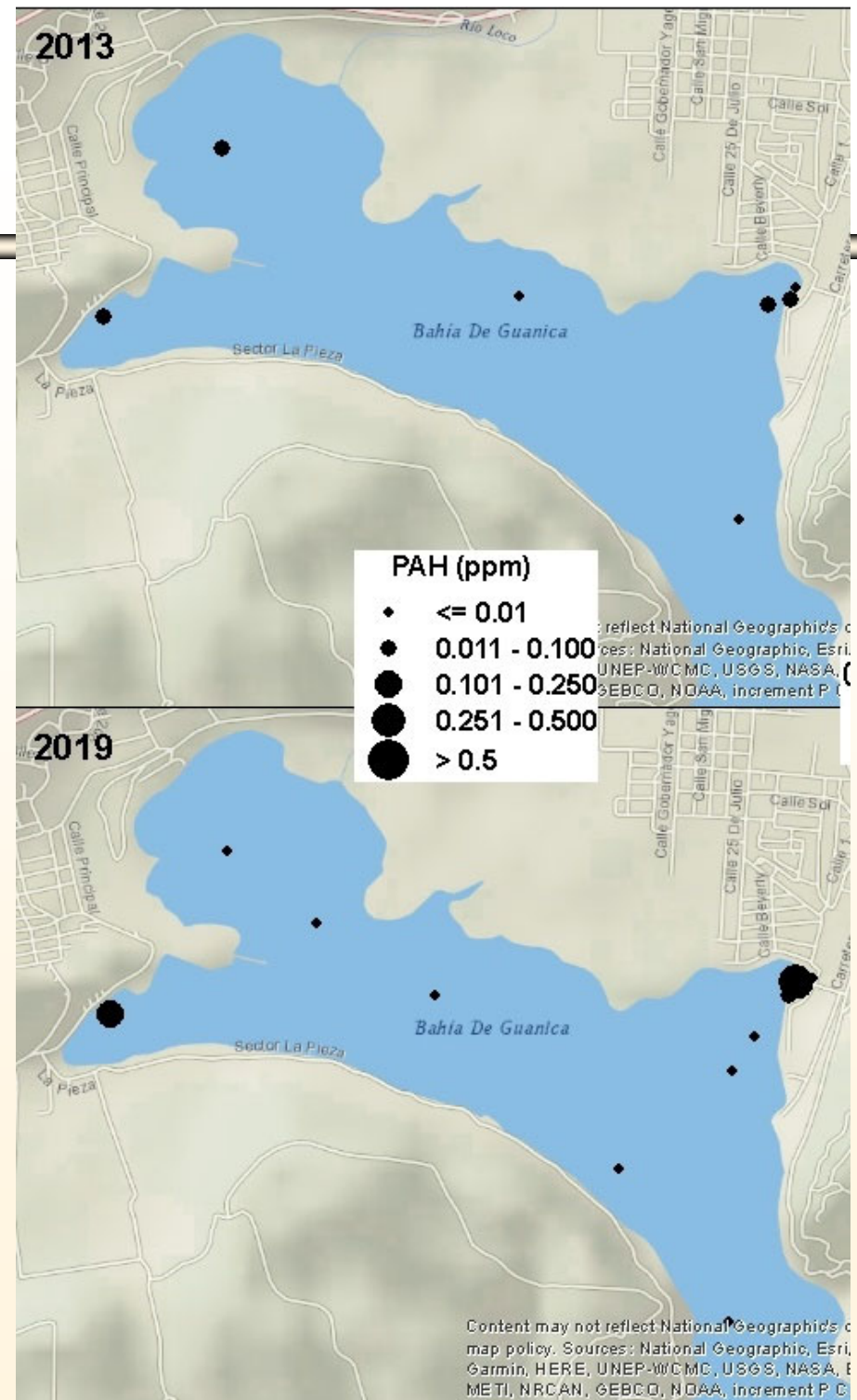
2019, PCB Air (pg/g)		
	Mean	Maximum
Hotspot (n=4)	740	1,145
Control site (n=1)		132

**8-fold increase in the maximum



D4. Total PAH

Acenaphthene
Acenaphthylene
Anthracene
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (b) fluoranthene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Chrysene
Dibenz (a,h) anthracene
Fluoranthene
Fluorene
Ideno (1,2,3-cd) pyrene
Naphthalene
Phenanthrene
Pyrene
1-Methylnaphthalene
2-Methylnaphthalene



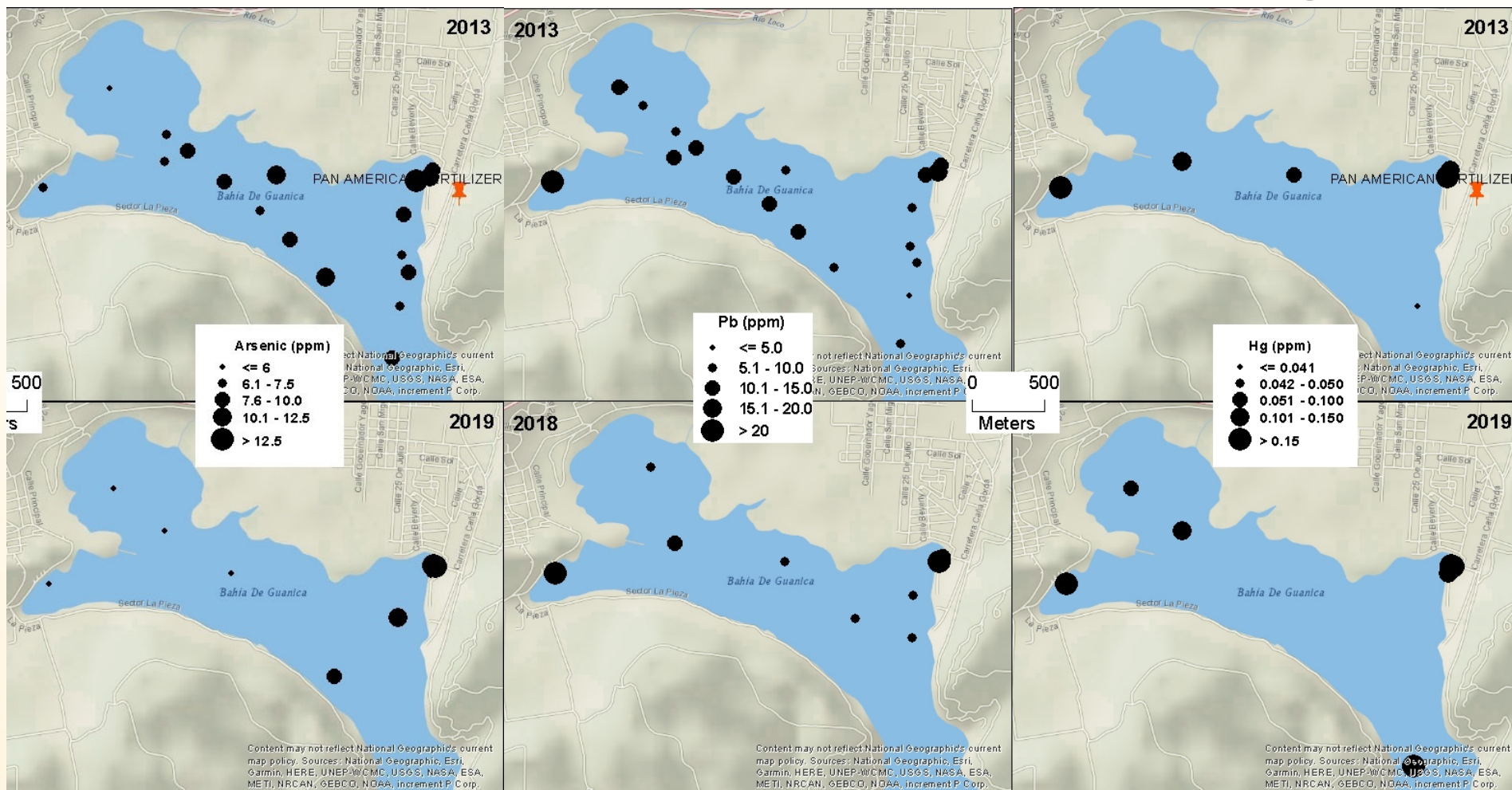


D5. Heavy metals

As

Pb

Hg



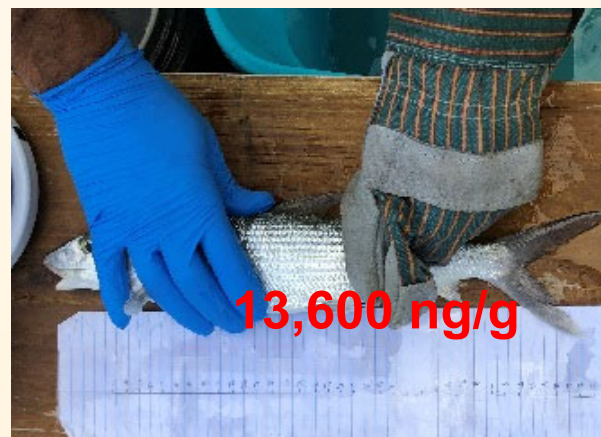
8.9 mg/kg

18 mg/kg

0.18 mg/kg

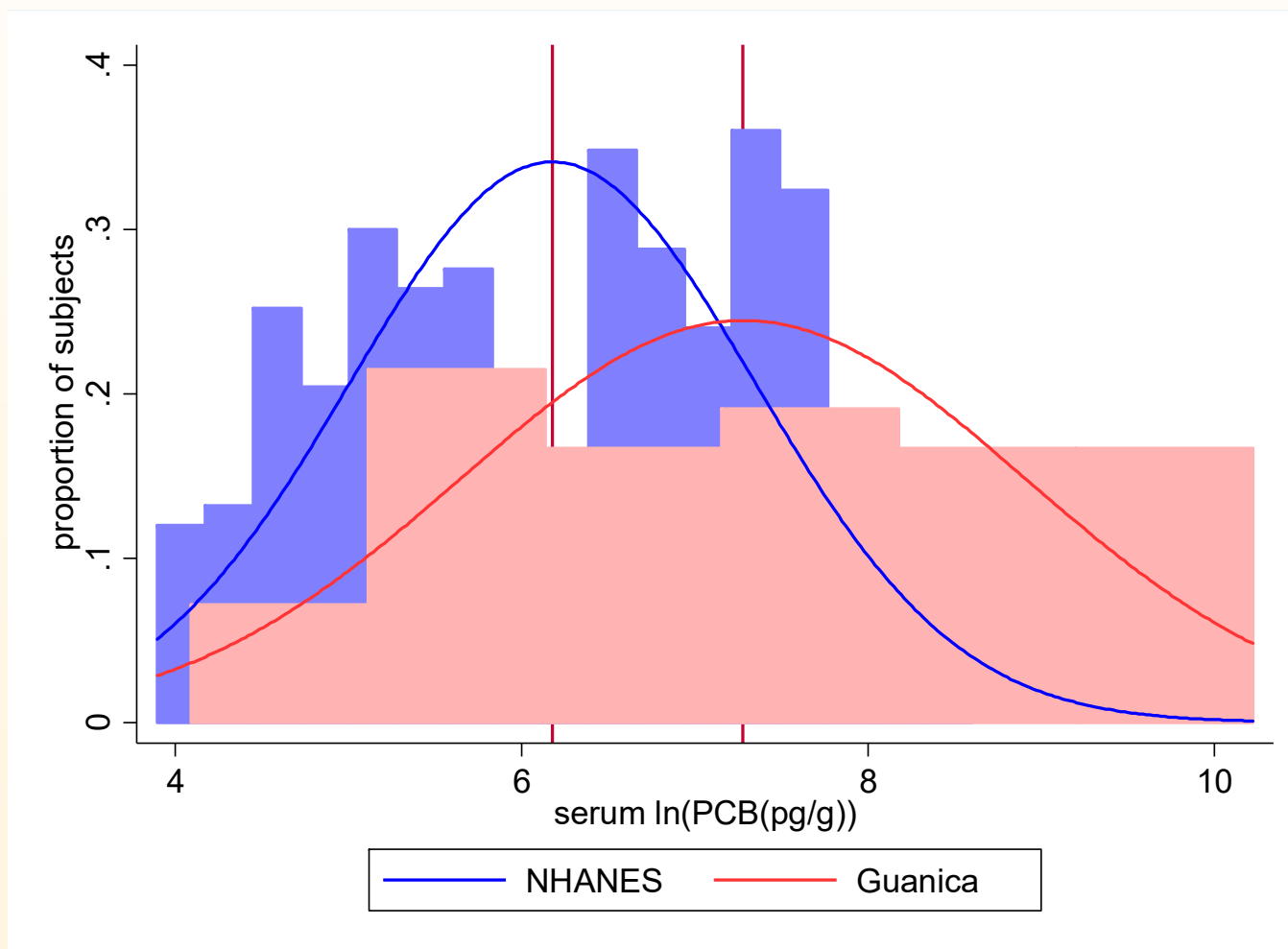
D5. Fish PCBs

- **Fish PCBs**
 - Inside > **10 $\mu\text{g} / \text{g}$**
 - Outside < **1 $\mu\text{g} / \text{g}$**



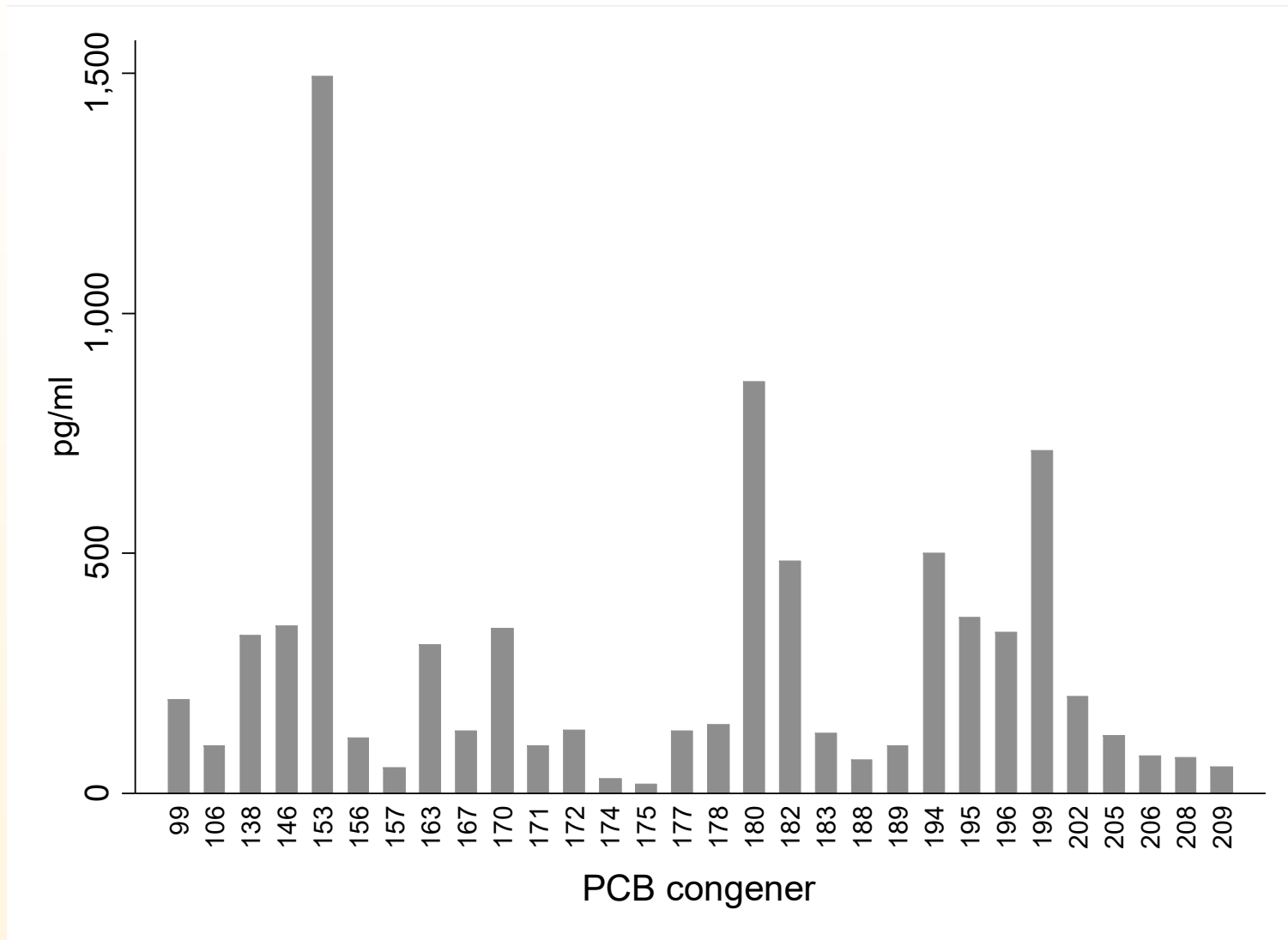
D6. PCBs body burden

Guánica residents = 4,244 pg/g
US population = 835 pg/g (based on NHANES)





D6.1 PCB congeners in serum samples



D7.1 Hurricane Maria's impact

Home damage

Hurricane Maria related damaged	% (# subjects)
Physical damage to home	29.4 (123)
Water damage to home	21.5 (90)
No damage	45.7 (191)

D7.2 Hurricane Maria's impact

Mold exposure

Any sign of mold after H. Maria in home	% (# subjects)
ceilings	17.7 (74)
walls	13.6 (57)
floors	5.5 (23)

D7.3 Hurricane Maria's impact

Power outage

Power restored after H. Maria	% (# subjects)
<1 week	0.7 (3)
1-2 weeks	1.4 (6)
2 weeks-1 month	8.9 (37)
1-2 months	35.7 (149)
>2 months	43.3 (181)

D7.4 Hurricane Maria's impact

Food and fish sources

Source	FOOD % (# subjects)	FISH % (# subjects)
Local store	8.1 (34)	14.8 (62)
Local restaurant	4.6 (19)	8.9 (37)
Local supermarket	76.1 (318) **	35.2 (147)
FEMA	30.08 (127)	2.4 (10)
Church/Food bank	9.1 (38)	0



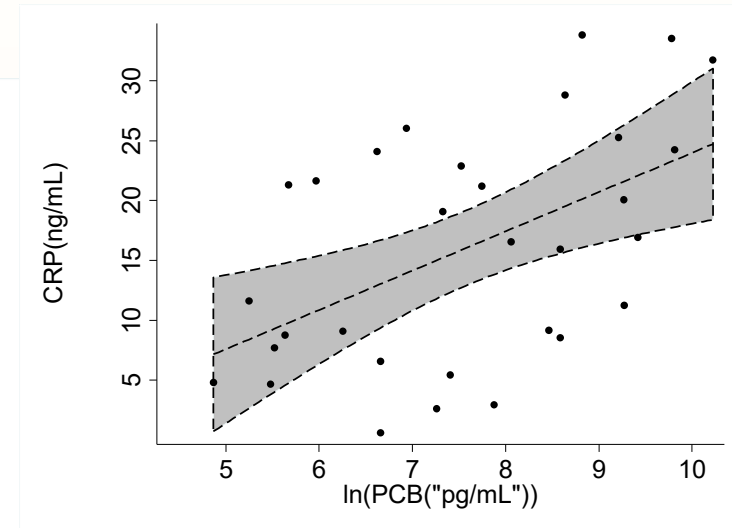
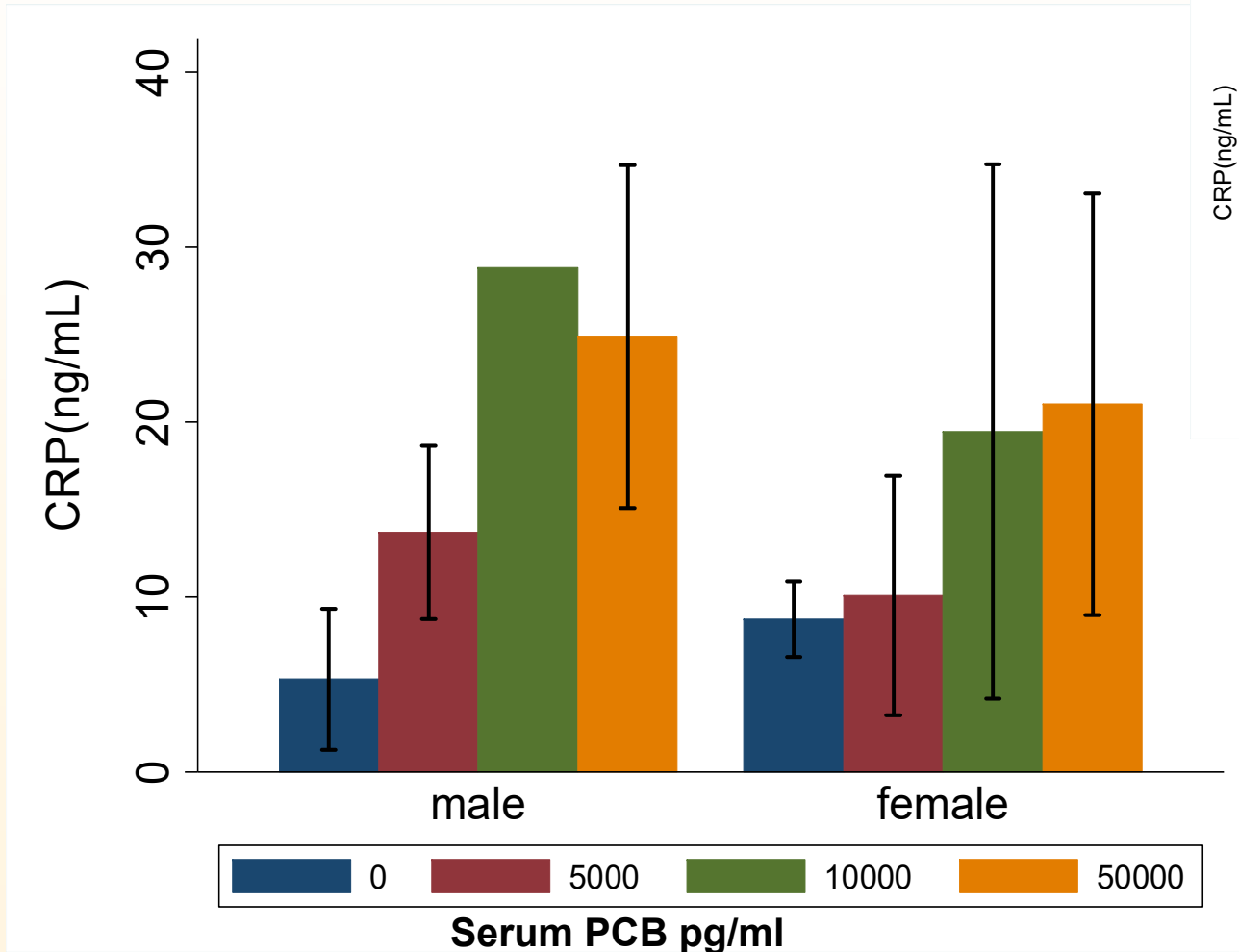
D7.2 Common sources of fish/seafood in municipality

Those consuming fish/seafood for the past 20 y

Fish source	% (# subjects)
Inside bay	6.2 (26)
Local fish store	39.0 (163)
Local fish store or inside bay	50.72 (175)



D8 CRP concentration by serum PCB categories





D9.1 Disease diagnoses before and after the hurricane

99 of 743 reported new clinical diagnosis of chronic diseases after the hurricanes

	Before	After	Not sure	Total
Maria	210 (36.5)	77 (13.4)	288 (50.1)	575 (100)
Irma	64 (61.5)	9 (8.7)	31 (29.8)	104 (100)
Michael	46 (71.9)	13 (20.3)	5 (7.8)	64 (100)
Total	320 (43.1)	99 (13.3)	324 (43.6)	743 (100)



D9.2 Time-lag of new diagnoses

Hurricane Name	# of months after the hurricane								Total
	<1	1-2	2-3	3-5	5-8	8-12	>12	not sure	
Maria	6 (7.3)	8 (9.8)	2 (2.4)	12 (14.6)	22 (26.8)	17 (20.7)	11 (13.4)	4 (4.9)	82 (100)
Irma	1 (12.5)	1 (12.5)	1 (12.5)	2 (25.0)	0 (0.0)	1 (12.5)	1 (12.5)	1 (12.5)	8 (100)
Michael	0 (0.0)	3 (21.4)	2 (14.3)	2 (14.3)	2 (14.3)	1 (7.1)	2 (14.3)	2 (14.3)	14 (100)
Total	7 (6.7)	12 (11.5)	5 (4.8)	16 (15.4)	24 (23.1)	19 (18.3)	14 (13.5)	7 (6.7)	104 (100)



D9.3 Allergy and asthma symptom worsening after the hurricane

Asthma prevalence rate ~ 14.26%

Allergy prevalence rate ~ 27.7%

N = 1,258

Hurricane	<u>Allergy</u>			Total	<u>Asthma</u>			Total
	YES	NO	Not Sure		YES	NO	Not Sure	
Maria	127 (59.6)	73 (34.3)	13 (6.1)	213 (100)	47 (48.5)	46 (47.4)	4 (4.1)	97 (100)
Irma	37 (36.3)	39 (38.2)	26 (25.5)	102 (100)	14 (27.5)	27 (52.9)	10 (19.6)	51 (100)
Michael	49 (92.5)	3 (5.7)	1 (1.9)	53 (100)	23 (88.5)	2 (7.7)	0 (0.0)	26 (100)
Total	213 (57.9)	115 (31.3)	40 (10.9)	368 (100)	84 (48.3)	75 (43.1)	15 (8.6)	174 (100)



D9.4 Pre-term birth outcomes

	Normal > 37 week	PTB < 37 week	Miscarriage Termination	Total
Maria	0 (0.0)	6 (75.0)	2 (25.0)	8 (100)
Irma	2 (40.0)	1 (20.0)	2 (40.0)	5 (100)
Michael	0 (0.0)	0 (0.0)	1 (100.0)	1 (100)
Total	2 (14.3)	7 (50.0)	5 (35.7)	14 (100)

D10. Disease burden in the aftermath of hurricane Irma

Table 1. Patient visit to healthcare and ER facilities of healthcare providers in OneFL consortium six month before and after hurricane Irma (number of patients (% in parenthesis)).

Selected disease	Patients in all <u>OneFL</u> partners		Emergency Room Visits within <u>OneFL</u> *	
	(3/10/2017-9/9/2017)	(9/10/17- to 3/10/18)	3/10/2017-9/9/2017)	(9/10/17-3/10/18)
<u>#patients</u>	4,701,295 (50.37)	4,633,147 (49.63)	1,227,594 (48.79)	1,288,725 (51.21)
Allergy	25,175 (54.36)	21,137 (45.64)	9,696 (54.76)	8,010 (45.24)
Asthma	41,715 (45.65)	49,662 (54.35)	16,928 (45.72)	20,095 (54.28)

Excess ER visits ~ 31,187 (2.42%)

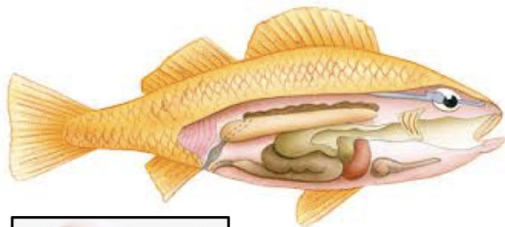
ER Cost ~ \$2800 * 31,187 ~ \$ 87,324,006



E. Changes in community PCB exposure after Hurricane Maria

- An increase in sediment PCBs more than 3 times
- Fish PCB levels could have been increased over time
- Strong possibility of PCB exposure through inhalation
 - $0.5\text{L} * 12\text{breaths} * 60\text{ minute} * 24\text{ h} = 8,640\text{L air inhalation}$
 - $8.7\text{ m}^3 * (1,146\text{pg} / 3)/\text{m}^3 = 3285.2\text{ pg/day}$ excess PCB exposure

F. Management



- X REMOVE ORGANS
- X REMOVE HEAD
- X REMOVE EYES
- X REMOVE LIVER
- ✓ FILET OK

- POP Bioaccumulation
- Raise awareness
- Unavoidable exposures



- Effect on contaminated sites
- Wind, rainfall, runoff
- Survival Necessities



Our team and community

**Guánica High School
Students & Teachers**



**CI, Solo-Gaberile and a
community member**



Community Members



Protectores de Cuencas



**Coordinator, Sara Rock and
community members**



**UM team and Community
members**





Any



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