

Pro-inflammatory Potential of Indoor Dust Collected from Households in San Juan, Puerto Rico in the Aftermath of Hurricane Maria

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Introduction

In September 2017, Hurricane Maria (Figure 1) caused extensive devastation in Puerto Rico, including substantial wind- and water-damage to homes. The extremely slow pace of recovery/repair of the water-damaged homes increases the risk of inhabitants' long-term exposure to pro-inflammatory indoor air pollutants.

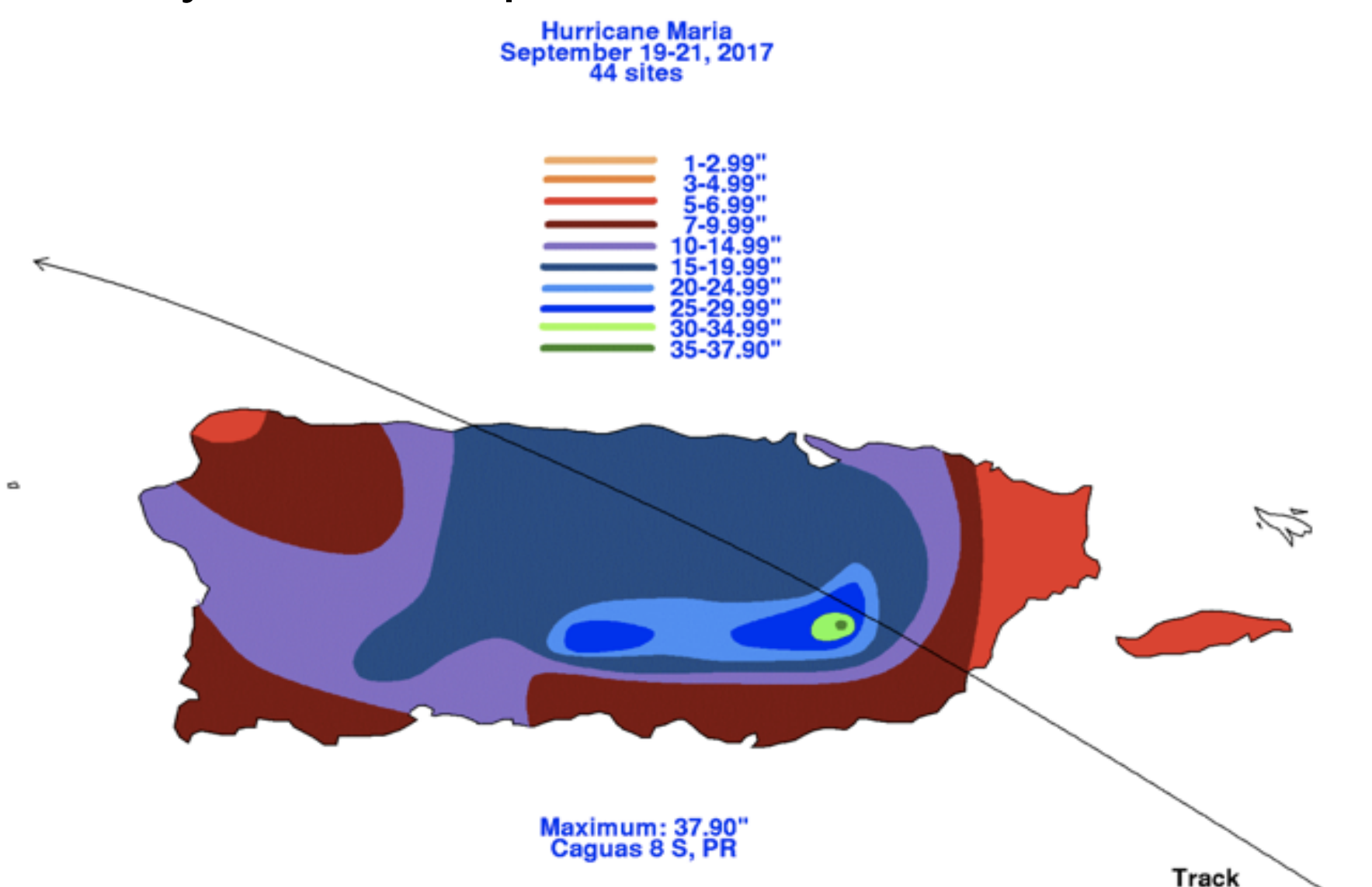


Figure 1. Map of total rainfall in Puerto Rico during the Hurricane Maria. NOAA Tropical Cyclone Report: Hurricane Maria (Accessed Feb, 2019).

Objective

Determine the pro-inflammatory potential (based on induced interleukin-1beta) of indoor settled dust samples from households in a flooded-area, and identify household variables influencing the dust pro-inflammatory potential.

Methods



Figure 2. Site of study (Tras Talleres Community) in San Juan, PR. Image retrieved with the ggmap R package.

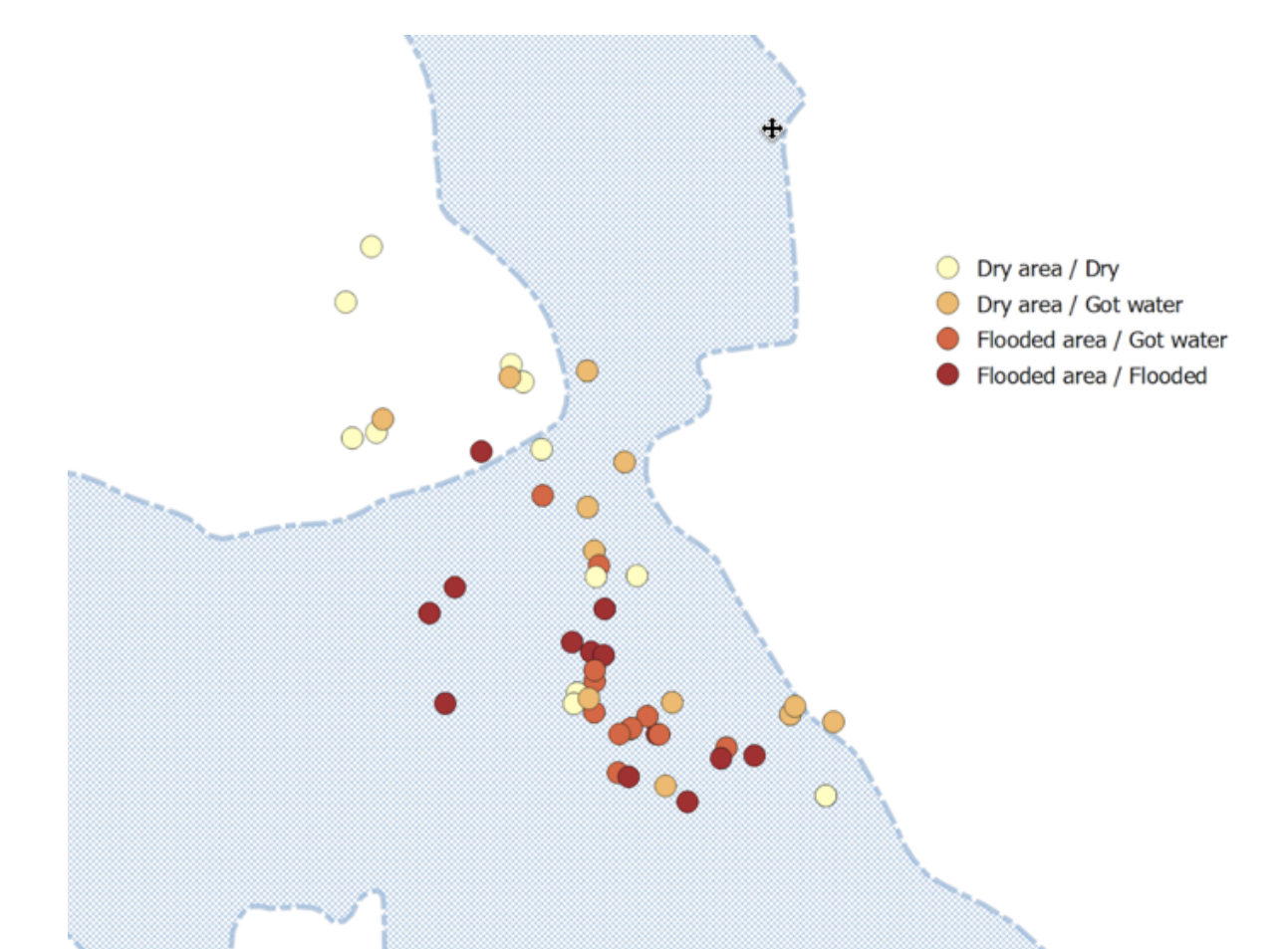


Figure 3. Distribution of houses from flooded and non-flooded areas. Blue area denotes FEMA's layer of flooding. Illustration courtesy of H. Cavallin.

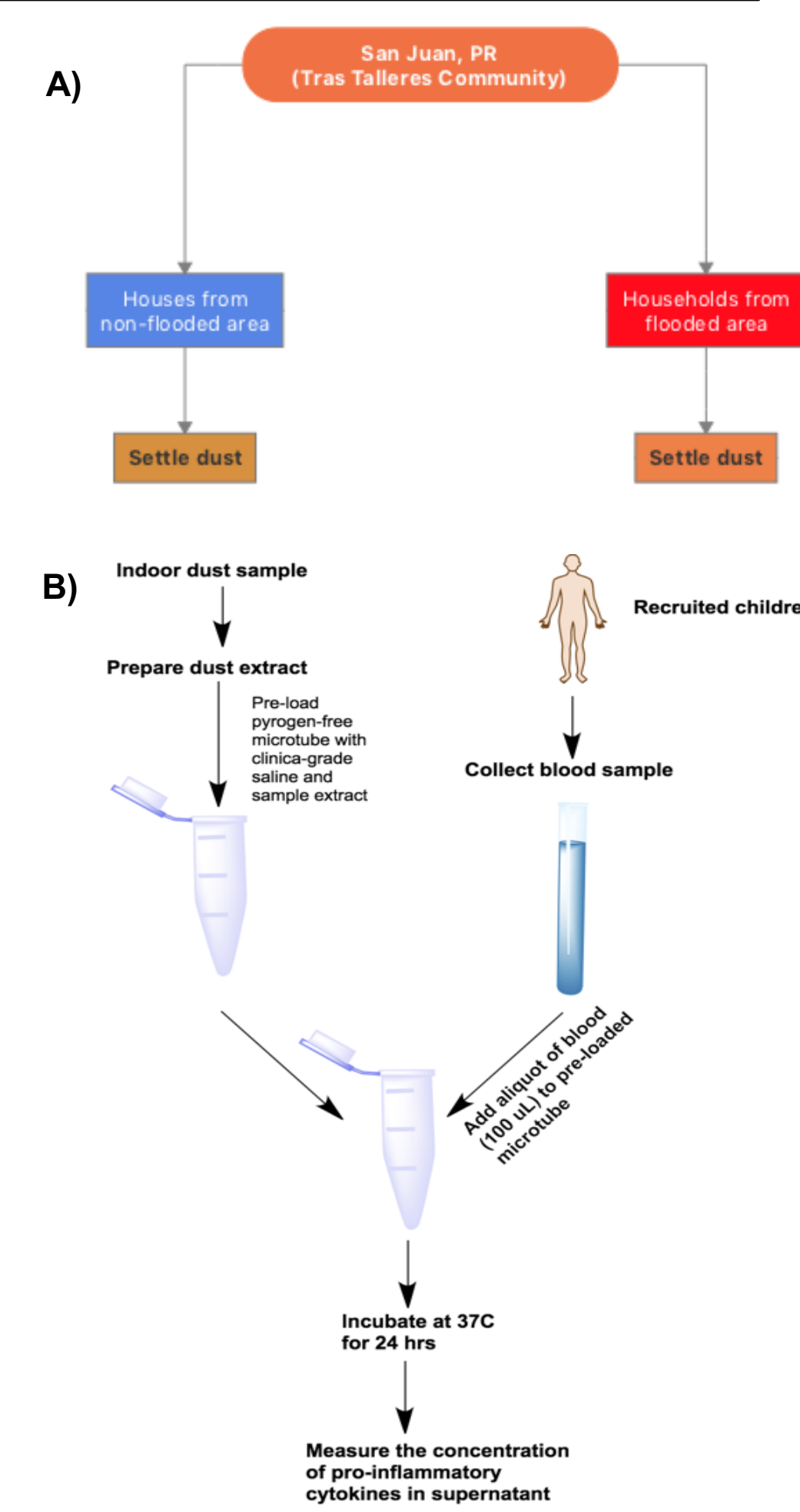


Figure 4. A) Sampling and B) immunological set-up to assess the pro-inflammatory potential of dust.

Results

Table 1. Distribution of sampled homes per flooded area and internal water damage.

	Homes sampled	Some internal water damage	Inside flooding
Flooded area	24	46%	54%
Non-flooded area	26	50%	NA

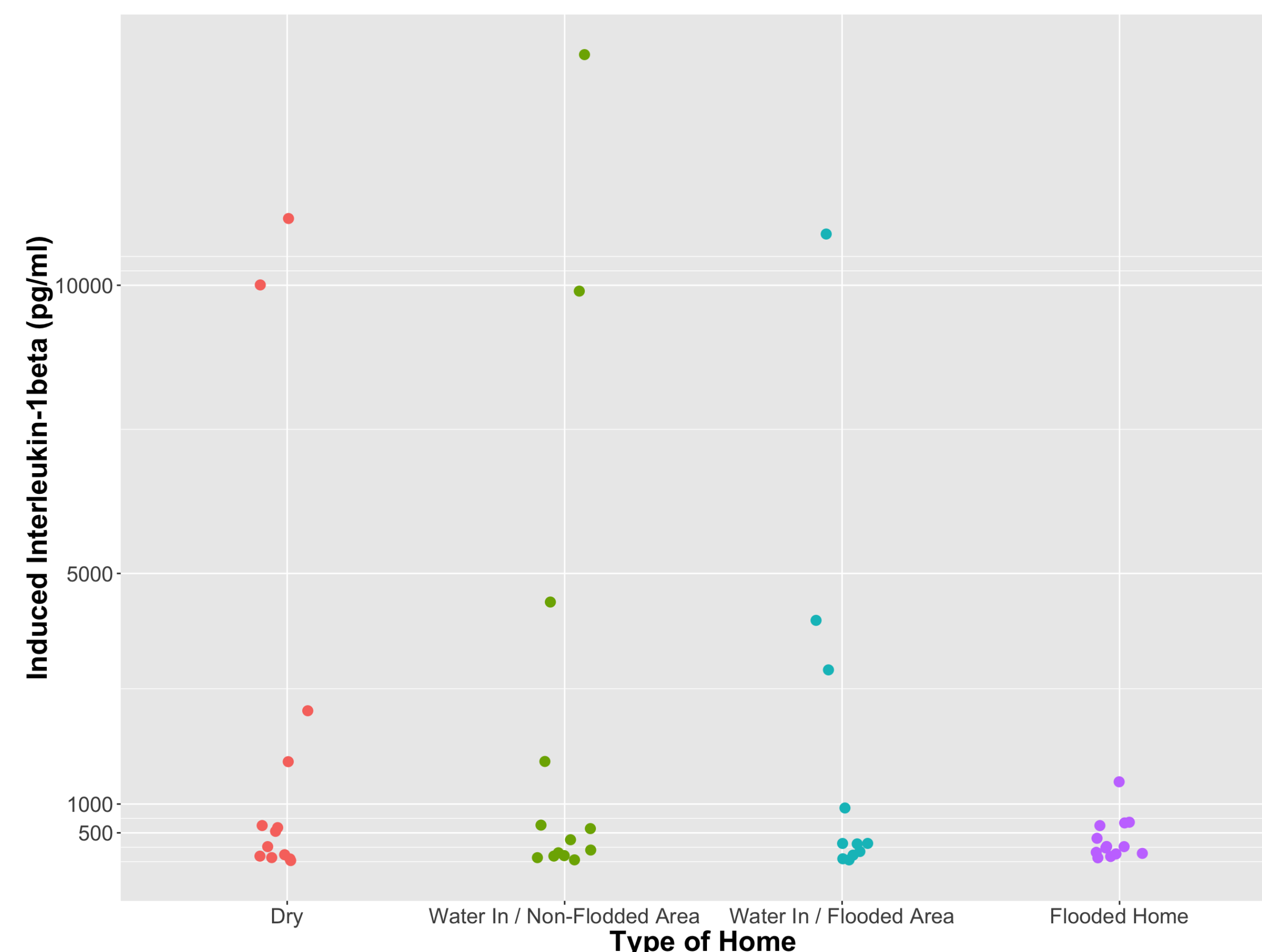


Figure 5. Induced interleukin-1beta by dust samples from non-damaged or water-damaged homes in flooded or non-flooded areas.

Table 2. Spearman correlation** between self-reported home environment and pro-inflammatory potential (IL-1beta).

	Dry	Water In / Non-Flooded area	Water In / Flooder Area	Flooded Home
Age of home	0.11 (0.56)	0.02 (0.94)	0.42 (0.26)	-0.23 (0.48)
Smoking	-0.30 (0.07)	-0.15 (0.61)	-0.54 (0.09)	-0.03 (0.92)
Indoor pest allergens	0.14 (0.39)	0.21 (0.48)	0.18 (0.62)	-0.27 (0.37)
Pet ownership	0.26 (0.13)	0.29 (0.34)	0.22 (0.51)	-0.26 (0.39)
Age of the house	0.10 (0.57)	0.02 (0.94)	0.42 (0.26)	-0.22 (0.49)
SES	0.04 (0.85)	0.12 (0.82)	0.42 (0.41)	-0.09 (0.83)

** rho coefficient (p-value).

Table 3. Regression models## for IL-1beta with living room, kitchen, bathroom, and bedroom as predictor variables.

	Water In / Non-Flooded area	Water In / Flooder Area	Flooded Home
Indoor damage			
Living room	11241 (0.16)	818 (0.14)	-247 (0.09)*
Kitchen	-6550 (0.27)	NA	319 (>0.01)*
Bathroom	NA	NA	-41.2 (0.58)*
Bedroom	+5162 (0.22)	NA	10.8 (0.87)*
Ventilation			
Living room	NA	NA	399 (0.03)**
Kitchen	-146 (0.96)	NA	NA**
Bathroom	-1783 (0.77)	1322 (0.75)	315 (0.15)**
Bedroom	543 (0.76)	1333 (0.39)	-190 (0.16)**
Open Windows			
Living room	-491 (0.48)	2746 (0.09)	21 (0.87)
Kitchen	2913 (0.05)	3416 (0.02)	-195 (0.56)
Bathroom	-1164 (0.46)	-2119 (0.36)	-21 (0.98)
Bedroom	256 (0.87)	-1347 (0.19)	-29 (0.93)

* adj r² = 0.47; ** adj r² = 0.31; for all other models adj r² > 0.1

One model per type of water damage.

Conclusion

- These results suggest that exposure risks to pro-inflammatory exposures include:
 - long term unrepaired water damage
 - affected homes with poor ventilation
- Indoor dust after extensive flooding may have immunotoxic properties.
- Based on these preliminary results,
 - timely repairs in the aftermath of water damage from hurricanes is recommended to reduce pro-inflammatory and immunotoxic exposure risks

Future Studies

Identify relationships between:

- Pro-inflammatory potential and biological and non-biologic components in dust
- respiratory symptoms of occupants and dust pro-inflammatory potential
- other built environmental variables and dust pro-inflammatory potential

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- The Field Team for their remarkable job administering the surveys and carrying out the indoor sampling of the homes.

Conflict of Interest

- The authors have no conflict of interest to disclose.