PROTECT

Puerto Rico Testsite for Exploring Contamination Threats

National Institute of Environmental Health Sciences

Superfund Research Program

NIEHS SRP P42 Research Center

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PUERTO RICO

Superfund Sites in Puerto Rico

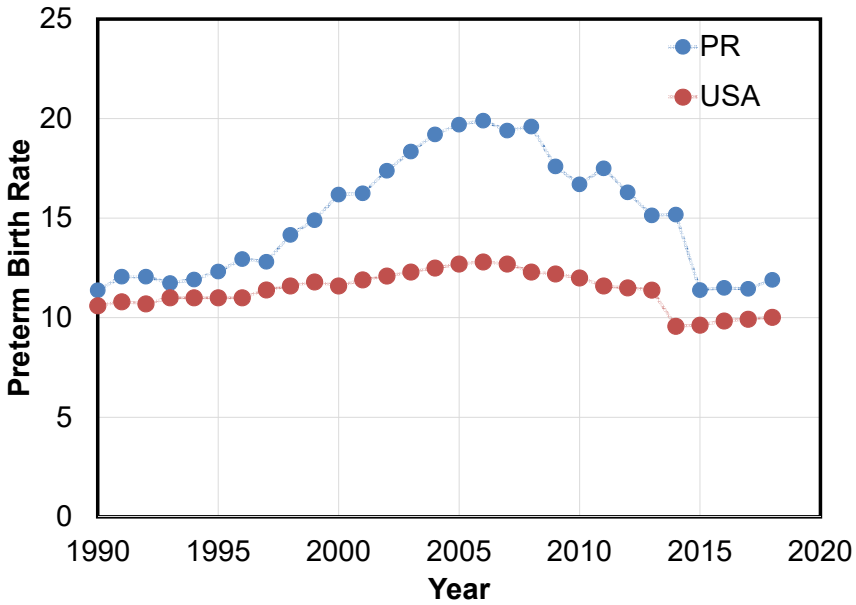
Source: https://www.epa.gov/superfund/

NPL Site

Deleted NPL Site

Preterm Birth Rate in Puerto Rico

Source: National Center for Health Statistics



ENVIRONMENTAL CONTAMINATION IN PUERTO RICO

Hazardous Waste

200+ Hazardous Waste Sites

National Priority List

18 Sites listed on the National Priority List (NPL)

Karst Systems

Many sites include unlined landfills above aquifer in karst geologic formations

Limestone Aquifers

Aquifer is primarily limestone with highly permeable karst aquifers from which the wells draw water

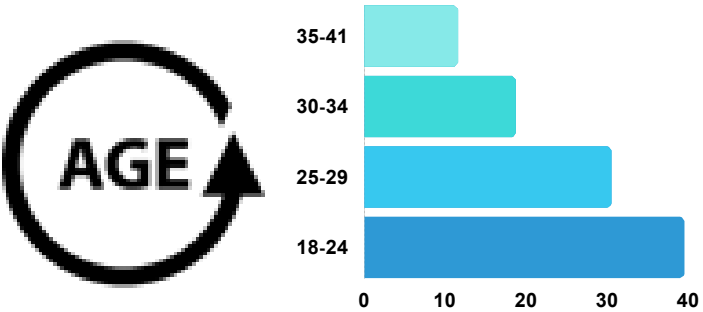
ENVIRONMENTAL STUDY AREA
NORTHERN KARST REGION

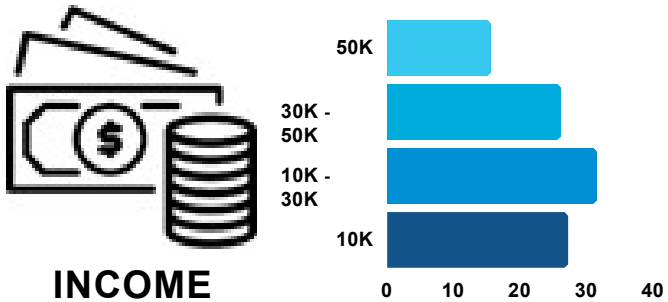
Photos courtesy of Ingrid Padilla

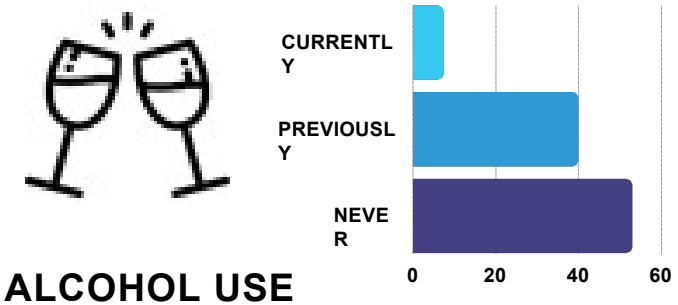
PROTECT SRP CENTER

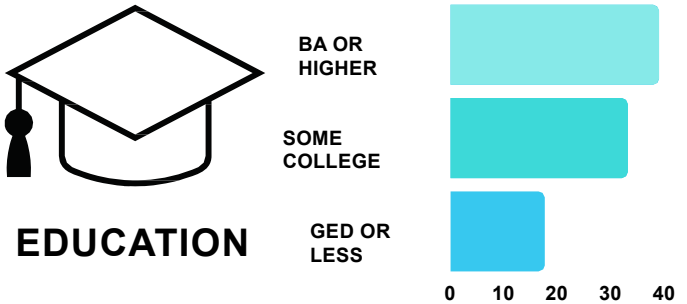
ESTABLISHED IN 2010 TO STUDY OF EXPOSURE TO SUPERFUND CHEMICALS (CHLORINATED SOLVENTS AND PHTHALATES) AND THEIR POTENTIAL CONTRIBUTION TO PRETERM BIRTH, FOCUSING ON PUERTO RICO WITH DYNAMIC CONTAMINATION EXPOSURE PATHWAYS THROUGH AQUIFERS IN KARST REGIONS.

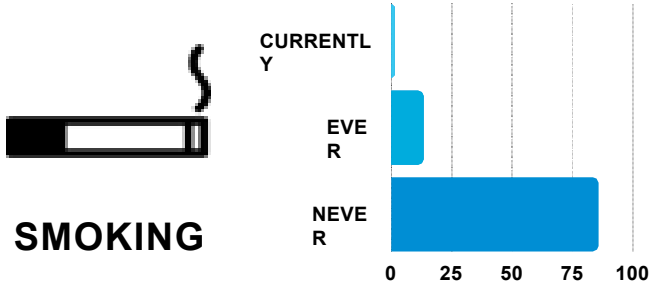
ESTABLISHED A PREGNANCY COHORT

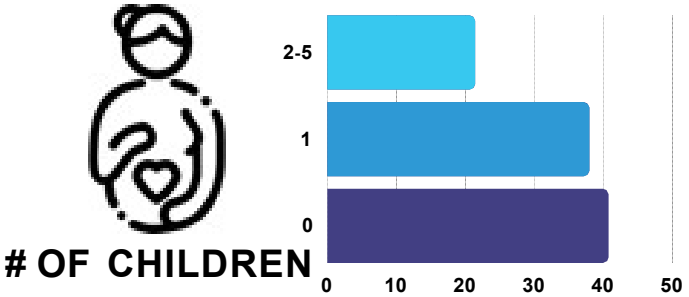


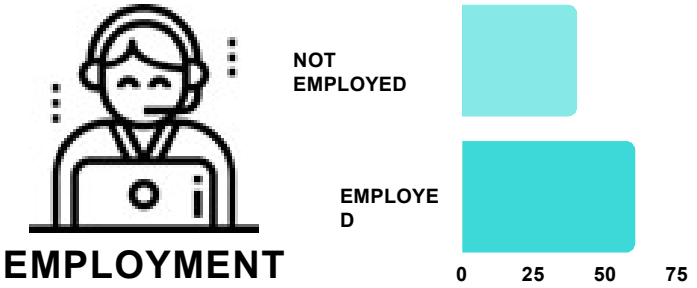


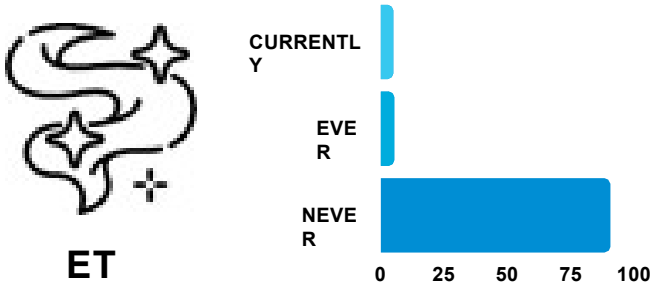


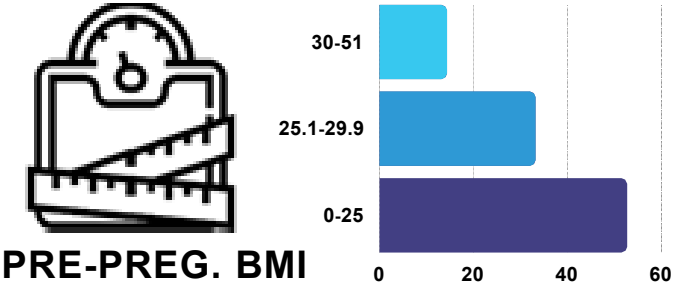












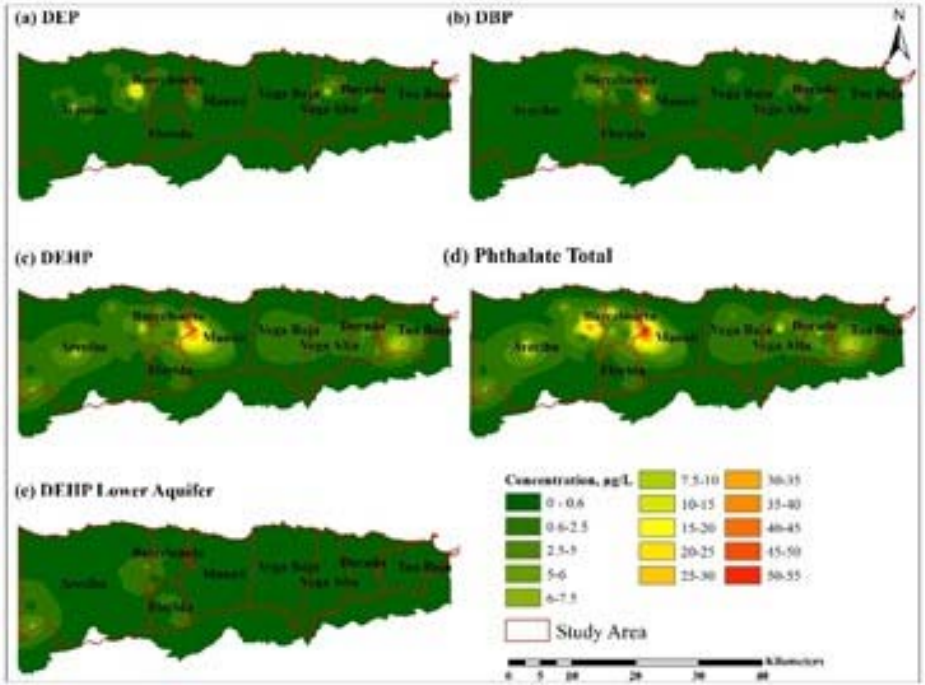
ENVIRONMENTAL CHEMICAL EXPOSURE AND PRETERM BIRTH

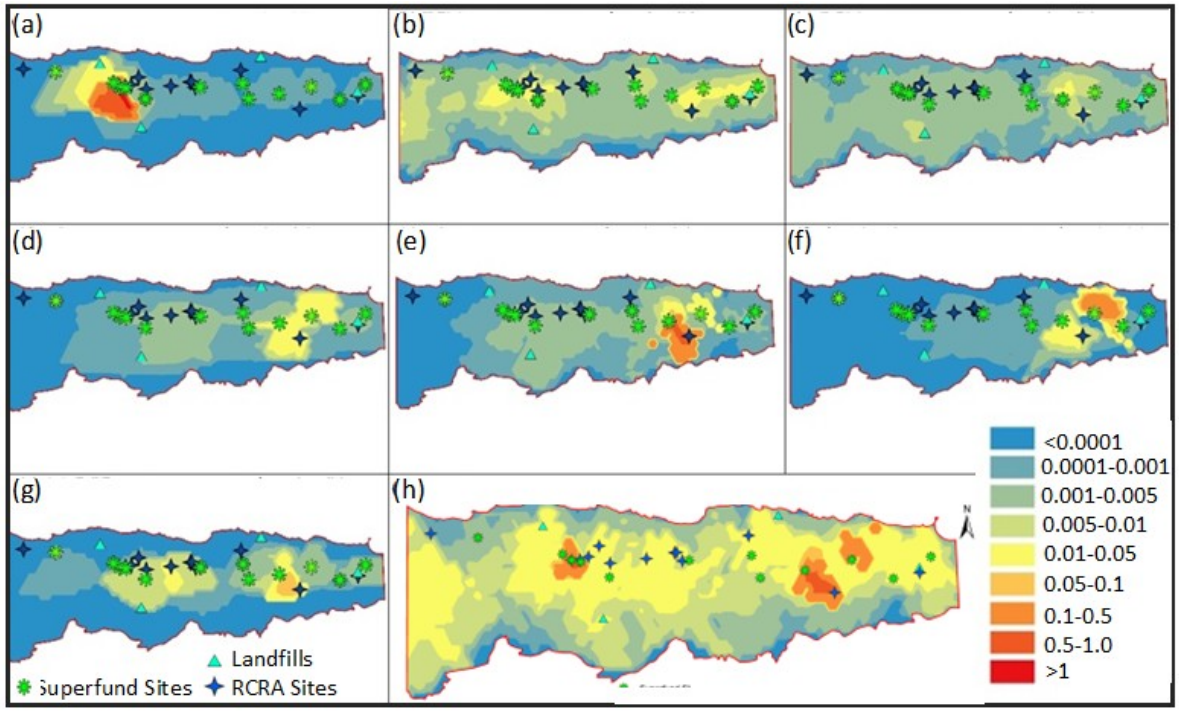
WE ESTABLISHED	WE FOUND	WE IDENTIFIED	WE OBTAINED	WE PROVIDED
an infrastructure that recruited 2000+ participants, with 1500+ completed live births, & collected 40K+ biospecimens	that exposure to a number of phthalates is significantly higher in PROTECT than the U.S. general population & Increased odds of preterm birth is associated with DBP and DiBP metabolites among pregnant women	specific phthalates in subjects' urine that are associated with markers of oxidative stress & inflammation, as well as reductions in critical pregnancy-related hormones.	evidence supporting oxidative stress in human placenta as a mechanism for adverse pregnancy outcomes	new knowledge of how TCE disrupts placental cell function & advanced understanding of how toxicant exposure can modify responses to infectious microorganisms

NEW DISCOVERY FOR SUPERFUND SITES IN KARST

WE FOUND	WE DISCOVERED	WE CONDUCTED	WE DEVELOPED	WE ESTABLISHED
that groundwater contamination strongly associated with superfund site (e.g., CVOCs) and is more extensive than those widely distributed (e.g., phthalates)	extensive contamination of Phthalates & CVOCs which were reaching drinking water sources & that the heterogeneous hydrogeological characteristics of karst aquifers dictate the distribution & concentrations of these contaminants	nontargeted and toxicogenomics analysis on groundwater samples identified several other toxicants on top of CVOCs & Phthalates.	an electrochemical technique for sustained in situ contaminant transformation in groundwater & breakdown chemicals in situ in groundwater to nontoxic forms.	an interdisciplinary indexed, centralized data repository

SPATIAL DISTRIBUTION OF CONTAMINANTS & TOTAL AVERAGE CONTCENTRATIONS IN STUDY AREA

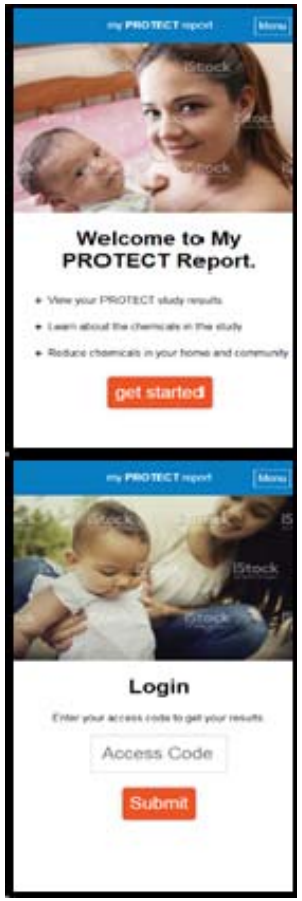


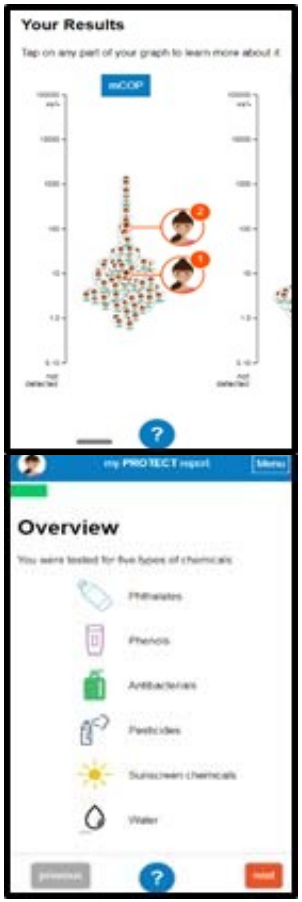


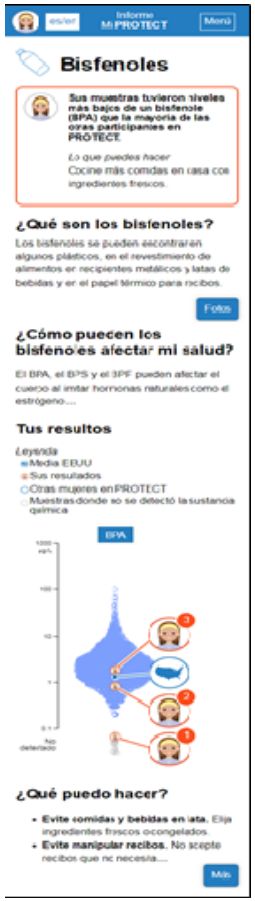
Spatial distribution of (a) CCl4, (b) TCM, (c) DCM, (d) PCE, (e) TCE, (f) CIS-1,2-DCE, (g) 1,1-DCE, and (h) total CVOC average concentrations (mg/L) in the environmental study area.

REPORT BACK
DERBI MOBILE APP

- Mobile App developed & currently identifying specific details which encourage sustainable/continuous education to be used by study participants
- Conducted consultations and focus groups with Community and Participant Advisory Groups for feedback & best dissemination practices
- Study participants, community key informants, and health care professionals that work at recruitment sites

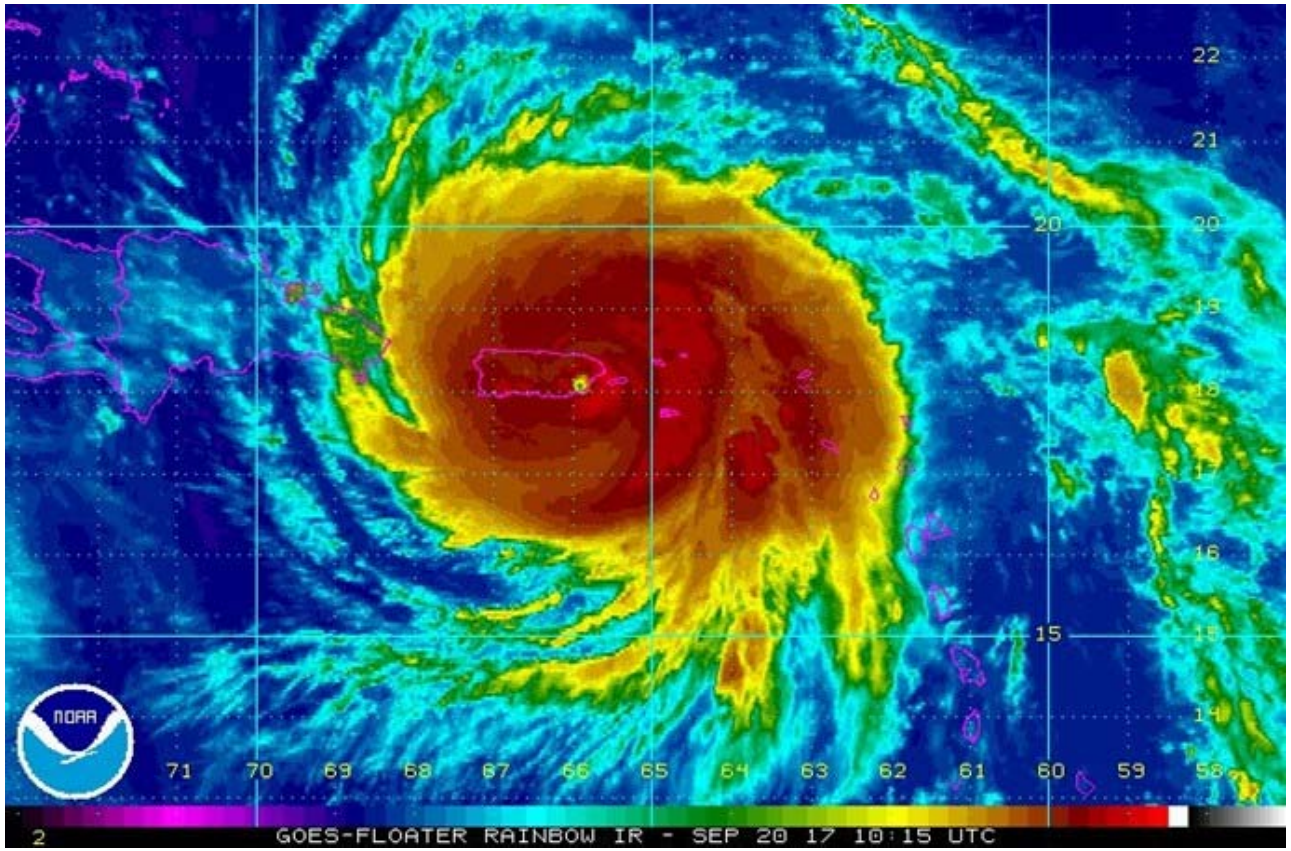






HURRICANE MARIA, SEPTEMBER 2017

- Collapse of the electric grid, water systems, telecommunications, roads, and many homes destroyed
  - All of Puerto Rico lost electricity and cell phone service, and half of the population lost water service
- Estimated to have cause over $100 billion in damage and resulted in over 4500 deaths



HURRICANE MARIA, SEPTEMBER 2017





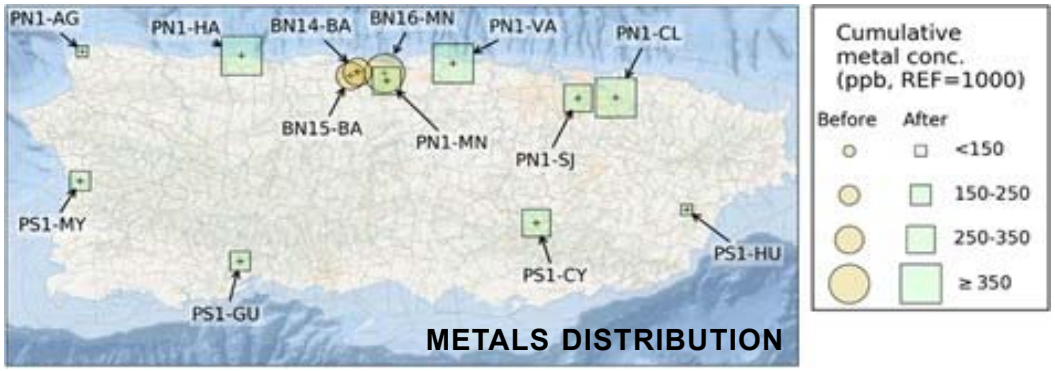

HURRICANE MARIA, SEPTEMBER 2017

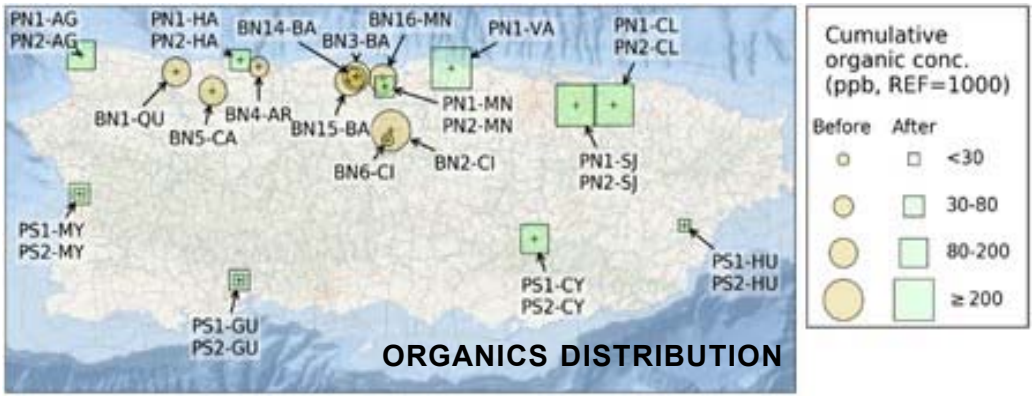
- 1st priority was our team. Over 20 staff in Puerto Rico
  - Field Nurses
  - Lab technicians
  - Project managers
  - Data Managers
  - Trainees/students
- 2 team members lost their homes entirely
- ~350 Maternal and close to 300 infant participants

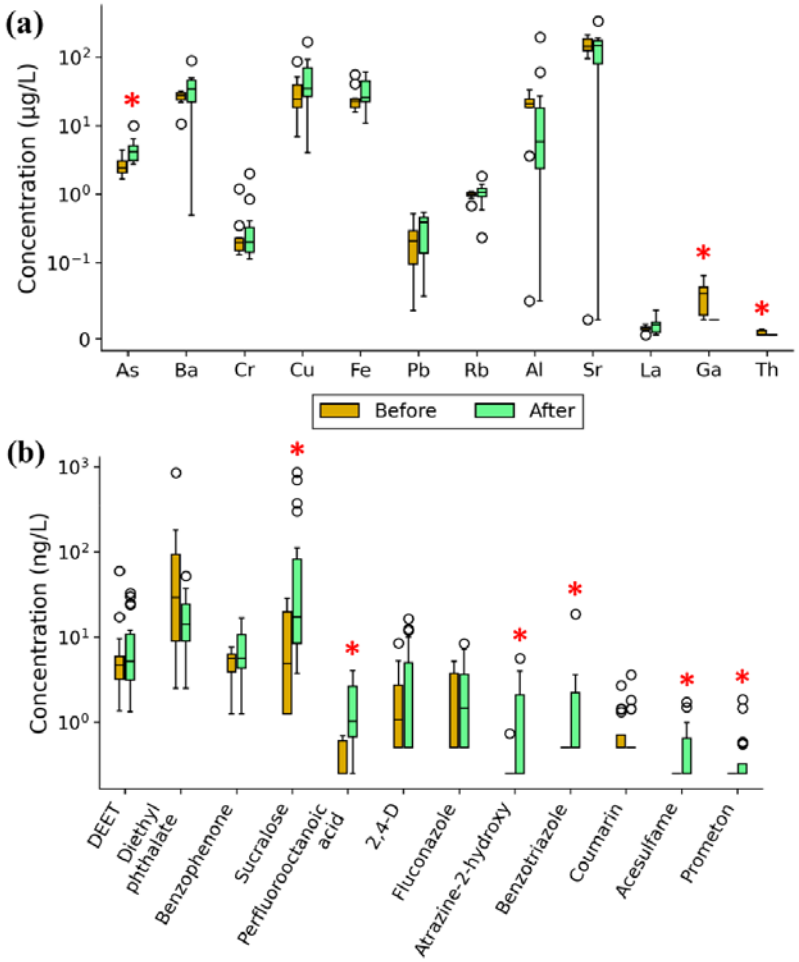
HURRICANE MARIA, SEPTEMBER 2017

- 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, …

TAP WATER CONTAMINANTION CHANGES AFTER MARIA

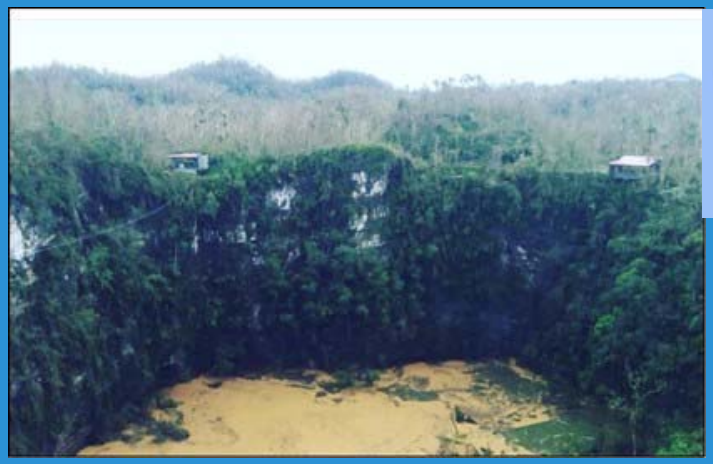






Higher Cumulative Contamination after Hurricane

HURRICANE MARIA, SEPTEMBER 2017



Tres Pueblos sinkhole one day after Hurricane Maria

Tres Pueblos sinkhole one month after Hurricane Maria

Sediment mobility, deposition, and characteristics

Hurricanes & high-flow events inject sediments into conduits at a great rates

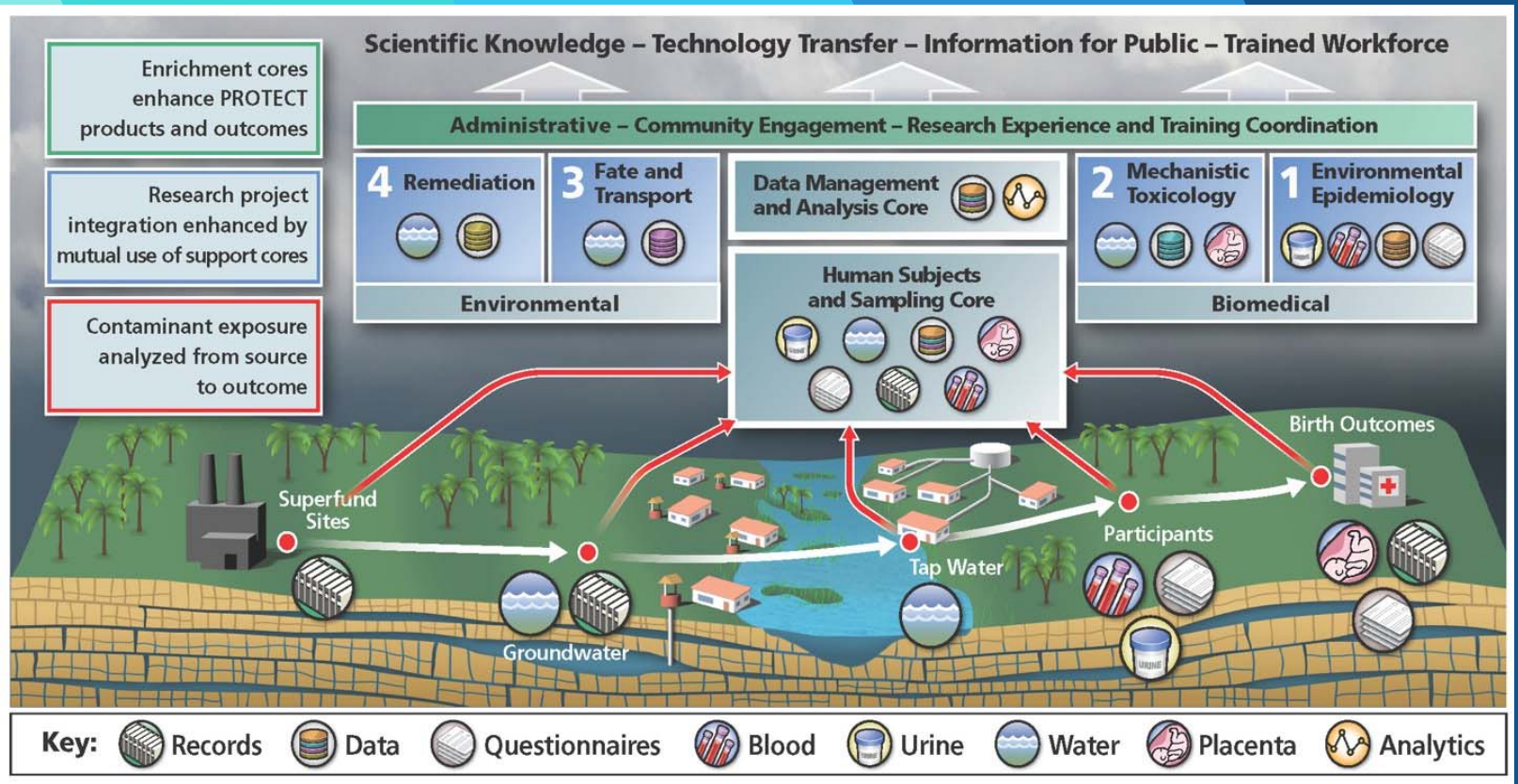
Photos curtesy of Prof. Angel A. Acosta-Colon, University of Puerto Rico

PROTECT RENEWAL

- What we Observed: Presence of mixtures of contaminants; Preterm birth rate decreased yet still high; High contamination, low SES, difficult economic and health services, community is devastated by natural disasters

- Employ a **data-driven** approach to study and reduce the impact of exposure to **mixtures** of suspect chemicals from Superfund sites in karst regions on **Adverse Pregnancy Outcomes** in PR
  - Target chemicals: Expand to include metals, pesticides, and polycyclic aromatic hydrocarbons in addition to chlorinated solvents and phthalates.
  - Mechanisms: Focus on oxidative stress as an underlying biological pathway
  - Extreme weather: Account for the impacts of extreme weather
  - Remediation: Focus on community and minimizing exposure
  - Community: Engage and educate; involve study participants and stakeholders.

PROTECT 2020-2025
APPROACH



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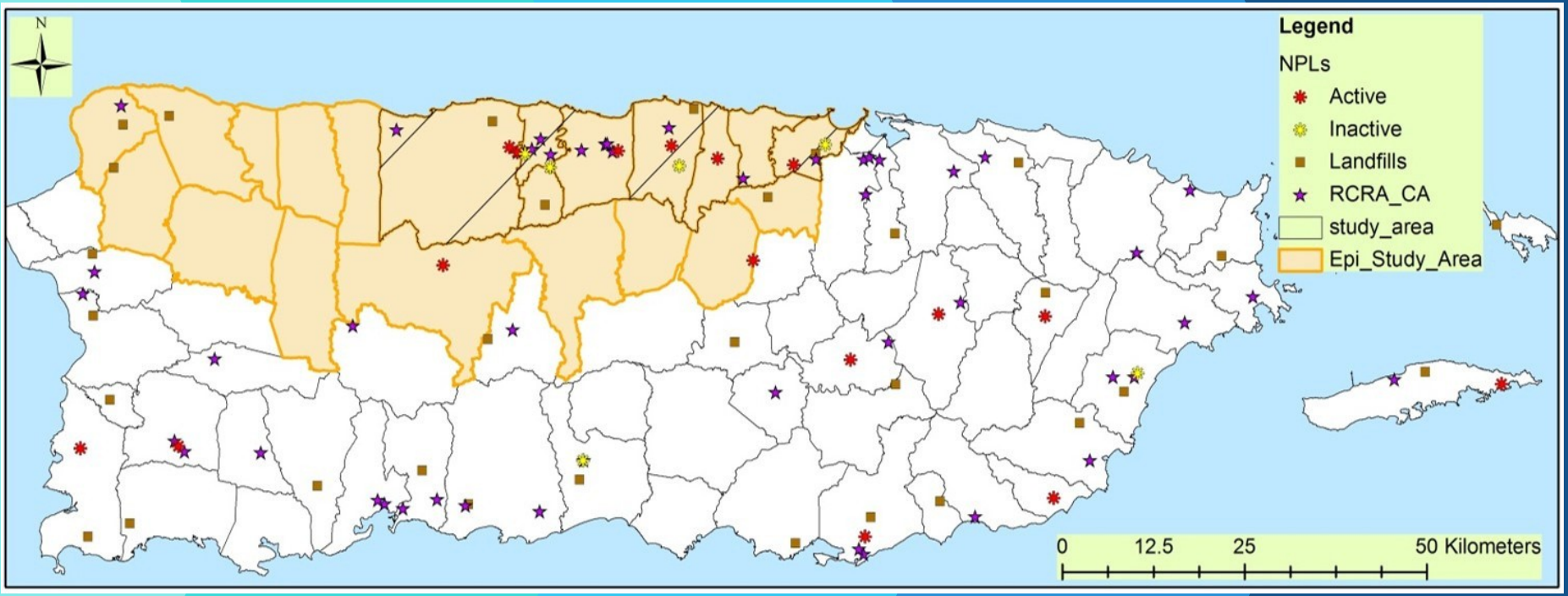
STUDY AREA & SUPERFUND SITES



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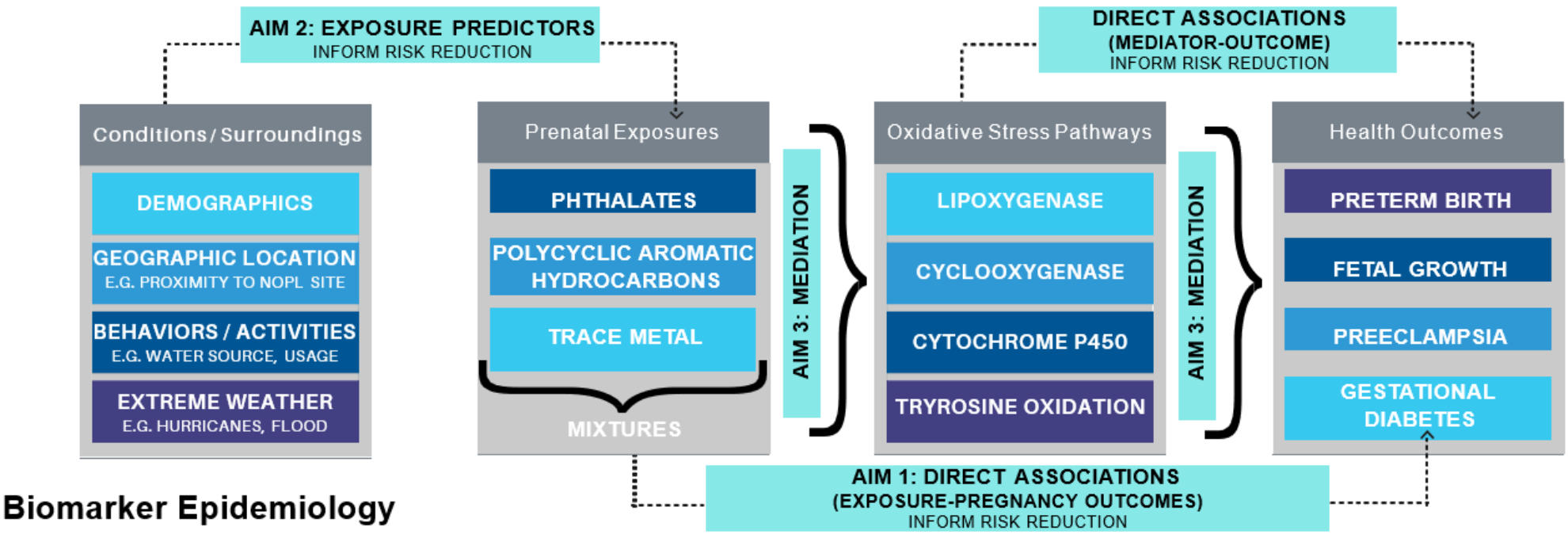
PROJECT 1(Led by John Meeker)

Title: Biomarker Epidemiology of Exposure to Mixtures, Oxidative Stress, & Adverse Pregnancy Outcomes in PR

Objective: Study environmental influences on pregnancy outcomes among 2,000 pregnant women in PR.
Impact: New and much needed information on the magnitude, sources, and impacts of exposure to Superfund-related chemicals among pregnant women in this high-risk population, and innovative methods for identifying relevant biological pathways and assessing health impacts from exposure to mixtures.



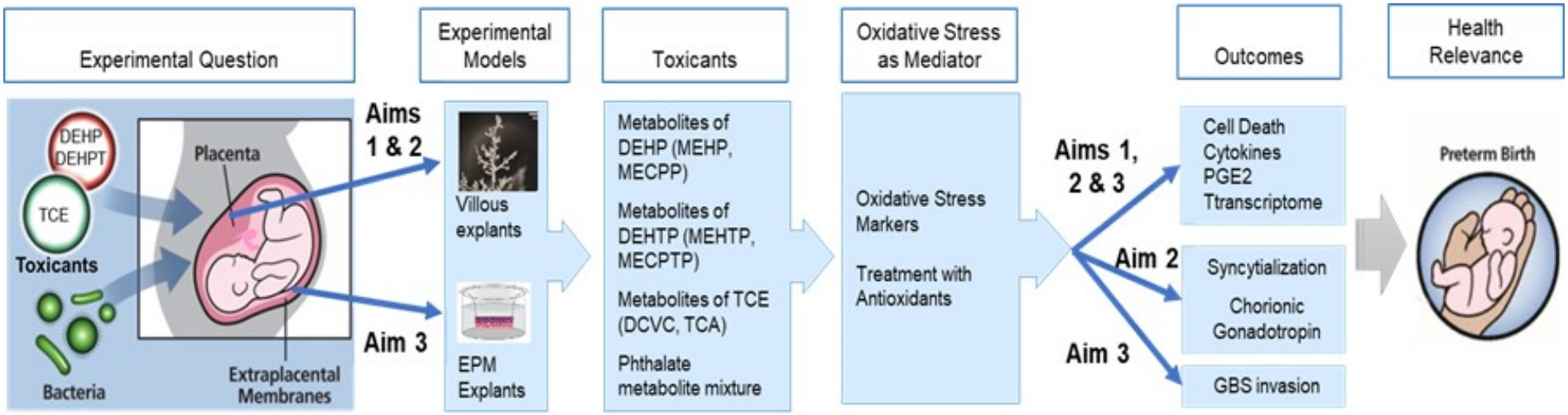
Biomarker Epidemiology

PROTECT 2020-2025
PROJECT 2 (Led by Rita Loch-Caruso)



Title: Toxicant-Stimulated Disruption of Gestational Tissues with Implications for Adverse Pregnancy Outcomes.

Objective: This toxicology project investigates disrupted placental function as a mechanism underlying pollutant risks for preterm birth.
Impact: This project addresses important gaps in our understanding of toxicant contributions to late preterm birth and toxicant-microbial interactions in placenta.



Mechanistic Toxicology

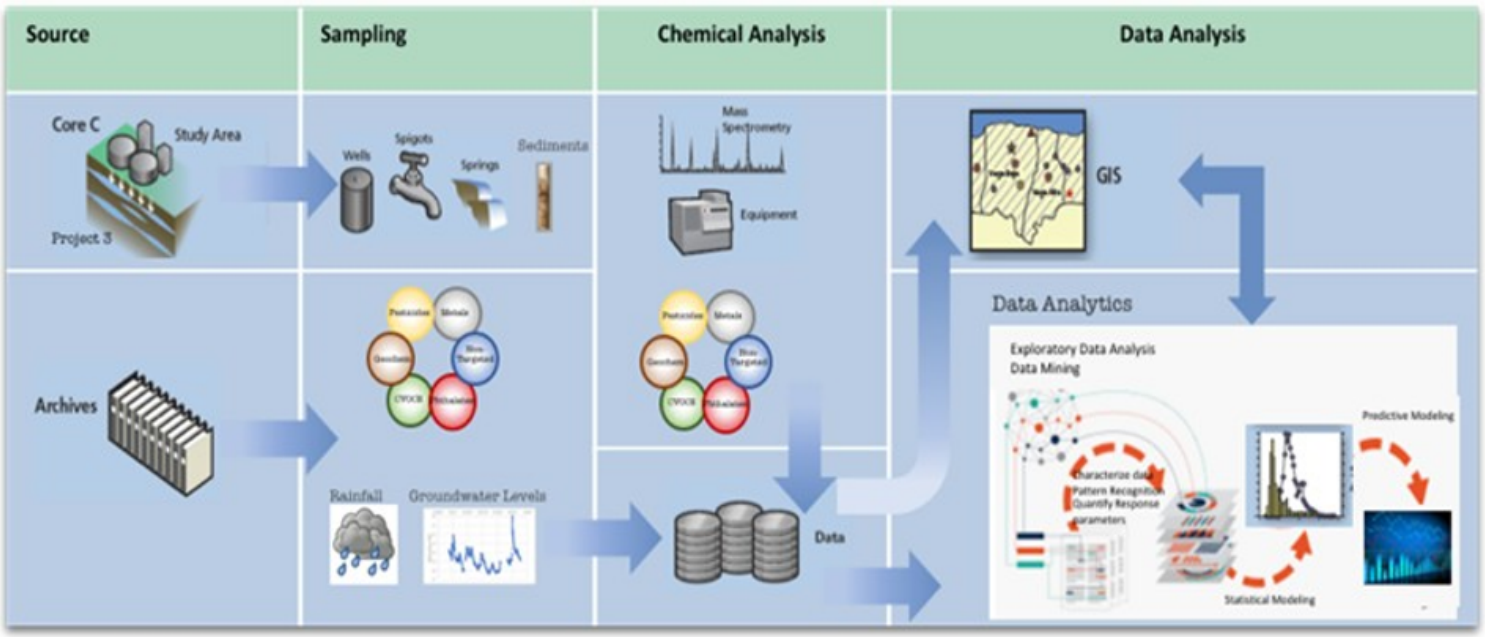
PROTECT 2020-2025

PROJECT 3 (Led by Ingrid Padilla)


Title: Effect of Extreme Weather on Potential Exposure of Contaminant Mixtures in Karst Water Systems

Objective: This project investigates the effect of extreme weather, such as hurricanes, droughts and intense storms, on potential exposure of contaminant mixtures in karst water systems.

Impact: This project will generate new fundamental knowledge and develop data-driven models to assess and reduce the risk of exposure to multiple, superfund-related hazardous substances in karst water systems posed by extreme weather and explore potential association between exposure and adverse pregnancy outcomes



Fate and Transport

PROTECT 2020-2025

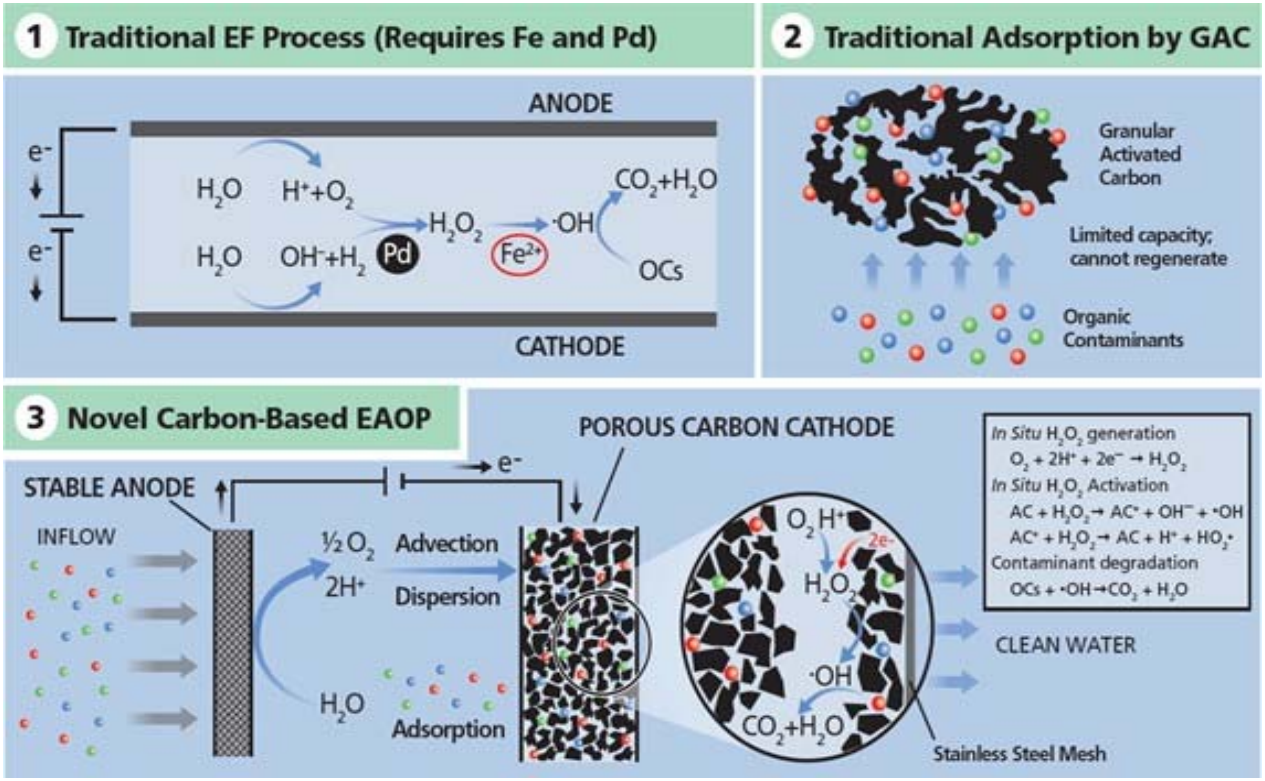
PROJECT 4 (Led by Akram Alshawabkeh)



Title: Portable, self-cleaning advanced electro-oxidation systems for distributed and point-of-use water treatment.

Objective: Develop and test a portable, low-maintenance, and self-cleaning water purification technology.

Impact: Providing access to clean water for communities near Superfund sites in Puerto Rico as well as addressing the need for portable water treatment processes that can be used in rural areas.



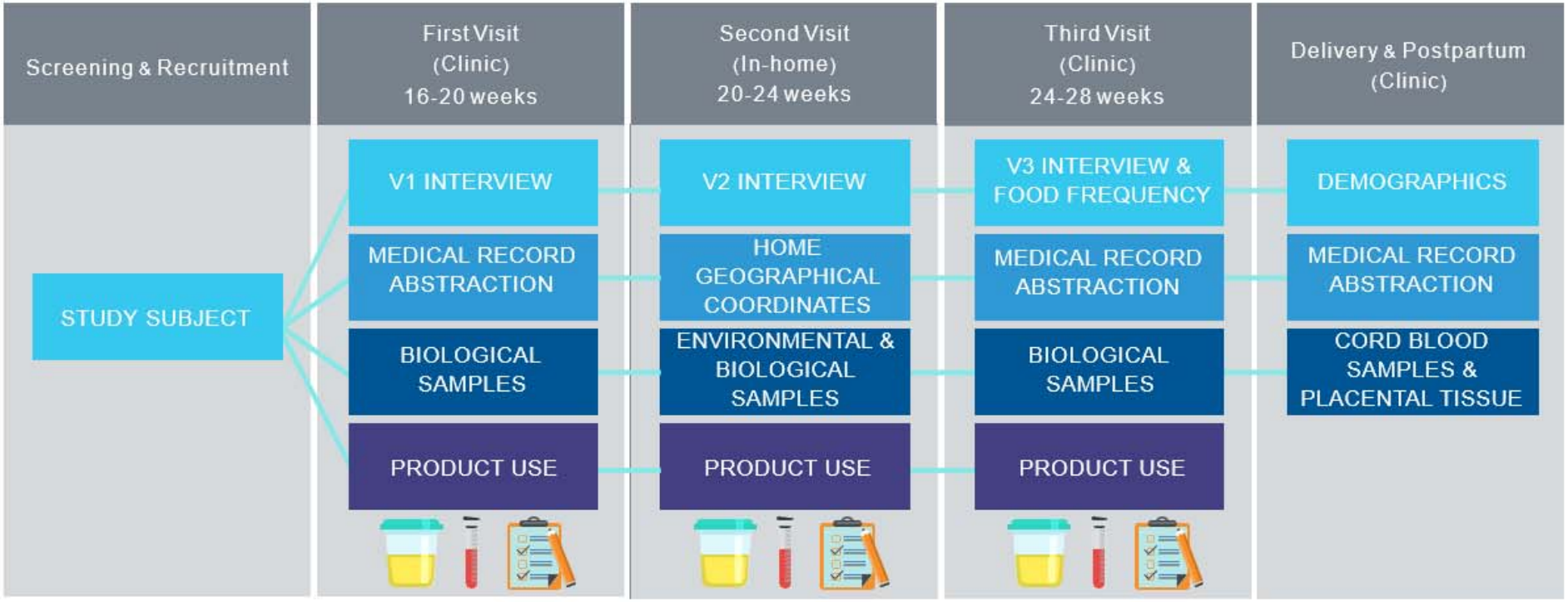
Remediation

PROTECT 2020-2025
HUMAN SUBJECTS & SAMPLING CORE




PROTECT 2020-2025

HSSC PROTECT COHORT STUDY DESIGN



PROTECT 2020-2025

PROTECT RECRUITMENT AND BIRTH OUTCOMES 2011 - 2020

STATUS	TOTAL NUMBER
SCREENED	2630
ELIGIBLE	2259
RECRUITED	2074 (91.8%)
PREGNANCIES COMPLETED	1598
LIVE BIRTHS	1513
OTHER PREGNANCY OUTCOMES	84 (5.3%)
PREGNANCY IN PROGRESS	225
WITHDRAWALS	251 (12.1%)

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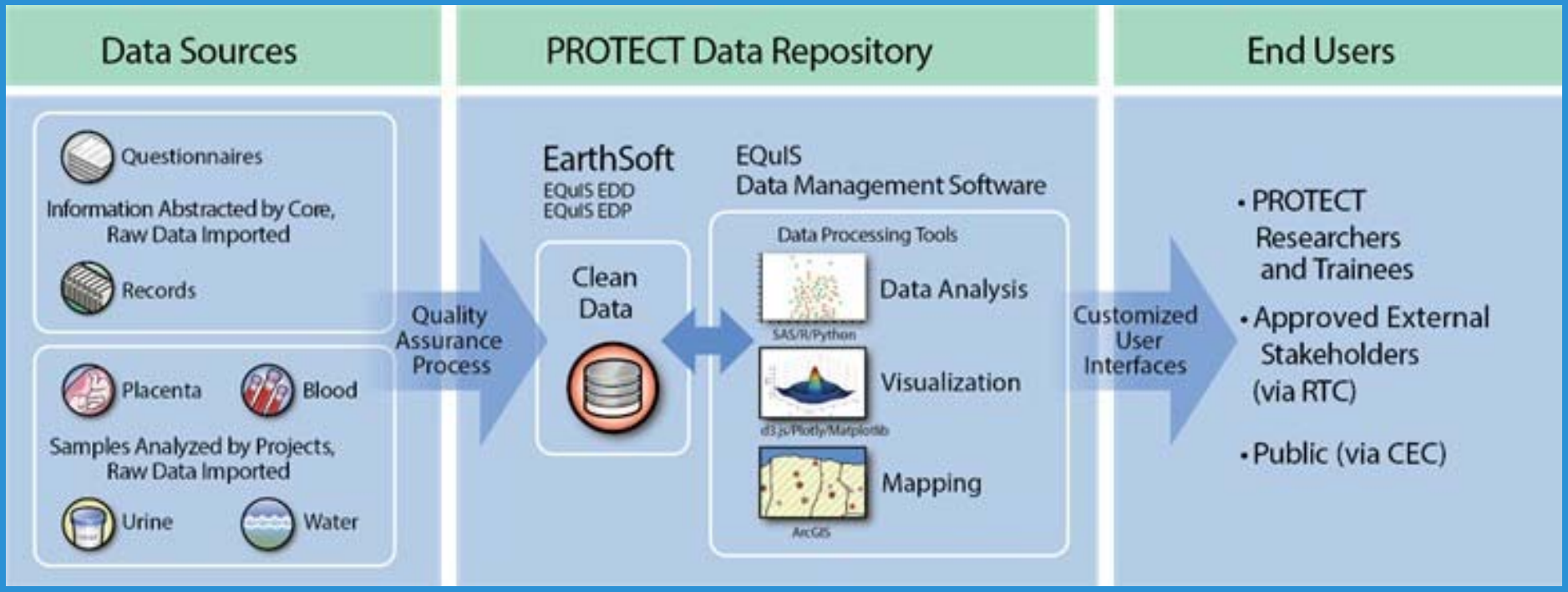
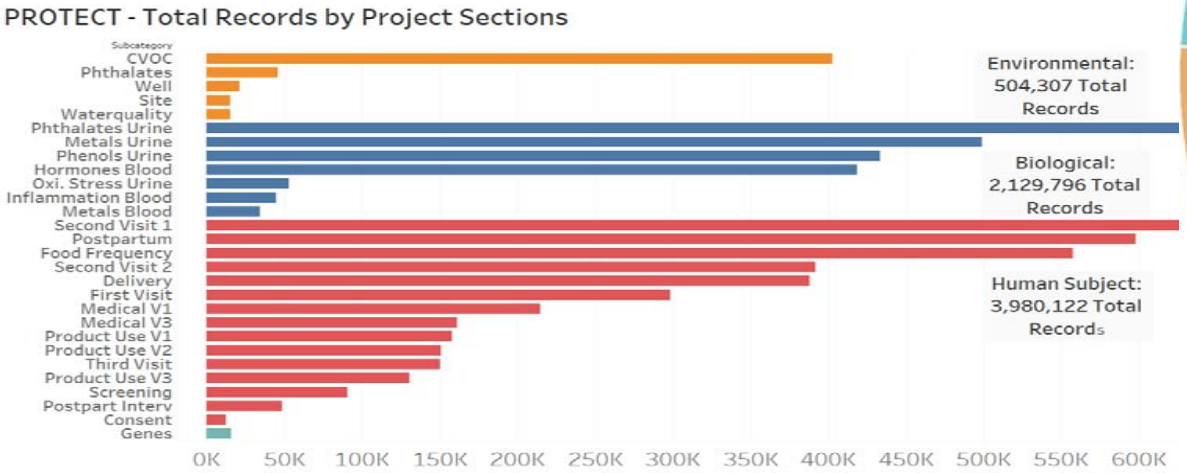
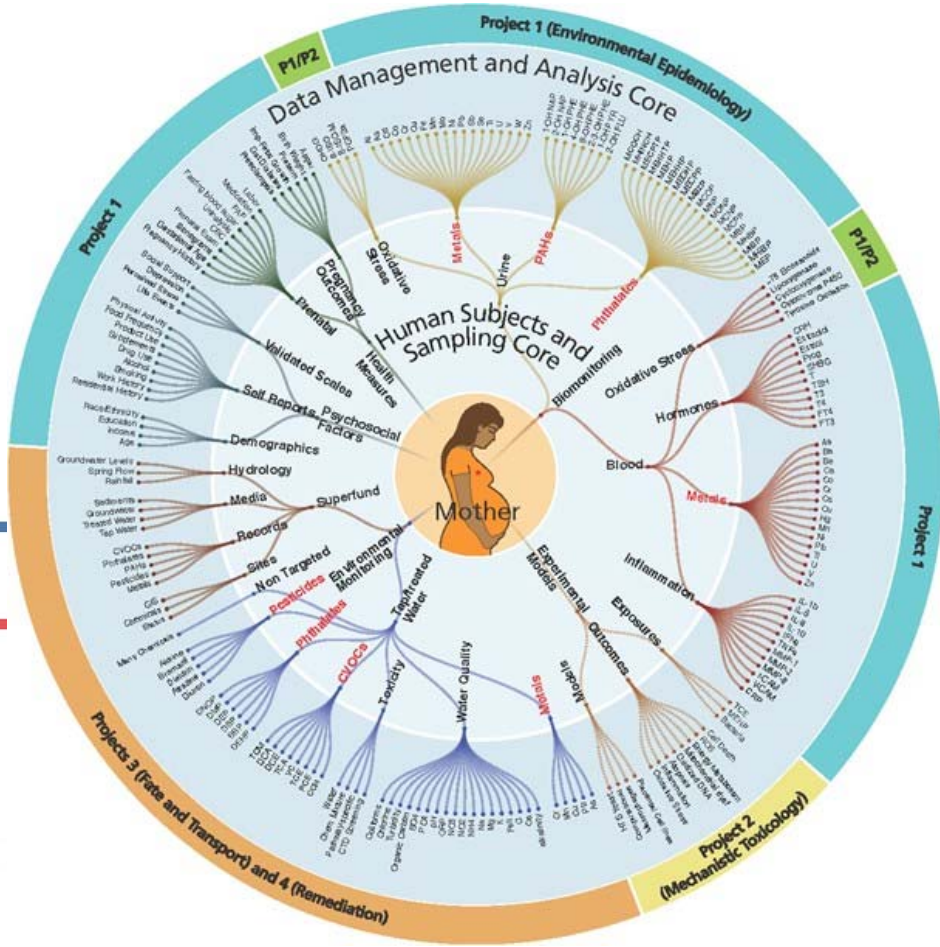
DATA MANAGEMENT CORE



PROTECT 2020-2025
DATA MANAGEMENT CORE

PROTECT will broaden its scope, employing a Data-Driven Approach to study and reduce the impact of exposure to Mixtures of suspect chemicals from Superfund Sites in karts on APOs Adverse Pregnancy Outcomes in Puerto Rico and the U.S.





PROTECT 2020-2025
PARTNERS & COLLABORATORS

PryMed
Unidos por tu salud

Manatí Medical Center

SILENT SPRING INSTITUTE
Researching the Environment and Women's Health

CHS
CAMUY HEALTH SERVICES, INC.
"Tu Salud es Nuestro Compromiso"

SSEHRI
Social Science Environmental Health Research Institute

Lares / Quebradillas
CISS
Centros Integrados de Servicios de Salud

march of dimes

basura cero
Puerto Rico

CIUDADANOS DEL KARSO

COTICAM

Morovis Community Health Center, Inc.

Collaboration with local stakeholders, health care professional groups, local community health centers, & environmental advocacy groups

ACKNOWLEDGEMENTS

National Institute of Environmental Health Sciences
Superfund Research Program

CRECE

PROTECT
Puerto Rico Testsite for Exploring Contamination Threats

ECHO
Environmental Influences on Child Health Outcomes
A program supported by the NIH

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CHS
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The University of Georgia

EPA

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NIEHS

SSEHRI
Social Science Environmental Health Research Institute

march of dimes

UPR
Universidad de Puerto Rico

earthsoft

Lares / Quebradillas
CISS
Centros Integrados de Servicios de Salud

basura cero
Puerto Rico

CIUDADANOS DEL KARSO

Northeastern

NIH
National Institutes of Health

COTICAM

DEPARTAMENTO DE SALUD
GOBIERNO DE PUERTO RICO

USGS

WestVirginiaUniversity

CDC
Centers for Disease Control and Prevention

Morovis Community Health Center, Inc.

PROTECT TEAM
GATHERINGS THROUGHOUT THE YEARS




Northeastern University, University of Puerto Rico, University of Georgia, University of Michigan, West Virginia University, Cornell University, Silent Spring Institute, EarthSoft Inc.