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Behavioral Responses to Arsenic and Lead Exposure: A Field Study

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Acknowledgement:
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Introduction

Hurricane Katrina (2005)

- Arsenic, chromium and lead found in Air samples (NRDC 2005).
- 37% of sediment samples exceeded the corrective screening guidelines for arsenic (Rotkin-Ellman at el. 2010).

Hurricane Sandy (2012)

- EPA reported lead and arsenic levels above the safe drinking water standards in Newark, NJ (EPA 2012).

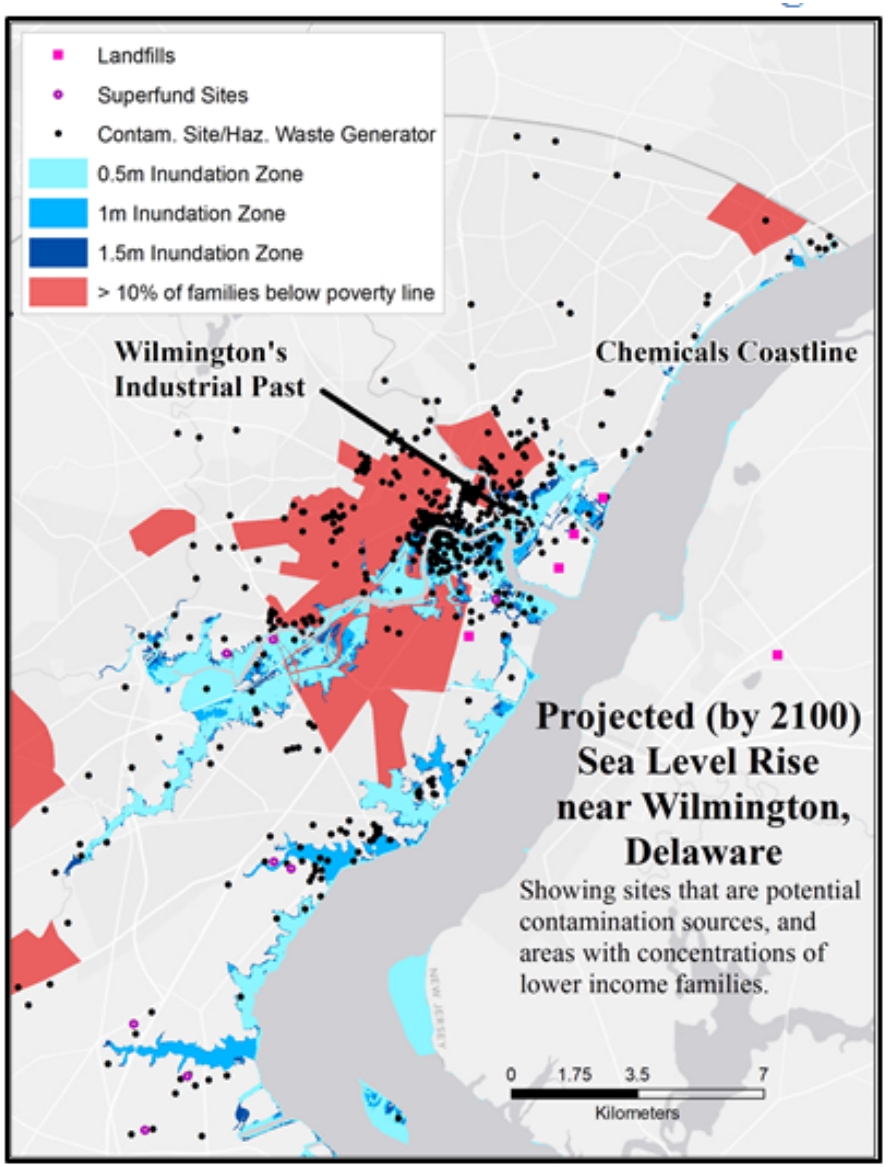
Introduction

- Sea level rise associated with global warming threatens many, in particular low lying, coastal areas.
- The link between sea level rise, toxic contamination and human exposure is an emerging threat.

Introduction

- Storm surges, flooding coastal lands are predicted to become more frequent and severe (IPCC, 2014).

- Delaware is one of the most polluted and lowest lying states (see map).

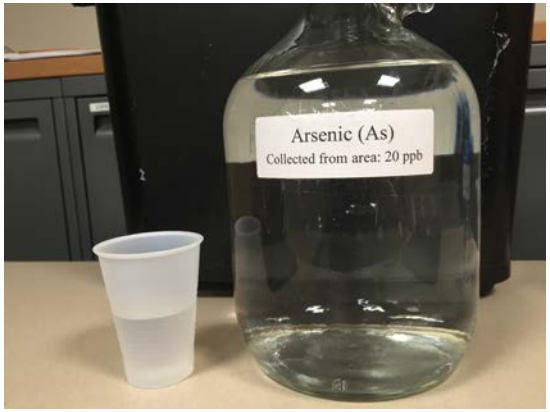


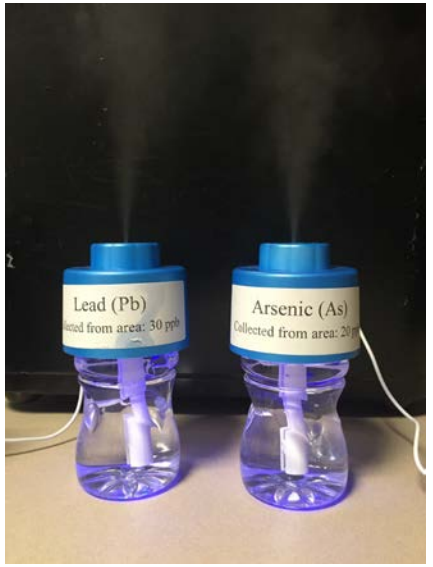
Research Questions:

(1) Are individuals concerned about the risks related to different levels of arsenic and lead contamination?

(2)How do these behaviors vary across socio-economic characteristics, current risk exposures and geographic locations?

(3) How does the level of concern vary across different exposure paths such as inhalation, absorption, and direct ingestion?





Dichotomous Choice Experiment

Decisions	• 6 Yes or No decisions at random prices. • Treatment 1: EPA standard off. • Treatment 2: EPA standard on.
Arsenic concentration in part per billion:	• 0, 1, 7, 10 (EPA standard), 13, 20
Lead concentrations in part per billion:	• 0, 1.5, 10.5, 15 (EPA standard), 19.5, 30
Implementation	• 1 decision was randomly determined.

The United States Environmental Protection Agency (EPA) drinking water standard for Lead is 15 parts per billion (ppb).

Task 2:

Are you willing to inhale three breaths of vapors from water from an area that, in a published government report, had levels of Lead that were measured at 1.5 parts per billion (ppb) for $3.64?

○ Yes ○ No

Results

Yes - Decision	Coefficient	Standard Error	Significance
Drink	-1.5836	0.2772	0.000
Inhale	-1.3780	0.2824	0.000
Touch	(Baseline)		
Concentration	-0.0621	0.0211	0.003
Male	1.1834	0.5072	0.020
Arsenic	-0.5132	0.2567	0.046
EPA Standard Shown	1.3141	0.5290	0.013
Above EPA Standard (Pb)	0.4443	0.5676	0.434
Above EPA Standard (As)	-0.4089	0.4848	0.399
Interaction Price/EPA Standard Shown	0.0055	0.0061	0.372
Interaction EPA Standard shown/Above EPA standard (Pb)	-1.1948	0.5966	0.045
Interaction EPA Standard shown/Above EPA standard (As)	-0.1696	0.5610	0.762
Low Income (<$20,000 per year per household)	1.9231	0.5681	0.001
Price	-0.0054	0.0046	0.242
Interaction Price/Touch	-0.0014	0.0073	0.850
Interaction Price/Inhale	0.0114	0.0065	0.079
Interaction Price/Drink	(Baseline)		
Constant	-0.0670	0.5308	0.900

Notes: Random Effects Logistic Regression. N=1074. Positive coefficient means more likely to respond “yes”.

Research “Answers”

(1) Participants have a bimodal response (they are not price sensitivity), they are either concerned or not.

(2) Compared to touching contaminated water participants are less likely to inhale vapors or drink contaminated water.

(3) Participants with a household income of less than $20,000 per year are more willing to expose themselves.

Thank you!

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References

EPA (2012) http://www.epa.gov/region2/passaicriver/sandyresults.html

NRDC (2005) http://www.nrdc.org/health/effects/katrinadata/metals.asp

IPCC (2014) http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_SPMcorr1.pdf

Rotkin-Ellman, Miriam, Gina Solomon, Christopher R. Gonzales, Lovell Agwaramgbo, and Howard W. Mielke. 2010. "Arsenic contamination in New Orleans soil: Temporal changes associated with flooding." *Environmental research* 110, no. 1, 19-25.

Summary of Key Findings

(1) Price does not play a significant role in the exposure decision.
(2) People are less likely to expose themselves to Arsenic compared to lead.
(3) EPA standard makes participants more likely to expose themselves – provides security.
(4) Participants with a household income below $20,000 p.a. are more likely to expose themselves.
(5) Shown the EPA standard participants are les likely to expose themselves to lead. This we don't find for arsenic, perhaps participants simply reject arsenic more than lead irrespective of information.
(6) Price has an impact on participants' inhalation decision but not on touch compared to drinking 3 ounces.

Results

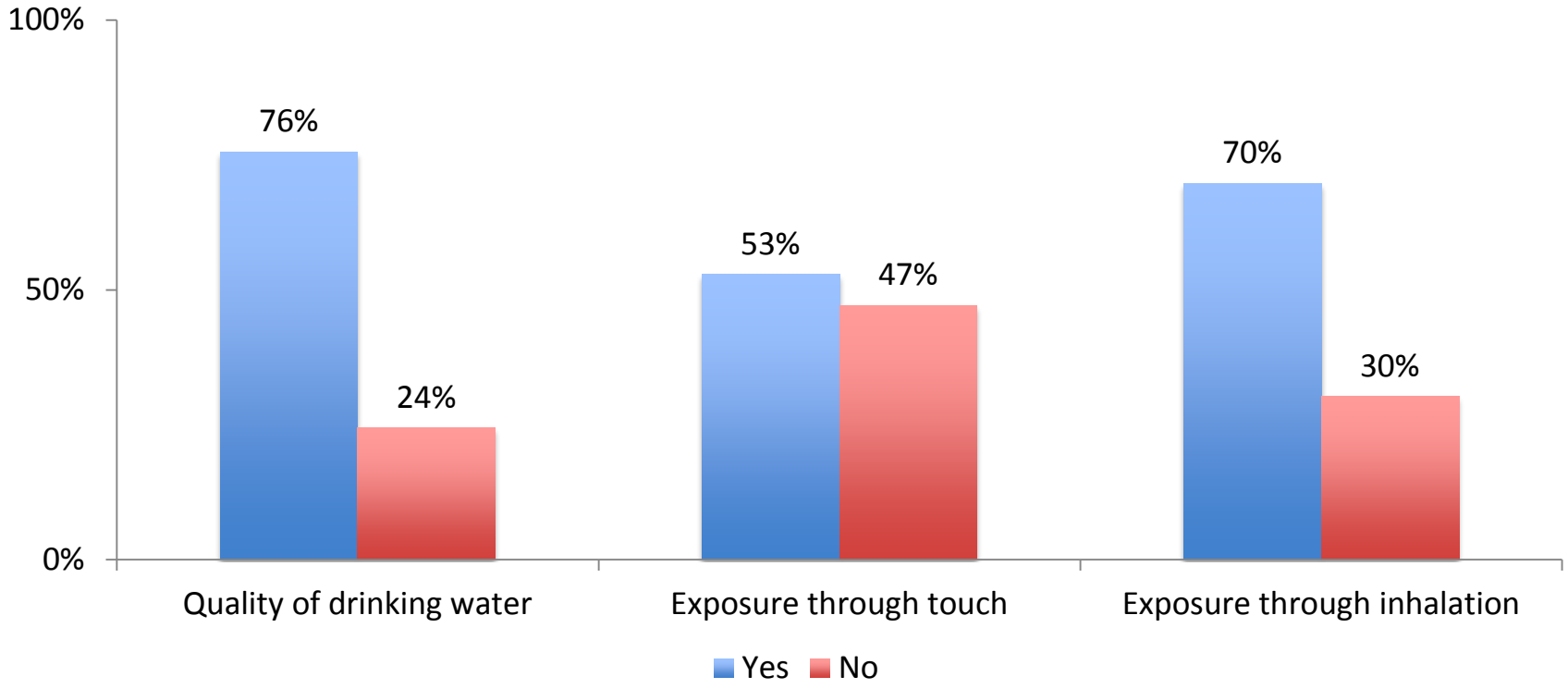
	Newark		Southbridge		Greenville	
Yes - Decision	EPA Standard N = 192	No EPA Standard N = 138	EPA Standard N = 114	No EPA Standard N = 114	EPA Standard N = 180	No EPA Standard N = 162
Price	0.0016 (0.0088)	0.0805 (0.0624)	0.2285*** (0.0742)	-0.0064 (0.0053)	-0.0075 (0.0071)	0.0027 (0.0054)
Arsenic	-0.2071 (0.3877)	-0.3731 (0.4805)	0.3704 (0.5615)	-1.3458** (0.6087)	-0.9248*** (0.3902)	-0.5625 (0.4796)
Submerge Hand	1.7929*** (0.4872)	2.4205*** (0.6465)	1.4372** (0.6448)	1.1172* (0.6617)	1.2437*** (0.4827)	3.1729*** (0.6457)
Inhale Vapors	1.2386*** (0.4525)	1.8778*** (0.6392)	1.3147** (0.6461)	-0.2745 (0.6134)	-0.4364 (0.4564)	0.2867 (0.5847)
Drink	(Baseline)					
Constant	0.9994 (1.1607)	-4.1684*** (1.3340)	-2.8034*** (1.1524)	2.7927** (1.3773)	0.9083 (0.9803)	-1.8306 (1.2012)

Notes: Logistic Regression Regression with subject fixed effects.
Significance: *=10%, **=5%, ***=1%

Experimental Design

Arsenic	**Lead**
0 ppb	0 ppb
1ppb	1.5 ppb
7 ppb	10.5 ppb
10 ppb*	**15 ppb***
13 ppb	19.5 ppb
20 ppb	30 ppb

Survey Result showing Overall Concern



Results

	ALL	
	EPA Standard	No EPA Standard
Yes - Decision	N = 486	N = 414
Price	0.0018	0.0004
	(0.0042)	(0.0030)
Arsenic	-0.2742	-0.5521**
	(0.2352)	(0.2790)
Submerge Hand	1.4910***	2.2844***
	(0.2931)	(3565)
Inhale Vapors	0.6962***	0.6495**
	(0.2744)	(0.3281)
Drink	(omitted)	(omitted)
Constant	0.3892	1.4805
	(0.9181)	(1.1810)

Notes: Logistic Regression Regression with subject fixed effects.
Significance: *=10%, **=5%, ***=1%

Thank you!

Dichotomous Choice Experimental Design

Dichotomous Choice Experiment	
Decisions	• 6 Yes or No decisions. • 6 random prices prices (Normal distribution with means $10 and $250 and standard deviation of $5 and $100). • Treatment 1: EPA standard off. • Treatment 2: EPA standard on. Arsenic concentration in part per billion: • 0, 1, 7, 10 (EPA standard), 13, 20 Lead concentrations in part per billion: • 0, 1.5, 10.5, 15 (EPA standard), 19.5, 30
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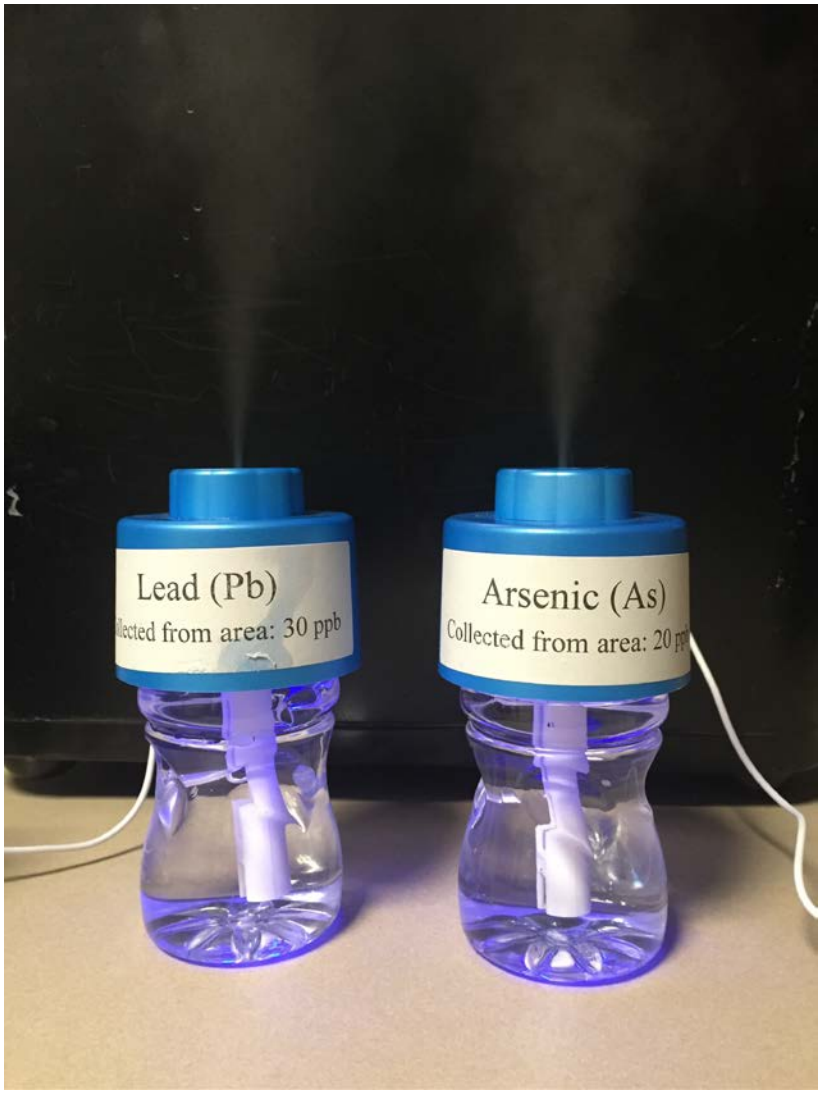

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Arsenic	-0.5132	0.2567	0.046
Touch	1.5836	0.2772	0.000
Inhale	0.2056	0.2567	0.423
Drink	(Baseline)		
Concentration	-0.0621	0.0211	0.003
EPA Standard Shown	1.3141	0.5290	0.013
Male	1.1834	0.5072	0.020
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