The Use of 51 TITAN Model 600/800 GeoExploration Check X-Ray Gun in Analyzing Pb, Cr, Zn, As, Cu, and Cd Concentrations in Long Island Elementary Schools and Public Parks's Soil

Madeline Competello

Abstract

As the concern over our planet's environmental state continues to increase, specific factors have been noted that could be one of the causes of this decline in environmental sustainability. In this study, from the use of a 51 TITAN Model 600/800 GeoExploration Check X-Ray Gun was used in measuring the heavy metal concentrations throughout the soil in Long Island Elementary Schools and Public Parks. Pb, Cr, Zn, As, Cu, and Cd were carefully examined. They were later measured in a water push, mimicking the event these metals being carried through the water cycle that everyone relies on every day. Children today are playing in playgrounds and parks where they could be exposed to harmful metals from the surrounding environmental factors such as close railroads, highways, industrial parks, and large bodies of water. After gathering soil from different areas of the Long Island that each have different surrounding environments, i.e. Fork Lane, Lloyd Harbor, Manorhaven, Pine Street Park, Syosset, Pasadena, Front Street, Village of Island Park. It was seen that out of the 6 metals that were detected, Pb, Cr, Zn, and As had the most evident results, showing that Valley Stream, NY and Front Street, Hempstead, NY had the highest heavy metal concentrations with Valley Stream showing (0.0255ppm of Pb, 0.0401 ppm of Cr, 0.0476 ppm of Zn, and 0.0155ppm of As) and Front Street having (0.0082ppm of Pb, 0.0118ppm of Cr, 0.0103ppm of Zn, and 0.0037ppm of As). The results show strong evidence that areas located in a low income portion of a town, are seen to have higher heavy metal concentrations in their soil, posing a health risk towards the adolescents that play in the soil every week.

a) Introduction / Review of Literature

Due to industrial sites expanding at a rapid pace, mine tailings, large amounts of high metal waste being disposed, gasoline and paints including lead, animal manures, contaminated sewage, pesticides, wastewater irrigation, and atmospheric deposition, soils are becoming contaminated without many people realizing. Children are being exposed to

harmful metals every day they are playing at certain playgrounds, leading to a higher health risk.

Heavy metals build an indistinct group of inorganic chemical hazards. The metals that are most commonly found within a contaminated site include lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni). When heavy metals are brought into the environment, soil acts as a sink for them (Wuana). Most metals do not go through chemical degradation, as organic contaminants do when oxidized to carbon (IV). Therefore, this results in the soil having a high concentration of heavy metals that last for a long time after arrived (Wuana).

However, there is a possibility that their chemical forms (speciation) and bioavailability can change. If the soil has a high presence of toxic metals, the biodegradation of organic contamination will activate. A high concentration of heavy metals in soil is a risk to the ecosystem and humans through the food chain, direct ingestion or contact with the contaminated soil, drinking groundwater coming from the contaminated soil, reduction in food quality, and land tenure problems (Wuana).

Heavy metals are present in soil naturally, but geologic activities have increased the concentration of these metals. Some of these activities are mining metals, burning of fossil fuels, use of fertilizers and pesticides in agriculture, production of batteries and other metal products in industries, sewage sludge, and municipal waste disposal (Chibuike).

Heavy metals have metallic properties such as ductility, malleability, conductivity, cation stability, and ligand specificity. They have high densities relative atomic weight. Some organisms need heavy metals such as Co, Cu, Fe, Mn, Mo, Ni, V, and Zn in small amounts. Large amounts of these elements can become harmful to organisms. Heavy metals like Pb, Cd, Hg, and As, are thought of as “main threats” because they are very harmful to plants and animals (Zhang).

b) Research Question(s)/Engineering Goal(s)

The questions stated were:

1. Are harmful metals are found within local playgrounds?

a. Yes, metals such as Pb, Cd, Cr, As, and Zn are located inside the soil.

2. If found, what are their concentrations?
    a. Pb has the highest concentration.
3. Do these harmful metals seep through the soil into the groundwater level? If so, could they be found in our water supply and to what degree?
    a. Yes, these metals are found within the water in the groundwater level, potentially harming the water flowing throughout our ecosystem.
4. Do plants affiliated to the playground soak up these harmful metals in their roots?
    a. Yes, the metals are present within plants.

c)Methodology:

Gathering Soil Data from Parks

As the metals that each park are exposed to vary from place to place due to various environmental factors, 64 samples were tested throughout Long Island. I traveled to different parks that each have a distinguishing factor, i.e. close to the ocean, near an industrial park, or next to the highway. Planning areas that are different in location differentiate the results. In this study, 6 samples were taken from each of the following schools or public parks: Fork Lane, Lloyd Harbor, Manorhaven, Pine Street Park, Syosset, Pasadena, Front Street, Village of Island Park, etc. Using a shovel and wearing gloves, I dug down to the top soil region, and dig 4 samples from the corners of the area and 2 in the middle. After

Fig 1: 6 Soil Samples wrapped in saran wrap, about to be tested.

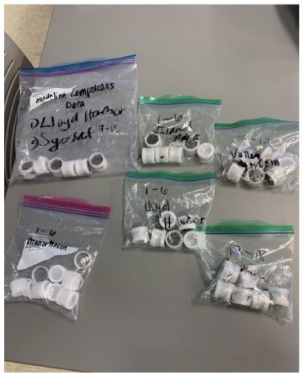
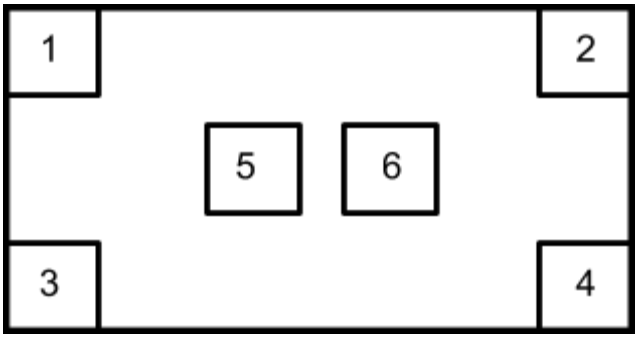


Fig 2: 6 Samples from each park or playground



digging, I placed the samples in 6 plastic containers, labeling each container from 1-6. Then, using a sterile scissor, I cut 6 square pieces of saran wrap and covered the samples with plastic saran wrap. After completion, I recorded the coordinates of those 6 samples. I then wrote down the longitude and latitude and take note of any side notes about the weather and what is different about the atmosphere compared to the other sites.

51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun Soil Data

Fig 3: 51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun

Using a 51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun, I placed the head of the machine facing upwards and locked it into the support to insure no one is exposed to X-Rays. Once locked, I placed the soil sample face down on the top of the platform on the target where the X-Ray went through. The samples were then covered with the cover of the X-Ray Gun to prevent dangerous exposure. On the home screen, I connected the machine to a computer via bluetooth. Once connected, the application on the desktop was opened to reveal the range of metals it will be scanning for. In settings, the X-Ray Gun to scanned for 85 seconds, ensuring that all important heavy metals will be reached. After pressing the button that reads “Ready for Testing”, it took 85 second for completion. Once done, all of the metal concentrations were recorded and an excel sheet was made with all of the dangerous metals, in this experiment lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), and copper (Cu) were recorded, along with their concentrations.

Soil Data from Water Push

Using the 6 samples from each of the locations, I mixed the 6 soil samples together from one location to create one large sample that replicates the entire park or elementary

school. I then placed the mixed soil on one large weighing boat and took a test tube and place a funnel on the top. Once placed, I carefully inserted a coffee strainer in the funnel. I then weighed the amount of soil that is in the weighing boat using a scale, and then using a sterile scalpel I measured exactly 1g of the soil. I then placed the 1g of soil on top of a coffee strainer and using a micropipette, micropipette 1000mL of distilled water. Slowly, I poured the water on top of the soil. If needed, I micropipette another 1000mL of distilled water and pour until the water seeps through the soil, leaving 2mL of water in the test tube. Letting the water soak through, I left the remaining soil on the top and the contaminated water in the test tube. Lastly, I placed the water inside the UV/Visible Spectrophotometer and took the data of the wavelength. Once completed, I made an excel sheet.

Fig 4: Test tube with coffee strainer in the funnel, with 1g of soil placed on top.

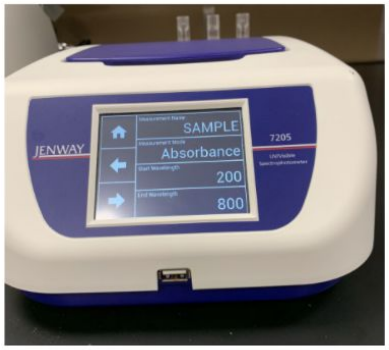


Fig 5: Jenway UV/Visible Spectrophotometer

Contaminated Water Data from 51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun Data

Fig 6: Samples placed inside spectrafuge

After recording the data of the water that seeped through the soil immediately, I measured 5mL of the remaining dry soil and put it into a test tube. Then, I poured distilled water until it reached the 10mL mark on the test tube. I then left the mixture inside the test tube for a week. Once a week had passed, I repeated the same steps for the wavelength machine, micropipetting 2mL out of the test tube and placing it in the small plastic test tube. I then placed the test tube inside the wavelength machine and recorded the date. Secondly, I placed the contaminated water on the platform of the X-Ray Gun. I then placed

the cover on top and waited 85 seconds for completion. Lastly, I recorded the metals found in the water and their concentration, and compared the metals found in the water to the metals found in the original soil. I then wrote these results down on an excel sheet.

Results

51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun Soil Data

After analysing the results from locations around the island using a 51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun, 7 different heavy metals all had different results. One of the main focuses of this experiment was to see the exposure of lead (Pb) that children were being exposed to everyday, as a high dosage of lead has been seen in the past. After looking at the numbers from all the locations, it seems that in areas that are surrounded by a highway or located within a low income neighborhood had an extremely high dosage of lead compared to parks and elementary schools that were located along the shore or located in a higher income facility. The highest lead concentrations were found at James A Dever School, Valley Stream, Corona Avenue with .0255 found in the weight percent. The second highest lead concentrations were found at the Front Street School, located in Hempstead. This school recorded 0.0063 of lead in the weight percentage. Both of these locations were found in lower income areas, located near a highway. After looking at lead, the next most important heavy metal was Zinc. The concentrations of Zinc were a lot higher than those of lead, as it is found normally within the soil, but higher concentrations determine if it is dangerous. The area with the highest Zinc concentration was also Valley Stream, supporting the past statement that lower income areas were seen to have higher concentrations of heavy metals. Chromium was analyzed as well, and the locations with the highest amount of Cr were once again James A Dever School, Valley Stream, Corona Avenue with .0401 and Front Street School with .0118. The same pattern followed for As and Cu, where Valley Stream recorded 0.0155 As and 0.0195 Cu. The only different results

Sample ID	Location	Lat	Long	Pb	Cr	Zn	As	Cu	Cd
1	Manorhaven Elementary School	40°50'42"N	073°43'09"W	< LOD	0.0079	0.0014	< LOD	< LOD	< LOD
2	Manorhaven Elementary School	40°50'51"N	073°42'38"W	0.0007	0.0068	0.0023	< LOD	0.001	< LOD
3	Manorhaven Elementary School	40°50'51"N	073°43'17"W	< LOD	0.0065	0.0025	< LOD	0.0012	< LOD
4	Manorhaven Elementary School	40°50'19"N	073°43'22"W	< LOD	0.013	0.0012	< LOD	0.0006	< LOD
5	Manorhaven Elementary School	40°50'43"N	073°43'17"W	0.0007	0.0087	0.003	< LOD	0.0013	< LOD
6	Manorhaven Elementary School	40°50'39"N	073°43'25"W	0.0012	0.0063	0.0043	< LOD	0.0013	< LOD
7	Pine Street Park, Port Washington	40°49'31"N	073°41'03"W	0.0017	0.0078	0.0015	< LOD	0.0012	< LOD
8	Pine Street Park, Port Washington	40°49'27"N	073°41'04"W	0.001	0.0074	0.0042	0.007	0.0017	< LOD
9	Pine Street Park, Port Washington	40°48'50"N	073°41'35"W	0.0064	0.0116	0.0049	0.0024	0.0054	< LOD
10	Pine Street Park, Port Washington	40°50'37"N	073°38'07"W	< LOD	0.0079	0.0044	< LOD	0.0004	< LOD
11	Pine Street Park, Port Washington	40°50'37"N	073°38'07"W	0.0051	0.0046	0.0039	0.003	0.0023	< LOD
12	Pine Street Park, Port Washington	40°50'37"N	073°38'07"W	0.001	0.0085	0.0039	< LOD	0.0009	< LOD
13	Lloyd Harbor School	40°53.933"N	073°27.661"W	0.0005	0.007	0.0016	< LOD	0.0011	0.0006
14	Lloyd Harbor School	40°53.918"N	073°27.645"W	< LOD	0.0087	0.0018	< LOD	0.001	< LOD
15	Lloyd Harbor School	40°53.927"N	073°27.645"W	0.0005	0.0092	0.0012	< LOD	0.0007	< LOD
16	Lloyd Harbor School	40°53.932"N	073°27.657"W	0.0006	0.0056	0.0016	< LOD	0.0011	< LOD
17	Lloyd Harbor School	40°53.926"N	073°27.655"W	< LOD	0.0072	0.0011	< LOD	0.0008	< LOD
18	Lloyd Harbor School	40°53.920"N	073°27.646"W	< LOD	0.0063	0.0016	< LOD	0.0006	< LOD
19	South Grove Elementary School	40°48.017"N	073°30.342"W	0.0004	0.0081	0.0021	< LOD	0.0008	< LOD
20	South Grove Elementary School	40°48.013"N	073°30.336"W	0.0005	0.0093	0.0013	< LOD	0.0005	< LOD
21	South Grove Elementary School	40°48.016"N	073°30.330"W	< LOD	0.0097	0.002	< LOD	0.0001	0.0007
22	South Grove Elementary School	40°48.022"N	073°30.333"W	< LOD	0.0068	0.0018	< LOD	0.0009	< LOD
23	South Grove Elementary School	40°48.017"N	073°30.335"W	< LOD	0.0075	0.0013	< LOD	< LOD	< LOD
24	South Grove Elementary School	40°48.019"N	073°30.332"W	0.0005	0.0069	0.002	< LOD	0.001	< LOD
25	Front Street School	40°48.015"N	073°30.340"W	0.0006	0.0059	0.0022	< LOD	0.0012	< LOD
26	Front Street School	40°42.395"N	073°30.953"W	0.005	0.0089	0.0061	0.0022	0.0026	< LOD
27	Front Street School	40°42.403"N	073°36.970"W	0.0082	0.0118	0.0103	0.0031	0.0032	< LOD
28	Front Street School	40°42.405"N	073°36.973"W	0.0038	0.0053	0.0059	0.002	0.0029	< LOD
29	Front Street School	40°42.404"N	073°36.967"W	0.0045	0.0072	0.0074	0.0037	0.0052	< LOD
30	Front Street School	40°42.405"N	073°36.966"W	0.0038	0.0105	0.0064	0.0026	0.0048	< LOD

Fig 7: Results from 51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun Soil Data

32	Village of Island Park Mayor Landgraf Playground	40°42.402"N	073°36.984"W	< LOD	0.0063	0.0023	0.0005	0.0008	< LOD
33	Village of Island Park Mayor Landgraf Playground	40°36.744"N	073°38.980"W	< LOD	0.0052	0.004	0.0003	0.0013	< LOD
34	Village of Island Park Mayor Landgraf Playground	40°36.746"N	073°38.979"W	0.0008	0.0063	0.0019	< LOD	0.0009	< LOD
35	Village of Island Park Mayor Landgraf Playground	40°36.747"N	073°38.983"W	0.0006	0.0109	0.0025	< LOD	0.0008	< LOD
36	Village of Island Park Mayor Landgraf Playground	40°36.749"N	073°38.978"W	< LOD	0.0079	0.002	0.0069	0.0007	< LOD
37	James A Dever School, Valley Stream, Corona Ave	40°40.861"N	073°41.276"W	0.0084	0.0078	0.0131	0.004	0.0057	< LOD
38	James A Dever School, Valley Stream, Corona Ave	40°40.865"N	073°41.275"W	0.0122	0.015	0.0253	0.0052	0.0081	< LOD
39	James A Dever School, Valley Stream, Corona Ave	40°40.862"N	073°41.271"W	0.0255	0.0401	0.0362	0.0125	0.0195	< LOD
40	James A Dever School, Valley Stream, Corona Ave	40°40.864"N	073°41.272"W	0.0233	0.0222	0.0212	0.095	0.0155	< LOD
41	James A Dever School, Valley Stream, Corona Ave	40°40.855"N	073°41.271"W	0.0218	0.0353	0.0476	0.0155	0.0153	< LOD
42	James A Dever School, Valley Stream, Corona Ave	40°40.861"N	073°41.268"W	0.0163	0.0179	0.0327	0.0123	0.0181	< LOD
43	Fork Lane Elementary School	40°44.801"N	073°31.538"W	0.001	0.0053	0.0077	< LOD	0.0011	< LOD
44	Fork Lane Elementary School	40°44.797"N	073°31.529"W	< LOD	0.0058	0.0027	< LOD	0.0011	< LOD
45	Fork Lane Elementary School	40°44.801"N	073°31.527"W	0.0005	0.0084	0.0023	< LOD	0.0012	< LOD
46	Fork Lane Elementary School	40°44.802"N	073°31.528"W	0.0005	0.0072	0.0056	0.004	0.0012	< LOD
47	Fork Lane Elementary School	40°44.806"N	073°31.528"W	< LOD	0.0055	0.0195	< LOD	<LOD	< LOD
48	Fork Lane Elementary School	40°44.799"N	073°31.532"W	< LOD	0.0066	0.0038	0.0017	0.0006	< LOD
49	Pasadena Elementary School	40°44.795"N	073°31.534"W	0.0009	0.0091	0.01	< LOD	0.0008	< LOD
50	Pasadena Elementary School	40°46.396"N	073°29.504"W	< LOD	0.0089	0.0023	< LOD	0.0008	< LOD
51	Pasadena Elementary School	40°46.400"N	073°29.504"W	< LOD	0.0067	0.0017	< LOD	0.0012	< LOD
52	Pasadena Elementary School	40°46.400"N	073°29.500"W	0.0008	0.0076	0.0027	< LOD	0.0016	< LOD
53	Pasadena Elementary School	40°46.408"N	073°29.505"W	0.0005	0.0084	0.003	< LOD	0.0008	< LOD
54	Pasadena Elementary School	40°46.402"N	073°29.508"W	< LOD	0.0112	0.0017	0.0002	0.0008	< LOD
55	Jericho, East Birchwood	40°47.416"N	073°31.771"W	0.0023	0.0043	0.0269	0.0008	<LOD	< LOD
56	Jericho, East Birchwood	40°47.424"N	073°31.765"W	0.0026	0.0046	0.0129	0.0011	0.0012	< LOD
57	Jericho, East Birchwood	40°47.436"N	073°31.740"W	0.0014	0.0098	0.0021	0.0034	0.0032	< LOD
58	Jericho, East Birchwood	40°47.426"N	073°31.724"W	0.0007	0.0087	0.0016	0.0006	0.0016	< LOD
59	Caledonia Park, Dix Hills	40°49.066"N	073°42.119"W	0.0005	0.0101	0.0022	0.0002	0.001	< LOD
60	Caledonia Park, Dix Hills	40°48.652"N	073°21.978"W	< LOD	0.0089	0.0025	0.0002	0.0012	< LOD
61	Caledonia Park, Dix Hills	40°48.649"N	073°21.977"W	0.0006	0.0085	0.0066	0.0004	0.0007	< LOD
62	Caledonia Park, Dix Hills	40°48.646"N	073°21.982"W	0.0004	0.0103	0.0033	< LOD	0.0009	< LOD
63	Caledonia Park, Dix Hills	40°48.640"N	073°21.984"W	0.0006	0.0079	0.0018	< LOD	0.0008	< LOD
64	Caledonia Park, Dix Hills	40°48.635"N	073°21.984"W	0.0006	0.0091	0.0025	< LOD	0.0011	< LOD

Fig 8: Results from 51 TITAN Model 600/800 GeoExploration Check Sample X-Ray Gun Soil Data

were for Cd, where it was only found in Lloyd Harbor School and South Grove Elementary

School. Neither showed a large dosage putting children at risk, but it was present.

Results from Each Heavy Metal

Lead

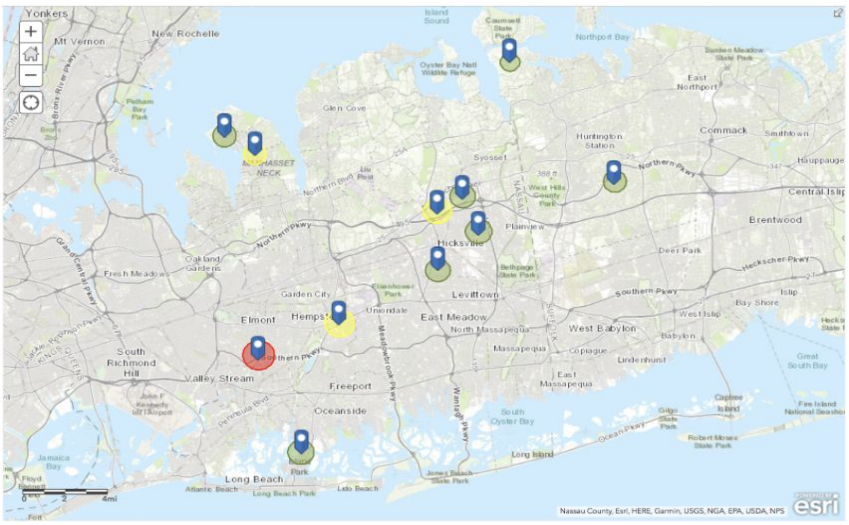


Fig 9: Lead Concentrations

After scanning the soil samples with the X-Ray Gun, it was seen that the majority of the island did not have a large risk towards high concentrations of lead, but it was found at a higher concentration than others in areas such as Valley Stream (0.255ppm), Hempstead (0.0082ppm), Jericho (0.0026ppm) , and southern parts of Port Washington (0.0064ppm), as seen on the data table found in Fig 1.

Chromium

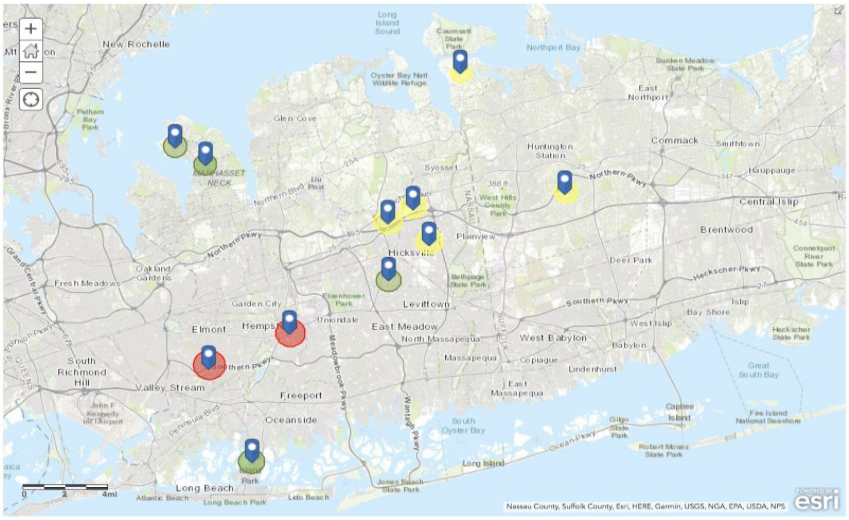


Fig 10: Chromium Concentrations

After the soil samples were scanned, it was seen that areas in the middle of the island, where less water was surrounding the environment, were more affected than areas located on the water. Valley Stream and Hempstead were once again the towns that posed the highest threat, with their parts per million reaching levels of .0401 in Valley Stream and 0.0118 in Hempstead. Towns such as Plainview were not affected as severely but had parts per million ranging anywhere from 0.008 to 0.01ppm.

Zinc

Before analyzing the data, it was known that Zinc is commonly found in soil and is necessary for the ecosystem, but when found at extreme levels, could pose a health risk. Therefore, the majority of the towns on the island were found to have low concentrations of zinc. The green and yellow towns should not cause any concern, but the only town that had a large concentration was Valley Stream, having parts per million of 0.0401ppm.

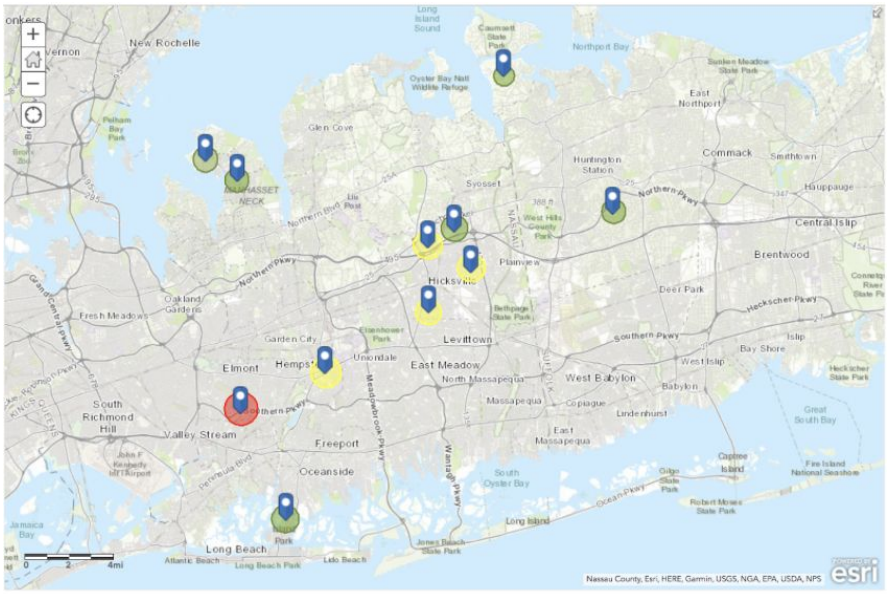


Fig 11: Zinc Concentrations

Arsenic

The results for arsenic were similar to those of Zinc, besides Island Park moving from green to yellow. The majority of the island was shown to have <LOD as their ppm, meaning the concentration was too low to distinguish, which is definitely a positive effect for the island's ecosystem. For this heavy metal, since there was barely any concentration, the yellow and red does not mean that there is a dangerous amount of arsenic in the soil, rather, these locations just have a higher concentration compared to the other soil samples.

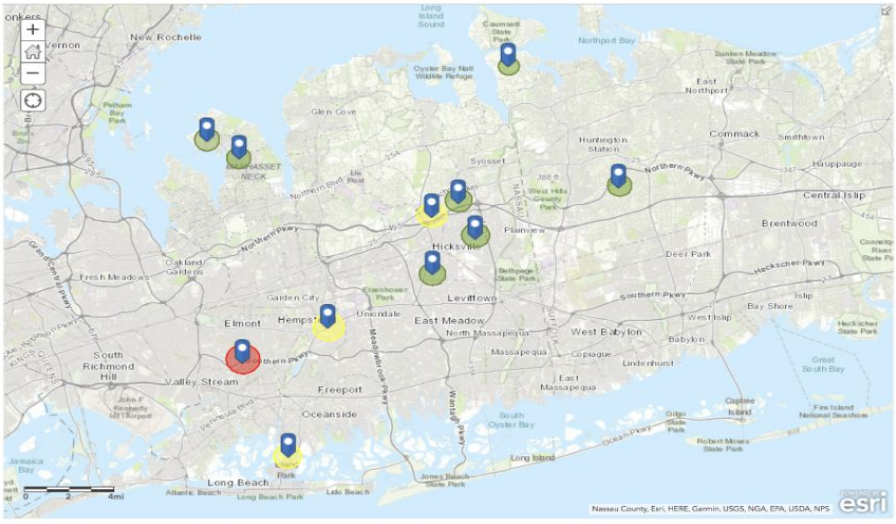
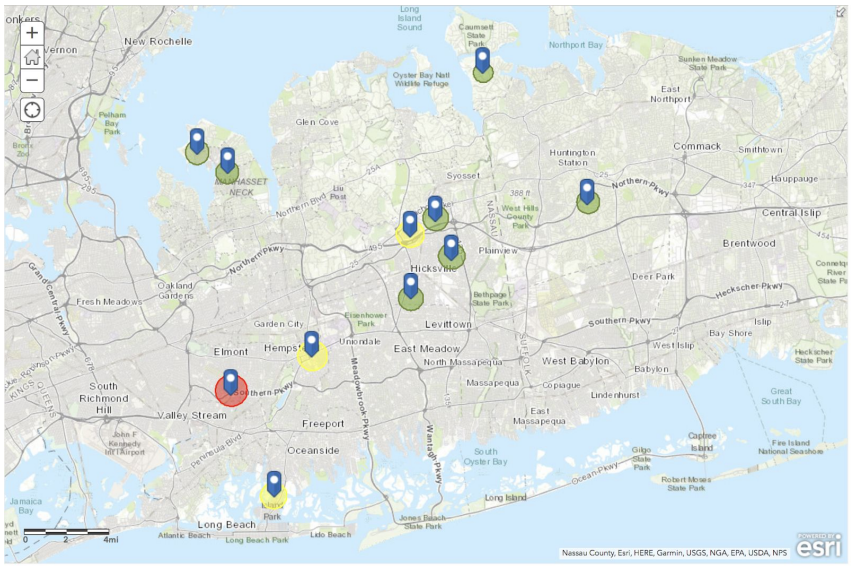


Fig 12: Arsenic Concentrations

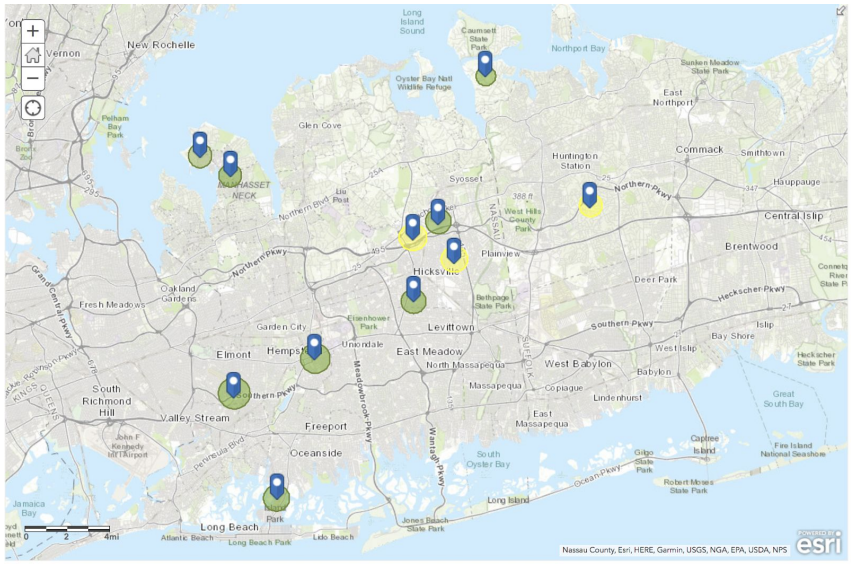
Copper

The results for copper were identical to that of Arsenic in what towns contained a higher concentration in their soil. Once again, Valley Stream was the most concentrated with 0.0195 ppm of Copper found in the soil. It is not that high of a concentration, but still more than the other towns.



Cadmium

The majority of the towns on the island were found with no Cadmium in their soil, but because it is a harmful heavy metal, it was looked for. Most of the towns had a ppm of <LOD, but the towns in yellow (Plainview, Jericho, and Dix Hills) had a ppm anywhere from 0.001 to 0.009.



Soil Data from Water Push

After analysing the data from the water push, it was found that the metals that were found within the original soil samples were also found within the water from the immediate results, but found at a lower concentration. This mimics the result of these heavy metals that are found within the soil in the local playgrounds and schools, showing that they could be

seeping through the soil and entering the water cycle that our ecosystem relies on. Once a single area of the ecosystem is changed, it will leave a substantial result on the global reliance.

d) Discussion

After analysing the results from the X-Ray Gun Soil Data and the Soil Data from the Water Push, it was noticeable that there were harmful metals in the soils of certain schools on Long Island, therefore, potentially putting children at harm without them knowing. The high concentrations pose a question as to what is it that the public is doing that leads to there being heavy metals in the soil. Along with what the solution may be. Seeing that both of the areas that had the highest concentration were located either near a highway or located in a low income area, poses the assumption that the waste or exhaust from the cars could follow its way into the playgrounds in the air. Or based on the income rate of the area, are the workers that are placing this soil in the parks and schools not caring about the quality of the soil? Or are the companies not watching what they use to put in the soil? All of these are possible solutions. Also, after seeing that the metals that were originally found within the soil were also found within the water shows that the metals could be entering the ecosystem that we all depend on today. If heavy metals were entering the soil, it could enter the water system that plants soak up, and potentially poison or harm any animal that eats that plant. Overall, the results of this experiment does correlate with the original hypothesis. Yes, there are harmful metals found within the soil in local elementary schools and playgrounds and these metals could be entering the water system, potentially harming the world's ecosystem.

Limitations

Throughout this project I wanted to include a biological aspect, studying the effects that each of these metals would have on the human body if found at high concentrations. I did not have the equipment provided by the lab in order to do so, so instead I researched the effects through articles. Also, not every playground on the island was made from soil. A lot of

schools and towns have made their playgrounds out of reused plastic that does not allow plants to grow, which limited the areas that I was able to get soil samples from.

Future Research

In the future I would definitely want to study the effects that these high concentrations of heavy metals had on the human body, and see if it was more severe in children or adults. I would also like to travel throughout the entire East Coast, or a part of the country that will have different environmental factors that could be the case for the high levels of heavy metal. For example, in the middle of the United States, there is barely any surrounding water. Lastly, seeing if the climate, such as a colder or hotter atmosphere had an effect on the intensity.

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