Toxic Sites Identification Program (TSIP) in Senegal

Award: DCI-ENV/2015/371157

Prepared by: Pure Earth

Prepared for: UNIDO

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LIST OF ACRONYMS

ADB-	African Development Bank
EC -	European Commission
HPAP	Health and Pollution Action Planning
ISS -	Initial Site Screening
LMICs -	Low and Middle-Income Countries
MoH -	Ministry of Health
MoM -	Ministry of Mining
NEMA -	National Environment Management Authority
PE -	Pure Earth
TSIP -	Toxic Sites Identification Program
ULAB -	Used Lead-Acid Battery
UNIDO -	United Nations Industrial Development Organization
USAID-	United States Agency for International Development
WB -	World Bank
XRF -	Alpha X-Ray Fluorescence

LIST OF ANNEXES

ACKNOWLEDGEMENTS

This activities described in this report were supported by the European Commission and the United Nations Industrial Development Organization project "Mitigating Toxic Health Exposures in Low-and Middle-Income Countries: Global Alliance on Health and Pollution" (DCI-ENV/2015/371157) and also made possible by the generous support of the American People through the United States Agency for International Development (USAID) under the award, "Reducing the Threat of Toxic Chemical Pollution to Human Health in Low- and Middle-Income Countries" (AID-OAA-A-16-00019).

INTRODUCTION

Pure Earth (PE), formerly Blacksmith Institute, is an international not-for-profit organization dedicated to solving pollution problems in low and middle-income countries where human health is most affected by pollution. To date, more than 3,000 sites have been identified in 47 countries. These sites alone represent a health risk to more than 80 million poor people. Importantly, however, these 3,000 sites likely represent a small fraction of the overall total number of contaminated sites in the world. To further this ongoing mapping work, Pure Earth contracts and trains highly qualified professionals, often from the environment or health departments at a national university, to identify and assess contaminated sites using the Initial Site Screening (ISS) protocol under the Toxic Sites Identification Program (TSIP).

The ISS protocol provides a rapid quantitative evaluation to help understand the risks posed by pollution. The protocol identifies types of contaminants, the size of individual sites, the number of impacted people, and the magnitude of health risks. The overarching goal of the TSIP is to have an accurate overview of the industrial pollution sites impacting public health in low and middle-income countries.

In 2008, Senegal had a case of lead intoxication in the suburbs of Dakar (Thiaroye Ngagne DIAW). This intoxication had consequences for human life losses and required significant financial resources to clean the area. It is in this context that the collaboration between the Senegal and Blacksmith Institute, now Pure Earth, was formed. The contaminated site was cleared and impacted populations were sensitized on the health issues caused by and trained on other livelihood activities such as processing of cereal products as a way to earn their living. In Senegal, Pure Earth works with the Ministry of the Environment and the Poison Control Center to identify and assess contaminated sites.

A handful of sites in Senegal were assessed following this success. Funding from USAID beginning in February of 2016 re-invigorated the program in the country and an additional 38 have thus far been assessed (as of November 2018). In addition, the funding will be used to undergo country-wide Health and Pollution Action Planning (HPAP). The HPAP process, currently in the planning stages in Senegal, convenes relevant government officials at all

levels from across agencies, NGOs, and other stakeholders to systematically review pollution issues and potential solutions at the country level with the aim of achieving government commitment to develop and execute pollution mitigation and control strategies.

The contaminated sites in Senegal were identified by trained investigators recruited from universities using the Initial Site Screening (ISS) protocol. The ISS identifies major elements of a contaminated site, including estimated population at risk, key pollutant information, human exposure pathway data and sampling data.

In partnership USAID, between February 2016 and November 2018, 38 sites were assessed. To date, a total of 61 sites (inclusive of the 38) located in 8 regions, namely Dakar, Thiés, Diourbel, Louga, Saint Louis, Tambacounda, Kédougou, and Ziguinchor have been identified and assessed using the ISS protocol. Investigators collected soil samples and measured levels of toxicity using an Alpha Xray Fluorescence (XRF) instrument and/or university laboratory facilities.

Based on lessons learned, this report provides the following recommendations to the Government of Senegal:

- Conduct detailed assessments for sites displaying high concentrations of pollutants in order to better understand the distribution and magnitude of contamination, and to develop feasible and cost-effective remediation plans to address identified problems
- Continue to use the ISS protocol to identify and assess additional sites in order to determine locations of contaminated sites in all 14 regions of the country
- Create a national assessment/inventory program based on the TSIP protocol
- Continue to use the data in the existing TSIP database (www.contaminatedsites.org) to make informed decisions about solving the country's pollution problems
- Conduct needs assessments to determine internal capacity and to identify priority areas.

TOXIC SITES IDENTIFICATION PROGRAM (TSIP)

The TSIP identifies active and abandoned hazardous waste sites resulting from both formal and informal industrial activities in low and middle-income countries (LMICs). It does not include exposure data from non-point sources such as vehicle traffic or sewage contaminated water. As part of a TSIP investigation, a "key pollutant" is identified and analyzed.

IMPLEMENTATION STRATEGY

Pure Earth conducted a TSIP training in Senegal in November 2016 for a network of national experts comprised of researchers and students from environmental or health departments of national universities, government officials from the Ministry of Health (MoH), Ministry of Environment (MoE) and Ministry of Agriculture (MoA), as well as three investigators.

The TSIP training consisted of both theoretical and practical components. The theoretical training, conducted on day one, introduced participants to the work of Pure Earth, the health impacts of pollution, and the model of Pollution-Migration-Pathway-People. Participants were also taught how to use a hand-held Alpha Xray Fluorescence (XRF) spectrometer (a precise instrument that permits collection of real-time field data and is key to building in-country capacity to monitor and assess heavy metal contamination). During day two, the practical, field-based component of ISS training, participants visited a site for hands-on experience in using the ISS protocol. Participants then returned to the classroom to learn how to enter data into the TSIP database. Each participant practiced using the data collected during the morning field visit.

IMPLEMENTATION STRATEGY/COORDINATION WITH GOVERNMENT

In order to properly implement the project, coordination with government agencies at all stages of the project is essential. At the national level, Pure Earth's work is supported by the following ministries: Ministry of Environment (MoE), Ministry of Health (MoH), Ministry of Agriculture (MoA). Pure Earth's investigators meet regularly with government officials to share data and findings. As such, government officials and their respective community constituents have gained a better understanding of the scope of toxic pollution and its impact on public health, economic growth, and sustainable development.

In some cases, government officials have accompanied investigators during site assessments to learn about the process. This served to engage the government at a more nuanced level, which helped ensure the sustainability and effectiveness of the project.

PROGRAM IMPLEMENTATION ACTIVITIES

- Introduction of the project to national and local government officials
- Recruitment and hiring of researchers
  - 3 investigators were hired and trained
- Training in conducting of rapid site assessments using the ISS protocol
  - 17 Participants total - Pure Earth investigators, researchers, students, government officials
- Coordination with national and local authorities on sites selection and priorities
- Assessment of sites
  - Including site history, estimation of population at risk, creation of site map, and taking of photos
- Collection of samples (water, soil or air)
- Analysis by reputable laboratory when necessary
- Entry of assessment information into existing TSIP database
- Review of data collected for quality and consistency (performed by PE team in New York)

SUMMARY OF KEY RESULTS

To date, a total of 61 sites have been assessed in 8 regions (Dakar, Thiés, Diourbel, Louga, Saint Louis, Tambacounda, Kédougou, and Ziguinchor) of Senegal.

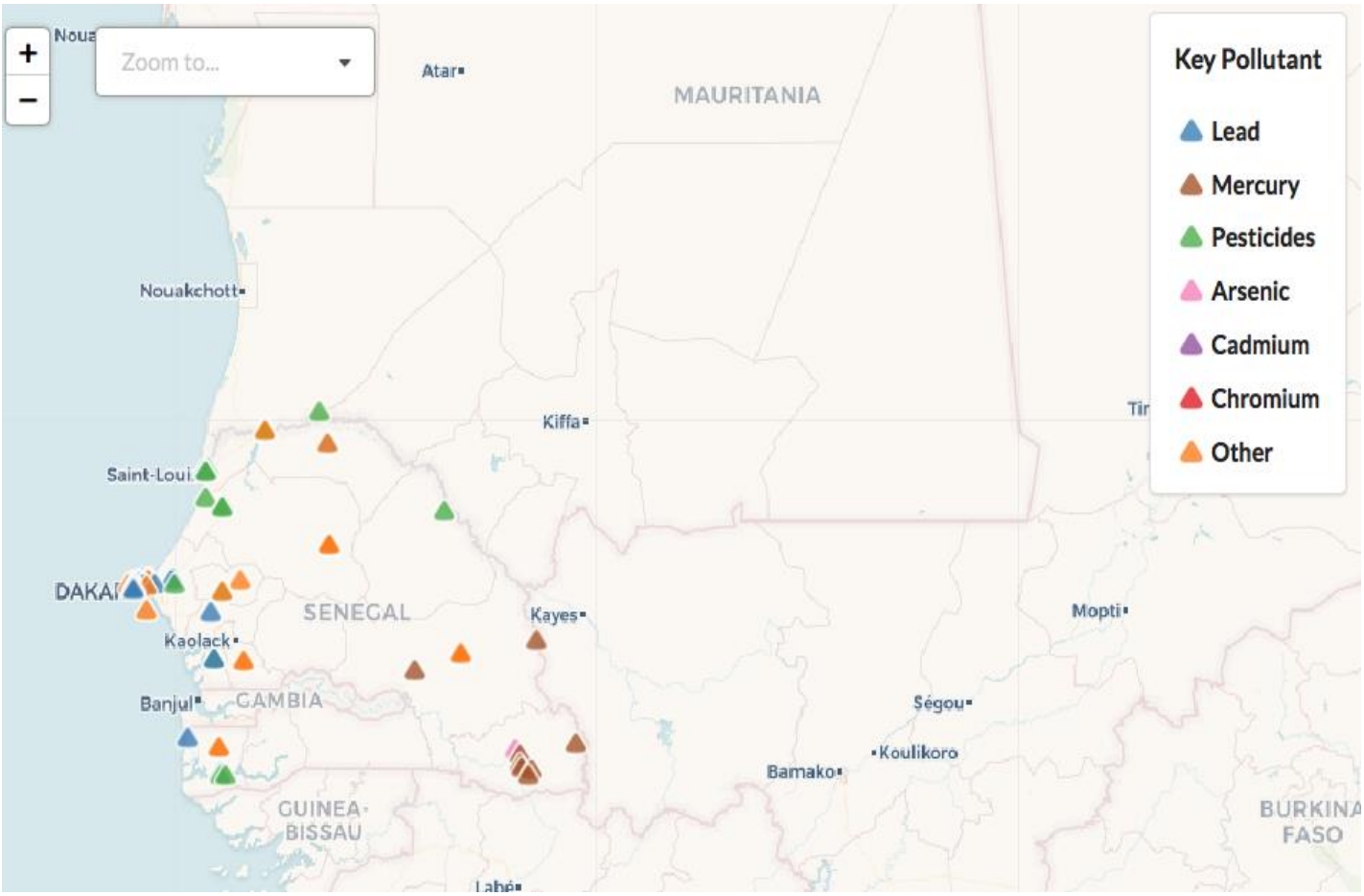


Table 1: Key Pollutants in Senegal identified in TSIP Assessments

Key Pollutant	Number of Sites Identified
Lead	26
Pesticides	14
Mercury – organic	7
Other	7
PAH	2
Mercury – elemental	1
PCBs	1
Arsenic	1
Cadmium	1
PM10	1
Total	61

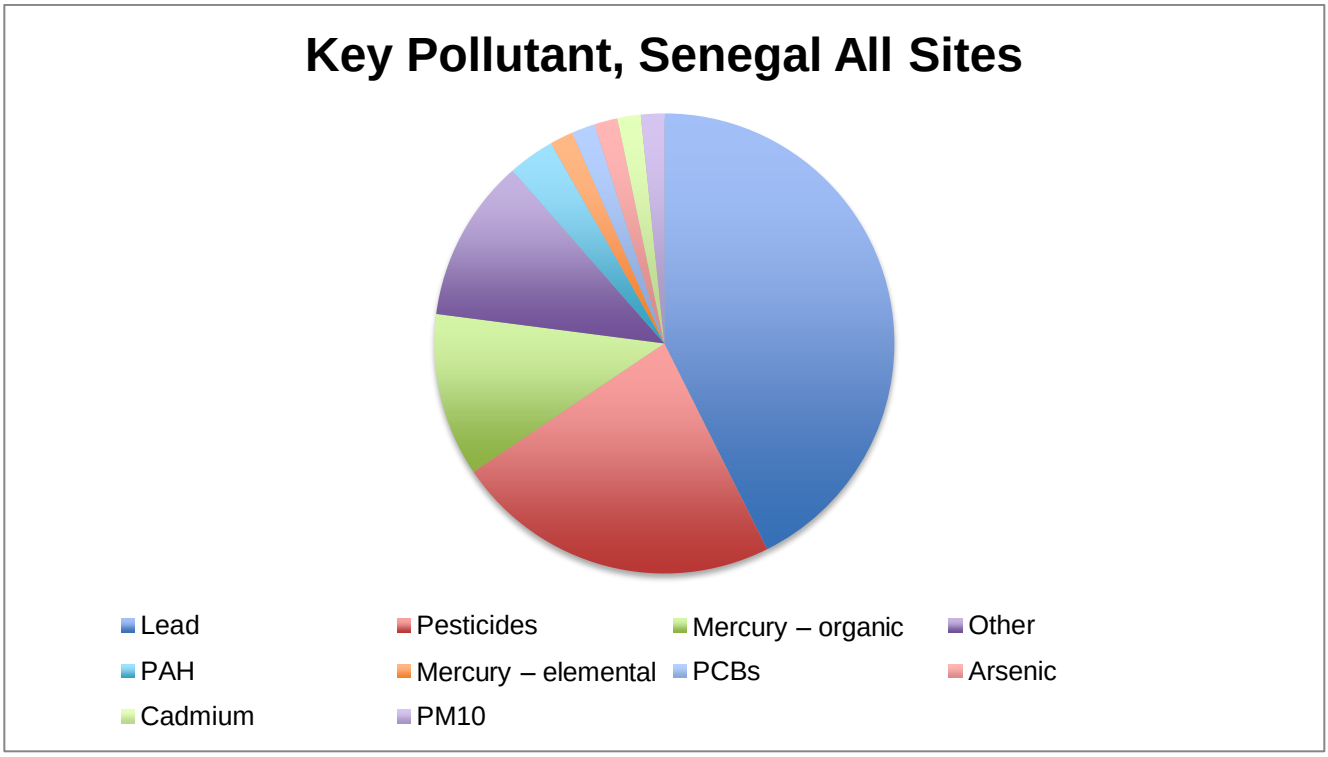
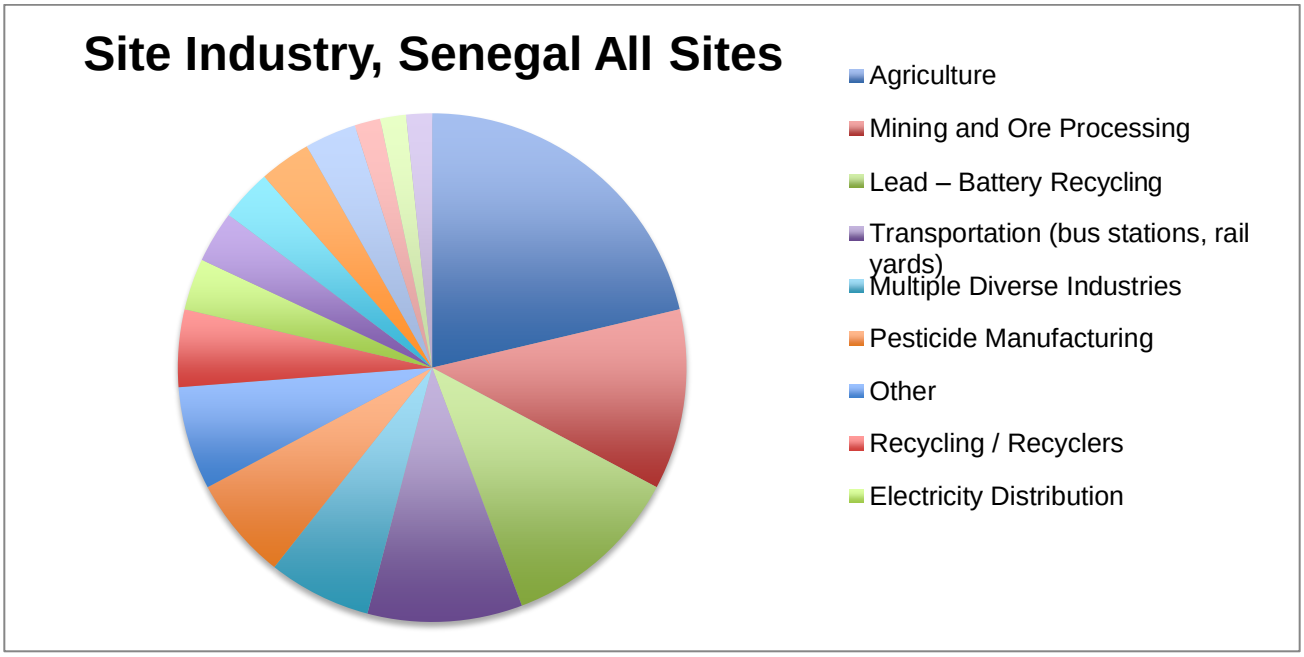


Table 2: Key pollutants identified in in Senegal during the TSIP program

Key Pollutant	Number of Sites Identified
Lead	26
Pesticides	14
Mercury – organic	7
Other	7
PAH	2
Mercury – elemental	1
PCBs	1
Arsenic	1
Cadmium	1
PM10	1
Total	61



Investigators collected soil samples each of the 61 sites and measured levels of toxicity using an Alpha X-ray Fluorescence (XRF) instrument and/or certified laboratory. Sources of pollution included: mining, agriculture, used lead acid battery (ULAB) recycling, and pesticide manufacturing. Key pollutants included mercury, lead, arsenic, cadmium, pesticides, PCBs,

and PAHs. Of these pollutants, lead was found in 43% of the sites, pesticides in 23% of sites, organic mercury was found in 11% of the sites, PAHs in 3%, elemental mercury in 2%, PCBs in 2%, cadmium in 2%, PM10 in 2%, and other pollutants in 11%.

Lead was present in 26 sites, with concentrations ranging from 17 ppm to 5,867 ppm. The source industries for lead contamination in Senegal are varied, including ULAB recycling sites, transportation such as bus stations and rail yards, lead smelting, the dye industry, and electroplating.

Pesticides were found at 14 sites, or 23% of total sites with concentrations ranging from .01 to 347 ppm. Site industries included agriculture, chemical manufacturing of acids, organics, and base chemicals, fertilizer manufacturing, and a power plant.

Of the 61 total sites, 38 were visited between February 2016 and November 2018 with financing from **USAID**.

Table 3: Key pollutants identified in Senegal during TSIP USAID site visits

Key Pollutant	**Number of Sites Identified**
Lead	20
Pesticides	11
Mercury – organic	6
Other	1
Total	**38**

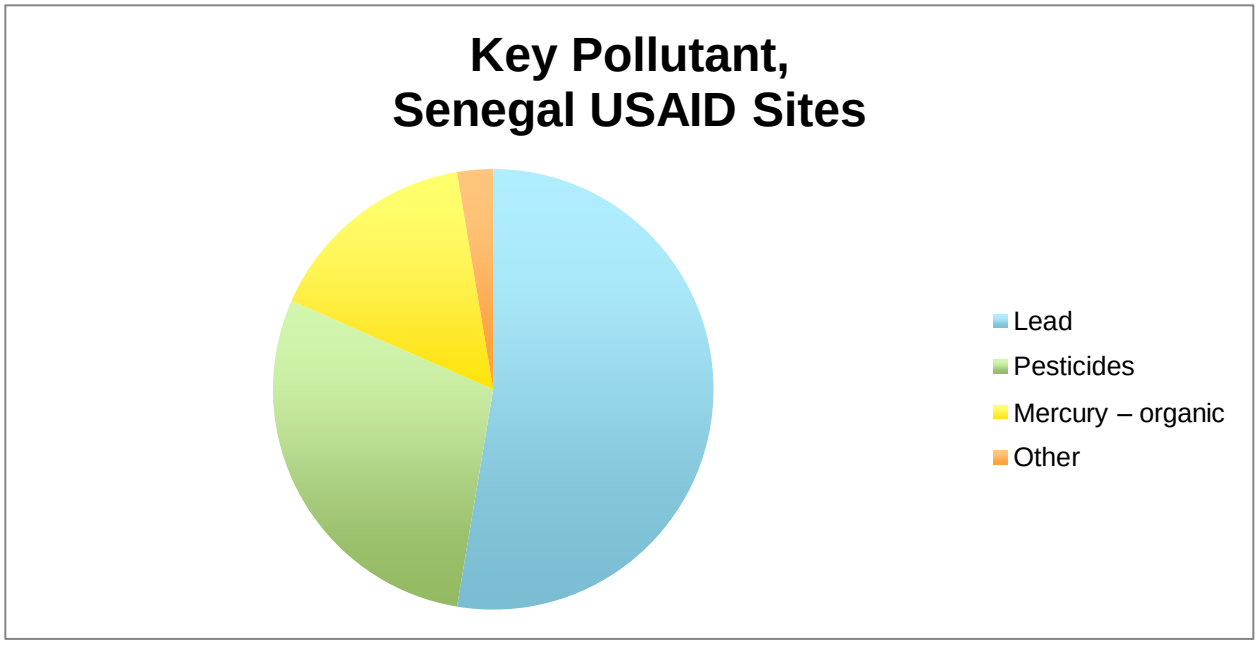
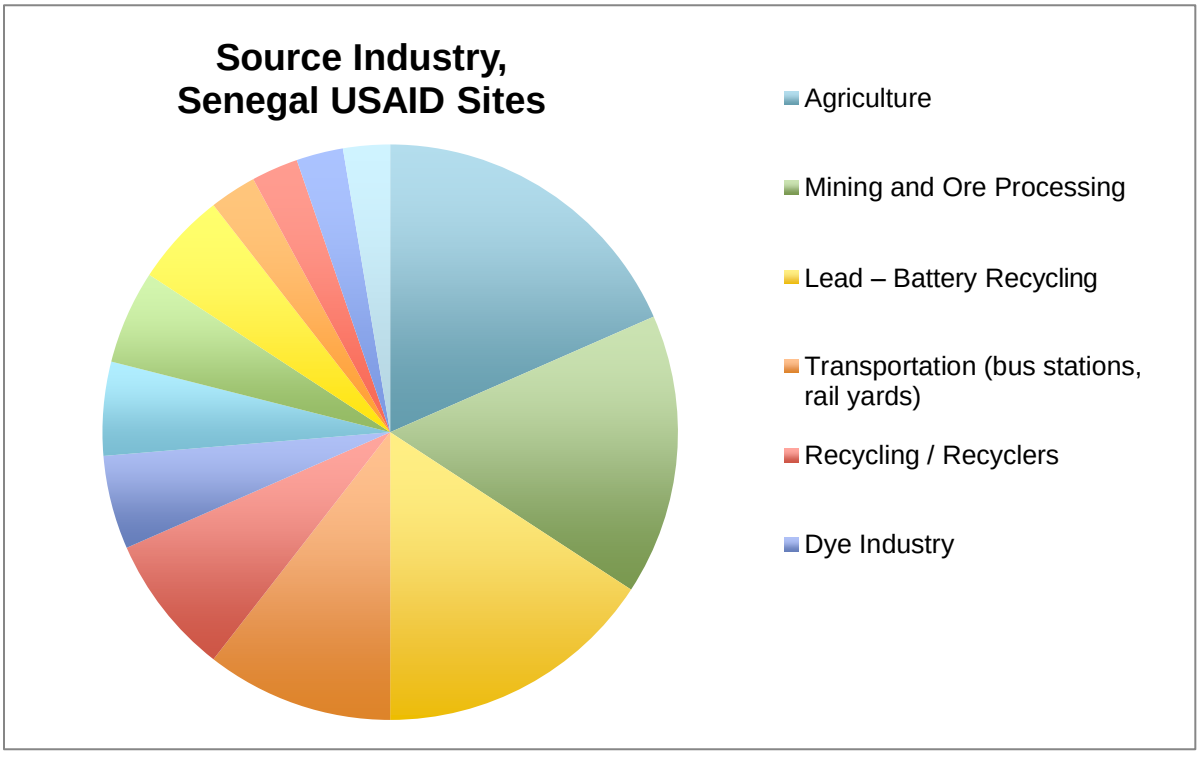


Table 4: The number of USAID-funded sites as categorized by pollution source in Senegal

Site Industry	Number of Sites Identified
Agriculture	7
Mining and Ore Processing	6
Lead – Battery Recycling	6
Transportation (bus stations, rail yards)	4
Recycling / Recyclers	3
Dye Industry	2
Fertilizer Manufacturing	2
Chemical (acids, organics, base chemicals) and Pesticide Manufacturing	2
Other	2
Multiple Diverse Industries	1
Lead smelting (with ingot production)	1
Industrial/Municipal Dump Site	1
Industrial Estate (mixed industries)	1
Total	**38**



Health Risks Identified and Other Concerns Identified During Sites Assessments

During site visits, many exposure risks were identified by both the investigators and the workers at the sites. Some of the workers in these industries knew of the health risks involved, while others were unaware of the associations between pollution and health. In many cases, workers were experiencing symptoms that could potentially be linked to pollution.

Exposure risks identified included:

- Lack of protective equipment for the vast majority of workers – inhalation/ingestion of polluted air and dermal contact were the primary routes of exposure
- Incorrect disposal of waste water during lead recycling – especially dangerous in residential areas
- Lack of awareness of health hazards posed by chemical pollution

Health symptoms identified included:

- Memory loss, frequent headaches, miscarriages, lack of appetite and poor body coordination
- Hyperactivity - especially in lead contaminated sites
- Chest pains associated with respiratory challenges in pesticides contaminated sites
- Livestock falling ill and/or dying after drinking contaminated water from mining areas

It is noted that the symptoms identified are only a fraction of potential effects. As research continues to identify and confirm pollution linkages, and as further sites are identified (to more accurately measure the pollution burden in a region) it is likely that the list of pollution-related diseases will expand substantially.

RECOMMENDATIONS FOR THE GOVERNMENT

- Conduct detailed assessments for sites displaying high concentrations of pollutants in order to better understand the distribution and magnitude of contamination, and to develop feasible and cost-effective remediation plans to address identified problems
- Continue to use the ISS protocol to identify and assess additional sites in order to determine locations of contaminated sites in all 14 regions of the country
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ANNEX 1 TSIP SITES IN SENEGAL

Site ID	Site Name	Latitude	Longitude	Key Pollutant	Site Industry
SN-271	Hann Bay, Dakar	14.709391	-17.429638	Other	Multiple Diverse Industries
SN-272	Décharge publique, Landfill de Mbeubeuss, Dakar	14.80466	-17.31152	Lead	Recycling / Recyclers (including salvage yards)
SN-273	Tambacounda Region	13.756726	-13.688965	Mercury - elemental	Mining and Ore Processing
SN-352	Dakar Air Quality	14.6953	-17.443899	PM 10	Transportation (bus stations, rail yards)
SN-566	Thioyre Sur Mer, Dakar	14.74336	-17.378421	Lead	Lead - Battery Recycling
SN-2367	SOCOCIM-INDUSTRIES:/ RUFISQUE	14.7167	-17.2667	PCBs (PolyChlorinated Biphenyls)	Electricity Distribution
SN-2515	Direction Regionale de Developpement Rurale (DRDR) de LOUGA	15.61468	-16.245569	Malathion	Agriculture
SN-2516	Pesticide Storage Aerodrome De Podor	16.67537	-14.96313	Pesticides	Agriculture
SN-2684	SENCHIM/ICS	14.744578	-17.37527	Carbaryl	Pesticide Manufacturing
SN-3748	Fana Hotel	14.737451	-17.508173		Lead - Battery Recycling
SN-3864	Sugar Company of Senegal-Compagnie sucrière du Sénégal	16.461309	-15.68758	Poly Aromatic Hydrocarbons (PAHs)	Agriculture
SN-3865	Saint Louis Guet Ndar fabrique de filets de peche	16.0209152	-16.5086938	Lead	Lead Smelting (with ingot production)
SN-3894	Fishing peer in Industrial Zone, Ziguinchor, Senegal	12.589797	-16.2811814	Lead	Multiple Diverse Industries
SN-3911	Utilisation du mercure dans l'Extraction Minière Artisanal et à Petite Echelle d'or à Tenkhoto, Kédougou	12.6728	-12.27844	Mercury - organic	Mining and Ore Processing
SN-4039	Cité ouvière (SEIB) Industrial Site	14.6506528	-16.261775	Hexane	Industrial Estate (mixed industries)
SN-4061	Utilisation du mercure dans l'Extraction Minière Artisanal et à Petite Echelle d'or à Tomboronkoto, Kédougou	12.79862	-12.2934	Mercury - organic	Mining and Ore Processing
SN-4063	sambrambougou	12.5604611	-12.1747083	Mercury - organic	Artisanal Mining (hand mining)
SN-4195	société de produits industriels et agricoles(SPIA)	15.6089389	-16.2497889	Dieldrin	Pesticide Manufacturing
SN-4202	Car Mechanic ancien bague	12.587408	-16.273278	Cadmium	Transportation (bus stations, rail yards)
SN-4203	Societe de production et de commercialisation de Produits phytosanitaires SENCHIM Thiaroye	14.744873	-17.375091	Other	Pesticide Manufacturing

Site ID	Site Name	Latitude	Longitude	Key Pollutant	Site Industry
	Dakar				
SN-4214	Site de stockage senelec Hann Mariste/CREOSOTE	14.434806	-17.261765	PAH (Total)	Electricity Distribution
SN-4215	Village de Diannah	12.975981	-16.713	Lead	Agriculture
SN-4250	Mako	12.8481667	-12.3549778	Arsenic	Tannery Operations
SN-4255	Guinaw Rails Sud (Darou Khoudoss),	14.746857	-17.3863615	Lead	Multiple Diverse Industries
SN-4257	Pesticide Storage, Direction Regionale de Developpement Rurale(DRDR) de Saint Louis	16.01217	-16.488387	Dieldrin	Agriculture
SN-4258	Base d'Avertissement Agricole (BAA)/Richard Toll/Région de Saint Louis	16.462425	-15.695845	Heptachlor	Pesticide Manufacturing
SN-4291	Colobane Wakhinane	14.698865	-17.441513	Lead	Lead Smelting (with ingot production)
SN-4323	SAED Pesticide Storage	15.707167	-16.469083	Pesticides	Agriculture
SN-5169	Usine de recyclage et de traitement du plomb, Gravita, Sebikhotane, Dakar	14.726	-17.156	Lead	Lead - Battery Recycling
SN-5202	Atelier Mamadou Ndao, lieu de stockage et de vente de batteries (Allee papa gueye fall) Dakar	14.67692	-17.44131	Lead	Electroplating
SN-5205	Garage mécanique de réparation des vehicules du domaine Stade Iba-Mar-Diop/RTS1 Dakar	14.68063	-17.44479	Lead	Industrial Estate (mixed industries)
SN-5211	Garage de reparation de vehicule et de recyclage de batteries Guinaw rail sud (Alla Yana) Dakar	14.74646	-17.38431	Lead	Lead - Battery Recycling
SN-5213	Ancien site de recyclage des batteries (Neuner service)	14.73214	-17.30574	Lead	E-waste recycling
SN-5214	Site de stockage de pesticides de la Direction de la Protection des Vegetaux (DPV) Dakar/Senegal	14.74513	-17.35477	Pesticides	Agriculture
SN-5215	Site de stockage de produits chimique de l'Organisation Commune de Lutte Antiacridienne et de Lutte Anti Aviaire (OCLALAV)	14.73128	-17.43138	Pesticides	Agriculture
SN-5216	Site stockage pesticides ISRA,	14.79197	-17.2259	Pesticides	Agriculture

Site ID	Site Name	Latitude	Longitude	Key Pollutant	Site Industry
	Sagalkam, Rufisque / Dakar				
SN-5317	Fonderie de fabrication d'ustensiles en aluminium de Croisement Cambérène, Dakar	14.745886	-17.431176	Lead	Agriculture
SN-5320	Iron Recovery and Scrapyard de Patte d'Oie Damel, Dakar	14.743142	-17.43729	Lead	Recycling / Recyclers (including salvage yards)
SN-5321	Atelier de teinture Thiaroye Sam Sam I Dakar	14.76268	-17.36558	Lead	Dye Industry
SN-5322	Atelier de teinture Thiaroye Thierno Ndiaye Dakar	14.76627	-17.36257	Lead	Dye Industry
SN-5323	Garage de stationnement de camions Maliens Mbao Dakar	14.72812	-17.30416	Lead	Transportation (bus stations, rail yards)
SN-5324	Atelier de réparation et de démantèlement de véhicules And Bolo Dalifort Dakar/ Dakar	14.74435	-17.41317	Lead	Transportation (bus stations, rail yards)
SN-5355	Parc Ferraille Grand Yoff Bignona	14.7374	-17.44347	Lead	Recycling / Recyclers (including salvage yards)
SN-5356	Garage mecanique de reparation et de demantellement de vehicules Damel Mixta Kambyeu, Dakar	14.74896	-17.45762	Lead	Multiple Diverse Industries
SN-5384	Utilisation du mercure dans l'Extraction Minière Artisanal et à Petite Echelle d'or à Ngaré Sekoto, Kédougou	12.63961	-12.25309	Mercury - organic	Mining and Ore Processing
SN-5385	Utilisation du mercure dans l'Extraction Minière Artisanal et à Petite Echelle d'or à Kharakheina, Kédougou	12.917504	-11.52503	Mercury - organic	Mining and Ore Processing
SN-5386	Gold mines de Samé Kouta, Kedougou	12.61227	-12.12538	Mercury - organic	Mining and Ore Processing
SN-5387	Site d'extraction et de traitement d'or de Kéniéba / Kedougou	14.09915	-12.05855	Mercury - organic	Mining and Ore Processing
SN-5395	Base de stockage de produits phytosanitaires de la DPV de Sokone, Fatick	13.8866497	-16.3719847	Other	Agriculture
SN-5396	Car Mechanic Amadou Ndiaye Sokone, Fatick	13.8739605	-16.3686852	Lead	Transportation (bus stations, rail yards)
SN-5667	Stockage de produits chimiques dans la Centrale Electrique de Boutoute a Ziguinchor	12.55904	-16.22442	Pesticides	Power Plants (coal or oil)
SN-	Garage mécanique de	12.57276	-16.27035	Lead	Lead - Battery Recycling

Site ID	Site Name	Latitude	Longitude	Key Pollutant	Site Industry
5668	Belfort, Ziguinchor				
SN-5677	Installation de stockage des pesticides de l'aéroport de Saint-Louis	16.05042	-16.45841	Other	Agriculture
SN-5678	Chemical storage unit of the National Oilseed Marketing Company (Sonacos) de Diourbel	14.64918	-16.26662	Pesticides	Chemical Manufacturing (acids, organics, base chemicals)
SN-5680	Obsolete Pesticide Storage de la Direction de la Protection des Végétaux de Richard Toll	16.46293	-15.69606	Other	Agriculture
SN-5681	Site de démantèlement et de réparation de batteries de la gare routière de Thiès	14.77931	-16.94709	Lead	Lead - Battery Recycling
SN-5682	Atelier mecanique de soudure Ablaye - Balacos - Saint Louis	16.02632	-16.49344	Lead	Lead - Battery Recycling
SN-5683	Ancien site de stockage de Pesticide de la DPV, Saint Louis, Sénégal	16.01211	-16.48854	Other	Fertilizer Manufacturing
SN-5684	Société de fabrication de produits phytosanitaires (SPIA), Pesticide Manufactuing, Louga Sénégal.	15.60822	-16.25007	Pesticides	Fertilizer Manufacturing
SN-5694	Entreposage de soude caustique à l' Aéroport de Ziguinchor	12.55844	-16.27749	Other	Industrial/Municipal Dump Site
SN-5709	Magasins de chargement et de réparation de batteries pour les locomotives de la Direction de Dakar Bamako Ferroviaire	14.79534	-16.91784	Lead	Transportation (bus stations, rail yards)

TSIP SITES USAID FUNDING

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SN-5214	Site de stockage de pesticides de la Direction de la Protection des Vegetaux (DPV) Dakar/Senegal	14.74513	-17.35477	Pesticides	Agriculture
SN-5215	Site de stockage de produits chimique de l'Organisation Commune de Lutte Antiacridienne et de Lutte Anti Aviaire (OCLALAV)	14.73128	-17.43138	Pesticides	Agriculture
SN-5216	Site stockage pesticides ISRA, Sagalkam, Rufisque / Dakar	14.79197	-17.2259	Pesticides	Agriculture
SN-5678	Chemical storage unit of the National Oilseed Marketing Company (Sonacos) de Diourbel	14.64918	-16.26662	Pesticides	Chemical Manufacturing (acids, organics, base chemicals)
SN-5684	Société de fabrication de produits phytosanitaires (SPIA), Pesticide Manufactuing, Louga Sénégal.	15.60822	-16.25007	Pesticides	Fertilizer Manufacturing
SN-5667	Stockage de produits chimiques dans la Centrale Electrique de Boutoute a Ziguinchor	12.55904	-16.22442	Pesticides	Power Plants (coal or oil)
SN-5395	Base de stockage de produits phytosanitaires de la DPV de Sokone, Fatick	13.8866497	-16.3719847	Other	Agriculture
SN-5677	Installation de stockage des pesticides de l'aéroport de Saint-Louis	16.05042	-16.45841	Other	Agriculture
SN-5680	Obsolete Pesticide Storage de la Direction de la Protection des Végétaux de Richard Toll	16.46293	-15.69606	Other	Agriculture
SN-5683	Ancien site de stockage de Pesticide de la DPV, Saint Louis, Sénégal	16.01211	-16.48854	Other	Fertilizer Manufacturing
SN-5694	Entreposage de soude caustique à l' Aéroport de Ziguinchor	12.55844	-16.27749	Other	Industrial/Municipal Dump Site
SN-4203	Societe de production et de commercialisation de Produits phytosanitaires SENCHIM Thiaroye Dakar	14.744873	-17.375091	Other	Pesticide Manufacturing
SN-3911	Utilisation du mercure dans l'Extraction Minière Artisanal et à Petite Echelle d'or à Tenkhoto, Kédougou	12.6728	-12.27844	Mercury - organic	Mining and Ore Processing
SN-4061	Utilisation du mercure dans l'Extraction Minière Artisanal et à Petite Echelle d'or à Tomboronkoto, Kédougou	12.79862	-12.2934	Mercury - organic	Mining and Ore Processing
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SN-5169	Usine de recyclage et de traitement du plomb, Gravita, Sebikhotane, Dakar	14.726	-17.156	Lead	Lead - Battery Recycling
SN-5211	Garage de reparation de vehicule et de recyclage de batteries Guinaw rail sud (Alla Yana) Dakar	14.74646	-17.38431	Lead	Lead - Battery Recycling
SN-5668	Garage mécanique de Belfort, Ziguinchor	12.57276	-16.27035	Lead	Lead - Battery Recycling
SN-5681	Site de démantèlement et de réparation de batteries de la gare routière de Thiès	14.77931	-16.94709	Lead	Lead - Battery Recycling
SN-5682	Atelier mecanique de soudure Ablaye - Balacos - Saint Louis	16.02632	-16.49344	Lead	Lead - Battery Recycling
SN-4291	Colobane Wakhinane	14.698865	-17.441513	Lead	Lead Smelting (with ingot production)
SN-5356	Garage mecanique de reparation et de demantellement de vehicules Damel Mixta Kambyeu, Dakar	14.74896	-17.45762	Lead	Multiple Diverse Industries
SN-272	Décharge publique, Landfill de Mbeubeuss, Dakar	14.80466	-17.31152	Lead	Recycling / Recyclers (including salvage yards)
SN-5320	Iron Recovery and Scrapyard de Patte d'Oie Damel, Dakar	14.743142	-17.43729	Lead	Recycling / Recyclers (including salvage yards)
SN-5355	Parc Ferraille Grand Yoff Bignona	14.7374	-17.44347	Lead	Recycling / Recyclers (including salvage yards)
SN-5323	Garage de stationnement de camions Maliens Mbao Dakar	14.72812	-17.30416	Lead	Transportation (bus stations, rail yards)
SN-5324	Atelier de réparation et de démantèlement de véhicules And Bolo Dalifort Dakar/ Dakar	14.74435	-17.41317	Lead	Transportation (bus stations, rail yards)
SN-5396	Car Mechanic Amadou Ndiaye Sokone, Fatick	13.8739605	-16.3686852	Lead	Transportation (bus stations, rail yards)

Site ID	Site Name	Latitude	Longitude	Key Pollutant	Site Industry
SN-5709	Magasins de chargement et de réparation de batteries pour les locomotives de la Direction de Dakar Bamako Ferroviaire	14.79534	-16.91784	Lead	Transportation (bus stations, rail yards)

ANNEX 2 Description of Pollutants

Lead, Pb

Lead is a bluish-gray metal that occurs naturally in the earth's crust. It has been used by humans for hundreds of years to produce pipes, and was widely used as a gasoline additive until the 1980's, when a worldwide movement began to ban its usage in fuel.

Common Sources

- Mining and smelting operations
- Fossil fuel combustion from industries and vehicles
- Industrial sources like battery production and recycling facilities, gun and ammunition factories, metal disposal and recycling facilities and electrical components manufacture
- Domestic sources like flaking lead-based paint and water supply pipes

Human Exposure Pathways

- Exposure to lead occurs mainly via inhalation or ingestion of lead dust. Lead can also be absorbed through the skin if present in dust or soil to which people come into routine contact
- In areas near lead contamination sources, ingestion of contaminated dust or soil is often the pathway of most concern. Food on the ground or exposed to lead dust may become contaminated and then eaten, children may eat with contaminated hands after playing in contaminated areas. Children absorb about 50% of ingested lead
- Humans can be exposed to lead through drinking water where contamination has occurred by the corrosion of old lead pipes

Human Health Effects

- Neurological disorders such as lead encephalopathy
- According to the WHO, children with blood lead concentrations of between 12 micrograms per deciliter (µg/dL) and 120µg/dL can suffer from lower IQ, shorter attention span, reading or learning disabilities, hyperactivity, impaired physical growth, hearing and visual problems or impaired motor skills

Mercury, Hg

Mercury occurs naturally in the environment and exists in several forms that can be broadly categorized into metallic mercury (elemental mercury), organic (bound with carbon), and inorganic mercury (not bound with carbon). Inorganic mercury compounds occur when mercury combines with elements such as chlorine, sulfur, or oxygen. It is a dense, silvery white, shiny metal, which is liquid at room temperature in its elemental form. The most common organic form of mercury, methyl mercury, is of particular concern as it can accumulate in fish and thus get transferred through the food chain. There are three types of mercury: Methylmercury, Elemental Mercury.

Common Sources

- Burning of fossil fuels (particularly coal-fired utilities) - the major source of mercury emissions to the atmosphere;
- Smelting processes
- Fungicides with inorganic mercury compounds

- Copper and silver amalgams in tooth filling materials
- Medical waste incinerators
- Atmospheric deposition from chlor-alkali plants, metal processing, and mining of gold and mercury
- Volcanoes, geologic deposits of mercury, and volatilization from the ocean, as sources of atmospheric mercury.
- Local mineral occurrences and thermal springs can be naturally high in mercury
- Bioaccumulation in fish, which can expose individuals with a high fish diet to high levels of mercury.

Human Exposure Pathways

- The general population is commonly exposed to mercury primarily by consuming mercury-contaminated fish.
- Common exposure also occurs via the release of elemental mercury from dental amalgams used in fillings.
- Additional exposure may occur occupationally and in heavily polluted areas or in areas where mercury-containing fungicides are used extensively.
- Elemental mercury can also be absorbed through the skin

Human Health Effects

- In general, mercury affects the immune system, alters genetic and enzyme systems, and damages the nervous system, including coordination and the senses of touch, taste, and sight.
- Exposure to very small amounts of methyl mercury can result in devastating neurological damage or death
- Can also cause permanent damage to the brain and kidneys.
- Symptoms of acute mercury poisoning include cough, chest tightness, trouble with breathing, and an upset stomach. Pneumonia can develop, which can be fatal
- Mental retardation, blindness, and cerebral palsy have been observed in children born to women having high levels of methyl mercury exposure. Exposure could have a negative impact on their neurological development resulting in psychological abnormalities like deficits in short-term memory, irritability, and social withdrawal.

Chromium, CR

Chromium is a steel-gray, naturally occurring element found as ore in natural deposits. It is commonly used in metal alloys like stainless steel, plumbing coatings, magnetic tapes, and pigments for paints, cement, paper, and rubber. It also finds application in wood preservatives. Although it is found widely in plants and soils, it is rare in natural waters. The most hazardous form of chromium is hexavalent chromium (Cr VI). Trivalent chromium (Cr III) is non-toxic.

Common Sources

- Tanneries
- Dye manufacturers
- Chemical manufacturing industry or hazardous waste facility
- Combustion of natural gas, coal, and oil
- Metallurgical facilities, electroplating

- Small amounts of chromium are found in fruits, nuts, vegetables, grains, and cereals
- Implants like cobalt-chromium knee and hip arthroplasts
- Contaminated landfills
- Cement dust

Human Exposure Pathways

- People can be exposed to chromium by eating food, drinking water, or breathing air that is contaminated
- In air, chromium compounds are present mostly as fine dust particles that eventually settle over land and water
- Cigarettes contain 0.24 to 14.6 milligrams (mg) chromium per kilogram (kg). Thus cigarette smoking might constitute a significant source of chromium intake
- Skin contact with chromium-contaminated dust, dirt, and puddles

Human Health Effects

- Hexavalent chromium, the most hazardous form, can cause cancer. It has been shown to cause tumors in the stomach, intestinal tract, and lungs
- Hexavalent chromium can also cause damage to the male reproductive system.
- Chromic acid or chromate dusts can cause permanent eye damage
- Short-term exposure causes skin irritation and ulceration
- Chronic health effects include damage to liver, kidney, circulatory and nerve tissues, and skin irritation
- Can cause allergic reactions, such as skin rash. Breathing it can cause nose irritations and nosebleeds.
- Inhalation of hexavalent chromium compounds can result in ulceration, asthmatic bronchitis, edema, cough, shortness of breath, and wheezing.

Other health effects include: upset stomach and ulcers, respiratory problems, weakened immune systems, and alteration of genetic material.

Cadmium, Cd

Cadmium is a soft, silver-white metal that occurs naturally in the environment. It is usually found as a mineral combined with other elements and is extracted during the production of metals like zinc, lead, and copper. It finds application in the manufacture of batteries, pigments, metal coatings, and plastics, as it does not corrode easily.

Common Sources

- Release of cadmium compounds from copper, lead, and zinc smelters and municipal incinerators;
- Natural release into the environment (~25,000 tons a year);
- Application of phosphate fertilizers or sewage sludge to soils;
- Tobacco leaves can accumulate high levels of cadmium from the soil; and
- Smelting and electroplating.

Human Exposure Pathways

- Human uptake of cadmium takes place mainly through food. Liver, mushrooms, shellfish, mussels, cocoa powder, dried seaweed, oysters, shrimp, lobster, and fish are potential

sources. Cadmium also tends to bio-accumulate in aquatic life. Additionally, leafy vegetables such as lettuce and spinach can contain high levels of cadmium.
- Smoking exposes people to significant amounts of cadmium. Tobacco smoke transports cadmium into the lungs.
- People who live near hazardous waste sites or factories that release cadmium into the air and people who work in the metal refinery industry are significantly exposed to cadmium via inhalation of dust or fumes.

Human Health Effects

- Damage to kidneys and lungs
- Diarrhea, stomach pains and severe vomiting
- Debilitating effects on bones and the skeletal structure
- Reproductive failure and possibly even infertility
- Damage to the central nervous system
- Damage to the immune system
- Psychological disorders
- Possibly DNA damage or cancer development

Arsenic, As

Arsenic is a naturally occurring, brittle, steel gray semi-metallic solid. Arsenic and its compounds are highly toxic. It finds application in the manufacture of insecticides, pesticides and various alloys. It is also used for bronzing and as a wood preservative.

Common Sources

- Human activities like mining, smelting and agricultural applications
- Release from pesticides and wood preservatives
- Natural sources, such as volcanic activity, the erosion of rocks and minerals, and forest fires

Human Exposure Pathways

- Arsenic exposure occurs by ingestion, inhalation of dust, and, to a much lesser degree, by absorption through the skin
- Accidental poisoning has been reported to occur from wearing inadequate clothing when applying arsenic-based products
- Arsenic exposure in the workplace occurs through inhalation, ingestion, or dermal or eye contact
- Most arsenic compounds are white or colorless powders that do not evaporate. They have no smell, and most have no special taste. Thus, you usually cannot tell if arsenic is present in your food, water, or air

Human Health Effects

- Arsenic in drinking water causes bladder, lung and skin cancer, and may cause kidney and liver cancer. Studies have also found that arsenic harms the central and peripheral nervous systems, as well as heart and blood vessels, and causes serious skin problems. It also may cause birth defects and reproductive problems

- Arsenic can be carcinogenic at very low levels and one-tenth of a gram accumulated over a two-month period can be fatal
- Symptoms of mild poisoning include loss of appetite, nausea, diarrhea, stomachache, and vomiting
- Severe exposure causes cramps, vomiting, neurological effects like restlessness, chronic headache, fainting, dizziness, convulsions or coma.
- Acute exposures can cause lung distress and death
- Chronic exposure to arsenic (known as arsenicosis) can lead to dermatitis, pigmentation of the skin, wart formation, hard patches on ones palms or soles of their feet, decreased nerve conduction velocity, and lung cancer.

Pesticides

Pesticides are used in the agricultural industry to protect food from pests, such as insects, rodents, weeds, mold, and bacteria. The term pesticide also applies to herbicides, fungicides and so forth. Pesticides are often referred to according to the type of pest they control or grouped by chemical types of pesticides. These include organophosphate, carbamate, organochlorine and pyrethroid pesticides. Pesticide contamination typically results from pesticide projection facilities, pesticide application on agricultural fields, and abandoned storage facilities or dumpsites for obsolete pesticides.

Sources

- Runoff from agricultural fields
- Illegal dumping or inadequate storage
- Waste from pesticide production facilities

Human Exposure Pathways

- People can be exposed to pesticides and insecticides by eating food on which it has been applied or by drinking water from sources contaminated by pesticides
- Children may be exposed to pesticide residues from their agriculture-worker parents through dust and soil

Human Health Effects

- Children, infants, and fetuses may be especially vulnerable to the health effects of pesticides. Children may be more susceptible to loss of brain function if exposed to neurotoxins, and may be more susceptible to damage to their reproductive systems. Increased odds of childhood leukemia, brain cancer and soft tissue sarcoma have been associated with children living in households where pesticides are used.
- Pesticides are intentionally toxic substances. Some chemicals commonly used on lawns and gardens have been associated with birth defects, mutations, adverse reproductive effects, and cancer in laboratory animals.
- Toxicology and Industrial Health published a study showing that the natural mix of chemical pesticides and fertilizers – in concentrations mirroring levels found in groundwater – can significantly affect immune and endocrine systems as well as neurological health.