SENEGAL

A. Regulation on sources

Source of lead	Relevant legislation/regulation	Government agencies	Data source
1. Used lead-acid battery recycling	1. No information on specific ULAB recycling regulation found		
2. Standards for lead in food	1. Senegal is a member of Codex Alimentarius Commission, a joint FAO/WHO food standards program. 2. The Commission set limits of no more than 0.1 mg of lead per kg of pulses (such as lentils and dried beans), 0.4mg/kg for jams, jellies and marmalades, and 0.05 mg/kg for preserved tomatoes, amongst other maximum levels for processed fruits and vegetables. No other specific set of national regulations found. 3. No other specific set of regulations found.	a. Ministry of Health and Prevention	1. FAO. 2019. "General Standard for Contaminants and Toxins in Food and Feed."
3. Standard for lead in cookware	No standards identified		
4. Standards for occupational exposure	1. Several codes and rules for protection against particular occupational hazards including specific hygiene measures applicable in establishments where staff are exposed to lead poisoning	a. Ministry of Public Function, Labour, Social Dialogue, and Professional Organisations	1. ILO. "Protection against particular hazards"
5. Lead in paint	1. Does not currently have a lead paint law		1. UNEP. 2019. Update on the Global Status of Legal Limits on Lead in Paint September 2019.
6. Waste generated from smelting or mining	1. Domestic regulations relevant here include the Environmental Code of 2001 and the Water Code of 1981	a. Ministry of the Environment	1. Amnesty International. 2011. "MINING AND HUMAN RIGHTS IN

Source of lead	Relevant legislation/regulation	Government agencies	Data source
	2. About waste from mining activities, the Environmental Code requires that any EIA assess how waste is to be managed, particularly in the case of hazardous waste (which is usually subject to more stringent regulation), as well as ensuring that an emergency or accident plan is in place. The environmental Code sets out quite general obligations on the disposal or environmentally-sound management of waste (in Articles 30 to 43 of the Environmental Code). 3. No specific references with respect to lead found		SENEGAL: Closing the Gaps in Protection" 2. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF).2016. "IGF Mining Policy Framework Assessment: Senegal"

B. International Agreements

Agreement	Year Ratified
1. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	1992 (Accession)
2. Rotterdam Convention on the Prior Informed Consent Procedure for certain hazardous Chemicals and Pesticides in international trade	2001
3. Stockholm Convention on Persistent Organic Pollutants	2003

C. Blood lead-level monitoring programs

No specific programs found

D. Inventory of toxic sites (Toxic Sites Identification Program (TSIP), Pure Earth)

There are 47 lead contaminated sites in Senegal

Site	Province/Region	Details (all data comes from the TSIP website)
1. Amadou Ndiaye Sokone, Fatick	Fatick	This vehicle repair garage is a former battery dismantling site. It is the oldest garage of Sokone and exists since 1973. Lead, which is the key pollutant, would come from the battery dismantling activities that were done before in the site. The site is borrowed from a third person who can retrieve it at any time and make a home.
2. Reubeuss battery repair and charging workshop	Dakar	This is a battery repair and charging site located in the popular district of Reubeuss. This site dates back more than 50 years, employs 6 people, and is housed in a house. Repairing and charging batteries can lead to releases and emissions of lead in environmental matrices. This polluted site can be a source of contamination for children and the people who frequent it. The vapors or lead salts enter the body through the digestive or respiratory tract.
3. old Wakam Track	Dakar	In the old Wakam track, there are mechanical garages, radiator repairers, ironworkers, electricians, etc. These activities are the source of the pollution that escapes into this environment. Contamination of workers and the local population can be by inhalation, ingestion, or dermal contact. There are also trade activities (vegetables and fruits) that blend into the site.
4. Mechanical repair garage for vehicles in the Stade Iba-Mar-Diop, RTS1 Dakar	Dakar	This site devoted to the mechanics and the repair of automobiles is located at the entrance of Dakar-Center (quarter plateau). It is an area reserved for mechanical garage or used batteries are also stored and repaired. It contains several activities going from the mechanics to the carpentry by way of the repair and the storage of used batteries

Site	Province/Region	Details (all data comes from the TSIP website)
		of automobiles. And it is this last activity that has aroused our interest because of the environmental and health impact that this equipment can have when it is open. Lead can be released into nature when handled and by ingestion or inhalation can be harmful to the health of populations.
5. vehicle repair garage in Cité Bissap (HLM)	Dakar	Vehicle repair activities take place in the city of Bissap, a locality located in the heart of the Dakar region, in the Municipality of HLM. The city has existed since 1970 and was occupied by industrialists but since the end of the 90s, repairers of vehicles of all categories have come to practice their profession there. Among these, we note the repairers of batteries but also radiators.
6. Vehicle repair and dismantling workshop at Bolo Dalifort, Dakar	Dakar	This is a polluted lead site resulting from vehicle repair and dismantling activities. Contaminants from the site pose health hazards to children and people going to the workshop. Vapors or salts of lead can enter the body through the digestive or respiratory tract.
7. Lead pollution from manufacture of utensils at Technopole, Cambérène, Dakar	Dakar	Lead smelting site for the manufacture of cooking pots, located in the area called Technopole, not far from the cambérène crossing, behind the sewage collection area. Pollution is transmitted by potential dilution in the soil where it can be inhaled/ingested.
8. Lead pollution at Aly Ndiaye Garage, Dakar	Dakar	This is a vehicle repair site (General mechanics). Thus, there is a place for repair and battery charging on the site. Repairing and charging batteries can lead to releases and emissions of lead in environmental matrices. This polluted site can be a source of contamination for children and the people who frequent it. The vapors or lead salts enter the body through the digestive or respiratory tract.
9. Lead pollution from Mechanical welding workshop at Ablaye - Balacos, Saint Louis	Saint-Louis	This is a welding site surrounded by residential homes for tin and lead for radiators that result in lead rods. The soil is so polluted that there are buyers of sand from the workshop to sell to the Indians to extract lead from it. Pollution can impact water, which can be ingested because there is a well on the site. Dust can also be inhaled/ingested.
10. Lead pollution from battery repair and charging workshop, Touba, Diourbelinhaled/ingested.	Diourbel	It is a site for repairing, dismantling and charging batteries (lead). Repairing and charging batteries can lead to lead releases and emissions in environmental matrices. This site has been in existence since 1983 and can be a source of contamination for people who use it. The vapors or lead salts enter the body through the digestive or respiratory tract.

Site	Province/Region	Details (all data comes from the TSIP website)
11. Lead pollution from Cheikhou Mbaye Battery Repair Shop, Thiès	Thiès	The workshop is located opposite the Amadou Ndate Seck high school in Thiès. As a repair workshop for motor vehicles, the key pollutant is lead resulting from the recycling of ULABs. Migration pathways include leaching into nearby water bodies, farmland and residential homes. Exposure pathways include inhalation, dermal contact and ingestion.
12. Lead Pollution at Bassirou Samb de Bargny battery repair and dismantling workshop, Dakar	Dakar	Bassirou Samb battery repair workshop. This is a battery repair and charging site. Repairing and charging batteries can lead to releases and emissions of lead in environmental matrices. This supposedly polluted site can be a source of contamination for children and people visiting it. The vapors or lead salts enter the body through the digestive or respiratory tract.
13. Lead pollution from Truck parking garage, Malians Mbao, Dakar	Dakar	It is a perimeter of truck parking from or to Mali. Trucks can park there for a few days depending on their delivery. Activities of mechanics and garage owners are also linked to the release of pollutants such as lead. The site is in the locality of Zac Mbao, south of the National 1. The contaminants settle on the ground and pollute the surrounding soils and water. Exposure pathways include dermal contact, inhalation, and ingestion
14. Lead pollution from motor vehicle garage, Damel Mixta Kambyeu, Dakar	Dakar	Damel mixta is a mixed site where the most remarkable activities are: the denormalization and repair of vehicles, the recycling of electronic materials, automotive materials, lead recycling with batteries. The site is located next to the Cité Mixta, a few hundred meters from the Léopaul Sédar Senghor Stadium. On the west side of the site is the VDN (North Bypass). Lead pollution from the recycling site is a source of contamination for children and those who frequent it. Vapors or salts of lead enter the body through the digestive or respiratory tract.
15. Lead pollution by Garage Ali mango Pikine, Dakar	Dakar	The Ali Mango site is a large garage where we find different types of activities (welders, mechanics, painters, metalworkers, electricians) which are the source of lead pollution. There are also restaurants on the site. contamination can occur through inhalation. There is also a landfill and dwellings next to the site.

(Information on the other 32 sites is available on the TSIP website)

E. Scientific papers on lead exposure (Please contact info@gahp.net for information on studies not in the public domain)

Topic	Authors	Year	Title	Abstract/ description
Childhood exposure	Cabral, M., D. Dieme, A. Verdin, G. Garçon, M. Fall, S. Bouhsina, D. Dewaele, F. Cazier, A. Tall-Dia, A. Diouf, and P. Shirali.	2012	Low-Level Environmental Exposure to Lead and Renal Adverse Effects: A Cross-Sectional Study in the Population of Children Bordering the Mbeubeuss Landfill near Dakar, Senegal	**Objective:** This study deals with the health effects within a child population, neighbouring a landfill. **Methods:** After detecting metals in soil and air samples collected in the surroundings of the landfill and in a control site, we have studied: (i) levels of lead (Pb) and exposure biomarkers in blood and urine, (ii) oxidative stress biomarkers and (iii) renal injury by applying a set of early effect biomarkers. Levels of Pb were higher in the exposed site (i.e. 1129 mg/kg and 640 ng/m3 in soil and air samples, respectively) versus those in the control site (i.e. 14.3 mg/kg and 9.3 ng/m3 in soil and air samples, respectively). **Results:** Pb impregnation and levels of delta-aminolevulinic acid in urine were influenced by the living site that shows the prevailingly alarming situation in the Mbeubeuss landfill. Malondialdehyde changes indicated Pb-induced excessive production of reactive oxygen species. Lactate dehydrogenase activities and proteinuria were found to be higher in the children living in the exposed site. These evidences may reveal the usefulness of these two effect biomarkers to monitor the kidney injury entailed by relatively low-environmental exposure to Pb. Overall, these results show that the Mbeubeuss landfill constitutes a real source of environmental and health risk, be it living or working on site, of the surrounding population, predominantly for children.
Childhood exposure	Jones, Donald E., Assane Diop, Meredith Block, Alexander Smith-Jones, and Andrea Smith-Jones	2011	Assessment and Remediation of Lead Contamination in Senegal	**Objectives**. The assessment and remediation process utilized to address the Senegal lead contamination has been used as a model approach to solving used lead-acid battery (ULAB) contamination in other economically depressed communities worldwide. This paper addresses exterior soil remediation with a future paper planned to address interior remediation and blood lead level declines as a marker for project success. **Materials & Methods**. A comprehensive field program was developed and implemented to delineate the extent of soil lead contamination. The lead-impacted soil was the source of elevated blood lead levels due to direct ingestion (children playing in impacted soil), dust migration and impacted soil tracking into homes, shops and schools. Soil lead concentrations in

Topic	Authors	Year	Title	Abstract/ description
				surface soil and at depth were determined during several site assessments. The soil lead data were collected in conjunction with blood lead testing and collection of dust wipe samples for laboratory analysis. Soil lead data were also collected during and after soil excavation activities to document remediation success. **Results.** The data showed widespread soil contamination throughout the community. Surface soil exhibited lead concentrations as high as approximately 20% lead (200,000 mg/kg or parts-per-million as compared to the U.S. standard of 400 mg/kg). Blood lead levels in children were highly elevated and reached as high as 613.9 μg/dL (as compared to the U.S. standard of 10 μg/dL). Bulk dust samples from inside residences were as high as 26,889 mg/kg (2.7% lead). Post-excavation soil testing demonstrated that the majority of impacted soil was removed and the exterior exposure pathway was significantly reduced. **Conclusions**. Lead contamination in an economically depressed community resulted in the deaths of at least 18 infants. A coalition of local community members, local and federal government agencies, and international non-governmental organizations was able to develop and implement a comprehensive assessment and remediation strategy specifically focused on minimizing future risks to the local population with minimal disruption. The implemented soil removal plan resulted in site remediation without population relocation, spanning just over two years, and being completed under the budget of USD 200,000.
Childhood exposure	Haefliger, Pascal, Monique Mathieu-Nolf, Stephanie Lociciro, Cheikh Ndiaye, Malang Coly, Amadou Diouf, Absa Lam Faye, Aminata Sow, Joanna Tempowski, Jenny Pronczuk, Antonio Pedro Filipe Junior,	2009	Mass Lead Intoxication from Informal Used Lead-Acid Battery Recycling in Dakar, Senegal	**Background and objectives**: Between November 2007 and March 2008, 18 children died from a rapidly progressive central nervous system disease of unexplained origin in a community involved in the recycling of used lead-acid batteries (ULAB) in the suburbs of Dakar, Senegal. We investigated the cause of these deaths. **Methods**: Because autopsies were not possible, the investigation centered on clinical and laboratory assessments performed on 32 siblings of deceased children and 23 mothers and on 18 children and 8 adults living in the same area, complemented by environmental health investigations. **Results**: All 81 individuals investigated were poisoned with lead, some of them severely. The blood lead level of the 50 children tested ranged from

Topic	Authors	Year	Title	Abstract/ description
	Roberto Bertollini, and Maria Neira			39.8 to 613.9 µg/dL with a mean of 129.5 µg/dL. Seventeen children showed severe neurologic features of toxicity. Homes and soil in surrounding areas were heavily contaminated with lead (indoors, up to 14,000 mg/kg; outdoors, up to 302,000 mg/kg) as a result of informal ULAB recycling. **Conclusions**: Our investigations revealed a mass lead intoxication that occurred through inhalation and ingestion of soil and dust heavily contaminated with lead as a result of informal and unsafe ULAB recycling. Circumstantial evidence suggested that most or all of the 18 deaths were due to encephalopathy resulting from severe lead intoxication. Findings also suggest that most habitants of the contaminated area, estimated at 950, are also likely to be poisoned. This highlights the severe health risks posed by informal ULAB recycling, in particular in developing countries, and emphasizes the need to strengthen national and international efforts to address this global public health problem.
Childhood exposure	Diouf, A., G. Garçon, Y. Diop, B. Ndiaye, C. Thiaw, M. Fall, O. Kane-Barry, D. Ba, J. M. Haguenoer, and P. Shirali.	2006	Environmental Lead Exposure and Its Relationship to Traffic Density among Senegalese Children: A Cross-Sectional Study	**Objective**: Leaded-gasoline is probably the primary source of lead (Pb) exposure in Dakar (Senegal). The present cross sectional study was undertaken to investigate the levels of Pb in Senegalese children and to present helpful data on the relationship between Pb levels and changes in biological markers of heme biosynthesis and oxidative stress. **Methods:** A total of 330 children, living since birth either in rural or urban areas (ie, Khombole (n=162) and Dakar (n=168), respectively) were included. **Results:** During this cross sectional study, the mean blood (B)-Pb level in all children was 7.32±5.33 µg/dL, and was influenced by the area of residence and gender. In rural children, 27 subjects (16.7%), 18 boys (19.6%) and nine girls (12.9%), had a B-Pb level >10 µg Pb/dL, whereas 99 urban children (58.9%), respectively, 66 boys (71.8%) and 33 girls (43.4%), had alarmingly high B-Pb levels. Accordingly, urine delta-aminolevulinic acid levels were higher in children living in the urban area than in the rural areas (P B±0.001), and closely correlated with the B-Pb levels (P B±0.01). Moreover, glutathione peroxidase (GPx) activity, selenium (Se) level, glutathione reductase (GR) activity, and glutathione status were significantly influenced by area of residence and/or by gender. GPx activity

Topic	Authors	Year	Title	Abstract/ description
				and Se level were not only negatively correlated with B-Pb levels, but also positively correlated together (P B±0.01). Taken together, the present results allow us to conclude that urban children have higher B-Pb levels than rural children, and that of these children, boys have higher B-Pb levels than girls, leading thereby to alterations of heme biosynthesis and pro-oxidant/antioxidant balance. We also suggest that exposure to Pb and the Pb-induced adverse effects merits attention and that the development of preventive actions are of increasing importance in Senegal.
Environmental exposure	Cabral, Mathilde, Aminata Toure, Guillaume Garçon, Cheikh Diop, Saâd Bouhsina, Dorothée Dewaele, Fabrice Cazier, Dominique Courcot, Anta Tall-Dia, Pirouz Shirali, Amadou Diouf, Mamadou Fall, and Anthony Verdin	2015	Cabral, Mathilde, Aminata Toure, Guillaume Garçon, Cheikh Diop, Saâd Bouhsina, Dorothée Dewaele, Fabrice Cazier, Dominique Courcot, Anta Tall-Dia, Pirouz Shirali, Amadou Diouf, Mamadou Fall, and Anthony Verdin	**Objective:** The purpose of the study was to determine Pb and Cd concentrations in humans and to assess the effect of co-exposure to these metals on biomarkers of oxidative stress and nephrotoxicity. **Methods:** Blood and urine levels of Pb and Cd, oxidative stress and urinary renal biomarkers were measured in 77 subjects neighboring a discharge and 52 in the control site. **Results:** Exposed subjects showed significantly higher levels of lead and cadmium in blood and urine than the controls. Excessive production of reactive oxygen species induced by these metals in exposed subjects conducted to a decrease in antioxidant defense system (GPx, Selenium, GSH) and an increase in lipid peroxidation (MDA). Moreover, changes in markers of nephrotoxicity (high urinary concentrations of total protein, RBP and CC16, as well as GSTα and LDH increased activities) suggested the occurrence of discrete and early signs of impaired renal function for the discharge neighboring population.
Food exposure	Ndong, Moussa, Nathan Mise, Masaki Okunaga, and Fujio Kayama	2018	Cadmium, Arsenic and Lead Accumulation in Rice Grains Produced in Senegal River Valley	**Objective:** Exposure to Cadmium (Cd), Arsenic (As), and Lead (Pb) in short or long term can cause health problems in humans. Rice is particularly susceptible to heavy metals contamination. Rice is the major staple food of different developing countries like Senegal leading to high exposure of the population to heavy metals if the rice is contaminated. In Senegal, two types of rice are consumed: local rice mainly produced in the Senegal river valley and imported rice from Asian countries. Thus, the objective of this study was to determine heavy metals accumulation in rice grains produced in Senegal or imported.

Topic	Authors	Year	Title	Abstract/ description
				Methods: Samples of five rice varieties produced in three different areas of the Senegal river valley and samples of imported rice from Japan, Thailand and Pakistan were analyzed for As, Cd and Pb contamination. **Results:** The results showed that all samples were conform in term of contamination by As, Cd and Pb. Changes in heavy metals contamination were noticed between some rice varieties and according to localities. They were not a significant difference in the risk of exposure to heavy metals between the consumption of local produced rice and imported rice. However, the high rice intake of Senegalese could affect the safety of dietary intake of these metals by rice.

F. Blood testing in National Health Surveys

National Health Survey	Senegal Continuous Demographic Health Survey	Source
Purpose	The purpose of the survey is to provide estimates of outcomes related to child and maternal health, family planning, nutrition, health behavior and knowledge, health care access and use, and immunization.	ICF International, Ministry of Health and Social Action (Senegal), National Agency of Statistics and Demography (Senegal), Unit for the Fight Against Malnutrition (Senegal). 2019. Senegal Continuous Demographic and Health Survey 2019.
Sample size	The nationally representative sample consists of 8649 women (age 15 to 49) and 3365 men (age 15 to 59) from 4538 households.	
Blood sample testing	No	
Latest round	2019 (Continuous)	
Next round	Unknown	