Advancing a Lead Pollution and Health Roadmap for Bangladesh

August 2021

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Purpose and Use of the Lead Roadmap

What is a Lead Roadmap?

The Lead Pollution and Health Roadmap (referred to herein as the “Lead Roadmap”) is a strategy document created with multi-stakeholder input that aims to lay a foundation for a unified strategy to tackle the challenge of lead exposures by bringing together the most relevant and updated information on the sources and impacts or lead exposure in Bangladesh, as well as lessons from around the world in effective source control and risk-reduction measures. The main body of the roadmap is limited to a discussion of the current situation, priority needs, and practical steps to address those needs. Much of the analysis used to develop the Lead Roadmap is included in the Annexes to keep the main body concise.

Why Develop a Lead Roadmap?

Bangladesh is one of the most lead-impacted countries in the world. The best available evidence suggests that exposures to lead in the environment, in consumer products and in food are taking a staggering toll on public health and economic development. Despite the severe impacts, few programs and policies exist to adequately control contemporary lead sources, reduce exposures, and identify and treat lead-poisoned children.

Presently, the government of Bangladesh and a small number of national and international groups carry out a limited number of regulatory enforcements, research, technical assistance and risk-reduction programs with varied goals and strategies. These programs are only loosely coordinated, and thus do not fully build on previous efforts, make use of all available data, or advance unified strategies. This uncoordinated approach is insufficient to address the scale of the problem and is an inefficient use of resources. A more holistic and unified approach is needed.

What is the Goal of the Lead Roadmap?

The roadmap aims to help all actors understand the drivers and impacts of lead exposure, design effective programs that advance priority needs, and coordinate activities so that each new program and policy builds on prior work and moves the country toward a future where every child can enjoy a healthy, productive life.

Executive Summary

Bangladesh's sustained economic growth has supported rapid improvements in development indicators such as poverty rates, life expectancy, literacy and others, but has also brought new pollution control and environmental health challenges, including severe childhood lead exposures. Today, Bangladesh is one of the most lead-impacted countries on Earth. An estimated 36 million Bangladeshi children (approximately 60%) have concentrations of lead in their blood that are recognized by the World Health Organization as causing brain damage and IQ loss (> 5 µg/dL). The impacts from lead exposure to Bangladesh's public health, societal wellbeing and future economic prosperity are significant and require increased attention and investment on the part of the government, related industries, civil society and the country's development partners.

Lead is particularly harmful to children. Childhood lead exposure can have life-altering consequences, including reduced neurological development resulting in permanently reduced intelligence, lower educational attainment, higher rates of juvenile delinquency and incarceration, and reduced lifetime earnings (WHO, 2010; WHO 2019). The average concentration of lead in children's blood in Bangladesh is estimated to be among the highest in the world at approximately 7.5 micrograms per deciliter (µg/dL). This concentration is significantly above common public health guidelines (5 µg/dL). At these levels, it would be reasonable to expect significant IQ reductions among the tens of millions of chronically exposed Bangladeshi children. In 2019, lead exposures resulted in more than 38,000 deaths (3.6% of all deaths) and the loss of 690,000 years of healthy life in Bangladesh. (IHME, 2019). Today, the death rate attributable to lead exposures in Bangladesh exceeds the death rate from unsafe water sources.

Bangladesh loses US $15.9 billion in GDP from productivity losses resulting from reduced IQ from lead exposures (Attina & Trasande, 2013). This economic loss does not include lost earnings from lead-attributable diseases, healthcare costs, lost earnings from premature death, lost tax revenue from illegal ULAB recycling operations, or other economic impacts. The World Health Organization has concluded that the economic benefits of interventions to prevent lead exposure vastly outweigh their costs.

Given the extraordinary health and economic toll from lead exposures in Bangladesh, a sustained, coordinated, national risk-reduction strategy is needed. Current programs and policies by government and non-government organizations are not designed around common goals and strategies, and rarely take full advantage of existing data and lessons from other countries. This piecemeal approach is insufficient to address the scale of the problem, and due to a lack of information-sharing and coordination, is an inefficient use of resources. A more holistic and unified strategy that different actors can use as the basis for designing complementary interventions is needed.

The Lead Pollution and Health Roadmap is a strategy document created with multi-stakeholder input that outlines the sources and impacts of lead exposures in Bangladesh and provides a strategic framework to better understand and reduce risks. This document aims to align government agencies, national and international civil

society organizations, researchers and academic institutions, and development agencies around a common understanding of the challenges and a unified set of goals and strategies to address priority exposure sources.

Through our analysis, we have highlighted known sources which require intervention. Used lead-acid battery (ULAB) recycling and manufacturing is prevalent in Bangladesh and, when undertaken in an unregulated manner, is highly polluting. Policy interventions are required to draw batteries into the formal sector; greater enforcement and oversight is needed to ensure the formal sector is operating in an environmentally sound manner; and abandoned ULAB sites must be remediated to prevent on-going population exposure in surrounding communities.

Adulterated turmeric has also been confirmed as a known source of lead exposure. Although rates of adulteration have decreased in recent years, on-going monitoring is required to ensure this trend persists. We also present recommendations for the recycling of jewelry waste, which is a cottage industry in Bangladesh known to generate lead pollution in surrounding communities.

In addition, we have identified probable sources that require further investigation, including aluminum cookware, contaminated food, traditional medicines, and lead-related industries including e-waste recycling.

A health roadmap workshop titled ‘Advancing a lead pollution and health roadmap for Bangladesh’ was undertaken by Pure Earth on 19th July 2021. The workshop was aimed at bringing together stakeholders to address the issue of lead exposure in Bangladesh, with cooperation from various ministries. Some of the priority actions that were agreed upon included:

- **A multi-stakeholder approach** led by relevant government ministries including the Department of Environment (DoE) which will also help government departments and ministries work closely on the issue of lead exposure.
- **A joint effort to develop a national action plan** with provisions for monitoring, reporting and enforcement.
- **Research** to identify polluting industries and lead containing consumer products.
- **Integrate blood lead level into existing health information system.**
- **Strengthen monitoring** by relevant agencies that will help identify various sources of lead exposure, develop interventions with sustainable solutions.
- **Strengthen interventions in the ULAB recycling sector** by shifting illegal, informal ULAB recycling industries to the regulated, registered sectors.
- **Effective waste management** across all sectors to ensure that contaminate waste foes not affect the health of the community.
- **Build and expand capacity of healthcare workers** to address lead exposure.

Section 1: Summary Findings of Lead Exposure and Source Analysis

This section contains summary infographics of key findings from our analysis of lead exposure and sources globally and in Bangladesh, as well as stakeholder maps for 1) industrial sources of lead; 2) lead exposure from consumer products; and 3) health sector response to lead. The full analysis is presented in Section 3.

Fact Sheets

PURE EARTH

Lead Sources and Impacts on Health & Economic Development

Health Effects of Lead Pollution

According to the World Health Organization [1]

- Lead is a toxic metal harmful to children
- It has no safe level in blood
- Poor families are most at risk of exposure

- Lead harms the brain and the nervous system
- Causes cardiovascular disease, stroke, kidney disease
- Exposure causes permanent brain damage, learning difficulties & behavioral problems
- Can cause miscarriage, stillbirth, premature birth & low birth weight

Each increase of 1 µg/dL of lead in a child's blood [2]:

- Decrease in IQ by 0.25
- Decrease in economic productivity by 2.4%
- Lower rate of high school graduation

Global Statistics

1 in 3
Kids Poisoned

Globally 1 in 3 kids have blood lead levels greater than 5µg/dL.[3]

1M Deaths Annually

1.5% of all global deaths (nearly 1M/year) are attributable to lead exposures. 92% are in low and middle-income countries.[4]

$1T USD in GDP Lost

Productivity losses from reduced IQ resulting from lead exposure cost Asia 2% of its annual GDP, 4% in Africa[5]

Bangladesh Statistics

Bangladesh is one of the most lead-impacted countries in the world.
It has the 4th highest rate of death from lead exposure (nearly 4% of all deaths in the country) [4]

Bangladeshi children have an average of approx. 7.5 µg/dL of lead in their blood. [4, 6]
This exceeds the common health guidelines of 5 µg/dL by 50%.[1]

>690,000 years of healthy life lost annually due to lead exposure across the population of Bangladesh [4]

60% of Children
36 million Bangladeshi children are estimated to have blood lead levels indicative of lead poisoning (>5 µg/dL); 10 million are above 10 µg/dL.[3]

6% of GDP Lost
Productivity losses from lead exposure cost US$16B annually; roughly half the country's income from apparel and textiles.[5]

70% of intellectual disability
in Bangladesh is due to lead poisoning.[4]

Confirmed and suspected lead sources in Bangladesh [2]

- Lead-acid battery manufacturing & recycling
- Spices (turmeric)
- Leaded paint
- Aluminum cookware
- E-waste
- Contaminated food
- Jewellery making & gold waste processing
- Traditional medicines
- Cosmetics & religious powders

1 World Health Organization. (2019). Lead Poisoning and Health. https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health
2 World Health Organization. (2010). Childhood Lead Poisoning. Geneva, Switzerland.
3 UNICEF and Pure Earth. (2020). The Toxic Truth.
4. Institute for Health Metrics and Evaluation. (2019). GBD Compare. Seattle, WA: IHME, University of Washington. http://vizhub.healthdata.org/gbd-compare.
5 Attina, T.M., and Trasande, L. (2013). Economic costs of childhood lead exposure in low-and middle-income countries. Environmental Health Perspectives, 121(9), 1097-1102.
6. Ericson, B., Hu, H., Nash, E., Ferraro, G., Sinitsky, J., & Taylor, M. P. (2021). Blood lead levels in low-income and middle-income countries: a systematic review. The Lancet. Planetary health, 5(3), e145–e153.

PURE EARTH

Current gaps in information and response capacities in Bangladesh

The lead-acid battery industry requires strong regulation.

• The recycling and manufacture of lead-acid batteries have been identified as a major source of lead in the environment.

• Highly polluting informal recyclers are currently processing an estimated 50% of batteries.

• Oversight and enforcement of registered facilities are required to ensure compliance with national regulations and international standards.

Economic instruments are needed to address informal battery recycling.

• Economic tools must be implemented to shift the market drivers that currently favor informal recyclers.

• Potential interventions drawn from international case studies should be examined for their efficacy and appropriateness in Bangladesh.

Data on other sources of exposure are limited.

• Lead exposure can occur from a range of sources including industrial activities, food stuffs, lead paint, and daily-use products.

• Most of our information on common lead exposures comes from research studies, rather than systematic surveys at the national level.

• For instance, no data specific to Bangladesh were found that quantified the prevalence of lead-containing kajal, sindoor, or amulets. Much of our current understanding comes from testing such products in South Asian communities in the United States.

• Some data is conflicting and requires further investigation. One such example is lead content in pesticides.

Enhancing oversight and compliance of lead-containing products.

• Food safety inspectors and consumer oversight agencies must have adequate training and resources to identify and address lead-containing products on the market.

• The prevalence of lead adulteration in turmeric has decreased significantly in recent years due to enforcement efforts. Monitoring must continue to ensure these gains continue. This approach can also act as a model for other products.

Blood lead data is not currently collected systematically.

• There are no routine datasets available in Bangladesh's health information management system on blood lead levels or lead poisoning among children.

• Awareness of lead poisoning among healthcare providers is limited and there is currently no training on the recognition or prevention of lead exposure.

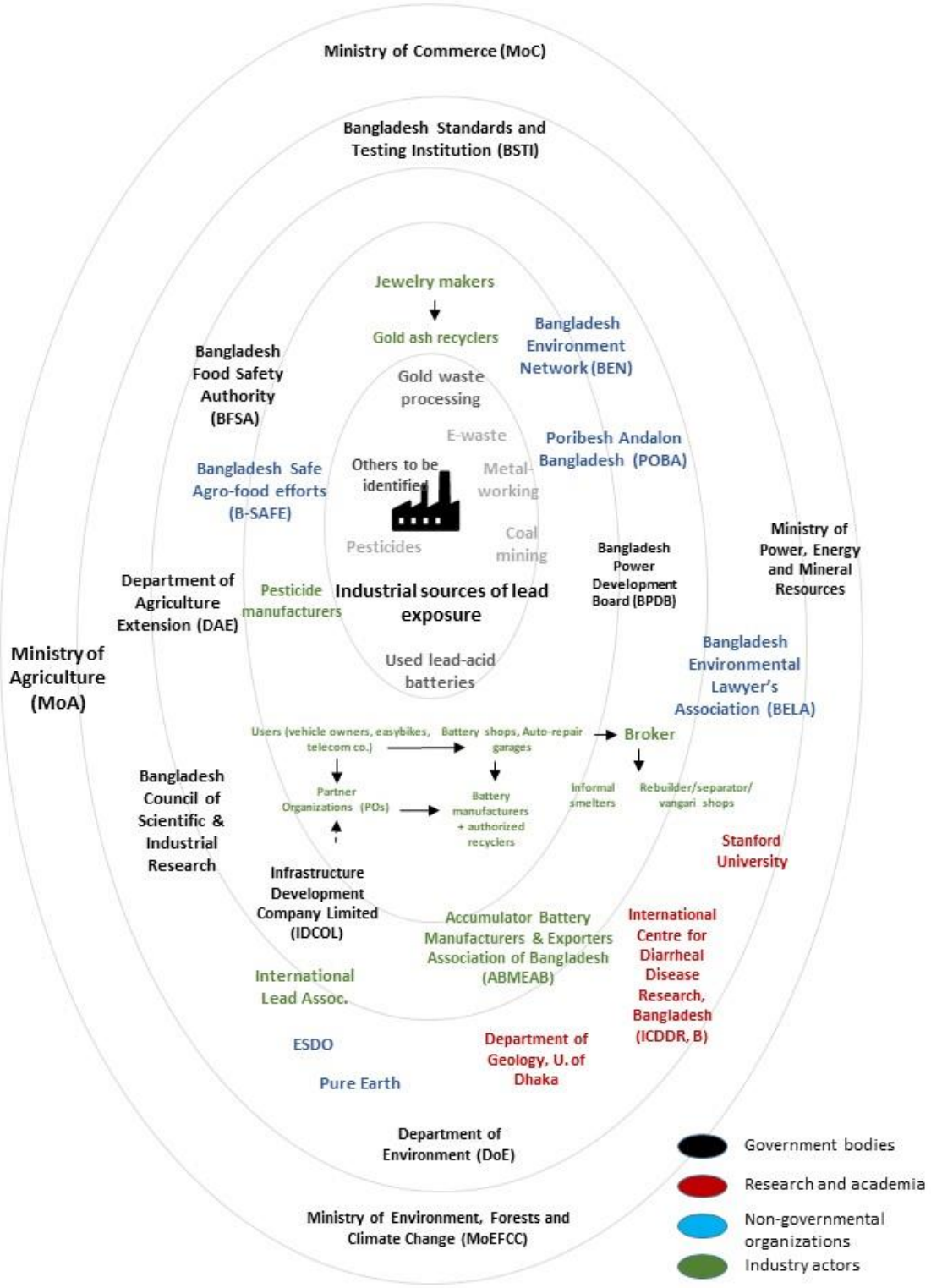
• Insufficient epidemiological data prevents existing health systems from identifying lead sources or tracking the efficacy of interventions.

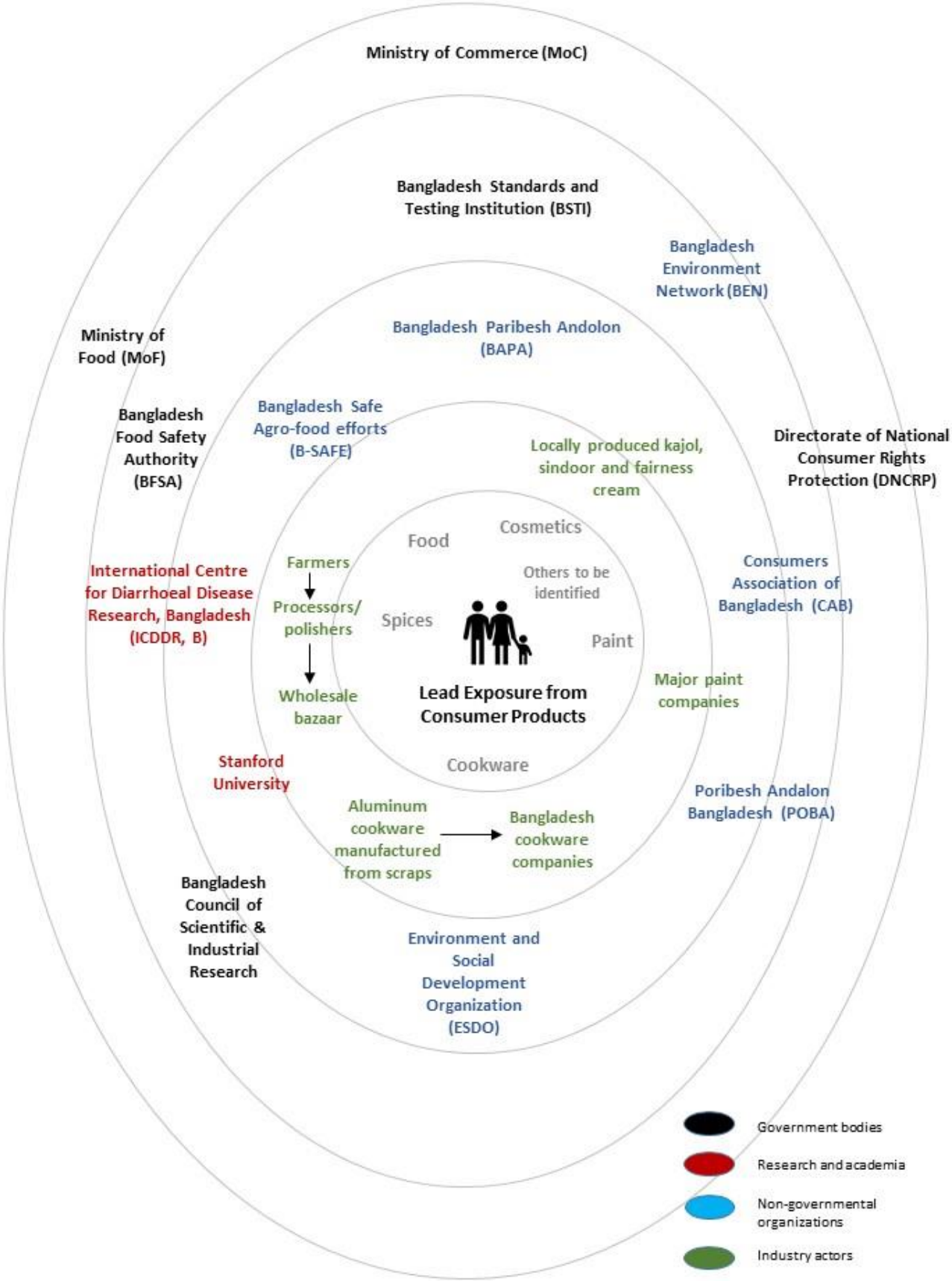
There is a need for cooperation and capacity building among responsible agencies.

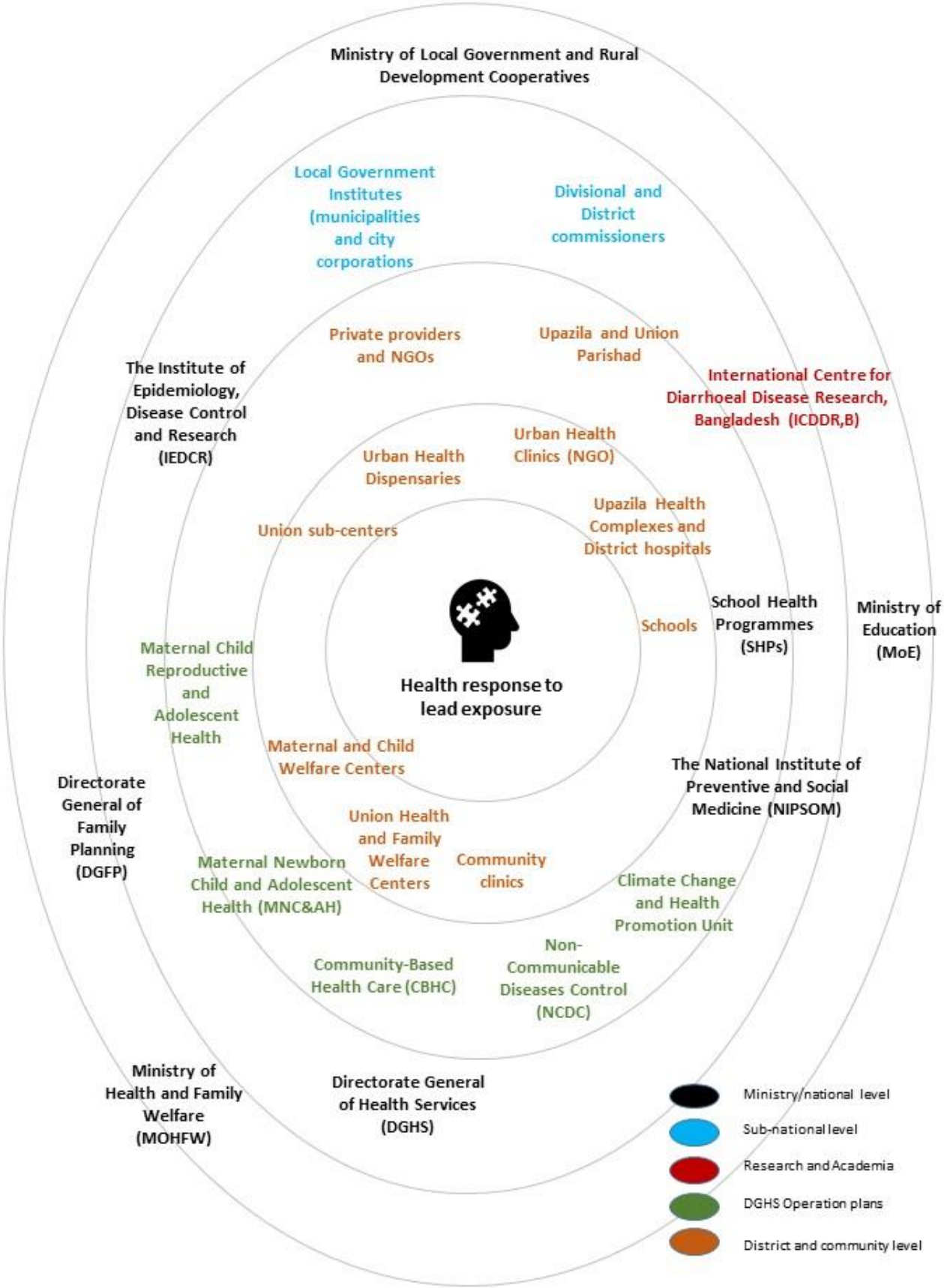
• Community members may face lead exposures from several sources and a coordinated effort is needed to reduce blood lead levels at the national level.

• Health agencies are critical in identifying at-risk populations; environmental, food safety and consumer agencies must create a regulatory environment where lead hazards are identified and addressed.

Stakeholder maps




Ministry of Commerce (MoC)
Bangladesh Standards and Testing Institution (BSTI)
Bangladesh Environment Network (BEN)
Bangladesh Paribesh Andolon (BAPA)
Ministry of Food (MoF)
Bangladesh Food Safety Authority (BFSA)
Bangladesh Safe Agro-food efforts (B-SAFE)
Locally produced kajol, sindoor and fairness cream
Directorate of National Consumer Rights Protection (DNCRP)
Cosmetics
Food
Farmers
Others to be identified
International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B)
Processors/ polishers
Spices
Consumers Association of Bangladesh (CAB)
Paint
Wholesale bazaar
Lead Exposure from Consumer Products
Major paint companies
Stanford University
Cookware
Poribesh Andalon Bangladesh (POBA)
Aluminum cookware manufactured from scraps
Bangladesh cookware companies
Bangladesh Council of Scientific & Industrial Research
Environment and Social Development Organization (ESDO)
Government bodies
Research and academia
Non-governmental organizations
Industry actors


Ministry of Local Government and Rural Development Cooperatives
Local Government Institutes (municipalities and city corporations
Divisional and District commissioners
Private providers and NGOs
Upazila and Union Parishad
The Institute of Epidemiology, Disease Control and Research (IEDCR)
International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B)
Urban Health Clinics (NGO)
Urban Health Dispensaries
Upazila Health Complexes and District hospitals
Union sub-centers
School Health Programmes (SHPs)
Ministry of Education (MoE)
Schools
Maternal Child Reproductive and Adolescent Health
Health response to lead exposure
Maternal and Child Welfare Centers
The National Institute of Preventive and Social Medicine (NIPSOM)
Directorate General of Family Planning (DGFP)
Union Health and Family Welfare Centers
Community clinics
Maternal Newborn Child and Adolescent Health (MNC&AH)
Climate Change and Health Promotion Unit
Non-Communicable Diseases Control (NCDC)
Community-Based Health Care (CBHC)
Ministry of Health and Family Welfare (MOHFW)
Directorate General of Health Services (DGHS)
Ministry/national level
Sub-national level
Research and Academia
DGHS Operation plans
District and community level

Section 2. Lead Roadmap

The primary goal of the Lead Pollution and Health Roadmap is to help the Government of Bangladesh and supporting partner organizations take effective measures in a systematic manner and achieve concrete goals with measurable results to address lead pollution challenges. Therefore, this document not only highlights the extent of lead pollution but also presents recommendations for a strategic roadmap for reducing lead exposures and lead pollution.

To address the issue of lead exposure at a national scale, cooperation among an array of stakeholders is essential. This multi-sectoral coordination requires the involvement of authorities in charge of environment, health, commerce, education, and women and child affairs, as well as non-governmental research and advocacy groups, and industry associations.

Representatives from various stakeholder groups with leadership from the Ministry of Environment, Forest and Climate Change and the Ministry of Health and Family Welfare successfully coalesced around an agreed set of recommendations and next steps.

A summarized list of proposed short- and long-term goals is included in **Appendix A**.

2.1 Recommendations from Health Roadmap Workshop

The workshop titled ‘Advancing a lead pollution and health roadmap for Bangladesh’ was held on 19th July 2021. Participants included 65 diverse sets of experts representing government agencies, national and international civil society organizations, research and academic institutions, development agencies, and print and electronic media agencies. The main goal of the workshop was to bring together various stakeholders to address the issue of lead pollution by developing a unified strategy. It was decided that the Department of Environment (DoE) will take the lead in a multi-stakeholder initiative for the eradication of lead exposure in Bangladesh, with cooperation from the Ministry of Health and Family Welfare, the Ministry of Commerce, and local development governments.

Some of the notable guests and participants of the workshop were: Abdullah Al Mamun, Deputy Director, Chemical and Waste Management Unit, DoE; Andrew McCartor, VP, Strategy and Partnerships, Pure Earth; Dr. Shahriar Hossain, Ecologist, General Secretary, Environment and Social Development Organization (ESDO); Dr. Anwar Sadat, DPM, Planning, Monitoring and Research (PMR), DGHS; (Chair) Mr. Ashraf Uddin, Director General, Department of Environment (DoE); (Chief Guest) Ahmed Shamim Al Razi, Additional Secretary, Ministry of Environment, Forest and Climate Change; Md. Zia-ul Haque, Director, Dhaka Region, Department of Environment; Zohura Sikdar, Deputy Director (Chemical), BSTI; Dr. Minjoon Kim, UNICEF; M H Faruquee, Associate Professor, Department of Occupational and Environmental Health, Bangladesh University of Health Sciences (BUHS); Dr. Rehnuma H Sarah, Assistant Scientist, icddr,b and Postdoc Fellow, Stanford University; Mostafa Yusuf, Reporter, The Daily Star.

The following recommendations were made:

1. A multi-stakeholder approach with the leadership of the relevant government ministries should be established to eradicate community lead exposure. The Department of Environment (DoE) should take the lead in a joint, multi-stakeholder approach to eradicating lead pollution. A coordination committee could be formed in the Ministry of Environment, Forest, and Climate Change, and a technical committee can be formed under the leadership of the Director-General of DoE.

2. The relevant government departments and ministries that should work closely on this issue are the Ministry of Environment, Forest and Climate Change, the Department of Environment, the Ministry of Health, the Ministry of Commerce, the Ministry of Industry, the Local Government Division, and the Food Safety Authority.

3. A time-bound, holistic national action plan which considers existing legislation is needed to advance progress on the issue of lead exposure. This action plan should include provisions for monitoring, reporting, and enforcement.

4. Comprehensive lead pollution studies and a national inventory on lead pollution sources are key to prioritizing effective exposure mitigation projects. This research is needed to identify polluting industries and lead-containing consumer products.

5. Effective monitoring by relevant agencies is needed to identify lead exposure sources, develop interventions, and ensure long-term success. This is needed for both industrial sources (e.g., the closure of informal ULAB sites), as well as in products (e.g., lead chromate adulteration in spices).

6. Interventions in the ULAB recycling sector should be prioritized as this is a major known source of community lead exposure. Research institutions and universities should come up with ways to shift illegal, informal ULAB recycling industries to the regulated, registered sector. Second-generation lead-acid batteries or alternatives such as lithium-ion batteries should be examined for application in Bangladesh.

7. Occupational health and safety hazards of working with lead need more attention; workers who are working directly with lead require additional education. For those workers engaged in informal lead industries, alternative livelihoods should be explored as more of the industry shifts to the formal sector.

8. Ensuring effective waste management across all sectors, especially industrial waste is important because contaminated waste ends up affecting health through different pathways, including the agricultural chain.

9. Blood lead monitoring must be established. Blood lead data could be integrated into the MOHFW's existing routine health information system, DHIS2. Investment is needed to conduct this testing at district and division levels. Blood lead data can be used to identify contributing sources and monitor the efficacy of interventions.

10. The capacity of health workers and the health care sector to address lead exposure should be expanded.

11. Sensitization through print and electronic media plays a crucial role in creating public awareness about the sources and effects of lead pollution and spurring government bodies to act. There should be various training sessions and workshops to enhance the knowledge and skills of stakeholders related to lead pollution.

A detailed report of the workshop is included in **Appendix B**.

2.2 Proposed National Goals

Addressing lead pollution and exposure requires a concerted approach, applied at the national level. The following four objectives would support this effort:

1) ***Monitoring and Reporting Systems***: Conduct baseline blood level testing to determine the current distribution of elevated blood lead levels in Bangladesh. Baseline blood lead level testing allows for the identification of priority geographic areas and demographic groups. Representative testing at the national scale should be completed regularly to monitor exposures and track the effectiveness of interventions.
2) ***Source Identification for Prevention and Control Measures***: Beginning with the priority geographic areas and demographic groups identified in Step 1 above, conduct assessments at industrial sites and at the household level to determine the sources of exposure. Possible sources of exposure in the home include ceramics and pottery, paint, children's toys, cosmetics, spices, traditional medicines and possibly illicit ULAB recycling.
3) ***Legislation and Policy***: Based on the sources identified in Step 2 above, develop, implement and enforce environmental, health and safety standards to prevent exposures from lead-related industries and eliminate the use of lead in products.
4) ***Build Industry Accountability*****:** Through monitoring and public awareness and education campaigns, build accountability among industries involving lead to prevent contamination of surrounding communities and ensure worker safety, and to prevent lead-adulterated products from entering commerce.

2.3 Proposed Detailed Recommendations by Source

2.3.1 Used Lead-Acid Batteries

One of the most concerning sources of lead exposure is the unsound recycling of used lead-acid batteries (ULABs). The environmental and health hazards generated by the informal smelting of used lead-acid batteries are well documented, and the prevalence of this practice in certain regions in Bangladesh has been established (see Section 3.2.1 for details on lead acid battery manufacturing and recycling).

The development of a safe, environmentally sound and efficient ULAB recycling industry requires a coordinated approach in order to ensure that appropriate regulations, enforcement activities, technical assistance, market and tax incentives, as well as infrastructure are in place and operational. There is no safe way to process ULABs outside of regulated, formal facilities. Therefore, it is imperative to support the transition of batteries out of the informal recycling that is commonly seen in Bangladesh and into registered facilities.

ESDO recently completed a “National Strategy for ULAB Recycling in Bangladesh”. A synopsis is presented on the following page and the complete document can be found in Appendix C. With this roadmap, we build upon this work and incorporate additional information from the experiences of Pure Earth and our partners and from international experts from organization such as the International Lead Association and the Global Battery Alliance.

ESDO's Strategies for policymakers

ESDO recently developed **a 10-step strategy** to guide government agencies towards an appropriate policy approach and a sound ULAB management system. Distinct strategies are discussed in the following sections:

1. **Situation Assessment: National Inventory of informal recycling:** This inventory procedure needs to be designed as a nationally applicable way, consistent method of identifying all the possible sources of illegal usage and finding essential gaps in the existing legislation.
2. **Evaluate the Appropriateness of Possible Actions:** Based on the findings of the baseline study, it will be important to evaluate what are the most appropriate instruments that will be beneficial when addressing the specific problems or needs that have been identified. Among the elements to be analyzed, and of upmost importance, are the institutional capacity and the existing economic conditions to ensure that the instrument(s) being considered are realistic and have high probability of being successfully implemented.
3. **Assess sustainable development impacts of preferred options:** Once the relevance of all possible actions has been assessed, governments may be left with a shortlist of possible and suitable instruments. A key step is to study the sustainable development impacts of the short-listed choices, taking into consideration all the sectors and all segments of the population.
4. **Development and implementation of a stakeholder engagement strategy:** Stakeholder engagement is only one piece of a larger communication plan, which the government will need to create. Here the government has a key role to play to facilitate the development of effective strategies and implementing them. ESDO has identified steps to engage stakeholders in Bangladesh.
5. **Raise awareness:** Evidence shows that resistance is likely to decrease if consumers are aware of the social, environmental and economic impacts of mismanaged used lead-acid batteries. These can be communicated through a variety of methods including conferences, brochures, roundtable meetings, electronic documentaries, awareness campaigns etc.
6. **Capacity building for environmentally sound management (ESM) of ULAB:** To ensure good governance, enforcement and monitoring and supervision of the ESM of ULAB recycling, it is important to clearly define roles and responsibilities between local, national and sub-national authorities and organizations beforehand. It is advisable to consider measures and budgets are in place that ensure the necessary skills and human resources are in place before the policy enforcement phase. ESDO has identified steps to address capacity building in Bangladesh.
7. **Support uptake of eco-friendly alternatives and provide incentives to industry:** Before implementing any regulations on lead acid batteries, governments may wish to verify the presence of valid alternatives which are environment friendly and easy to dispose.
8. **Ringfence Revenues:** When introducing an internal revenue service on used lead acid batteries, consideration should be given to how revenues from that economic instrument will be used. To maximize public benefits, the revenues from the tax could be ringfenced and reinvested to:
9. **Strategy towards national regulation and implementation plan:** The regulation must be enforced at all levels. For such initiatives to be pragmatically successful, it is imperative to monitor the progress and effectiveness of the law and adjust or update the directives accordingly.
10. **Carry out monitoring**: To ensure enforcement and monitoring of the policy, it is important to clearly distribute and define roles and responsibilities between local, national and sub-national authorities and organizations. As part of the policy development, it would be advisable to consider measures that ensure the necessary skills and human resources (and therefore budget) will be in place before the policy enters into force.

2.3.1.1 Shifting ULABs to the formal sector

Certain regulatory, policy, and economic changes could be made to address the root causes of the stream of ULABs into informal recycling. Below are recommendations to address the informal sector's role in ULAB recycling. These recommendations are based on the experience of Pure Earth and our partners, and recent reports which include the Global Battery Alliance's (GBA), "Consequences of a Mobile Future: Creating an Environmentally Conscious Life Cycle for Lead-Acid Batteries" (2020); the forthcoming "Training Manual for the Preparation of National Environmentally Sound Management Plans for ULAB in the Context of the Implementation of the Basel Convention"; and ESDO's national strategy document.

- ***Assessment of the existing market and supply chain***: Assess the existing ULAB recycling market to promote a better understanding of the supply chain, roles, incentives and its impact on the economy. In line with the ESDO guidelines, develop a national inventory by conducting a field survey. Such an assessment will provide important information as to why batteries move to certain informal and formal actors. It will answer key questions regarding volumes of batteries and the existing drivers that currently incentivize ULAB collectors to sell their batteries to the informal recycling sector. This information will help facilitate the design of an effective national strategy.

- ***Regulatory drivers to shift market forces***: Analyze and implement national policy and regulatory drivers that incentivize the incorporation of ULABs into the formal sector for recycling, and disincentivize informal operations. In order to assess the feasibility of the potential interventions, their economic implications for both industry and government should be analyzed. Economic modeling can predict the efficacy and financial implications of these interventions in shifting material from the informal to formal recycling sector. Parameters in the economic modeling will include, but not be limited to, changes in government revenue, the price of materials for industry and the cost to consumers, and the administrative burden of implementing the different programs. ILA has aggregated potential economic instruments – please see following page.

- ***Programs to incorporate part of informal sector into formal sector:*** Develop programs that encourage non-smelting activities such as waste collection and sorting by the informal sector to become a part of the formal supply chain. Other activities such as waste battery breaking, and smelting should be limited to the formal sector.

Economic Instruments and Environmentally Sound Management Measures

The *Training Manual for the Preparation of National ESM Plans for ULAB in the Context of the Implementation of the Basel Convention* (forthcoming) presents potential economic tools for increasing ULAB collection.

- ***Mandatory take-back requirements or a one-for-one exchange system*** (i.e., selling a replacement LAB only if a ULAB is handed in) is one set of regulatory measures to increase ULAB collection. This is an alternative to a deposit-refund system, in suitable for those cases where a deposit might encourage informal sector activities. However, they also require that retailers and car repair shops need to follow specific instructions on proper storage of ULAB and do have appropriate storage facilities.
- ***A deposit-refund system*** aims at enhancing the collection volume of ULAB, but it does not reduce collection costs. If combined with an information or awareness-raising campaign, it may significantly reduce the volume of uncollected batteries. The amount of the deposit will have to be carefully set, because too high an amount might encourage battery theft, or the use of reconditioned batteries provided by the informal sector. In essence, the buyer of a replacement LAB pays a premium for the battery in the form of a deposit, which is returned when the ULAB is returned to the dealer or retailer. The deposit needs to be sufficiently high to prevent the owner of the ULAB from selling it to an informal recycler, but not so high that a black market for stolen LAB sales develops. The major benefit of this scheme is that the consumer pays the deposit, and not the industry or the government.
- ***A recycling contribution fee*** is aimed at companies that produce products that could be detrimental to the environment or public health if not disposed of or recycled in a safe and environmentally sound manner. The most important feature of this financial instrument is that companies can reclaim or offset the recycling contribution fees for the ULAB that are returned and recycled in an environmentally sound manner. The fee should encourage the LAB manufacturers and importers to set up environmentally sound collection and recycling mechanisms so that the fees can be reclaimed. However, the informal sector cannot reclaim the recycling contribution fee because they did not pay it in the first place. If a company claims more money for offsetting than is payable as a fee, then the balance is carried over as a credit. Penalties for non-payment are up to 120% of the initial fee.
- ***A recycling or transport tax*** may be considered in the light of the profitability of a recycling operation and the significance of the transport costs. The latter mainly depends on availability of established and well-functioning transport routes. If transportation and recycling operations are properly managed, the need for a transport and/or recycling tax may only arise in periods of very low international lead prices, i.e. when the international lead price persistently drops well below US$ 500 per ton. Two practical safeguard approaches are possible to shield against such a situation:
    - Countries can impose a low, but permanent recycling/transport tax.
    - The imposition of the recycling/transport tax is confined to periods of low international lead prices. From an efficiency point of view this is the preferable option, but from a practical point of view the permanent levying of a low amount might be the easiest solution.

2.3.1.2 Ensure proper Health, Safety and Environmental performance standards in the formal sector

While eliminating informal smelting is a critical step to reducing environmental and health burdens from the battery industry, it is important to note that even formal recycling can pose health risk to its employees and the local community if the health, safety and environmental protection standards are inadequate. The following steps can allow this important industry can thrive while ensuring the practices are safe and sustainable.

- ***Build corporate responsibility for lead sourcing and end-of-life management of batteries*** Battery manufacturers in Bangladesh can be given the responsibility for the complete lifecycle of their product – including sourcing of raw materials and the recycling and disposal of ULAB components. (Extended Producer Responsibility – EPR)

- ***Review current environmental performance standards*** of the government, of Infrastructure Development Company Limited (IDCOL) and other buyers, of manufacturers and any other relevant actors with the aim to align them around a uniform set. Ensure these standards align with international best practices. Provide technical assistance to interested industry actors to bring them into compliance.

- ***Enforcement***: Develop the recently revised Statutory Regulatory Order (SRO) for ULAB smelting and recycling into a law with clear, enforceable requirements

- ***Regular inspection and monitoring of the formal sector*** for ULAB recycling to ensure that they are following the required environmental standards and guidelines. Store and organize enforcement data to track repeat offenses and observe trends in compliance issues.

2.3.1.3 Community awareness and behavioral change

The public has a role in addressing the ULAB industry as a source of community lead exposures, by increasing accountability from industry actors and by making consumer choices that improve battery life and performance.

- Create continual public education campaigns about the dangers and sources of lead exposure. For example, such awareness can empower communities to reject hazardous activities like informal ULAB recycling.
- Create community awareness about how to select appropriate batteries for energy access. Selecting the correct battery for a specific use will improve the lifespan of the battery and therefore reduce the number of waste ULABs.

- Generate greater awareness of how to return used batteries safely and responsibly.

2.3.1.4 Remediation of legacy sites

The prevention of the creation of contaminated sites is critical for protecting community health and is more effective and efficient than remediating a site later. We therefore highlight the approach needed to address the drivers behind informal ULAB recycling. Focusing enforcement efforts on informal recyclers before these other systemic changes are made can even compound the problem; informal recyclers can easily move their operation to a different area and contaminate another site. Once efforts to curtail informal recycling start to become effective, efforts to increase the remediation of legacy sites can increase.

Remediation and legacy site management is very important to address the severe lead pollution left behind from informal recycling operations. As lead tends to remain in soil over time, it can cause exposures for generations, which can perpetuate intergenerational poverty and poor health.

- Using an economic tool like those outlined in 2.2.1.1, collect and allocate funding for remediation of sites contaminated by ULAB activities.
- Establish hazardous waste sites capable of accepting contaminated soil and waste. These facilities are currently unavailable in Bangladesh.
- Assess, prioritize, and remediate former ULAB recycling sites that are contaminated with lead, especially focusing on sites adjacent to residential areas.
- Monitor sites to ensure quality control of the remediation.
- Work with communities to ensure long-term management of the site and to prevent re-contamination.

2.3.2 Other lead industries

Through its TSIP Program in Bangladesh, Pure Earth has recorded data at 293 sites with lead contamination where public health is deemed to be at risk. While the large majority of these sites are polluted by ULAB activities (lead smelting; battery recycling, repair and manufacturing), other industries have also been implicated, including jewelry making and gold waste processing, e-waste recycling, and mixed industrial areas. Other potential industries of concern include shipbreaking, e-waste coal mining, and pesticides (please see Section 3.2.1).

In order to address the issue of lead exposure holistically, a government system for identifying, recording and monitoring contaminated sites is needed to develop an integrated approach. For example, this information could be used to inform enforcement

actions or future land uses. Due to the diverse range of sources of lead exposure identified in Bangladesh, a range of stakeholders should be involved, or could be activated, to better quantify the extent of lead pollution and formulate effective responses, from government, industry, research organizations and community groups.

The following elements should be considered in a comprehensive strategic approach:

- Systematic monitoring and assessment around lead-related industries, particularly in residential or mixed use areas.
- Enforcement actions against operators found to be in violation of emission standards or other environmental regulations. Strengthening of environmental, health and safety standards.
- Implementation and oversight of appropriate zoning for industrial activities, to ensure they are carried out away from residential areas.
- Research organizations can support this effort by quantifying the extent and sources of lead pollution and associated health impacts (including elevated blood lead levels).
- Improved environmental controls or alternative methods must be identified for industries found to be polluting.
- Non-governmental and community groups are critical for reaching affected populations.

The example below lays out a recommended approach for addressing one lead-related industry – informal recycling of ash from precious metal jewelry making. This cottage industry has been identified as producing severe lead contamination in communities (see Section 3.2.1), but efforts have not yet been made to curtail the activity or identify safer alternative methods.

Concept Notes

Project title	Gold ash recycling - assessing community impacts and alternative processes
Location(s)	Bangladesh
Planned start date	TBD
Duration	1 year
Budget	TBD
Beneficiaries	
Government coordination agency and partner agencies	Department of Environment TBD

Background
In Bangladesh, certain small clusters of villages and urban centers engage in a form of gold recycling by which they recover precious metals from waste materials generated from jewelry making operations. In early 2020, investigators under Pure Earth's Toxic Site Identification Program (TSIP) assessed 11 sites in Chittagong and Dhaka Districts where this method is being used. The process involves the extensive use of lead, which, based on evidence at the sites, is sourced from ULABs (Pure Earth, 2020a).

Program Objectives
- Assess the environmental and health implications of the informal processing of jewelry waste processing
- Map the presence of this industry in Bangladesh, and understand the supply chain
- Identify and pilot an alternative method for waste processing that removes the risk of lead contamination in the surrounding community.

Project Description and Actions
1. Quantify extent of problem – How many communities/individuals are involved in this industry?
2. Select site for pilot project, conduct detailed site assessment at selected site.
3. Conduct qualitative research in community - supply chain, drivers of the industry, methodology.
4. Blood lead level assessments in surrounding community at selected site.
5. Engage technical advisors to identify and pilot an alternative to lead in the metal extraction process.

2.3.3 Turmeric

Recent reductions in the prevalence of lead-adulterated turmeric in Bangladesh indicates growing awareness of the hazards of this practice as a result of robust research findings that were promptly acknowledged by the government agencies. Continued monitoring of producers and screening of turmeric in markets will ensure that this downward trend continues (see Section 3.2.2).

Case Study: Progress in Tackling Lead in Turmeric

When elevated blood lead levels were identified among pregnant women in Bangladesh in 2014, researchers from Stanford University and icddr,b began investigating possible sources. They hypothesized that adulterated turmeric was a major contributor. They then carried out a supply chain investigation to determine how and why lead was ending up in the turmeric. This involved visiting turmeric harvesting and refining regions, as well as markets and mills, and conducting interviews. The research team also conducted lab analyses to demonstrate that the isotopic "fingerprint" of the lead in the women's blood matched that of the turmeric.

When the results of this research began to be published in early September 2019 (Forsyth et al, 2019), the Bangladesh Food Safety Authority (BFSA) organized meetings with the technical team of icddr,b on 23 September 2019. Following the meeting, public announcements went out the next day (24 September 2019) in six daily newspapers in order to raise public awareness against buying artificially colored and openly sold turmeric from the market. A five-member specialized monitoring team was established, which started its first enforcement drive on 10 October 2019 at Dhaka's *Shyambazar* turmeric wholesale market collecting samples and distributing leaflets. Enforcement with mobile courts is ongoing. On 10 October 2019, two wholesaling entities in *Shyambazar* were fined 400000 Tk. each under section 24 of Safe Food Act 2013 after finding traces of lead chromate in their stored turmeric. 900 kg of contaminated turmeric were later destroyed (BFSA, 2019).

At the same time, the Ministry of Commerce is convening committees to control import of lead chromate and its use in the country. The Ministry suggested imposing a complete ban on imports until completing proper testing protocol is formed by the appropriate authorities (The Financial Express, 2019).

[1]These courts are run by executive magistrates punishing or fining an offender based on the surrounding evidence and statements from witnesses. Established under the Mobile Court Act 2009, one of the primary intentions of the Act was to curb food adulteration.

2.3.4 Other consumer products

Unlike some lead sources described in this report, such as ULAB or turmeric, there are remaining data gaps in the prevalence of other potential sources of exposure (see Section 3.2.2). The majority of our information on common lead exposures comes from literature based on information from Bangladesh and other South Asian countries, as well as from Bangladeshi communities living outside of the country, which literature has

reported lead poisoning cases linked to exposures to kohl, sindoor and traditional medicines. Understanding the prevalence of lead-adulteration in these products is needed to prioritize and tailor actions. Continual public education campaigns about the dangers and sources of lead in consumer products can help bring about behavioral changes. Conducting source apportionment at local levels will also help identify the sources of exposure and identify lead-contaminated sites. This will help strengthen monitoring systems and prevent community members' exposure to high-risk sites.

If such products are identified as containing elevated lead levels, the supply chain would need to be further mapped and investigated to most effectively intervene, as demonstrated in the case study above. Once a baseline is established, monitoring and enforcement actions should be initiated.

Finally, it is important that consumers have the necessary knowledge to make informed decisions about the use or sourcing of products. Greater awareness among the public of the impacts of lead and the known sources can generate behavior change and shift market demands for products that have been found to contain lead.

Concept Note

Project title	Mapping of lead-containing consumer products
Location(s)	Bangladesh
Planned start date	TBD
Duration	1 year
Budget	TBD
Beneficiaries	
Government coordination agency and partner agencies	Suggested partners - Department of Environment (DoE) and The Bangladesh Standards and Testing Institution (BSTI)

Background
Literature based on information from Bangladesh and other South Asian countries, as well as from Bangladeshi communities living outside of the country, has reported lead poisoning cases linked to exposures to kohl, sindoor and traditional medicines. Understanding the prevalence of lead-adulteration in these products is needed to prioritize and tailor actions.

Project Objectives

- Determine the prevalence of lead-containing cosmetics and religious powders, and traditional medicines at the national scale
-

Project Description and Actions

- Market surveys in X urban centers and X rural districts
- Assessment with XRF, lab analysis of subset of samples
- Interviews with producers/vendors
- Based on findings, develop intervention and communication strategies with relevant authorities

2.4 Health system-based strategies

Bangladesh does not have a surveillance system in place to monitor blood lead levels of children or adults. This limits the ability to fully describe the lead exposure problem in the country. In order to better understand the problem and the distribution of elevated blood levels it is important to have a unified system to collect, maintain and analyze both child and adult blood lead levels. Below are a few strategies to strengthen healthcare systems to identify, manage and prevent lead poisoning in children and adults:

- ***Strengthen blood lead levels (BLL) monitoring and reporting systems.*** A central surveillance data system to collect and maintain elevated blood lead levels will enhance the government's ability to identify and monitor sources of lead exposure allowing for proper resource allocation. The BLL data can be integrated into the government's District Health Information Software (DHIS2). The availability of blood lead level data is critical to understanding the scope of this issue in Bangladesh, and to developing strategies that are responsive to specific needs, such as in addressing regional differences or trends in the ages of children exhibiting high blood lead levels. Blood lead level testing is needed to identify contributing sources and build evidence for policy reforms. Access to BLL is also important to monitor and keep track of the impact of new regulations.

- ***Build capacity for evidence-based decision making*****.** The Non-Communicable Disease Control (NCDC) program of the Directorate General of Health Services (DGHS) could be engaged further on lead, as part of its mandate on environment-related health issues. By building technical capacity and institutional mechanisms to fully address the impact of environmental pollution, this issue could be integrated into existing health programs. There are currently no routine datasets available in Health Information Management Systems (HIMS) on blood lead levels or lead poisoning among children. As a result, awareness of lead poisoning is poor.

- ***Include environmental health and lead poisoning in existing health and adolescent programs.*** Bangladesh has a number of relevant programs where education around lead sources and prevention could be incorporated, such as

school health programs. There is also an opportunity to connect this issue with the Ministry of Women and Children Affairs and through adolescent clubs. This objective would require awareness raising and capacity building among service providers. It is necessary to facilitate multi-sectoral coordination among health, education and communication sectors for increasing awareness and capacity building on lead poisoning.

Section 3: Supporting Information and Analysis of Lead Exposure and Response

3.1 National health and economic impacts from lead exposures

The best available evidence suggests that exposure to lead is taking a dramatic toll on public health and economic development in Bangladesh. Lead is a known neurological and cardiovascular toxicant with long-term health and developmental impacts, particularly to children. Lead exposure affects children's cognitive, social and behavioral skills and undermines their potential to enjoy healthy, productive lives.

According to the 2019 Global Burden of Disease analysis by the Institute for Health Metrics and Evaluation (IHME 2019), the health impacts from lead exposure, quantified as deaths and disability-adjusted life years (DALYs), have not declined in Bangladesh over the past 30 years, despite the ban of leaded petrol in 1999, and deaths attributed to lead have actually increased substantially. This trend stands in contrast to the gains made in other sectors over this same timeframe, particularly unsafe water (Figure 1). Recently, the death rate from lead exposures has in fact exceeded that from unsafe water sources.

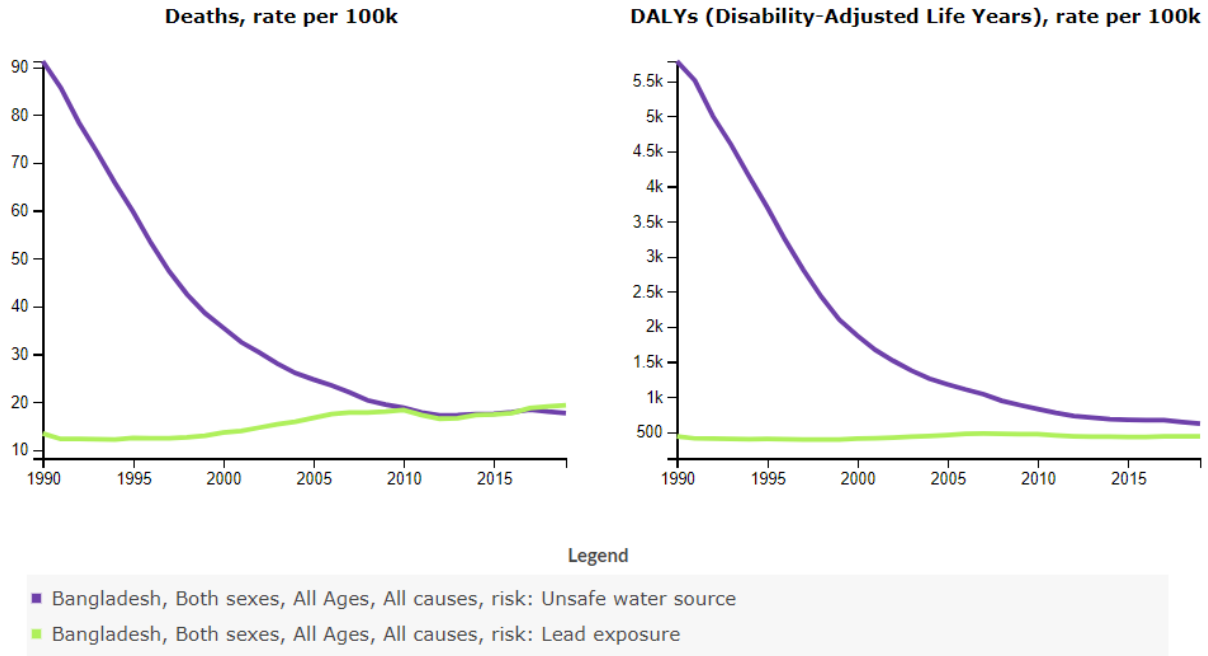


Figure 1. Death and DALY rates per 100K people between 1990 and 2017 associated with lead exposures (green) and unsafe water sources (purple) (Institute for Health Metrics and Evaluation, 2019).

3.1.1 Estimated childhood blood lead levels

The severity of a person's exposure to lead is typically understood by measuring the concentration of lead in the person's blood, or 'blood lead level.' This concentration is measured in micrograms of lead per deciliter of blood (µg/dL). The WHO has stated that there is no safe level of lead in blood, and that "there appears to be no threshold level below which lead causes no injury to the developing human brain" (WHO, 2010). Other studies have shown that IQ loss can occur at blood lead levels as low a 0.1-1.0 µg/dL (Budtz-Jørgensen, 2013). As lead exposure increases, the range and severity of symptoms and effects also increases.

The average blood lead level among children under the age of 19 in Bangladesh is between 6.83 and 7.87 µg/dL, according to two analyses from the 2019 Global Burden of Disease analysis by IHME (lower estimate) and a 2020 meta-analysis of peer-reviewed studies by Pure Earth (upper estimate). An average childhood blood lead level of approximately 7.5 µg/dL places Bangladesh within the top fifteen most impacted countries in the world.

IHME estimates that 35.5 million children in Bangladesh under the age of 19 have a blood lead level above 5 µg/dL. This equals approximately 60% of all children. Nearly 10 million of these children have a blood lead level above 10 µg/dL—a level considered 'highly elevated.'

Beyond these national estimates, previous studies have documented elevated blood lead levels among children, and these studies highlight the geographic heterogeneity of this problem. In Sirajdikhan (Munshiganj District), a primarily rural area, nearly 80% of children tested had blood lead levels above 5 µg/dL (Gleason et al., 2014). Mitra et al. (2009) found that the percentage of children above 10 µg/dL varied depending on land use, with 5% in an urban nonindustrial are (Azampur, Uttara), 14% in a rural nonindustrial zone (Chirirbandar, Dinajpur), and a shocking 99% in an urban industrial zone (Rajabari, Turag, Tongi). A number of studies were also carried out in and around Dhaka between 2000 and 2010; these studies reported mean BLLs in children between 7.6 and 15 µg/dL (Amin Chowdhury et al., 2021).

Blood lead levels among children have been found to be even higher at known lead hotspots. Pure Earth, U. of Dhaka Department of Geology, icddr,b and Stanford University collected data on soil contamination and BLLs among children at an abandoned, informal used lead-acid battery recycling operation in the small town of Kathgora, in the Ashulia area north of Dhaka. Contaminated soils in public areas used by children had lead concentrations exceeding 100,000 parts per million (ppm). Contaminated battery waste was left in large piles, and children played directly on these waste piles. Before completing a series of risk reduction activities in the community, BLLs among the local children were measured. The mean BLL among 69 local children prior to risk-reduction activities was approximately 19 µg/dL. All of the children tested in

Kathgora had BLLs exceeding 8 µg/dL, with the highest BLL exceeding approximately 48 µg/dL.

3.1.2 Available burden of disease data associated with lead exposures

Mortality

In 2019, nearly 31,000 deaths were attributed to exposure to lead exposure—3.6% of all deaths nationally—making Bangladesh one of the most severely lead-impacted countries in the world (IHME, 2019). Though leaded petrol ban in 1999, the cumulative, lifelong impacts of lead are reflected in the high death rate.

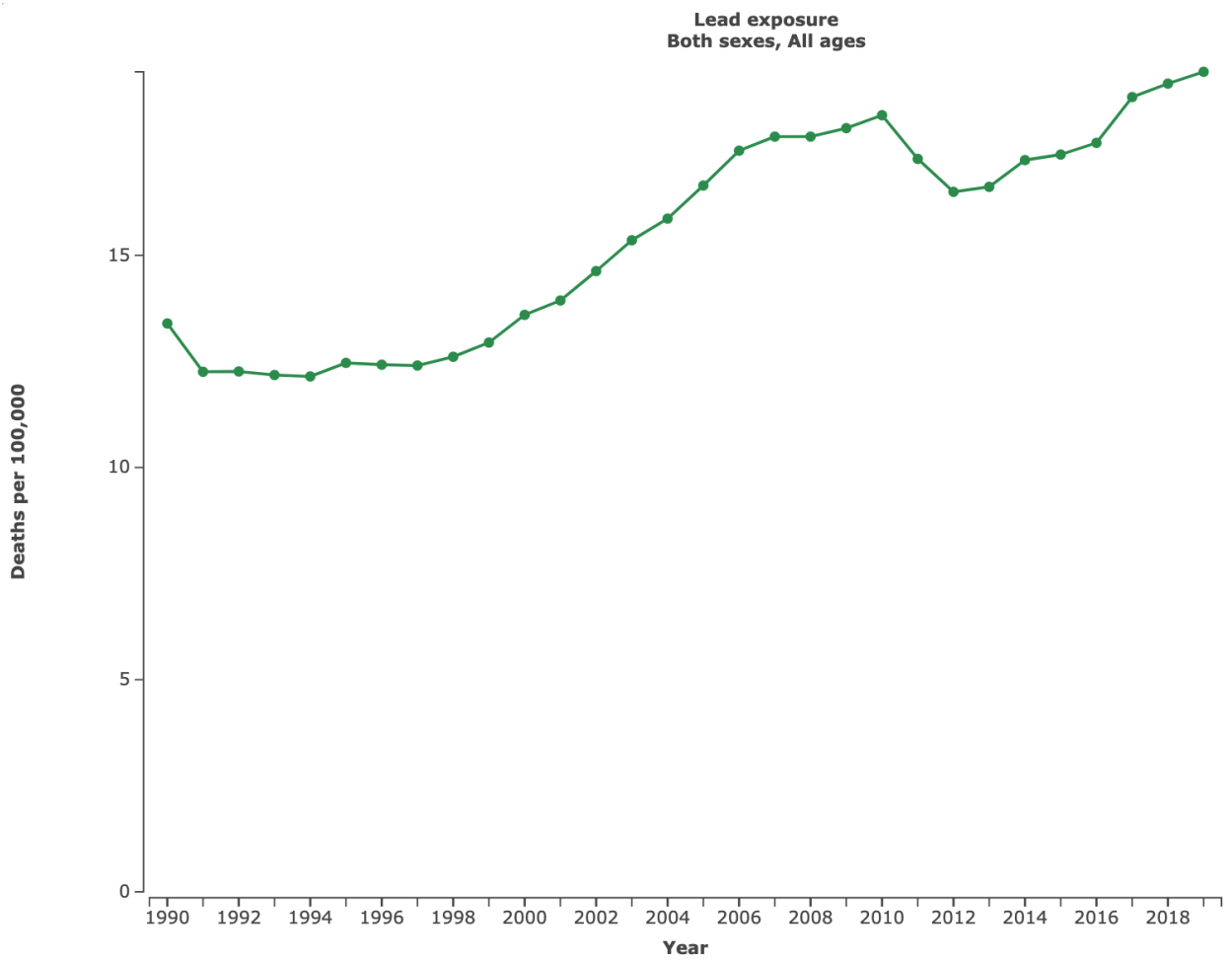


Figure 2. Death rate attributable to lead exposure from 1990 to 2019.

The same analysis by IHME estimates that lead exposures are responsible for a considerable portion of annual deaths from common diseases such as heart disease and stroke, as shown in Figure 3.

Disease Type	% of deaths attributable to lead exposure	% of total annual deaths attributable to disease
Hypertensive heart disease	15.6%	2%
Ischemic heart disease	9.2%	15.40%
Stroke	9.1%	18.70%
Chronic kidney disease	6.9%	1.50%
Atrial Fibrillation and flutter	5.7%	0.50%
Aortic aneurysm	5.7%	0.20%
Other Cardiovascular and circulatory disease	5.5%	0.60%
Endocarditis	4.8%	0.10%

Figure 3. Percentage of deaths that are specifically attributable to lead exposures for certain diseases in Bangladesh.

Morbidity and neurological damage

Lead exposures are estimated to cause 70% of the developmental intellectual disability in Bangladesh and result in the loss of 690,000 years of healthy life each year across the population (IHME, 2019). Exposure to lead has well documented neurotoxic effects on children's developing brains, including impaired cognitive development resulting in lower intellectual quotient (IQ). Increases in blood lead levels as low as 0.1-1.0 µg/dL in children are associated with the loss of one IQ point (Budtz-Jørgensen et al., 2013). Elevated blood lead levels in children have been associated with behavioural disorders, attention deficits, impulsivity and hyperactivity, anemia, hypertension, renal impairment, immunotoxicity, and toxicity to the reproductive organs, as well as depression and anxiety (WHO, 2019; US Environmental Protection Agency, 2013).

3.1.3 Economic impacts

Pervasive childhood lead exposure not only causes negative health outcomes but also inhibits economic growth (UNICEF & Pure Earth, 2020). Children with elevated blood lead levels have reduced IQs, complete less formal education, and earn less money over their lifetime. The World Health Organization states “Using a conservative

estimate, the decrease in intelligence attributable to each 1 µg/dl increase in blood lead level is 0.25 IQ points, and the decrement in lifetime economic productivity associated with each lost IQ point is 2.4%" (WHO, 2010). Using this “conservative estimate,” and an average childhood blood lead level of 7.5 µg/dL, Bangladesh may currently face a population-wide decrease in economic productivity of 4.5% annually.

A separate analysis of economic impacts in Bangladesh calculates that lead exposure costs the country US $16 billion annually due to productivity losses, or approximately 6% of the country’s GDP (Attina and Trasande, 2013). This figure includes only lost earning potential due to IQ decrements, and does not include healthcare costs, lost earnings from premature death, or lost taxes from illegal ULAB recycling operations (Grosse et al, 2002). For comparison, the productivity losses associated with reduced IQ from lead exposure are equal to half of the country's income from textiles and apparel (Attina and Trasande, 2013). Estimated annual GDP losses resulting from lead exposure are approximately 2.5 times greater than Bangladesh’s net foreign assistance in recent years (Chattopadhyay, 2018). Regardless of which estimate one uses, the economic toll from lead exposures is staggering.

In the recently published “8th Five Year Plan July 2020-June 2025: Promoting Prosperity and Fostering Inclusiveness” (8FYP), the General Economic Division (GED) of the Government of Bangladesh lays out a variety of ambitions related to poverty reduction, income inequality, job creation, education, public health, and ultimately, the government’s desire to achieve upper-middle income status by 2031. The best available data suggest that these goals are currently being undermined by widespread childhood lead poisoning, and that addressing the lead issue could advance a variety of government priorities.

3.2 Known and Suspected Sources of Lead Exposure

Lead can enter the body through a range of exposure pathways, including the ingestion of contaminated dust, water, and foodstuffs, or inhalation. Globally, lead has been found widely distributed throughout the environment in which children live, including the water they drink, the soil they walk or crawl on, the food they eat, the paint on the walls, the air they breathe and to some extent even the toys they play with. The Bangladeshi government does not currently have a comprehensive inventory of environmental lead levels or emission sources. Thus, this assessment relies on the data and experience of Pure Earth and the contributing organizations, as well as on published literature, as referenced.

Leaded gasoline was a significant historical source of lead exposure, and residual contamination from this use remains common globally. Bangladesh instituted a ban on leaded gasoline in 1999. Around the same time, cities in Bangladesh also saw rapid conversion of vehicles to run on natural gas as it was a cheaper alternative fuel. Analyses of air and dust samples indicate that lead concentrations remain correlated with heavy traffic areas and industrial activities (Begum and Biswas, 2008; Rahman et al., 2019a). High lead concentration in industrial air samples have been traced to

clusters of cottage industries that include battery recycling operations of the informal sector (Woo et al., 2018). Despite the gains in reducing lead exposure following the phase out of leaded gasoline, the large proportion of children with elevated blood lead levels described above indicates a significant ongoing threat. Current known and suspected sources of lead exposure are described below.

3.2.1 Industrial Sources

Lead Acid Battery Manufacturing and Recycling

In Bangladesh, the growth of automotive vehicles expanded the market for lead acid batteries (LAB) coupled with the spread of Solar Home Systems (SHS) and electric auto-rickshaws (locally known as easy-bikes). Electric powered rickshaws alone account for 65-75% of LABs used in Bangladesh. Estimates for the number of e-rickshaws vary from the Dhaka Tribune's report of approximately 500,000 to the e-rickshaw's association's estimate of 1.5 million. These vehicles are typically powered by 4-6 LABs, weighing 20-30 kilograms, and take about four hours to fully recharge. The number of motor vehicles registered in Bangladesh is reported to be 504,130 units as of December 2019. The number of vehicles is, however, dwarfed by the number of motorcycles, amounting to over 2 million, that are not included in the official vehicle registration data published by the Government (ILA). Battery manufacturers in Bangladesh aim to significantly raise their annual export in the next five years, which would contribute to the increasing demand for lead acid battery manufacturing and recycling industries. Typically, lead acid batteries used in Bangladesh have a usable life of about two years, after which they must be recycled.

While Bangladesh does have industrial operations for recycling used lead acid batteries (ULABs), the capacity of battery manufacturers and dedicated recyclers in the formal sector has not grown to cater to the volume of ULABs generated, creating conditions for informal recyclers to proliferate throughout the country engaging in illegal smelting activities. It is estimated that there are about 1,100 informal and illegal ULAB recycling units across the country, putting more than one million local community members living near these sites at risk (World Bank, 2018). The decentralized nature of the informal economy poses regulatory challenges which have implications for environmental quality and health.

The informal recycling of ULABs creates highly localized contamination hotspots and severe risks to children that live, play or go to school near active or abandoned informal recycling sites. Lead dust is released on site through the breaking and smelting of battery components. Because lead is quite heavy, fumes and airborne dust generally precipitate and fall back to the ground within several hundred meters of the source.

Investigations at the site by local Pure Earth staff indicate that site operations included breaking open ULABs, draining out sulfuric acid, removing lead plates, and processing other internal battery components and the plastic battery carcasses. Site operations

also include the uncontrolled smelting of the lead battery components in open pits with no pollution controls. The smelting operations can cause extensive lead contamination of the surrounding surficial soil and leaf litter through atmospheric deposition. These operations leave behind residual battery component wastes (e.g., separators and battery cases), concrete processing pads containing the smelting pits and highly contaminated soil not only in the area of operations, but in the surrounding area. Contaminated site remediation projects conducted by Pure Earth have shown that lead released during informal recycling is generally confined to the top 2cm of local surface soils outside of the immediate smelting area. Lead-contaminated waste left behind from these operations can contribute to elevated environmental lead levels, putting local residents, particularly children at risk.

The predominant exposure pathway at a ULAB recycling site is typically incidental ingestion of contaminated dust. The ingestion of soil and dust as an exposure pathway for lead and other environmental contaminants has been documented among Bangladeshi children (Kwong et al., 2019). This occurs via hand-to-mouth activity, mouthing objects, and, among the youngest children, directly ingesting soil. Kwong et al. also found that soil consumption in a rural Bangladeshi setting was substantially higher than existing estimates for children in high-income countries. As most inhaled lead dust particles are too large to penetrate the lungs, they are cleared from the lungs and then ingested. In addition, children often engage in hand-to-mouth behaviors, play in and around waste due to proximity to these sites, thereby ingesting whatever lead dust they have on their hands. A further possibility for lead exposure is the use of lead contaminated leaf litter in open fires.

The World Bank has estimated that Bangladesh has more than 1,100 informal and illegal ULAB recycling sites across the country, putting more than a million local community members at risk. More than 250 individual recycling sites have been identified and assessed by Pure Earth under the Toxic Sites Identification Program (TSIP) from 2011 to the present in conjunction with the University of Dhaka and with engagement with several Bangladesh government agencies. The industry dynamics surrounding lead acid batteries are further elaborated in Section 3.4

The issue of ULAB management is one that the DoE has recognized as a priority, and they have indicated that the government is working on this issue seriously. During a virtual ULAB stakeholder meeting in Bangladesh in October 2020 with Pure Earth, UNEP, ESDO, and DoE, the DG said the government is working on this issue seriously and requested assistance from these partners in developing a strategy that they can execute (Financial Express, 2020).

Jewelry Making and Gold Waste Processing

The handmade production of jewelry remains culturally important in Bangladesh, and there are a range of roles for artisans in this industry. Sikder et al. (2017) assessed the environmental health hazards of gold jewelry manufacturing shops in Tanti Bazar of old Dhaka’s historical downtown and found elevated concentrations of lead from dust

samples most likely originating from use of poor-quality zinc and copper. During the soldering process, heating of lead at high temperatures can generate dangerous fumes endangering the artisans (Sikder et al., 2017).

Certain small clusters of villages and urban centers engage in a form of gold recycling by which they recover precious metals from waste materials generated from jewelry making operations. In early 2020, investigators under Pure Earth's Toxic Site Identification Program (TSIP) assessed 11 sites in Chittagong and Dhaka Districts where this method is used. The process involves the extensive use of lead, which, based on evidence at the sites, is sourced from ULABs (Pure Earth, 2020a).

Investigations conducted by ESDO and Pure Earth indicate that these recyclers purchase ashes and discarded ceramic pots used in jewelry making from around the country. The process involves washing the waste; drying it in the sun; grinding it in a manual grinder; mixing the waste with charcoal and lead and shaping it into balls; drying the balls and then mixing them with borax. The balls are then fired in an oven furnace, where the gold and silver combine with the lead. The lead and precious metals are separated using nitric acid. The lead is released as vapor during the burning process, as dust, and through the water used for washing. In the villages that engage in this recycling, most families are engaged directly in the process and the work is carried out in very close proximity to residences, putting the whole community, including children at risk.

Electronic waste

Electronic waste (e-waste) is one of the fastest growing pollution problems worldwide given the presence of a variety of toxic substances including lead, posing a threat to both the environment and human health. (Sepulveda et al, 2009). This is a result of increasing global legal and illegal trade of e-waste and poor recycling techniques. Both the population handling e-waste and the surrounding environment are at risk due to the lack of health and safety guidelines and substandard recycling techniques such as dumping, dismantling, inappropriate shredding and acid leaching.

In Bangladesh almost 2.7 million metric tons of e-waste is generated per year. Of this amount only 20 to 30 percent is recycled and the rest of the waste is released into landfills, rivers, drains, lakes, canals, and open spaces, which are very hazardous for health and environment (Alam et al., 2015). Given the high economic growth that Bangladesh is witnessing, the consumer demand for electric and electronic gadgets and home appliances has increased (Hossain et al., 2010). As a result, the amount of locally produced and re-used electronics products has increased. Similar to the lifecycle observed with ULABs, the equipment is refurbished and recycled both in formal and informal settings. ESDO conducted a research survey to address this issue and create mass awareness on e-waste in Chittagong city and Dhaka (Hossain et al, 2010). The study showed that every year Bangladesh generated roughly 2.8 million metric tons of e-waste exposing more than 83% of the child laborers to toxic substances. The study also indicated that approximately 50,000 children are involved in the informal e-waste

collection and recycling process, of which 40% are involved in ship breaking yards. (Hossain et al, 2010).

Pesticides

Agriculture is one of the largest employment sectors in Bangladesh, and pesticide consumption has increased four-fold in the last decade (Rodriguez Eugenio, McLaughlin, & Pennock, 2018). Lead-based pesticides were widely used in the first half of the 20th century. Although they were banned in the US and Australia in the 1980s, their use may have continued in other countries. Forsyth et al. (2018) examined the impact of the use of agrochemicals on lead levels in soil and rice in rural Bangladesh, and assessed possible impacts on blood lead levels among pregnant women. Although there were statistical associations between elevated blood lead levels and the use of Rifit (a pretilachlor-based herbicide) and Basudin (a banned organophosphate pesticide), there was minimal evidence of lead contamination in the agrichemicals. Forty-nine samples of Rifit and one sample of Basudin were analyzed, out of which none of them contained detectable lead. The maximum lead concentration among all pesticides and herbicides analyzed was 8.3 µg/g and 6.3 µg/g, respectively. The authors do note, however, that this may have been a larger source of lead exposure in the past.

Recent reports from the popular press indicate that lead and heavy metals may still be present in pesticides but further investigation into these findings is required. Recently, 63 of 67 pesticides tested by the Bangladesh Food Safety Authority (BFSA) were found to contain heavy metals, including lead, cadmium and chromium (Hossain 2020), although concentrations were not reported. In another instance, lead and cadmium were found in the pesticides *Fana 5G, Brifur 5G, Unizoom*, in which heavy metals are not the active ingredient (Rahman, 2019). It is suspected that heavy metals may be added intentionally because they are cheaper than the approved active ingredients, or the heavy metals are present in low quality inert materials used in the formulation (Hossain 2020). Although licenses for importing pesticides are given by the Department of Agricultural Extension (DAE), the imported pesticides are not routinely tested (Hossain 2020).

The presence of lead in food products is discussed in Section 3.2.2.

Coal Mining

Pollution and soil contamination of lead is a localized concern near the only coal mine operating in Bangladesh. The Barapukuria coal mine is located in Dinajpur district of north-west Bangladesh, and assessment of soil quality in the surrounding area indicates high levels of lead contamination (Sahoo, Equeenuddin, & Powell, 2016). Heavy metal contamination was also observed in both drainage water and groundwater in the area around Barapukuria (Bhuiyan, Islam, Dampare, Parvez, & Suzuki, 2010). The Barapukuria Coal Fired Thermal Power Plant also generates significant quantities of solid by-products which are conventionally known as fly ash. However, a 2016 of the fly

ash from Barapukuria found that all major and minor parameters were within allowable limits; lead and was detected at 6 ppm (Howladar et al, 2016).

Shipbreaking

Shipbreaking has been an important economic activity in Bangladesh for more than 30 years. The method relies on stranding large vessels on the coast utilizing high tide while workers cut it into pieces, which are dragged closer to the beach (Hossain, 2017). Shipbreaking is concentrated in Sitakunda, north of Chittagong; it is one of the largest shipbreaking yards in the world. It has been reported that large amounts of hazardous materials with high concentration of metal pollutants accumulate in the sediments of Sitakunda as a result of shipbreaking. In addition to the release of various paints, coatings, oils and persistent organic pollutants, heavy metals [GKB2] are released into the surrounding water and sediment during the process (M. S. Hossain et al., 2016). The metals observed include lead, mercury, chromium, arsenic, copper, zinc, and aluminum (M. S. Hossain et al., 2016). This industry is the biggest source of trace metal pollution to the environment in the Sitakunda Upazila (Rahman et al., 2019b). Lead dust and fumes can also be generated from boats with paint containing lead that are broken during the process. Many boats have been painted with marine paints that are high in lead which can create a health hazard. The traditional safety colors such as red and orange contain high levels of lead. The paint chipping off these boats into water is also a serious threat to water quality (Department of Agriculture, Water and the Environment, n.d.).

Through its Toxic Site Identification Program, Pure Earth collected soil data from four shipbreaking areas in 2019. Two area were visited in Chittagong, and two along the Shitalakhya River in Dhaka. Using a portable X-ray fluorescence analyzer, investigators assessed the lead concentration along the shoreline and in nearby residential areas, and all readings were found to be below 400 ppm, which is Pure Earth’s maximum recommended level, as well as the US EPA’s standard for bare soil in play areas.

3.2.2 Products Containing Lead

Turmeric

Turmeric is a very widely used spice throughout Bangladesh. Consumers in Bangladesh favor vibrantly colored turmeric. When the roots are not of a high enough quality (i.e., they are dull colored), lead chromate can be added as a pigment, which is unsafe for consumption. The practice of polishing dried turmeric roots with yellow pigment began during the 1980s by wholesalers in Dhaka to cope with flood damaged turmeric, which is dull in color. The practice passed on from wholesalers to polishers in turmeric producing districts so that the color can be added early on (Forsyth et al., 2019). Lead chromate, a common industrial pigment, is often used to adulterate the turmeric and improve its color; the pigment was commonly sourced from color merchants and was never intended for use in food products.

As of 2019, evidence of adulteration with lead chromate was found in 7 out of 9 turmeric-producing districts. As per the Bangladesh Standards and Testing Institution's (BSTI) limit for lead in turmeric is 2.5 µg/g or ppm. Lead levels in turmeric have been found to exceed the national limit (2.5 ppm) by up to 500 times (Forsyth et al., 2019). The turmeric Pb concentrations were as high as 1151 µg/g. Eight of 28 market turmeric samples contained Pb above the 2.5 µg/g Government of Bangladesh limit for Pb in turmeric.

This practice has had measurable impacts on public health in Bangladesh. Forsyth et al. (2019) explored potential sources of blood lead level contamination in three rural districts. They were able to identify turmeric adulterated with lead chromate as the primary contributor to elevated blood lead levels using isotope analysis. The mean BLL for different varieties of turmeric included loose turmeric powder (market) with 19.0 µg/g, packaged turmeric powder (market) 4.0 µg/g, loose turmeric powder (pigment processed) 283.9 µg/g, turmeric root 413.9 µg/g.

Among common cooking spices, lead contamination has not been isolated to turmeric. A descriptive study by Hore et al. (2019) of lead contamination in spices systematically collected as part of lead poisoning cases in New York City showed that spice mixes used for South Asian cuisine such as curry masala contain elevated lead levels, with maximum concentrations ranging from 2700 ppm (turmeric and masala) to 21,000 ppm (curry). About half of these spices had detectable lead, with average concentrations exceeding the reference level of 2 µg/g or ppm.

Adulterated spices are a source is of particular concern because lead is directly ingested and children may face continuous exposure through their meals. Further analysis of turmeric as a priority lead source industry is provided below in Section 3.2.4.

Other Foodstuffs

In Bangladesh, lead has also been identified in a number of common foods. A nation-wide sampling of commonly grown and consumed vegetables collected from 64 districts across Bangladesh showed lead concentrations above a health-based guidance value (the FAO/WHO 2006 Codex general standard for contaminants and toxins in foods) in 29.47% of the samples (Hossain et al., 2016). The standard for lead varies from 0.1 ppm to 0.3 ppm depending on the type of vegetable; the study authors converted these fresh vegetable standards to a dry weight equivalent. This study found concentrations above the standard in all vegetable types sampled—white potatoes, green cabbage, red spinach, white radish and green beans. Furthermore, samples above the standard were collected from 49 of the 64 districts, indicating the source of lead is likely non-point in nature (Hossain et al. 2016). Islam et al. (2014) similarly identified concentrations of lead in vegetables that exceeded a health-based standard.

Rice has also been examined as a potential source of lead. Jahiruddin et al. (2017) looked at 10 sub-districts in Bangladesh. Four of the districts had average concentration levels above the Codex limit of 0.2 ppm. In areas where both rain-fed and irrigated rice were collected, higher concentrations were found in the irrigated rice, and the study authors noted that this could be linked to industrial effluent contamination.

The issue of lead in milk was one that captured the public's attention in recent years. In 2019, BFSA reported finding lead beyond the permissible limits in 11 out of 14 pasteurized milk samples from brands as approved by Bangladesh Standards and Testing Institutions (BSTI). The maximum permissible limit of lead in milk is 0.02 milligram per kilogram but BFSA found up to five times that amount (0.1 mg/kg) as reported in the *Dhaka Tribune* (Rahman, Nabi and Shovon, 2019). This milk contamination can be attributed to contaminated cattle feed and increased environmental pollutants (Rahman, Nabi and Shovon, 2019).

Another route by which accumulated lead in animals is passed to humans is through consumption of meat. A research study testing four types of meat samples for toxic heavy metals found lead concentrations above the maximum allowable concentration in food, with the highest mean concentration observed in chicken meat (1.9±3.0 mg/kg) and the lowest found in mutton (0.78±0.61 mg/kg) (Islam, 2018).

The storage or processing of food also has the potential to introduce lead contamination. In a study analyzing the BLLs of pregnant women from rural parts of Bangladesh, individuals with BLLs ≥ 7 µg/dL were more likely to consume food from cans (Forsyth et al., 2018). The researchers identified a common practice of recycling or repairing cans with lead solder. While Forsyth et al. (2018) did identify a statistical association between elevated BLLs and individuals grinding rice, they did not identify physical evidence of grinding slates being repaired with lead solder as has been seen in other parts of the world.

Aluminum cookware

Lead and other heavy metals have been found in aluminum cookware in Bangladesh. Aluminum cookware is common in South Asia including Bangladesh, given its cost effectiveness and heat conductivity. Low-grade aluminum cookware found in the local markets of Bangladesh are often made from scrap metals. Many traders add lead to the aluminum scarp to increase its weight for a higher price which ends up in the finished aluminum product.

In 2018, the Environmental and Social Development Organization (ESDO) published a report on high levels of lead in aluminum cookware. Four pieces of aluminum cookware from the local market of Bangladesh were collected by the ESDO team and analyzed in a laboratory in San Francisco. The researchers simulated cooking by boiling acetic acid in the pots and analyzed the liquid for leaching. This sampling effort appears to be part of a larger study carried out by Weidenhamer et al. (2017) on aluminum cookware from 10 developing countries. Four items for Bangladesh were tested, and three of the items

underwent three boils. Of the 10 boils, only one had a detectable lead concentration, with a reading of 2 µg/serving. According to ESDO, there are no standards for lead content in cookware in Bangladesh. To put the result in context, the US Food and Drug Administration has calculated the current Interim Reference Level (IRL) for lead to be 3 µg per day for children and 12.5 µg per day for adults; the IRL is the amount a person would need to consume daily that would result in blood lead levels of 5 µg/dL (US FDA, 2020). Additional research is needed to understand the prevalence of lead leachate from a wider range of cookware and cooking scenarios, and to compare the magnitude of this daily dose to other sources.

ESDO also conducted a follow up survey about people's level of awareness and use of aluminum cookware. They surveyed 1600 people in total, from Dhaka, Munshiganj, Manikganj, Savar, Gazipur and Tongi. In total, they found that 98% of the people (both urban and rural) use aluminum utensils (cookware, bakeware, cutlery etc.). They also found that the level of awareness was very low; only about 5% of respondents knew of the potential risks of aluminum cookware.

Paint

The extent of lead-based paint in use and for sale in Bangladesh is not well documented. Children can be exposed to lead from paint through the ingestion of dust or flakes, or by mouthing toys. Standards for the paint manufacturing industry on the lead content in household or decorative paints were not finalized by the Bangladesh Standards and Testing Institutions (BSTI) until 2018, when the limit was set at 90 ppm. Although the paint industry supported the promulgation of the standard, monitoring is still unknown and policy attention is lagging on labelling and legacy issues left by old paints (Hossain, 2013).

Cosmetics and Religious Powders

Many cosmetics and religious powders popular in Bangladesh and South Asia more broadly have been found to contain lead for pigmentation. While lead is not readily absorbed through the skin, exposure can occur through the eye (conjunctival absorption) and through hand-to-mouth transfer (Goswami, 2013).

Kajal is an eye cosmetic used extensively in South Asian countries including Bangladesh. Culturally it is believed that these products have medicinal purposes and are applied as part of the tradition. In fact, putting black makeup around baby's eyes is a common tradition where parents think these eyeliners can protect the eyes or improve sight. Studies have reported that kohl, kajal and surma contain high levels of lead (Hardy et al, 2008). These cosmetics contain galena (lead sulfide, PbS) as one of the main components and minimum (Pb_3O_4). Careless application of kajal, eye rubbing, and lacrimation may cause absorption of lead through the conjunctiva. Sometimes adulterated or defective manufacturing procedures of such cosmetics can introduce lead into the ingredients, which enters the body through ingestion. In addition, adulteration of these cosmetics is also very common in the local market of developing

countries. The findings of this study showed a significant difference between the two groups in relation to the sources of these shopping items.

Sindoor, also known as vermilion, is a traditional powder used for religious purposes in Hinduism and as a symbol of marriage for Hindu women. The orange or red pigment is used on both children and adults and is intended for topical use only. Sindoor should never be used in food. There are many varieties and manufacturers of sindoor, and not all products labeled sindoor contain lead. Lead may be added as a red pigment. A product may contain high levels of lead even if lead is not listed as an ingredient on the label. It is difficult for users of these products to tell the difference between safe and dangerous brands. When a person uses these products, some of the sindoor can get onto the hands. Lead can enter the body if the user puts their hands in their mouth, eyes or nose. There have also been lead poisoning cases where people used sindoor as a food coloring.

Shah et al. conducted a study with sindoor from 66 Asian stores in New Jersey and 23 samples from India. The analysis determined that 83.2% sindoor samples purchased in the United States and 78.3% samples purchased in India contained ≥1.0 µg/gm of lead per gram of powder.

Traditional Medicines

Herbal medications that are commonly used in South Asian countries including Bangladesh are known to contain some toxic ingredients including lead and arsenic. These often times go unidentified due to lack of quality control or missing ingredient listing on the medicine container. Studies have documented that some of these herbal medications contain heavy metals such as lead, mercury and arsenic (Mitra et al, 2012).

A cross-sectional study was conducted by Mitra et al. to determine the extent and risk factors for elevated BLLs in children in Bangladesh from September 2007 to July 2009. The study included 919 children under the age of 16 years recruited from six urban locations in Dhaka and one rural area in Dinajpur. It was found that indigenous medicine treatment (kabiraji) ($p=0.004$) was significantly correlated with higher BLLs. Proximity to industries and use of indigenous medicines remained significant predictors of high BLLs once controlled for confounders. (Mitra et al, 2012). The mean BLL was 2.3 µg/dL higher for users of traditional medicines.

In 2007, the New York City Department of Health and Mental Hygiene (NYC DOHMH) investigated five cases of adult lead poisoning associated with ingestion of imported manufactured or hand-made herbal medicine products (HMPs) made in China and India. These products were either purchased from retail outlets in NYC, obtained during travel abroad, or received from relatives overseas. These were used to treat skin rashes, diabetes and to promote overall well-being. Testing of these products revealed high levels of lead and or mercury contamination. As a result, NYC DOHMH banned the sale of these products by retailers and wholesalers in NYC and measures were taken to disseminate information to general and Asian communities. (Hore et al., 2007) Another

study led by Saper et al. analyzed the concentration of heavy metals in Ayurvedic HMPs manufactured in South Asia and sold in Boston-area stores. A total of 13 of 70 HMPs contained lead (n= 13, 40 µg/g; range, 5-37,000 µg/g).

Amulets and Jewelry

In many South Asian cultures, it is a custom for children to wear amulets (sheesha, tabeez and metal charms) on necklaces and bracelets for reasons including speech therapy, good luck as well as protection (NYCDOH, 2020). These can contain high levels of lead. They pose a hazard to a child's health when the child mouths the amulet or when the amulet is accidentally ingested.

There are case reports of the health impacts of the ingestion or mouthing of such amulets, but the available information largely comes from the United States. Mitra et al. (2009) did note that a child in Bangladesh with a highly elevated blood lead of 44 µg/dL was given a tabeez to wear in order to keep "evil spirits" away from her, although they drew no conclusions about the causality. Therefore, it is important to note that despite the awareness of widespread usage of these amulets including heesha, tabeez and metal charms in Bangladesh, there is very little information about the potential impacts on health. This indicates a data gap which hampers evidence-based practice and decision making.

3.2.3 Geographic Priorities and Known Contaminated Sites

One of the most robust sources of information about the location, contamination levels, and potential public health risks of chemical contamination hotspots in Bangladesh is the database of the global Toxic Sites Identification Program (TSIP). TSIP is designed and managed by the non-profit organization Pure Earth and implemented in Bangladesh in partnership with the Department of Geology of the University of Dhaka and with consultation from the Bangladesh Department of Environment (DoE). The TSIP endeavors to identify and screen industrially contaminated sites in low- and middle-income countries with a potential human health impact. The TSIP in Bangladesh began in 2011. Since then, several phases of the Program funded by different development partners have been completed. While some of these phases looked at a broad spectrum of chemical contaminants including pesticides, more recent phases have focused specifically on lead contamination resulting from informal recycling of used lead acid batteries. There are currently nearly 300 sites at which lead has been identified as the key pollutant in the TSIP database as shown on Figure 2. Further analysis of lead acid batteries as a priority lead source industry is provided below.

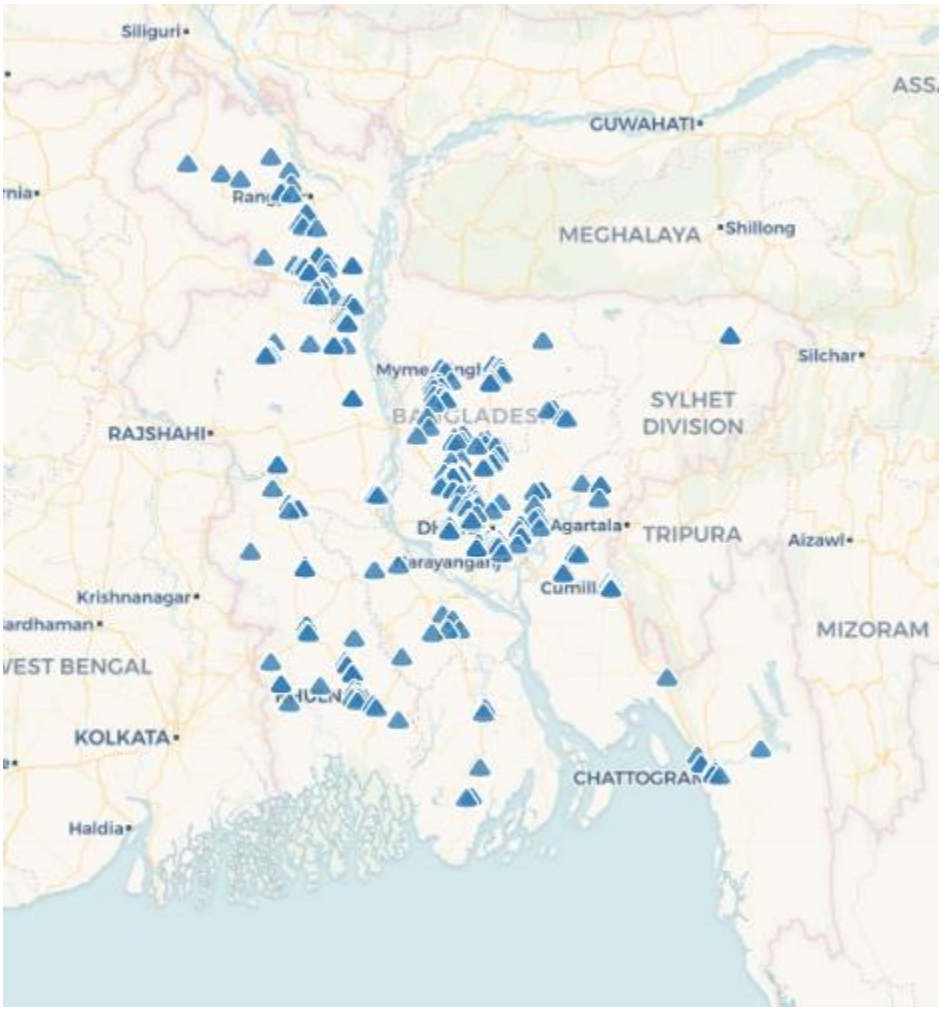


Figure 2. Map of Bangladesh showing the geographic distribution of all TSIP assessments at which lead was identified as the key pollutant, conducted between 2011 and 2020.

3.2.4 Industry Analysis for Priority Lead Sources

The section below is an industry analysis of two major lead sources to help elucidate market dynamics. Based on the suspected influence of these sources on blood lead levels, the available data, literature and each organization's experiences, detailed industry analyses are presented for two major sources—lead-acid batteries and turmeric production. Understanding these industry dynamics is critical for informing feasible approaches to addressing these lead sources.

Lead Acid Batteries

According to the International Lead Association (ILA), the annual generation of ULAB in Bangladesh is 118,000 metric tons (mt) (ILA, 2020). ULABs hold value as the lead is readily recyclable into new batteries or other goods. Only four battery manufacturers

have their own recycling facilities, and there are another two government authorized recyclers operating in the country. The known formal sector ULAB recyclers are:

- Panna Battery Ltd. – West Rasulpur, Kamrangirchar, Dhaka
- Khorshed Metal Industries (HAMKO Group) - Bangladesh Small and Cottage Industries Corporation (BSCIC) Industrial Area, Khulna
- RIMSO Battery - Masabo, Borpa, Narayanganj
- Kishan Accumulators Ltd. – Kashiyara, Uzirpur, Bokultala, Narail
- BengalXpo Ltd – Pabna

Additionally, Rahimafrooz Batteries Ltd. (Zirani Bazar, Zirani Kashimpur Road, Panisail, Dhaka) has a recycling facility, but has stopped recycling.

The locations of these recyclers near major towns & cities also poses a challenge, as they are located far away from many end-users. A host of other factors have enabled the growth of hundreds of unauthorized recyclers as part of an informal economy, posing hazards to the environment as well as occupational safety for the workers involved. Hotspot areas of illegal smelting have emerged in Tangail, Jessore, Bogura, Dhaka, Dinajpur and Pabna (Pure Earth, 2020b). It is estimated that there are more than 1,100 informal and illegal ULAB recycling units across the country, putting more than one million local community members that live in close proximity to these sites at risk (World Bank, 2018).

The size of the market for LABs assembled in Bangladesh is BDT 11B, or 11,000 crore (approximately US $129M) (Babu, 2020) and growing at a rate of 12% (Ahmed & Hasan, 2020). Currently around 25 local companies are catering to domestic needs by manufacturing batteries for three-wheelers, hybrid and electric cars, scooters, commercial vehicles, cars, instant power supply (IPS), and Solar Home Systems (SHS). The phenomenon that led to rapid growth of the battery market is the rise of the battery-powered rickshaws and easy-bikes, accounting for around Tk 8,000 crore ($92 million) worth of batteries bought (Pure Earth, 2020b). This market demand has also invited unregistered, non-compliant and clandestine battery factories that have now captured 70% local market share (Babu, 2020). The emergence of these illegal factories has significant implications for ULAB recycling as they have now become the major buyer of recycled lead and will happily purchase lead from low-cost, informal recyclers. According to Accumulator Battery Manufacturers & Exporters Association of Bangladesh (ABMEAB), there are around 50 battery factories, including 30 Chinese owned, operating in Bangladesh apart from the registered ones, producing 500,000-600,000 units a year. These unauthorized battery manufacturing factories—located in Khulna, Bagerhat, Narsingdi and around Dhaka city—neither have permission to install such plants nor have license from Bangladesh Standards and Testing Institution (BSTI) for purchase, use or storage of acid (Pure Earth, 2020b).

<u>Turmeric</u>

According to Bangladesh Bureau of Statistics (BBS), turmeric production in 2018-2019 was 147,439 MT with an estimated cultivation area of 70 thousand acres (BBS, 2020).

For the same financial year, 52,583 kg of turmeric was exported from Bangladesh fetching 24.6 million taka (approximately $300,000), which is five times the value received in 2015-2016 when export quantity was 22,805 kg (BBS, 2020). Bangladesh is the fifth largest turmeric producing country in the world, supplying 3 percent of global turmeric demand (The Financial Express, 2019). Following harvest, turmeric is cleaned, cured, boiled, dried, polished and ground into powder. Dried turmeric is polished to remove the outer dirty skin, roots and soil particles, eventually transforming into relatively smooth, bright and yellowish rhizomes. Three traditional methods of polishing turmeric fingers are found in Bangladesh. In one method, 3 to 4 kg of turmeric are placed in a sack and beaten on cement floors by hand. This operation is carried out manually, which is slow, tedious and labor-intensive. Another method used in hilly areas of Bangladesh involves putting 5 to 7 kg of turmeric in bags and beaten by a simple paddle operated device (Hoque & Hossain, 2018). Forsyth et al. (2019) describes another method of agitating by foot in a clay pot known as *chari.* Addition of color takes place at the polishing stage to reduce manual effort, time and achieve the desired color (Forsyth et al., 2019). Even with machine polishing, shorter polishing time can reduce wasted weight of the turmeric batch, creating incentives for machine polishers to add color. Based on field observations, Forsyth et al. (2019) found that acquiring polishing machines reduced the use of color, especially the amount of color added.

Tracing the supply chain for turmeric poses some difficulties. For example, Square Food & Beverages Ltd. (*Radhuni* brand*)* imports whole turmeric from India because it is cheaper and has better quality (Masoom, 2018). Existing market assessments do not separate out turmeric from the spice category. In the packaged spice market, *Radhuni, Pran, BD, Arku* are the key players. Radhuni has approximately 66% market share, Pran holds 19% market share, BD Food Holds 7% market share, Arku holds 3% market share and other brands hold 5% market share (EBL Securities Ltd., 2017). In 2013, US Food & Drug Administration found excessive lead levels on turmeric of *Pran* brand prompting a recall.

Although large-scale brand name Bangladesh spice processors have incentive to limit the amount of lead added to turmeric destined for export, the same cannot be said for other processors serving the local market and other export destinations lacking strict controls. The current system of periodic food safety checks may catch only a fraction of the adulterated turmeric being traded worldwide. Regulations have not focused attention on polishing mills and color merchants who sell lead- and chromium-containing yellow pigments. Turmeric-related food inspections are focused on grinding mills to check use of rice flour being mixed in, which is an offense that can result in fines of up to 600,000 taka ($7,000) and 3 years in jail (Forsyth et al., 2019).

3.3 Prior and Ongoing National and Subnational Programs Relevant to Lead Exposures and Health Impacts

There is currently a multi-disciplinary working group consisting of organizations active on the issue of lead in Bangladesh. The members include:

- Pure Earth
- United Nations Environment Programme
- Department of Geology, University of Dhaka
- Environment and Social Development Organization (ESDO)
- International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b)
- Stanford University
- International Lead Association
- UNICEF

This working group has quarterly calls to share updates and findings, as well as coordinate on upcoming activities. The group has the aim to evolve into a more formal and public-facing coalition.

Each of these members have on-going lead-related work in Bangladesh. For example, icddr,b and Stanford University have a long-term collaboration to research sources of lead exposure in Bangladesh. icddr,b is in the process of developing an intervention to reduce lead exposure among pregnant and lactating women in Bangladesh, and has active programs on turmeric and ULAB. In addition, icddr,b also formulated a training strategy fostering collaboration with key partners including universities and donors with the aim to deliver quality and need based education and training services. ESDO has undertaken a project in collaboration with UNEP and Pure Earth titled ‘The Environmentally Sound Management (ESM) of Used Lead Acid Batteries (ULAB) in Bangladesh’ which resulted in a national strategy on the ESM of ULAB in Bangladesh. ESDO has also done research on lead in cookware and paint.

Although there is currently no known coordinated lead program within the government, certain agencies have undertaken lead-related activities and appear to be devoting more attention to the issue of lead exposure. Until recently, there was no designated office within the Department of Environment to address chemical pollution specifically. However, within the past year, a Waste and Chemical Management branch has formed. Furthermore, the Ministry of Commerce has been active on the issue of turmeric adulteration. They have convened committees to control import of lead chromate and its use in the country and have suggested imposing a complete ban on imports until completing proper testing protocol is formed by the appropriate authorities (The Financial Express, 2019).

3.4 Health Systems

Bangladesh's healthcare system can be described as pluralistic, with four main streams of care - government, for-profit private sector, not-for-profit private sector (mainly NGOs), and international development organizations (Joarder et al, 2019). The discussion below will focus on relevant government entities.

3.4.1 Institutional Structure

The Ministry of Health and Family Welfare (MOHFW) is responsible for public healthcare and health policy, through various directorates.

The Directorate General of Health Services (DGHS) oversees all the healthcare delivery operations in the country, provides technical assistance to the Ministry in undertaking various new programs and interventions as well as execution of various policies. Additionally, it holds to the authority to encourage the development and implementation of strategies to identify and protect populations at risk, such as developing guidelines for environmental health. Several relevant sub-structures are described below:

The Policy, Monitoring and Research (PMR) of DGHS is mainly responsible for coordinating different ministries/departments, liaising for a multispectral approach, identifying gaps in knowledge, awareness raising and and mitigation of lead poisoning.

The Non-**Communicable Diseases Control (NCDC**) program of DGHS is responsible for the control of chronic diseases, such as cardiovascular diseases, diabetes, injury and disabilities. The impact of the environment on health, including pollutants such as lead, can fall within this authority.

The Institute of Epidemiology, Disease Control and Research (IEDCR) is responsible for epidemiological and communicable disease research and the functioning of disease control programs in Bangladesh. They also specialize in surveillance and research in various health issues including environmental health and pollution.

The National Institute of Preventive and Social Medicine (NIPSOM) conducts research and trains the public health workforce. The various courses, programs and research topics include community medicine, environmental health, occupational health, child and maternal health, and other related community health issues.

3.4.2 Complementary Programs

The government of Bangladesh supports a number of programs targeted at child health and well-being, to which lead awareness and prevention could be integrated. This includes school health programs, a collaboration of the Ministry of Health and Ministry of

Education. Another potential avenue is through adolescent clubs, supported by the Ministry of Women and Children Affairs.

3.4.3 Potential for Data Collection and Evidence Building

Currently, blood lead monitoring data at a regional or national level is limited, with the majority of information coming from disparate research initiatives. The availability of more comprehensive data would allow for the identification of contributing sources and timely, targeted interventions. It would also facilitate a focus on prevention, which is key to lead exposure as its neurological effects are irreversible. Blood lead data could be integrated into the MOHFW's existing routine health information system (HIS). This information is collected into the District Health Information System (2) database and platform, which has high uptake among health facilities. Widespread monitoring requires investment in the equipment required for conducting the testing, as well as capacity building for healthcare providers.

3.5 Lead Pollution/Source Management Capacities

A patchwork of laws and regulatory agencies are pertinent to lead pollution and lead exposures. Because lead has been identified as a threat both industrial areas and consumer products, agencies with seemingly very different missions are implicated.

3.5.1 Assessment of Chemicals Management Capacity

Chemicals management in Bangladesh has largely been addressed in a piecemeal fashion – with industry- or medium-specific policies (Syeda, 2020).

3.5.1.1 Relevant Agencies and Specific Mandates

Department of Environment (DoE)
This agency under the Ministry of Environment, Forest and Climate Change (MoEFCC) is tasked with maintaining ambient environmental standards and regulating environmental aspects and discharge standards of industries. Permitting authority for lead acid battery recycling and operating any industrial activity using lead belongs to the DoE.

As laid out in the Environmental Conservation Act (1995), the DoE is mandated to grant environmental clearances; undertake inspections of industrial units; prevent activities likely to cause environmental degradation; direct remedial measures for environmental harm; and formulate environmental guidelines. However, the DoE has significant staffing limitations. According to the World Bank (2018), the agency has 735 approved positions. This translates to 220,000 citizens per employee, whereas this same figure is approximately 56,000 in the Philippines and 20,000 in Mexico. The shortage of staff is

particularly evident at the divisional and district levels. Divisional offices typically have 5-6 staff and district offices typically have only 3 staff. These limitations are also evident in MoEFCC's budget. According to the 2017 Country Investment Plan for Bangladesh, the financing required to achieve the country's stated objectives in reducing industrial pollution is 651.6 million USD (MoEFCC, 2017); currently, only about 10% of that funding is available.

Based on Pure Earth's interactions over the past 10 years, the issues of chemical pollution and contaminated soil have in particular been under-resourced. Encouragingly, DoE has established a Waste and Chemical Management branch, under which lead pollution management falls.

Bangladesh Food Safety Authority (BFSA)
The BFSA, under the Ministry of Food, is a facilitating agency which coordinates the activities of the various agencies and organizations engaged in both policy formulation and implementation decisions around food safety, food production, import, processing, stockpiling, supplying, marketing and sales.

They support the entities/organizations directly involved in updating and upgrading the food safety standards or guidelines; in determining permissible limits at its highest safe level for use of contaminants and residue, additives or preservatives; in determining permissible limits of radiation in food; in formulating and implementing accreditation policies; in formulating procedural guidelines for accrediting food testing laboratories and requesting the government to increase the capacity of safe food controlling agencies and organizations.

Additional agencies involved in the food control system in Bangladesh include the Ministries of Agriculture; Fisheries and Livestock; Commerce; Law and Legislative Affairs; BSTI; DNCRP; and local governments, among others.

Bangladesh Standard and Testing Institution (BSTI)
The institute works for standardization of services and products, introduction of the international unit system of weights and measures, promotion of metrology services, promotion of quality assurance activities, rendering testing facilities for services and products, and preparation, promotion and adaptation of national standards. BSTI hosts and updates Bangladesh Standards (BDS) catalogue outlining product types and standards these must adhere to. Currently, there are standards for turmeric and lead paint which have been found to have lead levels above tolerable levels.

Ministry of Commerce and Ministry of Industry
Both the Ministry of Commerce and the Ministry of Industry are crucial in efforts to tackle lead pollution caused by used lead acid batteries given their role in amending/adding regulation and implementation of policies applicable to both domestic and foreign trade. Furthermore, the Directorate of National Consumer Rights Protection (DNCRP) sits under the Ministry of Commerce. The DNCRP was founded in 2009

through the Consumer Rights Protection Act, 2009. Anyone can file a complaint against anti-consumer activities that includes adulteration of food items. The DNCRP has officers in 48 districts of which 16 districts are covered by giving additional responsibilities to different officers, instead of them working exclusively for the directorate.

The Ministry of Commerce has also been active on the issue of turmeric adulteration. They have convened committees to control import of lead chromate and its use in the country, and have suggested imposing a complete ban on imports until completing proper testing protocol is formed by the appropriate authorities (The Financial Express, 2019).

3.5.1.2 Laboratories and Environmental Quality Monitoring

Laboratory facilities for elemental analysis such as lead vary for products and environmental mediums. The Department of Environment has laboratories in six divisional offices engaged in environmental monitoring of water and air quality. Laboratories are not available near industrial clusters of Gazipur, Narayanganj and Narsingdi which complicates enforcement of discharge or ambient standards.

Analytical capability is limited in the Department of Agricultural Extension (DAE) laboratories to test all of the pesticides marketed in Bangladesh. This has affected checking for heavy metals such as lead, cadmium, and persistent organic pollutants (POPs) impurities with low concentration in active ingredients. In 2007, it was reported that none of the existing laboratories in Bangladesh had yet to achieve Tier 1 capacity recommended by UNEP guidance for global monitoring for any of the POPs (DoE, 2007).

BSTI operates laboratories for cosmetics and food products. Cosmetics products are tested in specialized labs under the Chemistry division, while there is a dedicated spice and condiments laboratory under the Food and Bacteriological division. Appendix D includes testing details of product of interest for this report.

Although the role of Bangladesh Council of Scientific and Industrial Research (BCSIR) is to engage in basic and applied research in multiple disciplines, their laboratories in three divisions (Dhaka, Chattogram and Rajshahi) can conduct elemental analysis of both consumer products and environmental samples. Appendix D includes lead-related analysis BCSIR laboratories are equipped to deliver.

Mohiuddin (2019) lists other laboratories also involved in food safety analysis –

- Public Health Laboratory (IPH)
- SGS Bangladesh (private internationally recognized laboratory)
- Bangladesh Atomic Energy Commission (autonomous-government organization)
- Food Testing Laboratory (Ministry of Food and Disaster Management)
- Food Testing Laboratory (Dhaka City Corporation)
- Institute of Food Radiation Biology, Bangladesh Atomic Energy Commission

- Institute of Food Science Technology, BCSIR
- Institute of Nutrition and Food Science, University of Dhaka

3.5.1.4 Information Management Systems and Databases

As we are now connected with the Waste and Chemicals Branch, we will be seeking a clearer understanding of existing data management practices. At this point in time, we are not aware of any inventory of lead-contaminated sites in Bangladesh beyond the TSIP database. We seek to understand what systems DoE currently has for tracking environmental compliance and enforcement actions within the formal sector.

Similarly, we will be seeking further information on how BFSA tracks compliance among turmeric producers regarding adulteration, and if the DNCRP holds such information regarding consumer products.

3.5.2 Legal Framework

3.5.2.1 Policy-making Process

The policy making process in Bangladesh is an overall outcome of incentives created by patronage politics. Factors strongly affecting the public policy formulation and implementation process include—assistance and extent of pressure and persuasion from international development partners, and the capacity to mobilize and manage resources. The most critical determinant of policy formulation and implementation in Bangladesh is the political commitment (Shakil and Noman, 2016).

Despite Bangladesh's declining dependency on foreign aid, external stakeholders still influence the country's internal policy making process. The eventual impact on the quality of governance depends on the strategic interplay among all actors including politicians, bureaucrats, private sectors and NGOs. The Planning Commission is another central planning body of Bangladesh. It includes professionals and sector specialists engaged in formulating the government's macro- and micro-economic plans and policies. (Shakil and Noman, 2016)

3.5.2.2 Existing Legislation

Environmental Conservation Rules 1997 (ECR)

The Environmental Conservation Rules 1997 (ECR) Schedule-3 (B) sets the standard for lead in drinking water at 50 ppb. This standard is now more than twenty years old, and an amendment to the ECR is currently under consideration. It would lower the standard for lead to the WHO guideline value (10 ppb).

Currently, there are standards for wastewater emissions from specific sectors (ECR Schedule-12) and a set of catch-all standards for industrial units which do not fall within

those sectors and which depend on where the effluent is being discharged (ECR Schedule-10). The standard for lead under Schedule-10 is 100 ppb. These standards apply to the effluent itself, not the receiving water body where dilution would occur, and thus allow a comparatively high concentration. Changes to the sector-wise and catch-all standards are under consideration in the upcoming amendment.

No standard for the maximum allowable concentration of lead in soil was identified for Bangladesh.

Statutory Regulatory Order (SRO) No. 175-Act/2006

This regulatory order laid out instructions on collection and recycling of used/non-functional batteries for controlling and preventing environmental pollution. According to this SRO, no battery recycling will be permitted without environmental clearance from DoE. Restrictions were imposed on improper disposal of used batteries or any parts of used batteries in open space, water bodies, waste bins etc. All cast-off batteries must be sent to the DoE-approved battery recycling industry at the earliest convenience and no financial transaction is allowed for used/non-functional batteries. This SRO was later amended 2008 (SRO No. 29-Act/2008 dated February 11, 2008) to allow financial transactions on mutually agreed fixed cost (IDCOL, 2018). In 2018, another amendment to this SRO was proposed and stakeholder meetings were organized jointly by the DoE and Accumulator Battery Manufacturers and Exporters Association of Bangladesh (ABMEAB). While details of the amendment are not available yet from these institutions, it is expected to attempt to rein in the activities of unauthorized recyclers by compelling battery manufacturers to only buy lead from authorized recyclers (Channel i News, 2018).

The SRO is applicable only to formal facilities and does not present any strategy to address the widespread informal battery recycling and manufacturing, despite the prevalence of these operations and the high level of contamination they leave behind, as documented in Pure Earth's TSIP database.

Hazardous Waste and Ship-Breaking Waste Management Rules 2011

This law implemented by DoE applies to battery recyclers binding them to submit information periodically about the volume of recycled products, recycling processes and environmental impacts. The rules also direct the parties (transport included) to follow environmentally sound processes—failure of which can result in penalties according to Section 15 of the *Environment Conservation Act 1995*, which is the umbrella Act for environmental matters. This law also lays out a classification system for hazardous waste. A substance is considered hazardous if it contains one of 684 chemicals above a specified concentration. The concentration for lead and lead compounds is 5000 ppm. There is very little information regarding how industries and the Government use or enforce these standards in practice, as Bangladesh does not have a hazardous waste landfill where hazardous materials or the furnace residues from smelting processes could be safely disposed (World Bank, 2018).

Consumer Rights Protection Act 2009

The Act identified sale of any goods containing any ingredient that is injurious to human health and the mixing of such ingredients with any food item an anti-consumer rights practice. Section 42 of the Act mentions that any person mixing any ingredient with foodstuff which is injurious to human life or health and the mixing of which with foodstuff is prohibited by any act or rules, shall be punished with imprisonment for a term not exceeding 3 (three) years, or with fine not exceeding taka 2 (two) lacs, or both. However, it is not clear if this Act can be used to effectively control spice adulteration since Section 60 of the Act limits acceptance of a complaint if not made within 30 days of any anti-consumer rights practice. Furthermore, Section 71(1) states that a consumer cannot file a case directly before the court of the magistrate as under this law permission needs to be obtained from the Director General of DNCRP (Chandan, 2017).

Safe Food Act 2013

This Act replaced earlier patchwork of Pure Food Ordinances that was first enacted in 1959 and amended in the following decades. This Act came into force on 1st February 2015 and created BFSA as the implementing agency. Section 24 of the Act restricts "use or inclusion in any article of food or food ingredient any radioactive or irradiated matter or naturally of otherwise occurring similar matter or heavy metal in violation of maximum acceptable limit prescribed by regulations or by any other law for the time being in force." First time violation of section 24 can result in imprisonment for 3 to 4 years or a fine not less than four lakh taka and maximum eight lakh taka. Repeat offenders can be penalized with imprisonment for four years or a fine of sixteen lakh taka, or both.

Food Safety (Contaminants, Toxins and Harmful Residues) Regulations, 2017

This technical standard provides maximum tolerable limits for food additives. Schedule 1 lists food categories and maximum tolerable limits for heavy metals including lead. Interestingly, turmeric or spice as a broader category is not listed in Schedule 1.

Pesticides Act, 2018

This Act is the latest version that adds to the series of ordinances and previous legislations on this issue. It only covers the registration process and licensing for selling or manufacturing pesticides, but there is no mention of pollution or environment protection issues (Arifuzzaman, 2019). Pesticides are not routinely tested for lead.

Product Standards Enacted by BSTI

The following product standards enacted by the BSTI relates to the major sources of lead exposure in Bangladesh (BSTI, 2018).

Paint:	BDS 106:1960, BDS 107:1960, BDS 110:1960, BDS 1215:1989 *Most recent standards limit lead content at maximum 90ppm (Hossain, 2018).*
Lead Acid Batteries:	BDS 206, BDS 479. *BSTI recently announced development of standards for lead acid batteries used in solar home systems (Parvez, 2020)*.

Gasoline:	BDS 346:2010, BDS 347:2010, BDS 1320:1991
Turmeric:	BDS 991:2001, BDS 992:2015 *It sets 2.5 ppm as the maximum allowable level of lead in turmeric.*
Utensils:	BDS 1108:1984, BDS 1109:1984

International Conventions

Bangladesh has signed and ratified the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes. To address hazardous wastes under the Basel Convention, Bangladesh has done the following (Abdullah. M.M., 2007):

- Defined hazardous waste under the Bangladesh Environment Conservation Act, 1997.
- Banned import of all sorts of waste in the Import Policy Order.
- Prepared the “Regulatory Framework on Import of Hazardous and Toxic Materials” through a project funded by the Asian Development Bank.
- Organized training programmes on “Toxic Chemicals and Hazardous Waste” and “Risk Assessment and Management.”
- Drafted a position paper on use of toxic chemicals and disposal of toxic and hazardous wastes in Bangladesh.
- Drafted a National Chemical Profile.

As of 2020, Bangladesh participates in the Strategic Approach to International Chemicals Management (SAICM) (Syeda 2020). Although Bangladesh is a member of the International Labor Organization (ILO) and has ratified a number of its conventions, the country has not signed the Chemicals Convention 1990 (No. 170) providing the basis for the sound management of all types of chemicals at the workplace and Prevention of Major Industrial Accidents Convention, 1993, as of 2020 (Syeda 2020).

3.5.3 Role of NGOs

Non-governmental organizations engage on the issue of lead through various lenses in Bangladesh. For advocacy and activation specifically around lead, the Environment and Social Development Organization (ESDO) has played a vital role for over a decade. To address the issue of lead paint, ESDO tested paint samples, drafted guidelines, and organized meetings with DoE and BSTI. ESDO has also conducted research on aluminum cookware and is currently partnered with Pure Earth and UNEP to generate national policy recommendations around ULABs.

For policy advocacy and activism on environmental issues in general, prominent groups include Bangladesh Poribesh Andolon (BAPA), and Bangladesh Environment Network (BEN), and perhaps most prominently, the Bangladesh Environmental Lawyers Association (BELA). Their legislative advocacy has culminated in several constitutional and legal amendments (Khan, 2017). Their legal action against owners of shipbreaking

yards and government agencies were instrumental in bringing changes to the regulatory framework concerning shipbreaking.

For consumer products, advocacy groups such as Consumers Association of Bangladesh (CAB) are vocal on issues related to food and product safety. CAB and FAO's Food Safety Project formed the Bangladesh Food Safety Network (BFSN) in 2011. Along with CAB, four other NGOs—B-SAFE, Shishuk, Hunger Free World and UBINIG—make up the food safety network. Their activities in dealing with lead-contaminated turmeric are not publicly available. These organizations are working primarily on food safety issues in the areas of consumer education, monitoring and food product testing, advocacy, research and grassroots mobilization.

The Accumulator Battery Manufacturers and Exporters Association of Bangladesh (ABMEAB) represents the formal battery sector and is an important partner in addressing ULAB recycling. They have provided input to the DoE and have expressed an interest in collaborating with Pure Earth on future initiatives.

3.5.4 Involvement of Academia and Research Institutes

The following academic institutions support research and/or training related to environmental health, pollution and toxic site identification.

Since 2011, the Department of Geology at the University of Dhaka in collaboration with Pure Earth has implemented the Toxic Site Identification Program (TSIP), which aims to identify and screen contaminated sites and assess public health risks. Prior to initiating TSIP site assessments, all investigators are trained in the assessment methodology and the TSIP database, as well as principles of environmental health and exposure science. A field visit is made by the group to demonstrate the methodology. A range of representatives have participated in these trainings since the inception of the TSIP program in Bangladesh, including staff from the Department of Environment and ESDO. Under the TSIP program, investigators identified and assessed the Kathgora site in Savar district of Dhaka that is among the 288 informal battery recycling sites in Bangladesh.

In terms of academic training at the University of Dhaka, the B.S (Honors) in Geology included relevant courses aimed at building country capacity on environmental health. These comprised: environmental chemistry (introduction to solid waste pollution, toxic metal analyses), geochemistry (toxic pollutants and their impact on environmental health and ecology) and environmental geology (human interaction with the environment, including pollution, waste disposal, and environmental laws).

The International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) and Stanford University, in the United States, have a long-term collaboration to research sources of lead exposure in Bangladesh. Forsyth et al. (2018) conducted a case control study to evaluate the prevalence of elevated blood lead levels among pregnant women in rural Bangladesh and to identify sources of lead exposure. Raihan et al. (2018)

conducted a cross sectional study of children under 2 years of age in Bangladesh slum to examine the relationship between blood lead level and stunting, wasting and underweight. The icddr,b is in the process of developing an intervention to reduce lead exposure among pregnant and lactating women in Bangladesh, and has active programs on turmeric and ULAB. In addition, icddr,b also formulated a training strategy fostering collaboration with key partners including universities and donors with the aim to deliver quality and need based education and training services. The flagship training courses also include urbanization and environmental health.

The National Institute of Preventive and Social Medicine (NIPSOM) is a national public health institute in Dhaka which offers graduate level public health training. The institute has also been involved in lead-related research. In a collaboration between Dr. Arif Sikder of Virginia Commonwealth University and NIPSOM, a toxicity assessment of ash and dust from handmade gold jewelry manufacturing workshops in Bangladesh was conducted in 2017. SEM/EDS analysis revealed high concentration of cadmium, chromium and lead. Ahmad et al. (2014) conducted a cross-sectional study among workers of lead acid batteries (LAB) manufacturing located in Dhaka to measure the blood lead concentration and to assess the magnitude of health problems attributable to lead toxicity.

At North South University, a graduate program MS in Environmental Science and Management has been established in collaboration with University of Manitoba, Canada. This program focuses on environmental and natural resource governance and management capacity in Bangladesh. The courses here include: resources and ecological economics; pollution control: scientific, regulatory, fiscal and other instruments; causes and effects of water, air, soil and noise pollution; air quality standards; gaseous and particulate matter pollution control techniques; noise measurement and control; water quality standards; effluent treatment and plant solid waste management, hazardous waste management and risk analysis; and case studies of pollution control strategies and regulations from national to global contexts.

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APPENDIX A: Summary of short and long-term recommendations, for discussion

Below are recommended next steps for addressing various sources of lead exposure and for developing a coordinated national response in Bangladesh. These next steps can be built upon and adapted through discussion during the Lead Pollution and Health Workshop to reach a unified strategy.

Used Lead-Acid Battery Recycling

Short term

1. **Establish a multi-sectoral stakeholder engagement group** including different departments and ministries (including but not limited to Environment, Health, Finance, Commerce, Education, ABMEAB, BSTI).
2. **Review and assess current environmental performance standards** for ULAB recyclers of the government, IDCOL, and international bodies (for example, Basel Convention, UNEP) to ensure alignment around a uniform set.
3. **Identify current needs for training or technical assistance around the environmentally sound management (ESM) of ULAB** that will help ensure good governance, enforcement and supervision of the industry.
4. **Perform economic analysis of economic tools/instruments** that will support environmentally sound management of ULAB such as taxation adjustments or a deposit refund scheme (DRS) to ensure that the instrument is feasible and likely to achieve the desired outcome.
5. **Develop a national inventory** of active and legacy illegal ULAB recycling sites across the country (potentially building off of the existing data in Pure Earth's Toxic Site Identification Program).
6. **Raise consumer awareness** about health, environmental and economic impacts of illegal and substandard ULAB recycling processes, as well as how to select and maintain the appropriate battery for different uses. This can be done through awareness campaigns using social media, conferences, workshops, articles in newspapers etc.

Long term

1. **Support the elaboration of Statutory Regulatory Order (SRO) into a full law and enforcement of the conditions laid out in the SRO** for those involved in ULAB collection and recycling activities.
2. **Implement economic tool to incentivize the recycling of ULABs in the formal sector.**
3. **Develop program to assess, prioritize and remediate sites** contaminated by ULAB activities.

Other Lead-related Industries

Short term

1. **Implement systematic monitoring and assessment around lead-related industries** (for example, metal working, jewelry ash recycling, e-waste recycling), particularly in residential or mixed-use areas.

Long term

1. **Improve environmental controls, identify alternatives methods, or relocate** industries found to be putting communities at risk of lead exposure.

Consumer Products

Short term

1. **Support research organizations to quantify the extent and sources of lead exposure** through source identification studies across regions and demographic groups in Bangladesh.
2. **Conduct market assessments** to quantify and characterize the distribution of lead contaminated products across Bangladesh.
3. **Continual public education campaigns** about the dangers and sources of lead in consumer products can help bring about behavioral changes. This can be done through awareness campaigns using social media, conferences, workshops, articles in newspapers etc.

Long term

1. **Systematic monitoring and enforcement** of products known or suspected to contain lead, especially by BFSA and BSTI.

Health Sector

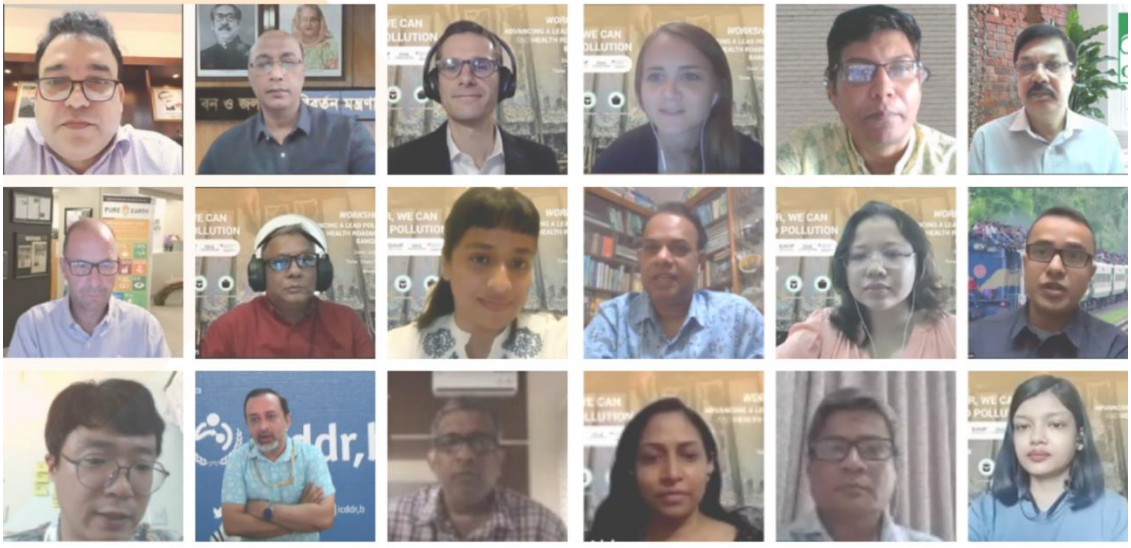
Short term

1. **Capacity building workshops for service providers** to raise awareness about health and environmental impacts of lead poisoning, its possible sources (including industrial sources or consumer products), and how to mitigate exposure.
2. **Build technical capacity and institutional knowledge for BLL testing.**
3. **Facilitate multi-sectoral coordination** among health, environmental, education and communication sectors for increasing awareness and capacity building on lead poisoning.

Long term

1. **Strengthen blood lead levels (BLL) monitoring and reporting systems** with central surveillance data system to collect and maintain elevated blood lead levels. This will enhance the government's ability to identify and monitor sources of lead exposure allowing for proper resource allocation.
2. **Build capacity for evidence-based decision making**. By building technical capacity and institutional mechanisms to fully address the impact of environmental pollution, this issue could be integrated into existing health programs.

APPENDIX B: Virtual Workshop Report – ‘Advancing a Lead Pollution and Health Roadmap for Bangladesh’



VIRTUAL WORKSHOP REPORT

ADVANCING A LEAD POLLUTION AND HEALTH ROADMAP FOR BANGLADESH

Prepared by: Pure Earth Bangladesh

19 July 2021

Executive Summary

"Together, we can end lead pollution." On 19th July 2021, **Pure Earth Bangladesh**, in coordination with the **Bangladesh Department of Environment (DoE)** and with support from **United States Agency for International Development (under Cooperative Agreement No. AID-OAAA-16-00019)**, **OAK Foundation, Swiss Agency for Development and Corporation SDC,** and the **Global Alliance on Health and Pollution (GAHP)** held a virtual workshop titled *'Advancing a Lead Pollution and Health Roadmap for Bangladesh'*. The workshop convened stakeholders with three goals: to share the state of knowledge about lead exposure from all sources in Bangladesh; build a common understanding of the related challenges, and lay the groundwork for a unified approach to lead exposure reduction. The event was enriched by more than 65 diverse sets of experts representing government agencies, national and international civil society organizations, research and academic institutions, and development agencies. The workshop, also attended by print and electronic media agencies, received excellent media coverage.

Despite the severe impacts of lead on public health and economic development, few programs and policies exist to adequately control contemporary lead sources, reduce exposures, and identify and treat lead-poisoned children. There is also a lack of communication and coordination among stakeholders and no unified plan at the national level. The overwhelming outcome of the meeting was that lead poisoning in Bangladesh should be viewed as a public health crisis. The speakers and participants shared recommendations to improve this situation, with a particular emphasis on establishing a multi-stakeholder approach with the leadership of the relevant government ministries to eradicate community lead exposure. Participants also discussed preparing comprehensive lead pollution studies, developing a national inventory on lead pollution sources, and importantly, a time-bound national action plan.

Additionally, the following topics were deemed to be of high priority to properly implement the roadmap – improved occupational health safety in lead-related industries, identifying community areas that are contaminated with lead and taking steps to restore these communities, increasing the monitoring capacity of the Department of Environment and the Ministry of Industry, addressing the import of lead chromate as a pigment, and ensuring effective industrial waste management. The participants and speakers highlighted the need for mechanisms to shift illegal, informal used lead-acid battery recycling industries to registered facilities, and consider options for alternative livelihoods among workers in informal lead industries. There were also suggestions for awareness building among the public and policymakers, and the organization of various training sessions and workshops to enhance the knowledge and skills of stakeholders related to lead pollution.

Notably, during the workshop, the Additional Secretary of the Ministry of Environment, Forest, and Climate Change committed to prioritizing the issue of lead exposure within the Ministry and requested the DoE to take the lead in a joint, multi-stakeholder approach to eradicating lead pollution.

Objectives

The primary goal of the workshop in support of the Lead Pollution and Health Roadmap was to help the Government of Bangladesh and partner organizations share current information and move towards a coordinated, unified and multi-sectoral approach to address lead pollution challenges.

The overall goals of this workshop were:

- **Understand how lead work in the country is evolving**
- **Build a common understanding of lead challenges, sources, impacts, and opportunities**
- **Develop common goals and strategies to mitigate lead exposures**

Major Insights from the Workshop

The following are key points from the speakers and participants:

Welcome Speech: *Abdullah Al Mamun, Deputy Director, Chemical and Waste Management Unit, DoE*

- Bangladesh is one of the most lead impacted countries in the world.
- The average blood lead level in children in Bangladesh is 7.5 mcg/dL, which is 50% higher than the common health guidelines.
- 4% of total deaths in Bangladesh are caused by direct or indirect exposure to lead pollution, making Bangladesh the 4th most impacted country in the world.
- Almost 70% of intellectual disabilities in Bangladesh are caused by lead pollution.
- The economic loss caused by the effects of lead pollution is equal to 6% of Bangladesh's GDP or 50% of the total income generated from apparels and textiles.
- The Bangladesh government has recently issued a special SRO on ULABs.
- The government will enforce the e-waste management rules of 2021.
- Pure Earth and the Department of Environment are working closely to combat lead pollution especially to control the sources of lead, reduce the exposure, and identify and treat children who are exposed to lead.
- With the input from multiple sectors, a strategic paper is being developed on the sources and impacts of lead exposure in Bangladesh. It will provide a strategic framework to align the government and non-government agencies, academia, national and international development agencies, and many other relevant stakeholders.
- Alternative livelihoods options should be created for the ULAB recycling workers to make the shift towards the formal sector.

- He suggested that the Coordination committee can be formed in the Ministry and the technical committee can be formed under the leadership of the Director-General of the Department of Environment (DoE) to prevent lead pollution.

Background and efforts to date: *Andrew McCartor, VP, Strategy & Partnerships, Pure Earth*

- There has been a positive change on the issue of lead – many organizations have picked up lead as a priority (University of Dhaka; ESDO; icddr,b; Stanford University; UNEP; UNICEF; International Lead Association; Accumulators Battery Manufacturers and Exporters Association of Bangladesh). The government has been active on this issue.
- Pure Earth has observed that donor organizations are interested in working on eradicating lead in Bangladesh.
- There is room for more coordination and communication between the government, the NGOs, universities, UN groups, the donors, and various stakeholders to striving common goals and strategies. Until now the projects have been somewhat intermittent and siloed.
- There is a very strong justification for further work on lead in Bangladesh.
- Bangladesh has banned lead in paint which is a significant achievement and a great step forward, but it was not a silver bullet to solve the problem completely. In the west and high-income countries, the death rate due to lead exposure declined after banning lead-based gasoline, but in Bangladesh, it has increased over the last three decades.
- Pure Earth has documented 300 lead-contaminated sites in Bangladesh.
- The chief concern of lead exposure is its impact on children's brains. Lead causes permanent brain damage and IQ loss, and as a result, decreases economic productivity.
- Productivity losses from lead exposure reduce Bangladesh's GDP by about 16B USD (1.3T Taka) annually, thus lead is not only a health issue but a poverty-reduction issue.
- The safe management of the ULAB also is critical to address climate solutions.

The full presentation on the ***'Background and efforts to date'*** *is included in* ***Annex A.***

Lead exposure sources: current status and needs: *Dr. Shahriar Hossain, Ecologist, General Secretary, Environment and Social Development Organization (ESDO)*

- It is important to understand what are the sources of lead and to understand why Bangladesh is among the most highly exposed countries.
- More discussion is needed around the source of lead in consumer products and there is a need for effective guidelines and regulations which are currently not available.

- Contamination of soil due to lead is a serious issue, as it ends up in the food chain.
- Gold ash processing is a recently-discovered source of lead exposure in Bangladesh.
- Spices, particularly turmeric, cause exposure to lead. icddr,b has researched this extensively.
- World Bank estimates there are 1100 informal ULAB recycling sites. ESDO estimates 2000+.
- Shifting ULAB recycling from informal to formal sector is very important.
- There are a growing number of relevant rules and regulations (e-waste, updated SRO on LABs 2021, household paint standard 2018), but enforcement is a problem. Inspectors, officials, and stakeholders need to be aware of the sources and impacts of lead.
- Public awareness and participation, behavior change are important.
- Recent studies have identified lead in food (rice, vegetables, and liquid milk). We have to understand how lead is entering in the food chain.
- Regional and global cooperation is required.
- Government should establish a holistic national framework that considers all sources of lead, with provisions for monitoring and enforcement.

*The full presentation on the **'Lead exposure sources: current status and needs'** is included in **Annex B.***

***Opportunities in the health sector:** Dr. Anwar Sadat, Deputy Program Manager, Planning, Monitoring and Research (PMR), Directorate General of Health Services (DGHS)*

- There is currently no routine blood lead level (BLL) testing in Bangladesh, but research efforts indicate that children in Bangladesh are among the most highly exposed to lead globally.
- All BLL data is currently conducted by development partners or research institutions. The government has not yet generated evidence on the current situation.
- A recent systematic review in 2021 estimates the mean BLL in Bangladesh is 7.87 µg/dL.
- Research has indicated seven districts as lead hotspots – Dhaka, Gazipur, Tangail, Bogura, Mymensingh, Khulna, and Magura.
- Several lead pollution causes were highlighted – pesticide use, industrial waste (including ULAB), shipbreaking, turmeric processing.
- ULABs are imported from India, recycled, and the lead is sold back to India.
- Comprehensive data on contributing sources are needed to respond to interventions.
- Prevention is the key due to lead's long-term effects.
- Blood lead level testing provides information on acute exposures but to get an understanding of cumulative lead exposure, bone lead level testing is needed.

- The health sector cannot do this alone. Multi-sectoral cooperation is needed.
- DGHS already formed a Technical Implementation Committee for PECP. PMR is considering establishing multi-sectoral activities and a committee to lead this project.
- Current initiatives:
  - Health Sector Situational Analysis (in development phase). Similar analyses should be carried out by the Ministries of Environment and Industry.
  - In process of developing communication materials for national campaigns and training modules for health service providers, particularly in lead-affected areas.
  - Raising awareness of lead poisoning in health systems and structures. Meeting with health sector regulatory bodies and research organizations to help with this.
  - Integrating lead pollution into policies and programs.
  - Establishing multi-sectoral networking and collaborations for synergistic impact with relevant stakeholders (may convene after Eid).

*The full presentation on the **'Opportunities in the health sector'** is included in **Annex C.***

***Possible next steps:** Andrew McCartor, VP, Strategy and Partnerships, Pure Earth*

***Structure of recommendations:** short- and long-term interventions in four categories:*

1. *Used lead-acid batteries*
2. *Other lead-related industrial sources*
3. *Consumer products*
4. *Health Sector*

1. Used lead-acid batteries

Short-Term Steps:

- Establish a multi-sectoral stakeholder engagement group with government leadership
- Review and assess current environmental performance standards
- Identify current needs for training or technical assistance around the environmentally sound management (ESM) of ULAB
- Perform an economic analysis of economic tools/instruments
- Develop a national inventory of active and legacy illegal ULAB recycling sites
- Raise public and consumer awareness

Long-Term Steps:

- Support the elaboration of Statutory Regulatory Order (SRO) into a full law and enforcement of the conditions laid out in the SRO
- Implement an economic tool to incentivize the recycling of ULABs in the formal sector.

- Develop a program to assess, prioritize and remediate sites

2. Other lead-related industrial sources

Short-Term Steps: Implement systematic monitoring and assessment around lead-related industries

Long-Term Steps: Improve environmental controls, identify alternatives methods, or relocate

3. Consumer products

Short-Term Steps:

- Support research organizations to quantify the extent and sources of lead exposure
- Conduct market assessments
- Continual public education campaigns

Long-Term Steps: Systematic monitoring and enforcement

4. Health Sector

Short-Term Steps:

- Capacity building workshops for service providers
- Build technical capacity and institutional knowledge for BLL testing
- Facilitate multi-sectoral coordination among health, environmental, education, and communication sectors

Long-Term Steps:

- Strengthen blood lead levels (BLL) monitoring and reporting systems (including source identification and interventions)
- Build capacity for evidence-based decision making

*The full presentation on the **'Findings on next steps'** is included in **Annex D.***

Major insights from the Open discussion and Q/A session on the next steps:
Moderator: Dr. Mahfuzar Rahman, Country Director, Bangladesh, Pure Earth

Dr. Mahbub, icddr,b

- It is important to inform the public about the situation and sensitize the print and electronic media to play a crucial role in creating awareness in the public about the sources and effects of lead pollution and spurring government bodies to act.

- As most people may not be aware of the harmful effects of lead, community awareness on this issue should be raised before taking regulatory actions.
- Many countries are using lithium-ion batteries or long-lasting batteries and noted that lead-acid battery quality is low in Bangladesh, so alternatives should be considered.
- The efforts of Pure Earth and the U. of Dhaka in identifying and mapping ULAB recycling sites in Bangladesh are laudable. Informal recyclers rapidly move and create new contaminated sites, so ongoing surveillance is needed (not just ULAB sites, but others like e-waste).
- The occupational health and safety hazards of working with lead are significant and it is important to educate workers working directly with lead.
- The Ministry of Industry and Ministry of Commerce should monitor the import of lead chromate as a pigment so that misuse of the compound does not happen (as an additive in turmeric). Food safety inspectors and workers from different sectors at the sub-district level could be trained and equipped to monitor.
- The informal ULAB recycling industry is growing and sustaining in Bangladesh because of the current cost-benefit scenario. Industry wants the government to subsidize the formal recycling of ULAB. Currently, the formal sector is mostly only refining, while the informal sector is doing most of the recycling.

Md. Zia-ul Haque, Director, Dhaka Region, Department of Environment (DoE)

- Md. Zia-ul Haque expressed his support for the short- and long-term recommendations.
- A multi-sectoral coordination committee is important and the MOEFCC should take the lead on this issue.
- It is important to conduct a national inventory of all sources of lead pollution and create a time-bound action plan (roadmap) to tackle this issue.
- DoE is supportive of action in the area and is committed to continued involvement, leadership, and coordination with DGHS, icddr,b, ESDO, Ministry of Commerce, and Ministry of Industry.
- As he has observed in his current role as Director of Dhaka Region, it is important to monitor lead pollution from industrial sources.
- There is a need to consider existing legislation to advance our future strategy.
- DoE now has a Chemical and Waste Management branch; a holistic approach to lead and mercury could be considered.

Mostafa Yusuf, Reporter, The Daily Star

- Recently the government destroyed 16 recycling facilities near Dhaka, but that these illegal sites keep cropping up, so strict monitoring from the government is needed to ensure that closed illegal ULAB recycling sites are not reopened. Increased manpower and logistics from the government are needed to respond.

- He noted that he was unaware of the impact of lead contamination and got to know about this serious issue by reading the articles of Dr. Mahfuzar Rahman and from this workshop.

Dr. Aoerangajeb Hossain, Researcher, DGHS

- As a researcher of environmental health, particularly heavy metals and suitable technologies for waste remediation, he reiterated concern over the occupational health of workers in lead industries.
- Effective waste management across all sectors, especially industrial waste, is important because contaminated waste ends up affecting health through different pathways, including the agricultural chain. Tannery waste in particular contains lead.

Dr. Minjoon Kim, Health Specialist, Health section, UNICEF

- UNICEF, DGHS, and Pure Earth are collaborating and working to mainstream lead poisoning issues of the health sector.
- UNICEF is helping the DGHS in conducting studies on assessment of the capacity of the healthcare sector and the treatment options for lead poisoning. It is important to have a "no one is left behind" approach to lead poisoning.
- This event will help create opportunities for wider consultation.
- UNICEF is very keen to collaborate with other government departments as well to form a multi-sectoral approach to this issue. They are also working on developing policy advocacy documents.

Irfan Noor

What options do consumers have in terms of alternatives to lead-acid batteries, spices tainted with lead, if they want to reduce lead exposure?

- *Response (Andrew McCarter, Pure Earth):* We need to develop communication materials to inform the public about these options and alternatives, and we can explore more about them in the future.

Zohura Sikdar, Deputy Director (Chemical), BSTI

BSTI has updated its standards for toys, cosmetics, household paint, and fuel oil; BSTI standards follow ISO norms.

Speech: Chief Guest: *Mr. Ahmed Shamim Al Razi, Additional Secretary, Ministry of Environment, Forest and Climate Change*

- Shamim Al Razi committed on behalf of the *Ministry of Environment, Forest, and Climate Change* to start working on the eradication of lead exposures. He added that the Department of Environment should take the lead to mainstream this issue with

proper actions as this department is committed to prevent exposures to hazardous chemicals.

- The government's election manifesto also pledges to play an effective role in protecting and developing the environment
- The government has made it a priority to protect the environment for future generations.
- Lead pollution is a cross-cutting issue that includes multiple stakeholders.
- The relevant government departments and ministries to work closely on this issue are the Ministry of Environment, Forest and Climate Change, the Department of Environment, Ministry of Health, Ministry of Commerce, Ministry of Industry, and the Local Government Division (LGD).
- The local government has a crucial role in raising awareness and battling this issue at the community level.
- An existing study found seven districts that have lead contamination, of which Chittagong was not included. Further studies of lead contamination should be conducted in the Chittagong district since the shipbreaking industry, a source of lead pollution is mostly located there.
- In the circulated notice of DoE to prevent lead contamination of old or useless lead-acid batteries, as per the Section 6A of Bangladesh Environmental Protection Act 1995 and through SRO No. 175-Act / 2006 and SRO No. 29-Act / 2008, the Government has imposed conditions on collection and recycling activities and management.
- The Minister has acknowledged the severity of the lead pollution and expressed to develop projects mitigating this issue as soon as possible.
- Shamim Al Razi gave the following recommendations as steps to prevent lead pollution:

  - The Department of Environment and other relevant government bodies will commit to joining existing multi-stakeholder platforms focused on lead, to facilitate regular communication and coordination across Ministries, NGOs, research teams, and institutions.
  - Support the transition of used lead-acid batteries from informal recycling to registered facilities, and ensure registered facilities are operating to high environmental performance standards.
  - Immediately identify community areas contaminated with lead, where children are being put at risk for disability, and develop a plan to fix them and return them to as a safe place.
  - The way the Government is increasingly monitoring and imposing taxes and fines for the pollution of water by the industrial units to prevent the loss of surface and groundwater quality due to the removal of untreated waste by various industrial

units. Similarly, especially soil contamination by lead pollution should be monitored and enforced by the ministry.
- The other means of lead contamination discussed in the workshop need more in-depth research.
- Organize various trainings and workshops to enhance the skills of different stakeholders.

Concluding remarks by the Chair and meeting adjournment: *Mr. Ashraf Uddin, Director General, Department of Environment (DoE)*

- Achieving sustainability goals is one of the six main goals of the Eighth Five-Year Plan of the country. With that goal in mind, the Bangladesh government has given priority to reducing air and water pollution, increasing greening, and conserving biodiversity.
- To conduct mobile court against the person/ organization violating the Environmental Protection Act and rules and to take legal action by filing a case in the Environmental Court; to encourage people's participation in environmental protection and management, the ministry is actively carrying out various activities including establishing partnership activities with various social, cultural and economic groups.
- The government is taking initiatives against unauthorized ULAB recycling factories and organizations through mobile courts. Recently 16 such operations were destroyed.
- There is a need for greater awareness both within the government and among the public.
- Lead must be addressed as its damage to the human body and environment is irreparable.
- The recommendations and solutions that have emerged from today's discussion to prevent lead pollution have led us to do more research in this area in the future and will play a helpful role in carrying out effective initiatives.

Notable quotes from the speakers

Abdullah Al Mamun, Chemical and Waste Management Unit, DoE

“We know what the problem is and we have to act on it. The Bangladesh Government is very serious on this issue.”

“Pure Earth and the Government has been working closely for a long time to combat this disaster, especially in controlling the sources of lead, reducing exposures, and identifying and treating lead-poisoned children.”

“The Coordination Committee could be formed in the Ministry and a Technical Committee could be formed under the leadership of the DG DOE. This model was used for plastics pollution.”

Andrew McCartor, VP, Strategy and Partnerships, Pure Earth

“The first reason for this workshop is that it is our perception that there is still a lack of coordination amongst all the stakeholder groups... The second reason for this workshop is that the available data are fairly concerning. Both informal battery recycling and spice adulteration with lead chromate has been extensively researched and have shown to be quite severe issues.”

“I’m particularly encouraged to hear Dr. Sadat say that the government will be establishing a multi-sectoral committee for networking and collaboration. That’s exactly the type of next step that we hope could emerge from this workshop and it is certainly part of the recommendations of the Lead Pollution and Health Roadmap.”

“We have visited many communities that have allowed illegal battery recycling in their communities and their back-yards, without understanding that such activity will damage their children and community. So greater awareness in the public would help prevent such operations finding a home.”

Dr. Shahriar Hossain, Environment and Social Development Organization (ESDO)

“We are talking about the lead in batteries and paint, but we don’t talk about the lead in products, particularly for consumer products and essential products.”

“High levels of lead have been detected in rice and vegetables. A recent study by Bangladesh Agricultural University found that food groups of cereal, fish, meat, fruits, vegetables, and spices are highly contaminated with lead.”

Dr. Anwar Sadat, DPM, Planning, Monitoring and Research (PMR), DGHS

“Even though Bangladesh is one of the most impacted countries, there is no routine evidence generation system in the government system of Bangladesh. All the presentations that we have seen here have been conducted by our development partners or research institutions.”

“We have to establish blood level monitoring and integrate blood lead data into MOH’s routine health information system, such as DHIS2… This requires investment to bring the equipment needed to conduct the testing at district or division levels.”

“We request Ministry of Environment and Ministry of Industry to conduct a Situational Analysis in their sectors, so this evidence can be used to collaborate and create a strong movement.”

(Chair) Mr. Ashraf Uddin, Director General, Department of Environment (DoE)

“We are unknowingly eating and breathing poisonous lead. The common people of the country and all our families need to be aware of this and talk about it. We need to work together to solve this global problem, and I think Pure Earth opened that door with today's event.”

“We need to raise public awareness about how the lead is increasing our environmental and health risks through industrial pollution in our communities, in spices and other foods, and through other products. Lead is a silent killer. Its damage to the human body and environment is irreparable.”

(Chief Guest) Ahmed Shamim Al Razi, Additional Secretary, Ministry of Environment, Forest and Climate Change

“The Department of Environment should take the lead to eradicate lead exposure from Bangladesh, as it is a very detrimental and harmful substance for the human body.”

“The whole earth is shivering from the threat of Covid 19, but the threat of lead and other pollutants can in no case be underestimated. Lead is the silent killer, unlike COVID-19.”

“From today, I declare that I am taking cognizance of this issue and we shall frame projects so that we can drive the eradication of lead exposures as soon as possible.”

Quotes from the participants

Md. Zia-ul Haque, Department of Environment: “We need to develop a national inventory on lead pollution sources. At the same time, we should prepare a comprehensive lead pollution abatement study and a time-bound action plan with a specific goal to achieve.”

Dr. Minjoon Kim, UNICEF: “With this collaboration from other sectors, UNICEF wants to support the Ministry of Health to develop a higher strategy note on environmental health, with focus on lead poisoning, so that no one is left behind for development.”

M H Faruquee (stated in the chatbox): “There is another aspect to work to improve the workplace environment in the recycling industries and gradual rehabilitation of workers engaged in these industries.”

Dr. Rehnuma H Sarah (stated in the chatbox): “As we all are aware, the number of informal ULAB sites numbers is more than 2000, so we can imagine how much loss of biodiversity around those sites. But there is hope; we have low-cost materials for phytoremediation of the soil like household waste, pond mud, wood chips, grass, etc. I think authorities may consider this bioremediation in the SRO ASAP before losing our biodiversity. Glad to see people are concerned about the health impacts but we should conserve our nature too!”

Recommendations

1. A multi-stakeholder approach with the leadership of the relevant government ministries should be established to eradicate community lead exposure. The Department of Environment (DoE) should take the lead in a joint, multi-stakeholder approach to eradicating lead pollution. A coordination committee could be formed in the Ministry of Environment, Forest, and Climate Change, and a technical committee can be formed under the leadership of the Director-General of DoE.

2. The relevant government departments and ministries that should work closely on this issue are the Ministry of Environment, Forest and Climate Change, the Department of Environment, the Ministry of Health, the Ministry of Commerce, the Ministry of Industry, the Local Government Division, and the Food Safety Authority.

3. A time-bound, holistic national action plan which considers existing legislation is needed to advance progress on the issue of lead exposure. This action plan should include provisions for monitoring, reporting, and enforcement.

4. Comprehensive lead pollution studies and a national inventory on lead pollution sources are key to prioritizing effective exposure mitigation projects. This research is needed to identify polluting industries and lead-containing consumer products.

5. Effective monitoring by relevant agencies is needed to identify lead exposure sources, develop interventions, and ensure long-term success. This is needed for both industrial

sources (e.g., the closure of informal ULAB sites), as well as in products (e.g., lead chromate adulteration in spices).

6. Interventions in the ULAB recycling sector should be prioritized as this is a major known source of community lead exposure. Research institutions and universities should come up with ways to shift illegal, informal ULAB recycling industries to the regulated, registered sector. Second-generation lead-acid batteries or alternatives such as lithium-ion batteries should be examined for application in Bangladesh.

7. Occupational health and safety hazards of working with lead need more attention; workers who are working directly with lead require additional education. For those workers engaged in informal lead industries, alternative livelihoods should be explored as more of the industry shifts to the formal sector.

8. Ensuring effective waste management across all sectors, especially industrial waste is important because contaminated waste ends up affecting health through different pathways, including the agricultural chain.

9. Blood lead monitoring must be established. Blood lead data could be integrated into the MOHFW's existing routine health information system, DHIS2. Investment is needed to conduct this testing at district and division levels. Blood lead data can be used to identify contributing sources and monitor the efficacy of interventions.

10. The capacity of health workers and the health care sector to address lead exposure should be expanded.

11. Sensitization through print and electronic media plays a crucial role in creating public awareness about the sources and effects of lead pollution and spurring government bodies to act. There should be various training sessions and workshops to enhance the knowledge and skills of stakeholders related to lead pollution.

Conclusion

The main goal of the workshop is to bring together the various stakeholders of lead pollution to come together on a unified strategy that has been largely successful. The representatives from the various departments of government acknowledged the

devastating social, health, and economic impacts of lead pollution, and agreed that better surveillance and public awareness are needed going forward.

The group highlighted current capacity gaps in national exposure and blood lead level surveillance. The important roles of the media and local governments in working with the public were also highlighted. It was decided that the Department of Environment (DoE) will take the lead in a multi-stakeholder initiative for the eradication of lead exposure in Bangladesh, with cooperation from the Ministry of Health, Ministry of Commerce, and local development governments.

Annexes

Relevant workshop documents are available at this link:
https://drive.google.com/drive/folders/1kY0Mz-KK50r6QthyrA5N_tnURAe5jiZT?usp=sharing

Annex A: Presentation on the Background and efforts to date
Annex B: Presentation on the Lead exposure sources: current status and needs
Annex C: Presentation on the Opportunities in the health sector
Annex D: Presentation on the Findings on next steps
Annex E: Workshop Agenda and Discussion Summary
Annex F: Draft of the Lead Health Roadmap Strategy Paper
Annex G: Zoom Recording of the event
Annex H: Chat history of the event
Annex I: List of guests and participants
Annex J: Photos of the event
Annex K: Media coverages of the event
Annex L: Social media and visibility materials of the event

APPENDIX C: ESDO's National Strategy for ULAB Recycling in Bangladesh

ESDO's National Strategy for ULAB Recycling in Bangladesh is available HERE

APPENDIX D: Laboratory testing information for lead in Bangladesh

Table 1: Testing details of products in BSTI Laboratories

Product	Normal Testing Time (days)	Fee (normal) Tk.	Urgent Testing Time (days)	Fee (urgent) Tk.
Turmeric powder	14	2099	8	4198
Paint	14	5625 – 6875	8	11250-13750
Unleaded motor gasoline (petrol)	14	3423	8	6845

Table 2: Testing details of lead in BCSIR laboratories

Name of Sample	Test Parameter	Methodology	Fee (Tk.)	Duration (days)
Water (surface/river water/sea /ground) - only in Dhaka Lab	Lead (Pb)	APHA/In House	2000	7
Air (lead in air) (to be done manually)	Lead in air	NIOSH 7082	5000	10
Cream (cosmetic) - only in Dhaka Lab	Lead (Pb)	In House	2000	7
Fertilizer - only in Dhaka Lab	Lead (Pb)	In House	2000	10
Heavy metal and metals in all types of samples (except pure metal)- Dhaka Lab	Lead (Pb)	In House	2000	10
Henna, food, drug & cosmetic grade dyes & pigments	Heavy metals (Lead)	In House	2000	7

Paint-varnish, lacquer, resin and adhesive products	Heavy metals (Lead)	In House	2000	7
Plastic/rubber/paper products (plastic bottles for drinking water, oil, soft drinks, fruit juices, drug solutions & suspensions, plastic tableware, baby toys & feeders, food packaging paper etc.)	Heavy metals (Lead)	In House	2000	
Sediment and riverbed sediment	Lead	SSSA	2000	10
Sludge	Lead	SSSA	2000	10
Soil – only in Dhaka lab	Lead	SSSA 21-4	2000	10
Textile fabric/ fiber/ yarn/RMG/jute goods	Heavy metals (Lead)	In House	2000	7
Wastewater/effluent – only in Dhaka Lab	Lead	APAH/In House	2000	7

Soil Science Society of America (SSSA); National Institute for Occupational Safety and Health (NIOSH), American Public Health Association (APHA).