Evaluating Awareness and Impacts of Heavy Metal Contamination in the Coastal City of Chattogram, Bangladesh: A Cross-Sectional Study and Structured Expert Interview.

Final Report

Santosh Kumar Rauniyar
Research Fellow
Ocean Policy Research Institute,
The Sasakawa Peace Foundation
Tokyo, Japan

July 20,2024

Acknowledgement

Contents

Figures

1. Introduction

This study represented the first comprehensive effort to assess awareness of heavy metal contamination (HMC) in Chattogram, Bangladesh. While numerous studies had measured the concentration levels of various heavy metals in the sediment, groundwater, air, marine species, and food sources in this region, none had focused specifically on public awareness. Previous studies consistently showed that the concentrations of heavy metals such as lead (Pb), cadmium (Cd), chromium (Cr), and arsenic (As) in Chattogram significantly exceeded the permissible levels set by the US Environmental Protection Agency (EPA), the European Union Directive on Environmental Quality Standards (EQS), and the Food and Agriculture Organization (FAO) heavy metal regulations.

Background and Rationale

The severe pollution levels in Chattogram due to heavy metals prompted this study. For instance, lead (Pb) concentrations in surface water ranged from 13.53 to 154.65 µg/L, exceeding the EPA limit of 15 µg/L. Similarly, cadmium (Cd) levels in sediments were recorded at 1.33 to 180.15 µg/L, compared to the EQS limit of 1.5 µg/L. Chromium (Cr) levels in water samples were observed at 3.00 to 964.89 µg/L, surpassing the FAO guideline of 100 µg/L. Arsenic (As) concentrations in groundwater were found up to 195.40 µg/L, far above the WHO guideline of 10 µg/L[1-3]. These rising levels of contaminants were associated with several sources such as industrial wastes, shipbreaking activities, agricultural wastes due to the use of chemical fertilizers and pesticides, and electronic wastes. These sources contributed to the accumulation of heavy metals in the environment, affecting the ecosystem and subsequently entering the human body through various pathways. (Figure 1 & 2) There are several existing regulations such as the Bangladesh Environmental Conservation Act, 1995, and the Environment Conservation Rules, 1997, to regulate the source of heavy metal contamination however the effectiveness of these policies is hindered by inadequate enforcement and low awareness among stakeholders including community people.
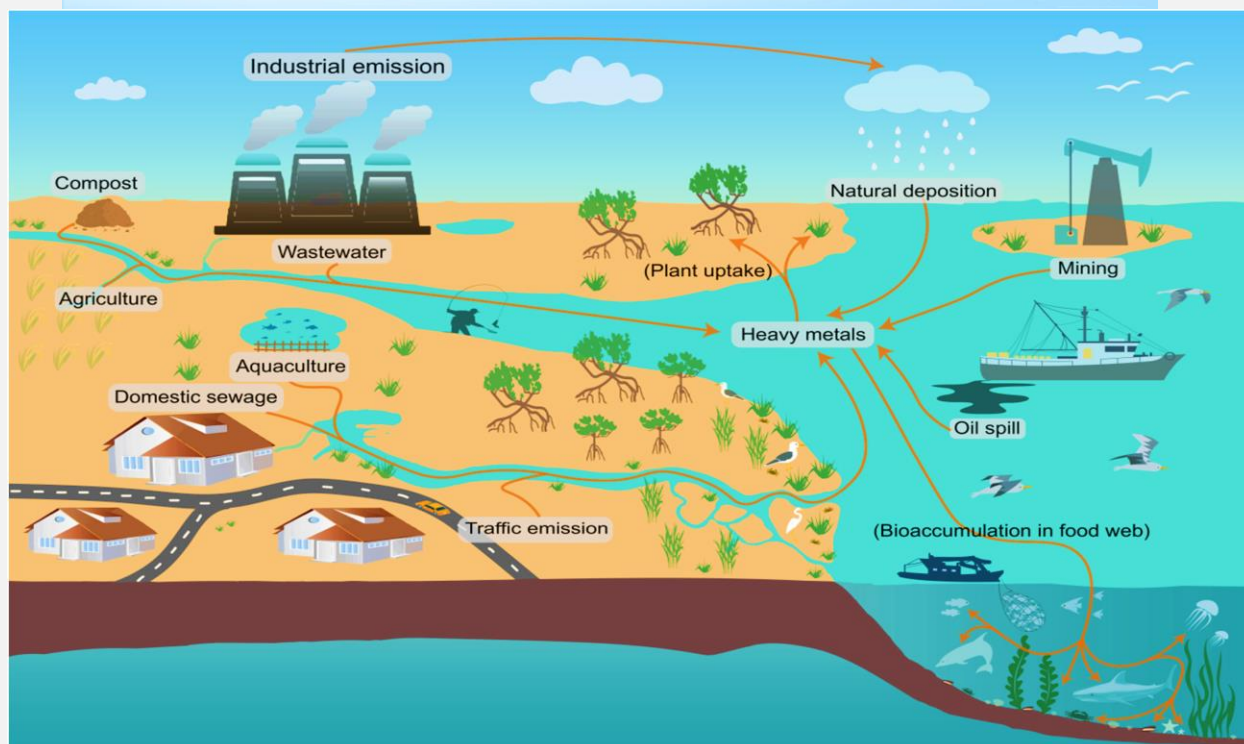
Figure 1. Different sources of heavy metal contamination ending up in sea.

Awareness among the local population, particularly those in coastal areas like Chattogram, is crucial for initiating community-level interventions to tackle the issue. Thus, this study aimed to fill this gap by evaluating the awareness levels among local communities and stakeholders, including policymakers, NGOs, and community leaders. Specifically, it sought to assess public awareness about heavy metal contamination among residents of Chattogram, identify gaps in policy communication that impeded effective policy formulation and implementation, and provide policy recommendations for improving awareness and policy effectiveness to mitigate heavy metal contamination.

Figure 2. Ship breaking yard in Chattogram, Bangaldesh.

2. Method

A cross-sectional survey was conducted in Sitakunda Upazila, a sub-district in Chattogram division area in Bangladesh, from January 2024 to March 2024. (Figure 3) The survey included 400 local residents to assess their awareness and perceptions of heavy metal contamination. Additionally, a structured expert interview was carried out during the same period to gauge stakeholder awareness, understanding, and perception. 40 experts were interviewed, representing local and central government, non-governmental organizations (NGOs), international non-governmental organizations (INGOs), research institutions, and universities.

To analyze the survey and interview data, both numerical and text data were processed using advanced analytical models. A logistic regression model with random intercepts, a random forest classifier model, and a bidirectional encoder representations from transformers (BERT) model were employed to ensure robust and comprehensive analysis.
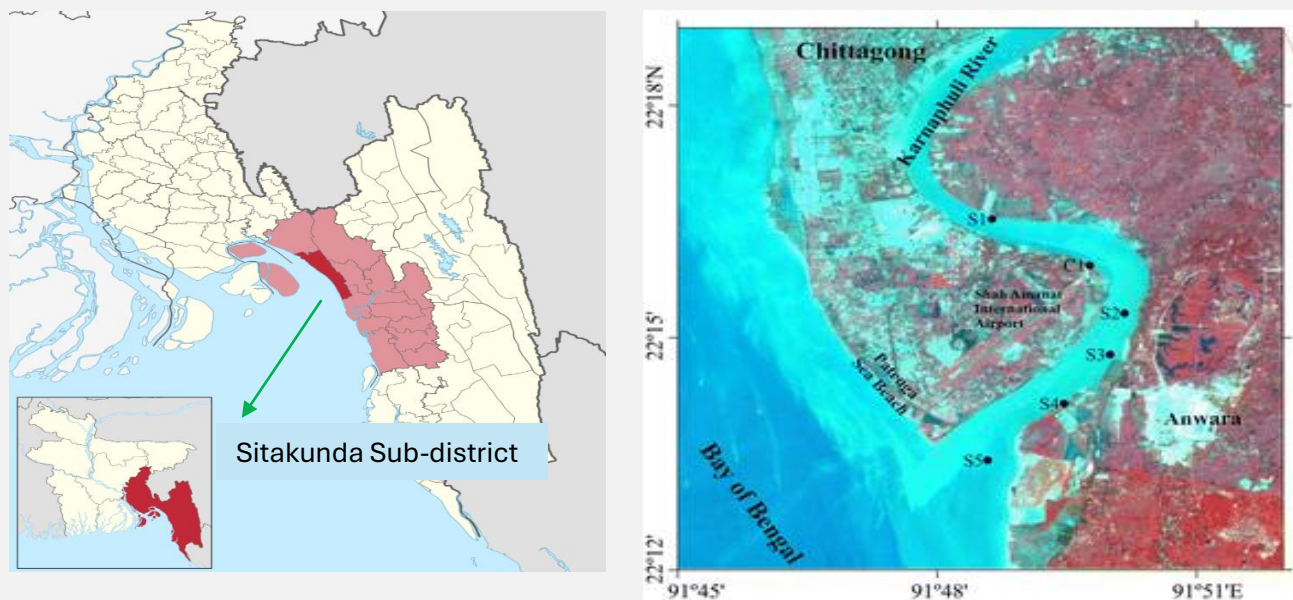
Figure 3. Map of Sitakunda sub-district, Chattogram, Bangladesh

3. Results

3.1 Findings from community based cross-sectional survey

The cross-sectional survey conducted in Chattogram, Bangladesh, yielded several critical insights into the awareness and perceptions of heavy metal contamination among the local population. The findings are summarized as follows:

3.1.1 General Awareness:

More than half (50%) of the community participants were unaware about the existence of heavy metal contamination in Chattogram, highlighting a significant gap in public knowledge regarding environmental health hazards. In addition, socioeconomic factors; income, education and types of occupation were significantly associated with the awareness level The analysis in Figure 4 indicates that higher education and increased income significantly enhance awareness about HMC, with the most educated and affluent groups showing the highest levels of awareness. Figure 5 reveals that environmental awareness varies significantly by occupation and age, with unskilled laborers showing the lowest awareness and professional/managerial workers the highest, especially in older age groups. Awareness increases notably in older age groups across most occupations, indicating the influence of occupational status and life experience on access to environmental health information.
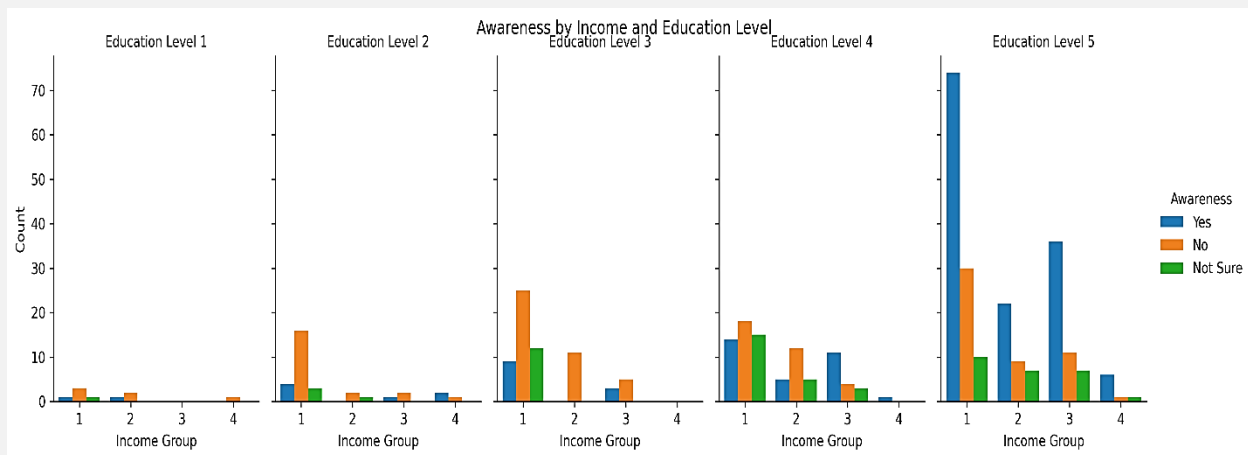
Figure 4. Awareness about HMC education vs. income
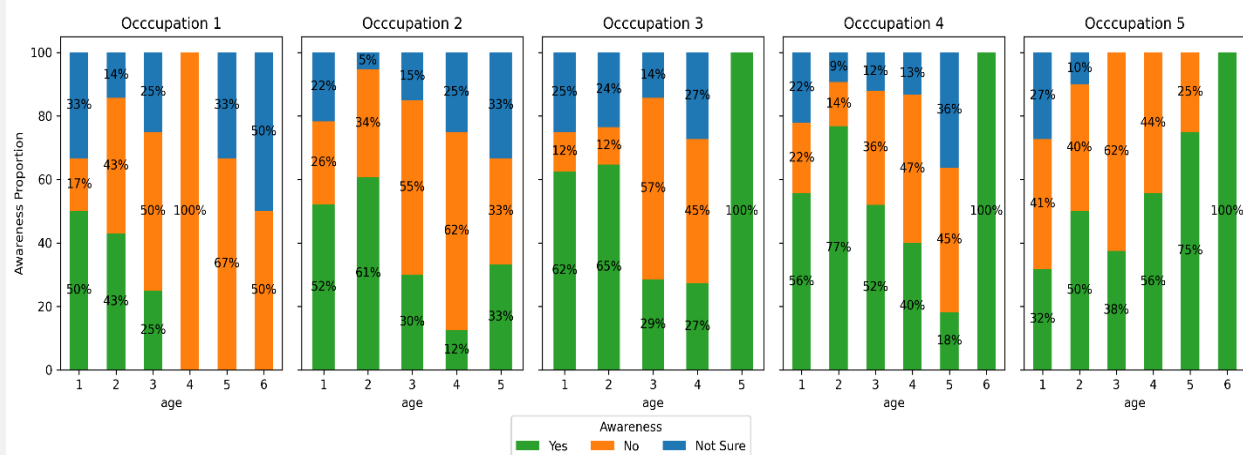
Figure 5. Awareness about HMC age Vs. occupation.

3.1.2 Perception of local community people:

A substantial majority (68%) of participants believed that pollution was adversely affecting the coastal environment of Chattogram, indicating a general awareness of environmental degradation, despite the low awareness about the heavy mental contamination itself.

3.1.3 Sources of contamination:

40% of participants identified industrial waste and ship-breaking yards as the primary sources of heavy metal contamination in Bangladesh. Conversely, 20% of respondents were unaware of the sources of contamination, pointing to a need for targeted educational initiatives to inform the community about specific environmental risks.

3.1.4 Understanding of a healthy coastal environment:

Nearly half (49%) of the respondents either did not know or were unsure about what constitutes a healthy coastal environment, suggesting a lack of environmental literacy which could hinder community efforts to advocate for and support environmental health initiatives. (Figure 6)

3.1.5 Health impacts:

Over half (54%) of the respondents reported experiencing some illness due to the consumption of contaminated water or food at least once, with 40% requiring hospitalization due to waterborne or foodborne illnesses. 72% perceiving that heavy metal contamination had a severe impact on

human health. This widespread recognition of health risks indicated that personal experiences with contamination were influencing public perceptions.
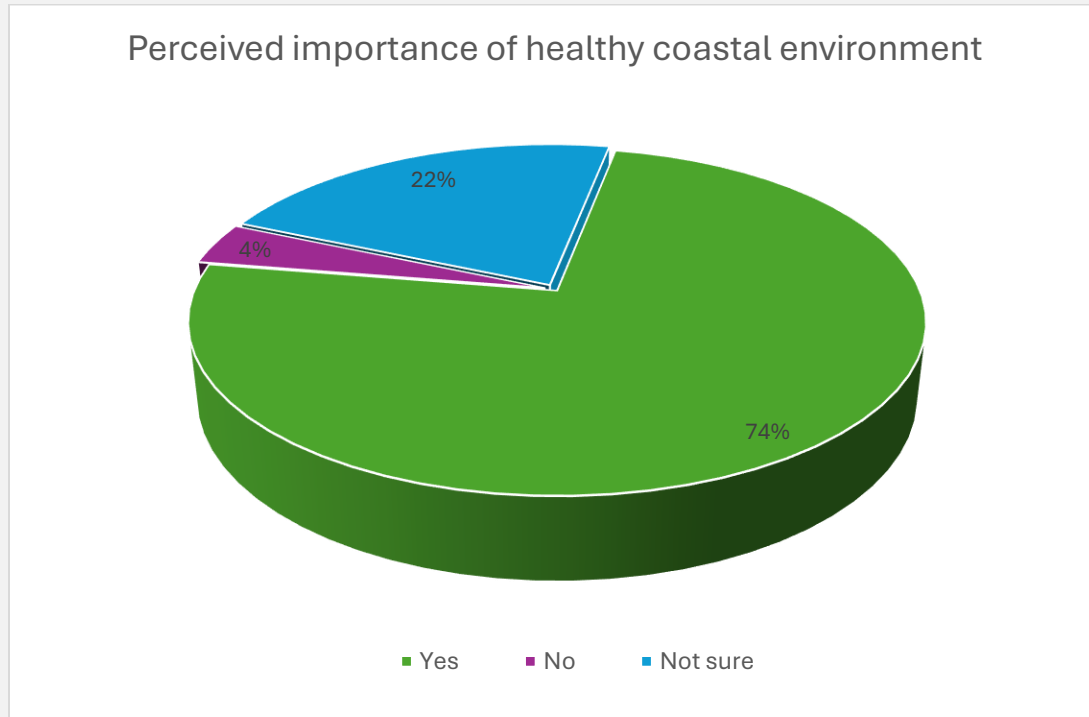
Figure 6. Perceived importance of healthy coastal environment in the local community.

3.1.6 Confidence in government action:

A significant majority (77%) of participants expressed either no confidence or uncertainty regarding the effectiveness of government actions and regulations to address heavy metal contamination in Chattogram. (Figure 7) This lack of confidence in governmental measures reflected a critical barrier to community trust and cooperation in mitigating environmental health issues.
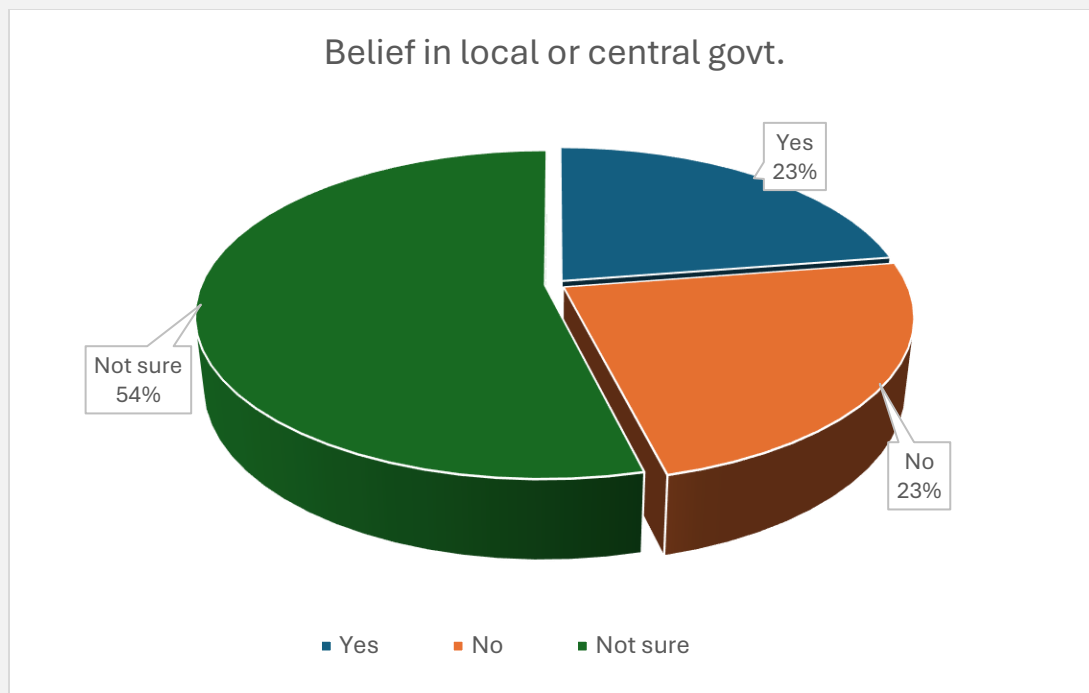
Figure 7. Belief of local people on the government action to tackle the issue of HMC.

3.2 Findings from structured expert interview

The expert interviews conducted in Chattogram, Bangladesh, provided critical insights into the perspectives of government officials, NGO and INGO experts, and academicians regarding heavy metal contamination. The summarized findings are as follows:

3.2.1 Sources of heavy metal contamination:

All the experts interviewed were aware and agreed that the heavy metal contamination is one of the major issues in Chattogram, Bangladesh. A majority of government officials (66%), NGO and INGO experts (85%), and academia (83%) identified industrial activities and ship-breaking yards as the primary sources of heavy metal contamination in Chattogram. This consensus aligned with the claims from local community participants, reinforcing the perceived link between industrial activities and environmental pollution.

3.2.2 Perceived severity:

A significant portion of government officials (50%), NGO and INGO experts (50%), and academia (44%) considered HMC to be very severe. Furthermore, 17% of NGO and INGO experts believed the situation was extremely severe, highlighting a critical concern among non-governmental experts.

3.2.3 Confidence in government actions:

While 50% of government officials believed the government was taking action to tackle HMC in Chattogram, only 8% of NGO experts and 22% of academia shared this belief. A majority of experts (54%) and academia (61%) did not believe in the effectiveness of government actions, indicating a significant communication gap between government officials and other experts.

3.2.4 Effectiveness of government actions:

Only 8% of experts and 22% of academia found the local government's actions to be moderate or very effective, compared to 34% of government officials. This discrepancy further underscored the need for improved communication and transparency in governmental efforts.

3.2.5 Stakeholder efforts:

A large majority of government officials (66%), NGO and INGO experts (85%), and academia (89%) rated the efforts of stakeholders and policymakers as poor or very poor.

3.2.6 Collaboration among stakeholders:
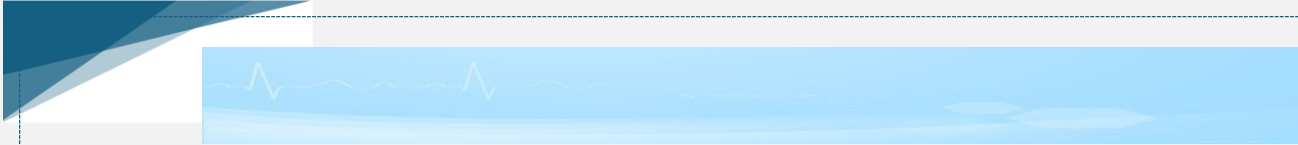
A significant proportion of government officials (67%), NGO and INGO experts (69%), and academia (94%) believed there was insufficient communication and collaboration among experts and policymakers. This lack of synergy was a critical barrier to effective environmental management.

3.2.7 Barriers to effective management:

Government officials identified lack of public awareness, inadequate government policy, and lack of funding as the main reasons for the failure to effecfively manage HMC in Chattogram. NGO and INGO experts cited insufficient scientific research, public awareness, and inadequate government policies as primary barriers. Academicians pointed to inadequate government policies, insufficient scientific research, and lack of funding and public awareness as main obstacles.

3.2.8 Organizational willingness and capacity:

A high percentage of government officials (80%) believed their organizations were moderately or highly willing to take action against HMC. Similarly, 63% of NGO and INGO experts and 72% of academicians

believed their organizations were willing to tackle the issue. A majority of government officials (84%) thought their organizations had moderate or high capacity (in terms of financial, technical, and human resources) to address HMC. Likewise, 67% of NGO and INGO experts and academicians believed their organizations possessed the necessary capabilities to combat HMC in Chattogram. Despite this, 39% of NGO and INGO experts and academicians felt there was insufficient information available to take necessary actions against HMC, indicating a gap in accessible, actionable data that is crucial for informed decision-making.

4. Conclusion

The survey findings revealed a complex landscape of awareness, perception, and confidence among the residents of Chattogram regarding heavy metal contamination. While there was a general recognition of pollution's adverse effects on the coastal environment, specific awareness of heavy metal contamination remained low. The identified sources of contamination and the significant health impacts experienced by the community highlighted the urgent need for comprehensive educational programs and more robust government interventions. Enhancing public understanding and confidence in regulatory measures is crucial for effectively addressing the challenges posed by heavy metal contamination in Chattogram. The expert interviews revealed a multi-faceted perspective on the issue of heavy metal contamination in Chattogram. There was a strong consensus on the primary sources of contamination and the severe impact it has on the environment and public health. However, significant challenges remained in terms of confidence in government actions, effective communication, and collaboration among stakeholders. Addressing these issues will require concerted efforts to improve public awareness, enhance governmental policies, and bridge the communication gap between various experts and policymakers.

2023/12/09 10:32

Workshop and training session organized with local experts and reserachers in Chattogram in December.

5. Policy recommendations and action plans to tackle heavy metal contamination in Chattogram, Bangladesh

The findings from this study highlight the urgent need for comprehensive and multi-faceted policy interventions to address heavy metal contamination (HMC) in Chattogram, Bangaldesh. Based on the insights gathered from community surveys and expert interviews, we propose following specific policy recommendations and action plans:

5.1 Strengthening regulatory frameworks and enforcement

Policy recommendation:

- Revise and update existing environmental regulations to include stringent limits on heavy metal emissions and discharges from industrial activities, particularly focusing on ship-breaking yards and industrial waste management.

Action plan:

- Conduct a thorough review of current environmental laws and regulations to identify gaps and weaknesses.

- Develop and implement stricter emission and discharge standards for industries and ship-breaking activities.

- Establish a dedicated environmental monitoring and enforcement body with adequate authority and resources to ensure compliance with regulations.

- Increase penalties for non-compliance to deter industries from violating environmental standards.

5.2 Enhancing public awareness and education

Policy recommendation:

- Implement widespread public awareness campaigns to educate the local population about the sources, risks, and health impacts of heavy metal contamination.

Action plan:

- Collaborate with local media, schools, and community organizations to disseminate information about HMC through various channels, including social media, public service announcements, workshops, and educational programs.

- Develop and distribute educational materials that explain the dangers of heavy metal contamination and practical steps individuals can take to minimize exposure.

- Organize community engagement sessions to encourage active participation in environmental protection efforts and to gather feedback from residents on their concerns and suggestions.

5.3 Improving interagency coordination and stakeholder collaboration

Policy recommendation:

- Foster better communication and collaboration among government agencies, NGOs, INGOs, academia, and local communities to create a unified approach to managing HMC.

Action plan:

- Establish an interagency task force that includes representatives from all relevant stakeholders to coordinate efforts, share information, and develop joint strategies for tackling HMC.

- Hold regular meetings and workshops to facilitate dialogue and collaboration between different groups.

- Create a centralized database to track and report on HMC levels, regulatory compliance, and the effectiveness of interventions.

5.4 Investing in research and development

Policy recommendation:

- Increase funding and support for scientific research to better understand the extent of HMC, its sources, and effective mitigation strategies.

Action plan:

- Allocate government and donor funding specifically for research projects focused on HMC in Chattogram.

- Encourage partnerships between universities, research institutions, and industries to develop innovative technologies and methods for detecting and reducing heavy metal contamination.

- Conduct longitudinal studies to monitor the long-term health impacts of HMC on local populations and the environment.

5.5 Implementing technological solutions for pollution control

Policy recommendation:

- Promote the adoption of advanced pollution control technologies and cleaner production practices among industries.

Action plan:

- Provide incentives such as tax breaks, subsidies, or grants to industries that invest in pollution control technologies and sustainable production methods.

- Develop and enforce regulations requiring industries to install and maintain effluent treatment plants (ETPs) and other pollution control devices.

- Organize training programs for industry personnel on best practices for reducing heavy metal emissions and waste.
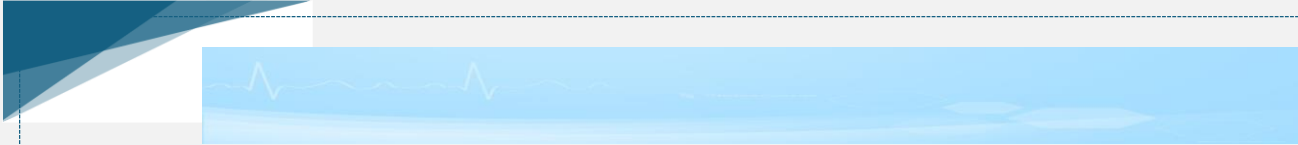
5.6 Ensuring transparency and accountability

Policy recommendation:

- Increase transparency and accountability in governmental and industrial actions related to environmental protection.

Action plan:

- Implement public reporting systems where industries and government agencies regularly publish data on HMC levels and regulatory compliance.

- Establish independent oversight bodies to audit and review environmental practices and policies.

- Engage civil society organizations in monitoring and reporting on the effectiveness of governmental and industrial actions to combat HMC.

The findings of this study underscore the critical need for a holistic and coordinated approach to managing heavy metal contamination in Chattogram. By implementing these policy recommendations

and action plans, it is possible to significantly reduce the levels of heavy metal contamination, protect public health, and preserve the environment. Enhanced regulatory frameworks, increased public awareness, improved interagency coordination, investment in research and technology, and strengthened community health programs are essential components of a comprehensive strategy to address this pressing issue.

6. References

1. Ahasanul K, Nath RK, Roy AK, Rabi S. Impact and Environmental Risk Assessment of Hazardous Metal Pollution in the Sediment at Shipbreaking Yard Chattogram. *Journal of Water Chemistry and Technology* 2024; **46**(2): 216-25.

2. Pandit D, Haque MM, Bhuyan MS, et al. A comprehensive scenario of heavy metals pollution in the rivers of Bangladesh during the last two decades. *Environmental Science and Pollution Research* 2024.

3. Rakib MRJ, Rahman MA, Onyena AP, et al. A comprehensive review of heavy metal pollution in the coastal areas of Bangladesh: abundance, bioaccumulation, health implications, and challenges. *Environmental Science and Pollution Research* 2022; **29**(45): 67532-58.