ASSESSMENT OF ENVIRONMENTAL IMPACTS OF IRON ORE MINING AND ITS MITIGATION MEASURES

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ABSTRACT

Iron is the most needed ingredient in manufacturing steel. Steel is by far the most adaptable, significant and widely used of all metals and has found many applications viz. constructions, manufacturing of motor cars, machines, pipelines, military equipment, electrical appliances, etc. For without steel, modern civilization will be absolutely impossible. Thus, Iron ore has been mined for the past three thousand years by ancient and modern mankind. However, mining of iron ore has copious negative impacts on the environment. It degrades natural landscapes, surface and ground water quality, flora and fauna, as well as the ambient air quality within the mining area and its environs. Iron ore tailings usually contain large amount of Silica, iron, and traces of Hg, Se, Cu, Pb, Zn, As, Mn etc. that are harmful to humans even at low levels. In the present research work, the air and water quality of two different mining areas of India and Liberia are investigated and the quality of each compared against relevant water quality standards, IS10500 (2012). Moreover, OB, tailings and blue-dust samples were collected from both mining areas, prepared as per relevant standard, characterized and leached to investigate their elemental composition and long term behaviour. Characterization of OB, tailings, and blue-dust was carried out by a combination of several analyses viz. XRD, FTIR and SEM-EDS while the leaching behaviour was assessed under two separate leaching conditions viz. double distilled water and TCLP (U.S. EPA) method 1311 (6010B-Lead). ICPMAS analysis was carried out on air borne particulates sampled in the mining area of India. Coagulation studies was carried out using two coagulants, Alum and Ferric Chloride concomitantly to study the settling behaviour of suspended solids derived from Iron Ore Mining. The results from all investigations carried out indicated that the air and water quality of both mining areas are degraded by iron ore mining. Results from elemental characterization revealed harmful trace elements viz. Hg, Pb, Cr, As, Cd, Co. Cu, Fe, Mn, Zn, Ni, Se, Al, Ba, Br, etc. Therefore, both mining regions are polluted due to iron ore mining but the regions of Liberia is the most polluted.

❖ BRIEF REVIEW OF LITERATURE

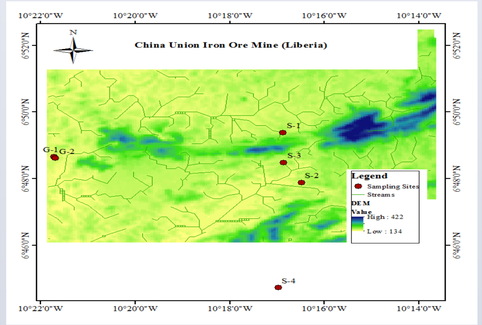
AUTHOR	YEAR	FINDINGS
Nuss & Eckelma	2014	Iron & Aluminium showed the largest Environmental impact on global scale in comparison to 63 other metals
Singh & Perwez	2015	Discovered the transportation of iron ore as the most devastating activity in Goa iron ore mining region & found the depreciation in air quality to be < -1 from the anticipated value of 0 at all locations.
Akcil & Koldas	2006	The Environmental impact of AMD, can be abated at three basic levels: (i) through primary prevention of the acid-generating process, (ii) secondary control, which involves the deployment of acid drainage migration prevention measures and (iii) tertiary control, or the collection and treatment of effluent.
Nordstrom & Alpers	1999	under a mine plugging remediation condition, the salts would liquefy and 600,000 m^3 mine pool would have pH ≤ 1.
Boularbad et al.	2006	metal toxicity increases with increasing availability of metal content in tailing and soil.

❖ METHODOLOGY

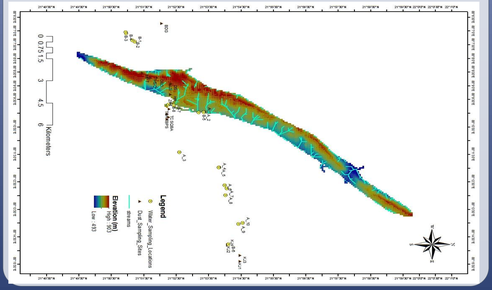
- A critical Review of Literature
- Sample Collection, Handling, Transportation & Storage – from Liberia & India Iron Ore Mines - Water & Solid (OB, Tailings & Blue-Dust) Samples.
- Samples Analyses
- Water Quality Indexing & Classification, as per sampling stations
- Air quality monitoring for PM_{10} and $PM_{2.5}$ & characterization; at Barsua Iron mines (BIM) & Koira Township, India
- Characterization of Filter Papers, used for monitoring PM_{10} and $PM_{2.5}$; XRD, SEM-EDS Analyses; Solid Samples Leaching using Toxicity Characteristics Leaching Procedure (TCLP) & Deionized Water.
- Coagulation Studies
- Interpretation of Findings
- Suggestion of suitable mitigation measures

❖ STUDY AREA

✓ **Liberia:** China Union Iron Ore Mines



✓ **India:** Barsua Iron Mines (BIM)

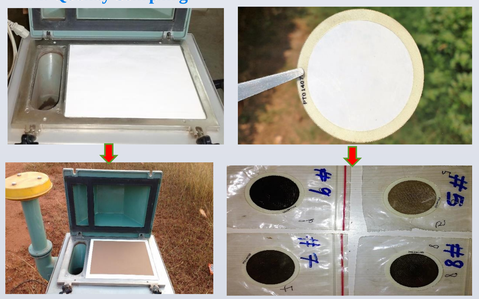


❖ Sample Collection

✓ **Water:** Surface Ground Water Sampling

Top Left & Right (India); Bottom Left & Right (Liberia)

✓ **Air Quality Sampling**



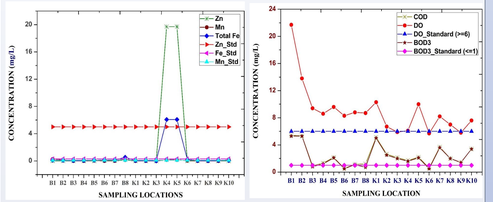
❖ Laboratory Testing of Raw Water Samples

- Display results
- Data storage & Retrieval
- GPS facility, etc.

Host sensors For 11 Parameters

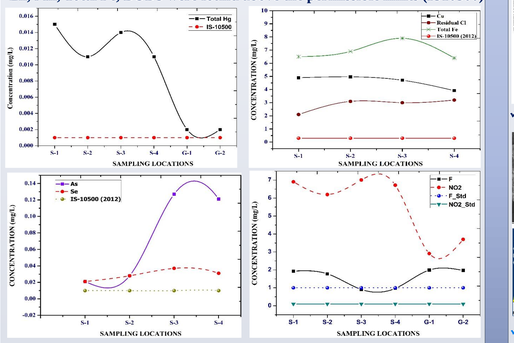
Top: Multi Parameter Water Quality Analyser (Horiba, Japan); Bottom Left: AAS 200 (PerkinElmer); Right: ICPMS-LSX-213 set up.

❖ RESULTS AND DISCUSSION



✓ **India :** Surface Ground Water Analytical results

Zn, Mn, Total Fe, BOD3 were found above the permissible limits (IS10500)



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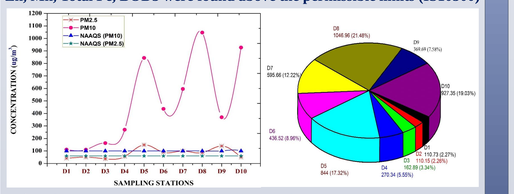
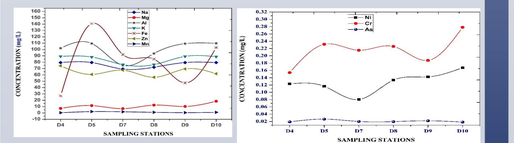


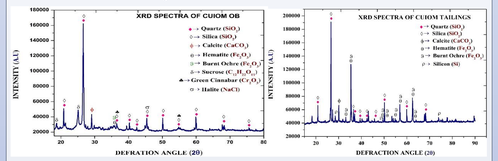
✓ **India :** PM_{10} & $PM_{2.5}$ Monitoring Results

All Sampling Stations revealed high concentration of PM_{10}. $PM_{2.5}$ varies

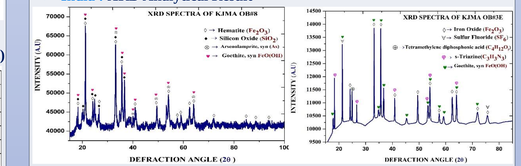


Characterization result of PM Sampled (Barsua Iron Mines, India)

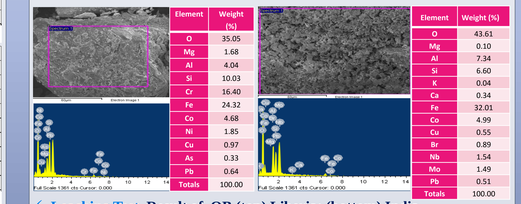
✓ **Liberia :** XRD Analytical Result



✓ **India :** XRD Analytical Result



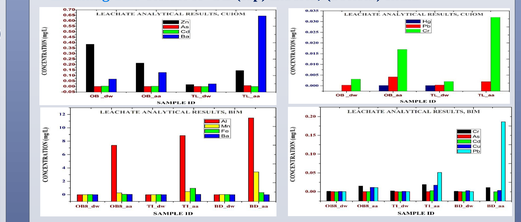
✓ **SEM-EDS Analytical Result of OB (a) Liberia; (b) India**



Element	Weight (%)
O	35.05
Mg	1.68
Al	4.04
Si	10.03
Cr	16.40
Fe	24.32
Co	4.68
Ni	1.85
Cu	0.97
As	0.33
Pb	0.64
Totals	100.00

Element	Weight (%)
O	43.61
Mg	0.10
Al	7.34
Si	6.60
K	0.04
Ca	0.34
Fe	32.01
Co	4.99
Cu	0.55
Br	0.89
Nb	1.54
Mo	1.49
Pb	0.51
Totals	100.00

✓ **Leaching Test Result of OB (top) Liberia; (bottom) India**



❖ CONCLUSION

From the above finding, it is worthy to note that Therefore, both mining regions are polluted due to iron ore mining but the regions of Liberia is the most polluted.

❖ SUGGESTION FOR MITIGATION:

PM_{10} & $PM_{2.5}$, Dust suppression measures are carried out within the mines (Little attention is given to residential areas). Different dust control measures including water spraying on the haul roads outside the mine boundary should also be carried out.

Steps should therefore be taken by the respective mine managements to contain the effluents and runoff generated within the mine lease itself.