IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402, p- ISSN: 2319-2399.Volume 19, Issue 5 Ser. 1 (May 2025), PP 18-23
www.iosrjournals.org

Analysis Of The Impact Of Dust Emissions Linked To Mining Activities On Communities Living Near The Sangarédi Mine (CBG Concession), Republic Of Guinea

KABA Ousmane Djènè[1,2], OUATTARA Gbele[2], KEITA Kandas[1,3], SYLLA Mohamed Lamine[1,3]

Institut Supérieur Des Mines Et Géologie De Boké (ISMGB), B.P. 84, Boké, République De Guinée.
Institut National Polytechnique Felix HOUPHOUËT-BOIGNY (INP-HB), B.P. 1093, Yamoussoukro, Côte d'Ivoire
Centre De Recherche Marine Et Côtière De Guinée (CEREMAC-Guinée), B.P. 1615, Conakry

Abstract
The bauxite mining site of the Compagnie des Bauxites de Guinée (CBG) concession in Sangarédi emits dust, affecting air quality and the health of nearby communities. The objective of this study was to measure the dispersion and concentration of fine particles (PM10 and PM2.5) emitted by mining activities related to bauxite mining, particularly blasting, transportation, storage, and handling of materials. Field measurement campaigns were conducted to quantify airborne dust levels and organize sampling areas based on their respective exposure. To link the field measurements, data were collected in GIS mode using ArcGIS and QGIS software to spatially visualize the geographic dispersion of dust and the associated environmental impact. The results show fine particle concentrations often exceeding environmental standards. Furthermore, the purifying properties of soil and surface water are impaired by suspended dust. This study highlights the need to implement a dust management system to limit the health and environmental impacts.
Key Word: *Bauxite, dust, pollution, impacts, Guinea.*

Date of Submission: 22-04-2025 Date of Acceptance: 02-05-2025

I. Introduction

The Republic of Guinea has the world's largest bauxite reserves, making it a key player in global supplies of this strategic mineral (Campbell, 1984). Industrial bauxite mining, particularly in one of the country's flagship concessions in Sangarédi, operated by the Compagnie des Bauxites de Guinée (CBG), represents a key economic lever for the Guinean state (I. S. M. Camara, 2021). However, this open-pit mining activity generates a multitude of environmental externalities, among which the dispersion of fine dust into the atmosphere is undoubtedly one of the most worrying (Ambastha and Haritash, 2021; Blondet et al., 2019; Ghose and Majee, 2007). The dust emitted by the different stages of mining activity, starting with stripping, then loading, transporting and crushing the ore, consists mainly of suspended particles of the PM10 and PM2.5 type, smaller than 10 and 2.5 micrometers respectively, and likely to penetrate deep into the human respiratory system, causing health effects ranging from irritation of the respiratory tract to chronic diseases, such as asthma, obstructive bronchitis or cardiovascular diseases in some cases (Ambastha and Haritash, 2021; Liu et al., 2023; Patra et al., 2016; Yu and Zahidi, 2022). In the Sangarédi concession, atmospheric dust levels recorded in surrounding inhabited areas are often higher than the regulatory limit values recommended by current international public health organizations (Camara et al., 2021; Xin et al., 2020). This is accentuated by the region's dry and windy climate, which promotes the resuspension of dust on unpaved roads, storage areas, and railways. Housing, located near extraction areas, also exposes populations to the negative effects of this particulate pollution, in the absence of containment measures or vegetative barriers.

The harmful effects of mining dust also affect the environment. By settling on crops, it impairs photosynthesis, pollutes surface water, and alters soil microbial biodiversity (Thaper et al., 2023). These impacts represent a new vulnerability factor for these rural communities, many of whom depend on agriculture and natural resources for their livelihoods.

Despite growing awareness of the problem of air pollution in mining areas, few studies have yet conducted a precise, contextualized, and comprehensive assessment of the actual concentration levels of particles in the ambient air of bauxite mining areas in Guinea. To address this shortcoming, this study aims to document the environmental and health effects of dust emitted by bauxite mining in the Sangarédi concession, using a rigorous methodological approach combining in situ measurements (PM10, PM2.5), statistical analysis of the results obtained, and even comparison of concentration levels with reference threshold values for air quality. The results obtained should thus make it possible to assess the degree of population exposure, extracting the associated health risks while providing options for reduction within a contextual and specific Guinean environment.

II. Material And Methods

The assessment of dust emissions in the CBG mining concession in Sangarédi was conducted using an approach combining ground surveys and environmental mapping. This methodology made it possible to characterize PM10 and PM2.5 concentrations and illustrate their spatial impact on the territory.

Field Surveys

Three MiniVol® TAS devices were used to collect suspended particulate data (Figure 1). These portable devices, strategically placed around the mine and in populated areas, draw air at a flow rate of 5 L/min through an impactor, capturing particles on 47 mm filters. Each measurement campaign targeted a single particle type (PM10 or PM2.5) at a time. Before each campaign, the devices were calibrated using a CAL200 acoustic calibrator (94 dB at 1 kHz), with post-campaign verification to ensure measurement consistency. The collected data were then processed using G4 LD Utility software.

Figure 1: Three Mini Flights side by side on a flat surface.

GIS and Remote Sensing Integration

To enhance the analysis, data from the measurement campaigns were cross-referenced with Landsat 7/8 satellite images processed in a GIS environment (QGIS). The Landsat 7/8 satellite imagery was used to identify landscape changes induced by mining, notably by using atmospheric and radiometric corrections as well as supervised classification methods (Figure 2).

The use of Machine Learning algorithms (notably Random Forest and SVM) made it possible to carry out a supervised classification of areas affected by particulate pollution. This processing generated several thematic maps, including sampling maps (Figure 3) identifying critical areas.

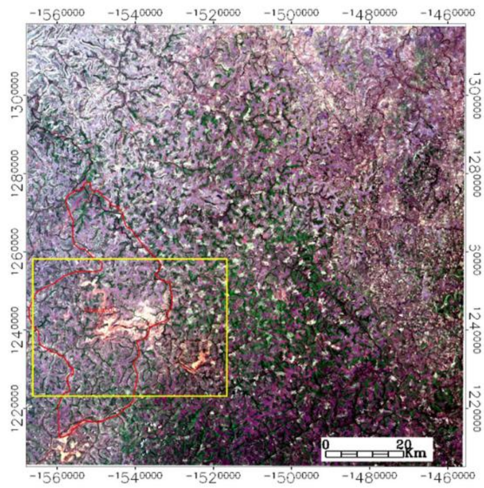


Figure 2: Location of the study area in the Sangarédi mining concession illustrates the satellite band covering the study area.

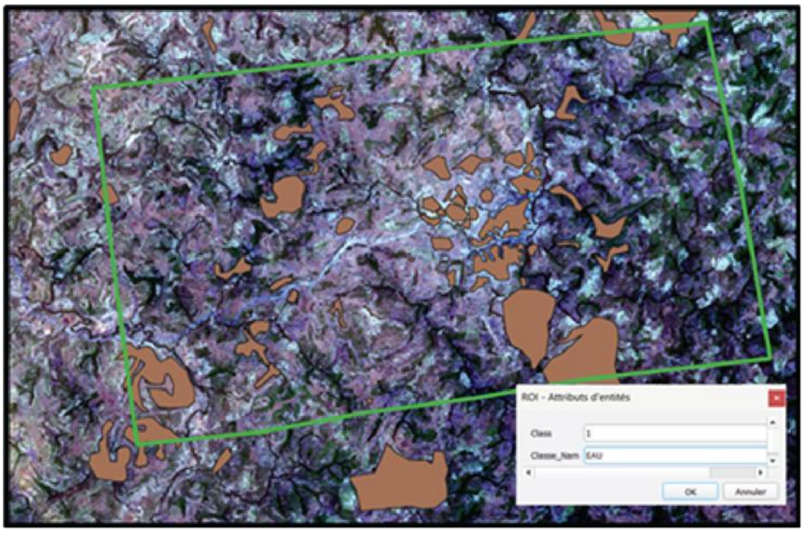


Figure 3: Sampling map for the classification of areas affected by mining pollution.

Land use mapping of our study area was possible thanks to the machine learning method using the Random Forest algorithm (ensemble method that “puts together” or combines results to obtain a super final result). The methodological flowchart applied is illustrated in Figure 4.

This combination of in situ measurements and geospatial analyses enhanced the rigor of the environmental assessment and made it possible to precisely locate the areas where dust emissions pose the greatest risks to populations and ecosystems.

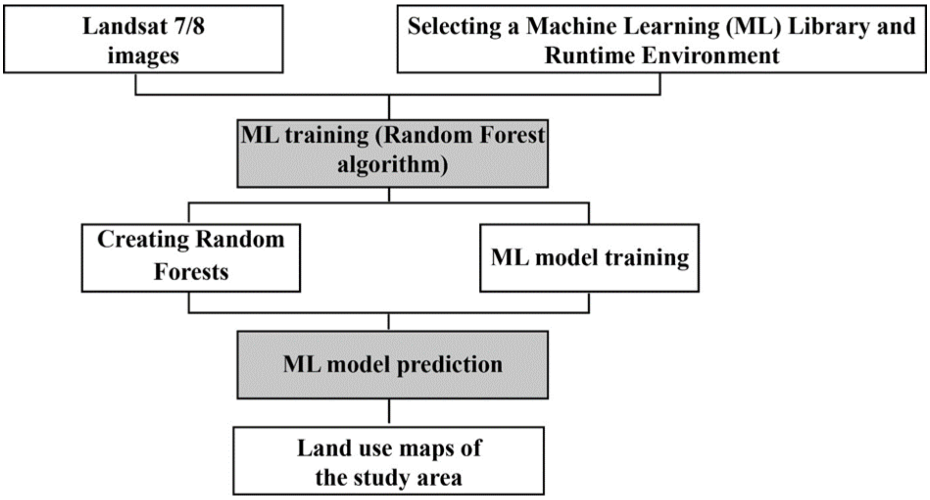


Figure 4: Machine learning-based mining pollution impact mapping process (noise, vibrations, dust) illustrates the steps of this approach.

III. Results And Interpretations

The measurement campaigns carried out between 2023 and 2024 collected precise data on PM10 and PM2.5 fine particle concentrations in the Sangarédi mining concession. These results were compared to international standards set by the World Health Organization (WHO) and the U.S. Environmental Protection Agency (EPA), (Figure 5). The Table 1 below shows the changes in concentrations measured over the five successive campaigns.

Table 1: Changes in concentrations measured over the five successive campaigns.

Campaigns	Measured PM10 (µg/m³)	*WHO PM10 Limit(µg/m³)*	Measured PM2.5 (µg/m³)	*WHO PM2.5 Limit (µg/m³)*
1	118	*150*	18	*75*
2	**150**	*150*	40	*75*
3	**170**	*150*	**75**	*75*
4	140	*150*	**75**	*75*
5	110	*150*	**75**	*75*

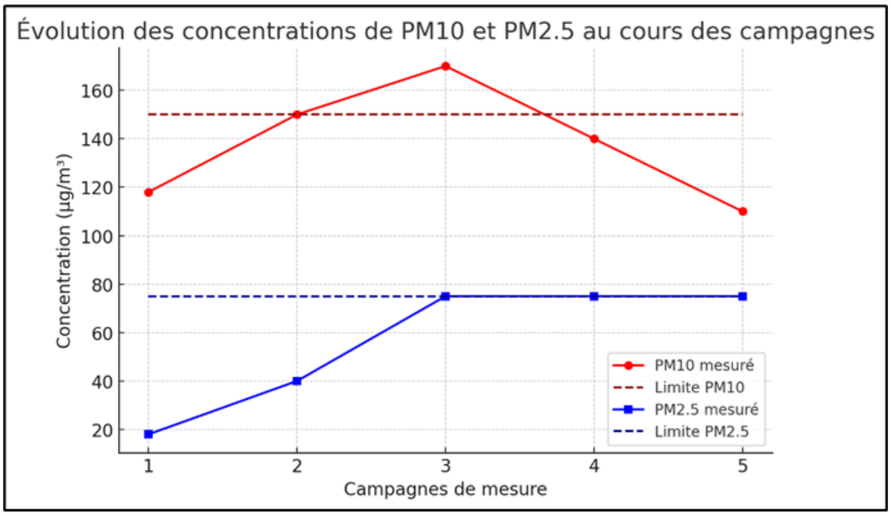


Figure 5: Graph showing the evolution of PM10 and PM2.5 concentrations measured during the various surveys, with the regulatory limits.

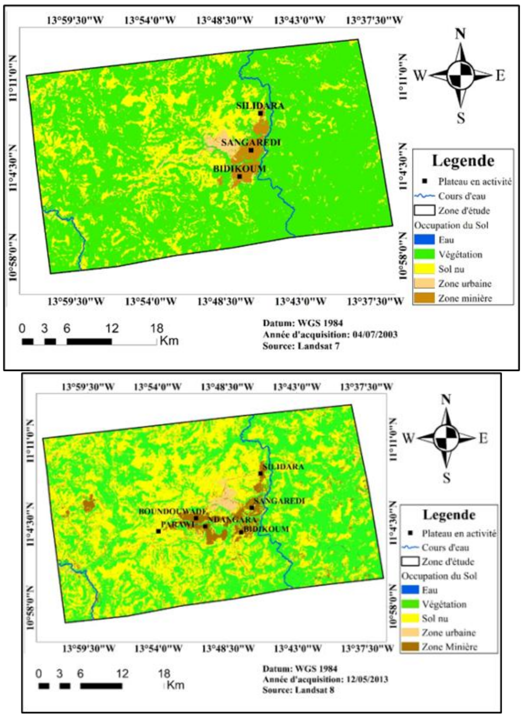
Interpretation of Exceedances

The results obtained reveal a significant exceedance of the regulatory limits for PM10 suspended particles during survey 3, with a measured concentration of 170 µg/m³, well above the established thresholds. Furthermore, the PM2.5 concentrations recorded during surveys 3, 4, and 5 reached or approached the maximum limit recommended by the World Health Organization (WHO), with values peaking at 75 µg/m³. Survey 3 represents the peak of fine particle emissions, likely related to an intensification of blasting activities or the transportation of unwatered materials. High concentrations of PM2.5, although at the threshold, are a cause for concern because these particles penetrate deep into the respiratory system and are associated with serious health effects.

Land cover maps from 2003, 2013, and 2023 (Figure 6), revealing the spatiotemporal evolution of the mining area and the gradual reduction of vegetated areas.

Cartographic Integration

The pie chart above represents the distribution of land cover as a percentage. Vegetation occupies the largest share of the land area at 50%, followed by bare soil at 30%. The mining area accounts for 16%, while the urban area and water bodies constitute 3% and 1%, respectively, of the study area (Figure 7).



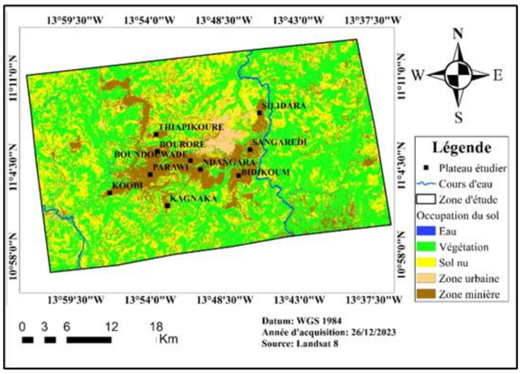


Figure 6: Land cover maps from 2003, 2013, and 2023.

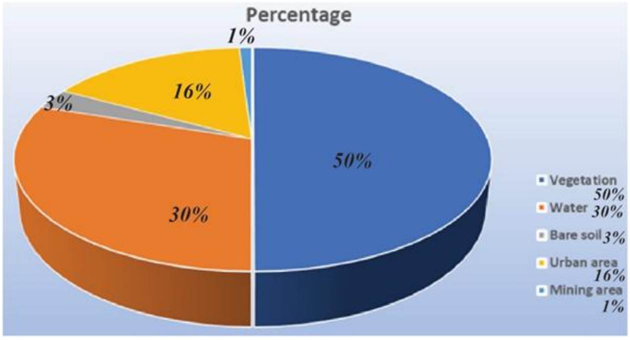


Figure 7: Land use analysis in the study area.

This graph is consistent with the land use map based on Landsat 8 data from December 26, 2023. The significant vegetation cover (50%) reflects the still dominant presence of forests and savannahs in the study region, although mining activities have a growing impact. The 16% of mining areas illustrate the extent of exploitation on the territory, particularly around areas identified as Sangarédi, Boundouwadé, and Bouroré. The notable presence of 30% bare soil can be interpreted as a consequence of mining activities, land clearing, and erosion due to human disturbances. Finally, the 3% of urban areas confirms the gradual expansion of infrastructure around mining hubs, particularly in Sangarédi and its surroundings. The evolution of these proportions over the years would make it possible to assess the impact of mining on the environment and urbanization.

IV. Discussion

The results of the five measurement campaigns conducted in the Sangarédi mining concession reveal alarming levels of air, noise, and vibration pollution. Concentrations of fine particles (PM10 and PM2.5) frequently exceed international standards established by the World Health Organization (WHO) and ANZEC, particularly during peak mining activities such as blasting, transport on dry roads, and dry handling. For example, the third campaign recorded a PM10 concentration of 170 µg/m³, exceeding the limit of 150 µg/m³, while PM2.5 reached 75 µg/m³, the maximum recommended value.

These excesses have direct repercussions on the health of local populations. Chronic exposure to fine particles is associated with respiratory conditions such as coughing, shortness of breath, and respiratory irritation. Furthermore, noise generated by mining operations causes hearing and psychological disorders (WHO, 2021), while vibrations caused by blasting cause cracks in homes (Keita & Camara, 2024). The local environment is also affected: dust deposits on vegetation impair photosynthesis, gradually degrading ecosystems. An analysis of land-use maps over the past twenty years shows a significant reduction in vegetated areas, particularly around storage areas and mining transport routes (CBG, 2014).

The main sources of pollution identified include unsupervised blasting, the transport of ore by truck on dusty tracks, and open-air storage of bauxite (Camara et al., 2021). The proximity of homes and the lack of effective mitigation measures exacerbate the situation. In light of these findings, several actions are required: regular watering of the tracks, covering of trucks, creation of dust-proof plant barriers, and installation of environmental monitoring sensors (MiniVol®, Sound Advisor). A cartographic model has identified the most exposed areas, justifying the urgent implementation of reinforced environmental zoning around the mine, in order to sustainably protect populations and ecosystems.

V. Conclusion And Recommendations

The results of this study revealed high concentrations of fine airborne particles, particularly PM10 and PM2.5, in the Sangarédi mining concession. During the five measurement campaigns conducted between 2023 and 2024, PM10 levels reached a maximum of 170 µg/m³ during the third campaign, exceeding the WHO limit of 150 µg/m³. Similarly, PM2.5 concentrations reached the maximum limit of 75 µg/m³ on three occasions, posing a significant health risk to local populations, particularly children, the elderly, and exposed workers.

These results confirm a worrying upward trend in air pollution, exacerbated by mining activities such as blasting, transportation on unwatered tracks, and open-air storage of materials. Land use and sampling maps have identified the most affected areas, revealing an increase in pollution to the detriment of vegetated and agricultural areas.

In light of these findings, urgent measures must be taken to contain the effects of these nuisances:
1. Reducing the frequency and intensity of blasting, using more controlled techniques to limit dust dispersion.
2. Systematic watering of runways and containment of dusty materials, particularly in crushing, transport, and loading areas.
3. Installation of noise barriers and plant hedges in sensitive areas, combining noise attenuation and particle filtration.
4. Strengthening community dialogue, involving local residents in environmental monitoring and complaint management.
5. Strengthening environmental regulations, with rigorous enforcement of air quality standards. 6. Empowering mining companies by integrating clear commitments into their Corporate Social Responsibility (CSR) policies.

In short, this study highlights the need to reconcile mining development and socio-environmental protection through the implementation of integrated, participatory, and sustainable management mechanisms for mining pollution in Sangarédi.

References

[1] Ambastha, S. K., & Haritash, A. K. (2021). Emission Of Respirable Dust From Stone Quarrying, Potential Health Effects, And Its Management. Environmental Science And Pollution Research, 29, 6670-6677. Https://Doi.Org/10.1007/S11356-021-16079-4
[2] Blondet, I., Schreck, E., Viers, J., Casas, S., Jubany, I., Bahí, N., Zouiten, C., Dufrechou, G., Freydier, R., Galy-Lacaux, C., Martínez-Martínez, S., Faz, Á., Soriano-Disla, M., Acosta, J., & Darrozes, J. (2019). Atmospheric Dust Characterisation In The Mining District Of Cartagena-La Unión, Spain : Air Quality And Health Risks Assessment. Science Of The Total Environment, 693, 133496. Https://Doi.Org/10.1016/J.Scitotenv.2019.07.302
[3] Camara, I., Deyi, J., & Lin, L. (2021). The Impact Of Mining Exploration On Sangaredi Community's Sustainable Development : Inhabitants Perspectives On Livelihood. International Journal Of Mineral Processing And Extractive Metallurgy, 6(1), 12-19. Https://Doi.Org/10.11648/J.IJMPEM.20210601.13
[4] Camara, I. S. M. & Lin, Deyi, J. & Lin, L. (2021). Uncovering Problems Caused By Mining Exploration Activities In Sangaredi. Global Journal Of Engineering Sciences, 8(1), 1-7. Https://Doi.Org/10.33552/Gjes.2021.08.000677
[5] Campbell, B. (1984). Bauxite Bargaining: Guinea Versus The Aluminium Multinationals. Minerals & Energy - Raw Materials Report, 2, 54-61. Https://Doi.Org/10.1080/14041048409408536
[6] CBG. (2014). Étude D'impact Environnemental Et Social Du Projet D'extension De La Mine CBG (P. 157).
[7] Ghose, M., & Majee, S. (2007). Characteristics Of Hazardous Airborne Dust Around An Indian Surface Coal Mining Area. Environmental Monitoring And Assessment, 130, 17-25. Https://Doi.Org/10.1007/S10661-006-9448-6
[8] Keita, O., & Camara, Y. (2024). Numerical Evaluation Of Vibration Induced By Explosive Blasting In The Bauxite Mines Of Sangarédi, Guinea. Physical Science International Journal, 28(2), 60-67. Https://Doi.Org/10.9734/Psij/2024/V28i2826
[9] Liu, H., Wang, Q., Liu, N., Zhang, H., Tan, Y., & Zhang, Z. (2023). The Impact Of Land Use/Cover Change On Ecological Environment Quality And Its Spatial Spillover Effect Under The Coupling Effect Of Urban Expansion And Open-Pit Mining Activities. Sustainability, 15, 14900. Https://Doi.Org/10.3390/Su152014900
[10] Patra, A., Gautam, S., & Kumar, P. (2016). Emissions And Human Health Impact Of Particulate Matter From Surface Mining Operation—A Review. Environmental Technology And Innovation, 5, 233-249. Https://Doi.Org/10.1016/J.ETI.2016.04.002
[11] Thaper, R., Sesek, R., Garnett, R., Acosta-Sojo, Y., & Purdy, G. (2023). The Combined Impact Of Hand-Arm Vibration And Noise Exposure On Hearing Sensitivity Of Agricultural/Forestry Worker - A Systematic Literature Review. International Journal Of Environmental Research And Public Health, 20, 4276. Https://Doi.Org/10.3390/Ijerph20054276
[12] Xin, T., Wang, S., Gao, L., Huo, H., Ding, Y., Wang, P., Chen, P., & Liu, P. (2020). Field Measurement Of Rail Corrugation Influence On Environmental Noise And Vibration : A Case Study In China. Measurement, 164, 108084. Https://Doi.Org/10.1016/J.Measurement.2020.108084
[13] Yu, H., & Zahidi, I. (2022). Environmental Hazards Posed By Mine Dust, And Monitoring Method Of Mine Dust Pollution Using Remote Sensing Technologies : An Overview. The Science Of The Total Environment, 864, 161135. Https://Doi.Org/10.1016/J.Scitotenv.2022.161135