**Assessment of soil pollution caused by wastewater from the truck gauging process: a case study from the Bureau of Mines and Geology (****BUMIGEB), Burkina Faso**

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ABSTRACT

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| This study focuses on evaluating soil and water management strategies in the truck gauging process at the Bureau of Mines and Geology of Burkina Faso (BUMIGEB). The site environment is facing pollution issues related to gauging activities, with significant accumulation of hydrocarbons and heavy metals in the soil, posing a risk to both the environment and human health. To carry out this study, a site analysis was first conducted to better understand the gauging activity. Then, three water samples and eight soil samples were collected from various strategic locations on the gauging platform. These samples were analysed to determine the concentrations of total grease and certain trace metallic elements. The ERACHECK ECO device was used to analyse total grease, and X-ray fluorescence spectrometry was employed to determine the concentrations of heavy metals. The analysis covered total grease in the water samples and the following elements in the soil samples: lead (Pb), copper (Cu), chromium (Cr), cobalt (Co), nickel (Ni), zinc (Zn), cadmium (Cd), arsenic (As), and mercury (Hg). The results showed varying levels of contamination depending on the areas. In the water samples, the total grease concentration was below the detection limit in the first sample, 44.8 mg/L in the second sample, and above the maximum detection limit in the third sample. The soil sample analysis showed chromium (Cr) concentrations ranging from 146.75 to 260.54 mg/kg, copper (Cu) from 33.96 to 148.58 mg/kg, and zinc (Zn) from 43.24 to 677.32 mg/kg. Arsenic (As) concentrations ranged from 7.00 to 9.07 mg/kg, and lead (Pb) from 44.74 to 167.82 mg/kg. Nickel (Ni) was detected in only one sample at a concentration of 22.29 mg/kg. Cobalt (Co), cadmium (Cd), and mercury (Hg) were not detected. To address this issue, phytoremediation was identified as an ecological, economical, and sustainable solution. A theoretical evaluation of plant species capable of extracting, stabilising, or degrading pollutants was carried out. Plants such as Vetiveria zizanioides, Helianthus annuus (sunflower), and Brassica juncea (Indian mustard) were proposed due to their tolerance to heavy metals and their decontamination potential. |

*Keywords:* gauging; hydrocarbons; depollution; heavy metals; BUMIGEB; gauging process

1. INTRODUCTION

The world is increasingly facing heightened sensitivity to environmental issues. The management of hydrocarbons and the control of pollution risks have become priorities for industries and companies operating in the field (Kharaka et al., 2005). In recent decades, there has been growing awareness of environmental problems at local and regional levels (such as air and urban pollution, and water and soil contamination) as well as at the global scale (such as the increase in greenhouse gases in the upper atmosphere) (IPCC, 2021). Soil is an important part of the terrestrial ecosystem, and it is the ultimate sink for heavy metals and becomes a medium to spread them into water bodies, organisms, and the atmosphere. Heavy metals are persistent and accumulative in soil and increase the toxicity of soils after combining with inorganic and organic matters (Ahmad et al., 2021). Global consumption of petroleum products is estimated at over 95 million barrels per day. According to "PIRA Energy Group," consumption in Africa increased by about 20% between 1990 and 2005 and is expected to rise by more than 30% by 2025 (IEA, 2019). The majority of the energy sources required for the functioning of societies and industries come from gas and oil, which fuel transportation and are used in the production of domestic and industrial chemicals (U.S. Energy Information Administration, 2020). Petroleum products contain aromatic hydrocarbons (such as benzene, toluene, etc.) and heavy metals that are insoluble in water. Due to their composition, structure, and poor biodegradability, petroleum products, particularly hydrocarbons, are toxic to the environment as they can enter the food chain (Qiu et al., 1997; Mekhalif, 2009; Harmens et al., 2013). They can persist in natural environments for long periods, cause mutagenic and carcinogenic effects, and harm biodiversity (Cerniglia, 1992; Atlas and Hazen, 2011). Soil contamination by heavy metals is a complex problem with potentially devastating consequences, affecting not only the health of terrestrial ecosystems, but also the quality of drinking water, food safety and human health (Alain et al., 2023). It is therefore increasingly important to seek viable, effective, and adapted solutions to prevent soil and water contamination. Phytoremediation, for example, is an ecological depollution technique that is being increasingly studied for its ability to extract, stabilise, or transform organic and metallic pollutants (Pilon-Smits, 2005; Ali et al., 2013).

In Burkina Faso, a country undergoing rapid economic growth, the management of hydrocarbons is a major environmental challenge due to the increased risks of soil and water contamination (Ouédraogo et al., 2017). Activities related to the transport, storage, and handling of hydrocarbons, often carried out with ageing or poorly monitored infrastructure, heighten the probability of accidental spills. Such pollution can have serious consequences for soils, including reduced fertility and increased toxicity for microorganisms and plants. Groundwater sources, which are vital for supplying drinking water to rural populations, are particularly vulnerable since hydrocarbons can easily infiltrate soils and pollute underground water supplies for extended periods. Soil pollution from hydrocarbons, particularly petroleum derivatives, has emerged as a critical environmental issue resulting from industrial activities, accidental spills, and improper waste disposal practices. These contaminants present serious threats to ecosystems, agricultural productivity, and human health (Abdulilah, H.A.Q et al, 2019)

As part of its regulatory and oversight responsibilities, the Bureau of Mines and Geology of Burkina Faso (BUMIGEB) has implemented a rigorous procedure for gauging tanker trucks. This activity ensures full transparency in the transport of liquids, especially in sensitive sectors like hydrocarbons. Gauging of tanker trucks plays a central role in hydrocarbon logistics for the industrial and mining sectors (BUMIGEB, 2023). As a key factor in Burkina Faso’s industrial and mining sector, BUMIGEB manages critical infrastructure for the gauging of tanker trucks. However, this activity poses a significant environmental risk. Leaks, accidental spills, or uncontrolled discharge of contaminated water used during the gauging process can lead to soil and water pollution (Béguin et al., 2006). If not properly managed, hydrocarbons can infiltrate the soil, affect groundwater quality, and cause serious harm to surrounding ecosystems and even nearby populations. This raises several questions: What are the current practices in the gauging area? What is the level of environmental contamination caused by this activity? How can we structure an environmental management plan tailored to the BUMIGEB gauging area? It is imperative to develop an environmental management strategy that encompasses prevention, control, and remediation or elimination of the impacts related to the gauging of tanker trucks at BUMIGEB. In order to provide answers to these questions, the chosen research theme is: "Evaluation of the Environmental Impacts of the Tanker Truck Gauging Process on Soils and Proposals for Ecological Remediation Methods: Case of the Bureau of Mines and Geology of Burkina Faso (BUMIGEB)".

The general objective of this study is to develop a strategy for environmental management of water and soils in the tanker truck gauging area at BUMIGEB, with the goal of providing both short- and long-term solutions to this pollution. Specifically, the study aims to: first, understand the gauging process; second, assess the levels of soil and water contamination in the gauging area.

2. material and methods

**2.1 Study Area Presentation**

The Bureau of Mines and Geology of Burkina (BUMIGEB) has a specialised infrastructure for the gauging of tanker trucks, located at its main site in Ouagadougou. This gauging area is designed to ensure volumetric control of trucks transporting liquids, particularly hydrocarbons. It consists of a developed platform with a retention basin intended to collect any effluents from the gauging operations. The surfaces are mostly covered with concrete, but some peripheral areas have bare or slightly altered soils. Due to the nature of the liquids handled, especially petroleum products, this area is subject to significant environmental risks, including soil and water contamination by hydrocarbons and heavy metals. The frequent movement of heavy trucks, tank cleaning, and repeated gauging operations increase the likelihood of pollutant infiltration into the local environment. This study focuses on this gauging area to assess the extent of soil contamination.

The region of Ouagadougou, located in central Burkina Faso, is mainly based on a Precambrian basement composed of metamorphic and granitic rocks. The local geology is dominated by granites, gneisses, schists, and volcano-sedimentary formations, resulting from the Eburnean orogeny dating from 2.1 to 1.9 billion years ago (Castaing et al., 2003). These ancient formations have undergone intense weathering, forming a lateritic crust on the surface and a saprolitic horizon in depth. This weathering plays a key role in the formation of basement aquifers, which consist of a weathered zone overlying a fractured zone.

From a hydrogeological perspective, the Ouagadougou region features a discontinuous aquifer, primarily developed in the saprolite and the underlying fractured rock (Wright, 1992; Bessoles, 1977). The aquifers are shallow, with water depths generally ranging from 10 to 50 meters. Aquifer recharge depends almost exclusively on seasonal rainfall, with significant spatial variability linked to local geological structures (Savadogo, 1984).

**2.2 Materials**

Several tools and equipment were used for sampling, laboratory analysis, and data processing. These materials can be grouped according to their use: sampling, laboratory analysis, and data processing.

**2.2.1 Materials used for sampling**

* Manual Auger

The auger is an essential tool for soil sampling, suitable for sandy or clayey soils. It allows extraction of homogeneous soil volumes without contamination. It consists of a handle and a spiral or gouge-shaped head, which enables drilling into the soil at various depths while maintaining sample integrity. It was used to extract uncontaminated samples.

* Sterile Bags

These bags are used for storing and transporting soil samples. Made from materials resistant to chemical agents, they protect the samples from external contamination during transport. Their sterility ensures that laboratory analyses reflect only the conditions at the sampling site.

* Plastic Cup

Used to collect samples from the basins; it helps avoid any contamination. It has a handle for an easy grip and a wide rim for easy filling.

* HDPE (High-Density Polyethene) Plastic Bottles

These 1L bottles are used to collect water samples. HDPE bottles are resistant and commonly used for sample storage and transport for laboratory analysis. Each bottle is carefully sterilised before use to ensure sample integrity.

* Sampling Forms

Used to record essential information such as location, date, depth, and sampling conditions.

* Disposable Nitrile Gloves

Used to handle samples safely and prevent contamination.

**2.2.2 Materials used for Laboratory Analysis**

* X-Ray Fluorescence Spectrometry (XRF)

XRF spectrometry is a global elemental analysis technique used to identify and quantify most of the chemical elements in a sample. This technique can be applied to a wide range of materials: minerals, ceramics, cements, metals, oils, water, glasses, in solid or liquid form.

It allows the analysis of all chemical elements from Beryllium (Be) to Uranium (U) in concentration ranges from a few ppm to 100%, providing precise and reproducible results.

* **Principle of X-Ray Fluorescence:**

XRF involves the absorption of incident X-ray radiation by matter, followed by the re-emission of less energetic X-rays by the same matter.

This phenomenon occurs at the atomic level via the transition of an electron from one orbital to another.

The high energy of X-ray radiation causes the loss of an inner-shell electron (core electron) of the atom, resulting in ionisation. The atom becomes unstable and tends to fill the vacant orbital by migrating an electron from an outer orbital.

This electronic transition leads to the re-emission of X-ray radiation by the matter.

The transition of an electron from the L shell to the K shell (Kα), from the M shell to the K shell (Kβ), and from the M shell to the L shell (Lα) are the possible transitions in X-ray fluorescence.

Each pulverised sample is placed into plastic capsules and sealed using transparent film wrap. It is important to note that each capsule is carefully labelled with the sample name and the corresponding grid reference to avoid any confusion.

From this point, each sample is scanned in turn using the portable OLYMPUS XRF 6000 in geochemical analysis mode. The results are directly collected on a desktop computer connected to the device.

* **ERACHECK ECO (Analysis of Total Grease and Total Petroleum Hydrocarbons)**

The ERACHECK ECO, a CFC-free oil-in-water tester, easily measures total oil and grease (TOG) and total petroleum hydrocarbons (TPH) concentrations in water and soil with sub-ppm accuracy. It quantifies oil and grease concentration in aqueous samples after a liquid-liquid extraction step using cyclohexane. It is primarily used in environmental monitoring, water treatment, and regulatory compliance to control industrial discharges.

* **Equipment Used for Data Processing**

The following tools were used for data processing:

* Microsoft Office Suite: Used for drafting this report and designing charts.
* Mobile phones: Used for taking various photographs.
* **Equipment Used for Mechanical Sample Preparation**

To prepare the samples, the following equipment was used:

* Crusher

A mechanical device used to reduce solid materials into finer particles. It serves to homogenise soil or rock samples by fragmenting them, thus enabling a grain size suitable for analysis.

* Pulveriser: A device for fine grinding of materials such as soil or rocks. It produces a homogeneous, very fine powder suitable for laboratory analysis.

**2.3 Methods**

* **Data Collection Methods**

Data collection is a crucial step in evaluating the impact of gauging practices on soil and water. This section presents the various methods adopted to conduct our study.

* **Field Data Collection**

Field data collection primarily focused on the retention basin, identified as a critical zone due to its role in managing water resulting from gauging operations. This basin collects effluents likely to contain hydrocarbons and other contaminants, justifying its selection as a sampling site.

The retention basin was accurately located using a handheld GPS. During the site visit, an in-depth visual inspection was conducted to identify key indicators such as water colour, the presence of oil films, specific odours (notably hydrocarbons), and the potential presence of sediments or solid particles.

**2.3.1 Sample Collection for Laboratory Analysis**

* **Water Sample Collection**

Three (03) water samples were taken from the three retention basins (1 at the main BUMIGEB site, our study site, and 2 at another of their sites) using a telescopic dipper. This allowed us to reach an average depth of 30 cm below the water surface without disturbing sediments. Samples were collected from each basin and transferred into sterile 1-litre plastic bottles, previously rinsed with water from the sampling basin. The samples did not require refrigeration, as they were quickly delivered for analysis.

* **Soil Sample Collection**

Eight (08) soil samples were collected around the retention basin to assess potential contamination. Using an auger, samples were taken from three zones: the immediate impact zone, located just a few centimetres from the retention basin, the peripheral zone, about ten meters from the basin, and the remote zone, about 50 meters away. Samples were taken at a surface depth between 15 cm and 30 cm. They were placed in sealed plastic bags, labelled, and transported under appropriate conditions for later laboratory analysis.

Special attention was given to data and sample traceability. A unique coding system was implemented to identify each sample by type, sampling site, and date. Additionally, photographs were taken at each site to visually document environmental conditions at the time of collection.

* **Mechanical Preparation**

After collection, the soil samples underwent mechanical preparation. First, they were crushed to reduce sample size; second, they were pulverised to facilitate digestion. After these operations, the samples were sent for analysis.

* **Secondary Data Collection**

Secondary data were also gathered to complement field observations and sampling:

* Operational Data: Information was collected regarding the functioning of the retention basins, their capacity to manage effluents, and current soil and water management practices at the site. These data were obtained through interviews with technical staff and direct observations.
* Technical Reports: Reports from the Bureau of Mines and Geology of Burkina were consulted to provide a historical database on gauging practices and effluent management. These documents also offered insights into applicable regulations and current environmental standards.
* Scientific Literature: Scientific articles and technical studies were reviewed to contextualise the expected results and better understand contamination mechanisms involving hydrocarbons and heavy metals.

3. results and discussion

**3.1 Presentation of Total Grease Analysis Results**

Table 1 presents the results of total grease analysis in the different water samples collected from the study area.

**Table 1. Total grease analysis results**

|  |  |  |
| --- | --- | --- |
| Sample | Concentration | Unit |
| Sample 1 | < LOD | mg/L |
| Sample 2 | 44.8 | mg/L |
| Sample 3 (study area) | > LOD | mg/L |

The results show a significant variation in total grease concentrations across the samples. Sample 1 exhibits a concentration below the limit of detection (LOD), indicating either the absence or a very low presence of grease in that area. Conversely, Sample 2 shows a high concentration of 44.8 mg/L. Sample 3, taken from the main study area, presents a concentration above the maximum detection limit, suggesting definite contamination by grease.

**3.2 Presentation of Soil Sample Analysis Results**

X-ray fluorescence (XRF) analysis was used to determine the concentration of several elements in eight samples collected from the study site. The results are summarised in Table 2 as below:

**Table 2. XRF analysis results for the different soil samples**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Unit |
| Elément |
| Chromium (Cr) | 169,46 | 205,27 | 146,75 | 182,63 | 260,54 | 175,8 | 151,57 | 233,13 | mg/kg |
| Cobalt  (Co) | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | mg/kg |
| Nickel  (Ni) | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | 22,29 | <LOD | mg/kg |
| Copper  (Cu) | 34,25 | 45,47 | 42,83 | 33,96 | 71,26 | 44,43 | 45,39 | 148,58 | mg/kg |
| Zinc  (Zn) | 46,75 | 93,85 | 43,24 | 54,76 | 677,32 | 98,65 | 77,05 | 506,12 | mg/kg |
| Arsenic  (As) | 7,28 | 8,56 | 7 | <LOD | <LOD | 9,07 | 7,68 | <LOD | mg/kg |
| Cadmium  (Cd) | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | mg/kg |
| Mercury (Hg) | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | mg/kg |
| Lead  (Pb) | 48,82 | 59,03 | 53,33 | 52,51 | 99,64 | 121,41 | 44,74 | 167,82 | mg/kg |

The XRF analysis results reveal a variable presence of heavy metals in the soil samples. Chromium (Cr) is detected at relatively high concentrations in all samples, peaking at 260.54 mg/kg in Sample 5. Copper (Cu) is also present in significant quantities, particularly in Sample 8 (148.58 mg/kg). Zinc (Zn) reaches its highest level in Sample 5 (677.32 mg/kg), followed by Sample 8 (506.12 mg/kg).

Lead (Pb) is detected in nearly all samples with concerning levels, often exceeding 100 mg/kg, especially in Samples 5 and 8. In contrast, elements such as cobalt (Co), cadmium (Cd), and mercury (Hg) are not detected in most samples (<LOD).

**Discussion of Total Grease Analysis Results**

The grease concentration analysis shows variability among the samples. These differences may be attributed to several factors. The low concentration observed in Sample 1 may indicate an area with minimal activity and no significant hydrocarbon discharge. In contrast, the high concentrations found in Samples 2 and 3 could result from intense activity or direct hydrocarbon discharge in those zones.

According to Burkina Faso’s national discharge standards, the grease concentration of 44.8 mg/L in Sample 2 and the concentration in Sample 3 (above the maximum detection limit) exceed the permissible threshold for saponifiable oils and greases, set at 20 mg/L for discharges into the natural environment. This indicates non-compliance with national regulations.

**Discussion of Soil Sample Analysis**

**Chromium (Cr)**

The analysis reveals variable chromium concentrations, ranging from 146.75 mg/kg to 260.54 mg/kg, with an average of approximately 190.64 mg/kg. The highest value was recorded in Sample 5, and the lowest in Sample 3. Chromium is present in all analysed samples, with particularly high levels in Samples 4 (182.63 mg/kg), 5 (260.54 mg/kg), and 6 (175.80 mg/kg). These findings indicate significant contamination of the area.

Although chromium is naturally present in the Earth's crust, its levels in soil typically increase due to anthropogenic activities such as fuel handling or industrial discharges. According to Burkina Faso’s AFNOR U44-041 standard, the threshold for chromium is 150 mg/kg. This limit is exceeded in several samples, suggesting widespread contamination. Abbas et al. (2021) reported average chromium levels ranging from 140 to 230 mg/kg in polluted soils around service station environments similar to our study site. These data support our findings. Fig. 1 illustrates the discussion.

**Fig.1. Chromium (Cr) Concentration by Sample**

**Cobalt (Co)**

Cobalt is a trace element naturally present in the Earth's crust. It is essential in small amounts for living organisms, but becomes toxic at high concentrations. In the analysed samples, cobalt concentrations were below the detection limit (LOD) of the XRF device. This apparent absence of cobalt may be due to very low concentrations in the study area or the technical detection limits of the XRF for this element.

According to the Burkinabe soil quality standards, although no specific threshold for cobalt is explicitly set, the Canadian CCME guideline recommends a limit of 50 mg/kg for agricultural soils. A study conducted by Konaté et al. (2018) in Kankan (Guinea) found cobalt concentrations below 10 mg/kg in urban soils, consistent with the non-detection observed in this study.

The Fig. 2 clearly shows no detection of cobalt concentration in the various samples.

**Fig.2.Cobalt (Co) Concentration by Sample**

**Nickel (Ni)**

Nickel (Ni) was detected only in Sample 7, with a concentration of 22.29 mg/kg. This may be due to the presence of nearby metallic structures or used fluids and oils containing nickel from truck operations at the gauging station. According to the AFNOR U44-041 standard for soil cultivation, this concentration does not exceed the critical threshold of 50 mg/kg. A study by Mouhamadou et al. (2017) in Senegal, in a similar zone, reported nickel levels lower than those observed here, supporting and confirming our results. This is shown in Fig. 3 as below.

**Fig.3. Nickel (Ni) Concentration by Sample**

**Copper (Cu)**

Copper (Cu) concentrations range between 33.96 and 148.58 mg/kg, with an average of approximately 58.27 mg/kg. The highest value was observed in Sample 8, and the lowest in Sample 4. These variations may be attributed to the local geological substrate, but mainly to anthropogenic pollution sources such as spills of used hydrocarbons or oils, or other industrial or mining activities. The AFNOR U44-041 standard sets the maximum permissible copper concentration at 100 mg/kg for cultivated soils.

Similar studies have been conducted. For example, Ouedraogo et al. (2019), in a study in Bobo-Dioulasso, found copper levels ranging from 70 to 180 mg/kg in soils treated with urban organic waste. This supports the idea that organic discharges and fuel residues can enrich soil in copper. The Fig. 4 shows the histogram of copper concentrations in each sample.

**Fig.4. Copper (Cu) Concentration by Sample**

**Zinc (Zn)**

Zinc, though beneficial at low doses, becomes toxic at high concentrations. Zinc (Zn) concentrations range from 43.24 to 677.32 mg/kg, with an average of approximately 199.72 mg/kg. As shown in Fig. 5, the highest value was found in Sample 5 and the lowest in Sample 3. This variability could be explained by the proximity of fuel transit or storage zones. In Burkina Faso, the standard for soil cultivation limits zinc concentration to 300 mg/kg. Levels above this pose risks of ecotoxicity and crop contamination. A relevant study is that of Udoh et al. (2024) in Benin, which found zinc levels exceeding 450 mg/kg in soils amended with solid urban waste in Cotonou. The authors attributed these levels to zinc in household and industrial waste.

**Fig.5. Zinc (Zn) Concentration by Sample**

**Arsenic (As)**

Arsenic (As) concentrations range between 7.0 and 9.07 mg/kg, with an average of about 7.92 mg/kg. The highest value was found in Sample 6, and the lowest in Sample 3. This presence may be linked to arsenic release through used industrial oils and fluids in the gauging process, or to an exceptional local geochemistry. According to the AFNOR U44-041 standard, which sets the limit at 20 mg/kg, these concentrations are below the standard. A similar study by Zhou et al. (2014) in China showed high arsenic concentrations in contaminated soils. Therefore, there is no indication of soil contamination by this element in our study. Figure 6 shows arsenic concentrations in the samples.

**Fig.6. Arsenic (As) Concentration by Sample**

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**Cadmium (Cd)**

Cadmium is extremely toxic even at very low doses. It often originates from industrial activity, phosphate fertilisers, or the combustion of fossil fuels. In this study, cadmium was not detected in any of the samples. Probable causes of this non-detection include the absence or very low levels of cadmium in the area, and the XRF’s limited ability to detect cadmium below 1 mg/kg. The AFNOR U44-041 standard generally sets the Cd limit at 2 mg/kg for agricultural soils. A study by Béavogui et al. (2021) on urban soils in Conakry showed that Cd concentrations were often below 2 mg/kg, confirming that this type of metal may remain undetectable depending on the method used. This is shown in Fig. 7 below.

**Fig.7. Cadmium (Cd) Concentration by Sample**

**Mercury (Hg)**

Mercury is one of the most dangerous pollutants to human health and ecosystems. In all samples, mercury was below the detection limit. This absence may indicate that the area was not exposed to industrial sources, or that the XRF method is not sensitive enough to detect the low typical concentrations of mercury.

The standard for mercury in agricultural soils is 1 mg/kg according to the soil cultivation guidelines. A study by Zongo et al. (2020) in artisanal mining areas in central-northern Burkina Faso measured average Hg concentrations of 0.14 mg/kg in contaminated soils and <0.02 mg/kg in unexposed zones. These low levels corroborate the non-detection observed in the present study. The histogram, as shown in Fig. 8, illustrates that mercury was not detected in the samples.

**Fig.8. Mercury (Hg) Concentration by Sample**

**Lead (Pb)**

Lead is one of the most toxic metals, even at low concentrations. Lead (Pb) concentrations ranged from 44.74 mg/kg to 167.82 mg/kg, with an average of 80.91 mg/kg. The highest value was observed in Sample 8, and the lowest in Sample 7. XRF analysis reveals concerning concentrations in several samples, especially Samples 5 and 8. Lead presence could be due to runoff of leaded oils or fuels, or residues from mining or artisanal activities. The Burkinabe standard (based on AFNOR U44-041) for cultivated soils limits lead concentration to 100 mg/kg. The values observed in this study therefore indicate a real risk, particularly if the lead is bioavailable (i.e., assimilable by plants). A study by Nacoulma et al. (2015) on soils near artisanal mining sites in the Gaoua region reported lead levels up to 210 mg/kg. These results confirm the potential for significant lead pollution in similar contexts. Fig. 9 illustrates the lead concentration in the samples.

**Fig.9. Lead (Pb) Concentration by Sample**

**Global Analysis of Heavy Metals in the Samples**

The global analysis of the eight samples reveals a significant presence of several heavy metals. Elements such as Chromium, Copper, Zinc, and Lead show relatively high concentrations in certain samples, which may represent a non-negligible environmental risk. The absence of detectable levels (<LOD) of Cobalt, Cadmium, and Mercury in all samples suggests they are present at levels below the detection limits of the equipment used. This heterogeneity in concentrations highlights the importance of implementing a differentiated management strategy for contaminated soils.

Phytoremediation could be considered for the most concentrated elements, taking into account plant species adapted to the extraction or stabilisation of specific metals identified.

4. Conclusion

This study focuses on evaluating soil and water management strategies in the truck gauging process at the Bureau of Mines and Geology of Burkina Faso (BUMIGEB). It addresses environmental issues related to the accumulation of hydrocarbons and heavy metals in the soil resulting from gauging activities. Field investigations, including site analysis and soil sampling, were conducted to assess the level of contamination. The overall analysis of eight samples revealed a significant presence of several heavy metals, such as Chromium, with a high concentration of 260.54 mg/kg in sample 5. Copper concentration peaked at 148.58 mg/kg in sample 8, Zinc at 677.32 mg/kg in sample 5, and lead at 167.82 mg/kg in sample 8.

To address this situation, phytoremediation is proposed as a sustainable, cost-effective, and environmentally friendly strategy. Plant species such as Vetiveria zizanioides, Helianthus annuus, and Brassica juncea were identified for their capacity to remediate contaminated soils. The study recommends the implementation of an integrated soil and water management approach, the development of an environmental monitoring plan, and awareness-raising actions for the sustainable restoration of the site.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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