



(RESEARCH ARTICLE)



Diagnosis of the impact of gold mining on the environment and on health in the commune of Fourou, Kadiolo district, Sikasso region

Oumar PLEA ^{1,*}, Alassane TOURE ² and Boubacar KEITA ³

¹ Ahmed Baba Private University (UPAB) of Bamako.

² National Engineering School (ENI/ABT) of Bamako.

³ Rural Polytechnic Institute (IPR) of Katibougou

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Abstract

This assessment aimed to analyze in depth the impact of gold mining on health in the commune of Fourou, Kadiolo Cercle, Sikasso Region, southern Mali. Field observations allowed for a description of the environmental, social, economic, and health impacts around mining sites, and the identification of potential sampling sites for a broader and more comprehensive impact study. The study also involved exploring various locations within the Fourou commune's watershed in relation to the Syama industrial gold mine and artisanal gold mining sites. Ultimately, six gold panning sites were identified, all causing mechanical damage and significant alterations to the natural landscape, along with eight health centers, approximately ten ecological observation sites, laterite hills, and one important site providing access to fresh surface rock. Suspected cases of water contamination in the Bagoé River at Sinty (dead fish in the water), skin diseases, and respiratory illnesses (cases of chronic cough recorded in health center registers, particularly in Ngolopéné) have been identified. The presence of dredges on the Bagoé River at Alhamdoulilaé and Sinty has also been noted. These preliminary findings pave the way for a broader study to assess the short- and long-term impacts of industrial and artisanal gold mining in the Fourou district.

Keywords: Diagnosis; Impact; Gold Mining; Environmental; Health

1. Introduction

The commune of Fourou, in the Kadiolo district, shifted towards gold mining in the 1990s, attracting sub-regional migrants. Gold panning now dominates the local economy, generating over 70% of income and more than 10,000 jobs. This has led to overpopulation, with a density exceeding 200 inhabitants per square kilometer, and the presence of several nationalities in the studied areas. Consequently, the current situation reveals under-explored environmental and health degradation: water pollution, deforestation, and health problems (respiratory illnesses, skin diseases).

The Fourou gold mining district, located near the Mali-Burkina Faso-Côte d'Ivoire border, consists of the Syama industrial mine and its satellite deposits in the vicinity of Bananso and Tabakoroni. It also includes a significant number of artisanal mining sites surrounding the industrial mine and at varying distances from it. The district is located in a hot and humid tropical climate zone with ubiquitous and well-developed savanna vegetation due to the prevailing humidity. The district's population, predominantly Senufo, has historically been agricultural, although since the 1990s, extractive activity has become part of their daily lives. This activity, attracting various peoples from the sub-region, now dominates and is the main activity and source of income for the population. It has generated serious environmental and health problems in the past, but these have been little explored. The findings of the preliminary project mission describe the

* Corresponding author: Oumar PLEA

current situation and the impacts of the extractive industry on the environment and human health in the rural commune of Fourou, in the Kadiolo district of southern Mali.

1.1. Study area

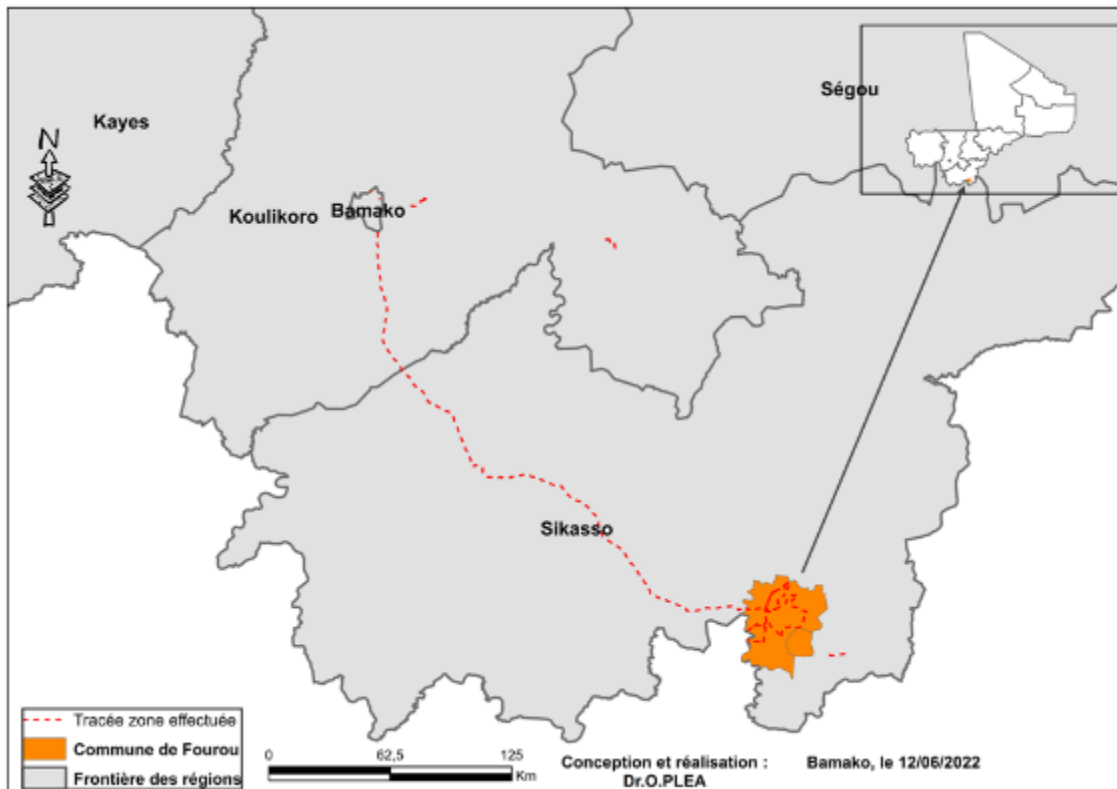


Figure 1 Location of the study area.

The study area is located in Fourou, in the Kadiolo district (Sikasso region) in southern Mali. It is a major gold mining area. It encompasses the town of Fourou and 22 villages, with a population exceeding 40,000 inhabitants according to the 2009 census. The area is undergoing significant socio-economic changes linked to gold mining and benefits from the redistribution of mining revenues for its development.

2. Materials and Methods

To carry out this project, a multidisciplinary approach was employed, utilizing several areas of expertise, namely: geographic information systems and remote sensing; public health; social sciences; sedimentary dynamics and the environment; petro-geochemistry and metallogeny; water chemistry; and ecology, fauna, and flora.

In accordance with the established objectives, several types of data were collected, including geolocation point clouds, qualitative surveys, and satellite imagery of the observed sites. Before conducting fieldwork, pre-processing of the digital terrain model allowed us to identify the hydrographic network and the watershed around the Syama mine. In the field, we were able to georeference key points related to environmental and health issues.

3. Results and Discussion

3.1. Current Situation

The main objective of this assessment was to geolocate significant features in the field that could explain the environmental and human health challenges surrounding the mine. The results highlight all mining sites (industrial and artisanal), various water points and dams, health centers, ravines, market gardening sites, and former mining pits in the municipality of Fourou. (Figures 2 and 3)

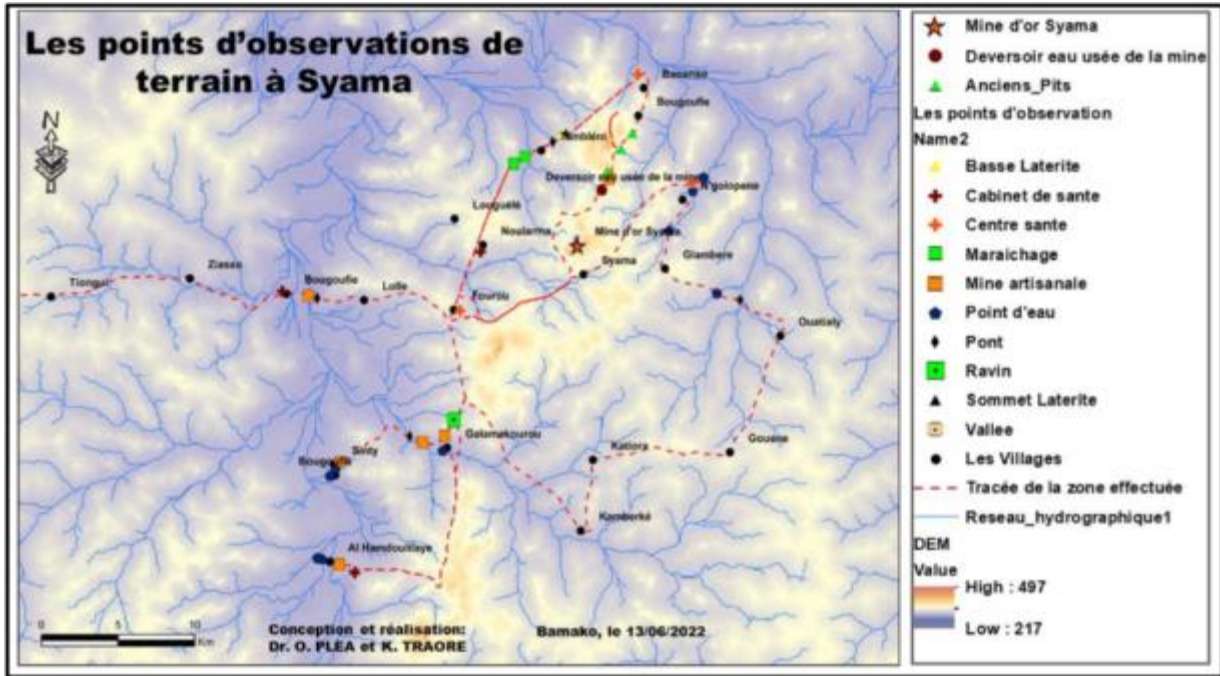


Figure 2 Les points d'observations de terrain à Syama. (Données personnelles)

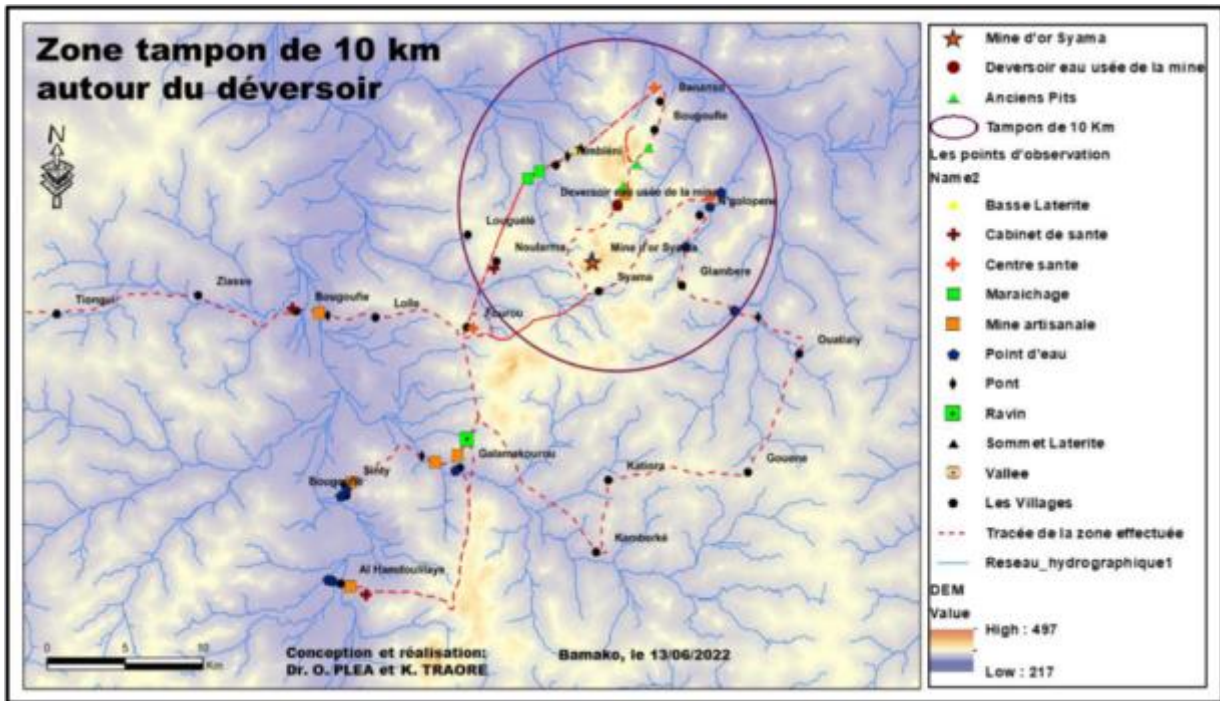


Figure 3 10 km buffer zone around the mine's wastewater overflow.

In Figure 3, we established a buffer zone around the overflow to identify the geographical areas most affected by the mine's impacts. Overall, the villages of Syama, N'golopéné, Noularma, and Bananso are the most affected by surface water pollution, groundwater pollution, and air pollution from volatile mine dust. Water pollution is also a concern. The overflow is located at the center of three branches of the hydrographic network, all directly connected to the watershed outlet. The main branch is just outside Fourou, heading towards Noularma. The second is located between Noularma and Tembléni. Finally, the third is in direct contact with the three former pits (Figure. 4).

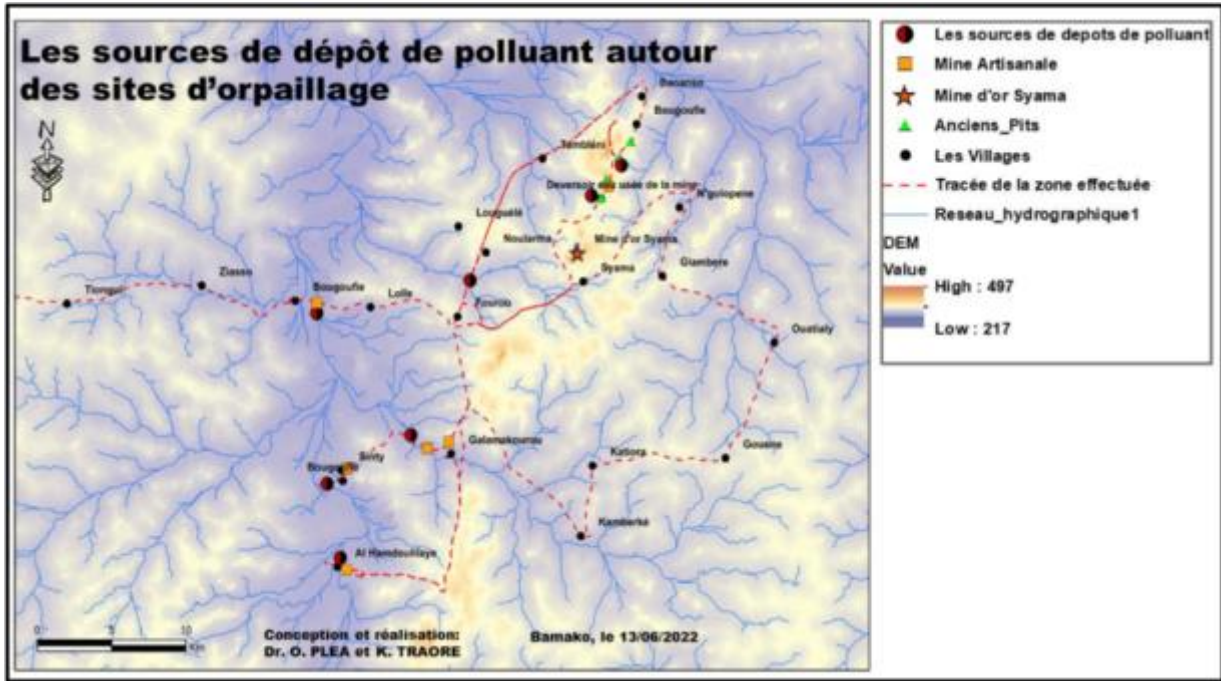


Figure 4 Sources of pollutant deposition around gold panning sites.

Throughout the municipality of Fourou, we identified seven main sources of pollutant deposition (Figure. 4). All are located along a network of streams that flow directly into the watershed outlet. In addition to these, we were also able to geolocate points that characterize the ecological dimension and features related to public health (Figures. 5 and 6).

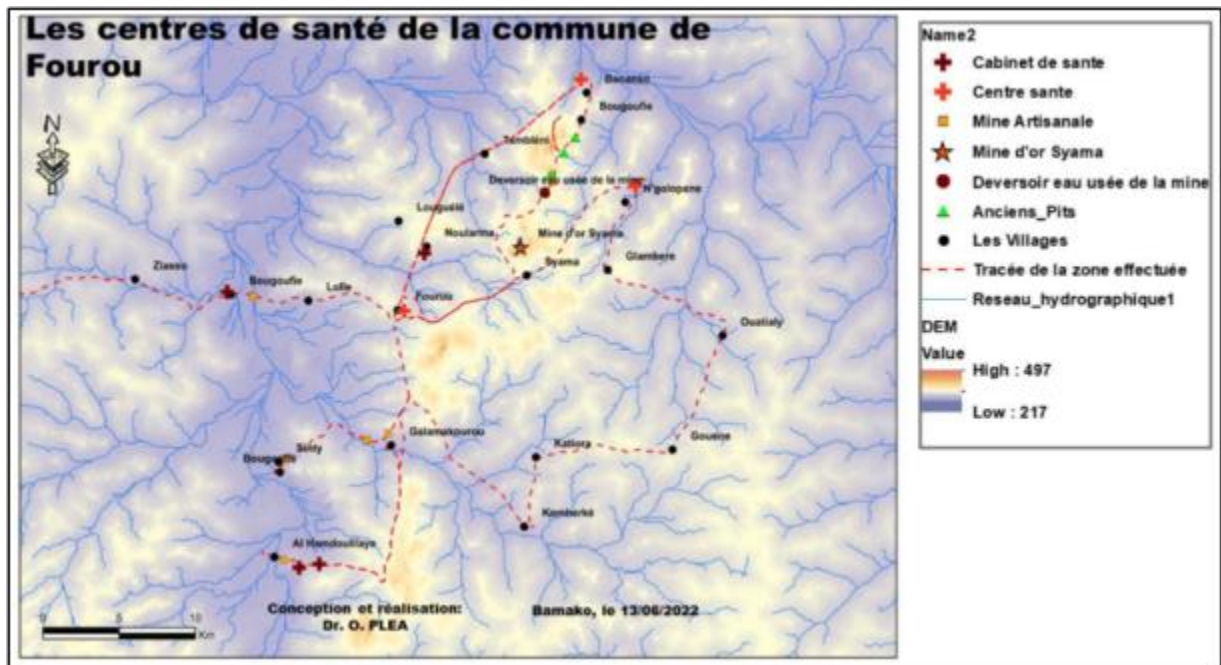


Figure 5 Health centers in the commune of Fourou.

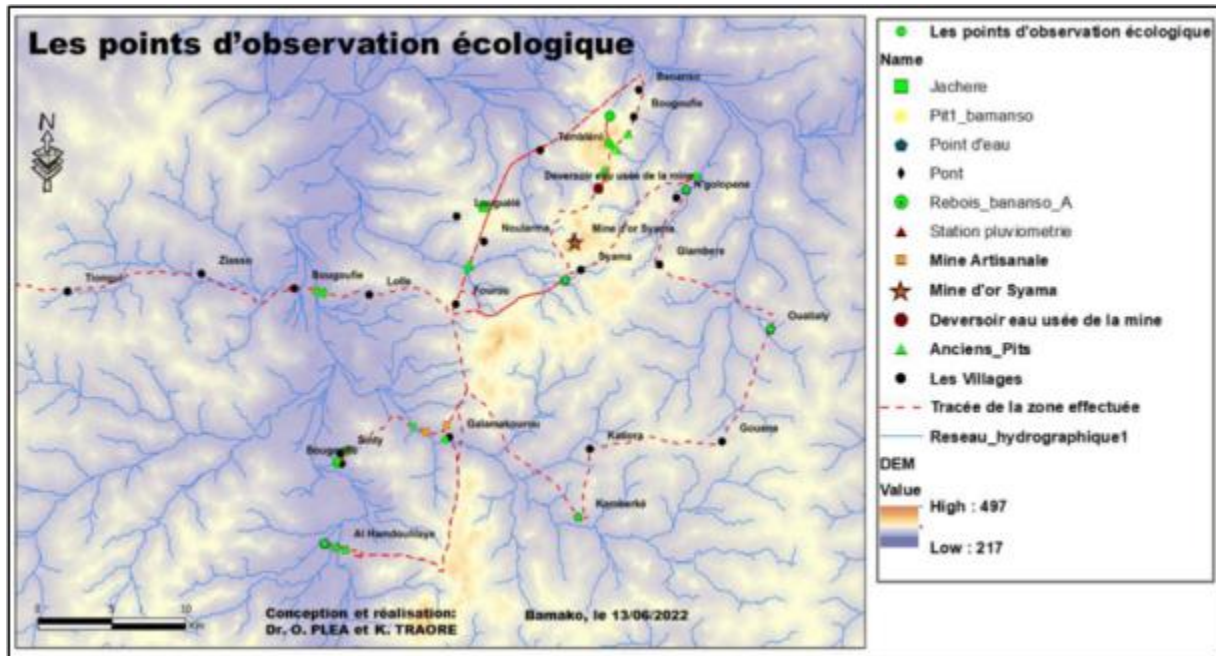


Figure 6 Ecological observation points.

In summary, the data collected in the field allowed us to better define and delimit the study area based on the focus of all the project's components. It also highlighted the key elements of the impact of mining on the environment and public health.

3.2. Impacts of gold mining on the environment and human health:

Among the impacts linked to gold mining activities are: the expansion of prostitution; drug trafficking and consumption; school dropout and child labor; high crime rates; and a rising cost of living. Prostitution has reportedly reached considerable proportions due to the increasing presence of Nigerian and Ghanaian women in brothels in the Fourou district. Our observations in a gold mining camp called Bougoufiè, located in the village of Bananso, confirmed the presence of these groups. Others also reportedly work in the bars of Fourou. These women are said to be in high demand from both gold miners and mine workers. Faced with this phenomenon, some Fourou residents are even encouraging the opening of these brothels, fearing further moral decay among the local youth. These young women are also tempted by this practice, but in other forms. They are allegedly approached by gold miners based on certain characteristics deemed positive by some marabouts and fetish priests in the context of gold prospecting. Drug trafficking and consumption are said to be commonplace in Fourou. These substances, highly prized by gold miners, are largely responsible for numerous accidents in the mines. Their excessive use is also a factor in widespread violence among gold miners, as well as traffic accidents in Fourou, sometimes resulting in loss of life, according to a young interviewee. Because of the income generated by gold mining, many young children are tempted to drop out of school to work at the sites. Although this phenomenon has been less widespread this year, it remains quite worrying, according to a young interviewee: "We used to see children hitchhiking every morning around 7 a.m. to get to the sites. (...) Imagine a 15-year-old who goes to the site and earns 2 million. He'll wonder why he should go back to school?" Generally encouraged by their mothers, these children drop out of the third and fourth grades to work at the sites, according to a former gold miner who now works for the mine. Another gold miner in Bananso stated that children are not allowed on the site in his village. However, women who sell food are sometimes accompanied by their young children, the same source added. During our visit to this site, we did indeed observe the presence of minors, both as gold panners and supervisors. Whether in Bananso or at other gold panning sites, the criminal phenomenon, particularly homicide, appears to be quite widespread. According to one of our sources, due to certain social perceptions, quarrels and murders are believed to impact a site's productivity: "Simple quarrels cause gold panning sites to lose productivity. (...) On the other hand, if there is a murder, it will considerably increase the amount of gold in the site's subsoil. (...) This is why some gold panners do not hesitate to trap some of their colleagues by deliberately destroying gallery pillars to cause collapses. (...) A few months later, or even a year later, these same galleries would contain abundant quantities of gold."

The population of Fourou, which hosts workers from various traditional and industrial mining sites, is also bearing the brunt of the economic effects of these industries. Given that mine workers and gold panners have incomes of their own,

their presence has a considerable impact on the cost of living. For example, a mine worker told us that it is now difficult for a farmer in Fourou to buy poultry at a reasonable price. According to him, the alternative would be to encourage the population to develop fish farming and other forms of livestock breeding, particularly poultry, sheep, and goats. Unfortunately, faced with the allure of the gold panning sites, these populations are inclined to abandon agricultural activities, resulting in shortages of certain products in local markets. This scarcity leads to both soaring prices and the inability of some to access basic necessities. These realities are said to be at the root of many frustrations between mine operators and local farmers and populations, especially farmers.

3.3. Risks and Challenges of Water Contamination/Pollution

The alteration of biotite ($K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2$) to kaolinite ($Al_2Si_2O_5(OH)_4$) (Penven et al., 1981) has already been observed in Korhogo, Côte d'Ivoire (Kimpé and Tardy, 1967), located in the neighboring south and forming a geological continuum of the Syama mining district. This transformation releases iron and magnesium into surface geodynamic systems.

The presence of graphite that stains the fingers upon contact suggests easy and rapid carbon mobilization in the environment. This carbon is subsequently drained down slopes and carried away by water currents. In the study area, soil acidification is a cause of soil degradation and the destruction of arable land. It manifests itself through sporadic plant growth.

4. Conclusion

This study aimed to diagnose the impact of mining on the environment and public health in the Fourou area, Kadiolo district, Sikasso region, southern Mali. Using a multidisciplinary approach, several areas of expertise were employed, namely: geographic information systems and remote sensing; public health; social sciences; sedimentary dynamics and the environment; petro-geochemistry and metallogeny; water chemistry; and ecology, flora, and fauna. The application of these areas of expertise allowed for the integration of scientific knowledge to highlight the impacts of mining on the environment and human health. In addition to the risks of environmental degradation, pollution of the biophysical environment, and gold panning activities, these activities have led to an increase in prostitution; drug trafficking and consumption; school dropout and child labor; a high crime rate; and a rise in the cost of living.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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