Study on Impact of Mineral Resources Development in Africa

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Abstract. One of the continents with the greatest mineral wealth is Africa. The economies, militaries, and fields of science in African nations and around the world have all benefited greatly from these natural resources. As a result, the mining sector is one of the most significant ones in Africa, and it has a wide range of influences. This review will examine the growth of the mining business in Africa and its effects on the continent, explaining how the development of the mining industry has affected the continent's economy, vegetation, water supplies, and human health. Human disorders like pneumoconiosis can be brought on by the dust and toxic materials created during the mining operation. The mining industry has a significant impact on water resources. Heavy metal components pollute water supplies, causing damage to flora along a chain of events. This review also examines the effects of mining on vegetation covering in the section on how it affects vegetation using the Normalized Difference Vegetation Index (NDVI). In terms of the economy, the mining sector is essential. The development of mineral resources is the primary source of income for the majority of African nations. In some ways, the mining sector has aided in the economic growth of African nations. The purpose of this essay is to investigate how resource extraction affects the ecosystem. Environmental governance is still in the developing phase on a global scale. It exhorts people to consider and save the environment. In order to promote sustainable development, the society should implement the relevant governance measures.

Keywords: Africa, mining resources, development, human health, water resources.

1. Introduction

Africa is renowned for having abundant mineral resources. The social, economic, and environmental effects of mining growth in Africa are extensive and far-reaching, and they influence the continent's present and future course. Africa's mining sector is developing in a variety of ways across its many nations and areas. While some nations have effectively used their mineral resources to spur economic development and prosperity, others still have a difficult time maximizing the potential of their mining industries. The environmental effects of the African mining sector are extensive and encompass a wide range of topics, such as ecosystem harm, air pollution, water pollution, and land destruction. Often, considerable land reclamation and damage are necessary for mining operations. As a result, there is a loss of biodiversity, soil erosion, and vegetation cover. After mining, the area may turn into a wasteland that is challenging to reclaim. Wastewater and effluents from mining operations contain a range of dangerous chemicals and compounds. These waste products and emissions could contaminate nearby water sources if they reach those bodies of water. Water resource pollution jeopardizes the wellbeing of aquatic ecosystems as well as the access of local residents to safe drinking water. Air pollution is a result of mining operations and includes dust, exhaust, and gaseous pollutants. These pollutants, which could endanger both human health and the quality of the air, include hazardous gases, particulate matter, and greenhouse gases. Coral reefs, wetlands, and other nearby habitats, as well as forests, are frequently harmed by mining activities. These harms can disrupt the ecological balance, degrade ecosystems, and result in the extinction of some plant and animal species.

However, it is still challenging to fully develop and utilize the natural riches of other African nations due to a number of issues. Access to remote mineral-rich regions is frequently hampered by inadequate infrastructure, including weak power grids and inadequate transportation networks. Additional difficulties arise from a lack of institutional, technical, and financial resources, which restrict their potential to draw in investment and operate mining operations well.

Examining the effects of mining on the environment in Africa is the main goal of this article. This article begins by providing a quick overview of the effects of mining development on Africa before moving on to discuss the effects of mining development on human health, water resources, vegetation, and the economy. Finally, it offers examples of environmental protection strategies from the worlds of technology, government, business, and the general public.

2. Impact of Mining Development on Africa

Pre-colonial times, when indigenous communities engaged in small-scale mining activities, are when mining first began in Africa. The extraction of valuable metals like gold and silver as well as precious stones is the main goal of these activities. In pre-colonial periods, the majority of mining processes were artisanal, relying on conventional methods and local expertise. The mining industry in Africa witnessed significant changes throughout the colonial era. European nations profited economically from Africa's mineral abundance. Large-scale mining operations targeting minerals like gold, diamonds, copper, and coal were built. Mineral extraction and export increased as a result of the introduction of sophisticated mining infrastructure and technologies by colonial powers. The mining industry has been Africa's primary economic development strategy up until now because of the continent's abundant mineral resources, and substantial amounts of money have been invested in it to do so. This strategy has effect on the economy, to be sure. The surrounding area also had an impact. African countries that generate minerals perform better than those that produce oil and non-mineral goods in terms of governance and human development indices. Additional study is necessary to conduct comprehensive studies of all the reasons causing reported changes in economic and social contribution by mining [1].

2.1. Impact of Mining Development in Africa on Human Health

The consequences for human health are the first byproduct of mining development. According to a report on safety and health conditions in the mining sector in South Africa, the persistent risk of rock falls and rock explosions brought on by seismic activity makes worker safety a top concern. The survey also showed that there are more events and accidents involving machinery, materials handling, and underground transportation. In the sector, silicosis and tuberculosis continue to play a key role in the high rates of morbidity and mortality. Regarding employee health, TB and silicosis continue to play a key role in the industry's high rates of morbidity and mortality [2]. Additional, mining unintentionally aids in the spread of disease. The toxic metals included in the tailings may have effect on the environment as a result of inappropriate handling of tailings during the mining process. Zinc (Zn), lead (Pb), aluminum (Al), cadmium (Cd), nickel (Ni), iron (Fe), manganese (Mn), and arsenic (As) are the hazardous metals that are most frequently found in soil. These metals can pollute soil, food, surface and groundwater, and they can also impact the growth, endocrine system, and biological processes. These harmful metals can cause plants to grow and produce less as a result of their presence in the soil. Through plant absorption, animal consumption of polluted plants, and human consumption of contaminated animal products, toxic metals can build up in the food chain. Damage to the brain system, kidneys, liver, and other organs are a few of the potential health dangers to both humans and animals. Additionally, toxic metals can impair a child's ability to develop normally and raise their risk of developing cancer [3].

These airborne dusts and poisons from mining are also a source of respiratory illnesses like pneumoconiosis. Additionally, mining operations may contaminate and deteriorate the environment, impacting the health of neighboring people. Psychological stress, noise pollution, accident injuries, etc. are additional concerns [4]. High levels of coal output are linked to higher incidences of cardiovascular illness, hypertension, lung disease, kidney disease, and other health issues, according to a West Virginia study. According to a Chinese study, inhalation of particulate matter during the mining process is the leading cause of human sickness linked to coal mining [5].

2.2. Effects of African Mining Development on Water Resources

Water resources are also seriously impacted by the development of the mining industry. 99% of the world's fresh water resources come from groundwater resources, according to statistics provided by the United Nations. The existence of groundwater traces over the world, notwithstanding their uneven distribution, has a significant impact on the social, economic, and environmental conditions, especially addressing climate change. The resources in the groundwater will inevitably be exposed and to some degree contaminated during deep mining. Due to geological contamination, saltwater intrusion, and anthropogenic pollution, Tanzania's East African Rift Valley is experiencing serious problems with water quality. The most prevalent toxins in the area's groundwater are fluoride and arsenic, both of which may significantly harm the health of the residents. Geological pollution is the term used to describe the non-anthropogenic contaminants found in the rocks and soils of the local aquifers. When saltwater seeps into a freshwater aquifer, the water becomes unsuitable for human consumption. Anthropogenic pollution is pollution brought on by human activities including mining, farming, and industry. The health of the local people can be significantly impacted by fluoride and arsenic. Arsenic can be found in rocks that have been oxidized by mining, whereas fluorine is most frequently found in rocks in rift zones. While excessive quantities of arsenic can result in skin sores, cancer, and other health issues, high levels of fluoride can induce tooth and bone fluorosis [6]. High phosphate levels have been linked to eutrophic conditions in water bodies and have been demonstrated in studies to be indicators of pollution. It is possible to link high phosphate loading to the influx of eroded material from waste rock dumps. The weathering of calcium-bearing minerals, which was greatly aided by mining activity in the region, may also be connected to elevated phosphate levels. Groundwater and surface water in Nigeria have arsenic amounts of 0.05 and 0.14 mg/L, respectively. Additionally, lead may be found in polluted water. Lead poisoning in children can cause a number of health issues, including brain damage, behavioral issues, anemia, liver and kidney damage, and hearing loss [7].

2.3. Effects of Mining Development on Vegetation in Africa

Mining operations may have a substantial negative influence on the environment and society. Some of the environmental issues related to mining activities include improper waste management, deforestation, water contamination, and land deterioration. According to research on the effect of mining on ecosystems, a bigger proportion of land areas have been barren as a result of mining activity. Mining has caused the loss of plant cover over vast amounts of land in several places. Huge ditches, excessive runoff, severe erosion, decreased soil infiltration, decreased groundwater recharge, and thus decreased land productivity are the results. Due to the loss of vegetative cover, both the viability for agricultural use and the habitat for birds and other animals have decreased. In the end, this results in the eradication of water bodies, cultural places, and diverse vegetation [8]. Maximum soil thickness may be controlled by plants [9].

Trees are frequently cut down when mining regions are developed, and the bare soil is vulnerable to land degradation. One of the major agricultural issues that seriously jeopardizes food production and the standard of living of Ethiopians is land degradation. It has put the environment in danger and resulted in significant economic losses. The improper use of land by various economic activities in Ethiopia is the biggest contributor to land degradation. The rate of soil loss due to erosion is influenced by a number of factors, one of which is the contribution of human activities to land degradation, such as deforestation, removal of natural vegetation, overgrazing, and agricultural intensification without erosion control measures [10].

2.3.1 Analyzing mining impacts on vegetation through NDVI imagery

NDVI is an index reflecting the status of land cover vegetation, NIR is the near infrared band, and Red is the red band [11]. An indicator used to reflect vegetation growth is the NDVI value. NDVI has a range of -1 to 1. A positive number shows the presence of flora, and the higher the coverage, the higher the value; a negative value denotes the presence of water, clouds, snow, etc.; and a positive

value indicates barren soil or rocks. Higher NDVI readings so typically suggest thicker vegetation cover and better growth. Using QGIS software, this revie()w creates NDVI images of a specific region in South Africa. Landsat 8 served as the image's data source. As shown in the formula, to calculate the NDVI value, you need to subtract the value of the Red band (RED) from the Near Infrared band (NIR) and divide it by the value of NIR plus RED (equation (1)).

$$\mathrm{NDVI} = \frac{\mathrm{NIR}-\mathrm{RED}}{\mathrm{NIR}+\mathrm{RED}} \tag{1}$$

The NDVI images in Fig. 1 and Fig. 2 are for 2013 and 2023, respectively. The legend shows that the map in 2013 includes a significant area of red regions, which make up nearly 98% of the overall area. The NDVI intervals of a few yellow areas and orange areas are more than 0.0902, while the NDVI values of the red areas are all less than or equal to 0.0902, demonstrating that the region was completely covered by vegetation in 2013. A significant portion of the 2023 map is orange, and its NDVI value is between -0.0773 and 0.0604. Soil or rock make up the majority of this area. These two images can be compared to see how much less greenery there will be in this part of South Africa between 2013 and 2023. The amount of greenery has been severely impacted by mining.

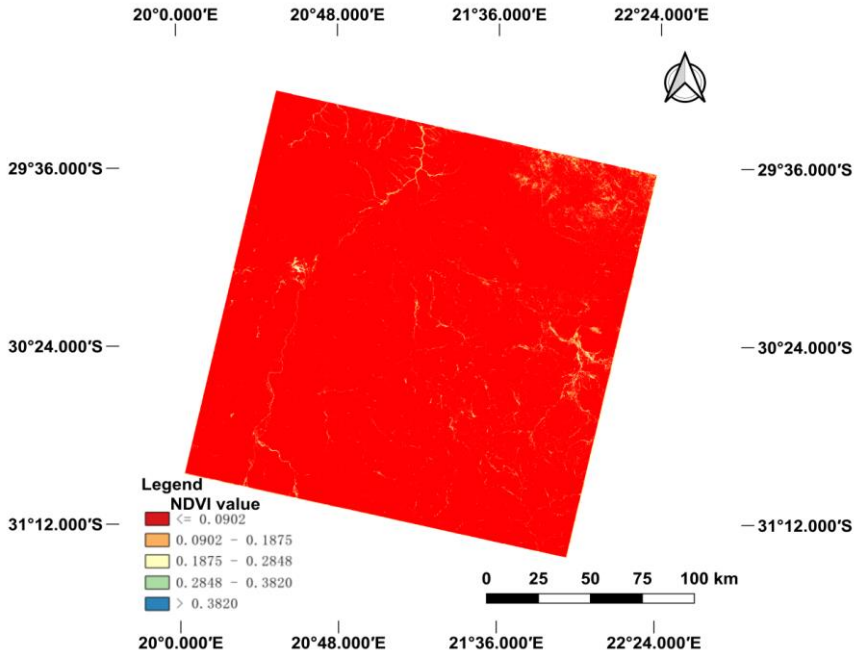


Fig. 1 The NDVI map in 2013. (Photo/Picture credit: Original)

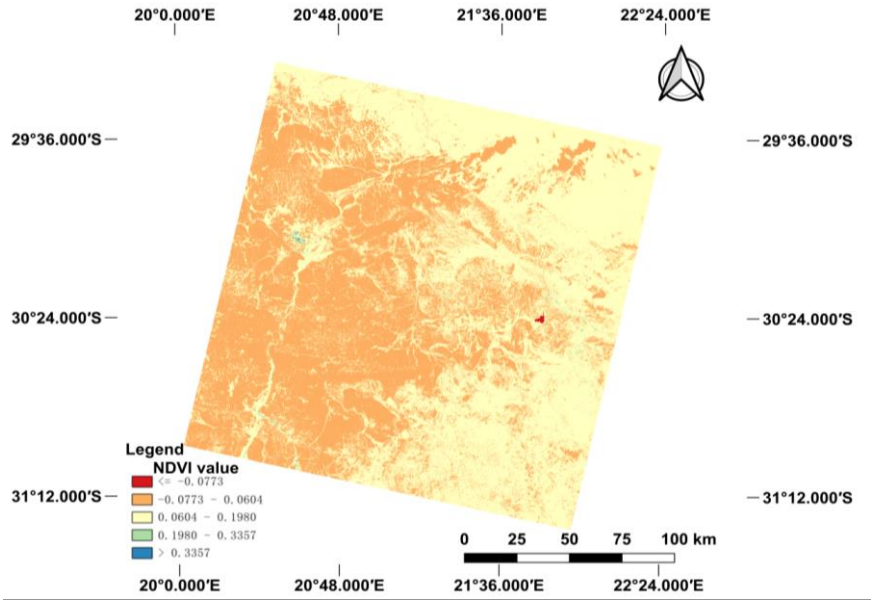


Fig. 2 The NDVI map in 2023. (Photo/Picture credit: Original)

2.4. African Mining Development's Economic Impact

In Africa, mining development is a crucial component of economic growth. This strategy has stimulated economic growth around the world including in Africa. According to research, mining is crucial to the economic growth of many low- and middle-income nations, particularly in Africa.

Exports were thus very low in Burkina Faso, which had little mining in the early 2000s and a production value as a proportion of GDP that was almost nil. But by 2016, exports as a share of all exports were steadily increasing, with the output value as a proportion of GDP hovering around 6%. Gold's proportion to exports has risen to approximately 80% in 2016.However, the mining industry's contribution to socio-economic and human development is a complicated subject that needs thorough examination of a number of variables, including the influence on the environment, social development, and economic growth. Even if there are signs that social development in the mining industry is not worsening or stalling, it is vital to take into account any potential harm that mining may do to nearby populations and the environment [1]. More foreign cash has been introduced into African nations, which has had a stronger effect on the continent's economies. According to Farole and Winkler's (2014) research, foreign investors' aid to local mining suppliers helped those suppliers grow into exporters. Support in implementing health, safety, environmental, and social conditions is one type of help, along with worker training and early payment. According to them, 33% of Ghana's mining suppliers began exporting as consequence of doing business with international mining firms, while 42% of Chile's local suppliers began exporting as a result of doing business with foreign mining firms. These instances show how the mining business may benefit other economic sectors and how foreign investment in the mining industry can foster the growth of local suppliers and boost their exportability. Due to a resource bonanza, FDI in the mining industry may have a net adverse impact on overall FDI. This is due to the possibility that a resource boom might result in an appreciation of the currency, which would reduce the competitiveness of other economic sectors [12]. However, the entrance of international businesses has also hurt the regional economies of Africa. Mining under Chinese control has had a severe impact on indigenous employment in sub-Saharan Africa. According to the survey, those who lived close to Chinese mining regions reported being unemployed more frequently than people who worked in non-Chinese mining industries. This problem may be brought on by the fact that Chinese businesses use international workers more frequently than domestic ones, which restricts local job options. Additionally, Chinese businesses are less eager and equipped to train domestic employees, which further reduces the likelihood of economic spillovers [13].

3. Improvements in the African Mining Industry

The ecology, public health, and economies of African nations have all been negatively impacted by the growth of the mining sector in that continent. As a result, governance measures are crucial. Furthermore, a variety of factors must support and aid in the execution of the measures.

3.1. Technical Support

Over the years, businesses have neglected to dispose of their tailings. The coal mining sector faces a significant issue with spontaneous combustion, which could result in underground fires and environmental contamination. Spontaneous combustion incidents are a regular issue in open pit mines, trash accumulations, storage heaps, and waste soil accumulations, however their incidence and severity varies by nation. The main causes of spontaneous combustion are spontaneous oxidation and spontaneous ignition of coal; other causes include the type of coal, the environment, and storage techniques. Technical control procedures, such as monitoring the temperature of coal storage heaps, reducing storage pile size, improving underground mine ventilation, employing chemical additives, etc., have been developed to prevent spontaneous combustion incidents. By restricting the supply of oxygen or lowering the heat produced during oxidation, these strategies try to reduce spontaneous ignition. To avoid water and air pollution brought on by spontaneous fires, proper waste management and disposal are crucial. Overall, to maintain safe and sustainable mining processes, new technologies and prevention methods must be continuously developed [14]. A sustainable environmental management technique called phytoremediation can assist Africa in addressing its pollution issues while fostering ecosystem restoration and sustainable development. To increase remediation efficiency, phytoremediation technology must choose the right plant species and different remediation strategies based on the different contaminants, such as phytooxidation, microbial remediation, and volatilization, etc. To get superior restoration results, this technique must be used in conjunction with other restoration procedures, such as physical and chemical restoration processes [15].

3.2. Government Business and Public Support

Support from the government and business cannot be separated from the improvement efforts. By informing policymakers in African nations, research findings can help to lessen reliance on natural resources and the significance of economic diversification. To ensure that mineral resources contribute to economic progress and social development, policies that encourage transparency and inclusivity are required [16]. To prevent the contamination of land, water sources, plants, animals, and marine life with harmful metals, the government and businesses must develop strong tailings management standards. Human health is seriously threatened by the buildup of hazardous metals in the food chain. It is crucial to keep an eye out for contamination in food sources and take precautions to reduce exposure. Governments, business, and citizens must work together to implement effective pollution control and preventive measures [3]. To discover solutions that strike a balance between resource demands and requirements for environmental protection and human health, governments, businesses, and individuals must work together. Promoting moral and ethical mining methods is essential for maintaining a healthy environment and safeguarding public health. We can strive towards more responsible mining for the benefit of all by taking individual action, supporting international accords, and pressing for change at the government level [4]. The use of phytoremediation technology in Africa still confronts several obstacles, such as a lack of policies and regulations, a lack of funding, a lack of technology and knowledge, etc., but these issues can be gradually remedied with more research and practice. Technology research and implementation, as well as environmental protection and sustainable development, can all be facilitated by the collaboration and assistance of the government, academics, businesses, and all spheres of society [15]. Improved investment in research and development is required to advance safety technologies, as well as improved regulation and enforcement of safety and health standards. Greater cooperation between

businesses, employees, and governmental organizations is also required in order to solve industry safety and health issues, as well as the need of worker education and training [2]. Businesses and governments must use ethical mining methods and consider how mining operations affect the social and natural surroundings [1].

4. Conclusion

This study does a thorough investigation to look at the effects of mining. It is impossible to undervalue how the mining sector affects people's health. The mining operation will result in significant amounts of waste rock production. If these waste pebbles are not processed, the heavy metal elements they contain will contaminate the land, water, and flora, which will ultimately affect the ecosystem in which people live. Cancer was a factor, which led to organ failure and the development of other disorders. Aquatic plants and animals will become infested once water resources have been contaminated. The natural vegetation will likewise perish in the absence of nutrients because of the contaminated water on which it depends for living. Excessive mining would result in soil erosion and desertification of the vegetation, drastically reducing the vegetation cover and increasing the likelihood of sandstorms and other natural disasters in the future. The technical government, businesses, and the general public should support and aid the governance measures since environmental governance is crucial. For places that have been severely impacted by environmental pollution, the government has enhanced oversight and implemented reform and rehabilitation initiatives. The business enhances the handling of waste rock and tailings, strengthens employee training, achieves corporate transparency, and upholds the notion of sustainable development. The people should be urged by the government and businesses to support and uphold the principle of sustainable environmental development. Future environmental governance must be stricter, and everyone on earth should take part. African nations must diversify their economies in order to lessen their reliance on natural resources and achieve sustainable growth.

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