

# Mining and African Environment: Bridging the Gap between Legislation, Enforcement and Compliance

<sup>1</sup>Salati, L.K. and <sup>2</sup>Adeyemo, J.T.

<sup>1</sup>Department of Mineral and Petroleum Resources Engineering, Kaduna Polytechnic, Kaduna, Nigeria

<sup>2</sup>Geocardinal Engineering Services, Abuja, Nigeria

---

Salati, L. K. and Adeyemo, J. T. (2020), "Mining and African Environment: Bridging the Gap between Legislation, Enforcement and Compliance", *Proceedings of 6th UMaT Biennial International Mining and Mineral Conference*, Tarkwa, Ghana, pp. 296-307.

---

## Abstract:

Mining in Africa has come a long way in the annals of history of civilization and raw materials production for industrialisation. The continent is home to many varieties of mineral resources more than other continents thereby globally offering diverse market opportunities for industrial utilisation. However, in spite of its contribution to global demands, mining activities in many African countries have wrecked immeasurable havocs and left profound negative impacts on the natural environment, leading to loss of lives, environmental degradation, extensive pollution and other hazards. Although laws have been enacted across the continent to regulate the mining industry, wide gap still exists between enforcement of mining legislations by governments and compliance by the operators most of whom are unlicensed, artisanal or small-scale and environmentally destructive. This paper, therefore, discusses the unfolding scenarios surrounding the violation of mining laws amidst environmental destruction in the African mining industry. The paper identifies and characterises the main causes of lapses in mine environmental regulations as well as the imbalance between law enforcement and compliance. Possible panaceas to address the identified problems are also proffered.

**Keywords:** African mining industry, Legislation, Enforcement and Compliance

## 1 Introduction

Africa, no doubt, represents a historical hub of minerals supply to the rest of the world due its huge mineral endowments. Africa's major contribution to civilisation and global industrialisation in the past was the supply of raw materials for the industries through mineral production. The world largest reserves of platinum, gold, diamonds, vanadium, chromite and manganese are domiciled in Africa (Anon., 2009). Tables 1 and 2 allude to this fact.

**Table 1 Some Leading African Mineral Resources, 2005**

| S/N | Mineral              | African percent of world Production (%) | rank | African percent of world Reserves (%) | rank |
|-----|----------------------|---|------|---------------------------------------|------|
| 1.  | Platinum Group Metal | 54                                      | 1    | 60+                                   | 1    |
| 2.  | Phosphate            | 27                                      | 1    | 66                                    | 1    |
| 3.  | Gold                 | 20                                      | 1    | 42                                    | 1    |
| 4.  | Chromium             | 40                                      | 1    | 44                                    | 1    |
| 5.  | Manganese            | 28                                      | 2    | 82                                    | 1    |
| 6.  | Vanadium             | 51                                      | 1    | 95                                    | 1    |
| 7.  | Cobalt               | 18                                      | 1    | 55+                                   | 1    |
| 8.  | Diamonds             | 78                                      | 1    | 88                                    | 1    |
| 9.  | Aluminium            | 4                                       | 7    | 45                                    | 1    |

Source: [ECA and African Union, 2008]

**Table 2 Africa's Leading Mineral-Producing Countries**

| S/N | Country                      | Leading mineral (s) produced                     | remarks  |
|-----|------------------------------|--|--|
| 1.  | Botswana                     | Diamonds   | 1. World's leading producer of diamonds by value.<br>2. Producer of other minerals including copper, gold, nickel, and soda ash, diamond.<br>3. Botswana's main industry and account for the bulk of its gross domestic product.   |
| 2.  | Democratic Republic of Congo | Diamonds, Copper                                 | 1. The DRC is one of the greatest producers of diamonds (34 percent) and copper (13 percent) in Africa.<br>2. However, the DRC continues to suffer from corruption and crime, and has been forced to shut down many mining operations to curb illegal activity.  |
| 3.  | Ghana                        | Gold   | 1. Ghana is Africa's second-largest producer of gold after South Africa, and holds more than 15 percent of the continent's supply.<br>2. Gold contributes more than 90 percent of Ghana's mineral exports.   |
| 4.  | Guinea                       | Bauxite (for aluminum)                           | 1. Guinea is responsible for more than 95 percent of Africa's bauxite production, while Ghana accounts for the remainder.<br>2. In 2005, Guinea was the only African producer of alumina — synthetically produced aluminum oxide — and the country continues to hold its critical place in helping with the world aluminum demand.   |
| 5.  | Mozambique                   | Aluminum   | 1. The mining industry in Mozambique accounted for 1.5 percent of the country's economy in 2012.<br>2. The country remains a critical producer for aluminum, with about 32 percent of Africa's supply.   |
| 6.  | Namibia                      | Uranium  | 1. Namibia has a wide variety of mineral resources with about 46 percent of the continent's uranium stashes generating nearly a quarter of Namibia's annual income.<br>2. The mining industry of Namibia is on the rise, and outputs are increasing significantly each year.   |
| 7.  | Niger                        | Uranium  | 1. With 44 percent of Africa's uranium supply, Niger is one of the continent's leading producers. 2. Exports of minerals account for more than 40 percent of Niger's exports.  |
| 8.  | South Africa                 | Diamonds, Gold, Aluminum, Copper, Platinum, Coal | 1. South Africa is the largest producer of gold in Africa.<br>2. While diamonds and gold constituted the largest portion of South Africa's initial mining interests, the discovery of many other minerals allowed the country to diversify its investments.<br>3. South Africa is the world's largest producer of chrome, manganese, platinum, vanadium, and vermiculite, and the second-largest producer of ilmenite, palladium, rutile, and zirconium. |
| 9.  | Tanzania                     | Gold   | 1. Though it is the fourth-largest gold producer in Africa, Tanzania earns just under 3 percent of its gross domestic product from the mining industry. Future years may see that number grow as the mining sector expands.<br>2. Tanzania also has impressive deposits of iron ore, nickel, copper, cobalt, silver, diamond, and more.  |
| 10. | Zambia                       | Copper   | 1. Africa's copper's supply (65 to 77 percent) comes from Zambia making the country leading producer of copper in Africa.<br>2. With several prolific mines, the country is able to create jobs for its citizens while contributing to the nation's overall gross domestic product.  |

Source: AFK Africa (2015)

Africa's huge minerals reserves and production date back to the pre-colonial era when many countries across the continent had been involved in local mining activities and trading within the ancient communities. The production process involved prospecting, mining, smelting and forging of different types of ores which were extracted by either shallow or alluvial mining methods. The Africa's export mining triggered by the struggle to find and control minerals and mineral production among the colonialists had been one of the major motives of colonial penetration and eventual partition of the continent in the late 19<sup>th</sup> century (Anon., 2011). Although there has been a drastic change in the landscape of mineral production across the mineral producing countries in Africa, the continent still remains a major hub for mineral reserves and trade.

However, despite Africa's feat in mineral production, the continent is riddled with enormous environmental challenges, unemployment and poverty thereby rubbing the gains of mineral endowments in the events of mining. The negative effects of unregulated mining activities in most African communities range from large-scale environmental degradation to socially induced atrocities and economically bankrupt people (Mensah, 2018). Environmental effects of artisanal and small scale mining in most communities include loss of arable lands, pollution of water bodies and deforestation, to mention a few (Ako *et al.*, 2014; Mensah, 2018; Salati and Mustapha, 2016).

Socially, migration of different miners with diverse background coupled with lack of organisation and non-adherence to established rules of business and engagement attracts criminality to the minefields. Prostitution and spread of infectious diseases often thrive in the midst of chaotic mining scenes (Salati, 2015); yet, the existing infrastructures in such mining communities are overstretched and sometimes vandalized amidst unhealthy rivalry within the miners and stiff interrelationship competition between the miners and the host residents of the mining communities.

Economically, the entire mining communities do not have any tangible positive results to show for the massive but uncoordinated mining activities in spite of direct employment opportunities to a significant number of local miners (Amankwah and

Anim-Sackey, 2003; Eshun and Mireku-Gyimah, 2002). Although pockets of influential traders make huge profits from the mining business, there is apparent loss of revenue to the government (Mallo, 2012) and overall economic deprivation of the vast majority of the mining population.

Interestingly, a wide gap exists between mining laws, enforcement and compliance which has continuously triggered environmental, social and economic challenges for the stakeholders in the African mining industry. Although the concept of legal obligation for mining companies to restore mined-out-areas safely after mine closure is well accommodated in the legislations of most advanced economies, reverse is the case in most African countries (Anon., 2016). This realization could be a manifestation of low technical and financial capability associated with the scale of mining (artisanal and small-scale) predominant in the continent. Figure 1 shows a typical Sub-Sahara African mining scene.



**Fig. 1 A Mining Site in a Sub-Sahara African Country**

In view of these highlighted environmental challenges and the need to sanitise the mining environment in Africa, this paper seeks to identify the lapses causing imbalance between legislations, implementation and compliance with a view to finding a meeting point. Hence, the paper attempts to bridge the existing gap between legislation, enforcement and compliance in African mining environment using the identified panaceas.

## 2 Appraising the Impacts of Mining on the African Environment

Mineral deposits across Africa, which had earlier attracted local miners to the mining scenes, have eventually become centres of attraction for illegal mining activities. According to Mensah (2018), the illegality in these mining scenes has been worsened by the influx of small-scale and illegal miners, especially Chinese merchants who have continuously abused mining laws and practices through unhindered migration to mining sites across the continents.

The overall effects of indiscriminate mining activities have negatively assumed unprecedented and alarming environmental, social and economic dimensions in many African communities (Ako *et al.*, 2014; Salati and Mustapha, 2016; Murombo, 2013). In the midst of all these, Africa continues to supply minerals to the rest of the world in large quantities either through large scale mining outfits or illegally operated artisanal mining sites through which mostly unprocessed minerals find their ways (Salati, 2015) to the world market.

No doubt, these environmental challenges are directly linked to massive ASM activities. Africa is regarded as the home of artisanal and small-scale miners who are spread in their millions across the continent with widespread discriminate mining activities creating huge environmental degradation in no small measure. According to the United Nations report (Anon., 2011), challenges of ASM in Africa, which are the major causes of environmental problems in the continent include: policy challenges, lack of technical capacity and access to appropriate technology, lack of financing, inadequate access to exploration and mining areas, difficulties in accessing markets and conflicts over certain minerals.

Direct environmental impacts of mining such as biodiversity loss, pollution, formation of sinkholes, soil, ground water and surface water contamination often result in adverse alteration of the natural and structural architecture of the mining environment. In their study, Nuss and Eckelman (2014) estimated the life cycle environmental impacts of metals during mining and showed how gold and platinum group metals have constituted highest environmental burdens. Despite Ghana's enviable position as the second largest gold producer in

Africa and ninth in the world (Mensah *et al.*, 2015), the growing environmental concerns created by uncontrolled small-scale mining activities in the country have left so much to be desired (see Fig. 2). Therefore, there is need to draw a logical line between mineral production in Africa and limitation to environmental degradation which comes as response to indiscriminate mining.



**Fig. 2 Artisanal (Galamsey) Mining Site in Ghana**

Devastation of the environment is a direct manifestation of the unregulated nature of mining in most African communities and has often dominated discourse among analysts and stakeholders; hence, issues about the amount of mineral produced, positive impacts of mining in the communities and other favourable aspects are mostly relegated. As much as the environmental problem of mining in Africa is a reality, other issues such as socio-economic benefits, technological advantage, etc., are too significant to be ignored. Mining activities taking place in remote villages often help to project the unreported, ignored and under-rated events and challenges faced by the people in rural communities. On the other hand, improvisation of mining technologies, technology transfer through innovation and support services ingenuity mostly contribute in no small measures to the overall mineral production. Notwithstanding these positive contributions, the environmental consequences caused by indiscriminate mining leave mine managers and the host communities with more problems than the envisaged benefits.

## 3 Between Environmental Regulations and Gap Creation in African Mining

One of the primary objectives of enacting mining laws is to safeguard the sanctity of the environment and safety of the miners and the public. Although

Edwards *et al.* (2013) affirm Africa's proximity to mining boom in view of huge prospective investments trooping into the continent, they equally agree to the high level of environmental devastations spreading across the continent's mining landscape. Over the years control and regulation of mining in the African minefields have had to contend with severe issues of environmental degradation, weak enforcement and non-compliance. Government approval is a mandatory pre-requisite for licensing before mining becomes legitimate but unregistered mining operations and late or non-renewal of operating titles often make monitoring and enforcement of mining regulation difficult (Mensah *et al.*, 2015). The establishment of the regimes of royalty and corporate taxes is a critical obligation that must be fulfilled by the operators but which has become a burden mostly for small-scale mining operators thereby constituting an impediment to harmonious relationship between them and the regulators. Disregard for environmental and social responsibility by mining companies and artisanal miners is widespread in Africa and gradually making nonsense of the widely touted 'sustainable mining' concept (Murombo, 2013). However, the growing activities of civil societies and environmentalists seem to be raising awareness about the rights of the environment and safety of the population, especially in the mining communities. Figure 3 shows a typical mining environment in Africa.



**Fig. 3 A Typical African Mining Environment**

The Nigerian Minerals and Mining Act 2007 requires mining companies in the country to reach community development agreements with their host mining communities (Akinsulore, 2016). Salati *et al.* (2017) identified regulatory lapses, centralized licensing system, obsolete environmental laws and overlapping regulatory

functions as the major impediments facing effective regulation of mining operations in Nigeria. Presently, minefields in Nigeria, which are mostly artisanal, are not only chaotic but are also unsafe and ridden with a lot of clandestine activities with resulting insignificantly low mineral production and aggravated environmental degradation. These are obvious consequences of weak regulation and increasing illegal mining activities triggered mostly by poverty and corruption (Salati, 2015). The situation is not too different in other African countries except for few ones whose improvements in their mining regulation have resulted in better global rating and economic recovery.

According to Adjarko *et al.* (2016), despite the existence of Ghana's Environmental Protection Agency (EPA), several environmental issues are still unaddressed due to little knowledge of the existence of other environmental laws in the country and how they can be incorporated into small, medium and large scale contracts. Appiah and Osman (2014) also attest to the low awareness about Environmental Impact Assessment (EIA), especially among mining communities in Ghana despite increased mining activities and increasing number of large scale and artisanal and small-scale mining companies in the country. Amidst this challenge of low awareness coupled with poor implementation of relevant environmental laws, the combined effects of environmental problems have culminated in the widespread prevalence of diseases such as malaria, respiratory tract infections and skin diseases across the country (Yeboah, 2008).

In Burkina Faso's mining legislation, there are provisions that regulate the environmental, health and safety aspects of mining activities (Kempen, 2013). Applications for mining title, except for exploration permit or authorization for quarrying exploitation, involve carrying out an environmental impact study together with a public survey and an environmental management and mitigation plan. However, environmental effects of indiscriminate artisanal gold mining activities in the country, especially in Essakane district (Porgo and Gokyay, 2017), have indicated low compliance by operators and apparent weak enforcement.



**Fig. 4 Environmental Devastation in the Mpumalanga Region of Tanzania**

Many African countries have environmental policies in form of Environmental Impact Assessment (EIA) to guide the corporate environmental goals of mining companies (Appiah and Osman, 2014). However, comprehensive but cumbersome procedures and discriminatory distribution of social and benefits from mineral revenue costs and benefits are major upsets.

#### **4 Bridging the Gap between Law Enforcement and Compliance in the African Mining Industry**

A lot of issues have sprung up from law enforcement within the African mining environment thereby necessitating the need for a balanced structure of operation between the regulator and the operators in the industry. In most cases, there is either stringent enforcement of mining and environmental laws and poor compliance or there is poor enforcement and little or no enforcement at all. In both scenarios, the mining industry becomes the worst for it; with stringent enforcement by the regulator, the operators (local miners) turn to illegality, refusing to get licensed and amidst poor compliance, there is worsening environmental devastation (Salati, 2015). Thus, bridging the gap between law enforcement and compliance in the industry becomes a difficult burden for the regulators and other stakeholders. To underline this fact, Salati *et al.* (2014) show the linking factors between enforcement and compliance in the management of artisanal and small-scale gold mining in Anka, Zamfara State, Northern Nigeria, through SWOT matrix and SWOT-PESTLE analyses as shown in Tables 3 and 4.

**Table 3 SWOT Matrix of Regulators' Roles on ASGM Management**

|                                 | <b>Strengths (Internal)</b>   | <b>Weaknesses (Internal)</b>  |
|---------------------------------|---|---|
| <b>Opportunities (External)</b> | <p><b>Clear Priorities</b></p> <ul style="list-style-type: none"> <li>-Possible decline in illegal ASGM and associated impacts.</li> <li>-Miners' compliance is feasible.</li> <li>-Improved revenue and stable political economy.</li> <li>-Feasible business and investment opportunities.</li> <li>-Youth employment and crime reduction.</li> </ul> | <p><b>Potential Alternatives</b></p> <ul style="list-style-type: none"> <li>-Evolve policies on ASGM and involve community leaders on enlightenment campaigns.</li> <li>-Simplify registration procedures in the ASGM sector.</li> <li>-Centralise MCA functions and educate miners on their importance.</li> <li>-Create ASGM management committees and units at State and Local Government Levels.</li> <li>-Enforce the law strictly.</li> <li>-Collaborate with local authorities on the development of the ASGM sector.</li> </ul> |

|                           |   |   |
|---------------------------|---|---|
| <b>Threats (External)</b> | <b>Defend and Counter</b><br>-Compliance threatened by miners' ignorance of the law.<br>-Weak legislation and poor enforcement encourage illegal ASGM.<br>-Struggling still thrives amidst good policy but poor implementation.<br>-Viable investment is threatened by rural underdevelopment.<br>-Socio-environmental, health and safety concerns threaten sustainable ASGM. | <b>Potential Risks</b><br>-Continuous illegal and underdeveloped ASGM sector.<br>-Rising cases of smuggling.<br>-Increased violence and criminality.<br>-Persistent mercury-dependent gold processing.<br>-Rising environmental Risks and impacts.<br>-Increase in child labour and corresponding negative effect on child education.<br>-Lead poisoning threat feasible.<br>-Cattle rustling a growing threat. |
|---------------------------|---|---|

**Table 4 SWOT-PESTLE Analysis of Stakeholders Roles on ASGM Management. S, W, O and T represent strengths, weakness, opportunities and threats.**

| SWOT/PESTLE              | S   | W   | O   | T  |
|--------------------------|---|---|---|--|
| <b>Political (P)</b>     | 1. Potentially viable ASGM business.<br>2. Better control of ASGM at the local level. | 1. Corruption.<br>2. Strong political-will lacking.       | 1. Future investment and job prospects in a stable political climate. | 1. Volatile business environment.                        |
| <b>Economic (E)</b>      | 1. Growing local ASGM economy.  | 1. Poorly managed and impoverished ASGM economy.          | 1. Future investment and job prospects.                               | 1. Economic jeopardy due to environmental hazards.       |
| <b>Social (S)</b>        | 1. Highly respected local authorities.<br>2. Occupational alternatives to ASGM.       | 1. Harmful socio-cultural practices.                      | 1. Socially beneficial future ASGM.                                   | 1. Negative perceptions of government policies.          |
| <b>Technological (T)</b> | 1. Improvised local technology and use of mobile phones.                              | 1. Poor technology and unskilled workforce.               | 1. Future development of local technology.                            | 1. Use of technological device for crime.                |
| <b>Legal (L)</b>         | 1. Traditional legal system-based concession acquisition and ASGM management.         | 1. Stringent legal requirements and ignorance of the law. | 1. Feasible legalisation of ASGM due to robust local administration.  | 1. Land use conflicts and low legal status of operators. |

|                          |  |                                   |  |   |
|--------------------------|--|-----------------------------------|--|---|
| <b>Environmental (E)</b> | 1. Reduced women exposure to ASGM related risks. | 1. Poor environmental management. | 1. Sustained environmental campaigns by interest groups. | 1. Land degradation, pollution, mercury emissions and lead poisoning. |
|--------------------------|--|-----------------------------------|--|---|

Source: Salati (2015)

**Table 5 Comparison between Selected Latin America and African Countries**

| <b>Country</b> | <b>Area of Environmental Concern</b> | <b>Policy Compliance Level</b> |
|----------------|--------------------------------------|--------------------------------|
| Ecuador        | Pollution                            | Growing and encouraging        |
| Ghana          | Massive environmental degradation    | Slowly growing                 |
| Uganda         | Massive socio-environmental issues   | Growing but slowly             |
| Peru           | Mercury-induced pollution            | Growing and encouraging        |
| Tanzania       | Massive Environmental issues         | Growing and encouraging        |
| Nigeria        | Massive environmental challenges     | Low and discouraging           |

From the tables, it is crystal clear that enforcement and compliance in the African mining industry are linked in so many ways and bridging the gap between them requires breaking the complex scenarios militating against their smooth attainment. A critical tool for assessing the compliance of large mining companies is Environmental Impact Assessment (EIA). EIA is a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. In Ghana, the regulatory agencies are only mandated to undertake check-monitoring and periodic audits to confirm companies' compliance with license conditions and regulatory standards. In parts of Ghana with massive mining operations such as Tarkwa and Obuasi areas, EIA issues and its compliance are portrayed as a burden to mining

companies (Appia and Osman, 2014). This is a common trend in most African countries, though compliance seems to be getting better amongst companies in Ghana. Table 5 shows the comparison in environmental compliance level between selected Latin American and African countries.

From Table 5, only Tanzania shows some encouraging level of compliance among the selected African countries when compared with the Latin American countries. In terms of payment of royalties and other mining taxes, compliance on the part of multinational companies continues to grow, while most of the indigenous companies and other companies mostly owned by both local and expatriate businessmen remain the biggest culprits. Corruption has been a major factor in this regard; connivance between the officials of the regulatory agencies and operators is apparently responsible for evasion of royalty and mining taxes by the mining companies. Aubynn (2017) cited political interference in the affairs of regulatory agencies, inadequate personnel capacity, multiple regulations and inter-institutional crisis as factors militating against strong regulatory structures in Ghana's mining sector. Consequently, it is rarely feasible for any government to have the liberty to formulate mineral taxation policy using a "best practice" template without political constraints as succinctly captured by Guj (2012). In Nigeria, apart from the few large scale limestone quarrying companies and other construction companies in operation, payment of royalties and mining taxes is almost non-existent among the several artisanal and small-scale mining operators in the country. This is not surprising since the latter are the foot soldiers of the mining industry and represent over 90% of mining activities in the country (Mallo, 2012; Nashuni, 2003).

In view of the above unfolding scenarios and their consequences on the African mining industry, therefore, the following measures are identified as panaceas to bridging the widening gap between legislation, enforcement and compliance in the continent's mining environment (Anon., 2014; Heyes, 2000):

- i. Stakeholders should strictly adhere to the principle of environmental justice by paying utmost attention to biophysical features of the activities and natural resources as well as unconditional safety of residents in the African mining environment;
- ii. Constant engagement of people in the mining communities by mutual agreement and advocacy would improve enforcement and discourage illegality;
- iii. Review of obsolete and ineffective extant environmental laws is long overdue for good governance and restoration of sanity to the African mining environment;
- iv. The concept of "green environment" must be 'rebranded' especially targeting post-mining reclamation and resuscitation of mined-out-areas;
- v. Increased funding is for mining investments in African countries requires that a major proportion for environmental remediation be earmarked;
- vi. Foreign direct investment (FDI) is required in the mining sector in Africa especially as it concerns funding towards environmental sanity and safety; and
- vii. To curb corruption and strengthen synergy among the regulatory bodies in the African mining industry, there must be a fair and transparent licensing regime, cutting of discretionary power granted to mine officials and effective verification of environmental and social impact assessments.

## 5. Conclusions

It can be concluded from this paper that, for a sustainable and safer mining environment, the existing gap between legislation, enforcement and compliance across the minefields in Africa require a bridge. Unless the gap is bridged, monumental ecological/environmental ruins, economic losses and human casualties would continue unabated in

the course of mining. Therefore, having discussed the emerging issues affecting the African mining environment with a view to bridging the elusive gap between legislation, enforcement and compliance, the following facts are established:

- i. African mining environment is increasingly becoming chaotic, unsafe and unfit for effective mineral production and human safety;
- ii. The instrument of enforcement by the government is weak and ineffective, thereby mostly overwhelmed to achieve the required compliance in most African minefields;
- iii. With the increasing wave of poverty-induced illegal mining activities across Africa, the rate of compliance among mining operators is extremely low and complicating failure of law enforcement in the minefields across the continent;
- iv. Due to inadequate synergy between the relevant regulatory agencies and increasing lack of funding of small-scale mining enterprises, many more mining juniors in Africa are being relegated and converted to artisanal mining outfits, while others simply slip into bankruptcy thereby increasing the rate of non-compliance among operators;
- v. The increasing devastations especially in the informal mining sector have dramatically changed the ecological landscape of Africa from bad to worse;
- vi. Incorporation of artisanal and small-scale mining operators into the formal mining sector in Africa and their subsequent training specifically on environmentally responsible obligations are gradually being put in place by few African countries but are conspicuously missing in the programmes of others; and
- vii. Notwithstanding the environmental and safety challenges, the African mining environment possesses sufficient market potentials which can be mobilized for eventual economic breakthrough provided the emerging environmental threats are reasonably curtailed.

## References

- Adjarko, H., Gemadzie, J. and Agyekum, K. (2016), "Construction Related Environmental Laws and Policies in Ghana: A Literature Review", *Asian Journal of Science and Technology*, Vol. 7, Iss. 5, Pp. 2984 – 2992. [www.journalajst.com](http://www.journalajst.com), Retrieved on 14, May, 2018.
- AFK Africa, (2015), "10 Most Mineral-Rich Countries in Africa" *African Leadership Magazine*, 4 pp, Retrieved on 10, April, 2018.
- Akinsulore, A. (2016), "The Effects of Legislation on Corporate Social Responsibility in the Minerals and Mines Sector of Nigeria", *Afe Babalola University Journal of Sustainable Development Law and Policy*, Vol. 7, No. 1, Pp. 97 – 89.
- Ako, T. A., Onoduku, U. S., Oke, S. A., Adamu, I. A., Ali, S. E., Mamodu, A. and Ibrahim, A. T. (2014), "Environmental Impact of Artisanal Gold Mining in Luku, Minna, Niger State, North Central Nigeria" *Journal of Geosciences and Geomatics*, Vol. 2, No. 1, pp. 28 – 37.
- Amankwah, R. K. and Anim-Sackey, C. (2003), "Strategies for Sustainable Development of the Small-scale Gold and Diamond Mining Industry of Ghana", *Resources Policy*, 29, pp. 131 – 138.
- Anon, (2009), "Africa Review Report on Mining (Summary)", *United Nations Economic and Social Council, Economic Commission for Africa, Committee on Food Security and Sustainable Development (CFSSD-6)/Regional Implementation Meeting (RIM) for CSD-18*, Addis Ababa, Ethiopia, 16 pp, Retrieved on 21 February, 2018.
- Anon, (2011), "Minerals and Africa's Development: The International Study Group Report on Africa's Mineral Regimes", *Economic Commission for Africa and African Union*, 210 pp, [www.uneca.org](http://www.uneca.org). Retrieved on 10 April, 2018.
- Anon, (2014), "Environmental Justice: Comparative Experiences in Legal Empowerment", *United Nations Development Programme*, 34 pp, [www.undp.org](http://www.undp.org). Retrieved on 30 June, 2018.
- Anon, (2016), "Illicit Trade in Natural Resources in Africa — A Forthcoming Report from the African Natural Resources Center", *African Natural Resources Center*, African Development Bank, 13 pp, [www.afdb.org/anrc](http://www.afdb.org/anrc). Retrieved on 10 April, 2018.
- Appiah, D.O. and Osman, B. (2014), "Environmental Impact Assessment: Insights from Mining Communities in Ghana", *Journal of Environmental Assessment Policy and Management*, Vol. 16, No. 4, 20 pp. [www.worldscientific.com](http://www.worldscientific.com). Retrieved on 14 May, 2018.
- Aubynn, T. (2017), "Regulatory Structures and Challenges to Developmental Extractives: Some practical observations from Ghana", *United Nations University World Institute for Development Economics Research, WIDER Working Paper 2017/179*, 28 pp. [www.wider.udu.edu](http://www.wider.udu.edu). Retrieved on 30 June, 2018.
- Edwards, D. P., Sloan, S., Weng, L., Dirks, P., Sayer, J. and Laurance, W. F. (2013), "Mining and the African Environment", *Conservation Letters*, Policy Perspective, 10 pp. Retrieved on May 29, 2020.
- Eshun, P. A. and Mireku-Gyimah, D. (2002), "Small Scale Mining in the Tarkwa District: A Review of its Impacts", *SWEMP 2002, 7th International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production*, Sardinia, Italy, Italy, pp. 877 – 884.
- Guj, P. (2012), "Mineral Royalties and Other Mining Specific Taxes", *International Mining for Development*, Centre Mining for Development: Guide to Australian Practice, 16 pp. [www.im4dc.org](http://www.im4dc.org). Retrieved on 30 June, 2018.
- Heyes, A. (2000), "Implementing Environmental Regulation: Enforcement and Compliance", *Journal of Regulatory Economics*, Pp. 107 – 129.

- Kempen, J. V. (2013), "Overview on Mining Law in Burkina Faso and Current Trends", *Emery Mukendi Wafwana & Associates, Business Law, Business News, Mining News, OHADA Law*, 9 pp. [www.cabemery.org/blog](http://www.cabemery.org/blog).
- Mallo, S. J. (2012), "Mitigating the Activities of Artisanal and Small-scale Miners in Africa: Challenges for Engineering and Technological Institutions" *International Journal of Modern Engineering Research*, Vol. 2, Issue 6, pp. 4714 – 4725.
- Mensah, P. (2018), "Uncontrolled and Illegal (Galamsey) Mining Activities in Africa: An Increasing Threat to Water and Food Security", *Woodrow Wilson International Center for Scholars, Africa Up Close*, 5 pp, Retrieved on 10 April, 2018.
- Mensah, A.K., Mahiri, I.O., Owusu, O., Mireku, O.D., Wireko, I. and Kissi, E.A. (2015), "Environmental Impacts of Mining: A Study of Mining Communities in Ghana", *Applied Ecology and Environmental Sciences*, Vol. 3, No. 3, P. 81 – 94. Retrieved on 10 April, 2018.
- Murombo, T. (2013), "Regulating Mining in South Africa and Zimbabwe: Communities, the Environment and Perpetual Exploitation", *LEAD Journal (Law, Environment and Development Journal)*, 51 pp. Retrieved on 10 April, 2018.
- Nashuni, M. (2003), "Problems of Small-scale Mining in Nigeria", *Nigerian Mining Journal*, Vol. 4, No. 1, pp. 34 – 37.
- Nuss, P. and Eckelman, M.J. (2014). "Life Cycle Assessment of Metals: A Scientific Synthesis", *PLoS ONE*. 9 (7): e101298. doi:10.1371/journal.pone.0101298.
- Porgo, M. and Gokyay, O. (2017), "Environmental impacts of gold mining in Essakane site of Burkina Faso", *Human and Ecological Risk Assessment: An International Journal*, Vol. 23, No. 3, pp. 641 – 654.
- Salati, L. K. (2015), "Development of an Integrated Management Model for Artisanal and Small – scale Gold Mining in Northern Nigeria", Unpublished PhD Thesis, University of Mines and Technology, Tarkwa, 172 pp.
- Salati, L.K. and Mustapha, N. (2016), "Environmental Assessment of Artisanal Gold Mining in Birnin-Gwari Area of Kaduna State, North-Western Nigeria", *Nigerian Mining Journal*, Vol. 14, No. 1,
- Salati, L.K., Mireku-Gyimah, D. and Eshun, P.A. (2014), "Evaluation of Stakeholders' Roles in the Management of Artisanal and Small-scale Gold Mining in Anka, Zamfara State, Nigeria", *Developing Country Studies*, Vol. 4, No. 19, pp. 150 – 161.
- Salati, L.K., Mireku-Gyimah, D. and Eshun, P.A. (2017), "Artisanal and Small-scale Gold Mining in Nigeria: A Case for Review in Line with Policies of Selected Developing Countries", *Nigerian Mining Journal*, Vol. 15, No. 1, pp. 5 – 18.
- Yeboah, J.Y. (2008), "Environmental and Health Impact of Mining on Surrounding Communities: A Case Study of AngloGold Ashanti in Obuasi", Unpublished B.A. Thesis, Kwame Nkrumah University of Science and Technology, 141 pp.

## Authors



**L. K. Salati** is a Senior Lecturer and Head of Department of Mineral and Petroleum Resources Engineering, Kaduna Polytechnic, Kaduna, Nigeria, where he also graduated in the year 2000.

He obtained his M.Eng. and PhD degrees in Mining Engineering from the Federal University of Technology, Akure, Nigeria, and University of Mines and Technology, Tarkwa, Ghana in 2011 and 2015 respectively. He is a registered engineer with the Council for the Regulation of Engineering in Nigeria (COREN), Council of Nigerian Mining Engineers and Geoscientists (COMEG) and many other professional bodies. He has attended many local and international conferences and published in reputable journals both within and outside Nigeria.



**J. T. Adeyemo** is the Chief Executive Officer of Geocardinal Engineering Services Limited based in Abuja, Nigeria. He is a graduate of Mining

Engineering from the Federal University of Technology, Akure, Ondo State, Nigeria. He is a Mining Engineering consultant and is registered with the Council for the Regulation of Engineering in Nigeria (COREN), Council of Mining Engineers and Geoscientists (COMEG), Nigerian Society of Engineers, among other professional bodies.