

Multiple scales of diamond mining in Akwatia, Ghana: addressing environmental and human development impact

Kaakpema Yelapaala^{a,b}, Saleem H. Ali^{c,d,*}

^a*Yale University, School of Epidemiology and Public Health, New Haven, USA*

^b*Brown University, 115 Waterman Street, Providence, RI 02912, USA*

^c*Rubenstein School of Environment and Natural Resources, University of Vermont,
153 S. Prospect St, Burlington, VT 05401, USA*

^d*Watson Institute for International Studies, Brown University, Box 1970, Providence, RI 02912-1970, USA*

Received 20 November 2004; received in revised form 19 July 2005; accepted 10 August 2005

Abstract

Ghana is the second largest producer of gold in sub-Saharan Africa, and has experienced a significant increase in national mining production over the last two decades. Between 1983 and 1998, the mining industry brought approximately US \$4 billion in foreign direct investment to Ghana. While large-scale gold mining has seen a significant increase, artisanal gold and diamond mining product have grown exponentially. While much research has been conducted on gold mining in Ghana, there is relatively little research on the environmental and human development consequences of diamond mining in the country. Unlike other West African countries such as Sierra Leone and Liberia, small-scale diamond mining in Ghana has not been linked to conflict but its role in development has also been relatively modest. This paper examines large and small-scale mining in Ghana's largest diamond mining town, Akwatia, and their relative impact on environmental degradation, health, and the livelihood of artisanal miners. We conclude that while an increase in artisanal diamond mining has been a means of employment and income-generation for small-scale miners, there are some human development challenges, related to environmental burden from land degradation and health. GCD is an ailing mining company in Ghana, in desperate need of an injection of capital to keep the mine alive, but botched bidding has slowed the process of de-regulating the company. We also conclude that the de-regulation of GCD may lead to a relatively reduced environmental burden in Akwatia and more revenue for the GCD to invest in the human development needs of communities in the town.

© 2005 Elsevier Ltd. All rights reserved.

Keywords: Artisanal and large-scale mining; Diamonds; Ghana; Environmental burden; Environment and health

Introduction

The mining sector in Africa has been a source of intense controversy regarding development trajectories for mineral-rich countries. While development institutions and macro-economists have argued for harnessing natural resources as an entry point for development (Davis and Tilton, 2003),

social and environmental activists have often pointed to the potential linkages between mineral endowments and conflict and consequential underdevelopment (Ross, 2001). The negative impact of mining activities on the environment and health is well documented (Heath, 1993; Veiga, M.M. and Beinhoff, C., 1997; Warhurst, 1999; Warhusrt, A., 1994). Particular attention has been given to the effect of small-scale gold mining activities on environmental contamination. While the land degradation caused by the gold mining is significant, chemical contamination from the gold extraction process imposes a double burden on the environment, with harmful health outcomes for mining communities and persons residing in close proximity to such activities. However, relatively less attention has been paid to environmental degradation in diamond mining towns, primarily because diamond-mining

* Corresponding author. Address: Watson Institute for International Studies, Rubenstein School of Environment and Natural Resources, University of Vermont, 153 S. Prospect St, Burlington, VT 05401, USA. Tel.: +1 802 656 0173; fax: +1 802 656 8015.

E-mail addresses: kaakpema.yelapaala@yale.edu (K. Yelapaala), saleem@alum.mit.edu (S.H. Ali).

production does not entail the same degree of chemical processing.

This paper discusses the environmental and human development impact of mining activities in Ghana's largest diamond production town, Akwatia. Indeed, while the environmental impact of diamond mining in Akwatia is not linked to environmental contamination from mercury (as is found in artisanal gold mining), the town provides a unique example of the negative impact of large-scale and artisanal diamond mining on environmental degradation and sustainable development. At the same time there is potential for mitigating the negative impacts and accruing benefits from appropriate schemes that could help build capital and provide a means of catalyzing sustainable livelihoods for communities.

Methodology

Data for this paper was collected via a combination of bibliographic research in the United States and Ghana, and field research in the case-study town, Akwatia. Qualitative and research techniques were employed to collect primary data on the mining industry in Ghana, mining practices in Akwatia, mining-related sickness, and information from the major diamond mining company in Akwatia. This process included structured interviews with miners, mining officials, government officials, and local community members. Interviews were recorded as text either during or immediately after being conducted. Recording devices were not used during the interviews given the sensitivity of the topic to the region and the possibility of getting erroneous or misleading responses from respondents. Some secondary quantitative economic data was obtained from sources in the Ghanaian government, but verified for accuracy by conferring with other stakeholders.

An overview of mining in Ghana

The geological setting

Ghana, a West African nation located on the Gulf of Guinea, is well endowed with many natural resources. The country covers an area of 238,555 square kilometers, about the size of Great Britain or the state of Oregon. Ghana's population is approximately twenty million, and Cote D'Ivoire, Burkina Faso, and Togo border the country. It was formerly a British colony, at which time the territory was known as the Gold Coast for its abundance of gold reserves.¹

¹ The Portuguese were the first Europeans to occupy the territory that is now known as Ghana in the late 15th century. The Dutch also had a short stay in the territory, but it is the British that colonized the Gold Coast for the longest period of time, from 1844 until March 6, 1957, Ghana's independence day.

Small-scale mining activities in Ghana date back more than 2000 years. There is evidence citing gold mining going as far back as the seventh and eight centuries AD (Hilson, 2001). Ghana is presently the second largest producer of gold in sub-Saharan Africa, only behind South Africa, and a leading exporter of bauxite, diamonds, and timber. Ghana's geologic setting is the primary reason for its wealth of mineral resources. The country falls within the Precambrian Shield of West Africa. The major Precambrian rock units in Ghana are the primary source of the country's major mineral products: gold, bauxite, diamonds, and manganese (Grubaugh, 2002). They are associated with Proterozoic, Birimian, and Tarkwaian rocks, and the majority of gold produced in Ghana comes from Birimian rocks, which constitute approximately one-third of the country (Grubaugh, 2002).

Mineral laws and policies in Ghana since 1986

Ghana gained independence from British colonial rule on March 7, 1957, and became a republic on July 1, 1960 (Austin, 1964; Apter, 1955). At that time, Ghana was one of the strongest economies in sub-Saharan Africa, with a per capita income that was comparable to South Korea, and was one of the world's largest producers of cocoa. President Kwame Nkrumah, the country's first president and leader of the nation's independence movement, adopted socialist planning techniques, with a public sector that was primarily buttressed by cocoa revenues (Agbodeka, 1992).²

On February 24, 1966, there was a political coup in Ghana that led to the ousting and exile of President Kwame Nkrumah. For almost two decades following this coup d'état, Ghanaian political development was plagued by coups, failed coup attempts, and general socio-political turmoil. This harsh political environment had negative impacts on socio-economic development, and contributed to economic decline and a decrease in living standards in Ghana (Chazan, 1983; Frimpong-Ansah, 1992). In 1983, Ghana adopted a World Bank Economic Recovery Program (ERP), with the general objectives of short-term economic stabilization and long-term economic structural adjustment. These aims included improving government finances, stabilizing Ghana's currency (the cedi), improving the domestic production of goods and services, and strengthening the social and economic infrastructure of the country (Nyanteng, 1997).

Despite the economic potential of the mining industry in Ghana, mining output had decreased significantly since the late 1950s, with gold experiencing the most dramatic decline in production. As Aryee (2001) puts it:

² The cornerstone of President Nkrumah's industrial development strategy was the construction of the Akosombo Dam, a hydroelectric dam on the Volta River that would electrify Ghana, while providing linkages to an aluminum industry fuelled by Ghana's bauxite reserves (Hart, 1981).

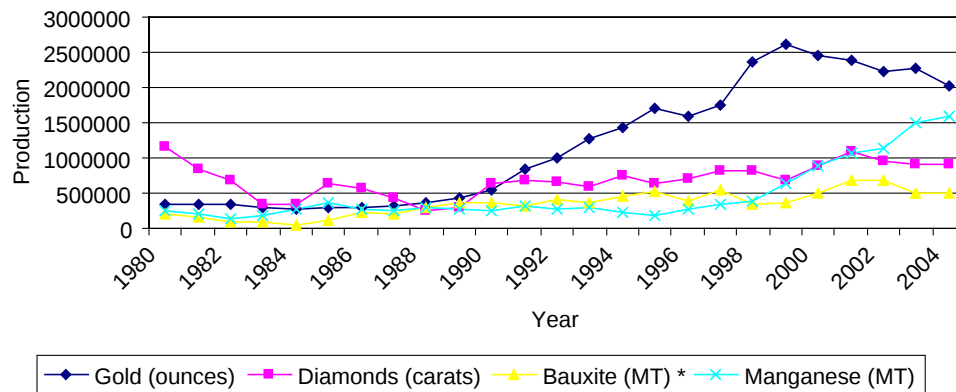


Fig. 1. Mineral production in Ghana: 1980–2004.

For four decades, up to the 1980s, no new mine was opened in Ghana due to a myriad of problems faced by mining sector investors and potential investors alike, as a result of the economic, financial, institutional and legal framework within which the mining sector operated (p. 62).

To stimulate investment into the minerals economy in Ghana, from 1985 onwards, the government implemented a series of laws and policy measures to create an effective regulatory framework for the mining industry (Iddirisu and Tsikata, 1998; Tsikata, 1997).

Up until this time, mining in the gold sector was not regulated, though diamond-mining activities had been regulated through the Minerals Regulation since 1962. The primary laws were:

- The Additional Profile Tax Law (PNDCL 122; 1985);
- The Minerals and Mining Law (PNDCL 153; 1986);
- The Minerals (Royalties) Regulations (LI 1349; 1985, 1987);
- The Small Scale Mining Law (PNDCL 218; 1989); and
- The Precious Marketing Corporation Law (PNDCL 219; 1989).

To complement these legal reforms, the government founded the Minerals Commission in 1986 as the primary institution to oversee domestic and international actors in the Ghanaian mining sector. In 1989, the Precious Minerals Marketing Corporation (PMMC) was established as the primary buyer and seller of minerals produced by the small-scale mining sector.

In addition the regulatory framework developed via the laws and institutions described above, generous incentives were provided to foreign investors to boost foreign direct investment in mining (Campbell, 2003; Akabzaa and Darimani, 2001; Addy, 1998). For example, corporate income tax on the mineral production of private companies in Ghana decreased from 50–55% in 1975 to 45% in 1986 and 35% in 1994. Royalties paid to the government

decreased from 6% of total value of mineral production in 1975 to 3.7% in 1987. Companies received breaks on import duties on equipment and accessories necessary for mining production. Additionally, mining companies were allowed to keep a minimum of 25% of foreign exchange in an external account for various purposes, including acquiring physical capital requirements necessary for production and dividend payment and remittance for expatriate labor. The benefits accrued by mining companies as a result of the dynamic evolution of mineral laws and policies, in turn, led to the rapid growth of Ghana's mining economy.

Scales of mining in Ghana

While the national production of bauxite, diamonds, and manganese has seen modest or no growth over the last two decades, gold production has grown exponentially, with a slight decline in recent years (See Fig. 1). In 2003 gold production in Ghana amounted to 2,274,627 ounces, and the provisional estimate of gold production for 2004 is 2,029,970 (Minerals Commission, 2004). Between 1983 and 1998, the mining industry brought approximately US \$4 billion in foreign direct investment to Ghana (Minerals Commission, 2000). Technological advances in the mining and mineral extraction process, including heap leaching, have led to an increase in surface mining activities in Ghana, which is relatively more capital intensive, and less labor intensive than deep, underground mining.

Though the Ghanaian economy is not, by the United Nations' definition, a mining economy,³ the minerals sector has made noteworthy contributions to foreign exchange earnings and gross domestic product (GDP). Ghana's mining sector contributes to approximately 40% of gross foreign exchange earning and accounts for approximately 5.6% of Gross Domestic Product (GDP). In 2000, minerals accounted for 38.96% of total export earnings, followed

³ By the United Nations' definition, a mining economy is one that generates "at least 10 percent of gross domestic product from mining and at least 40 percent of foreign exchange earnings from mineral exports" (United Nations, Item 7—UN Publication No. E/C.7/1998/4).

by cocoa (22.51%) and timber (9.03%) (Institute of Statistical, Social, and Economic Research (ISSER), 2001) (Fig. 1)

Since the enactment of the Small Scale Mining Law (PNDCL 218) in 1989, which formalized small-scale gold mining activities nationwide, and other mineral regulations associated with ERP, there has been a subsequent surge in licensed small-scale production of gold. Small-scale miners must obtain licenses to mine from either the Minerals Commission or from the mining company with concession rights in a mineral rich area.⁴ There has also been an increase in illicit mining activities by individuals engaged mining without licenses, known in Ghana as ‘galamseys.’ It should be noted that there has not been an internationally agreed upon common definition for small-scale or artisanal mining, though certain common characteristics of the terms have been recognized globally.⁵ In this paper, the terms ‘artisanal’ and ‘small-scale’ (as they relate to mining) refer to licensed miners as well as *galamseys*.⁶

As stated earlier, diamonds have been subject to regulations and laws since the Minerals Regulation of 1962. In 1963 the government of Ghana established the Diamond Marketing Board (DMB) as the state entity responsible for marketing all diamonds produced in Ghana (Aryee, 2003). By 1972, through government regulation, the DMB was transformed to the Diamond Marketing Corporation (DMC), and given expanded responsibilities, including the purchasing and selling diamonds produced in Ghana, and fostering the development of the industry. This responsibility was taken over by the PMMC in 1989. Between 1989 and 2000, small-scale mining produced approximately US \$117 million worth of gold, and \$US 98 million worth of diamonds.⁷ In 1997 alone, small-scale gold mining brought \$US 33 million in revenue, up from \$US 6 million in 1990, while small-scale diamond product earned \$US 11 million (Minerals Commission, 2000).

There are no exact figures on the number of small-scale miners in Ghana, though it is estimated that approximately 100,000 Ghanaians are legally employed by mining (Aryee, 2003). *Galamseys* involved in illegal mining activities also create challenges for monitoring and regulating small-scale

mining activities in the country. A UN study on artisanal mining and poverty reduction reports that there may be 50,000–80,000 people engaged in illegal small-scale mining activities in Ghana (Carnegie, 2000).

Artisanal mining activities bring benefits to developing countries, primarily employment and a means of quick wealth. Labor-intensive small-scale mining operations are economically feasible because investment costs per job are typically only 10–12 percent of those costs associated with large-scale mining (United Nations, 1992). Most small-scale mining activities in Ghana have occurred in the southern regions of the country, but in recent years, there has been an increase in mining in the northern, savannah areas of the country, particularly in Bolgatanga (Northern Region) (Yembilah, 1997). The recent growth of small-scale mining activities in savannah areas extends to Ghana’s northern neighbor, Burkina Faso (Bayah, 2003; Gueye, 2001).⁸

Environmental policy and development objectives in Ghana

While aiming to achieve rapid economic growth, macroeconomic stabilization, and wide-reaching poverty alleviation, it is also important for developing countries to concurrently pursue robust policy and regulatory measures to ensure that economic activities do not endanger the livelihood of future generations. In the context of the minerals sector, not only is an effective regulatory framework needed to create the right incentives for boosting foreign direct investment, but also for minimizing the detrimental effect of mining activities on land degradation and biodiversity conservation.

In Ghana in recent decades, land degradation and environmental burden from the extraction of natural resources and related activities has been significant (International Monetary Fund, 2004; Awudi, 2002; Akabzaa, 2000).⁹ Since the early 1990s the government has taken substantial action to address these challenges. In 1991, Ghana adopted a National Environmental Policy for “ensuring a sound management of resources and the environment, and to avoid any exploitation of these resources in a manner that might cause irreparable damage to the environment” (Environmental Protection Council, 1991, p. ix). The Ghana National Environmental Action

⁴ In some cases, a person or group or people may obtain a license to mine a plot of land, and then hire laborers to do the mine the plot, paying them a percentage of findings.

⁵ According to Hentschel et al (2002), these common characteristics include: “lack or reduced degree of mechanization; [a] great amount of physically demanding work; low level of occupational safety and health care, deficient qualification of the personnel on all levels of operation; inefficiency in the exploitation and processing of the mineral production; low level of productivity; insufficient consideration of environmental issues; and lack of social security” (p. 8).

⁶ This described interchangeability is in accordance with the common usage of the terms in Ghana. There is also a distinction between artisanal and small-scale mining, dependant upon what miners do with the mineral. See <http://www.casmsite.org>.

⁷ PMMC company profile: Precious minerals marketing corporation. Accra, Ghana: 2001.

⁸ Small-scale diamond mining in Burkina Faso began in the late 1980s, when the country was suffering from a severe drought. Given the persistence of the drought, which put pressures on the agricultural industry in Burkina Faso, small-scale gold mining became primarily a rural, poverty-driven activity to earn quick revenue for survival. It is estimated that there are approximately 100,000–200,000 artisanal miners in the country.

⁹ For example, in Ghana, the country’s forest cover had been reduced from 8.2 million hectares to 1.7 million hectares between the 20th and 21st centuries (International Monetary Fund, 2003). Much of this was related to the unsustainable extraction of timber resources in the late 21st century.

Plan of 1991, the framework for the implementation of this policy, laid out concrete action items towards achieving the objectives of the policy.¹⁰

In 1994, the Environmental Protection Council, in collaboration with the Minerals Commission, adopted guidelines mandating an environmental impact assessment for mining activities in the country (Minerals Commission and Environmental Protection Council, 1994).¹¹ According to the policy, environmental impact assessments must ensure that mining companies: “demonstrate that the project has been planned in an environmentally sensitive manner and that appropriate pre-emptive or mitigative measures and safeguards have been integrated into the projects design.” On December 30, 2004, government Act 490 formalized the establishment of the Environmental Protection Agency as the primary government agency responsible for the formulation and enforcement of policies related to all aspects of the environment (Environmental Protection Act, 1994). The Ghana Poverty Reduction Strategy: 2003–2005 (International Monetary Fund, 2003) points out that the country is implementing a number of activities related to natural resource and environmental management. It explains that while the focus on these activities focuses on increasing community involvement in the management of forest and wildlife savanna woodland resources, improved land and water management, and improved management of wildlife, these programs are also important to promote the sustainable use of natural raw materials and other resources (International Monetary Fund, 2003, p. 89).

On July 5, 2001, nearly forty countries, including Ghana, adopted the ‘Kimberly Process’ to adopt minimum standards for a certification system to reduce the trade of conflict diamonds (Gberie, 2003; Rapport News, 2001; <http://www.diamonds.net>; UN, 2000; Kimberly Process Certification Scheme). In West Africa, Guinea, Liberia, and Sierra Leone have all had significant problems with conflict diamonds, which have fuelled social, economic, political, and regional instability. Ghana has not had significant difficulties with conflict diamonds, though Gberie (2003) points out that foreigners bring diamonds to sell to licensed sellers in Accra, many of which are conflict diamonds from Guinea, Liberia, and Sierra Leone.

Mining, environment, and human development: a case study of Akwatia, Ghana

Scales of diamond mining, their driving forces, and artisanal miners in Akwatia

Akwatia is a small town located in the Kwaebibirem District, Ghana (Eastern Region). Diamonds were first discovered along the Birim River, in an area nineteen miles northwest of Akwatia, in 1919 (GCD, 1999). Over 100 million carats of diamonds have been recovered from the area. Ghana Consolidated Diamonds, Ltd (GCD) is the chief producer of diamonds in the town and the country, having a total concession area of 185.35 square miles within the Birim diamond field and Kobriso Gold Concession (GCD, 1999). Historically, mining has brought economic benefits to Akwatia, including a means of employment and poverty alleviation.

For many years, GCD’s large-scale mining production eclipsed artisanal diamond mining in Ghana. While there has been a steady decline in total diamond mining production in Ghana over the past two decades, small-scale diamond mining product has increased exponentially (Fig. 2). Between 1980 and 1989, the artisanal mining sector produced 207,272 carats of diamonds, in comparison to 5,328,054 carats by GCD (GCD, 2003a,b). In contrast, between 1990 and 1999, small-scale diamond mining product drastically increased to 4,637,093 carats, while GCD production declined by about 50% to 2,244,240. In 1980, artisanal mining accounted for less than 1% of total diamond mining product in Ghana, but by 1989 it was 53%, and by 1999, it was approximately 70% of national diamond output. This paralleled a decrease of production by GCD from 99% of total diamond mining production in 1980, to 47% in 1989, and 30% in 1999.

The primary driving force for an increase in artisanal mining activities in Akwatia was that GCD, Ltd began to sell licenses to small-scale miners to mine its concession (Iddirisu and Tsikata, 1998). Moreover, in 1992, GCD, Ltd was permitted to sell diamonds independent of the Precious Minerals Marketing Corporation through its own selling company (Tsikata, 1997). The main small-mining site in Akwatia is Saltpond, a site on the GCD premises, but there are problems with illicit *galamsey* mining activities in the town as well (Table 1).

Outsourcing production to the small-scale mining sector has been a way to compensate for decreased production by GCD, Ltd due to the depreciation of its capital stock (Personal Correspondence, 08/06/2003). GCD has been in dire need of re-capitalization and went up for sale to private bidders in 1995, but because of unsuccessful divestiture deals, it has not gained the financial resources necessary to refurbish its production machinery (Gberie, 2003; Personal Correspondence, 08/07/2003). In GCD’s 2002 Annual Technical Report, a number of plant equipment and machinery breakdowns were noted as hampering the overall

¹⁰ These action items included: “[the] maintenance of ecosystems and ecological processes essential for the functioning of the biosphere; [the] sound management of natural resources and the environment; [the] protection of humans, animals and plants and their habitats; guidance for healthy environmental practices in the national development effort; [the] integration of environmental considerations in sectoral structural and socio-economic planning at all levels; [a] common approach to regional and global environmental issues” (p. ix,x).

¹¹ Minerals Commission and Environmental Protection Council, 1994, p. 20.

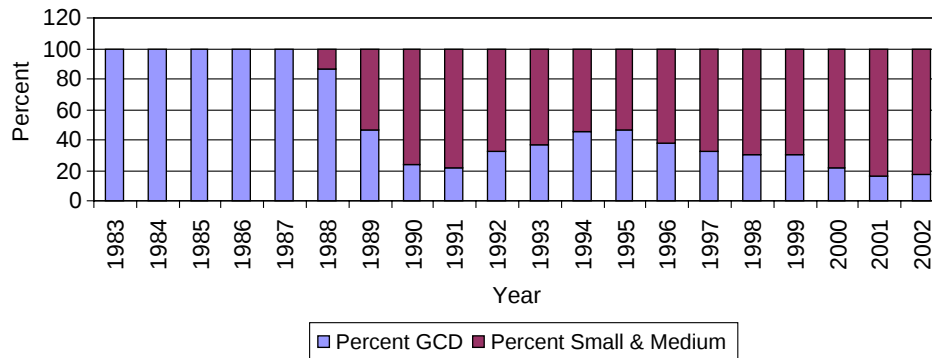


Fig. 2. Percentage of total diamond mining production for GCD, Ltd versus small & medium scale mining: 1983–2002.

productivity and efficiency of the company. For example, the report stated that in 2002, the company's machinery for the diamond mining process operated at anywhere between a dismal 30.18% to 60.20% efficiency (GCD, 2002) (Fig. 3).

There is a high level of unpredictability in the revenue that small-scale miners can earn. In many ways, small-scale mining is a poverty-driven activity, pursued to complement other livelihood activities or in the absence of other options. In Table 2, it is evident that there is significant variability in the earnings of small-scale miners on different plots of land. The source of the data in the figure owned ten plots of land at the site, for which he outsourced the mining of the plots to teams. The identity of the source and miners has been kept confidential. Payment to each team was negotiated independently, based on factors including the intensity of work and total diamonds found.

Total revenue earned from one-day of mining ranged from \$0 to \$80 (US\$ 1:7000 cedis), with 4 of ten teams not earning any revenue after a day of mining. In the absence of other livelihood activities, this can be a driving force for illicit diamond mining activities in areas outside of those set aside for legal mining, to compensate for revenue not gained. In a discussion with a government official at the Minerals Commission, it was pointed out that there are

challenges in regulating gamamseys because of this reality (Personal Correspondence, 08/11/2003).

Environmental and health challenges in Akwatia

Large and small-scale mining activities in Akwatia have incurred a negative impact on the environment and other human development challenges. As observed in numerous cases world-wide, without careful planning, environmental concerns over mining can lead to entrenched conflicts even in developed countries (Ali, 2003). From the perspective of land degradation, GCD's mining process involves stripping the land of gravel, as deep as 1 meter, with a two metric ton (M^3) capacity bucket. The extracted land is taken to the plant for processing, at which stage the waste is to be trucked back to its original location, or used for the production of other goods. For example, GCD uses by-products of its mining process for other sources of income, including sand and stones and the sale of tailings (GCD, 2002).

An average of 1100 M^3 of gravel is mined by GCD per day (GCD, 2002). Between 1959 and 2002, GCD has extracted approximately 29 million M^3 of gravel for 50 million carats of diamonds (GCD, 2003a,b). This equates to an average grade of diamond production for that time period of 1.73. Table 3 shows that the grade of diamonds (Carat/ M^3) has significantly declined over the past four decades. Metric tons of gravel extracted by GCD, Ltd per carat of diamond (M^3 /Carat) has increased over time, implying increased land degradation by mining activities relative to diamond output. This points to the possibility that improved efficiency of large-scale diamond mining production could lead to relatively less land degradation, thus reduced environmental impact, than is currently being achieved.

Artisanal mining in Akwatia also imposes a burden on the environment. Miners dig the land on licensed plots as deep as 10–12 feet to reach the diamondiferous zone on land that has already been mined by GCD. They then carry the gravel to a water source, where the diamonds are separated from the gravel through a washing process. In Akwatia, most of the mining licenses given to small-scale miners are on plots already mined by GCD.

Table 1
Revenue of GCD versus total diamond mining revenue in Ghana

Year	GCD revenue (\$US)	Total revenues	% Small scale to total rev.
1993	5,283,667.88	17,300,000	66.9
1994	8,352,724.75	20,400,000	54.9
1995	5,366,803.38	14,800,000	56.3
1996	4,416,217.44	13,400,000	66.1
1997	5,098,344.36	11,300,000	54.9
1998	4,437,430.59	10,600,000	57
1999	3,464,675.77	9,000,000	61.6
2000	4,249,413.05	15,400,000	75.1
2001	4,434,858.35	20,500,000	74.0
2002	3,469,170.15	22,200,000	72.1
Total	48,573,305.72	154,900,000	63.9 (Avg.)

Source: Ghana consolidated diamonds, Ltd and Minerals Commission, 2004.

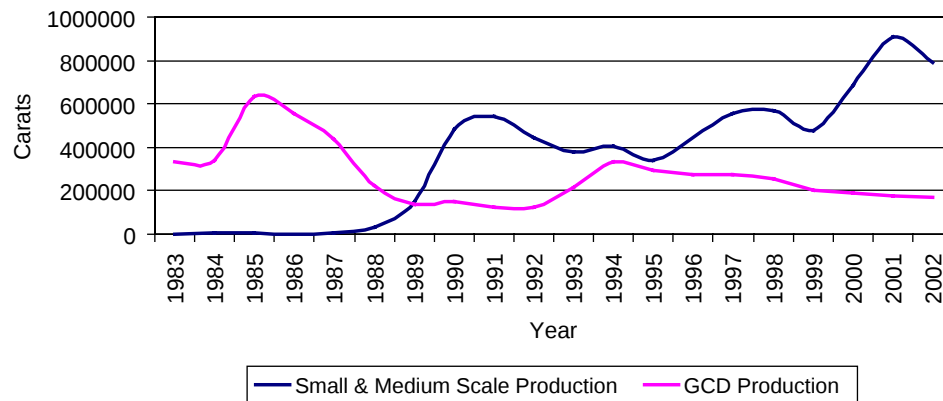


Fig. 3. GCD, Ltd mining production compared to national small & medium scale diamond mining production: 1983–2002.

Table 2

Mining revenue (Cedis) on mining plots at saltpond small-scale mining site—GCD, Ltd: August 8, 2003

Mining team	Total revenue (\$US conversion)	Revenue earned by team	Team % total	Net revenue for plot owner	Plot owner % total
1	230,000 (\$33)	80,000 (\$11)	35%	150,000 (\$21)	65%
2	550,000 (\$79)	150,000 (\$21)	27%	400,000 (\$57)	73%
3	0	0	—	0	—
4	290,000 (\$41)	100,000 (\$14)	34%	190,000 (\$27)	66%
5	0	0	—	0	—
6	0	0	—	0	—
7	65,000 (\$9)	20,000 (\$3)	31%	45,000 (\$6)	69%
8	0	0	—	0	—
9	400,000 (\$57)	140,000 (\$20)	54%	260,000 (\$37)	46%
10	No show—0	No show—0	—	0	—
Total	1,535,000 (\$219)	490,000 (\$70)	32%	1,045,000 (\$150)	68%

Source: Saltpond plot owner (Anonymous), personal correspondence, August 9, 2003. Exchange Rate used for dollar calculations: \$1: 7000 cedis.

According to a mining official at GCD, this allows for more intense mining of the land in which GCD, Ltd obtains the best gradient on the diamonds, but also benefits from the efforts of artisanal mining to mine lower grade diamonds on the same land (Personal Correspondence, GCD Technical Services Officer, 08/07/2003). This increased intensity of mining the land has a double burden on the environment by both GCD, Ltd and artisanal miners. In addition, mining activities in Akwatia decrease the agricultural productivity of the land (Tetteh, 1996). Because many people in Akwatia rely on subsistence agriculture for their basic nutritional needs as well as the uncertainty of artisanal mining yields (See Table 2), this can have negative impact on livelihoods for communities of Akwatia.

GCD's environmental policy is in accordance with national guidelines, declaring that: "GCD, Ltd is committed to managing all its mining activities so as to demonstrate a high leadership and excellence in the care and safety for its employees and environment" (GCD Environmental Policy, 2002). Ghana Consolidated Diamonds is engaged in activities to mitigate environmental degradation from its mining processes. Between 2000 and 2002, GCD invested over \$75,000 towards filling open pits from its mining activities with 420,400 M³ of gravel (GCD, 2000). In this same time period, through its re-vegetation plan, GCD

planted 140 beds in areas that could be re-vegetated with 28,000 seedlings, investing just over \$20,000 for this project (GCD, 2000). Nonetheless, the report also points out that GCD's financial resources are limited to fully reclaim all mined-out areas (GCD, 2000).

So far, the paper has alluded to a negative impact on the land of large and artisanal mining activities on the environment, but there are also some health-related perspectives worth noting. The connections between a healthy environment and healthy productive communities are significant. There is a combination of physical, chemical, biological, political, social, economic, and cultural factors that relate to how people experience the environment around them (Corvalán, 1999). From an

Table 3

Tons of gravel extracted by GCD, Ltd and mining production gradient

Year period	M ³ gravel extracted	Total diamonds (Carats)	Avg. grade	Avg. M ³ /Carat (inverse grade)
1963–1972	10,968,011	23,416,024	2.16	0.47
1973–1982	9,617,806	16,435,832	1.65	0.62
1983–1992	2,945,434	3,062,772.8	1.00	1.02
1993–2002	3,558,635	2,384,776	0.67	1.52

Source: GCD, Ltd, 2003a,b.

environmental health perspective, these complex interactions mandate that these issues be not only addressed in the health sector, but also as broader issues of every segment of society.¹²

Attention has been given to the occupational and environmental health impact of mining practices for artisanal and large-scale miners, and communities within close proximity of such activities. Health and safety risks associated with small and large-scale mining are complex, and dependent upon the mineral mined, depth of mining, and its scale (Ahern and Stephens, 2001). Migratory labor at mines in African countries such as South Africa has been identified as a major factor in the spread of HIV/AIDS (Campbell, 2000; Campbell and Williams, 1999; Jochelson and Mothibeli, 1991).

Small-scale gold mining, which involves chemical processes to extract the gold, and its associated health and environmental impact, is a topic that has been given attention in recent years. Artisanal miners worldwide use mercury in the gold extraction process, which has been documented to have a negative environmental and healthcare impact in a number of countries, including Brazil, French Guiana, Ghana, the Philippines, Tanzania, and Zimbabwe (Frery et al. 2001; Malm, 1998; United Nations Industrial Development Organization, 2001; UNIDO 2003; van Straaten 2000a; van Straaten 2000b).

Chemical environmental contamination is not a major health issue in Akwatia because diamond mining does not involve chemical processes. However, health problems are directly and proximately related to mining in Akwatia. Ghana is a malaria endemic country; malaria accounts for 43% of total outpatient morbidity in the country, and 38% in the Eastern Region, where Akwatia is located (Ministry of Health, 2001). Malaria is also the leading cause of outpatient cases at St. Dominic's Hospital, the major healthcare provider in Akwatia (St. Dominic's Hospital, 2001).¹³ The digging of the land to mine diamonds by both legal mining activities on GCD's sites and *galamsey* leaves large pits, which fill with water during the rainy season. Standing water creates a breeding ground for *Anopheles* mosquitoes, the vector of transmission for malaria in African countries.

Standing water from mining activities is a commonly cited problem in both gold and diamond mining communities in Ghana, and other parts of the world (Clarke and Edith, 1998; Dianou et al., 1999). In a study on mining in Tarkwa, one of Ghana's largest production areas, Akabzaa and Abdulai (2001) pointed out that many people in Tarkwa complained that the intensity of both large and small-scale

mining activities increased malaria cases.¹⁴ The Wassa West District, where Tarkwa is located, has the highest prevalence of malaria in the Western Region. Because Ghana is a malaria endemic country, it would be unreasonable to claim that malaria cases are related to mining alone. However, it is evident that mining activities facilitate and increase the spread of malaria. In Akwatia, though it is known that standing water likely increases malaria-related morbidity, according to health officials in the area there have been no substantial or sustained interventions by GCD Ltd in Akwatia to drain these pits, or to determine cost-effective ways to mitigate malaria-related morbidity (Personal Correspondence, 08/06/2003). While some may note that this is not necessarily the responsibility of GCD, collaboration between GCD and district health officials is a worthwhile objective to reduce malaria-related morbidity of miners and other members of the Akwatia community.

In an informal interview, a company official explained that when GCD Ltd. does not fill its pits and vegetation grows over them. These pits can become death traps, creating health and safety hazards for Akwatia residents (Personal Correspondence, 08/07/2003). As earlier mentioned, to avert some of the land degradation and accidents related to the described hazards caused by diamond mining activities, GCD invests in filling pits, but the company reports that its financial resources are limited to fully reclaim all mined-out areas (GCD, 2000). The land degradation from illicit mining activities reduces biodiversity, and can subsequently decrease the availability of medicinal plants (Savannah Resources Management Project, 2000; Biodiversity Support Programme, 1993; Ayitey-Smith, 1989; Barbier, 1989). A local herbalist certified by the Traditional Medical Practitioners Association in Ghana (TMPAG) claimed that the mining activities of *galamsey*, miners operating without permits in lands not set aside for mining, destroy medicinal plants that are used for a variety of ailments including: anemia, asthma, gonorrhea, measles, and typhoid. The herbalist did maintain that it was still possible to find the herbs, but he often has to travel longer distances to obtain plants that were once found near his shop. This illuminates the potential of mining activities to deplete local natural resources relevant to treating health problems of people in Akwatia and surrounding areas.

A number of seminal studies have shown the inter-relationship between migration, sexual networking, social and familial disruption, and the transmission of HIV for miners and mining communities (Meekers, 2000). While the focus of this paper is not mining and HIV/AIDS, it is

¹² In support of this claim, Corvalán (1999) point out that: "It is [now] understood that appropriate developments must occur in agriculture, industry, and energy if sustainable health improvements are to be attained. That said, the health sector has an important role as advocate and guide for healthy development."

¹³ Malaria accounted for 20% of outpatient cases at St. Dominic's Hospital in 2001.

¹⁴ In support of this statement, in another report on mining and the environment at the Tarkwa-Abosa-Nsuta mine, Songsore (1994) pointed out that: "[an] important environmentally-related disease [at the Tarkwa-Abosa-Nsuta mine] is malaria, with an increasing incidence because of new surface mines which have led to the creation of stagnant waters which serve as breeding sites for malarial mosquitoes."

important to take note of the issue as it relates to the Akwatia case-study. Since HIV first emerged on the scene in Ghana in the mid-1980s, HIV/AIDS cases have risen. According to Ghana's 2004 HIV Sentinel Survey, national HIV prevalence is projected at 3.1% (NACP, 2004). HIV/AIDS in Ghana is a heterosexual epidemic, following the broader trend of HIV transmission in sub-Saharan Africa.

According to health officials in Akwatia, HIV/AIDS is a significant problem. Residents have minimal access to comprehensive prevention, care and treatment services. Little is known about HIV/AIDS in Akwatia as it relates to mining. Akwatia is a town in the Eastern Region of Ghana, which had an HIV prevalence more than twice the national prevalence rate, at 6.5%, in 2004 (NACP, 2004). In its 2003 report, the Ghana National AIDS/STI Control Program (NACP) reported growing HIV incidence at a number of sentinel sites, including mining sites and ports, and the current rates show similar trends (NACP, 2004).¹⁵ In 2003, the NACP reported that at 10 sentinel sites throughout the country, HIV prevalence in 2002 was 50% higher than in 2000, including Obuasi, one of Ghana's largest gold mining sites. At a conference on artisanal mining in 2003, Mr. Benjamin Aryee, the Director of the Minerals Commission in Ghana, recognized the growing challenges related to HIV/AIDS in Ghana's mining areas (Aryee, 2003).

Conclusion

The rapid growth of the Ghanaian minerals economy in the last two decades has brought significant benefits to the country's economy. The primary driving force for these benefits has been the effective implementation of an appropriate regulatory and policy structure for the minerals sector. While large-scale mining activities, particularly gold mining, have brought significant foreign direct investment, foreign exchange, and employment opportunities, a concurrent increase in artisanal mining has widened the distribution of these benefits, including increased income generation activities for people residing in rural areas.

Despite the benefits of mining at both the macroeconomic and grassroots level, the negative impact of such activities cannot be ignored, and are well documented. Akwatia, Ghana is an unusual case study on the confluence of operations between different scales of mining, as they

relate to development and environmental degradation. On the one hand, we find that a significant injection of capital into GCD, Ltd could do a lot of mitigate environmental degradation by improving the gradient and efficiency of large-scale diamond production. GCD, Ltd is the last government mining company in Ghana in need of divestiture.¹⁶ In a popular press article, Frimpong and George Kyei (2005) reports that GCD was hit with a devastating blow when the company that won the bid to take over GCD, Messrs Sapper & Associates did not inject a planned \$34 million into GCD to revitalize the company. The Government of Ghana will still work to ensure that the right investor takes over the mine, and it will be important to ensure accountability of the new company to government standards for environmental and natural resource management is critical.

As we have also seen, because small-scale mining occurs on the same land that has been previously mined by GCD, there is a double burden on the environment from increased intensity of mining the land of GCD mining plots and then small scale-miners mining on these same plots for lower grade diamonds. Other burdens discussed include large pits, which create health hazards and standing water from land degradation of mining activities, which can promote the spread of malaria. As well, Eastern Region has a high HIV prevalence, but little is known about mining activities in Akwatia, as they may relate to the spread of HIV. These challenges should be considered when evaluating the environmental impact of mining activities in the area. Lessons from Akwatia can also help to promote more deliberate environmental and social planning in other expanding diamond mining areas of Ghana such as Akim Oda. Future studies could focus on this region, which is also downstream from Akwatia on the Brim River. The communities are thus aware of the environmental concerns more acutely as downstream recipients of some of effluent from the Akwatia mines.

Due to the unpredictability in diamond revenue earned by artisanal miners, miners who do not earn enough revenue may resort to illegal mining activities outside of areas set aside for artisanal miners to compensate. This implies that both the government and the mining company will need to be partners in enforcing the regulation of illicit mining activities to reduce the environmental burden of mining outside of set aside areas. Lastly, poverty alleviation activities other than mining that target small-scale miners in Akwatia can reduce illicit mining activities, by creating an alternative source of revenue to mining. While so far diamond mining in Ghana has been largely managed with relative success as compared to countries such as Sierra Leone, there are cautionary signs, which need to be

¹⁵ For example, Tema, Ghana's largest port, has the third highest HIV/AIDS prevalence in Ghana, at 6.6%. The report suggests that this is connected to truck drivers who come through the port to transfer goods to West African countries along the major West African highway, as well as ships that travel in and out of the port. Obuasi, a gold mining town that is Ghana's largest and most active mining site, has the fifth highest HIV incidence of sentinel sites in Ghana at 6.0%. Ghana is the second largest producer of gold in sub-Saharan Africa behind South Africa. In light of findings in other parts of the world, both of these sites are important areas for further research as they relate to the spread of HIV.

¹⁶ In August 2003, there was a strike in Akwatia of small-scale miners and GCD employees, related to the breakdown of the most recent bidding process for GCD (Ghanaian Times, 08/13/2003).

considered. Appropriate environmental planning, social safety nets for managing the economics of this sector, and allowing communities to transition to other sectors after resource depletion can prevent conflict and also lead to sustainable livelihoods for these communities.

Acknowledgements

The project was sponsored by the Brown University Luce Environmental Scholars Program, and was officially supported by the Ghana National Development Planning Commission. Logistical support for field research and literature review in Ghana was also obtained from the Minerals Commission, the Ministry of Environment and Science, and the Ministry of Health.

References

- Addy, S., 1998. Ghana: revival of the mineral sector. *Resources Policy* 24, 229–239.
- Agbodeka, F., 1992. *An Economic History of Africa: From the Earliest Times*. Ghana University Press, Accra.
- Ahern, M.J., Stephens, C., 2001. Worker and community health impacts related to mining operations internationally: a rapid review of the literature. Report for the Minerals and Mining for Sustainable Development Project at the International Institute for Environment and Development, UK.
- Akabzaa, T., 2000. Boom and Dislocation: The Environmental and Social Impacts of Mining in the Wassa West District of Ghana. Third World Network, Africa.
- Akabzaa, T., Darimani, A., 2001. Impact of mining sector investment in Ghana: A study of the Tarkwa Mining Region. A Draft Report for SAPRI.
- Ali S.H., 2003. Mining, the Environment and Indigenous Development Conflicts. University of Arizona Press, Tucson AZ.
- Apter, D., 1955. *Ghana in Transition*. Princeton University Press, New Jersey.
- Aryee, B., 2001. Ghana's mining sector: its contribution to the national economy. *Resources Policy*, 27.
- Aryee, B., 2003a. Small-Scale Mining in Ghana as a Sustainable Development Activity: Its Development and a Review of the Contemporary Issues and Challenges.
- Aryee, 2003b. Retrospective on the Ghana experience: overview of artisanal mining and its regulation in Ghana. Presentation at the 3rd Annual General Meeting of the World Bank Communities and Small-Scale Mining Program 2003 (Minerals Commission, Ghana).
- Austin, D., 1964. *Politics in Ghana: 1946–1960*. Oxford University Press, London.
- Awudi, G., 2002. The role of foreign direct investment in the mining sector of Ghana and the environment. A Paper Presented at the Conference on Foreign Direct Investment and the Environment — 7–8 February 2002. OECD Paris, France. Friends of the Earth, Accra, Ghana.
- Ayitey-Smith, E., 1989. *Prospects and Scope of Plant Medicine in Healthcare*. Ghana University Press, Accra, Ghana.
- Barbier, E., 1989. *Economics, Natural Resource Scarcity and Development: Conventional and Alternative Views*. Earthscan Publications Ltd., London.
- Bayah, J., 2003. Attempts to break the mould — constructive interventions in Africa: capacity building for artisanal mining in burkina faso. Presentation at the 3rd Annual General Meeting of the World Bank Communities and Small-Scale Mining Program. Geoman Consult, Ltd.
- Biodiversity Support Programme, 1993. *African Biodiversity: Foundation for the Future*. Professional Printing, Inc, Maryland.
- Campbell, C., 2000. Selling sex in the time of AIDS: the psycho-social context of condom Use by sex workers on a southern African mine. *Social Science and Medicine* 50 (4), 479–494.
- Campbell, B., 2003. The challenges of development, mining codes in Africa, and corporate responsibility. *International and Comparative Mineral Law and Policy Trends and Prospects*.
- Campbell, C., Williams, B., 1999. Beyond the biomedical and behavioral: towards and integrated approach to HIV Prevention in the southern African mining industry. *Social Science and Medicine* 48 (11), 1625–1639.
- Carnegie, J., et al., 2000. Project RAF/99/023 — poverty eradication and sustainable livelihoods: focusing on artisanal mining communities. Prepared for the United Nations Development Program and the Government of Ghana. United Nations Department of Economic and Social Affairs (UNDESA), New York.
- Chazan, N., 1983. *An anatomy of Ghanaian politics: managing political recession, 1969–1982*, Westview Special Studies on Africa. Westview Press, Colorado.
- Clarke, Edith, 1998. Working and health conditions among small scale miners in rural Ghana, Occupational Health Unit. Ministry of Health, Ghana.
- Corvalán, et al., 1999. Health, environment, and sustainable development: identifying links and indicators to promote action. *Epidemiology* 10 (5), 656–660.
- Davis, G., Tilton, J., 2003. Should developing countries renounce mining? Working paper, Colorado School of Mines.
- Dianou, Danyéri, Poda, Jean-Noel, 1999. Health impacts of mining on communities and human settlements in burkina faso. Paper Presented to the Conference on Mining, Development, and Social Conflicts in Africa (November 15–18, 1999). Third World Network, Africa Secretariat.
- Environmental Protection Council, 1991. *Ghana Environmental Action Plan 1991* (P.O. Box M-326).
- Frey, N., et al., 2001. Gold-mining activities and mercury contamination of native Amerindian communities in French-Guiana: key role of fish in dietary intake. *Environmental Health Perspectives*, 449–456.
- Frimpong, George Kyei, 2005. Collapsing Diamond Mine: GCD Gasp for Breath. *Ghanaian Chronicle*, Accra.
- Frimpong-Ansah, J., 1992. *The Vampire State in Ghana: The Political Economy of Decline in Ghana*. Africa World Press, New Jersey.
- Gberie, L., 2003. West Africa: rocks in a hard place — the political economy of diamonds and regional destabilization, The Diamonds and Human Security Project. Partnership Africa Canada.
- Ghana Consolidated Diamonds, Ltd, 1999. *A Brief Profile of Ghana Consolidated Diamonds, Ltd*. Company Document.
- Ghana Consolidated Diamonds, Ltd, 2002. *Annual Technical Report: 2002*. Company Document.
- Ghana Consolidated Diamonds, Ltd, 2000. *Costed Reclamation Plan for Mined-Out Areas: June 2000–December 2002*. Company Document.
- Ghana Consolidated Diamonds, Ltd, 2002. *Ghana Consolidated Diamonds, Ltd Environmental Policy*. Company Document.
- Ghana Consolidated Diamonds, Ltd, 2003a. *Mining Production: 1959–2002*. Company Data.
- Ghana Consolidated Diamonds, Ltd, 2003b. *Mining Revenue: 1993–2002*. Company Data.
- Grubaugh, K., 2001. Profile of Ghana's mining industry. SME, 39–44. Paper Presented at the SME Annual Meeting, February 26–28, 2001.
- Gueye, D., 2001. Small-scale mining in burkina faso. *Mining, Minerals, and Sustainable Development*, 73.
- Heath, et al., 1993. *Environmental impact of mining in tropical forest*. Mining Environmental Management.
- Hentschel, T., et al., 2002. *Global report on artisanal and small-scale mining*. Mining, Minerals, and Sustainable Development, 4.
- Hilson, G., 2001. A contextual review of the Ghanaian small-scale mining industry. *Mining, Minerals, and Sustainable Development*, 76.

- Iddirisu, A. and Tsikata, F., 1998. Mining sector development and environment project: regulatory framework study to assist small scale miners. Final Report for the Minerals Commission Board, Accra.
- Institute of Statistical, Social, and Economic Research (ISSER), 2001. The State of the Ghanaian Economy in 2000. University of Ghana, Legon.
- International Monetary Fund, 2003. Ghana poverty reduction strategy paper: an agenda for growth and prosperity. IMF Country Report No. 03/56, March 2003, Washington, D.C.
- International Monetary Fund, 2004. Ghana poverty reduction strategy paper annual progress report. IMF Country Report No. 04/207, July 2004, Washington, D.C.
- Kimberly Process Certification Scheme and Industry by Self-Regulation. World Diamond Congress. <http://www.diamonds.net/news/newsitem.asp?num=7163> type=all&topic=Conflict.
- Malm, O., 1998. Gold mining as a source of mercury exposure in the Brazilian Amazon. *Environmental Research*, 73–78.
- Meekers, D., 2000. Going underground and going after women: trends in sexual risk behaviour among gold miners in South Africa. *International Journal of STD and AIDS* 11 (1), 21–26.
- Minerals Commission, 2004. Ghana Production of Major Minerals and Aluminum: 1980–2004. Finance, Research, and Marketing Unit, Accra, Ghana.
- Minerals Commission and Environmental Protection Council, 1994. Ghana's Mining and Environmental Guidelines. Accra, Ghana.
- Ministry of Health, Ghana, 2002. National Outpatient Morbidity National Summary — 2001. Ministry of Health Center for Health Information Management.
- National AIDS/STI Control Program, 2004. HIV Sentinel Survey: 2004 Report. Ghana Health Service, Accra, Ghana.
- Nyanteng, V.K. (Ed.), 1997. Policies and Options for Ghanaian Economic Development, second ed. ISSER. University of Ghana, Legon.
- Rapport News, 2001. Kimberly Process Delegates Adopt Conflict Diamond Certification.
- Ross, M., 2001. Extractive resources and the poor, Oxfam America Report. Savannah Resources Management Project, January 2000. Medicinal Plant Conservation Management and Sustainable Utilization in Northern Ghana. SRMP Medicinal Plant Survey Report. Upper West Region Forestry Directorate.
- Songsore, J., et al., 1994. Mining and the environment: towards a win-win strategy (A study of the Tarkwa-Aboso-Asuta Mining Complex in Ghana) (Final Report). Study Prepared for the Ministry of Environment, Science, and Technology (MEST-EPC) and the World Bank in Support of the Formulation of a Growth Strategy for the Western Region 1994.
- St. Dominic's Hospital, 2001. Monthly Outpatient Morbidity Tally Sheets — 2001. St. Dominic's Hospital, Akwatia, Ghana.
- van Straaten, P., 2000a. Human exposure to mercury due to small-scale gold mining in northern Tanzania. *Science of the Total Environment* 259, 45–53.
- van Straaten, P., 2000b. Mercury contamination associated with small-scale gold mining in Tanzania and Zimbabwe. *Science of the Total Environment* 259, 105–113.
- Tetteh, K., 1996. Approaches to applying economic cost-benefit analysis to mining regulations in Ghana. Dissertation Submitted in Partial Fulfillment of the Masters Course in Environmental and Resource Economics. Department of Economics, University College London.
- Tsikata, F., 1997. The vicissitudes of mineral policy in Ghana. *Resources Policy* 23, 9–14.
- United Nations, 1992. Mining and the environment: the Berlin guidelines. Study based on an international round table in June 1991, Mining Journal Books, Department of Technical Cooperation. United Nations, New York.
- United Nations Industrial Development Organization, February 2001. Assistance in Assessing and Reducing Mercury Pollution Emanating from Artisanal Gold Mining in Ghana — Phase I. UNIDO, Vienna, Austria.
- Veiga, M.M., Beinhoff, C., 1997. UNECA centers: a solution to reduce mercury pollution from artisanal gold mining activities. *UNEP Industry and Environment* 20, 49–52.
- Warhurst, A., 1994. Environmental Degradation from Mining and Mineral Processing in Developing Countries: Corporate Responses and National Policies. Development Centre, OECD, Paris.
- Warhurst, A. (Ed.), 1999. Mining and the Environment: Case-Studies from the Americas. Stylus Publishing, VA.
- Yembilah, N., 1997. The social, economic, and ecological effects of Galamsey in the Bolgatanga District: a case-study of Yale and Gbani Villages. A Dissertation Presented to the Department of Geography and Resource Development, University of Ghana, Legon. In partial fulfillment of the requirement for the Bachelor of Arts (Honors).