

RESEARCH PAPER
**ADOPTED PRACTICES FOR MINED LAND RECLAMATION
IN GHANA: A CASE STUDY OF ANGLOGOLD ASHANTI
IDUAPRIEM MINE LTD**

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ABSTRACT

*Although mining is an economic booster, its negative ecological backlashes have become a great concern to environmental experts, development planners and policy makers in the era of increasing environment and sustainable development concerns. Reclamation of derelict mine sites is necessary for restoration of ecological integrity but must be based on sound ecological principles. Using AngloGold Ashanti as a case study, this study was conducted to identify land reclamation practices in Ghana and draw implications for ecological sustainability. Using semi-structured interviews, desk studies, focus group discussions and direct field observations, the study confirmed that AngloGold Ashanti adheres to the reclamation security agreement signed with the Environmental Protection Agency (EPA). *Acacia magium*, *Gliricidia sepium*, *Senna siamea* and *Leucaena leucocephala* were the very important agroforestry multipurpose tree species used in the reclamation of the mined sites. The communities' participation in the reclamation practice at the sites were frequent visits to reclaimed sites, permanent employment and casual labourers in maintaining trial farms. The adopted procedures and processes used in the reclamation of mined sites in Ghana as reminiscent in the company's activities were: earthworks/slope battering, spreading of oxide material, spreading of top soil, construction of crest drains and raising of cover crops to control run-off and erosion. Included also were tree planting, field maintenance-weeding, pruning and monitoring. Success criteria for the company's reclamation were the ability of the reclaimed sites to support plants growth without further monitoring.*

Keywords: *Agroforestry multipurpose trees, land reclamation, mining, soil fertility, success criteria*

INTRODUCTION

The United Nations Environment Programme (UNEP) describes mining as a process that begins with exploration for and discovery of mineral deposits and continues through ore extrac-

tion and processing to the closure and rehabilitation of mined-out sites (UNEP, 2000). In terms of benefits, the mining sector is undoubtedly one of the most important sources of foreign exchange particularly in many sub-

Saharan African countries. In Ghana, the mineral sector contributes in excess of 40% towards the country's foreign exchange earnings with gold accounting for 95% of exports (Awotwi, 2003). It is estimated that gold together with manganese and bauxite provide about 100,000 jobs in the country (Aryee, 2001). Following its contribution to the socio-economic transformation in the country, the industry has between 1984 and 1999, attracted about 4 billion dollars of direct foreign investment for mine development, expansion and extraction aimed at poverty reduction and enhancement of living standards (Minerals Commission, 2000). Some mining companies undertake development projects such as schools and hospitals for communities within which they operate as part of their cooperate social responsibilities. In addition, mining creates employment for both skilled and unskilled personnel of their surrounding communities.

Notwithstanding the benefits of mining, many communities and organizations see the benefits achieved at a high cost detrimental to the environment namely: access to potable water, loss of biodiversity, vegetation cover, soil fertility, agricultural lands, increased fragmentation as well as decline in the livelihoods of individuals, groups and communities. These have over the years remained issues of great concern to conservationists, ecologists, policy-makers and all environmental advocates. Surface mining is perhaps the greatest agent of land degradation, utilizing over 13% out of the 240,000 km² of the remaining forest in Ghana (Awotwi, 2003). In the Tarkwa area alone, it is estimated that over 70% of the land previously used for farming activities is under mine concessions (Akabzaa and Darimani, 2001). Recently, the president of the republic of Ghana in May 2013 inaugurated a taskforce to look at the activities of illegal surface mining. Mining competition with farmlands often deprive farmers the right to ownership and employment. This situation usually frays the cultural, social and economic development of many farming communities (Mate, 1998). In spite of all these concerns,

many view the industry as a necessary evil whose resources are required for development and at the same time need to be conserved. This therefore makes it more imperative for communities, mining companies and regulatory agencies to ensure that the nexus between accrued benefits and conservation of environmental resources are grounded on ecologically sustainable principles (Grigg *et al.*, 1998).

It has been widely recognized since the late 20th century that reclamation is a desirable and necessary remedy "to return the mined areas to an acceptable environmental condition whether for resumption of the former land use or for a new use" (Redgwell, 1992), or to allow such lands to achieve their optimum economic value as much as possible (Bastida, 2002). In addition, reclamation is generally considered as an ongoing programme because of growing environmental effects as mining evolves through the different stages of development (Walde, 1993). According to Lamb and Gilmour (2003), reclamation is widely used to refer to revegetation of degraded sites such as mined or salt-affected lands. It aims to recover the productivity of a degraded site mostly using exotic tree species. The original biodiversity is not recovered although the protective function and many of the ecological services may be re-established. Mining is a temporary use of land and mined land reclamation is clearly justified from the perspective of sustainable development. Thus, it has become an important part of the sustainable development strategy in many countries (Gao *et al.*, 1998).

Currently, most mining companies employ various reclamation techniques to impact on conservation values of degraded sites in anticipation of returning some pre-disturbance functions. However, the ecological implications of the reclamation techniques are not well understood. Also, knowledge about processes involved in the reclamation of these mined out sites is lacking in our studies in Ghana even though EPA of Ghana has outlined the end-use objectives of those sites in the reclamation se-

curity agreement with the companies. The study was therefore necessary for governments, regulatory agencies, local communities and the industry itself to adopt strategies attributing landscape, flora and fauna properties to ensure the functionality of reclaimed ecosystems (Elliot *et al.*, 1996). The purpose of the survey was to identify the various land reclamation practices in the selected mining areas and their respective management.

MATERIALS AND METHODS

Description of study site

The research was carried out at AngloGold Ashanti, Iduapriem mine located 10 km South West of Tarkwa in the Western Region of Ghana. The mining interests cover three main concession areas; namely, the Iduapriem Mining Lease (IML) with 34 hectares; the acquired part of the Teberebie Mining Lease (TML) covering an area of 28 hectares; both at the southern section of the concession; and the adjacent Ajopa – North Range (Ajopa Prospecting License) of 48 hectares area in the northwest (AngloGold- Iduapriem, 2010). The climatic conditions are transitional between the high rain forest (very humid) zone and the semi-deciduous rain forest (humid) zone. The average annual rainfall ranges from 1750 to 2000 mm. The major wet season generally covers the period March to July with a peak in June. There is a short dry spell in August. The minor wet season starts from September and ends in October. The area is characterized by high humidity (92 – 95%) throughout the year in the early mornings when temperatures are lower. The soils within the area are a mixture of the very acid Forest oxysols of the high rain forest zone and the moderately acid forest ochrosols of the semi-deciduous rain forest zone. The population within the catchment area of the Iduapriem mining concession boundaries, which is estimated to be about 10,200, is scattered.

Sociological Survey

The study was carried out in eight communities within the catchment area of the mining concession including Iduapriem, Adieyie, Adisak-

rom, Abonpuniso, Techiman, Wangarakrom, Badukrom, and Teberebie. Four reclaimed sites (aged 2, 5, 9 and 11 years), an unclaimed site as well as a nearby pre-disturbed forest reserve (Neung forest reserve) were selected for the study. The survey included community members, workers of the Environmental Department of the mining company and the Community Relation Officer. Chiefs and Opinion Leaders were consulted and facilitated group discussions were also held.

Interviews were conducted on the following:

- Reclamation security bond agreement between EPA Ghana and AngloGold, Iduapriem Mine Ltd.
- Adopted reclamation practices (sustainability and performance)
- Levels of communities' participation in the reclamation
- The biological /tree species used in the reclamation exercise
- The processes involved in the reclamation of the mined out sites.
- Identification of the success criteria/ indicators in the reclamation of the mined out sites.
- Identification of the indigenous tree species before the mining commenced.
- Determining the benefits of land reclamation by the communities
- Level of perceived satisfaction of the reclamation exercise by the various respondents

Personal observation and interviews using semi-structured questionnaires were administered to all the concerned bodies mentioned above. The interviews were carried out during the 'rest

days' (taboo days) in the communities and normal working days in the offices of the Environmental Department and the Community Relation Officer. Participatory Rural Appraisal as described by Chambers (1992) which optimizes local people's input into research and development processes and encourages decision makers to make appropriate schemes on current development process was used to obtain the views of the chiefs and opinion leaders. The facilitated group discussion covered all the eight communities. Ninety respondents in all were interviewed as shown in Table 1.

RESULTS AND DISCUSSION

Reclamation security agreement between EPA-Ghana and AngloGold Iduapriem mine Ltd, Tarkwa

A Reclamation Security Agreement document between EPA-Ghana and the Company was produced by the mining Company that describes how the areas affected by the Company could be reclaimed. An amount of five million seven hundred thousand United States dollars (US\$5,700,000) was deposited by the company with the Stanbic Bank Ghana Ltd at the end of 2007 and held in an interest bearing account in the joint names of the company and EPA (EPA, 2004). This amount was to be used as a guarantee and could be used to rehabilitate the de-

graded mined lands in case the company refuses to do so. This was in conformity with the EPA Act 494 of 1994 and LI 1652 of 1999 which further requires mining companies to obtain an environmental permit after submitting a favourable environmental impact assessment of their activities, and also commit to pay a reclamation security bond to environmental protection agency which acts as a guarantee and could be used to rehabilitate the degraded mined lands in case the company concerned fails. This corroborated the assertion of Laurence (1999) that apart from adhering to the preparation and submission of the reclamation plan, mining companies are mandated in many countries to post a pre-mining financial assurance or security in the form of cash, letters of credit, surety bonds, or trust fund to cover the cost of environmental damages in circumstances of insolvency during the closure.

Reclamation practices at AngloGold Ashanti, Iduapriem mine Ltd, Tarkwa

AngloGold Ashanti, Iduapriem mine was started since 1992 and has five reclaimed sites. The reclaimed sites identified were 2, 5, 9 and 11 year old. There was also a 7-year-old site that was inaccessible because active mining by the company was ongoing.

Table 1: Respondents interviewed in the survey

Respondents interviewed	No. of respondents interviewed
Iduapriem community	10
Adieyie community	10
Adisakrom community	10
Abonpuniso community	10
Techiman community	10
Wangarakrom community	10
Badukrom community	10
Teberebi community	10
The Environmental Department	9
The Community Relation Officer	1
Total	90

Adopted land reclamation processes at AngloGold Ashanti, Iduapriem Mine, Tarkwa

The identified processes involved in the reclamation are shown in Fig. 1. Earthworks/slope battering is done to get a visual blend of the disturbed area and the nearby undisturbed land. The slopes are battered at an angle not exceeding 30°. Immediately following the slope battering is the spreading of oxide material. This binds all the soil particles together to enhance the stability of the land surface. It also covers all the uneconomic or waste rocks. The top soil is then spread on the surface of the oxide material to promote plant growth. Soil amendments such as poultry droppings and cow dungs are used to improve the fertility of the soil. Fertilizer is applied as and when necessary. Crest drains are then constructed to check run-off and control erosion. Bamboo stripes, vetiver grass, *Gliricidia sepium* stumps and stones are used as vegetative barriers to control erosion (Plate 1). Jute mat from some trees are also used on the

surface to control run-off.

The system of strips of vetiver grass (*Vetiveria zizanioides*) has been widely promoted as a vegetative barrier to runoff (Greenfield, 1988; National Research Council, 1993; Young, 1997). Vetiver grows under a wide range of climates. It is relatively non-invasive and non-competitive and can be established as narrow strips, 0.5-1.0 m wide. It is a tufted perennial grass, which creates a dense physical barrier or filter to runoff.

Growing of cover crops such as *Puereria phaseoloides* and *Centrosema pubescens* follows after the earthworks/slope battering, spreading of oxide material, application of soil amendments and construction of crest drains. The cover crops are raised in order to further enhance erosion control.

Tree planting is the next process after the cover

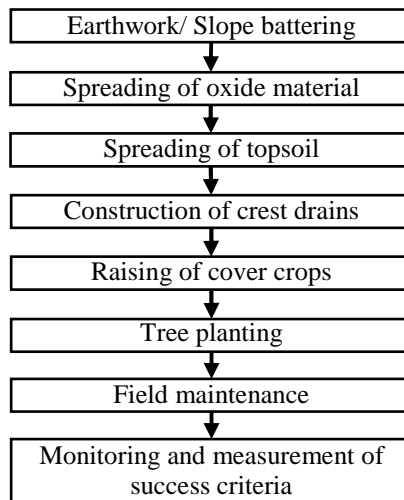


Fig. 1: Flowchart showing adopted land reclamation practices at AngloGold Ashanti, Iduapriem mine Ltd



Plate 1: Plate showing a barrier approach using vetiver, bamboo strips, stones and *Gliricidia sepium* at the block one southeast (2yr old site under reclamation) at AngloGold Iduapriem mine Ltd, Tarkwa

crops are raised. Seedlings of *Acacia magium*, *Gliricidia sepium*, *Leucaena leucocephala* and *Senna siamea* from the nursery are planted in a specified order. The tree planting is followed by field maintenance where pruning, weeding and fertilizer application are done.

Success criteria and monitoring are the next processes climaxing the reclamation procedure and processes. The company monitors against Acid Mine Drainage (AMD) at the tailings dam site. The company checks that the embankments are stable and free from erosion. Monitoring creates the platform for detecting changes in water, air and land properties associated with the implementation of reclamation plan (Viljoen, 1998). In Ghana, monitoring is strictly mandatory particularly in areas with high environmental sensitivities and significance, where impacts are uncertain as well as fragile habitats (Fitzgerald, 1993; EPA, 1996; Allen et al., 2004).

Success criteria could be the restoration of the disturbed site to acceptable physical appearance and acceptable after-use. Success criteria according to the company are based on the end-use objectives. For the purposes of agriculture/farming, the following were the completion criteria stipulated by EPA (2004) for the company's reclamation activities:

- Appropriate topsoil cover
- On waste dump topsoil cover of 0.5 m thickness
- Soils stable and free from erosion
- Completion of three food crop cycles
- Qualitative and quantitative analysis of vegetative cover
- Creation of conditions favourable for the return of fauna

- Sustainability of planted cash crop species

A site is deemed to have a final completion if it continues to retain the criteria for land use when no additional monitoring and maintenance are required after reclamation works have been achieved after tree seasonal cycles, excluding sites experiencing acid mine drainage (AMD) phenomenon. Where AMD phenomenon occurs, an area will be deemed to have a final completion when no additional monitoring and maintenance are required after reclamation works have been achieved after a period of not less than 7 years (EPA, 2004). These are done according to Environmental Protection Agency L1 1652 of 1999 which obliges all mining companies to rehabilitate the lands disturbed during their operations, almost close to the original state and to fill the pits with the waste material, to re-build soil fertility levels and restore the ecosystem resilience as close as possible to pre-mining conditions where practicable. Completion criteria have been defined as reclamation success objectives (Johnson and Tanner, 2004). The success indicators are usually generated on site specific basis to enable regulatory agencies, communities and mining companies to judge the success or otherwise of reclamation programmes (Elliot *et al.*, 1996).

Indigenous tree species before the mining started

According to a baseline survey by the environmental advisory unit contained in a document at the Environmental Department of the Company, within the primary forest, the emergent trees were *Piptadeniastrum africanum*, *Ceiba pentandrum*, *Canarium schweifurthiini*, *Tieghella heckelli*, *Milicia excelsa* and *Petersianthus macrocarpus*. The secondary forests were characterized by colonizing species such as *Musanga cecropioides*, *Trema orientalis*, *Anthrocleista rogelii* and *Harungana madagascariensis*. The forest timber tree *Lophira alata* was also regenerating.

Swamp vegetation occurs in the valley floor.

The vegetation is characterized by *Raphia hookeri*, *Sclerosperma manni*, *Anthonotha vogelii* and *Mitragyna stipulsa*.

Tree species used in the reclamation exercise

The tree species used in the reclamation exercise were *Acacia magium*, *Gliricidia sepium*, *Senna siamea* and *Leucaena leucocephala*. All the reclaimed sites were dominated by equal species diversity of these tree species except *Acacia magium* which was said to inhibit undergrowth hence it was less in species richness as compared to the other three tree species. The reasons given to the choice of the tree species were that, they are fast growing and have the ability to establish and survive on degraded sites. In addition to this, *Acacia*, *Gliricidia*, and *Leucaena* are nitrogen fixing. Nitrogen-fixing tree species (NFTS) are ideal class of trees for afforestation of degraded sites (Mac Dickens, 1994) because they are able to establish and thrive in nitrogen deficient soils. In addition to their nitrogen-fixing capacity, NFTS grow quickly and tolerate a variety of adverse soil conditions. It is widely believed that 75% of nitrogen is contributed by the root nodules of leguminous plants (Lawrie, 1981). This agrees with the assertion by Young (1997) that the woody perennials suitable for soil fertility maintenance or improvement should have: a high rate of production of leafy biomass, a dense network of fine roots, with a capacity for abundant mycorrhizal association, extensive deep roots, a high rate of nitrogen fixation, a capacity to grow on poor soils and have other productive or service functions other than soil improvement. Leguminous trees also have the ability to rehabilitate degraded land by improving the physical, chemical and biological characteristics of soils.

Even though *Senna siamea* is not nitrogen fixing, its association with vesicular – arbuscular mycorrhizas (VAM) can contribute to the resultant nitrogen fixing ability of *Acacia magium*, *Gliricidia sepium* and *Leucaena leucocephala* at the reclaimed sites. Van Noordwijk and Dommergues (1990) postulated that when roots

of nitrogen fixing trees are in close contact with roots of non- nitrogen fixing plants, greater number of nodules and the resulting N_2 fixation is stimulated in the N_2 fixing plants. This might indicate the ability of the *Acacia magium*, *Gliricidia sepium* and *Leucaena leucocephala* to survive and improve their nitrogen fixing ability in these mined out sites and hence their selection for reclaiming these degraded sites. According to Huang *et al.* (1985) and Osonubi *et al.* (1991), drought tolerance of woody plants has been shown to be improved by VAM colonization. Bethelfalvay *et al.* (1988) reported that VAM plants can absorb soil moisture below the levels accessible to non-mycorrhizal plants which suggests that VAM association can be important during periods of drought-stress on degraded lands.

Community participation in the reclamation practices

About 90 % of all the communities confirmed the fact from the Environmental Department of AngloGold Iduapriem mine that there is a very high community participation in the reclamation practices. Seven percent had no idea and 3% disputed the fact that communities were involved in the reclamation practices. Areas of community participation as identified include weed and fire control, supply of local seeds, seedling establishment and maintenance of trial farms. In addition, communities are periodically consulted to make inputs into ongoing reclamation projects. The chiefs, unit committee members and other opinion leaders are taken round the sites under reclamation three times in every year to see progress of work and solicit for further comments/concerns. Workshops and focus group discussions are organized for the communities and their traditional authorities to allow them determine the final land use desired which is incorporated into the decommissioning and closure cost document. All the casual workers are taken from the various communities. Some are engaged in activities such as weeding, collection of seeds, clearing and maintenance of oil palm, cocoa, pineapple and maize farm trials at the old tailings

dam site which was 9 years under reclamation. This is in conformity with Fitzgerald (1993) that as a step in reducing pressure on reclaimed sites, many mining companies currently employ local communities in various stages of their reclamation efforts. This collaboration enhances peace between the company and the communities.

Benefits of land reclamation as perceived by the communities at AngloGold Ashanti, Iduapriem mine, Tarkwa

The benefits associated with land reclamation as identified by the various communities were:

- Building food security through increased agricultural production;
- Creation of opportunities for marginalized groups to access land;
- Restoration of authority to original land-owners;
- Increasing the monetary value of the land;
- Reduction in environmental health hazards;
- Creation of safe playgrounds for children;
- Creation of employment;
- Increasing the skills and capacity of youths to find employment;
- Preventing conflict and enhancing peace and stability;
- Protection of traditional activities such as indigenous medicines; and
- Improving the aesthetic beauty of the land.

These benefits as enumerated by the communities are in conformity with the perceived views of land reclamation benefits by the communi-

ties at a Consultative Workshop on Land Reclamation and Alternative Land Use held at Satta Kumba Amara Resource Centre, Koidu, Kono District, Sierra Leone by the Foundation for Environmental Security and Sustainability (FESS, 2007) under the auspices of the United States Agency for International Development (USAID).

Overall satisfaction level of the reclamation practices by the various respondents

The various stakeholders at the study area came out with their perceived level of satisfaction of the reclamation exercise. All the eight communities and the Community Relation Officer as well as the workers of the Environmental Department rated the reclamation practice as either very satisfactory, satisfactory or not satisfactory. Ninety percent of Teberebie, Iduapriem, Techiman communities and the Environmental Department workers see the reclamation practice to be very satisfactory. For Badukrom, Wangarakrom, Adieyie and Adisak-

rom communities, 80% of the people viewed the reclamation practice to be satisfactory (Fig. 2). It was only Abonpuniso community where 70% rated the practice to be satisfactory. The Community Relation Officer (CRO) of the company also viewed the reclamation as satisfactory. Their views were that representatives of the communities were always in contact with the company and as a matter of fact, the company goes about its duty as stipulated in the reclamation security agreement with the EPA (EPA, 2004). Majority of the community members have also been employed by the company on both casual and permanent basis and that the communities are always aware of what is going on. According to the respondents, none of the sites affected by the mining exercise have been left out without reclamation. They also indicated that conflicts associated with mining between communities and companies are not prevalent. These influenced their decision on their ratings on the level of satisfaction of the reclamation practice because most local com-

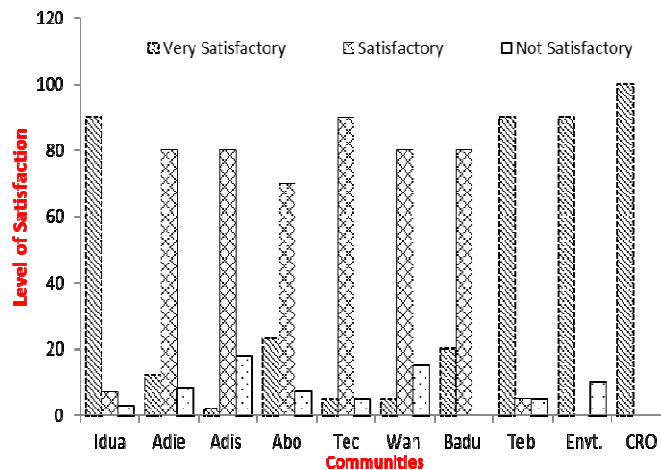


Fig. 2: Level of satisfaction of reclamation processes/practices by the various stakeholders at AngloGold Ashanti, Iduapriem mine, Tarkwa

Idua (Iduapriem community), Adie (Adieyie community), Adis (Adisakrom community), Abo (Abonpuniso community), Tec (Techiman community), Wan (Wangarakrom community), Badu (Badu community), Teb (Teberebie community), Env't (Environmental department), CRO (Community Relation Officer)

munities are fundamentally concerned with questions of control over their own destinies, both in relation to the state and in terms of the management of projects, the flow of benefits, and the limitation or redistribution of mining impacts (Wesley-Smith 1990; Banks, 2002).

CONCLUSION

AngloGold Ashanti, Iduapriem mine Ltd, Tarkwa has 2, 5, 7, 9 and 11 year old sites under reclamation. The 7 year old site was inaccessible at the time of the study because active mining was on-going. The study revealed that the company adheres to the reclamation security agreement signed with EPA- Ghana in 2004. Land use in the communities before the mining operations commenced were agriculture (food/tree crops production), forestry (timber logging) and artisanal mining (Galamsey) with most of the common tropical tree species dominating. *Acacia magium*, *Gliricidia sepium*, *Senna siamea* and *Leucaena leucocephala* were the tree species used in the reclamation of the disturbed sites due to their ability to grow on degraded soils with high biomass production and some nitrogen fixing ability. The company uses the following reclamation processes and procedures to rehabilitate the disturbed sites: earthworks/slope battering, spreading of oxide material, spreading of top soil, construction of crest drains and raising of cover crops to control run-off and erosion, tree planting, field maintenance-weeding, pruning and monitoring. Success criteria for the company's reclamation were the ability of the reclaimed sites to support plant growth without further monitoring. These processes were found to be in line with the required processes for rehabilitating disturbed mine sites which are ecologically sustainable. There was high community participation in the reclamation practices. It is recommended that other mining companies in Ghana follow strict land reclamation practices to enhance ecosystem sustainability under the auspices of EPA.

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