Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.3, 2016

Impact of Mining Activity on Soil Quality and Plant Biodiversity in Senkele Faris, West Shoa Zone, Ethiopia

Adamu Chanyalew Futa, V. Sreenivasa, P. Natarajan and L. Prabhadevi
Department of Biology, Ambo University, PO Box No. 19 Ethiopia.

Abstract
Sand and rock mining is an alarming problem for the agricultural land users in Senkelefaris area since it creates long term negative impact on the environment. The present study focuses the impacts of sand and rock mining on the soil quality and plant biodiversity. The results revealed water retention rate of the soil has reduced in the mined area due to variation in the physical nature of the soil. The percentage composition of sand fraction was significantly high in the mining area with low in organic content, low fertility, due to the permeable nature. The bulk density was significantly ($p<0.05$) higher in mined soil which might be a cause for change in soil properties. Though the pH values remains within the permissible limit, the moisture content and *cation exchange capacit*y were significantly ($p<0.001$) higher in the unmined soil. There were 1340 trees (22 genera and 19 family) in the unmined area whereas in the mined plots have 174 (16 genera and 19 family) were observed. The most dominant species was *Olea europaea* belongs to the family Oleaceae in both area. The density of shrubs was high (3975) in the un mined area when compared to (231) the mined places. Among shrubs species belonging to the family Apocynaceae were dominant (2082) in the unmined area and those of family Rubiaceae (89) in the mined area.
Keywords: Senkelefaris, mining, bulk density, Oleaceae, Apocynaceae, Rubiaceae.

Introduction

Mining along with agriculture are the earliest human activity as these are fundamental to the development and continuation of civilization (Khoshoo, 1984). Unlike agriculture, man exploits other resources from place where the minerals are present. Hard rock and sandstone mining, undoubtedly can induce development and contribute to the socio-economic development of the rural areas where mining activities under way. It is a source of income to the government and local people, providing raw materials for construction and offering jobs for a large number of local communities. Irrespective of its economic benefits, mining operations also have adverse impacts on the environment like deforestation, loss of biodiversity, water and soil pollution, socio-economic impacts, depletion of non-renewable resources and aesthetic degradation (Khanna, 1999; Seyoum, 2006). Mining whether small or large scale, are inherently disruptive to the environment producing enormous quantities of wastes that can have deleterious impacts for decades (Makweba and Ndonde, 1996).The adverse impacts of mining operation start with mineral exploration and continue throughout the extraction and persist even after the entire operations are over. Brian Kiio (2011) stated that impacts of mining not only affects the environment negatively but also leads to social health problems including drop outs from the school, alcoholic abuse addiction to drugs and prostitution.The impact of mining depends on many factors, especially the type of mining and the extent of the operation (Enatfenta Melaku, 2007). Open cast mining causes uncontrollable soil property and quality loss in the form of low concentrations of organic matter, nitrogen, phosphorus, high soil bulk density, poor structure, low porosity and water-holding capacity and low biomass productivity (Indorante *et al.,* 1981; Boerner *et al.,* 1998) and can also produce health hazards to local people (Ghose, 2004).The problems of mining waste dumps become devastating to the landscape around every mining area (Goretti, 1998). Regeneration and reclamation of mine soil are very tedious processes (Kiranmay, 2005). These soils usually contain This kind of nutrient deficient sandy spoils are generally hostile to plant growth (Hearing *et al.,* 2000; Burger, 2004). Senkele faris, the study site is one such place in west shoa zone, Oromia regional state, Ethiopia where the rock and sandy mining activities are going on for years and causing damage at various levels. Hence, the present study was undertaken to study the impacts of this mining operations on soil degradation and plant biodiversity.

Materials and Methods

Description of the Study Area

Senkele faris is in Oromia Regional State, Ethiopia, located at 5°37'08" - 5°44'11" N latitudes and 38°49'41" - 38°55'39" E longitudes. It has the total area of 2,800 square meters and has an elevation of 1800-2300 masl (Kebede and Endalew**,** 2006). The mean annual temperature ranges between 20^0 C - 25^0C. The area is mostly covered by black cotton soil. The vegetation cover varies from luxurious mixed forests to thorny trees.

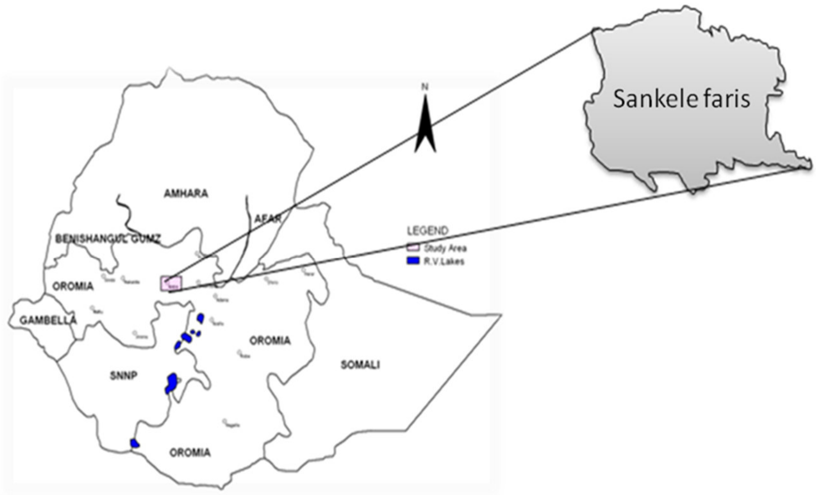

Fig.1. Location Map of the Study area

Soil survey

Six replicates of composite samples of top soil from depth of 0-15 cm were collected randomly from each site using an auger (FAO, 1977). The control site used was unmined site in and around the project area that is 1km away from the mines. The soil samples were air-dried, finely ground and sieved to pass through 2 mm sieve. Samples were collected in Polythene bags for further analysis. Soil texture (Mocek *et al*., 1997), bulk density, organic matter (Walkley and Black, 1934), total nitrogen (Kjeldahl, 1883), available phosphorous (Olsen *et al*., 1954), soil pH (using digital probe), soil moisture content (Johnson,1962), Cations exchange capacity (CEC) (Mocek *et al*., 1997) and EC (Ca, K, Mg and Na) (AOAC, 2000) were analyzed in the laboratory. Statistical analysis was undertaken using one way analysis of variance (ANOVA) with SPSS statistical software, version 16.0 (Jole, 2008) to determine the effect of mining on soil chemical and physical properties by comparing mined and unmined areas.

Vegetation Survey

From the study area composition of vegetation was observed in two different areas namely mined areas and unmined areas. A total 72 Sample plots of 30m x30m size were selected from mined and unmined area. Complete list of tree species in each sample plot from each field was recorded. The local names of the species were registered with the help of the local community. Plant species collected from the study area were first assigned with suitable numbers and then pressed and dried for identification. The numerical abundance of tree and shrub species and their frequency were used for description of vegetation composition**.**

Results and Discussion

Physico-chemical properties of soil

Table 1: Soil physical and chemical properties of mined and unmined area (Mean±SE)

Parameter	Soil Samples	
	Mined Area	**Unmined Area**
Sand(%)	69.38 ± 2.18	64.81 ± 1.04
Silt (%)	11.25 ± 1.88	16.45 ± 1.59
Clay(%)	19.37 ± 0.43	18.66 ± 0.60
Bulk density (g/cm^3)	01.63 ± 0 .55	01.27 ± 1.12
Organic matter (mg/l)	1.226±0 .21	2.80±0.35
Total Nitrogen (mg/l)	0 .075 ± 0 .01	0.137±0.01
Available Phosphorous (mg/l)	3.267 ± 0 .11	3.533 ± 0.30
pH	6.0±0.16	6.6±0.13
Moisture (%)	0 .43±0.09	0.95±0.34
CEC (cmol/100g)	8.8433±0 .55	11.943±1.12

The percentage composition(mean) of the soil components from the soil mining area showed distinct variations from that of the control site. The texture of the soil sample was in the order of sand, clay and silt as 69.38 ± 2.18, 19.37 ± 0.43 and 11.25 ± 1.88 respectively in mined area and 64.81 ± 1.04, 18.66 ± 0.60 and 16.45 ± 1.59 in the unmined area. Sand and clay content were slightly high in the mining place. This might be attributed to the physical weathering and disintegration of surface rock fragments and pre weathered sandstones as observed by Ciolkosz *et al.* (1985). According to Brady (1990) the texture of a soil is not easily modified by agricultural or forestry but through weathering, erosion, over a long period of time Dominance of sand particles indicates low stability of aggregates and consequently a low rate of infiltration. The more sand dominated mined area also implies that soils tend to be low in organic content and low fertility, low capacity to hold moisture and nutrients and rapidly permeable.

There was significant difference in bulk density of soil between mined and unmined areas. The average bulk density for mined and non mined area was 1.63g/cm^3 and 1.27g/cm^3, respectively. The mined soil had significantly ($p<0.05$) higher bulk density than that of the unmined soil, which may be due to the indiscriminate mining activity and the use of machineries during mining. The high bulk density of the mined soil has serious implication for subsequent changes of soil properties because gaseous diffusion is made more difficult. Such high bulk density may pose restoration on the growth of deep rooted plants and may be one of the reasons of cessation of the plant growth at the shrub stage. The present result is accordance with Ghose (2004). Campbell *et al.* (1977) indicated that excessive use of farm machinery and over-grazing of land usually leads to reduced infiltration and increase the BDs in soils. The organic matter in unmined soil showed significantly ($p<0.05$) higher than that of the mined soil. The low soil organic matter content of mined soil is may be due to intensive mining of land which increases the loss of organic matter. This is in agreement with Olatunji (2009) who reported that intensive tillage of land increase the loss of soil organic matter by speeding decomposition. There was significant difference in total nitrogen content between mined and unmined area. The unmined soil had significantly ($p<0.05$) higher total nitrogen than the mined soil. The average total N (%) for mined and unmined area was 0.075 and 0.137, respectively. This is in accordance with the report that the intensive tillage increases the loss of organic matter by speeding up decomposition and hence loss of mineralizable nitrogen (Olatunji, 2009). Phosphorus values of mined and unmined soil samples showed that there was no significant difference. However, the value was slightly lower in mined area (3.2 %) than unmined site (3.53 %). This decline of average soil phosphorous was associated with the soil organic matter. The present results are in conformity with that of Haile (2007) and Olatunji (2009).The mean pH of mined and unmined soil was 6.0 and 6.6. The soil pH in both the areas was within the suitable level for plant growth, particularly for the grasses, legumes, and woody species. However, the low pH value of mined soil could be due to the leaching of basic cations (Sobek *et al.,* 2000).

The average moisture content in mined and unmined area were 0.43% and 0.95 %respectively. The unmined soil had significantly ($p<0.05$) higher moisture content than the mined soil. This moisture content of mined soil was significantly affected by mining activity. The low water holding capacity of this soil may be due to the presence of high rock fragments coupled with the compaction in the zones besides the relatively high bulk density and the sand particles in soil. Maiti (2006b) stated that the percentage of soil moisture in the mined depends on time of sampling, height of mining spills, stone content, and amount of organic carbon, texture and thickness of litter layers. There was a significant difference in cation exchange capacity (CEC) between the two areas. Soil comparison showed that unmined land had significantly ($p<0.001$) higher CEC than mined land. The mean value of CEC for mined and unmined area was 8.84 cmol/100g and 11.94 cmol/100g respectively. The low CEC in soil from mined area may be correlated with the low level clay and humus in the area. The high CEC observed in the unmined area could be due to its soil texture and organic matter composition (Fanta**,** 2007).

Plant Community Characteristics

There were 1340 plants belonging to 21 genera and 19families in the unmined area (Table2.). The most dominant species was *Olea europaea* subsp.*cuspidata* (22.5%) belongs to the family Oleaceae, followed by *Pittosporum viridiflorum* (12.5%); *Croton macrostachus* (10.8 %) ;*Osyris quadripartite* (8.1 %) *Ilex mitis* (7.7%) *Acacia abyssinica* (7.5 %); *Acacia albida*(6.2 %) *Olinia rochetiana* (5.0 %) and *Rhus vulgaris* (4.3%).In terms of abundance *Olea eurpaea ranks first having (*8.361%) among all the vegetation. There were 174 trees belonging to 16 genera and 14 families were identified in the mined area. The most dominant species *in this part of the land are Acacia abyssinica* (44.859%) followed by *Olea europaea subsp.cuspidata* (13.228 %) and *Olinia rochetiana* (12.652%) and *Croton macrostachus* (10.4%). The species *Acacia abyssinica* was comparatively less dominant in the unmined area. *Pittosporum viridiflorum,* which was more abundant in the unmined area declined considerably in the mined area. Even though *Rhus vulgaris Meikle*, *Prunus Africana*, *Ilex mitis*, *Euphorbia abyssinica*, *Buddleja polystachya* and *Albizia schimperiana* are the less dominant species in the control plot, these species occurred in higher densities in the mined plots.

Table 2: Total number of individual species, families, relative density, frequency and relative frequency of tree species in the unmined and mined area

Species name	**Family**	**UNMINED AREA**			**MINED AREA**		
		Total	**Abundance**	**Dominance**	**Total**	**Abundance**	**Dominance**
Acacia abyssinica Hochst.ex Benth	Fabaceae	100	2.778	7.463	78	2.167	44.859
Acacia albida	Fabaceae	83	2.306	6.194	2	0.056	1.15
Albizia schimperiana Oliv.	Fabaceae	21	0.583	1.567	3	0.083	1.725
Bersama abyssinica Fresen.	Melianthaceae	15	0.417	1.119	-	-	-
Buddleja polystachya Fresen.	Scrophulariaceae	31	0.861	2.314	6	0.167	3.451
Celtis africana Burm.f.	Cannabaceae	2	0.056	0.15	-	-	-
Cordia africana Lam.	Boraginaceae	44	1.222	3.284	-	-	-
Croton macrostachyus Del.	Euphorbiaceae	145	4.028	10.822	15	0.417	8.627
Ficus sur Forssk	Moraceae				2	0.056	1.15
Euphorbia abyssinica Gmel	Euphorbiaceae	15	0.417	1.119	6	0.167	3.451
Gardenia ternifolia Schumach. Thonn.	Rubiaceae	5	0.139	0.373	2	0.056	1.15
Grewia ferruginea Hochst. Ex A.Rich.	Tiliaceae	8	0.222	0.597	1	0.028	0.575
Ilex mitis	Aquifoliaceae	103	2.861	7.687	5	0.139	2.876
Maesa lanceolata Forssk	Myrsinaceae	2	0.056	0.149		-	-
Maytenus obscura (A.Rich)cuf.	Celastraceae	27	0.75	2.015	2	0.056	1.15
Olea capensis subsp.macrocarpa (C.H.wright)Verdc.In Bothalia	Oleaceae	6	0.167	0.448	-	-	-
Olea europaea subsp.cuspidata (Wall.ex DC)*cifferri*	Oleaceae	301	8.361	22.464	23	0.639	13.228
Olinia rochetiana A.Juss.	Oliniaceae	67	1.861	5	22	0.6111	12.652
Osyris quadripartita Decn.	Santalaceae	108	3	8.06		-	-
Pittosporum viridiflorum Sims	Pittosporaceae	168	4.667	12.538	1	0.028	0.575
Prunus africana (Hook.f.) Kalkm	Rosaceae	23	0.639	1.717	-	0.055	1.15
Rumex nervosus Vahl	Polygonaceae	9	0.25	0.672	2	-	-
Rhus vulgaris Meikle	Anacardiaceae	57	1.583	4.254	4	0.111	2.3
		1340			**174**		

Table 3: Total number of individual species, families, relative density, frequency and relative frequency of Shrub species in the unmined area

Species name	**Family**	**Unmined**			Mined		
		Total	**Abundance**	**Dominance**	**Total**	**Abundance**	**Dominance**
Acanthus eminens	Acanthaceae	64	1.778	1.61	15	0.4167	6.49
*Calpurnia aurea(*Ait.) Benth.	Fabaceae	1051	29.194	26.439	32	0.889	13.846
Canthium oligocarpum Hiern	Rubiaceae	16	0.444	0.402	89	2.472	38.508
Carissa spinarum L.	Apocynaceae	2082	57.833	52.376	84	2.333	36.344
Capparis tomentosa Lam.	Capparaceae	33	0.917	0.83	2	0.056	0.865
*Clausena anisata(*willd.) *Benth*	Rutaceae	29	0.806	0.73	-	-	-
Hypericum quartinianum A.Rich	Clusiaceae	88	2.444	2.214	-	-	-
Maytenus gracilipes (Welw.) *Exoliv*.Exel	Celastraceae	395	10.972	9.937	6	0.167	2.596
Myrsine africana	Primulaceae	1	0.028	0.025	-	-	-
Otostegia tomentosa.	Lamiaceae	7	0.194	0.176	-	-	-
Phytolacca dodecandra L.Herit	Phytolaccaceae	124	3.444	3.119	-	-	-
Rhamnus staddo A.Rich	Rhamnaceae	10	0.278	0.252	-	-	-
Vernonia auriculifera Hiern	Compositae	28	0.778	0.704	-	-	-
Vernonia amygdalina Del	Compositae	47	1.306	1.182	3	0.083	1.298
	Total	3975			231		

The population density of shrubs was also very high in the unmined area. A total 3975 shrub plants belonging to 13 families were recorded from the unmined plot. Whereas in the mined plot 231 plants belonging to seven families were noticed. The dominant species in terms of numerical abundance are *Carissa spinarum* L (52.3%);*Calpurnia aurea* (26.4%)and *Maytenus gracilipes* (9.93%). The less abundant species are *Phytolacca dodecandra* (3.1%); *Hypericum quartinianum* (2.2%); *Acanthus eminens* (1.6%)and *Vernonia amygalina* (1.2%) in the control plot (Table3). The rest of the species each constituted less than 1% in terms of abundance. Number of species and their abundance of shrubs in the mined area are tabulated in the Table 3. Among the 7 species identified, *Canthium oligocarpum* (38.6%), *Carissa spinarum* (36.4%) and *Calpurnia aurea* (13.9%) are found in high density. The species *Canthium oligocarpum is least represented in the control area has thickly grown in the mined area.* The *Acanthus eminens* (6.5%); *Maytenus gracilipes* (2.6%);*Capparis tomentosa* (0.9%) and *Vernonia amygdalina* (1.3%) were the other species which are less abundant in the mined space. Seven species of shrubs which are sparsely distributed in the unmined area were completely vanished from the mined area.

The unmined area had greater vegetation density (both tree and shrub species) when compared to that of the mined area. The lower density of tree and shrub species in the mined area may be due to mining activity, acidic pH, moisture stress and nutrient deficiency in mined soils. Mining alters the physical and chemical properties of soil. When the top fertile soil is removed the space may be filled with large rock fragments and coarse gravel which are devoid of organic matter and does not hold more water. This leads to low fertility of the soil. Compared to native soils, mine spoils have low moisture content, low porosity, poor structure or high bulk density (Bussler et al., 1984). Chemical properties such as high pH and soluble salts or low nutrient levels can also adversely affect tree growth (Torbert et al., 1998).This could be the reason for the excessive reduction in trees in the mined area. Moreover it takes long time to establish tree species as there is competition for soil nutrients which are replenished by the activity of soil microbes. Soil pH has a dominant role in the restoration of plant growth. Showalter,et al.(2005) stated that the effect of PH change depends on species of tree and on the site. Webb *et al.* (1967), Ashton (1972) and Austin (1972) indicated that in the absence of major disturbance, soil and water conditions play major roles in controlling species distribution pattern in the unmined area. In the unmined area, three tree species namely *Olea eurpaea* subsp. *cuspidata*, *Croton macrostachus* and *Pittosporum viridiflorum* and two shrub species, *Maytenus gracilipes*, *Carissa spinarum* and *Calpurnia aurea* showed clump distribution. But in mined area only two shrub species namely *Canthium oligocarpum* and *Carissa spinarum* showed a clumped distribution. This distribution pattern of species suggests that the increase in fragmentation of vegetation was due to mining. The dominance of shrub species in the mined area is due to their tolerance in low nutrient levels and low moisture conditions (Baiga, 1992; Lyngdoh, 1995; Das Gupta, 1999 and Sarma, 2002). Bradshaw and Chadwickwell (1980) reported that the number of species colonizing in the mined areas is influenced by its pH.

Mining areas are low nutrient habitats which may not support for growth of plants or low relative growth rate can be noticed. In the present study even though the variation in PH is insignificant between the two sites other soil properties might have influenced the growth of shrubs and trees which leads to variations in the pattern of abundance as well as the absence of many species.

REFERENCES

AOAC(2000) Official methods of analysis.association of Official analytical chemists,EUA

Ashton PS (1972) The quaternary geomorphological history of Western. Malaysis and lowland forest phytogeography. *Trans. Second Aberdeen Hull Symp.Malaystan Ecology,* pp.33-42

Austin MP(1972)The application quantitative methods to vegetation survey 111. A re-examination of rain forest data from Brunei. *J.Ecol.*, 60:305-324

]"n Baiga MN(1992)Natural revegetation of coal mine spoils in the rocky mountains of Alberta and significant for species selection in land restoration. *Mount. Res. Dev.,* 12(3): 285-300

Boerner REJ, Scherzer AJ and Brinkman JA(1998) Spatial patterns of inorganic Nitrogen, Phosphorous availability, and organic Carbon in relation to soil disturbance: A chrono sequence analysis. *Appl. Soil Ecol.*, 7:159–177

Bradshaw AD and Chadwikwell MJ (1980)The international of land. Blackwell Scientific Publication Oxford England, pp. 363-384

Brady NC(1990) The Nature and Property of Soils. Macmillan Publishing Company, New York

Brian KM (2011)Assessment of of socio-economic and environmental impacts of unsustainable sand harvesting along river Muooni Emali location,Makueni county,20p

Burger JA(2004) Restoring forests on mined land in the Appalachians: Results and outcomes of a 20-year research program. p. 260. *In:* R.I. Barnhisel (ed.). Proc. of a Joint Conf. of American Society of Mining and Reclamation. 21st Annual National Conf., 25th West Virginia Surface Mine Drainage Task Force Symp., 18–22, Morgantown, WV

Bussler B H, Byrnes WR, Pope PE, Chaney WR (1984). Properties of mine soil reclaimed for forest use. Soil Sci. Soc. Am. J. 48:178-184

Campbell RE, Baker Jnr MB, Larson PF and Avrey CC (1977) Wildlife effects on Ponderosa pine ecosystem: U.S Department of Agriculture, Forest Service. Rocky Mountain Forest Range Experiment Station

Ciolkosz EJ, Cronce RC, Cunningham RL and Petersen GW (1985) Characteristics, genesis, and classification of Pennsylvania mine soils**.** *Soil Sci.,* 139:232–238

Das Gupta S (1999) Studies on vegetation and microbiological process in coal mining affected areas. Ph.D. Thesis. North Eastern Hill University, Shillong, India. 121-128

Enatfenta Melaku (2007). Impact assessment and restoration of quarry site in urban Environment: the case of Augusta quarry. M.Sc., in Environmental Science, Addis Ababa University, 102 p.

Fanta RB (2007) Assessment of soil quality in fantale district, east shewa, as influenced by land use.Msc thesis ,A, ddis Ababa University,92p

Ghose MK (2004), Effect of opencast mining on soil fertility, Journal of environment and industrial research, 63, pp 1006-1009

Goretti KKM (1998) The environmental impacts of underground coal mining and land cover changes analysis using multi-temporal remotely sensed data and GIS. M.Sc., Thesis.International Institute of Aerospace Surveys and Earth Sciences. Enschede. The Netherlands, 13:149-160

Hearing KC, Daniels WL and Feagley SE (2000) Reclaiming mined lands with bio solids, manures, and paper mill sludge. 615–644. *In:* R.I. Barnhisel *et al.* (ed.). Reclamation of drastically disturbed lands. ASA, CSSA, and SSSA, Madison, WI

Indorante S, Jansen IJ and Boast CW(1981) Surface mining and reclamation: Initial changes in soil character. *J. Soil Water Conserv*., 36:347–351

Johnson AI(1962)Methods of measuring soil moisture in the field.Geological survey water supply paper,US government printing Office,Washington

Jole (2008) SPSS 16 Macintosh: Statistic software review.http://ww.weboria.com /macstats/software /spss htmi

Khanna T (1999) Mining and the environmental agenda. *Mining Mag*., 183 (1): 158–163

KhoshooTN(1984)27th Holland Memorial Lecture. Mining, Geological and Metallurgical Institute of India

KiranmayS(2005)Impact of coal mining on vegetation: A case study in Jainta Hills District of Meghlaya, India. MSc in Geoinformation Science and Earth Observation with specification in Natural Hazards studies, 85p

Kjeldahl JZ (1883)A new method for the determination of nitrogen in organic bodies. Anal. Chem. 22: 366-382

Lyngdoh,T.(1995).Community dynamics and edaphic change in relation to coal mining in Jainta Hill, Meghalaya. Ph.D. Thesis. North-Eastern Hill University, Shillong. India,176p

Maiti S K., (2006b), Properties of minesoil and its affects on bioaccumulation of metals in tree species: A case study from a large opencast coalmining project. International Journal of Mining Reclamation and Environment, 20(2): 96 – 110

Makweba, M.M, Ndonde, P.B. (1996).The mineral sector at national environmental policy. In:Mwandosya M .J.(ed.).Proceedings of the workshop on the national environmental policy for Tanzania (Dares Salaam). Tanzania, 1:64-73

Mocek,A., Drzymala,S. and Maszner, P.(1997).Genesis, analysis and classification of soil. AR Poznan, 416p

Nardi, S., Cocheri, G. and Dell‟Agnola, G., (1996) Biological activity of humus. In: Piccolo, A. (Ed.), Humic Substances in Terrestrial Ecosystems. Elsevier, Amsterdam, pp. 361–406. In: K.R., Islam, R.R., Weil, Land use effects on soil quality in a tropical forest ecosystem of Bangladesh

Olatunji ,K.J.(2009).Organic matter and nutrients deplation in soil of Itakpe Irone ore Deposite Area of Kopi state Nigeria. Res.J.Appl.Sci., 4(1):17-19.

Sarma, K.(2002). Coal mining and its impact on environment of Nokrek Biosphere Reserve , Meghalasya. Ph.D.Thesis. Norh-Eastern Hill University, Shillong,India, 365p

Seyoum Zenebe (2006). Environmental Impacts of Gold Mining on Waters and Sediments of Legadembi area, southern Ethiopia. M.Sc., in Environmental Science, Addis Ababa University, 113p

Showalter, J. M. Burger, J. A. Zipper C. E., and Galbraith. J. M. 2005. influence of physical, chemical, and biological mine soil properties on white oak seedling growth.Paper was presented at the 2005 National Meeting of the American Society of Mining and Reclamation, June 19-23, 2005. Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502

Sobek, A.A., Skousen J.G. and Fisher S.E., Jr. (2000). Chemical and physical properties of overburdens and mine soils, 77–104. *In* R.I. Barnhisel *et al.* (ed.) Reclamation of drastically disturbed lands. Agron. Monogr., 41. ASA, CSSA

Torbert, J. L., J.A. Burger, W.L. Daniels. 1990. Pine growth variation associated with overburden rock type on a reclaimed surface mine in Virginia. J. Environ. Qual., 19(1):88-92

Walkley, A. and I. A. Black. 1934. An examination of the Degtjareff method for determining organic carbon in soils: Effect of variations in digestion conditions and of inorganic soil constituents. Soil Sci., 63: 251-263

Webb,C.J.,Tracy,J.G.,Willium.,W.T. and Lance, C.N. (1967). Studies in numerical analysis of complex rain forest communities 1. A comparison of methods, applicable to site/species data. J.Ecol., 55:171-191