Effect of Sand Winning on Agriculture and Its Socioeconomic Impact on the Community: A Case Study of Atwima Twedie, Ashanti Region, Ghana

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Abstract:

A study was conducted at Twedie in the Atwima Kwanwoma District in the Ashanti Region of Ghana to assess the current levels of soil nutrients at the sand winning site, compare with a closed farmland (undegraded land) which is of the same geology with the study area and the socio-economic effect of the people. Ten (10) soil samples were taken each from these areas and transported to the laboratory for analysis for the levels of pH, N, C, P, K, Ca, Mg, Na and CEC. The cation exchange capacity (CEC), pH, Nitrogen, Organic matter of undisturbed land varied from 3.18me/100g, 5.56, 0.11% and 2.92% to 4.65me/100g, 6.42, 0.23% and 4.01% with average of 3.75me/100g, 6.13, 0.16% and 3.47% which were far higher than the values from the disturbed land. A field survey was also done to assess the level of education and employment situation of the indigenes in the area. The results showed that there was significant difference in terms of soil nutrient levels between the undisturbed and degraded land. The men in the town have also resorted to sand winning activity and this has affected food production, high illiteracy level and other activities.

Keywords:

Sand Winning, Land Degradation, Atwima Twedie, Natural forest, Farm Land

1. Introduction

As a process of land degradation, sand winning deteriorate the soil profile, destroys soil surface configuration and changes topography of the land [9]. Land degradation can be defined as the progressive reduction of intrinsic quality of land or loss of biological and economic productivity of land resulting from natural and anthropogenic activities of environmental degradation [5] [10]. Sand winning refers to

the gathering and carrying away of parts of the solid earth such as sand and gravel using machines such as peel-loader or manpower as raw material for construction of roads and buildings. In this regard, sand and gravel consist of eroded fragments of rock formation in which the diameter of grain of sand ranges between 0.002 and 0.08 inches and that of gravel from 0.08 to 4 inches [6]. This has caused degradation of land, followed by subsidence and consequential mine fires and disturbance of the water table leading to topographic disorder, severe ecological imbalance and damage to land use patterns in and around mining regions [4].

In West Africa, particularly Ghana, sand and gravel are derived from natural deposits. The grains of sand is found in natural form at the sea coast, river side, savanna areas and disintegration of rocks in an area by natural or artificial means [11]. The granules and pebbles of gravel are also derived from the earth or crushed from quarrying rock. Sand and gravel constitute the primary raw materials for the construction of projects such as roads, bridges, houses, factories, schools, markets and offices [11]. This paper aimed at the upsurge demand for sand and gravel at Atwima Twedie in the Kumasi metropolis in the Ashanti Region of Ghana. The opportunities created by the increased demand are good since this has created jobs for the indigenes. However, these activities have led to land degradation particularly with regard to collection and destruction of topsoil which supports farmers' crops, deterioration of fertility levels of soil and the natural vegetation. This is gradually creating food shortage in the community and the surrounding villages. Therefore there was the need to assess the current levels of soil nutrients at the sand winning site, compared with a closed farmland (undegraded land) which is of the same geology with the study area and socio-economic effect on the indigenes.

2. Materials and Methods

2.1. Location of the Study Area

The study was conducted in Atwima Twedie, located in the Atwima Kwanwoma district in the Ashanti Region of Ghana lying between the latitude 6.40 ° N and longitude 1.42 °W (Figure 1). Atwima Twedie has a population of about 4000 people which forms about 1.5% of total population of Ashanti Region.

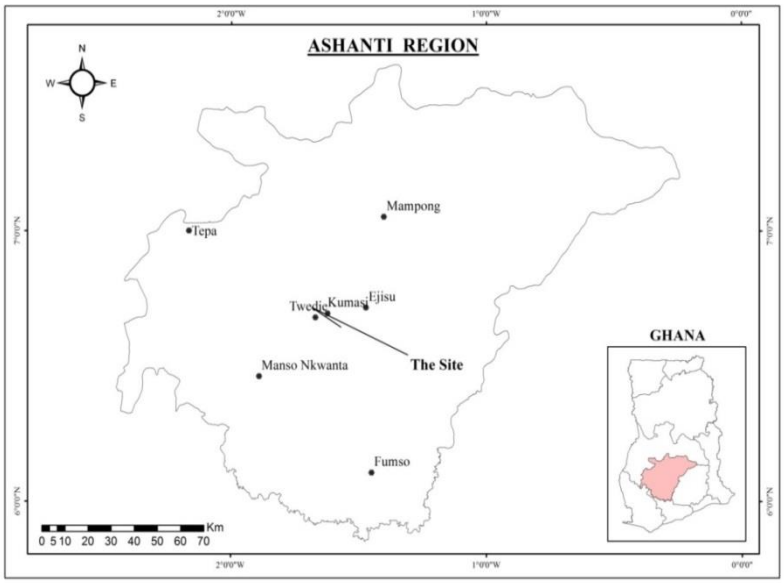

Figure 1. *Map of the study area showing other farming communities.*

Because of the nature of the land and topography of the area the people in Twedie were mostly farmers, and most of the crops cultivated in the area were cassava, plantain, coconut, yam, vegetables and fruits, which were produced in commercial quantities (Figure 2).

Figure 2. *General environment and harvested products before sand winning years. (Source: From the Assemblyman of the District).*

According to the elders, the village used to be called Betinase. Market women trekked from Kumasi and surrounding communities to Betinase during market days to purchase the produce from the farmers and sometimes they fought with colleagues over relatively low price produce, hence the name of the village in Twi language "TWEDIE" meaning fight.

The activities of sand winning started over 20 years ago according to the elders of the community when the young energetic men in the community realized that this was a viable venture and creating jobs for the people in the area. The duty of these men is to load the sand into the tipper trucks for a fee (manpower) and this engages about 40 young men a day depending on the number of trucks which trek to the site (Figure 3). Modern technology which involves the use of machines such as peel-loader has sought to reduce the number of people engaged in these activities and fast deteriorating the land.

Figure 3. *Sand winning applications in the study.*

2.2. Soil Sampling and Analysis

In this context, two locations were identified for this study namely, degraded and undegraded land (farmland). The degraded land was the one which had been destroyed by sand winners and undegraded was the farmland which is of the same geology with the degraded land.

According to [1], top soils are the first locus of degradation and nutrient deterioration. Soil samples were randomly sampled at the depth of 0-15cm from 10 locations in each site making a total of 20 samples. The samples were placed in labeled polythene bags and transported to laboratory for analysis. The samples were subsequently air-dried to constant weight to avoid microbial degradation [10]. They were homogenized, made lump free by gently crushing constantly using a pulverizing machine and passed through a 2 mm plastic sieve prior to analysis. Parameters considered in the study were pH, Nitrogen (N), Phosphorus (P), Potassium, Organic carbon (OC), Calcium (Ca), Magnesium (mg), and Sodium (Na). These were analyzed using methods described by [6].

2.3. Field Survey

The survey of families was conducted through this research project. In the period under study, a questionnaire was developed and administered to 3 communities in the study area (Agyakum, Akatase and Abromem) of people who lived around the study area. 1250 inhabitants were selected randomly from these areas and interviewed on the assessment of their knowledge and level of education and employment situation. A total 1250 inhabitants from 100 households [Agyakum (40), Akatase (30) and Abromen (30)] were interviewed for the study. Inhabitants who were able to read and write were considered literate and vice-versa was considered illiterate. Also non-school-going age were not interviewed but considered in the population and public servant, artisan etc. were also considered as others (Table 4) in the study.

2.4. Statistical Analysis

In this context, the analysis for the interpretation of the data gives a clear understanding of the variations of the chemical parameters with respect to concentration of the degraded and undegraded areas. For data processing, ten variates, pH, N, P, K, OC, OM and exchangeable Ca, Mg, Na and K were subjected to statistical analysis using Genstat 12th edition to analyze locational variations of chemical parameters with respect to concentration. According to this package if P-value is less than 0.05, there is significant difference and vice-versa.

3. Results and Discussion

Tables 1, 2, 3, 4 and 5 below represent the analytical results of soil samples selected randomly from the farmland and degraded land, and statistical analysis of the soil nutrients parameters of farmland and degraded land. Table 6 also represents survey results of 3 communities in the study area (Agyakum, Akatase and Abromem). Figures 4 and 5 below also show direct effect and relative contribution of the chemical parameters to the soil.

Soil is the main source of nutrients for crops. Soil also provides support for plant growth in various ways. The health of soils can be assessed by the quality and stand of the crops grown on them. Sand winning removes these nutrients which support the crops from the land surface.

Soil pH is the measure of sodicity, acidity and neutrality. It is an important estimation for soils as soil pH has a considerable influence on the availability of nutrients to crops and also affects microbial population in soils. Most nutrient elements are available in the pH range of 5.5 – 6.5 and also crop yields are normally high in soils with pH values between 6.0 and 7.5 [3].

The pH of undisturbed and degraded land varied from 5.56 to 6.60 (Table 1) and 4.19 to 4.56 (Table 2). This was far higher than the degraded land ($P<0.05$), indicating that the land has been disturbed.

The soil organic matter of the undisturbed and degraded land ranged from 2.92 to 4.01% and 1.53 to 2.1%. This could be described as high (Fertile) to low from undisturbed land to degraded land according to [2], and this is as a result of the sand winning activities. Low soil organic matter is an indication of low fertility and high fragility of soils [3]. To maintain the fertility of the soils, management practices that promote accumulation of organic matter are recommended e.g. cover cropping, soil and water conservation, manure application etc.

Total nitrogen followed the same trend as was observed in the soil organic matter. They ranged from 0.11 to 0.23% in the undisturbed soil and 0.09 to 0.12% in the degraded respectively. This could generally be described as low but higher in the undisturbed soils [3]. Total nitrogen is inadequate and would require any N amendment for a season's cultivation.

Cation exchange capacity varied from 3.18 to 4.65me/100g in the undisturbed soils and 1.48 to 2.61me/100g in the degraded soils. CEC is a measure of the nutrient power of the soil. Organic matter significantly contributes to the CEC levels of soils. Management practices that improve soil organic matter content like organic manure application (cow dung, compost, poultry manure, etc.), mulching, leguminous cover cropping and improved fallows are recommended to improve the CEC of the soils [3].

Texture of the soils was Clay, Sandy Clay Loam, Loam and Sandy Loam. These are considered heavy to light textured soils.

Table 1. *Analytical results of soils from undisturbed land (farmland).*

Label	pH	N	P	K	OC	OM	C:N
		%	Mg/kg		%		
U1	6.60	0.23	8.21	72.16	1.77	3.04	7.70
U1	6.42	0.17	8.11	32.47	2.15	3.7	12.65
U1	5.56	0.15	6.89	32.47	2.06	3.54	13.73
U2	6.12	0.21	5.74	18.04	2.33	4.01	11.10
U2	5.98	0.13	4.99	14.43	1.7	2.92	13.08
U2	6.02	0.11	4.23	14.43	1.74	2.99	15.82
U3	6.13	0.12	6.54	54.12	1.75	3.01	14.58
U3	5.98	0.11	6.42	28.87	2.33	4.00	21.18
U3	6.33	0.12	3.11	21.65	2.31	3.98	19.25
U4	6.41	0.12	3.11	18.04	2.2	3.78	18.33
U4	5.98	0.23	8.81	20.45	1.73	2.98	7.52
U4	6.02	0.17	7.99	65.13	2.15	3.7	12.65
Mean	6.13	0.16	6.18	32.69	2.02	3.47	14.00

Table 2. *Analytical results of soils from undisturbed land (farmland). Continuation*

Label	Ca	Mg	Na	K	CEC	Sand	Silt	Clay	Texture
	Exchangeable cations (me/100g)					%			
U1	2.4	1.34	0.15	0.2	4.09	55.50	26.10	18.40	Sandy Loam
U1	1.99	1.02	0.08	0.15	3.24	47.30	20.90	31.80	Sandy Clay Loam
U1	2.01	1	0.07	0.1	3.18	39.10	18.20	42.70	Clay
U2	2.94	0.93	0.07	0.1	4.04	37.60	14.70	47.70	Clay
U2	2.88	0.88	0.06	0.1	3.92	47.70	24.30	28.00	Sandy Clay Loam
U2	2.41	0.87	0.04	0.3	3.62	49.30	28.70	22.00	Loam
U3	2.67	1.07	0.12	0.21	4.07	55.40	32.60	12.00	Sandy Loam
U3	2.34	1.1	0.08	0.15	3.67	45.70	34.30	20.00	Loam
U3	2.11	0.9	0.07	0.1	3.18	27.80	30.60	41.60	Clay
U4	2.4	0.8	0.04	0.26	3.50	27.20	30.50	42.30	Clay
U4	2.34	1.08	0.15	0.22	3.79	39.40	12.70	47.90	Clay
U4	2.95	1.34	0.14	0.22	4.65	37.40	20.80	41.80	Clay
Mean	2.45	1.03	0.09	0.18	3.75				

Table 3. *Analytical results of soils from degraded land.*

Label	pH	N	P	K	OC	OM	C:N
		%	Mg/kg		%		
D1	4.8	0.1	5.29	29.58	1.22	2.1	12.20
D1	4.19	0.12	4.19	25.01	1.11	1.91	9.25
D1	4.28	0.11	4.59	25.21	1.11	1.91	10.09
D2	4.46	0.11	3.71	35.09	1.12	1.93	10.18
D2	4.48	0.12	2.47	35.42	1.12	1.93	9.33
D2	4.56	0.09	2.21	34.32	1.1	1.89	12.22
D3	4.47	0.1	3.53	47.13	1.04	1.79	10.40
D3	4.49	0.09	3.01	45.21	1.04	1.79	11.56
D3	4.46	0.1	2.1	40.32	1.04	1.79	10.40
D4	4.53	0.09	1.99	7.91	0.89	1.53	9.89
D4	4.46	0.11	1.2	8.12	0.89	1.53	8.09
D4	4.53	0.11	1.56	7.32	0.89	1.53	8.09
Mean	4.48	0.10	2.99	28.39	1.05	1.80	10.14

Table 4. *Analytical results of soils from degraded land: continuation.*

Label	Ca	Mg	Na	K	CEC	Sand	Silt	Clay	Texture
	Exchangeable cations (me/100g)					%			
D1	1.34	0.67	0.03	0.12	2.16	54.8	27.1	18.1	Sandy Loam
D1	1.34	0.93	0.03	0.11	2.41	55.1	23.9	21	Sandy Clay Loam
D1	1.07	0.8	0.03	0.12	2.02	39.1	18.2	42.7	Clay
D2	1.07	0.8	0.03	0.12	2.02	41.6	14.7	43.7	Clay
D2	0.8	0.53	0.03	0.12	1.48	47.7	29.3	23	Sandy Clay Loam
D2	0.8	0.8	0.03	0.12	1.75	52.1	23.1	24.8	Loam
D3	0.8	0.54	0.03	0.16	1.53	52.4	32.6	15	Sandy Loam
D3	1.34	0.55	0.02	0.15	2.06	49.7	30.3	20	Loam
D3	1.34	0.8	0.02	0.14	2.3	30.4	30.6	39	Clay

D4	1.34	0.8	0.02	0.06	2.22	31.4	30.5	38.1	Clay
D4	0.8	0.5	0.02	0.05	1.37	39.4	17.7	42.9	Clay
D4	0.9	0.5	0.02	0.12	1.54	37.4	22.8	39.8	Clay
Mean	1.77	0.69	0.03	0.12	2.61				

Table 5. *Data analysis based on locations.*

Location **Chemical Parameters**	**P-value**	**Analysis**
pH	0.001	Significant
Nitrogen	0.02	Significant
Phosphorus	0.001	Significant
Potassium	0.046	Significant
Organic Carbon	0.001	Significant
Exchangeable Cations		
Calcium	0.339	Insignificant
Magnesium	0.006	Significant
Sodium	0.003	Significant
Potassium	0.073	Insignificant

Generally there was also significant difference ($P < 0.05$) between the chemical parameters in the undisturbed and disturbed land indicating that there has been a significant environmental degradation in the study area (Table 2). Exchangeable Calcium and Potassium showed insignificant difference (Table 3) and this might due to high contribution of exchangeable Calcium and Potassium to the soil in the study area (Figure 5).

Figure 5 showed that chemical parameters such as Ca, exchangeable K, available K, N, Mg, Na, pH, P and OC contributed 69%, 15%, 9%, 4%, 1% and the rest below 1%. Hence the contribution of chemical parameters to the soil was in order: Ca>exch. K>avail. K>N>Mg>OM. The average cation exchange capacity (CEC) of the soil in both cases was 3.75me/100g and 2.61me/100g which were very low according to [3]. Low CEC and OM is an indication of low fertility because less cation can be retained in the soil.

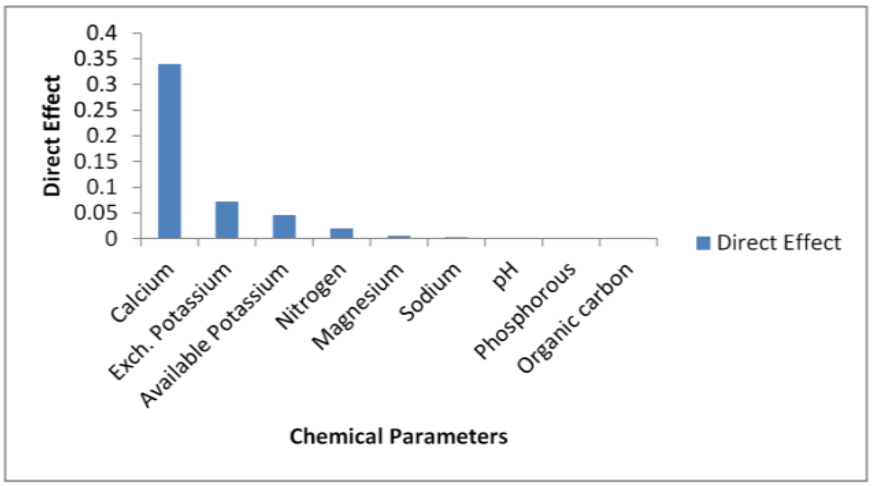

Figure 4. *Average direct effects of Chemical Parameters under Study on Environmental Degradation.*

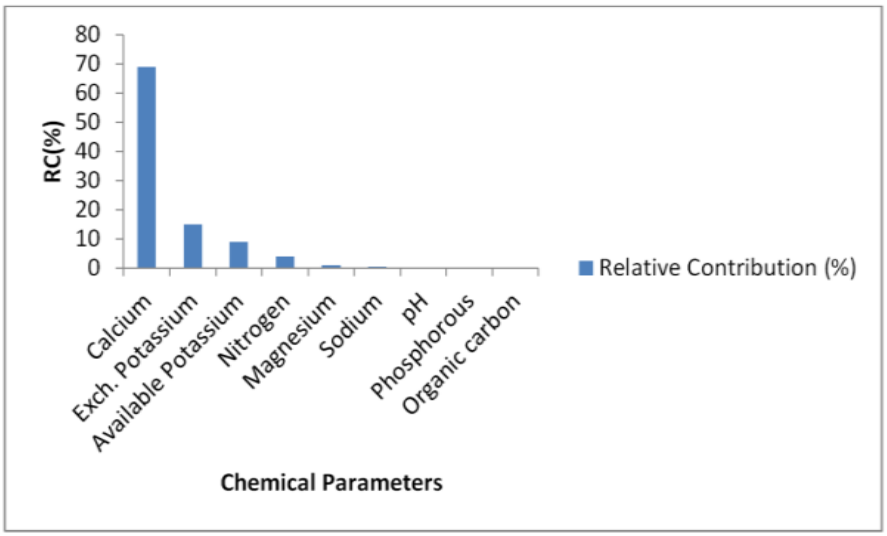

Figure 5. *Relation Contribution of Chemical Parameters under Study on Environmental Degradation.*

Table 6. *Survey results in agyakum, akatase and abromem.*

Community			**Agyakum**		**Akatase**		**Abromem**	
No. of Household			**40**	**%**	**30**	**%**	**30**	**%**
No. of Inhabitants	Men		195	36	122	45	173	40
	Women		235	43	51	19	196	46
	Children	Up to 19 years	120	21	97	36	61	14
	Total		550	100	270	100	430	100
Education Level								
	Literates		213	39	89	33	201	47
	Illiterates		337	61	181	67	229	53
	Total		550	100	270	100	430	100
Employment Situation	Sand Winners		67	34	42	34	49	28
	Farmers		35	18	39	32	57	33
	Others		93	48	41	34	67	39
	Total(men)		195	100	122	100	173	100

During the time of visit, even though lots of people were interviewed at Agyakum community it was revealed that most of them were unemployed, being catered for by their active wives who were market women. It was observed that most of the men sit under trees relaxing and others playing draughts and Oware (traditional game played by local people)

To assess the human condition in the study area the survey determined the male and female population, education level and employment situation. Total number of people selected randomly from the three communities in the study area was 1250.

The results from the field survey (Table 6) indicated that the percentage of women was higher in all the three communities, with Agyakum being the highest (235 women) followed by Akatase (51 women) and Abromem (46 women). During the field survey it was realized that the market, which consisted of high percentage of women was in the premises of Agyakum community and it was no surprised that there were many women in Agyakum community.

4. Conclusion

Optimizing the use of sand which serves as the medium for growing crops for building construction and other economic activities through sand winning has deteriorated the soil nutrient levels and rendered some people in Atwima Twedie Township inactive. From research conducted at the undisturbed and degraded land it can be concluded that there was significant difference in terms of soil nutrient levels between the undisturbed and degraded land, except exchangeable Calcium and Potassium which showed insignificant difference and this might due to high contribution of exchangeable Calcium and Potassium to the soil in the study area. The few farmers around had no option than to go to outskirt villages in search of land to farm, and this has affect the market value of foodstuff in the town. The men in the town have also resorted to sand winning activity and this has rendered most people unemployed, high illiteracy level and other activities.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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