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Assessment of Cost and Benefit Associated with Ecological Restoration in Ghana.

(A case study in Bekwai Municipal Area)

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ABSTRACT

Ghana has had a long-standing problem of illegal gold mining that has led to the destruction of the environment. The government of Ghana is taking steps to not only curb illegal mining but also to restore destroyed lands that resulted from illegal mining. The government intends to spend financially in the area of ecological restoration to returned disturbed lands to their natural states possible, but the question remains whether restoring those disturbed lands will be beneficial to the country.

The study was undertaken in Bekwai Municipal Area in the Ashanti region of Ghana where most locals are farmers. The research studies whether the benefits of ecological restoration outweigh the cost of ecological restoration? The research deployed a quantitative data collection. The data collected was analyzed using benefit-Cost ratio.

The result shows that the benefit of ecological restoration outweighs the cost incurred as dependent on the land use as a carbon sequestration project. In conclusion, investment in ecological restoration is a step in the right direction for a country endowed with gold resources. This will spur growth and at the same time improve and protect the country’s natural resources and environment.

Keywords: Ecological restoration, illegal mining, Clean Development Mechanism, Carbon sequestration,

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INTRODUCTION

Management of natural resources in an environment is a major question researcher have delved into, owing to the connected relationship of components in the environment system. Indeed, diverse methods have been designed and applied to provide sound and sustainable environmental management options.

Mining entities both legal and illegal should be responsible for restoring disturbed lands during their operations. As part of being a responsible mining entity, restoration plans are to be designed to bring disturbed lands back to their previous state or even a better land use type.

Mining entities need to be responsible in their operations and restoring lands involve steps that continue to the point of decommissioning where there is not any likelihood of a reclaimed or restored land later having some negative impacts on communities surrounding them. The safety, environmental and social risks arising from badly conducted mine closure can result in significant liabilities for mining companies. For communities, closure can cause severe distress because of the threat of economic and social collapse. In the case of illegal mining entities who are not accountable for their operations, the disturbed lands from their operation could led to enormous negative impact on the economy, environment and social integrity of the community and country in general. Abandoned mines may result in large clean-up costs and closure liabilities for governments (world bank, 2002).**Error! Reference source not found.Error! Reference source not found.** Illegal mining popularly referred to as “Galamsey” which was derived from the phrase “Gather them and sell” is a social menace causing havoc to many natural ecosystems in Ghana. According to Ghana Minerals Commission, there are about 20,000 to 50,000 illegal miners as of 2013 and their operations are increasing at an exponential rate. These operations have lasted over decades until it was recently banned by the country in 2017. There are no doubts these operations provide some sources of employment in Ghana but needs to be regulated by government in order to prevent it from destroying the society and environment. According (UNDP, 2013) to, management of extractive industries is one of the most critical challenges facing many resource dependent developing countries today. Ghana being one of such countries needs to adopt management systems like the ones used by large scale mining companies to mine responsibly for the less regulated, illegal and small-scale mining industry in Ghana. Restoration economy has proven to be a successful economic model in countries like the

USA where a growing body of evidence suggests the presence of a restoration industry does not only protect public environmental goods, but also contributes to national economic growth and employment. Federal and state agencies have begun to evaluate the impact of their restoration investments on local and state economies, finding that restoration projects support as many as 33 jobs per $1 million invested (Edwards, 2013). This research will provide evidence of the importance of ecological restoration on the economy. (BenDor, 2015) published a study called Estimating the Size and Impact of the Ecological Restoration Economy, which found restoration businesses in all 50 states. California had the most, but four "red" states filled out the top five: Virginia; Florida; Texas; and North Carolina. Fifth place went to North Dakota. By their very nature, restoration projects are in rural areas, and a study by Cathy Kellon and Taylor Hesselgrave of Eco Trust found that Oregon alone had more than 7,000 watershed restoration projects, which generated nearly 6,500 jobs from 2001 through 2010. Many of those jobs went to unemployed loggers. "The jobs created by restoration activities are located mostly in rural areas, in communities hard hit by the economic downturn," report authors wrote. "Restoration also stimulates demand for the products and services of local businesses such as plant nurseries, heavy equipment companies and rock and gravel companies." The study analyses the benefit and cost involved with the project (Cathy Kellon, 2012). This analysis will assist government in making effective decision concerning the project. To provide a quantitative analysis of the insight ecological restoration can have on Ghana's economy.

MATERIALS AND METHODS

Bekwai Municipal Assembly (BMA) is one of the 27 districts in the Ashanti Region established under Legislative Instrument (L.I. 1906, 2007) as shown in Figure 1. Until recently the Bekwai Municipality was part of the Amansie East District made up of the Bekwai and Bosome-Freho Constituencies. It is in the southern part of Ashanti Region. It shares boundaries with Bosomtwe District in the north, Adansi –North in the south, Bosome-Freho District to the East and Amansie-Central and Amansie –west to the west. The Municipal Assembly lies within latitude 6° 00'N 6° 30'N and Longitudes 1°00 W and 1° 35W. It covers a total land area of about 633sqkm.

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Amansie East (Bekwai) is an area endowed with gold deposits in most areas. The area has many galamsey activities going on. The entire District is rich in gold deposits and mining has emerged as the most important economic activity in the communities. Mining companies have acquired almost all the remaining land area in the District for either prospecting or actual mining (Ministry of Food and Agriculture 2010). Apart from the companies with large concessions in the district, there are other interested parties in the mining industry. The activities of small-scale miners, mostly galamsey operators who employ very crude methods to mine for gold are continually increasing in the district. The activities of these various groups are not properly regulated and not well organized as part of a total package development effort even though it goes a long way to alleviate the poverty situation in the district.

AngloGold Ashanti mining company mines on lands owned by the municipality. The rate of deforestation and land degradation is high and collectively has led to government's bold step to ban this illegal activity.

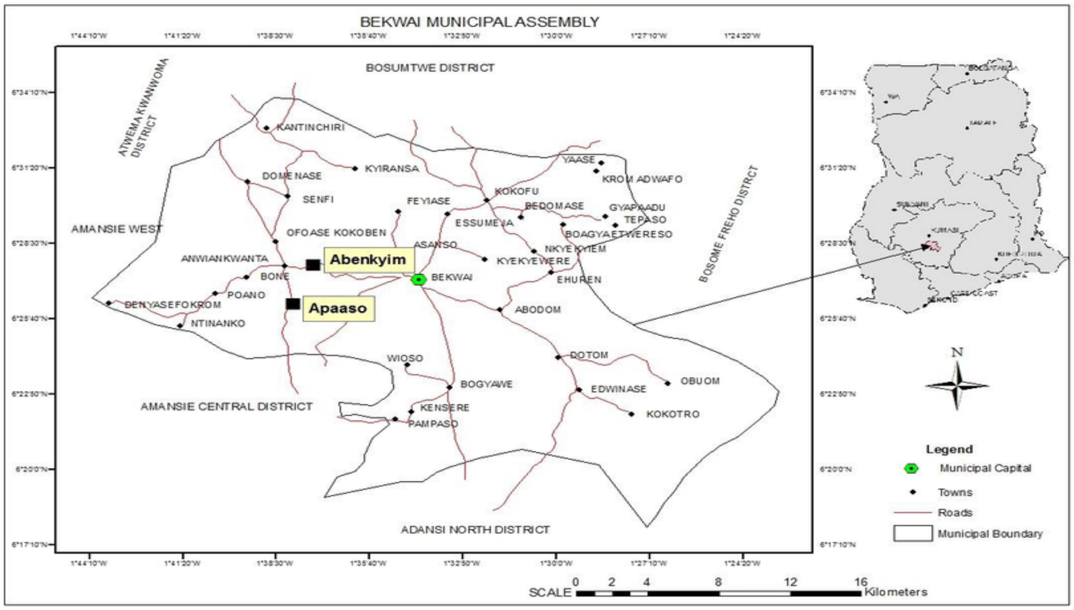

Figure 1 Map of Ghana showing the location of Bekwai

To perform the cost benefit analysis, the direct cost related to the project was identified. This data was collected from ecological restoration project done at AngloGold Ashanti Obuasi mines in Ghana. In the study, we used methods from the Toolkit for Ecosystem Services Site-based Assessment to calculate the ecosystem service values of a restored land. We chose this toolkit because it enables the collection of site-scale data relevant to decision without the need for specialist technical knowledge of the modeling approaches or GIS software typical of most currently available tools such as Infrastructure Voluntary Evaluation Sustainability Tool (Tallis, 2013). Using the cost benefit scale, the cost associated with ecological restoration was calculated in terms of cost in dollars/hectare of land restored. According to methods derived by Toolkit for Ecosystem Services Site-based Assessment, benefits of ecological services can be calculated in terms of climate change mitigation (Carbon sequestration in tonnes of CO_2 in dollars), nature services like tourism, air purification, non-forest products like mushrooms, peat and others services. The benefits associated from this project was based on climate change mitigation where the amount of carbon sequestered by trees on the disturbed land were calculated using the price of Carbon based on US Government CO_2value of $22.78 per tonnes of CO_2, adjusted to 2011. This procedure as shown in Figure 2 for calculating the price of CO_2 was based on an extension publication from the University of Nebraska. (Toochi, 2018)

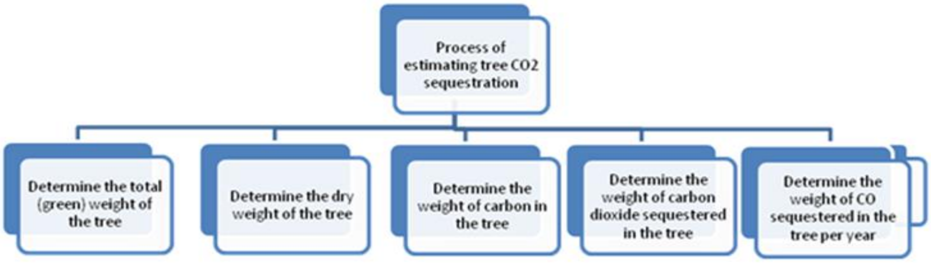

Figure 2 Procedure for calculating Carbon dioxide sequestered by a tree (Toochi, 2018)

To measure the weight of carbon stored, the following steps where followed

•I determined the total green weight of the tree. W and multiply by 120%. (Dewald, 2005)

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For diameters >11inches the w=0.25(D)^2*2H; For diameters<11inches the w=0.15(D)^2*2H

Where (H) is height (feet), (W) is weight (pounds), (D) is diameter.

•Secondly determined the dry weight of the tree by multiplying the green weight by 72.5% since the dry weight of a trees is averagely 72.5% of the whole weight. _(Birdsey, 1992)

•I determined the weight of carbon in the tree by multiplying the dry weight by 50% because averagely the dry weight of a tree is 50% carbon.

•I determined the weight of carbon dioxide sequestered in the tree by calculating the atomic weight of carbon in one molecule of carbon which is 3.6663 and multiplying it by the weight of carbon which is 50% of the dry weight.

•Finally, I determined the weight of carbon dioxide sequestered by the tree in a year by dividing the weight of carbon dioxide sequestered in the tree by the age of the tree

Data collected from AngloGold Ashanti Obuasi mines showed that the cost of ecological restoration of mine land for forest cover was $2000/hectare as shown on Table 1and the benefits derived from Ecological restoration within a period was used to analyze if financing ecological restoration was beneficial.

Table 1 Cost of Adubriem Ecological restoration Project

ACTIVITIES	No. of People	cost ($)/time
ENGINEERING WORKS	5	500
CLEAN UP AND CONTAMINATION	5	500
TOPSOIL SPREADING	1	200
SEED COLLECTION AND TREE NURSERY MANAGEMENT	5	200
GRASSING AND PLANTING	7	200
MAINTENANCE EG THINNING	2	200
MONITORING	2	200
TOTAL	**27**	**2000**

A simple random sampling based on the principle of the first law of geography which according to (Tobler, 1970) states that" everything is related to everything else but near things are more related than distant things and a sample number of 30 trees were monitored to determine the amount of carbon sequestered.

Every restoration project has an objective and the government of Ghana has made it clear that restoring and protecting Ghana's forest cover will be the objective of the ecological restoration projects. To make sure that objective works out there was the need for participatory land use plan which included all stakeholders. This research quantified the amount of carbon to be sequestered by trees for carbon credits which could serve as a source of income for the community while preserving the forest cover for other ecological services in the future. The forest could also provide community members with benefits like recreation, Non-Forest Products and other agroforestry benefits like intercropping trees with suitable crops.

RESULTS AND DISCUSSIONS

We identified and measured the weight of carbon dioxide found in the tree species on the project site as shown in Table 2. From the data collected the amount of carbon dioxide sequestered by trees involved in the study was calculated as seen in Table 3 and Figure 3. The cost of Adubriem ecological restoration project was $2000/ha as shown in Table 1 and this was used to equate the benefits derived from ecological restoration in terms of Carbon sequestration. The cost of Carbon sequestered by 1500 trees was $2,111in 2017, $2.815.37 in 2018 and $7,352.66 in 2019 as shown in Figure 4

Table 2 Weight of Carbon dioxide (Ibs) sequestered by Trees in Adubriem Ecological restoration Project

	TREE	**GPS COODINATES**		**(WCO)IBS**	**(WCO)IBS**	**(WCO)IBS**
TREE CODE		X	Y	2017	2018	2019
A1	Asanfna-1	607540	583495	109.0606031	333.142142	1009.556
A2	Asanfna-2	607524	583475	144.678361	369.363008	1332.672
C1	Cedrela-1	607455	583497	200.7408146	487.225893	1433.415
C2	Cedrela-2	607541	583409	64.07643626	197.038557	1026.329
C3	Cedrela-3	607532	583470	113.5935736	293.212223	1007.878
C4	Cedrela-4	607529	583471	137.9338507	397.153886	1467.948
E1	Emire-1	607480	583474	76.70399898	222.9626	831.3268
E2	Emire-2	607503	583452	51.34832681	147.34714	787.172
E3	Emire-3	607443	583565	44.78949901	244.159539	957.661
ED1	Edinam-1	607506	583468	53.74566394	134.684931	728.6551
ED2	Edinam-2	607522	583533	50.06710372	213.946179	1166.126
ED3	Edinam-3	607495	583574	61.87299186	199.175756	1088.452
G1	Glicidea-1	607456	583568	134.5108413	dead	dead
G2	Glicidea-2	607504	583572	185.6189756	664.459227	1885.567
G3	Glicidea-3	607543	583510	143.049906	326.856684	1592.641
G4	Glicidea-4	607539	583436	232.4458052	dead	dead
K1	Kyenken-1	607480	583515	144.3946915	415.462317	1303.274
K2	Kyenken-2	607498	583490	98.77846065	306.186334	1247.612
LI	Lucinea-1	607472	583584	127.0963927	493.360976	1843.196
L2	Lucinea-2	607445	583584	201.9310457	519.272731	1914.132
CG1	Cola gigantea-1	607495	583574	133.6378671	334.812049	1677.661
CG2	Cola gigantea-2	607497	583580	186.8808644	425.188464	1578.194
TS1	Triplochiton sclerocylon-1	607532	583472	80.25632916	408.711051	1762.855
TS2	Triplochiton sclerocylon-2	607529	583470	178.3363406	471.336131	2002.055
T1	Terminalia ivorensis-1	607540	583496	148.7592707	422.554241	1873.034
T2	Terminalia ivorensis-2	607524	583475	54.20101164	158.074466	1020.004
T3	Terminalia ivorensis-3	607455	583498	108.94743	354.397086	1455.201
AF1	Albizia ferruginea-1	607539	583472	105.4396198	488.372721	1876.694
AF2	Albizia ferruginea-2	607480	583474	153.4314469	416.444751	1433.601
AF3	Albizia ferruginea-3	607513	583452	179.9941581	442.250547	1429.259

Table 3 Amount of carbon dioxide sequestered by Trees of study site.

	TREE	**GPS COODINATES**		**CO2 SEQ.**	**CO2 SEQ.**	**CO2 SEQ.**
TREE CODE		X	Y	2017	2018	2019
A1	Asanfna-1	607540	583495	109.0606	166.5711	336.5187
A2	Asanfna-2	607524	583475	144.6784	184.6815	444.2239
C1	Cedrela-1	607455	583497	200.7408	243.6129	477.8049
C2	Cedrela-2	607541	583409	64.07644	98.51928	342.1098
C3	Cedrela-3	607532	583470	113.5936	146.6061	335.9593
C4	Cedrela-4	607529	583471	137.9339	198.5769	489.3161
E1	Emire-1	607480	583474	76.704	111.4813	277.1089
E2	Emire-2	607503	583452	51.34833	73.67357	262.3907
E3	Emire-3	607443	583565	44.7895	122.0798	319.2203
ED1	Edinam-1	607506	583468	53.74566	67.34247	242.885
ED2	Edinam-2	607522	583533	50.0671	106.9731	388.7085
ED3	Edinam-3	607495	583574	61.87299	99.58788	362.8173
G1	Glicidea-1	607456	583568	134.5108	dead	dead
G2	Glicidea-2	607504	583572	185.619	332.2296	628.5222
G3	Glicidea-3	607543	583510	143.0499	163.4283	530.8802
G4	Glicidea-4	607539	583436	232.4458	dead	dead
K1	Kyenken-1	607480	583515	144.3947	207.7312	434.4247
K2	Kyenken-2	607498	583490	98.77846	153.0932	415.8708
LI	Lucinea-1	607472	583584	127.0964	246.6805	614.3986
L2	Lucinea-2	607445	583584	201.931	259.6364	638.0441
CG1	Cola gigantea-1	607495	583574	133.6379	167.406	559.2204
CG2	Cola gigantea-2	607497	583580	186.8809	212.5942	526.0647
TS1	Triplochiton sclerocylon-1	607532	583472	80.25633	204.3555	587.6184
TS2	Triplochiton sclerocylon-2	607529	583470	178.3363	235.6681	667.3517
T1	Terminalia ivorensis-1	607540	583496	148.7593	211.2771	624.3446
T2	Terminalia ivorensis-2	607524	583475	54.20101	79.03723	340.0013
T3	Terminalia ivorensis-3	607455	583498	108.9474	177.1985	485.0668
AF1	Albizia ferruginea-1	607539	583472	105.4396	244.1864	625.5646
AF2	Albizia ferruginea-2	607480	583474	153.4314	208.2224	477.8671
AF3	Albizia ferruginea-3	607513	583452	179.9942	221.1253	476.4196

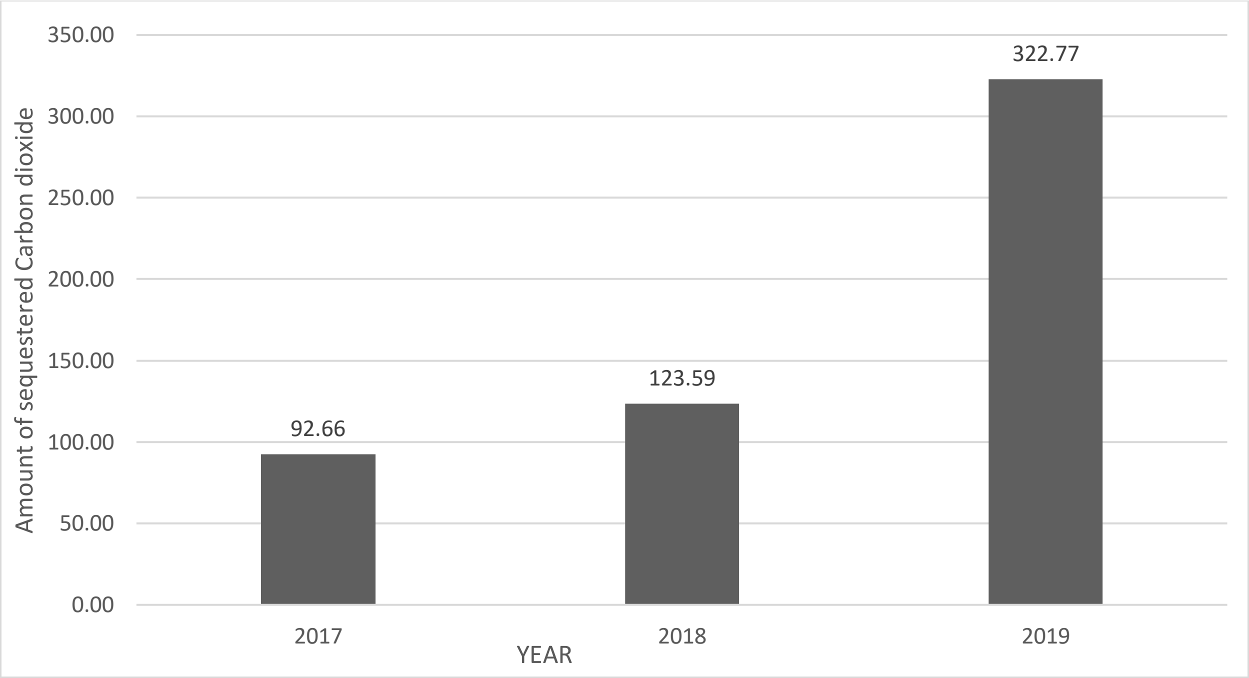

Figure 3 Amount of Carbon dioxide sequestered by trees (lbs/hectare of 1500 trees)

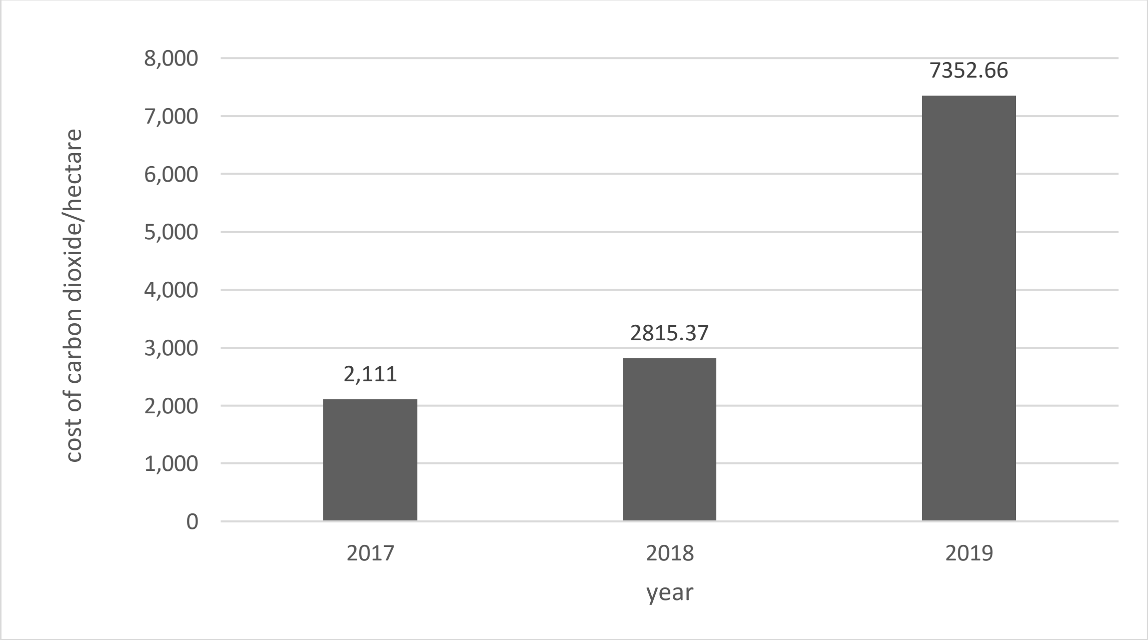

Figure 4 Cost of Carbon dioxide sequestered by 1500 trees.

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Article 3.3 of the Kyoto Protocol stated that net changes in Greenhouse Gases emissions by sources and removals by sinks through direct human-induced activities, limited to afforestation, reforestation and deforestation that occurred since 1990, can be used to meet Parties' emission reduction commitments (United Nations, 1998). At the inception of the Kyoto Protocol, only afforestation and reforestation activities were identified as qualifying for the carbon development mechanism due to environmental and market concerns with other activities within the full scope of Reducing Emissions from Deforestation and Forest Degradation. the negotiation of modalities and procedures for forestry carbon development mechanism took two years longer than for other carbon development mechanism sectors, which also caused some delay in investment in the sector. under carbon development mechanism Afforestation/Reforestation, the approved methodologies give project developers options to manage and harvest forests for agroforestry, bioenergy, timber production or urban forestry (Neeff, 2006). (Biocarbon fund, 2011), scaling up Afforestation/Reforestation activities is critical to mitigating climate change, improving rural livelihoods, improving resilience to climate change, conserving biodiversity, restoring degraded lands, and strengthening the human, social, and financial capital of local communities. Ecological restoration projects could also provide additional environmental and social benefits which include reductions in air pollution, water pollution which extends to improve water availability, reduced soil erosion and protected biodiversity. (F.A.O, 2001), a healthy forest sector can contribute positively to the economic development of Uganda, by providing environmental services in terms of climate regulation, soil conservation, and carbon sequestration. Furthermore, the forestry sector has multiple socio-economic benefits by offering significant employment, providing raw materials for the construction industry and the national energy demand, as well as contributing medicinal, cultural, and spiritual values held by rural communities. These carbon development mechanism projects could inculcate other management practices to maximize profits and benefits for people in the area. Bekwai municipality has many destroyed lands which could be used for carbon development mechanism forestry projects which can achieve government's object of creating forest cover through ecological restoration, provide local people with incentives from carbon sequestration projects whiles managing their farmlands to maximize crop yields and finally non-market values such as preventing soil erosion, water pollution, air pollution and mitigating of climate change just to mention a few.

CONCLUSION

From the research, the benefits derived from ecological restoration outweighs that of the cost. The benefits are sustainable, multiple and community wide depending on the end use of the restored land which in this case is for carbon sequestration and farming. Clean Development Mechanism remains uncertain but a promising mechanism that can help developing countries gain financial and improve environmental quality. Restoring ecosystems help reduce deforestation and degradation but also can help affected communities get incentives and sorts of income from carbon sequestration land use plan. According to (Surendran, 2016) 60% of Clean Development Mechanism projects displayed some economic sustainable development.

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APPENDICES

	TREE	GPS COODINATES		W(IBS)	W(IBS)	W(IBS)	(WD)IBS	(WD)IBS	(WD)IBS	(WC)IBS	(WC)IBS	(WC)IBS
TREE CODE		X	Y	2017	2018	2019	2017	2018	2019	2017	2018	2019
A1	Asanfna-1	607540	583495	82.06007	250.6649	550.722	59.49355	181.7321	399.2735	29.74678	90.86603	275.361
A2	Asanfna-2	607524	583475	108.8598	277.9185	726.9845	78.92336	201.4909	527.0637	39.46168	100.7454	363.4922
C1	Cedrela-1	607455	583497	151.0427	366.6016	781.9408	109.5059	265.7862	566.9071	54.75297	132.8931	390.9704
C2	Cedrela-2	607541	583409	48.2128	148.257	559.872	34.95428	107.4863	405.9072	17.47714	53.74316	279.936
C3	Cedrela-3	607532	583470	85.4708	220.6206	549.8066	61.96633	159.9499	398.6097	30.98316	79.97497	274.9033
C4	Cedrela-4	607529	583471	103.7851	298.829	800.7791	75.24417	216.6511	580.5649	37.62209	108.3255	400.3896
E1	Emire-1	607480	583474	57.71411	167.7629	453.4963	41.84273	121.6281	328.7848	20.92136	60.81406	226.7482
E2	Emire-2	607503	583452	38.63583	110.8679	429.4095	28.01098	80.37921	311.3219	14.00549	40.1896	214.7048
E3	Emire-3	607443	583565	33.7008	183.7121	522.4128	24.43308	133.1912	378.7493	12.21654	66.59562	261.2064
ED1	Edinam-1	607506	583468	40.43965	101.3405	397.488	29.31875	73.47185	288.1788	14.65937	36.73593	198.744
ED2	Edinam-2	607522	583533	37.67181	160.9787	636.1321	27.31206	116.7096	461.1958	13.65603	58.35479	318.066
ED3	Edinam-3	607495	583574	46.55487	149.8651	593.7604	33.75228	108.6522	430.4763	16.87614	54.32609	296.8802
G1	Glicidea-1	607456	583568	101.2095	dead	dead	73.37689	dead	dead	36.68844	dead	dead
G2	Glicidea-2	607504	583572	139.6646	499.9566	1028.594	101.2568	362.4686	745.7305	50.62842	181.2343	514.2969
G3	Glicidea-3	607543	583510	107.6345	245.9356	868.8	78.03502	178.3033	629.88	39.01751	89.15165	434.4
G4	Glicidea-4	607539	583436	174.8983	dead	dead	126.8013	dead	dead	63.40065	dead	dead
K1	Kyenken-1	607480	583515	108.6464	312.6048	710.9478	78.76862	226.6385	515.4372	39.38431	113.3192	355.4739
K2	Kyenken-2	607498	583490	74.32352	230.3827	680.5839	53.88455	167.0274	493.4233	26.94227	83.51372	340.292
LI	Lucinea-1	607472	583584	95.63067	371.2178	1005.48	69.33224	269.1329	728.973	34.66612	134.5665	502.74
L2	Lucinea-2	607445	583584	151.9382	390.7145	1044.177	110.1552	283.268	757.0281	55.07761	141.634	522.0883
CG1	Cola gigantea-1	607495	583574	100.5527	251.9214	915.1795	72.90067	182.643	663.5052	36.45034	91.32151	457.5898
CG2	Cola gigantea-2	607497	583580	140.6141	319.923	860.9193	101.9452	231.9442	624.1665	50.97261	115.9721	430.4596
TS1	Triplochiton sclerocylon-1	607532	583472	60.38698	307.525	961.6536	43.78056	222.9556	697.1989	21.89028	111.4778	480.8268
TS2	Triplochiton sclerocylon-2	607529	583470	134.185	354.6457	1092.139	97.2841	257.1181	791.8009	48.64205	128.5591	546.0696
T1	Terminalia ivorensis-1	607540	583496	111.9304	317.9409	1021.757	81.14954	230.5072	740.7738	40.57477	115.2536	510.8785
T2	Terminalia ivorensis-2	607524	583475	40.78227	118.9394	556.4214	29.56714	86.23106	403.4055	14.78357	43.11553	278.2107
T3	Terminalia ivorensis-3	607455	583498	81.97492	266.6577	793.8251	59.43181	193.3268	575.5232	29.71591	96.66342	396.9126
AF1	Albizia ferruginea-1	607539	583472	79.33555	367.4645	1023.754	57.51827	266.4118	742.2214	28.75914	133.2059	511.8768
AF2	Albizia ferruginea-2	607480	583474	115.4459	313.344	782.0426	83.69825	227.1744	566.9809	41.84912	113.5872	391.0213
AF3	Albizia ferruginea-3	607513	583452	135.4323	332.761	779.6736	98.18845	241.2517	565.2634	49.09423	120.6258	389.8368

w, green weight; wD, dry weight; wC, weight of Carbon

Table 2 Green weight and Dry weight of tree species on Adubriem Ecological restoration site

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	TREE	GPS COODINATES		2017 (D) INCHES		2018 (D) INCHES		2019(D) INCHES		(H) FEETS	(H) FEETS	(H) FEETS
TREE CODE		X	Y	<11	D^2	<11	D^2		D^2	2017	2018	2019
A1	Asanfna-1	607540	583495	6.38	40.7044	8.86	78.4996	9.44	89.1136	5.6	8.87	10.3
A2	Asanfna-2	607524	583475	6.62	43.8244	8.24	67.8976	9.36	87.6096	6.9	11.37	13.83
C1	Cedrela-1	607455	583497	6.51	42.3801	8.78	77.0884	10.15	103.0225	9.9	13.21	12.65
C2	Cedrela-2	607541	583409	5.86	34.3396	8.5	72.25	10.8	116.64	3.9	5.7	8
C3	Cedrela-3	607532	583470	5.08	25.8064	7.3	53.29	8.37	70.0569	9.2	11.5	13.08
C4	Cedrela-4	607529	583471	5.48	30.0304	7.93	62.8849	9.22	85.0084	9.6	13.2	15.7
E1	Emire-1	607480	583474	6.97	48.5809	8.91	79.3881	9.72	94.4784	3.3	5.87	8
E2	Emire-2	607503	583452	5.46	29.8116	7.58	57.4564	9.5	90.25	3.6	5.36	7.93
E3	Emire-3	607443	583565	5.03	25.3009	9.65	93.1225	10.4	108.16	3.7	5.48	8.05
ED1	Edinam-1	607506	583468	5.51	30.3601	7.09	50.2681	9.1	82.81	3.7	5.6	8
ED2	Edinam-2	607522	583533	5.81	33.7561	8.92	79.5664	10.66	113.6356	3.1	5.62	9.33
ED3	Edinam-3	607495	583574	6.26	39.1876	8.04	64.6416	9.75	95.0625	3.3	6.44	10.41
G1	Glicidea-1	607456	583568	5.25	27.5625	dead	dead	dead	dead	10.2	dead	dead
G2	Glicidea-2	607504	583572	6.26	39.1876	9.7	94.09	10.62	112.7844	9.9	14.76	15.2
G3	Glicidea-3	607543	583510	5.67	32.1489	7.48	55.9504	10	100	9.3	12.21	14.48
G4	Glicidea-4	607539	583436	6.77	45.8329	dead	dead	dead	dead	10.6	dead	dead
K1	Kyenken-1	607480	583515	6.03	36.3609	8.77	76.9129	9.3	86.49	8.3	11.29	13.7
K2	Kyenken-2	607498	583490	5.47	29.9209	8.04	64.6416	9.18	84.2724	6.9	9.9	13.46
LI	Lucinea-1	607472	583584	5.18	26.8324	8.73	76.2129	10.5	110.25	9.9	13.53	15.2
L2	Lucinea-2	607445	583584	6.31	39.8161	8.45	71.4025	10.4	108.16	10.6	15.2	16.09
CG1	Cola gigantea-1	607495	583574	5.51	30.3601	7.02	49.2804	9.92	98.4064	9.2	14.2	15.5
CG2	Cola gigantea-2	607497	583580	6.86	47.0596	8.5	72.25	10.01	100.2001	8.3	12.3	14.32
TS1	Triplochiton sclerocylon-1	607532	583472	5.08	25.8064	8.3	68.89	10.55	111.3025	6.5	12.4	14.4
TS2	Triplochiton sclerocylon-2	607529	583470	6.4	40.96	8.3	68.89	10.6	112.36	9.1	14.3	16.2
T1	Terminalia ivorensis-1	607540	583496	6.97	48.5809	8.88	78.8544	10.55	111.3025	6.4	11.2	15.3
T2	Terminalia ivorensis-2	607524	583475	5.46	29.8116	7.6	57.76	10.7	114.49	3.8	5.72	8.1
T3	Terminalia ivorensis-3	607455	583498	5.03	25.3009	7.38	54.4644	9.29	86.3041	9	13.6	15.33
AF1	Albizia ferruginea-1	607539	583472	6.51	42.3801	8.93	79.7449	10.2	104.04	5.2	12.8	16.4
AF2	Albizia ferruginea-2	607480	583474	5.81	33.7561	8	64	9.3	86.49	9.5	13.6	15.07
AF3	Albizia ferruginea-3	607513	583452	6.26	39.1876	8.4	70.56	9.6	92.16	9.6	13.1	14.1

Table 4 Tree data collection

D, Diameter

H, Height