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Editorial Board

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PREFACE

Dear readers of the Journal of Middle East and North Africa Sciences,

It is a great pleasure to publish this issue of the Journal of Middle East and North Africa Sciences for our readers. The issue is composed of 3 different papers having an acceptance rate of 82% in various disciplines of science. We would like to thank all authors, referees, our editorial board members and content editors that show efforts for the publication of the issue.

I would like to invite you to submit your manuscript/s to the next issue of the Journal of Middle East and North Africa Sciences.

Ahmad Saleh, PhD
Editor-in-Chief

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Influence of Environmental Pollution on Soil Types and Properties in The Niger Delta Area of Akwa Ibom State, Nigeria

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Abstract: A field soil survey and laboratory studies were carried out to examine the influence of crude oil and industrial wastes pollution on soil profile development and characteristics in Ikot Abasi, Niger Delta area of Akwa Ibom State, Nigeria. Nine soil profiles, three each, in oil affected site (OAS), industrial waste affected site (IWAS) and non-contaminated (control) site (NCS), respectively, were studied. Soil samples were collected and analyzed in the laboratory for some physical and chemical properties. The result of soil classification following the USDA Soil Taxonomy and correlated with the World Reference Base for Soil Resources (WRB) showed that all the three pedons from the control (NCS) were highly weathered and matured soils (Ultisols). Of the three pedons from the OAS, two (66.7%) were matured while one (33.3%) was young soil (Inceptisol/Cambisol). Similarly, of the three pedons from the IWAS, one (33.3%) was matured (Ultisols/Acrisols) while two pedons (66.7%) were young soils (Inceptisols/Cambisols). This indicates that environmental pollution can retard soil formation and profile development resulting in relatively young soils. Furthermore, analysis of variance (ANOVA), showed that soils of OAS were significantly ($P< 0.05$) different from those of IWAS and NCS in 12(52.2%) and seven (30.4%), respectively, of the 23 soil properties considered. Also, soils of IWAS were significantly different from those of the NCS in six (26.1%) of the soil properties. The result further showed that oil pollution significantly increased soil total hydrocarbon (THC) and lead (Pb) contents as well as organic matter content (OM), available phosphorous (P) exchangeable potassium (K), micronutrients (Fe, Zn, Cu, Mn) and lowered exchangeable acidity (EA). Industrial wastes also increased soil exchangeable calcium (Ca) and K and effective cation exchange capacity (ECEC) and lowered EA. Therefore, appropriate remediation and land management practices can ameliorate the harmful effects of these pollution activities while the essential nutrients and positive influences imparted to the soil during the pollution are harnessed to improve the land/soil qualities and characteristics.

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Keywords: Environmental pollution, soil development, land qualities, land management, Niger Delta.

1. Introduction:

Soils have strong relationships with food security, rural poverty, maintenance of environmental quality and promotion of plants, animals and human health. Agronomists, plant breeders, plant pathologists, ecologists, foresters, livestock specialists and others depend on soil for the proper management of their resources. Soil is one of the most important items in world development issues.

Soil is the basis of agricultural and of natural plant communities. Thus, the thin layer of soil covering the surface of the earth represents the difference between survival and extinction for most land-based life (Doran et al., 1996). However, inventories of soil productive capacity indicate human-induced degradation on nearly 40% of the world's agricultural land as a result of soil erosion, atmospheric pollution, extensive soil cultivation, over-grazing, land clearing, salinization, and desertification (Oldeman, 1994). Indeed, degradation and loss of productive agricultural land is one of our most pressing ecological concerns, rivaled only by human caused environmental problems like global climate change, depletion of the protective ozone layer and serious declines in biodiversity (Lal, 1998).

Environmental pollution through oil spills and industrial effluent can cause serious damages to both terrestrial and aquatic ecosystems and destruction of forest and farmland through deforestation and burning. These effects can be further modified by erosional and depositional processes. All these may severely affect the characteristics and management of agricultural soils (Dambo, 2000).

Ikot Abasi in Akwa Ibom State is a major oil producing area in the Niger Delta area of Nigeria. It has both on-shore and off-shore fields, as well as large deposit of gas (Udo et al., 2001). The area has been affected by crude oil spillages of serious magnitude. Furthermore, the disposal of solid and liquid industrial wastes also constitutes another source of environmental pollution in the area. Some previous studies (Udo et al., 2001; Worgu, 2000; Andrade et al., 2004; Chukwu, 2014), have shown that soil pollution has had serious environmental effects on soils, forests and water bodies in host communities in the Niger Delta. It alters both the chemical and physical properties of soil and degrades soil fertility (Udoh and Chukwu, 2014).

The aim of this present study was to assess the influence environmental (crude oil and industrial wastes) pollution on soil types (in terms of profile development) and soil (physical and chemical) properties in Ikot Abasi, Niger Delta Area, Akwa Ibom State, Nigeria.

2. Materials and Methods:

2.1. Description of the Study Area:

The area of this study was Ikot Abasi Local Government Area in Akwa Ibom State, Nigeria. It is located in the extreme south western part of the State in the Niger Delta and situates between latitudes 4°28' and 4°43'N and longitudes 7°30' and 7°50'E.

The area has a humid tropical climate characterized by heavy rainfall with mean annual rainfall of about 4000mm and mean annual temperature of about 27°C. Relative humidity is above 80% almost throughout the year with high cloud covers resulting in low incipient solar radiation. The geological material includes quaternary deposits (which give rise to alluvial plains and beach ridge sands) and the tertiary coastal plain sands (Udo et al., 2001).

2.2. Field Work:

Three sites were identified using free survey. The sites were: oil affected site (OAS), where major crude oil spillage occurred five years ago; industrial waste affected site (IWAS), where a manufacturing company used as waste dump site, and non-contaminated site (NCS), an area free from major environmental pollution as a control. Three profile pits were sited in each study location to represent the land type under investigation. Each of the nine profile pits was described following the FAO, (2006) guidelines for profile description. Soil samples were collected according to the observed genetic horizons of all the pits, for laboratory analysis.

2.3. Laboratory Analysis:

The physical and chemical analyses carried out on the soil samples included the following: particle size distribution – determined by the hydrometer method according to the procedure of Gee and Or (2002). Saturated hydraulic conductivity was determined using constant head permeameter as described by Klute (1986), while bulk density was by the method of Grossman and Reinsch (2002). Soil pH was determined using pH meter and read at a soil: water ratio of 1:2.5. Available phosphorus (P) was determined by Bray P-1 extractant as described by Udo et al., (2009). Exchangeable acidity (H+ and Al3+) was extracted with INKCl and titrated against 0.05M NaOH. Organic carbon was determined by Walkley and Black wet digestion method (Nelson and Sommers, 1982), while total nitrogen (N) was estimated from organic carbon. Exchangeable bases were extracted with neutral ammonium acetate (at pH 7), K+ and Na+ contents were read with the aid of flame photometer, while Ca2+ and Mg2+ were determined by EDTA complexiometric titration method (Jacson, 1965). Effective cation exchange capacity (ECEC) was determined by the summation of exchangeable acidity and exchangeable bases (Soil Survey Staff, 2010). Base saturation was calculated as the percentage of ECEC occupied by Ca, Mg, Na and K. Heavy metals/ micronutrients (Cd, Pb, Cu, Mn, Fe, Zn) were determined using total elementary analysis of perchloric and nitric acid digestion and read using atomic absorption spectrophotometer (AAS). Total petroleum hydrocarbon (TPH) was extracted with xylene and measured using AAS as described by Osuji and Nwoye (2007).

2.4. Soil Classification:

From the result of the field morphological properties and laboratory analysis, the nine pedons were classified according to the USDA Soil Taxonomy system (Soil Survey Staff, 2010) and the World Reference Base for Soil Resources (FAO, 2006). Pedons were placed in a particular order based on the presence or absence of diagnostic horizons. The differentiae used in defining the suborder were the presence or absence of properties associated with wetness (Soil Moisture Regime). In the great group category, the classification was based largely, on the presence or absence of horizon features and their arrangement. At the subgroup category, soils were placed in a particular class based on whether they represent the central concepts of the great group, intergrades or transitional forms.

2.5. Statistical Analysis:

Statistical analysis carried out included: descriptive statistics (mean, minimum and maximum values), analysis of variance (ANOVA), to compare the differences in soil characteristics among the different pollution sites (OAS, IWAS and NCS (control), (SAS Institute, 1996).

3. Results and Discussion:

3.1. Influence of Environmental Pollution on Soil Profile Development and Classification in the Study Area:

Each of the three study sites, namely, oil affected site (OAS), industrial waste affected site (IWAS) and non-contaminated site (NCS), was represented by three pedons, respectively. Some profile characteristics of soils in the three study sites (OAS, IWAS and NCS) are presented in Tables 1, 2 and 3, respectively, while the classification of soils in the three study sites is presented in Table 4.

The nine pedons (three from each study site) were classified following the criteria outlined in the USDA Soil Taxonomy (Soil Survey Staff, 2010) and correlated with the World Reference Base (WRB) for Soil Resources (FAO, 2006) system. The nine pedons were classified into order, suborder, great group and subgroup on the basis of diagnostic horizons, the properties of the soils that reflect the nature of the soil environment and the dominant pedogenic processes that are responsible for the soil formation (Soil Survey Staff, 2010; Ajiboye and Ogunwale 2010; Udoh et al., 2013).

From the result of the field study of profile pits and laboratory analyses of soil samples, it was observed that soils in the study area have high sand content which generally decreases with profile depth, irrespective of the study site. The results in Tables 1, 2 and 3, show that based on the stage of profile development, profiles 1 and 2 of the OAS (Table 1), profile 2 of the IWAS (Table 2) and all the 3 profiles of NCS (Table 3) showed evidence of argillic (Bt) horizon which placed these pedons in the Ultisols order (Soil Survey Staff, 2010). Although they all have high base saturation (>35%), which should have qualified them as Alfisols, previous workers, Kang and Juo (1980), and Enwezor et al. (1981) have described soils in this area as “Low Activity Clay” (LAC) soils due to their low ECEC, hence they are placed in the Ultisols order. On the other hand, profiles 3 of OAS, 1 and 3 of IWAS did not show enough evidence of the argillic or kandic horizon but had moderate weathering with features of cambic B horizon, hence they were classified as Inceptisols (Soil Survey Staff, 2010).

All the Ultisols correlated with Acrisols while the Inceptisols correlated with Cambisols of the World Reference Base for Soil Resources (IUSS/INRB,2007). All the freely drained Ultisols (under Udic moisture regime), pedons 1, 2,5,7,8,9 (Table 4), were classified as Udults whereas Inceptisols under similar conditions were classified as Udepts (pedons 3) at the suborder category (Table 4). Similarly, Inceptisols under poor drainage conditions (seasonally flooded) were classified as Aquepts at the suborder level (pedons 4 and 6, Table 4).

Furthermore, all the Udults, pedons 1 and 2 (OAS), 5 (IWAS) and 7,8, and 9 (NCS) (Table 4), were placed in the Paleudult great group because of the minimal decrease in clay content with increasing depth in addition to the absence of a densic or lithic contact within 150cm depth (Soil Survey Staff, 2010). One of the Paleudults (Pedon 9 from NCS; Table 4), with a loamy argillic horizon (Table 3, profile 3), qualified as Typic Paleudult at the subgroup category. The remaining four Paleudults, two each, from the OAS and NCS, respectively, all qualified as Arenic Paleudults at the subgroup category (Table 4), because they have sandy textures extending from the mineral soil surface to the top of an argillic horizon (Tables 1 and 3) (Soil Survey Staff, 2010).

Also, further classification of the Inceptisols placed the freely drained pedon (Udept) from OAS, in the Dystrudept pedon (Udept) from OAS, in the Dystrudept great group because of the acidic reaction in the profile. It also qualified as Typic Dystrudept at the subgroup level, being freely drained, acidic and deep profile (Soil Survey Staff, 2010). The two wet Inceptisols (Aquepts, from IWAS; Table 4) qualified as Endoaquepts at the great group category due to their fluctuating ground water level. Also, because of the relatively high chroma in some horizons, the two Endoquepts qualified as Aeric Endoaquepts at the subgroup category.

The result of this study agrees with earlier observations by Enwezor et al., (1990) and Udoh et al., (2011) that the most prevalent soils in Eastern Nigeria (including Akwa Ibom State) are the Ultisols, while other soil orders identified include Inceptisols and Entisols. But specifically, the result has shown that environmental pollution by crude oil and industrial wastes, with the attendant soil disturbances, may adversely affect the rate of soil development. As can be observed in this study (Table 4). All the three pedons in the NCS were Ultisols – highly weathered and matured with well-developed argillic (Bt) horizons. On the other hand, two of the pedons in the OAS and one in the IWAS were Ultisols, while one pedon from the OAS and two pedons from the IWAS were Inceptisols – relatively young soils with moderate weathering lacking argillic or kandic horizons (Soil Survey Staff, 2010; Udoh et al., 2013). This is as a result of the disturbances including remediation measures in these pollution sites which retarded the soil profile development.

Table 1: *Some profile characteristics of soils in the oil affected site (OAS)*

Horizon depth(cm)	Horizon design	Sand ←	Silt g/kg	Clay →	TC[1]	Org.M[2] g/kg	ECEC[3] Cmol/kg	B/Sat[4] %
Profile 1								
0 -10	Ap1	873.60	37.30	89.10	LS	23.90	8.89	87.63
10-20	Ap2	873.60	37.30	89.10	LS	13.00	4.45	88.17
20-30	BA	893.60	7.30	99.10	S	15.00	11.65	87.12
30-50	Bt	833.60	37.30	129.10	LS	17.00	10.13	75.32
50-90	C1	833.60	27.30	139.10	LS	16.00	7.21	75.03
90-200	C2	843.60	17.30	139.10	LS	12.00	15.70	93.63
Mean		709.70	27.30	114.10		16.20	10.32	84.48
Profile 2								
0 -14	Ap	943.60	25.30	31.10	S	21.90	5.36	72.01
14-15	Bt	863.60	27.30	109.10	LS	24.50	6.70	71.64
50-100	B	843.60	27.30	129.10	LS	22.70	7.69	80.49
100-164	BC	843.60	27.30	129.10	LS	29.50	7.94	83.63
164-200	C	863.60	17.30	119.10	LS	19.80	7.68	83.07
Mean		867.60	24.90	103.50		23.60	7.07	78.17
Profile 3								
0 -9	Ap1	833.60	27.30	139.10	LS	24.90	8.88	71.85
9 – 20	Ap2	823.60	27.30	149.10	LS	18.60	8.38	76.13
20-50	B	853.60	17.30	129.10	LS	27.90	10.69	71.94
50-100	BC	853.60	17.30	129.10	LS	13.40	6.45	84.50
100-200	C	833.60	27.30	139.10	LS	19.00	10.79	75.47
Mean		839.60	23.30	137.10		20.80	8.92	75.98

1: TC =textural class.
2: Org.M = organic matter.
3: ECEC = effective cation exchange capacity.
4: B/sat = base saturation.

Table 2: *Some profile characteristics of soils in the industrial wastes affected site (IWAS)*

Horizon depth(cm)	Horizon design	Sand ←	Silt g/kg	Clay →	TC'	Org.M2 g/kg	ECEC3 Cmol/kg	B/Sat4 %
Profile 1								
0 -20	Ap	923.60	27.30	49.10	S	18.00	13.50	77.78
20-35	B	870.90	44.00	85.10	LS	15.40	6.38	84.33
35-69	C1	940.90	14.00	45.10	S	15.20	10.04	91.45
69-92	C2	880.90	34.00	85.10	LS	20.90	10.07	90.07
92-143	C3	964.91	3.00	38.10	S	3.00	7.27	86.24
Mean		916.24	24.46	60.50		14.50	10.25	85.97
Profile 2								
0 -15	Ap	920.90	24.00	55.10	S	1.60	10.19	90.19
15-58	Bt1	870.90	24.00	105.10	LS	5.10	15.34	93.48
58-106	Bt2	879.10	24.00	105.10	LS	14.20	12.07	91.71
106-180	C	860.90	44.00	95.10	LS	8.30	12.35	91.10
Mean		870.00	29.00	90.10		7.30	12.49	92.17
Profile 3								
0 -33	Ap	890.90	14.00	95.10	LS	5.80	10.43	80.82
33 – 54	B1	879.10	15.30	105.10	LS	3.20	13.91	91.37
54-105	B2	869.10	34.00	105.10	LS	6.00	10.32	80.62
105-183	C	879.10	34.00	95.10	LS	13.00	16.03	81.29
Mean		879.55	24.32	100.10		7.00	12.67	85.52

1: TC =textural class.
2: Org.M = organic matter.
3: ECEC = effective cation exchange capacity.
4: B/sat = base saturation.

3.2. Differences Among Some Soil Properties Influenced by Environmental Pollution:

The result of statistical analysis to compare differences in some (23) soil properties among the three study sites – oil affected site (OAS), industrial waste affected site (IWAS) and the non-contaminated site (NCS) (control), is shown in Table 5.

Table 3: *Some profile characteristics of soils in the non-contaminated site (NCS)*

Horizon depth(cm)	Horizon design	Sand ←	Silt g/kg	Clay →	TC'	Org.M2 g/kg	ECEC3 Cmol/kg	B/Sat4 %
Profile 1								
0 -27	Ap	889.10	44.00	75.10	LS	8.0	11.56	80.10
27-67	Bt1	9.10	24.00	105.10	LS	20.5	8.42	76.25
67-107	Bt2	820.90	14.00	165.10	SL	5.4	12.04	76.74
107-152	BC	820.90	14.00	165.10	SL	7.0	9.00	66.67
152-200	C	750.90	94.00	155.10	SL	9.4	13.22	77.31
Mean		832.18	38.00	133.10		10.6	10.85	60.66
Profile 2								
0 -26	Ap	920.90	40.00	39.10	S	14.0	11.77	74.51
26-65	Bt1	820.90	44.00	135.10	LS	5.4	10.62	71.75
65-100	Bt2	820.90	44.00	135.10	LS	30.9	8.40	64.29
100-150	BC	820.90	44.00	135.10	LS	34.9	8.50	64.71
150-200	C	810.90	4.00	185.10	LS	13.0	7.04	71.59
Mean		838.9	35.20	125.90		19.64	9.27	63.37
Profile 3								
0 -30	Ap	900.90	44.00	55.10	S	23.9	15.96	81.20
30 – 50	Bt1	800.90	14.00	185.10	SL	12.0	13.02	92.32
50-85	Bt2	770.90	14.00	215.10	SCL	21.3	14.56	79.40
85-107	BC	770.90	14.00	215.10	SCL	13.0	10.36	71.04
107-200	C	770.90	14.00	215.10	SCL	10.4	10.82	72.27
Mean		802.90	20.00	177.10		16.12	12.94	79.25

1: TC =textural class.
2: Org.M = organic matter.
3: ECEC = effective cation exchange capacity.
4: B/sat = base saturation.

Table 4: *Classification of Soils in the Study Area*

Pedons	USDA Soil Taxonomy	FAO/WRB
Oil affected site (OAS)		
1	Arenic Paleudults	Haplic Acrisol
2	Arenic Paleudults	Haplic Acrisol
3	Typic Dystrudepts	Haplic Cambisol
Industrial waste affected site (IWAS)		
4	Aeric Endoaquepts	Endogleyic Cambisol
5	Arenic Paleudults	Haplic Acrisols
6	Aeric Endoaquepts	Endogleyic Cambisol
Non-contaminated site (NCS)		
7	Arenic Paleudults	Haplic Acrisol
8	Arenic Paleudults	Haplic Acrisol
9	Typic Paleudults	Haplic Acrisol

The result shows that soils of the OAS were significantly ($p<0.05$) different from IWAS soils in 12 (52.2%) of the 23 soil properties tested. Also, the OAS soils were significantly different from the NCS soils in seven (30.43%) of the 23 soil properties. Furthermore, soils of IWAS were significantly different from those of the NCS in six (26%) of the soil properties tested.

Specially, the result (Table 5) shows that mean sand content in IWAS (896.69g/kg) was significantly higher ($P<0.05$) than those of OAS (855.48g/kg) and NCS (824.66g/kg). The trend was as follows: IWAS > OAS > NCS. On the other hand, the clay content of the OAS (117.97g/kg) and NCS (138 g/kg) were statistically similar but both were significantly higher than that of the IWAS

(77.00g/kg). The high sand content in the study area generally, could be attributed to the nature of the soil percent materials which are beach ridge sands and coastal plain sands (Petters et al., 1989; Ibia and Udo, 2009; Udoh et al., 2013).

In terms of the chemical properties, the result in Table 5, shows that oil pollution increased the soil content of total nitrogen (N), available phosphorus (P), manganese (Mn), lead (Pb) and total hydrocarbon (THC), which were significantly ($p<0.05\%$) higher in OAS than the corresponding values in the NCS soils. Also, comparing OAS with IWAS, the values of the following six soil properties, organic matter, total N, available P, Cu, Mn and Pb, were significantly higher in OAS than in IWAS. On the other hand, soils from IWAS had significantly higher values of exchangeable Ca, Na, ECEC and exchangeable acidity (EA) than soils of the OAS.

It could be observed from the above result that oil pollution had significant influence on a wider range of soil properties than industrial waste pollution, previously workers (Baker, 1976; Amadi et al., 1993; Osuji et al., 2005; Wang et al., 2010) have equally observed that oil pollution excerted adverse effects on soil properties and plant community. Both the physical and chemical properties of the soil are affected by oil pollution. Comparing soils of the OAS with those of the control (NCS) the result (Table 5) shows that oil pollution increases soil bulk density (BD) lead content (Pb), total hydrocarbon (THC), micronutrient elements (Fe, Mn, Zn, Cu) as well as organic matter (OM), nitrogen (N), phosphorous (P) and Potassium (K). On the other hand, the result (Table 5), also shows that oil pollution depressed soil pH, exchangeable Ca and Mg, effective cation exchange capacity (ECEC) exchangeable acidity (EA) and cadmium (Cd) content.

The above result is in line with the observations of several other workers in similar studies. Ekundayo et al., (1989) had observed that oil pollution leads to build up of P in soils. Also, Kayode et al., (2009) had observed that oil pollution altered the physical and chemical properties of the soil and resulted in increased bulk density, water porosity, organic matter content and reduced soil capillarity, soil aeration, water holding capacity, soil nitrogen, phosphorus and potassium among others. The increase in soil bulk density can be attributed to the destruction of soil structure which in turn can reduce root penetrations of crops and subsequently impedes nutrient up-take from the soil.

The result of this study has also indicated that environmental pollution, although generally considered to be deleterious, may have some beneficial effect by adding some micro-and macro nutrients to the soil. However, as observed by Wang et al. (2010) and Udoh and Chukwu (2014), the level of soil contamination and impact of oil residuals on soil quality greatly depends on the length of time the oil well was in production as well as on the magnitude and frequency of occurrence of pollution.

Table 5: *Comparing the mean values of soil properties between the three locations, oil affected site (OAS), industrial waste affected site (IWAS) and non-contaminated site (NCS)*

Soil Properties	OAS	IWAS	NCS	Critical	Range
Sand (g/kg)	855.48b	896.69a	824.66c	26.09	27.40
Silt (g/kg)	25.30a	25.86a	37.73a	23.39	24.57
Clay (g/kg)	117.97a	77.00b	138.70a	25.43	26.71
OC (g/kg)	19.60a	9.80b	14.90ab	5.759	6.049
TN (g/kg)	0.90a	0.40b	0.60ab	2.411	2.533
Av.P (mg/kg)	15.53a	1.33b	5.44b	5.247	5.512
pH	5.53a	5.52a	5.69a	0.259	0.272
Exch.Ca (cmol/kg)	4.15b	6.50a	5.01ab	1.534	1.611
Mg (cmol/kg)	2.07a	2.84a	2.90a	1.158	1.217
K (cmol/kg)	0.84a	0.50a	0.25a	0.623	0.654
Na (cmol/kg)	0.12a	0.80b	0.12a	0.210	0.022
ECEC (cmol/kg)	8.87b	11.32a	11.01a	1.979	2.079
B.Sat (%)	79.85b	87.50a	74.68b	5.409	5.682
EA (cmol)	1.71b	1.41b	2.67a	0.494	0.519
BD (g/cm3)	2.00a	1.91a	1.85a	0.186	0.795
HC (cm/min)	0.34a	0.10b	0.21ab	0.131	0.138
Fe (mg/kg)	41.72a	15.43a	20.37a	25.40	26.63
Zn (mg/kg)	3.30a	1.74a	1.86a	2.578	2.703
Cu (mg/kg)	9.16a	10.44a	7.61a	5.536	5.806
Mn (mg/kg)	27.05a	14.88b	14.41b	6.306	6.613
Cd (mg/kg)	0.18b	0.22b	0.98a	0.535	0.5614
Pb (mg/kg)	1.35a	0.59b	0.67b	0.316	0.3312
THC (mg/kg)	146.67a	117.78b	97.78c	67.44	70.72

BD= bulk density, HC = saturated hydraulic conducivity, OC=organic carbon, TN=total nitrogen, Av.P= available phosphorus, Exch.Ca = exchangeable calcium, Exch. Mg=exchangeable magnesium, Exch. Na=exchangeable sodium, Exch. K= exchangeable potassium, ECEC = effective cation exchange capacity, Bsat=base saturation, Fe=iron, Zn=zinc, Cu=copper, Mn=manganese, Cd=cadmium, Pb=lead, THC = total hydrocarbon; a,b,c, = means with the same letter in the same row are not significantly different

4. Conclusion:

The result of this study has shown that environmental pollution by oil spillage and industrial wastes has significant effects on the land/soil quality and characteristics. Soil formation and development, as well as the physical, chemical and biological characteristics of the soils, were seriously altered. Total hydrocarbon content of soils and lead (Pb) were increased. This may have serious implications on the agricultural productivity of the land, and consequently on food security.

Nevertheless, the study also revealed that environmental pollution both by oil and industrial wastes may add some essential plant nutrient elements to the soil and bring about an improvement in the land/soil quality and characteristics. For instance, this study showed that, compared with the control (NCS), oil polluted soils had higher organic carbon (OC), total nitrogen (N), available phosphorus (P), exchangeable potassium (K), base saturation (BS), micronutrients (Fe, Zn, Cu, Mn) and lower exchangeable acidity (EA). Similarly, industrial wastes polluted soils had higher exchangeable calcium (Ca) and K, BS, effective cation exchange capacity (ECEC) and lower EA.

Therefore, a better understanding of the immediate and long term effects of pollution on the environment in areas prone to these activities is imperative. This will facilitate the development of appropriate remediation and land management practices that would ameliorate the harmful and hazardous effects, including the danger of soil nutrient imbalances and toxicity usually associated with this pollution. If properly managed, polluted land may not only be reclaimed for agricultural and other land uses, but with time, there may be marked improvement in the land/soil qualities and characteristics because of the essential nutrients and positive influences imparted to the soil during the pollution.

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References:

1. Ajiboye, G. A., & Ogunwale, J. A. (2010). Characteristics and classification of soils developed over talc at Ejiba, Kogi State, Nigeria. Nigerian Journal of Soil Science, 20(1), 1-14.
2. Amadi, A., Dickson, A. A., & Maate, G. O. (1993). Remediation of oil polluted soils: 1. Effect of organic and inorganic nutrient supplements on the performance of maize (Zea may L). Water, Air, and Soil Pollution, 66(1-2), 59-76.
3. Andrade, M. L., Covelo, E. F., Vega, F. A., & Marcet, P. (2004). Effect of the oil spill on salt marsh soils on the Coast of Galicia (Northwestern Spain). Journal of Environmental Quality, 33(6), 2103-2110.
4. Baker, J. M. (1976). Marine ecology and oil pollution.
5. Chukwu, E. D. (2014). Characterization and Classification of Soils Affected by Oil Exploration and Industrial Activities in Southern Akwa Ibom State, Nigeria. M. Sc. Dissertation. Department of Soil Science and Land Resources Management, University of Uyo, Nigeria, p. 128.
6. Dambo, W. B. (2000). Ecotoxicology of Heavy Metals and Petroleum Related Compounds on the Mangrove Oyster (Crassostrea gasar) from the Lower Bonny Estuary, Nigeria.
7. Doran, J. W., Sarrantonio, M., & Liebig, M. A. (1996). Soil health and sustainability. Advances in agronomy (USA).
8. Ekundayo, J. A., Aisueni, N., & Benka-Coker, M. O. (1989). The Effects of drilling fluids in some waste and burrow pits in western operational areas of Shell Petroleum Development Company of Nigeria Limited, on the soil and water quality of the areas. Environmental Consultancy Service Group, Consultancy Services Unit, University of Benin, Benin City, Nigeria.
9. Enwezor, W. O., Ohiri, O. C., Opuwaribu, E. E., & Udo, E. J. (1990). A Review of Fertilizer Use on Crops in Southeastern Zones of Nigeria (in Five Vols.) (FFDD Eds). Boboma Publ., Ibadan, 47-70.
10. Enwezor, W. O., Udo, E. J., & Sobulo, R. A. (1981). Fertility status and productivity of the acid sands. Acid sands of Southeastern Nigeria. Soil Science Society of Nigeria Special Monograph, Lagos, Nigeria, 56-76.
11. Gee, G. W., & Or, D. (2002). 2.4 Particle-size analysis. Methods of soil analysis. Part, 4, 255-293.
12. Grossman, R. B., & Reinsch, T. G. (2002). 2.1 Bulk density and linear extensibility. Methods of Soil Analysis: Part 4 Physical Methods, (methodsofsoilan4), 201-228.
13. Ibia, T. O., & Udo, E. J. (2009). Guide to fertilizer use for crops in Akwa Ibom state, Nigeria. Uyo, Ministry of Agriculture and Natural Resources.
14. FAO, I. (2006). Working Group WRB (2007). The World reference base for soil resources.
15. Jacson, M. L. (1965). Soil chemical analysis. Constable, Ltd. Co., London, 498.
16. Kang, B. T., & Juo, A. S. R. (1980). Management of low activity clay soils in tropical Africa for food crop production. Tropical Root Crops: Research Strategies for the 1980s. Ottawa, Ontario, IDRC, 129-133.
17. Kayode, J., Oyedeji, A. A., & Olowoyo, O. (2009). Evaluation of the effects of pollution with spent lubricating oil on the physical and chemical properties of soil. Pac J Sci Technol, 10(1), 387-390.

18. Klute, A. (1986). Water retention: laboratory methods. Methods of Soil Analysis: Part 1—Physical and Mineralogical Methods, (methodsofsoilan1), 635-662.
19. Lal, R. (1998). Soil quality and agricultural sustainability. CRC Press.
20. Oldeman, L. R. (1994). The global extent of soil degradation.
21. Osuji, L. C., & Nwoye, I. (2007). An appraisal of the impact of petroleum hydrocarbons on soil fertility: the Owaza experience. African journal of agricultural research, 2(7), 318-324.
22. Osuji, L. C., Egbuson, E. J., & Ojinnaka, C. M. (2005). Chemical reclamation of crude-oil-inundated soils from Niger Delta, Nigeria. Chemistry and Ecology, 21(1), 1-10.
23. Petters, S. W., Usoro, E. J., Udo, E. J., Obot, U. W., & Okpon, S. N. (1989). Akwa Ibom State: physical background, soils and land use and ecological problems. Govt. Print Office. Uyo 603p.
24. Soil Survey Staff. (2003). Keys to soil taxonomy. Department of Agriculture: Natural Resources Conservation Service.
25. Udo, E. J., Ibia, T. O., Ogunwale, J. A., Ano, A. O., & Esu, I. E. (2009). Manual of soil, plant and water analysis. Sibon Book Limited, Lagos. pp, 82-92.
26. Udo, E. J., Usen, A. M. and Asuquo, J. E. (2001). Assessment of Environmental Problems of Ikot Abasi Local Government Area. Pan Scientific Laboratories, Uyo, Nigeria, 60p.
27. Udoh, B. T. and Chukwu, E. D. (2014). Post-Impact assessment of oil pollution on some soil characteristics in Ikot Abasi, Niger Delta Region, Nigeria. Journal of Biology, Agriculture, and Healthcare, 4 (24): 111-119.
28. Udoh, B. T., Esu, I. E., Ibia, T. O., Onweremadu, E. U., & Unyienyin, S. E. (2013). The agricultural potential of the beach ridge soils of the Niger Delta, Nigeria. Malaysian Journal of Soil Science, 17, 17-37.
29. Udoh, B.T., Ogunkunle, A.O. and Sambo (2011) Occurrence and distribution of major soil types as influenced by topography in a humid tropical climate of Akwa-Ibom State, Nigeria. Journal of Agricultural Research and Policies, 6, 105-111.
30. Wang, X., Feng, J., & Zhao, J. (2010). Effects of crude oil residuals on soil chemical properties in oil sites, Momoge Wetland, China. Environmental monitoring and assessment, 161(1-4), 271-280.
31. Worgu, C. A. (2000). Heavy Metal Concentration in Some Seafood Commonly Consumed in Selected Parts of River State. Journal of Applied Chemistry and Agricultural Research, 2, 44-47.

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Influence of Cropping Systems on the Characteristics and Fertility of Beach Soils in The Niger Delta Area of Akwa Ibom State, Nigeria

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Abstract: The influence of cropping systems on the characteristics and fertility of soils derived from beach sands was investigated. The study site was the Cross-River Basin farm, Onna Local Government, in the Niger Delta area of Akwa Ibom State, Nigeria. Two cropping systems- sole cropping (SC) and mixed cropping (MC) and fallow plot [FP] as control, were examined. Pineapple (Ananas commosus) plot and water melon (Citrullus lanatus) plot, represented SC. Plantain/cassava (Musa spp/Manihot esculenta) plot and water leaf/scent leaf (Talinum triangulare L./Ocimum grattissimum) plot represented MC. Representative soil samples were collected at 0-15 and 15-30 cm depths from each plot for laboratory analysis. The result showed that irrespective of cropping system or soil depth, total nitrogen [N] and exchangeable potassium (K) were low – (values below critical levels: < 0.15% and < 0.20 cmol/kg, respectively). Available phosphorus (P) was medium 8 – 20 mg/kg) at both depths in the pineapple plot, and high (> 20mg/kg) at both depths in all others cropping systems. Organic matter (OM) was low (< 2%) in the plantain/cassava MC, and medium (2 – 3%) in other cropping systems, at 0 – 15 cm depth, but at 15 – 30 cm, OM was medium in water melon SC and plantain/cassava MC and low in other cropping systems. Exchangeable bases (Ca, Mg, K) and P were highly variable (coefficient of variation (CV), > 35%) within each cropping system. Analysis of variance (ANOVA) test showed that, irrespective of soil depth there were significant differences ($P \geqslant 0.05$) among the cropping systems in 11 (79%) of the 14 soil characteristics tested. In view of the deficiencies and variations in soil fertility, regular soil testing for proper fertilizer recommendations is essential to ensure balanced soil nutrient application. Also, well planned crop combinations and rotation programmes will ensure optimum and sustainable land productivity, improved ecological balance and environmental quality.

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1. Introduction:

Soil is the natural capital asset upon which agricultural system is based. Therefore, land and soil degradation affects food shortage, food insecurity or underdevelopment and livelihood for poor farmers and the entire citizens of any continent (Yahaya et al., 2014; Ogunkunle, 2015). Agricultural activities largely influence soil properties since these operations affect the soil environment in terms of physical, chemical and biological properties, fertility, organic matter content and nutrient cycle.

Amidst food production, the main concern of agriculture is to ensure sustainability of crop yield, minimum environmental degradation and profitability of the poor farmers within the minimum use of input. Therefore, one of the challenges facing agriculture is the need to develop viable minimum degradation cropping systems for sustainable crop production (Bello, 2008). Already, there is a widespread decline in the yields of most crops because poverty and the need to produce more food, the change in land use and farming practices have resulted in soil organic matter depletion, nutrient mining and soil degradation (Van Keulen and Breman, 1990; De Jager et al., 1998).

These observations, over time, have led to the development of farming systems that are productive and profitable, conserve natural resources base (the soil), protect the environment and enhance health and safety in the long run.

Cropping system is defined as the pattern and spatial arrangement of crops on a piece of land (Bello, 2008). Many important crops in Nigeria and other parts of Africa are grown under different cropping systems. Inter cropping, the practice of growing two or more crops simultaneously in the same field is common throughout the tropics. It is practiced in 80% of the cultivated area in West Africa.

A sustainable cropping system ensures biophysical sustainability by restoring and protecting life support system through reducing contamination of air, water and soil by reducing or eliminating the use of biocides and fertilizer. Cropping patterns enhance biotic diversity. This occurs by introduction of new spices into the agro-ecosystem and must employ mixed cropping pattern for diversification of the ecosystems.

There is no single cropping system which can be used for sustainability of the tropical environment, but the best approach is the diversification of both traditional and modern cropping systems such as, sole cropping, relay cropping, multiple cropping, inter cropping, etc. The multistorey homestead gardens where more than three annual crops and regrettable species are mixes – planted with the crops are common in the humid forest regions (Juo and Manu, 1996).

The Cross-River Basin Development Authority (CRBDA) farms in Akwa Ibom State practice a range of these cropping systems, particularly under the use of supplementary irrigation, which encourages continuous crop production on the farms all – round the year. The soil serves as a medium for plant growth by supplying plants with growth factors, controlling the development and distribution of roots, and movement of nutrients, water and air to root surfaces for absorption.

Different crops exhibit various root distribution and growth habit, thus under varying cropping systems the network of root distribution differs (Millar & Turk, 2002). Therefore, the crop combinations employed in cropping system practice directly influence the soil nutrient management and consequently crops yields and farmers' income. Furthermore, land use and soil management practices influence the soil nutrients and related soil processes, such as erosion, oxidation, mineralization and leaching, etc. (Celik, 2005; Xiao-Li et al., 2010).

The scarcity of information on cropping systems and land management as they affect soil properties and fertility in the CRBDA farm necessitated the setting up of this research study. Therefore, the aim of this study was to examine some cropping systems and determine their influence on the characteristics and fertility of soils derived from the beach sands parent material in the CRBDA farm, Onna, Akwa Ibom State Nigeria. This is with a view to generating relevant information to facilitate the development of improved and adaptable technology to ensure optimum crop yield and sustainable land productivity and environmental quality.

2. Materials and Methods:

2.1. Study Area:

The study was conducted in the cross-river basin development authority (CRBDA) farm, Onna Local Government Area (LGA), Akwa Ibom State Nigeria. The area is located between latitudes 4035 and 4043'N and longitudes 7050' and 7055' E. It is bounded by the following L.G.A: on the west, by Mkpat Enin; east by Eket; south, by Ibeno; north, by Etinan; and south- west by Eastern Obolo. It is situated near large offshore oil and gas drilling operations. The farm covers a total land area of about 360 hectares.

The climate characteristics of the area are typical of a humid tropical environment, having mean annual rainfall of 2900-3100 mm; temperature range of 27-320C and relative humidity between 75 and 85% (Ekanem, 2010; Itina et al., 2013). Soils are derived from the beach ridge sands (BRS) parent material and highly influenced by the Qua Iboe River in the east, and the Atlantic Ocean in the south. Thus, the area has characteristic features of a coastal environment such as mangrove and swamp lands.

2.2. Field Work:

Two cropping systems – mixed cropping (MC) and sole cropping (SC) were used for the study. The MC system was represented by plantain/cassava (Musa spp/Manihot esculenta) intercrop and waterleaf/scent leaf (Talinum triangulare L/ Ocimum grattissimum) intercrop plots. Similarly, the SC system was represented by pineapple (Ananas commosus) plot and water melon (Citrullus lanatus) plot. Fallow plot (FP) was used as control. From each of the plots, soil samples were randomly collected from two depths: 0-15 cm and 15- 30 cm. Each depth was represented by three bulked samples per plot. Core samples were also collected. All the samples were subjected to relevant laboratory analysis and determinations.

2.3. Laboratory Analysis:

Some physical and chemical analyses performed on the soil samples included the following: particle size distribution, saturated hydraulic conductivity and bulk density. Particle size was determined by hydrometer method (Gee and Or, 2002) while hydraulic conductivity and bulk density were determined as described by Klute (1982) and Grossman and Rein sch (2002), respectively. Soil pH was read by pH meter at a soil: water ratio of 1: 2.5; available P (phosphorus) was by Bray P-1 extractant

(Udo et al., 2009). Exchangeable acidity was extracted with IN KCl and titrated against 0.05M NaOH. Organic carbon was determined by Walkley and Black wet digestion method (Page, 1982). Total nitrogen (N) was estimated from organic carbon. Exchangeable bases (Mg, Ca, Na and K) were extracted with neutral ammonium acetate (at pH 7), K+ and Na+ contents were read with the aid of flame photometer, while Ca2+ and Mg2+ were determined by EDTA complexiometric titration method (Jacson, 1965). Effective cation exchange capacity (ECEC) was by summation of exchangeable acidity and exchangeable bases (Soil Survey Staff, 2010), while base saturation was calculated as the percentage of ECEC occupied by Ca, Mg, Na and K.

2.4. Statistical Analysis:

Statistical analyses carried out included descriptive statistics and analysis of variance (ANOVA) to assess the impact of cropping systems on soil properties (SAS Institute, 1996), as well as t-test analysis to determine the influence of depth on soil properties.

3. Results and Discussion:

3.1. Soil Fertility Status (Rating) in the Study Area:

The rating of soil fertility status under the different cropping systems used for the study, is shown in Table 1. The soil fertility status was assessed based on the criteria by the Fertilizer Procurement and Distribution Division (Enwezor et al., 1989)

The result (Table 1), shows that, irrespective of the cropping system or soil depth, all the soils in the farm were rated low (below critical level) in two of the major plant nutrients, namely, N and K. values for N ranged between 0.03 and 0.07%, while those of K ranged between 0.03 and 0.15 cmol/kg. On the other hand, P was rated high (21.33-62.71 mg/kg) under four of the cropping system and fallow plot (control), and medium (10.33-15.53 mg/kg) under pineapple (SC). Previous works have had similar results. Udo et al. (2007) and Ibia and Udo (2009), have observed that soils derived from the beach sands are generally low in N and K and medium to high in P nutrients.

Organic matter (OM) content (at 0-15 cm depth) was rated medium (2.02-2.46%) under all the cropping systems except plantain/ cassava (MC) which was low (1.64%) At 15-30 cm depth, water melon (SC) and plantain/ cassava (MC) were rated medium (2.59-2.96%) in OM content. Other cropping systems and the fallow (control) plot, were rated low (1.41-1.84%). The relatively low values may be attributed to intensive cultivation (all- year-round farming) which the soil is subjected to, which accelerates OM mineralization and rapid losses from the soil.

Table 1: *Rating of Soil Fertility Status Under Different Cropping Systems in the Study Area.*

Cropping System	N (%)	Rating*	P (mg/kg)	Rating*	K (cmol/kg)	Rating*	OM (%)	Rating*
				0 – 15 cm Depth				
Sole cropping (SC)								
Pineapple	0.05	Low	15.53	Medium	0.06	Low	2.02	Medium
Water melon	0.06	Low	33.14	High	0.11	Low	2.46	Medium
Mixed cropping (MC)								
Plantain/ Cassava	0.04	Low	39.77	High	0.08	Low	1.64	Low
Waterleaf/scent leaf	0.05	Low	61.32	High	0.15	Low	2.09	Medium
Control								
Fallow plot (FP)	0.05	Low	30.88	High	0.06	Low	2.36	Medium
				15-30cm Depth				
Sole cropping (SC)								
Pineapple	0.03	Low	10.33	Medium	0.07	Low	1.41	Low
Water melon	0.06	Low	21.43	High	0.09	Low	2.59	Medium
Mixed cropping (MC)								
Plantain/cassava	0.07	Low	21.33	High	0.05	Low	2.96	Medium
Waterleaf/scent	0.04	Low	62.71	High	0.12	Low	1.84	Low
Control								
Fallow plot (FP)	0.04	Low	32.44	High	0.03	Low	1.63	Low

* = Fertility rating based on the criteria by Enwezor et al., (1989).
N = Total nitrogen; P = Available phosphorus.
K = Exchangeable potassium; OM = Total organic matter.
Low = The value below critical level.
Medium =The range above the critical level where the variable response to fertilization is expected.
High = The range where the response is unlikely and fertilization may not be necessary.

3.2. Some Chemical Properties of Soil and their Variation Under Different Cropping Systems:

In assessing some chemical properties and their variation in soils of the different cropping systems, mean values of the two sole crops (pineapple and water melon) and those of the two mixed crops (plantain /cassava and waterleaf/ scent leaf) were used as mono cropping and mixed cropping, respectively, while fallow (FP) was control. Table 2 shows the values of the soil characteristics and their respective coefficient of variation (CV) under the different cropping systems.

The result in Table 2 shows that the soil reaction (pH) at 0- 15 cm depth for the FP (control), was very strongly acid (4. 86) whereas for mono cropping and mixed cropping plots, it was strongly acid (5. 13 and 5.50, respectively) (FitzPatrick, 1980). The trend was similar at 15-30 cm depth although the values were relatively lower. Soils of the beach ridge sands have been described as "acid sands" and therefore acidic in reaction (Udo and Sobulo, 1981; Udoh et al., 2013). However, the relatively lower pH in the control plot compared to the cultivated (mixed- and mono- cropping) plots, seems to indicate good soil management by the farmers which tend to suppress soil acidity.

The values of electrical conductivity (EC) at 0-15 cm, were 0.047, 0.033 and 0.45 dS/m, for control, mono cropping and mixed cropping, respectively. In all the cropping systems, the values decreased at 15-30 cm depth as follows: 0.026, 0.031 and 0.039 dS/m, respectively. By the Soil Survey Staff (2012) rating, all the soils are non-saline (dS/m: 0-2), therefore, salinity does not pose any problem in the farm. The coefficient of variation (CV) test, carried out to assess the variability of the properties under the different cropping systems showed that the fp (control) plot, had the least number of highly variable soil properties, both at 0-15 and 15-30 cm, depths. The result (Table 2) showed that in the FP (control) at 0-15 cm depth, Ca and Mg were highly variable (CV > 35% (Wilding and Dress, 1983). Under mono cropping, four soil properties: Ca, Mg K and P were highly variable whereas under mixed cropping three properties: Ca, Mg, and K were highly variable. Similarly, at 15-30 cm depth: zero, five and four soil properties under control, mono cropping and mixed cropping, respectively, were highly variable.

The above result has shown that exchangeable cations (Ca, Mg and K) and available P were the highly variable (CV > 35%), of the 11 soil properties tested. The other seven properties at both depths had CV ratings between less and moderately variable (CV < 15 and 15-35 %). Furthermore, soil properties under intensive cultivation (mono-or mixed cropping) were more variable than under fallow condition. This could be the result of different tillage and management practice including the application of soil amendments and fertilizers by the farmers which have a strong influence on the more easily variable properties.

Influence of land use, cultural and management practices on the variation of soil properties had been reported by Udoh et al., (2007). Similarly, Ogunkunle and Eghaghara (1992) and Ogunkunle and Erinle (1994), observed significant changes in certain soil properties resulting from different land uses. Also, Beckett and Webster (1971) had observed soil variation as a result of contrasting crops, soils amelioration and the addition of fertilizers while Fasina (2003), also noted high level of variation in some properties imposed by management practices and activities such as bush burning, grazing and different cultivation practices.

Table 2: *Some Chemical Properties of Soils and their Variation Under Different Cropping Systems.*
X = Mean, SD= Standard deviation; CV= Coefficient of variation (*significant CV>35%)

Soil properties	Fallow Land			Mono Cropping			Mixed Cropping		
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV
0-15cm									
pH (H_20)	4.860	0.047	0.965	5.130	0.221	4.30	5.500	0.245	4.45
Nitrogen (%)	0.059	0.013	22.03	0.056	0.007	1.33	0.046	0.008	0.42
OM (%)	2.357	0.513	21.76	2.246	0.292	13.00	1.870	0.320	17.11
Ca^{2+} (cmol/kg)	7.520	3.847	51.15*	4.240	2.374	56.00*	6.160	3.585	58.19*
Mg^{2+} (cmol/kg)	2.507	1.282	51.13*	1.413	0.791	56.00*	2.053	1.195	58.20*
Na^{+}(cmol/kg)	0.088	0.004	4.54	0.086	0.014	17.20	0.098	0.012	12.24
K^{+} (cmol/kg)	0.061	0.002	3.27	0.092	0.035	38.10*	0.114	0.039	34.20*
EA (cmol/kg)	0.587	0.150	25.55	0.826	0.143	17.30	0.853	0.119	13.95
EC (ds/m)	0.047	0.002	4.25	0.033	0.006	19.60	0.045	0.012	26.66
BS (%)	85.73	2.861	3.33	85.30	4.706	5.50	92.91	2.310	2.48
Av. P (mg/kg)	30.88	0.316	1.02	24.23	8.984	37.00*	50.54	11.39	22.59
15-30cm									
pH (H_20)	4.967	0.047	0.95	5.067	0.197	3.88	5.433	0.292	5.37
Nitrogen (%)	0.040	0.004	10.00	0.050	0.021	42.00*	0.059	0.017	28.81
OM (%)	1.632	0.192	11.76	2.006	0.843	42.02*	2.396	0.676	28.21
Ca^{2+} (cmol/kg)	9.920	2.941	29.64	3.600	2.459	68.30*	6.240	2.799	44.85*
Mg^{2+} (cmol/kg)	3.306	0.980	29.64	1.200	0.819	68.20*	2.080	0.932	44.80*
Na^{+}(cmol/kg)	0.078	0.001	1.28	0.094	0.004	4.25	0.096	0.013	13.54
K^{+} (cmol/kg)	0.039	0.004	10.25	0.084	0.021	25.00	0.088	0.032	36.26*
EA (cmol/kg)	0.853	0.150	17.58	0.773	0.109	14.10	0.987	0.283	28.67*
EC (ds/m)	0.026	0.001	3.85	0.031	0.005	16.12	0.039	0.008	20.51
BS (%)	82.78	6.481	7.83	82.13	9.295	11.31	92.65	2.217	2.39
Av. P (mg/kg)	32.44	1.258	3.87	15.88	11.98	75.44*	42.02	22.05	54.17*

3.3. Soils Differences Among Cropping Systems:

The result of analysis of variance (ANOVA) to test the differences among soils under the different cropping systems, with respect to some soil physical and chemical properties is shown in Table 3. The result showed that there were significant differences ($p \geqslant 0.05$) among the five cropping systems (pineapple (SC); water melon (SC); plantain/cassava (MC); waterleaf/scent leaf (MC) and fallow (control) plot (FP), in 11(79%) of the 14 soil properties considered.

In term of coarse sand, waterleaf/scent leaf (MC) was significantly different from all other cropping systems. Also, except water melon: (SC) and waterleaf/scent leaf (MC) which were statistically similar in terms of soil clay content all other cropping systems were significantly different. In the case of soil pH, FP and water melon (SC), were similar, but were significantly different from pineapple (SC), which was similar to plantain/cassava (MC). The result (Table 3), further reveal that except waterleaf/scent leaf (MC), which was significantly different, all other cropping systems were similar with respect to electrical conductivity (EC). On the other hand, FP, pineapple (SC) and waterleaf/scent leaf (MC) were significantly different in terms of available P. whereas OM in FP, pineapple (SC) and waterleaf/scent leaf (MC) was similar, but significantly different from water melon (SC) and plantain/cassava (MC) which were also similar. Similar trends were exhibited by total N and exchangeable bases (Mg, Ca, K and Na).

Several other studies have also shown the influence of land use/ cropping system on soil properties. Yimer et al. (2007), observed a decrease in soil organic carbon and total N in crop lands as compared to forest lands. Celik (2005) and Xiao-Li et al. (2010) observed the influence of land use and soil management practices on soil nutrients and related soil processes such as erosion, oxidation, mineralization and leaching, which can modify the process of transport and re-distribution of nutrients (Selassie, & Ayanna, 2013). Also, Akamigbo, (1999) and Onweremadu, (2009) observed that changes in soil properties due to land use had a significant influence on P, K, Ca, Mg, total N, organic matter and bulk density.

However, the result (Table 3) also revealed that there was no significant difference among the five cropping systems in terms fine sand and silt fractions as well as exchangeable acidity (EA). This is a manifestation of the inherent characteristics of the beach ridge sands parent material. They describe as fluvio-marine deposit of unconsolidated sands deposited by tidal waters along the fringes of the Atlantic Ocean (Tahal Consultants, 1982; Enwezor et al., 1990). Soils formed from this parent material are described as “acid sands” (Udo and Sobulo, 1981) and are coarse textured (sandy), loose, highly leached and strongly acidic (Udo et al., 2013).

Conclusion:

The result of the study has revealed that irrespective of the cropping system or soil depth, soils of the CRBDA farm, Onna, are generally deficient in total N and exchangeable K but have high to medium values of available P. The result further showed that there were significant differences $(P \geqslant 0.05)$ among the five cropping systems –pineapple (sole cropping) water melon (sole cropping), plantain/cassava (mixed cropping), waterleaf/scent leaf (mixed cropping) and fallow (control) plot in 11 (79%) of the 14 soil properties considered.

Table 3: *Result of Analysis of Variance (ANOVA) to Test Effect of Cropping System on Soil*

Soil properties	Cropping Systems*					
	FP	**P**	**WM**	**P/C**	**W/S**	**LSD $_{(0.05)}$**
Coarse sand (%)	21.30	27.30	29.40	26.90	36.80	12.80*
Fine sand (%)	70.30	64.70	60.20	62.30	52.40	12.45
Silt (%)	6.00	6.30	6.67	6.33	6.00	0.795
Clay (%)	2.40	1.70	3.06	4.40	3.40	0.660*
pH	4.91	5.28	4.91	5.31	5.61	0.236*
EC	0.03	0.03	0.03	0.03	0.05	0.007*
Av. P (mg/kg)	31.70	12.80	27.30	30.50	62.00	9.48*
OM (%)	1.99	1.72	2.52	2.30	1.96	0.379*
TN (%)	0.04	0.04	0.06	0.05	0.04	0.009*
K (cmol/kg)	0.05	0.07	0.10	0.06	0.13	0.026*
Ca (cmol/kg)	8.72	3.04	4.80	8.32	4.08	2.971*
Mg (cmol/kg)	2.91	1.01	1.60	2.77	1.36	0.990*
Na (cmol/kg)	0.08	0.08	0.09	0.08	0.11	0.007*
EA (cmol/kg)	0.72	0.82	0.77	0.93	0.90	0.214

FP = Fallow plot; P = Pineapple sole cropping;
WM = Watermelon sole cropping;
P/C = Plantain/cassava mixed cropping;
W/S = Waterleaf/scent leaf mixed cropping.

For optimum and sustainable crop production, appropriate soil tests are indispensable in order to establish the required amount of each of the deficient essential nutrients needed. This is to avoid over - or under-application and the resultant deleterious effects of nutrient imbalances.

Furthermore, the farm should adopt well planned crop combinations and rotation programmes. This will result not only in optimum land productivity but in improved ecological balance and environmental quality. In view of the coarse/loose and fragile nature of the soils due to high sand content and organic fertilizer should be the principal means of soil nutrient replenishment under continuous cultivation.

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References:

1. Akamigbo, F. R. O. (1999). Influence of land uses on soil properties of the humid tropical agroecology of southeastern Nigeria. Niger. Agric. J, 30, 59-76.
2. Selassie, Y. G., & Ayanna, G. (2013). Effects of different land use systems on selected physico-chemical properties of soils in Northwestern Ethiopia. Journal of agricultural science, 5(4), 112.
3. Beckett, P. H. T., & Webster, R. (1971). Soil variability: a review. Soils and fertilizers, 34(1), 1-15.
4. Bello, W. B. (2008). Environmental Sustainability of Some Cropping Systems in the Humid Tropics. African Research Review, 2(3), 262-277.
5. Celik, I. (2005). Land-use effects on organic matter and physical properties of soil in a southern Mediterranean highland of Turkey. Soil and Tillage Research, 83(2), 270-277.
6. Ekanem, E. M. (2010). Climate Characteristics in Akwa Ibom State, A Geography Perspective. Dept of Geography and Regional Planning, Univ. of Uyo. Nigeria. p.98.
7. Fasina, A. S. (2003). Top soil variation of soil properties in some mapping units in a Farm in Southern Nigeria. Journal of Sustainable Agricultural Environment, 5(1), 137-146.
8. FitzPatrick, E. A. (1980). Soils. Their formation, classification, and distribution. Longman.
9. Enwezor, W. O., Ohiri, A. C., Opuwaribo, E. E., & Udo, E. J. (1990). Literature reviews on soil fertility investigations in Nigeria. Federal Ministry of Agriculture and Natural Resources, Lagos. P, 281.
10. Enwezor, W. O., Udo, E. J., Usoroh, N. J., Ayotade, K. A., Adepetu, J. A., Chude, V. O., & Udegbe, C. I. (1989). Fertilizer use and management practices for crops in Nigeria (Series No. 2). Fertilizer Procurement and Distribution Division. Federal Ministry of Agriculture. Water Resources and Rural Development, Lagos, Nigeria, 163.
11. Gee, G. W., & Or, D. (2002). 2.4 Particle-size analysis. Methods of soil analysis. Part, 4, 255-293.
12. Grossman, R. B., & Reinsch, T. G. (2002). 2.1 Bulk density and linear extensibility. Methods of Soil Analysis: Part 4 Physical Methods, (methodsofsoilan4), 201-228.
13. Millar, C. E., & Turk, L. M. (2002). Fundamentals of soil science. Daya Books.
14. Ibia, T. O., & Udo, E. J. (2009). Guide to fertilizer use for crops in Akwa Ibom state, Nigeria. Uyo, Ministry of Agriculture and Natural Resources.
15. Itina, V. I., Noutcha, A. M., & Okiwelu, S. N. (2013). Spatial and Temporal Distribution of Tabanids (Diptera: Tabanidae) in Akwa Ibom State, Nigeria. Research in Zoology, 3(2), 62-65.
16. Jacson, M. L. (1965). Soil chemical analysis. Constable, Ltd. Co., London, 498.
17. De Jager, A., Nandwa, S. M., & Okoth, P. F. (1998). Monitoring nutrient flows and economic performance in African farming systems (NUTMON): I. Concepts and methodologies. Agriculture, ecosystems & environment, 71(1), 37-48.
18. Juo, A. S., & Manu, A. (1996). Chemical dynamics in slash-and-burn agriculture. Agriculture, Ecosystems & Environment, 58(1), 49-60.

.19. Klute, A. (1986). Water retention: laboratory methods. Methods of Soil Analysis: Part 1—Physical and Mineralogical Methods, (methodsofsoilan1), 635-662.

20. Xiao-Li, L. I. U., Yuan-Qiu, H. E., Zhang, H. L., Schroder, J. K., Cheng-Liang, L. I., Jing, Z. H. O. U., & Zhang, Z. Y. (2010). The impact of land use and soil fertility on distributions of soil aggregate fractions and some nutrients. Pedosphere, 20(5), 666-673.
21. Page, A. L. (1982). Methods of soil analysis. Part 2. Chemical and microbiological properties. American Society of Agronomy, Soil Science Society of America.
22. Ogunkunle A. (2015). Soil quality maintenance by sustainable land use management: an imperative for food security. Nig. Journal of Soil Science (Special Edition) Vol. 25: 11-45.
23. Ogunkunle, A.O, and Eghaghara, O.O. (1992): influence of land use on soil properties of a forest region of southern Nigeria. Soil Use and Management Vol. 8 (3): 121-125.
24. Ogunkunle, A. O., & Erinle, W. O. (1994). Influence of tillage on the variability of some properties of an Alfisol in Southern Nigeria. Journal of Science Research, 1(1), 52-57.
25. Onweremadu, E. U. (2009). Magnesium Content of Two Soil Groups in Southeastern Nigeria in Relation to Selected Pedological Properties. American-Eurasian Journal of Sustainable Agriculture, 3(3), 481-486.
26. Soil Survey Staff (2012). Soil Survey Manual. USDA Handbook No.18 Scientific Publishers, India. JODHPUR – 342001. 437pp.
27. Soil survey staff. (2010). Keys to Soil Taxonomy. 11th edition, Washington DC,

Natural Resources Conservation Service, United States Department of Agriculture.

28. Statistical Analysis System (SAS) Institute. (1996). Systems for Information Delivery for Windows Release 6.12. Cary, N.C: SAS Institute, pp.6-17.
29. Tahal Consultants. (1982). Qua Iboe River Basin Pre-Feasibility Study Vol.1. Main Report. Cross River Basin Development Authority (CRBDA), Calabar.
30. Udo, E. J. and Sobulo, R.A. (1981). Acid Sands of Southern Nigeria (eds.) Soil Science Society of Nigeria (SSSN) Special Publication Monograph No. 1.
31. Udo, E. J., Ibia, T. O., Ogunwale, J.O., Ano, A.O. and Esu, I.E. (2009). Manual of Soil, Plant and Water Analyses. Sibon Books Ltd., Lagos. 183pp.
32. Udoh, B. T., Esu, I. E., Ibia, T. O., Onweremadu, E. U., & Unyienyin, S. E. (2013). The agricultural potential of the beach ridge soils of the Niger Delta, Nigeria. Malaysian Journal of Soil Science, 17, 17-37.
33. Udoh, B.T., Ogunkunle, A.O and Ibia, T.O. (2007). Soil – landscape relationship in a low-lying; topography in Akwa Ibom State, Nigeria. Nigeria Journal of Agriculture, Food, and Environment 4(1-4):69-76.
34. Van Keulen, H., & Breman, H. (1990). Agricultural development in the West African Sahelian region: a cure against land hunger? Agriculture, ecosystems & environment, 32(3-4), 177-197.
35. Wilding, L. P., & Drees, L. R. (1983). Spatial variability and pedology. Developments in Soil Science, 11, 83-116.
36. Yahaya, O. Y., Adamu, G. K., Bamidele, O. I., & Moshood-Oniye, T. (2014). The Impact of Cropping Systems on Fertility Status of Soil in Babanla Rural Area, Nigeria. Academic Research International, 1(5), 181-188.
37. Yimer, F., Ledin, S., & Abdelkadir, A. (2007). Changes in soil organic carbon and total nitrogen contents in three adjacent land use types in the Bale Mountains, south-eastern highlands of Ethiopia. Forest Ecology and Management, 242(2), 337-342.

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Radio Resource Management in Coexistence Scenario of LTE and Wi-Fi Over the Unlicensed Spectrums

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Abstract: The development of wireless broadband access network (WBAN) leads to enhance the insufficiency of unoccupied radio resources. This is quite expected in coming times, wireless cellular technologies and wireless local area networks (WLANs) will work together in coexistence scenario within the alike unlicensed spectrums (USs). Although, two most emerging wireless networks, i.e., Long Term Evaluation (LTE) and Wi-Fi, are available to operate in separate bands, but not to operate in the coexisting scenario, particularly in unlicensed spectrum. Here, we review the challenges that occur as a result of the simultaneous functioning of LTE and Wi-Fi within the alike USs from the angle of radio resource management (RRM). We demonstrate that Wi-Fi can strongly affect by LTE transmissions; thus, the integrated LTE and Wi-Fi requires to be cautiously examined. We introduce few feasible coexistence operations and scopes in coming time which may result in the fruitful allied deployment of LTE and Wi-Fi within the alike USs.

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1. Introduction:

To overcome from the mobile traffic offloading (MTO) issue, small cell networks (SCNs) and advancement of dynamic spectrum access (DSA) mechanism has come into light. The idea of small cells (SCs) (Ghosh & Roy, 2016b; Ghosh & Roy, 2015), as proposed for heterogeneous networks (HetNets), is developed from the point of view of the data plane. One of the objectives is to deploy a large number of SCs with smaller coverage radius but will have the ability to serve large traffic loads. The other objective is to implement ideas like self-organization and self-adaptation. These demands cause to go with 3rd Generation Partnership Project (3GPP) to standardize LTE small cells to perform within the licensed spectrum (LS) in Release 12. 3GPP also anticipates the adoption of expanded IEEE 802.11 WLANs in unlicensed bands as a corresponding way out. Dynamic spectrum access (DSA) mechanism has come into view as another method to deal with the growing need of extra capacity in wireless networks and spectrum insufficiency (Akyildiz et al., 2006).

DSA mechanism enablers like cognitive radio (CR) ideas stimulated regulatory service providers to permit license-exempt (LE) action in LS. For example, the United States (Federal Communications Commission, 2010) and Europe (ECC, 2013) published laws at a recent time on functioning of secondary users (SUs) in frequencies made available for unlicensed use at locations where the spectrum is not being used by licensed services, such as television broadcasting. This spectrum is located in the VHF and UHF bands. The alternative initiative is authorized shared access (ASA) (Matinmikko et al., 2013), where existing spectrum holders share their spectrum with SUs in underused locations while keeping defensible interference levels. In spite of SCs and DSA mechanism, spectrum requirement is so high that collaborative operation of LTE and Wi-Fi within the same LE spectrum may be anticipated (Rahman et al., 2011).

Nevertheless, present resource allocation does not incorporate any overlapped frequency band between both techniques. Latest discussions on 3GPP regarding the need for practicality studies about the deployment of LTE in USs is an intense issue (Ericsson, 2013). The goal of this review is to evaluate which expansions would be required from the point of view of LTE to satisfy regulatory demands to use those spectrums, for instance, 5.8 GHz radio band, known as ISM band, is reserved internationally for the use of radio frequency (RF) energy for industrial, scientific and medical purposes other than telecommunications.

Certain technical challenges and performance degradation issue are arising from the concurrent operation of LTE and Wi-Fi within the same USs.

This short paper demonstrates the coexistence of LTE and Wi-Fi networks within the same USs from the RRM perspective. We articulate the channel access mechanisms (CAM) for LTE and Wi-Fi, and latest results illustrating the performance of the network when both of them have been incorporated within the same USs. Thereafter we highlight coexistence mechanisms and the different challenging issue regarding the coexistence mechanism considering the adaptation of properties in both LTE and Wi-Fi and transmit power control. Ultimately, Section 6 concludes this short paper.

2. Constraints for Coexistence of LTE and Wi-Fi in Unlicensed Spectrums:

This is essential to consider few issues into the account for enabling different incompatible networks to perform in the same band. One of the vital aspects is coexistence, which involves the definition of bounding limit for using the radio resources from the point of view of time and spectrum. The shortfall of cross-technology coordination and mutual interference mitigation technique are some of the prime issues for the efficient coexistence of different incompatible technologies. Most of the broad-band access networks have interference management schemes, but all of them are launched to perform properly for the technologies of same types. All these in-built features become less effective in multi-layer network protocols, which invoke asynchronous time frames, different channel access techniques (CAT).

Nevertheless, two most useful WBAN networks, incompatible while operate within the same band and also dissimilar too, are LTE and Wi-Fi. Wi-Fi applies orthogonal frequency division multiplexing (OFDM) technique to encode a sequence of digital bits over the many carrier frequencies and also, they are grouped within subcarriers where OFDM symbols are normally transmitted. In Wi-Fi, operating mode, an access point (AP) correlates a fundamental subscriber set (FSS) of wireless stations (WSs) to a wired Ethernet network (WEN). WSs and APs use a Wi-Fi default CAT for sharing information, control, and resource management. CAT uses clear channel based assessment (CCA) named as carrier sense multiple accesses with collision avoidance (CSMA/CA).

In CCA mechanism, nodes follow the channel before data transmission. A node in CCA can collect transmit data arriving from other nodes. If a channel which has experienced a collision, due to the provision of collecting data from other nodes, waits for an amount of time before attempting to retransmit and put in the transmission to a random back off time. A random back off minimizes the probability that the same nodes will collide again, even if they are using the same back off algorithm. CCA and back off reduce the possibility of transmission collisions in Wi-Fi at the price of less channel usage. On the other side, LTE applies orthogonal frequency-division multiple access (OFDMA), which is a more than single user based OFDM. Many accesses are obtained in LTE by allotting subsets of subcarriers to each user equipment's (UEs) for a certain number of physical resource blocks, hence permitting concurrent transmissions from multiple UEs.

In contrast with Wi-Fi applying CCA, LTE has, even more, liability from the point of view of resource allocation in time domain and frequency domain. Besides, LTE does not need carrier sensing before transmission. One of the challenging issues is the LTE deployment for US bands. The initial constraint is that regulatory agencies stop the effective isotropic radiated power (EIRP) in US bands to much lower levels than normally considered in LTE macrocells. In addition, LTE should be capable of evaluating whether Wi-Fi is collaboratively operating within the same band as well as establishing a coexistence mechanism with it. Hence LTE femtocells come into view as a normal deployment model for LTE mechanism in the US.

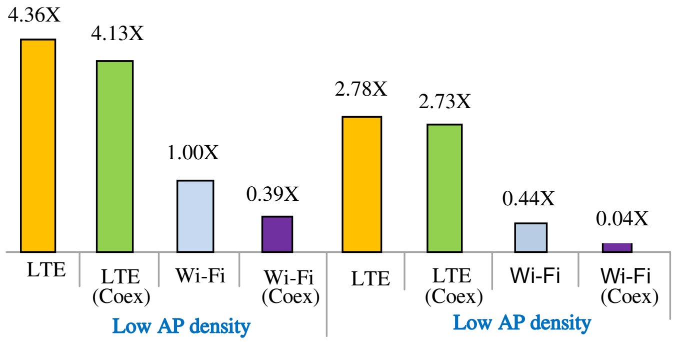

Figure 1(a)

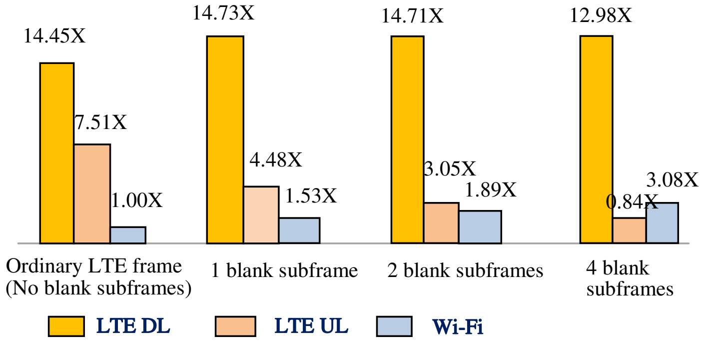

Figure 1(b)

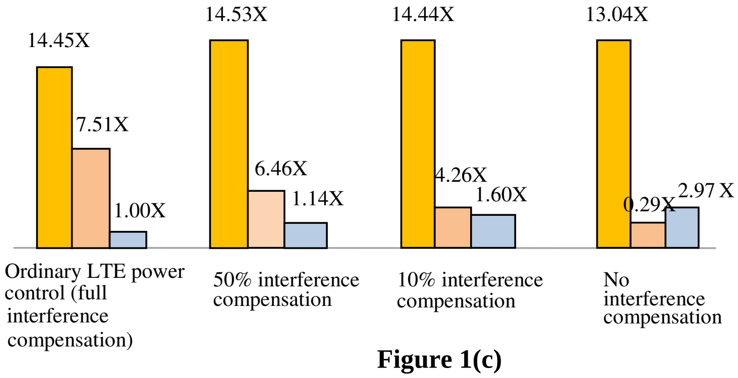

Figure 1(c)

Figure 1. LTE and Wi-Fi average user throughput relative to Wi-Fi low AP density for the indoor scenario. Deployments: low AP density (4 APs per technology) and high AP density (10 APs per technology) with an average STA density of 2.5 per AP for both cases. LTE and Wi-Fi evaluations: isolated (LTE, Wi-Fi) and in coexistence (LTE (Coex) and Wi-Fi (Coex)) (Fig 1a); blank sub frames allocation (Fig 1b); LTE UL power control with an interference-aware operating point (Fig 1c).

3. Channel Selection (CS):

Two main dissimilarities between Wi-Fi and LTE are CS and network deployment. Initially, Wi-Fi was launched to be worked in USs with uncoordinated deployments, whereas LTE was developed to be worked in LSs with coordinated deployments. When both LTE and Wi-Fi operate within the same spectrums, massive degradation due to LTE transmission can be noticed in Wi-Fi performance, as explained earlier. Hence, CS supposes to be a substantial enabler for LTE and Wi-Fi integrated networks. The unplanned deployments of Wi-Fi and the constraints of non-overlapping channels in the ISM bands have encouraged many studies on CS for Wi-Fi networks, which might be exploited with LTE.

In the least, congested channel search (LCCS), the access point (AP) scans those channels that are its own and also search for arriving packets from other APs and chooses the minimum crowded one. The flexibility in subcarrier channel assignment supplied by OFDM and OFDMA technologies may be employed in coexistence scenarios. In spite of static bandwidth channels (SBC), adaptive bandwidth channels (ABC) could be stated and chosen in coexistence scenarios. The best interest of Wi-Fi is to choose a minimum crowded channel to perform the operation due to the fact that Wi-Fi can be obstructed by LTE in a coexistence scenario. In such situation, minimum coordination between APs and LTE eNode Bs for CS could make the task of CS easier. It is one of the challenges as information sharing among the nodes experiencing interference that relies on a common inter technology communication framework, which is presently not available for LTE and Wi-Fi.

4. Transmit Power Control (TPC):

LTE uplink TPC is an option to the LTE blank sub frames time-sharing approach for integrated LTE/Wi-Fi network. A controlled lowering of LTE users transmits power devalues the interference, hence making Wi-Fi transmission opportunities as Wi-Fi nodes identify the existence of the channel as unoccupied. Traditional LTE uplink power control recompenses only a tiny part of the path loss (PL).

This brings down LTE cross-tier interference, especially for the users who located at the cell edges (Ghosh & Roy, 2016a), in such a manner as to achieve desired results. Although, LTE TPC based on PL is not much useful for Wi-Fi coexistence. Wi-Fi coexistence needs scaling down of the transmit power for UEs resulting in large interference to Wi-Fi nodes. An LTE UL TPC with an interference-conscious power functioning point is introduced in (Chaves et al., 2013) for authorizing to exist together with Wi-Fi.

UEs determining large interference is greater chance to cause large interference, so UL transmits power is decreased based on a small amount compensation of the determined interference. LTE power control in UL transmission stipulates UE transmit powers, result in path loss and interference are compensated, and a target signal to interference plus noise ratio (SINR) is obtained maintaining signal quality at the receiver. This tiny amount of compensation of the computed interference corresponds to reduce the target SINR when large interference is noticed. Therefore, LTE UE throughput is reduced correspondingly. As noticed in Fig.1, the reduction of key LTE UEs' transmits power permits co-existing Wi-Fi transmissions at the price of less LTE throughput.

Simulated throughput depicts in Fig. 1 exactly demonstrates that LTE blank sub frames and UL TPC states of different possible trade-off features for coexistence scenario of LTE and Wi-Fi. In Fig. 1b, the concurrent Wi-Fi throughput grow and LTE throughput lessen the number of blank sub frames assigned, whereas in Fig. 1c the decrease in the fraction of interference compensated by LTE UL TPC also reduces LTE throughput to increase Wi-Fi throughput.

5. Standardization

Research unveils that quite a few issues require being dealt with for the operation of LTE and Wi-Fi within the same USs. Regulating bodies (i.e., 3GPP and IEEE) are undertaking few of these challenges. From the point of view of LTE, 3GPP has presently begun discussion on operation in USs. A review model was formed for stating changes require to LTE radio for deployment in USs (Ericsson, 2013). On the other side, with Wi-Fi normally working in USs, IEEE has operated on standardized mechanisms for permitting well organized coexistence among heterogeneous WBAN within TV White Spaces spectrums. One prime instance of IEEE drives to work in TV White Spaces spectrums is the IEEE 802.19 Task Group (TG) (Baykas et al., 2010), where a working group known as 802.19 TG1 pointed out coexistence for IEEE 802 architectures and devices. These reviews can also be helpful for non-IEEE 802 architectures TV White Spaces spectrums. Another drive is the IEEE 802.11af standard, also referred to as White-Fi and Super Wi-Fi (Lekomtcev & Maršálek, 2012) is a wireless computer networking standard in the 802.11 family, that allows wireless local area network (WLAN) operation in TV white space spectrum in the VHF and UHF bands between 54 and 790 MHz (Feng et al., 2013). The standard was approved in February 2014 (Flores et al., 2013). Cognitive radio technology is used to transmit on unused TV channels, with the standard taking measures to limit interference for primary users, such as analog TV, digital TV, and wireless microphones.

Conclusion

The wireless communications community has been probing by means of analyses to get the way out for the purpose to deal with the growing demand of WBAN. In this context of spectrum scarcity, it has been a present context of a discussion about the subject matter of spectrum scarcity to permit emerging technologies like LTE and Wi-Fi to operate within the same USs. In this short communications, we illustrate that Wi-Fi is very badly affected by the simultaneous operation of LTE in the coexistence environment.

This demands a genuine requirement of coexistence operations for improving the performance of both technologies. The usefulness of coexistence enabling features for the integrated LTE and Wi-Fi are explored, and research motivations for further progress of inter-technology coexistence are presented. We also introduce entangled mechanisms by reutilizing the blank sub-frame application and the UL-TPC applied in LTE and present that it can remarkably revamp Wi-Fi performance for the co-existence of LTE and Wi-Fi within the same USs.

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References:

1. Akyildiz, I. F., Lee, W. Y., Vuran, M. C., & Mohanty, S. (2006). NeXt generation/dynamic spectrum access/cognitive radio wireless networks: a survey. Computer networks, 50(13), 2127-2159.
2. Baykas, T., Kasslin, M., & Shellhammer, S. (2010). EEE 802.19.1 System Design Document. IEEE 802 WG.
3. Chaves, F. S., Almeida, E. P., Vieira, R. D., Cavalcante, A. M., Abinader, F. M., Choudhury, S., & Doppler, K. (2013, September). LTE UL power control for the improvement of LTE/Wi-Fi coexistence. In Vehicular Technology Conference (VTC Fall), 2013 IEEE 78th (pp. 1-6). IEEE.
4. Electronic Communications Committee (ECC). (2013). "Technical and operational requirements for the operation of white space devices under geo-location approach".
5. Ericsson. (2013). Study on LTE Evolution for Unlicensed Spectrum Deployments, 3GPP TSG RAN Meeting 62, 3GPP TSG RAN Std. RP-131 788. http://www.3gpp.org/ftp/tsg ran/TSG RAN/TSGR 62/Docs/RP- 131788.zip
6. Federal Communications Commission. (2010). FCC 10-198, Notice of Inquiry: In the matter of promoting more efficient use of spectrum through dynamic spectrum use technologies (et docket no. 10-237).
7. Feng, X., Zhang, Q., & Li, B. (2013, June). Enabling co-channel coexistence of 802.22 and 802.11 af systems in TV white spaces. In 2013 IEEE, International Conference on Communications (ICC) (pp. 6040-6044). IEEE.
8. Flores, A. B., Guerra, R. E., Knightly, E. W., Ecclesine, P., & Pandey, S. (2013). IEEE 802.11 af: a standard for TV white space spectrum sharing. IEEE Communications Magazine, 51(10), 92-100.
9. Ghosh, J., & Roy, S. D. (2016a). Mitigating ICI at cell edges in cognitive-femtocell networks through fractional frequency reuse. International Journal of Communication Networks and Distributed Systems, 16(2), 162-175.
10. Ghosh, J., & Roy, S. D. (2016b). The Implications of Cognitive Femtocell Based

Spectrum Allocation Over Macrocell Networks. Wireless Personal Communications, 1-19.
11. Ghosh, J., & Roy, S. D. (2015). Qualitative analysis of coverage probability and energy efficiency in cognitive-femtocell networks under macrocell infrastructure. Electronics Letters, 51(17), 1378-1380.
12. Lekomtcev, D., & Maršálek, R. (2012). Comparison of 802.11 af and 802.22 standards–physical layer and cognitive functionality. Elektro Revue, 3(2), 12-18.
13. Matinmikko, M., Palola, M., Saarnisaari, H., Heikkilä, M., Prokkola, J., Kippola, T., ... & Yrjölä, S. (2013). Cognitive radio trial environment: First live authorized shared access-based spectrum-sharing demonstration. IEEE Vehicular Technology Magazine, 8(3), 30-37.
14. Rahman, M. I., Behravant, A., Koorapaty, H., Sachs, J., & Balachandran, K. (2011, May). License-exempt LTE systems for secondary spectrum usage: scenarios and first assessment. In New Frontiers in Dynamic Spectrum Access Networks (DySPAN), 2011 IEEE Symposium on (pp. 349-358). IEEE.

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