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SOIL SEED BANK DYNAMICS AND REGENERATION POTENTIALS IN A DEGRADED FOREST RESERVE

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ABSTRACT

Prolonged degradation of a forest has the tendency to reduce its potentials for regeneration, most especially when the degradation impact has dovetailed to the soil level. This study investigated soil seed bank status of Omo forest reserve in Ogun state through seedling emergence in randomly sampled soil at 0-10, 10-20 and 20-30 cm depths. One kilogramme of air-dried soil samples (approximately 1.3 L) of each depth were placed in separate plastic trays, watered and observed for seedling emergence within 20 weeks. Emerged wildlings were identified by species, counted and removed. Data were analysed using Analysis of Variance (ANOVA). The results showed that seed bank varied significantly ($p<0.05$) both in distribution and abundance across seasons and depths, with 0 to 20 cm soil depth holding up to 89% of seeds. The study showed that the soil of the enumerated Forest Reserve still supports some of the most diverse and productive plant communities despite anthropogenic activities. Therefore, stringent conservative management measures are recommended to forestall forest degradation and from eroding the soil of the Forest Reserve.

Keywords: Degradation, depth, regeneration, season, seedbank, soil

INTRODUCTION

FAO (2011) reported that between 1990 and 2005 the loss of forests was highest in the tropics. In Nigeria, the rate of deforestation appears to have accelerated in recent years at an alarming rate despite policy measures to stem it (Sambe *et al.*, 2018). Almost all estimates in the literature confirm that the Nigeria's forest estate is declining in size and perhaps quality (Sambe *et al.*, 2018). The Federal Ministry of Environment in year 2011 showed that Nigeria's total forest coverage, which was 10% at the end of the British colonial rule in 1960 had reduced drastically to about 6% by 2010. This implies that the country lost 40% of her forest cover within this period (FAO, 2011). Popoola (2016) estimated a loss of 400, 000 hectares of forest every year from continuous legal and illegal deforestation without corresponding afforestation or reforestation. This trend shows that deforestation is a major problem facing the forest ecosystem in Nigeria (Adeniyi, 2016) and hence rendered her forest estate degraded.

Deforestation and forest degradation are location-specific and are mainly as a result of anthropogenic activities resulting from the multiplicity of forest uses by different stakeholders (Sambe *et al.*, 2018). In Nigeria, forest reserved under government (the three tiers) and private individuals have declined in size from 13, 517, 000 ha in year 2000 to 11, 089, 000 ha in 2005 and declined further to 9, 041, 000 ha by 2010 based on published data by FAO (2011). The question now is, would the degraded forest naturally regenerate if anthropogenic activity is halted? The status of the forest seed bank tends to have an answer to this question. Soil seed banks are viable seeds stored in litter, duff or mineral soil that can germinate when germination requirements are met, for the purpose of

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vegetation development and management (Thompson, 1987; Bakker *et al.,* 1996).

Seed banks provide propagules that may influence plant community changes after disturbance events and management activities (van der Valk and Roger, 1989). Soil seed banks are important for vegetation management in at least four ways: (1) soil seed banks may provide on-site seed sources for species considered undesirable (for example, exotic species) for site colonization after management activities such as tree thinning (2) they may provide seed sources for early succession species and species considered desirable (for example, perennial grasses) that hasten vegetation recovery after disturbance (3) soil seed banks can provide seedlings for the establishment and maintenance of some above-ground plant populations in the absence of major disturbance (4) soil seed banks lacking desirable species may be showing indication that seeding or other treatments are necessary to meet management objectives for understorey vegetation. Hence, this study was carried out to determine the regeneration status of degraded Omo forest reserve.

MATERIALS AND METHODS

Study Area

The study area, Omo Forest Reserve ($6^0 42^1$ - $6^0 60^1$ N and $4^0 30^1$ - $4^0 48^1$ E), located in Ogun State, Nigeria, about 135 km north-east of Lagos and some 20 km from the coast lies within a tropical lowland rainforest and has the most complex and productive vegetation type in the country, estimated to support about 8, 000 species of plants (Adeyemi, 2012). The total land area covered by the reserve is 1, 325 km^2 with undulating terrain and elevation of about 300 m on some rocky hills. The eastern border is formed by Omo River which drains the reserve. Omo is administratively compartmentalised into jungles 1, 3, 4 and 6 popularly referred to as J1, J3, J4 and J6. The vegetation is mixed moist semi-evergreen rainforest. Due to selective exploitation in the past, the forest is largely matured secondary forest, with pockets of primary forests along river courses and in other areas with difficult log extraction. Average annual rainfall is over 2, 000 mm with temperatures ranging between 25^{o}C and 31^{o}C and 23^{o}C and 27^{o}C during the day and the night, respectively. Within the J1 compartment of Omo Forest Reserve is a 460-hectare forest block, to the south of the confluence of Omo and Owena Rivers. This 460 hectare block is mainly 'virgin' forest and thus declared a Biosphere Reserve by the Federal government (Adeyemi, 2012).

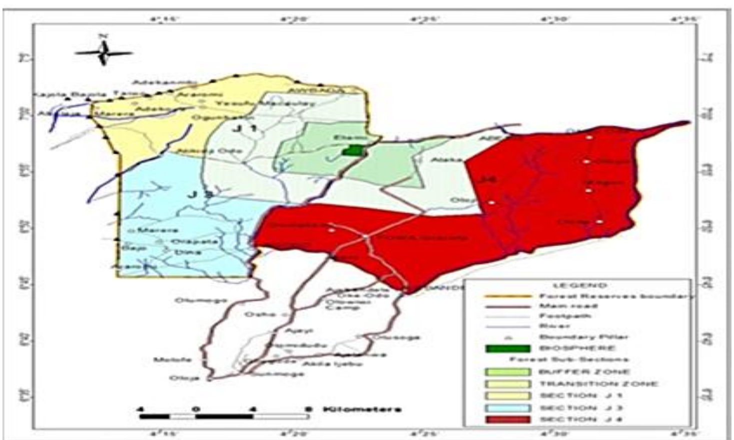

Figure 1: Map showing Omo Forest Reserve

Seed bank Estimation

Seed bank study was conducted using soil from experimental plots of size 20 m X 20 m already established for assessment of understorey species. Soil samples were collected during rainy (April – October) and dry (November – March) seasons at 3 different depths (0-10, 10-20 and 20-30 cm) using soil auger from 20 randomly chosen locations within each 20 m x 20 m plot, following an M pattern to ensure that alternate plots were catered for. A composite of the soil sampled was pooled on depth basis, thoroughly mixed, air-dried and stored in paper bags at room temperature for seed emergence estimation.

One kilogramme of dry soils (approximately 1.3 L) of each depth (0-10, 10-20 and 20-30 cm) were placed in separate plastic trays, moderately watered twice daily (morning and evening) and monitored for seedling emergence for 20 weeks (until emergence subsided). Emerged wildlings were identified by species, counted and removed. Unidentified ones were potted and allowed to grow until identification was possible. Following the initial counts, the soil was dried, stirred, re-watered and the process repeated 4 times at five week-intervals. Seed bank means were compared and separated using One-way ANOVA.

RESULTS AND DISCUSSION

The knowledge of density and composition of seeds is an important component of a successful integrated seed management programme. Seed bank estimate has the capacity to provide indicator for past, present and future problems of regeneration around plants of a given species at a location (Daniel *et al.*, 2006).

Plate 1: Cross-section of experimental trays showing seedling emergence

The seed bank of the studied site showed richness in enumerated species. A total of 1, 976 and 3, 776 seeds emerged from the soils sampled in dry and rainy seasons, respectively (Plate 1). The emerged seeds, from 86 species (9 climbers, 3 ferns, 8 grasses, 28 herbs, 20 shrubs and 18 tree species) represent 46 families (Table 1). Seeds with considerably high emergence in dry season include *Chromolaena odorata* (144), *Helianthus annuus* (113), *Tectona grandis* (107), *Hedychium coronarium* (95), *Helenium amarum* (76) and *Ageratum conyzoides* (75). Least emergence value of one (1) was obtained from seeds of the following species: *Cleistopholis patens*, *Landolphia sp.*, *Terminalia catapa*, *Bauhinia rufescens*, *Cola millenii*, *Ochna serrulata* and *Syzygium jambos*. However, the soil sampled in the rainy season showed highest seed emergence in more species namely *Striga sp.* (212), followed by *Chromolaena odorata* (194), *Salix sp* (116), *Stevia ovate* (111), *Stachytarpheta sp.* (104), *Nassella tenuissima* (99), *Ageratum conyzoides* (95), *Leucaena leucocephala* (95), *Piper aduncum* (95), *Helianthus annuus* (94), *Solanum mauritianum* (82), *Pennisetum setaceum* (78), *Ligustrum lucidum* (76), *Cyathula prostrate* (75), *Asparagus africanus* (75) and *Momordica charantia* (73), with lowest emergence in *Carica papaya* (1) and *Tabernaemontana penduliflora* (1).

This progression presented a seed bank dominated by herbaceous species, which may be a reflection of degradation of the natural flora; disappearance of forest canopies that has made herbaceous species to thrive with enhanced seed dispersal and probably more light reaching forest floor. Dominance of herbaceous species in forest soil had been reported by various workers (Oke *et al.*, 2006; Scott and Springer, 2008; Nasr, 2012; Oladoye, 2015). Penetration of more light to the forest floor is also a good reason capable of triggering dominance of herbs in the study area.

Table 1: Seed pool with depth and seasonal variations in the study area

			Dry season				Rainy season			
Species	**Family**	**Life form**	**0-10 cm**	**10-20 cm**	**20-30 cm**	**Sub-total**	**0-10 cm**	**10-20 cm**	**20-30 cm**	**Sub-total**
Acacia karroo	Fabaceae	Shrub	3	8	2	**13**	12	2	0	**14**
Acacia nilotica	Fabaceae	Tree	12	14	3	**29**	32	2	1	**35**
Adenia lobata	Passifloraceae	Shrub	23	5	0	**28**	12	26	11	**49**
Agelaea obliqua	Connaraceae	Shrub	15	7	0	**22**	12	11	2	**25**
Agelaea pilosa	Connaraceae	Climber	11	2	3	**16**	4	2	0	**6**
Ageratina adenophora	Asteraceae	Shrub	8	7	1	**16**	15	4	3	**22**
Ageratum conyzoides	Asteraceae	Herb	48	22	5	**75**	43	48	4	**95**
Albizia gummifera	Leguminosae	Tree	4	0	5	**9**	15	7	0	**22**
Albizia zygia	Leguminosae	Tree	12	2	0	**14**	9	5	2	**16**
Allamanda cathartica	Apocynaceae	Shrub	23	1	1	**25**	9	3	1	**13**
Alternanthera philoxeroides	Amaranthaceae	Herb	44	4	0	**48**	12	2	0	**14**
Ambrosia artemisiifolia	Asteraceae	Herb	32	11	7	**50**	23	8	2	**33**
Andropogon gayanus	Poaceae	Grass	22	5	11	**38**	12	14	3	**29**
Araujia hortorum	Asclepiadaceae	Herb	1	1	0	**2**	27	33	3	**63**
Aristolochia spp.	Aristolochiaceae	Climber	11	14	3	**28**	23	5	0	**28**
Asarum canadense	Aristolochiaceae	Climber	9	5	2	**16**	16	2	0	**18**

Asparagus aethiopicus	Asparagoideae	Herb	8	6	0	**14**	22	13	1	**36**
Asparagus africanus	Asparagoideae	Climber	10	11	1	**22**	48	22	5	**75**
Asparagus plumosus	Asparagoideae	Herb	21	7	1	**29**	1	2	0	**3**
Asystasia gangetica	Acanthaceae	Climber	7	1	0	**8**	22	13	1	**36**
Azadirachta indica	Meliaceae	Tree	14	2	3	**19**	31	3	1	**35**
Baisse subsessilis	Apocynaceae	Herb	8	4	1	**13**	31	3	1	**35**
Bauhinia rufescens	Leguminosae	Shrub	0	1	0	**1**	14	0	2	**16**
Bengonia sp.	Begoniaceae	Herb	1	2	0	**3**	8	4	1	**13**
Brachiaria mutica	Poaceae	grass	23	11	0	**34**	23	1	1	**25**
Carica papaya	Caricaceae	Herb	1	2	1	**4**	0	1	0	**1**
Senna siamea	Leguminosae	Tree	12	5	0	**17**	31	0	1	**32**
Chromolaena odorata	Asteraceae	Shrub	78	52	14	**144**	99	68	27	**194**
Cleistopholis patens	Annonaceae	Tree	1	0	0	**1**	1	2	0	**3**
Cola millenii	Sterculiaceae	Tree	0	0	1	**1**	11	2	3	**16**
Commelina diffusa	Commelinaceae	Herb	27	1	3	**31**	39	14	4	**57**
Cyathula prostrata	Amaranthaceae	Shrub	5	2	0	**7**	48	22	5	**75**
Equisetum sp.	Equisetaceae	Herb	26	12	2	**40**	44	4	0	**48**
Eragrostis curvula	Poaceae	Grass	39	14	4	**57**	32	11	7	**50**
Eriocereus sp.	Cactaceae	Herb	31	23	2	**56**	22	5	11	**38**
Gleditsia sp.	Fabaceae	Tree	12	26	11	**49**	11	14	3	**28**
Gmelina arborea	Verbenaceae	Tree	32	23	3	**58**	8	6	0	**14**
Hedychium coronarium	Zingiberaceae	Herb	43	48	4	**95**	10	11	1	**22**
Helenium amarum	Asteraceae	Herb	44	23	9	**76**	21	7	1	**29**
Helianthus annuus	Asteraceae	Herb	72	27	14	**113**	72	14	8	**94**
Heterotheca grandiflora	Asteraceae	Herb	24	11	2	**37**	14	2	3	**19**
Hygrophila costata	Acanthaceae	Herb	22	3	2	**27**	23	11	0	**34**

Ipomoea cairica	Convolvulaceae	Shrub	19	0	1	**20**	26	12	2	**40**
Lagarosiphon major	Hydrocharitaceae	Herb	21	1	1	**23**	12	26	11	**49**
Landolphia sp.	Apocynaceae	Shrub	1	0	0	**1**	1	1	0	**2**
Lantana camara	Verbenaceae	Shrub	18	3	1	**22**	32	23	3	**58**
Leucaena leucocephala	Verbenaceae	Tree	13	0	0	**13**	43	48	4	**95**
Ligustrum lucidum	Oleaceae	Tree	16	5	0	**21**	44	23	9	**76**
Lycium ferocissimum	Solanaceae	Shrub	1	2	0	**3**	24	11	2	**37**
Malacnta alifolia	Sapotaceae	Shrub	1	2	0	**3**	11	7	9	**27**
Melinis minutiflora	Poaceae	Grass	13	3	1	**17**	22	3	2	**27**
Mimosa pudica	Fabaceae	Herb	7	1	0	**8**	11	14	0	**25**
Momordica charanta	Cucurbitaceae	Climber	9	3	1	**13**	49	23	1	**73**
Morinda lucida	Rubiaceae	Shrub	4	4	0	**8**	22	3	2	**27**
Nassella tenuissima	Poaceae	Grass	5	2	0	**7**	51	43	5	**99**
Nephrolepis biserrata	Davalliaceae	Fern	1	1	0	**2**	23	5	0	**28**
Ochna serrulata	Ochnaceae	Shrub	1	0	0	**1**	30	23	4	**57**
Oplismenus hirtellus	Poaceae	Grass	31	3	1	**35**	24	11	5	**40**
Passiflora subpeltata	Passifloraceae	Climber	8	4	1	**13**	23	31	2	**56**
Pennisetum purpureum	Poaceae	Grass	15	4	0	**19**	26	12	11	**49**
Pennisetum setaceum	Poaceae	Grass	0	0	0	**0**	43	32	3	**78**
Pergularia sp.	Asclepiadaceae	Climber	1	0	2	**3**	1	7	0	**8**
Piper aduncum	Piperaceae	Tree	4	2	0	**6**	48	43	4	**95**
Pteris sp.	Adiantaceae	Fern	8	9	0	**17**	8	9	0	**17**
Rauvolfia vomitoria	Apocynaceae	Shrub	0	0	0	**0**	7	1	0	**8**
Salix sp.	Salicaceae	Shrub	21	1	1	**23**	63	44	9	**116**
Salvinia sp.	Verbenaceae	Fern	18	3	1	**22**	43	1	1	**45**
Sansevieria trifasciata	Asparagaceae	Herb	13	0	0	**13**	53	0	3	**56**
Schefflera actinophylla	Araliaceae	Tree	16	5	0	**21**	48	8	0	**56**

Schinus terebinthifolius	Anacardiaceae	Tree	1	2	0	**3**	13	7	1	**21**
Secamone sp	Apocynaceae	Shrub	4	2	0	**6**	5	2	0	**7**
Senecio madagascariensis	Asteraceae	Herb	13	3	1	**17**	23	1	0	**24**
Sida acuta	Malvaceae	Herb	15	4	3	**22**	12	5	0	**17**
Solanum mauritianum	Solanaceae	Shrub	1	1	0	**2**	38	32	12	**82**
Spathodea campanulata	Bignoniaceae	Tree	7	1	0	**8**	50	18	1	**69**
Stachytarpheta sp.	Verbenaceae	Herb	1	1	0	**2**	61	28	15	**104**
Stevia ovata	Asteraceae	Herb	7	1	0	**8**	66	34	11	**111**
Striga sp.	Scrophulariaceae	Herb	18	2	0	**20**	96	68	48	**212**
Syngonium podophyllum	Araceae	Herb	8	4	1	**13**	14	11	3	**28**
Syzygium jambos	Myrtaceae	Tree	1	0	0	**1**	13	18	0	**31**
Tabernaemontana penduliflora	Apocynaceae	Herb	0	0	0	**0**	1	0	0	**1**
Talinium triangulare	Talinaceae	Herb	3	2	0	**5**	43	9	5	**57**
Tectona grandis	Verbenaceae	Tree	42	44	21	**107**	26	11	0	**37**
Terminalia catapa	Combretaceae	Tree	0	0	1	**1**	0	0	0	**0**
Turbina corymbosa	Convolvulaceae	Climber	4	2	0	**6**	47	14	2	**63**
Urena lobata	Malvaceae	Shrub	22	13	1	**36**	32	23	3	**58**
TOTAL			**1,251**	**565**	**160**	**1,976**	**2,290**	**1,174**	**312**	**3,776**

Field data, 2018

Irrespective of seasonal variation, *Chromolaena odorata*, *Helianthus annuus* and *Ageratum conyzoides* (all herbs) had the highest seedling emergence as characterised by typical weeds. *Gmelina arborea*, *Tectona grandis*, *Eragrostis curvula*, *Eriocereus sp.*, *Ambrosia artemisiifolia*, *Equisetum sp.*, *Andropogon gayanus*, *Heterotheca grandiflora*, *Urena lobata*, *Ablutium sp.*, *Brachiaria mutica* and *Jatropha gossypiifolia* had average emergence values. However, emergence of the seeds of *Cleistopholis patens*, *Landolphia sp.*, *Terminalia catapa*, *Pennisetum setaceum*, *Rauvolfia vomitoria* and *Tabernaemontana penduliflora* were generally poor across seasons in the study area (Table 1). This might be attributed to dormancy which hindered early germination of the seeds of some trees/shrubs.

Using analysis of variance (Table 2) to explore the impact of depths and seasons on seed pool in the study, differences that were statistically significant ($p > 0.05$) in seedling emergence for depths 0-10 cm in the rainy season and 20-30 cm in both dry and rainy season samples were depicted, $F(2, 97) = 2.154, 1.185, 1.535$.

Table 2: Anova of seed pool means across depths

	Standard Deviation	Sum of Squares	df	Mean Square	F	Sig.
OMO DRY(0-10CM)	16.046	99.684	2	49.842	.190	.082
OMO DRY(10-20CM)	10.888	66.217	2	33.109	.275	.076
OMO DRY(20-30CM)	3.908	36.073	2	18.036	1.185*	.031
OMO WET(0-10CM)	20.900	1837.825	2	918.913	2.154*	.012
OMO WET(10-20CM)	14.585	187.873	2	93.936	.436	.065
OMO WET(20-30CM)	6.241	118.301	2	59.150	1.535*	.022

Significance at $p < 0.05$ level

The seeds in the sampled soils varied with depth as just few seeds were observed beyond the depth of 10 cm. Hausman *et al.* (2007) also observed that the top 10 cm of soil contained most seeds, highest species diversity and greatest proportion of annual to perennial plants.

Seed density of the study site decreased with depth (Table 1). In other words, soil depth was inversely related to emergence and density. Seed germination and emergence are influenced by their position in seed bank profile (Traba *et al.*, 2004). A depth-related decrease in soil seed bank density has been documented by many authors (Roberts, 1981; Rubbiet *et al.*, 1992, Li Ning *et al.*, 2007; Mohammed and Hussein, 2008; Akinyemi and Oke, 2013).

Seeds of *Chromolaena odorata*, *Striga sp.*, *Salix sp.*, *Stevia ovate*, *Ageratum conyzoides*, *Leucaena leucocephala*, *Piper aduncum*, *Gmelina arborea*, *Tectona grandis*, *Helianthus annuus*, *Solanum mauritianum*, *Pennisetum setaceum* and *Momordica charantia* showed significantly high emergence in the sampled soils, accounting for 11. 27% and 28. 59% of total seeds during dry and rainy seasons, respectively. The composition of the existing vegetation and the species density may have influenced the soil seed pool in their favour. This agrees with the findings of Brainard (2006), who observed the seeds of ten common summer a nnual species (or genera) which accounted for between 0 and 100% of all seeds identified with an average of 53%; the seeds of broadleaf weeds being dominant, accounting for 82% of all seeds counted. Scott and Springer (2008) also observed common mullein constituting 78 (closed plots) and 88 (open plots) percent of total average exotic seed density in their study. Numerous descriptions of seed bank populations have been done in studies of agricultural and natural vegetation and their results have been reviewed by Dwilette and Shafer (2011).

The observed seedling emergence in the rainy season samples was significantly higher than that of the dry season in the study area (Table 1). Abundance of water (one major factor in germination) during the rainy season could have helped in soaking the coats of the seeds and broken dormancy for increased germination (Susanto *et al.*, 2016). Also, the high soil temperature occassioned by excessive heat of the dry season could have affected the viability of the seeds thereby reducing seedling emergence in the samples obtained during the season.

The results of this study have shown that the soil of Omo Forest Reserve still maintains richness in the seeds of some of the most diverse and productive plant communities despite anthropogenic disturbance that has led to degradation of the existing vegetation cover. However, a further degradation to the enumerated reserve will not only erode the soil nutrient but diverse seed pool where the future forest restoration domiciles. Therefore, stringent conservative management measures like zero logging, slashing and grazing prevention; mass afforestation reforestation with indigenous species; withdrawal of all licenses (including felling, skidding, farming and concession licenses) except license to afforest without any further deterioration/degradation of the forest are highly recommended to forestall further degradation and soil erosion.

REFERENCES

Adeniyi, P. A. (2016). Environmental Sustainability and Conservation of Nigerian Forest Reserves. *Journal of Geography, Environment and Earth Science International*, 6(1): 1-9.

Adeyemi, A. (2012). An article on Omo Forest Reserve. http://www.cometonigeria.com/wheretogo/wildlife_parks/omo-forest-reserve.

Akinyemi, D.S. and Oke, S.O. (2013). Soil seed bank dynamics and regeneration in three different physiognomies in Shasha Forest Reserve in south-western Nigeria. *Ife Journal of Science*, 15(2) p 367-383.

Bakker, J.P., Poschlod, P., Strykstra, R.J., Bekker, R.M. and Thompson, K. (1996). Seed banks and seed dispersal: important topics in restoration ecology. *Acta Botanica Netherland*, 45:461-490.

Brainard, D. C. (2006). Estimating weed seed banks for improved monitoring and management of weeds. NY-IPM programme final report.

Daniel, J.A., Yoo, J., Bettinger, B.T., Amberg, D.C. and Burke, D.J. (2006). Eliminating gene conversion improves high-throughput genetics in *Saccharomyces cerevisiae*. *Genetics*, 172(1):709-711.

Dwilette, G. M. and Shafer, D. J. (2011). Protocol considerations for aquatic plant seed bank assessment. *Journal of Aquatic Plant Management*, 49:9-19.

F.A.O. (2011). State of the World Forest. Cooperate Document Repository, Rome, Italy.

Hausman, C. E., Fraser, L. H., Kershner, M. W. and de Szalay, F. A. (2007). Plant community establishment in a restored wetland: Effects of soil removal. *Applied Vegetation Science*, 10: 383-390.

Li N., Feng, G. and Tian, C. Y. (2007). Characteristics and dynamics of the soil seed bank at the north edge of Taklimakan Desert. *Sci China Ser D-Earth Science,* 50:122-127.

Mohammed, H. and Hussein, M. (2008). *Temporal and spatial variation in soil seed bank in Elain Natural Forest Reserve, North Kordofan, Sudan*. Conference on International Research on Food Security, Natural Resource Management and Rural Development. University of Hohenheim.

Nasr, H. G. (2012). Soil seed bank in different habitats of the eastern desert of Egypt. *Saudi Journal of Biological Sciences*, 19(2): 211-220.

Oke, S.O., Oladipo, O.T. and Ishichei, A.O. (2006). Seed bank dynamics and regeneration in a secondary lowland rainforest in Nigeria. *International Journal of Botany*, 2(4): 363-371.

Oladoye, A.O. (2015). Assessment of Floristic Composition of Forest Undergrowth of International Institute of Tropical Agriculture (IITA) Forest Reserve, Ibadan, Nigeria. *Journal of Natural Sciences Research*, 5(21):2224-3186. www.iiste.org

Popoola, L. (2016). Valuing Nigeria's Forests: Issues and Context. A paper Presented at the 14th Annual Chief S.L. Edu Memorial Lecture organised by the Nigerian Conservation Foundation, Victoria Island, Lagos, Nigeria.

Roberts, H.A. (1981). Seed banks in soils. *Advances in Applied Biology*, 6:1-5.

Rubbiet, L., Cocks, P.S. and Roberts, E.H. (1992). Seed bank dynamics in a Mediterranean grassland. *Journal of Applied Ecology*, 29: 763-771.

Sambe, L. N., Adeofun, C. O. and Dachung, G. (2018). The Economic and Ecological Effects of Deforestation on the Nigerian Environment. *Asian Journal of Advanced Research and Reports*, 1(2): 1-25.

Scott, R. A. and Springer, D. J. (2008). Estimating Soil Seed Bank Characteristics in Ponderosa Pine Forests using Vegetation and Forest-Floor Data. USDA Forest Service RMRS-RN-35.

Susanto, D., Daddy, R., Maman, S. and Rudianto, A. (2016). Flowering, fruiting, seed germination and seedling growth of Macaranga gigantean. *Biodiversitas*, 17(1): 192-199.

Thompson, K. (1987). Seeds and seed banks. *New Phytologis*, 106 (Suppl.):23-34.

Traba, J., Francisco, M. A. and Begoña, P. (2004). From what depth do seeds emerge? A soil seed bank experiment with Mediterranean grassland species. *Seed Science Research*, 14:297-303.

Van der Valk, A.G. and Roger, L. P. (1989). Seed banks and the management and restoration of natural vegetation. In: Leck, M. A., Parker, T. V. and Simpson, R. L. (eds). *Ecology of soil seed banks*. NY: Academic Press: 329-346.