UNIVERSITI PUTRA MALAYSIA

DISTRIBUTION, DEPOSITION AND SPATIAL VARIABILITY OF CARBON IN SOIL USING CARBON AND NITROGEN STABLE ISOTOPES

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By

FATHIA AHMAD M. ALASWAD

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DEDICATION

"And they ask you about the Sprit. Say: "The Spirit by command of my Lord: and you are not given aught of knowledge but a little."

(Al-Quran Alkareem, Surat Al-Israa, 85)

Every challenging work needs self-effort as well as the guidance of elders especially those who are close to our heart. Whose affection, love, encouragement and praise through day and night make me able to reach such success and honor and the reason of what I become today. I dedicate my humble effort I to my sweet and loving

Almarhom Father& Mother

Whom always have been my epitomes of strength

My Husband

Who has been very understanding and patient

My Kids, My Family, My Friends

I am really grateful to you all!

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Soil carbon (C) storage has gained much attention in the past decade due to its potentially huge impact on climate change mechanisms. However, there is still a lack of knowledge about the contribution of different C sources to soil organic carbon (SOC) formation, particularly in the subsoil. Land-use conversion to agricultural systems can affect soil C storage in terrestrial ecosystems by altering either the biotic or the abiotic processes involved in carbon cycling, such as the distribution of SOC in size at different depth of profile. The focus of this thesis was to; determine the impacts of land.-use conversion on soil carbon distribution and dynamics, as well as (2) provide an understanding of the sources of C in the investigated site.

In this study, the organic carbon (OC) contents and their $\delta^{13}C$ and $\delta^{15}N$ stable isotopes of three soil profiles (0-30, 30-60 and 60-90 cm) under different land uses in the Selangor State in Southwest Malaysia were analyzed using (i) physical fraction of soil into different particle-size, (ii) natural abundance of the $\delta\ ^{13}C$ and $\delta^{15}N$ stable isotopes and (Ⅲ) FTIR spectroscopy.

Regarding the effect of land use change on soil chemical and geo-physical properties, a two way MANOVA was used to analyses the data, with respect to spatial and depth variations, with Tukeys post-hoc tests to separate the means. Same analysis was also done for the distribution of SOC and ($\delta^{13}C$ and $\delta^{15}N$) in different particle size fractions. Furthermore, Person correlation was used to determine the relationship between SOC and chemical and geo-physical properties of soil under different land use. Finally, discriminant analysis was applied to the data to predict the model of TOC (%) and SOC contents with respect to land use and depth. The results from MANOVA showed that, the conversion of secondary forest to rubber plantation caused significant decline

of SOC on top soil (0-30cm). Conversely, converting rubber to oil palm plantation and pasture lead to net gain of SOC. Relative to the soil depth, the top soil 0-30 had greater contents of SOC than sub soil of 30-60 and 60-90 cm.

However, in relation to $\delta^{13}C$ & $\delta^{15}N$ in different land use and depth, the value of $\delta^{13}C$ was enriched by increasing the depth of profile. According of different plant species, the value of $\delta^{13}C$ at top soil in pasture site indicted that the source of carbon in this site was from pasture $\delta^{13}C$ (-19.38), by increasing the depth of profile, the source of carbon was attributed to rubber plantation as revealed by $\delta^{13}C$ (-26.67) value. Interestingly, unusual value of $\delta^{15}N$ was reported on topsoil 0-30cm, which might be a useful indicator of the source and limited level of nitrogen in the area of study. Regarding to physical fraction, the highest value of SOC, $\delta^{13}C$ and $\delta^{15}N$ were found in fine particles (clay and silt). Meanwhile, FTIR result revealed that, land use and soil texture plays the significant role for SOC composition.

This study concluded that, the relative distribution of SOC, its fractions, carbon $\delta^{13}C$ and nitrogen $\delta^{15}N$ stable isotopes and FTIR absorbance can be good indicators of the soil organic matter (SOM) quantity and quality. This study therefore recommended that, conversion of rubber to other plantation has more advantage to gain more carbon rather than conversion of secondary forest to plantation, and to quantify the effects of land-use changes and soil texture on soil organic carbon distribution, carbon stored in subsoil and chemical composition of SOM should be taken into account.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGAGIHAN, PEMENDAPAN DAN KEBOLEHUBAHAN SPATIAL KARBON DALAM TANAH PERLADANGAN UPM LADANG PENGGUNAAN ISOTOP STABIL KARBON DAN NITROGEN

Oleh

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Penyimpanan karbon (C) tanah telah mendapat banyak perhatian sejak sedekad yang lalu disebabkan oleh kesannya yang berpotensi besar terhadap mekanisme perubahan iklim. Walau bagaimanapun, masih terdapat kekurangan dari sudut ilmu pengetahuan mengenai sumbangan sumber C yang berbeza kepada pembentukan karbon organik tanah (SOC), terutamanya di lapisan bawah tanah. Penukaran penggunaan tanah kepada sistem pertanian dapat mempengaruhi penyimpanan tanah C pada ekosistem daratan dengan mengubah sama ada proses biotik atau abiotik yang terlibat di dalam kitaran karbon, seperti taburan saiz SOC pada kedalaman profil yang berbeza. Fokus kajian ini adalah untuk (1) menentukan kesan-kesan penukaran kegunaan tanah ke atas pengagihan dan dinamik karbon tanah dan (2) memberi pemahaman tentang sumber C di tapak yang dikaji. Dalam kajian ini, kandungan karbon organik (OC) serta kandungan isotop δ13C dan δ15 bagi tiga profil tanah (0-30, 30-60 dan 60-90 cm) yang berlainan di Negeri Selangor iaitu Barat Daya Malaysia dianalisis dengan menggunakan (i) pecahan fizikal tanah ke atas saiz zarah yang berbeza, (ii) kelimpahan semula jadi bagi isotop stabil δ 13C dan δ15N dan (iii) spektroskopi FTIR.

Bagi kesan perubahan penggunaan tanah ke atas sifat kimia tanah dan geofizikal, MANOVA (two way MANOVA) digunakan untuk menganalisis data yang berkaitan dengan perbezaan spasial dan kedalaman, manakala ujian post-hoc Turkey pula digunakan untuk memisahkan data min. Analisis yang sama juga dilakukan bagi taburan SOC dan (δ^{13}C dan δ^{15}N) pada saiz zarah yang berbeza. Selain itu, korelasi Pearson digunakan untuk menentukan hubungan antara SOC dan sifat kimia serta geofizikal tanah pada penggunaan tanah yang berbeza. Akhir sekali, analisis diskriminasi (discriminant analysis) telah digunakan pada data bagi meramalkan model kandungan TOC (%) dan SOC pada penggunaan tanah dan kedalaman.

Keputusan dari MANOVA menunjukkan bahawa penukaran hutan sekunder untuk perladangan getah menyebabkan penurunan SOC yang ketara pada tanah atas (0-30cm). Sebaliknya, penukaran penanaman getah ke ladang kelapa sawit dan padang rumput menyebabkan penambahan SOC. Berkenaan dengan kedalaman tanah, tanah pada lapisan atas iaitu yang berketinggian dari 0-30 cm mempunyai kandungan SOC yang lebih besar daripada tanah yang berada di ketinggian 30-60 cm dan 60-90 cm.

Walau bagaimanapun, berhubung dengan $\delta^{13}C$ & $\delta^{15}N$ dalam penggunaan dan kedalaman tanah yang berbeza, nilai $\delta^{13}C$ semakin bertambah dengan peningkatan kedalaman profil tanah. Mengikut spesies tumbuhan yang berlainan, nilai δ13C pada lapisan tanah atas di kawasan padang rumput menunjukkan bahawa sumber karbon di tapak ini adalah dari padang rumput δ13C (-19.38), dengan peningkatkan kedalaman profil, sumber karbon adalah disebabkan oleh ladang getah seperti yang dinyatakan oleh nilai δ13C (-26.67). Menariknya, nilai δ15N yang luar biasa dilaporkan pada lapisan tanah 0-30cm, yang mungkin merupakan penunjuk berguna sumber dan tahap nitrogen yang terhad dalam kawasan kajian. Mengenai pecahan fizikal, nilai tertinggi SOC, $\delta^{13}C$ dan $\delta^{15}N$ dijumpai dalam zarah halus (tanah liat dan lumpur). Sementara itu, hasil FTIR mendedahkan bahawa, penggunaan tanah dan tekstur tanah memainkan peranan penting bagi komposisi SOC.

Kajian ini menyimpulkan bahawa pengagihan relatif SOC, pecahannya, karbon $\delta^{13}C$ dan nitrogen $\delta^{15}N$ isotop stabil dan penyerapan FTIR boleh dijadikan sebagai penunjuk yang baik bagi kuantiti dan kualiti bahan organik (SOM). Oleh itu, kajian ini mencadangkan supaya penukaran getah ke ladang lain mempunyai lebih banyak kelebihan untuk mendapatkan lebih banyak karbon daripada penukaran hutan sekunder ke perladangan, juga untuk mengukur kesan perubahan penggunaan tanah dan tekstur tanah terhadap pengagihan karbon organik tanah, karbon yang disimpan dalam tanah selain perlu mengambil kira komposisi kimia SOM.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy**.** The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

BBOT	2, 5(Bis-tert-butyl-2-benzo-oxanol-2yl) thiophene.
DA	Discriminant Analysis
BD	Bulk Density
Cdp	Carbon derived from pasture
Cdr	Carbon derived from rubber
C	Carbon
$\delta^{13}C$ Vp	Carbon stable isotope values in pasture (leaves and root).
C3	C3 photosynthesis: the type of carbon assimilation performed by most plants. This is the most efficient form of photosynthesis under moderate to cool temperatures, high CO2 concentrations, and high water availability.
C4	C4photosynthesis: a form of photosynthesis that is evolutionarily derived from C3 photosynthesis, but which includes an additional mechanism for actively transporting CO_2 into specialized cells where photosynthesis occurs. This makes C4 plants particularly tolerant of high temperatures, low water availability, and/or low CO_2 concentration. C4 photosynthesis is most common among grasses, including maize, millet, and sorghum.
$\delta^{13}C$ srf	Carbon stable isotope value in soil under references area (rubber)
$\delta^{13}C$ Sc4	Carbon stable isotope value in soil under pasture
CO_2	Carbon Dioxide
$\delta^{13}C$	Natural abundance of Carbon Stable Isotope
CCr	Canonical Correlation
D	Depth
DIW	De Ionized Water
FTIR	Fourier-transform infrared
HCL	Hydrochloric Acid
LUC	Land Use Change

MRT	Mean Residence time
MAT	Mean annual temperature
MAP	Mean annual precipitation
NAP3	Third National Agriculture Policy
NaOH	Sodium Hydroxide
$\delta^{15}N$	Natural Abundance of Nitrogen stable Isotope
OM	Organic Matter
OC	Organic Carbon
OP15	15 years old oil palm plantation
OP5	5 years old oil palm plantation
P	Pasture
POM	Particulate organic matter
R	Rubber plantation
SOC	Soil Organic Carbon
SOCs	Soil Organic Carbon Stock
SF	Secondary Forest
SOM	Soil Organic Matter
TBG	Tropical Grass Biomass
V-PDB	Vienna Pee Dee Beleminte, Standard
WC	Water content

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Soils provide multiple ecosystem services, allowing sustained food and fibre production, and delivering climate regulation, flood regulation, improved air and water quality, reducing soil erosion, and provide a reservoir for biodiversity. Understanding and predicting the fate of OC in soils is a key focus for our society to understand not only the current but also the forecasted global changes. Soils are dynamic interactions of organic matter (OM), minerals, gases, water, and dissolved constituents. Recently the dynamics of SOC and the capacity of soil to accumulate and stabilize OC in response to land use change have become a focus of research in the scientific debate on global climate change.

Soil organic carbon (SOC) is the largest carbon pools on earth's surface and it plays an important role in global carbon cycling (Scharlemann et al., 2014; Xin et al., 2016). Therefore, any small change in the soil C pool can potentially affect atmosphere carbon dioxide (CO_2) concentration and regional or global C balances (Marin-Spiotta et al., 2009; Don et al., 2011; Zatta et al., 2014). Maintaining and increasing SOM) is a prominent strategy for mitigation atmospheric CO_2 and adapting agriculture to climate change (Walthall et al., 2012; Xin et al., 2016). It has long been recognized that land cover change and management can alter the amount of OC stored in the soil and decomposition rate (Laganiere et al., 2010; Deng et al., 2014; Zhang et al., 2015; Zhu et al., 2016) and this in turn affects both soil fertility and atmospheric CO_2 concentrations (Powers et al., 2011; Yonekura et al., 2012; Zhang et al., 2015), and thus potentially affects C sequestration and loss (Deng et al., 2016; Zhu et al., 2016).

Land use changes are the second largest source of human induced greenhouse gas emission, mainly due to deforestation in the tropics and sub-tropics. In the tropics land use changes are responsible for 12-20% of the human induced greenhouse gas emissions(Van der Werf et al., 2009; Don et al., 2011), and 13 million ha being deforested per year (Don et al., 2013) and greatly impacts soil C dynamics by altering C inputs, decomposition, and turnover (Yonekura et al., 2012; Zhang et al., 2013). Due to increasing the attention upon the responses of C pools in different soil particle size fractions to climate change (Nian-Peng et al., 2014; Loss et al., 2016; Sistla et al., 2016) physical fraction of SOM has provided useful information about the dynamics in nature and agricultural environments (Chen et al., 2010; Shang et al., 2014; Sistla et al., 2016), also sensitive indicators of changes in soil quality (Wei et al., 2014), structure and function of SOC (Shang et al., 2014). Therefore, analysis of these fractions can provide important insight about how soil OC responds to changes in land use (Benites et al., 2010; Loss et al., 2016). An estimated 42,000 megatons of ancient carbon is stored in 12% of the total land area of Southeast Asia alone, making this of the largest stores of terrestrial carbon on Earth (Tonks et al., 2017). The increase of agricultural land area in the tropics is ongoing mainly at the expense of primary and secondary forests (Gibbs et al., 2010; Guillaume et al., 2016). While tropical deforestation rates are tending to stabilize or to decrease in regions like Brazil, they are still increasing in Indonesia and Malaysia, driven by the international demand for cash crop plantation products such as wood, agro-biofuels (particularly oil palm) and commodity-based tree cash crop plantation (particularly rubber) (Mganga & Kuzyakov, 2014; Abood et al., 2015; van Straaten et al., 2015; Kurniawan et al., 2016).

Studies on the conversion of lowland tropical forest to rubber and oil palm plantations showed contrasting results with regard to SOC (Guillaume et al., 2015). Significant decreases of SOC under rubber and oil palm plantations were reported down to 1 m depth (Busch et al., 2015; Kotowska et al., 2015; Mande et al., 2015), or only in the topsoil (Schroth et al., 2002; Chiti et al., 2014). In contrast Patthanaissaranukool & Polprasert, (2011); Siangjaeo et al., (2011); Flynn et al., (2012); Frazão et al., (2013); Kho & Jepsen, (2015); van Noordwijk et al., (2015); Adugna & Abegaz, (2016); Burton et al., (2016) reported that, no differences or even slightly higher SOC stocks under oil palm plantations than in the surrounding forest. Those inconsistent results may depend primarily on multiple factors including previous land use change, climate and species planted (Laganiere et al., 2010; Burton et al., 2016). Particularly, species planted are expected to alter SOC stock by affecting the amount and quality of C inputs (Wei et al., 2010; Jiang et al., 2011). Detecting changes in bulk soil with complex compounds that differ in decomposition rates may, thus, be helpful to better understand soil C dynamic (Marin- Spiotta et al., 2009; Suryawanshi et al., 2018).

Land use and land cover transitions provide a unique opportunity to utilize the natural abundance of $\delta^{13}C$ and $\delta^{15}N$ isotopes to evaluate changes in C and N dynamics (Zhang et al., 2015; Deng, et al., 2016; Sun et al., 2016; Liu et al., 2017; Muhammad et al., 2017). Stable isotopes provide one of the most effective means of constraining uncertain components of the global carbon (C) cycle, such as the net carbon exchange between the terrestrial biosphere and atmospheric reservoirs, and the size and partitioning of terrestrial carbon reservoirs (Laceby et al., 2015; Qiu et al., 2015; Zhang et al., 2015; McCorkle et al., 2016), monitoring environmental change (Balesdent et al., 1993; Deng et al., 2016), explore the mechanisms of new and old soil OC changes after land use changes especially when C3 vegetation is replaced by C4 vegetation (Balesdent et al., 1993; Yonekura et al., 2012; Mendez-Millan et al., 2014; Guillaume et al., 2015; Qiu et al., 2015; Zhang et al., 2015; Deng et al., 2016), sourcing SOM in natural and agricultural landscapes (Balesdent et al., 1996; Portenga & Bierman, 2011; Laceby et al., 2015; McCorkle et al., 2016), estimate the degree of decomposition and humification of SOM (Wynn et al., 2006; Peri et al., 2012), evaluate nitrogen transformation and mineralization (Nadelhoffer & Fry, 1994; Zhang et al., 2014; Busari et al., 2016), and processes of nitrogen cycling and fixation (Ryabenko, 2013; Unkovich, 2013; Zhang et al., 2014).

However, like many studies into SOC dynamics in Asia, (Yonekura et al., 2012; Guillaume et al., 2015, Zhang et al., 2015), these investigations focused on processes within the top 30 cm of soil. Subsoil organic carbon comprises a large (70%) of SOC is located below the top 20 cm, (Batjes, 2016; Hobley et al., 2016) yet still poorly understood (Rumpel & Kögel-Knabner, 2011) component of the global carbon cycle. With increasing depth from the surface, SOM generally increases in age (Hobley et al., 2013; Hobley et al., 2016), implying enhanced stability, and its utilization as a carbon source by microorganisms (Kramer & Gleixner, 2008; Deng et al., 2014; Pérez-Pantoja, 2015) and hence more carbon dynamics at depth than at the surface. Understanding SOC dynamics and its role in the global carbon cycle therefore requires investigation of both topsoil and subsoil.

However, there is lack of investigation using the stable carbon isotope technique to explore new and old soil OC distribution in different depths relating to agricultural plantation in Malaysia, which are fundamental to our understanding the effects of land use change on the environment.

1.2 Statement of the Problem

The increase in the population and the resultant increase in the per capita consumption have resulted to the ecosystem degradation and decrease in biodiversity all over the world. As such agricultural intensification due to production of food, fuel, fibre and animal feed, has generated essential benefits for human well-being (Godfray et al., 2010). However, this comes with a multiplicity of externalities (Newbold et al., 2015). The externalities negatively affects human well-being eventually (Pullin et al., 2013; McKinnon et al., 2016), some of these they are linked to greenhouse gas emissions (Smith et al., 2008; Smith et al., 2016) , causing decrease in biodiversity (Gibson et al., 2011; Drescher et al., 2016), and various ecosystem services degradation affecting air quality, water treatment, carbon storage or soil erosion (Obidzinski et al., 2012; van Straaten et al., 2015; Drescher et al., 2016; Smith et al., 2016).

Moreover, the growing concern among scientists and research in recent times on the accumulation of atmospheric CO_2 levels combined with the efforts to mitigate climate change have resulted considerably in the growing interest on the world's soil carbon (Pachauri & Reisinger, 2007; Fang et al., 2018). As land-cover change is believed to be the second most significant source of anthropogenic greenhouse gases (GHG) emissions. This led to the generation of nearly 7–14% of the total CO_2 emissions all over the world (Harris et al., 2012).

Furthermore, studies have shown that most significant contribution to global warming from land conversion to oil palm plantation emanates right from agricultural stages, which are 15% in cultivation, 17% at clearance stage and 18% at replanting stage. Most of this recent deforestation has taken place in tropical countries (Kim et al., 2015; Lawrence & Vandecar, 2015). It has also been shown that conversion of rubber estate to oil palm plantation lead to synthetic production rubber from fossil fuel so as to meet the world rubber demand through industrial process that produces highest carbon emissions (Hansen et al., 2014). Yet, carbon emissions are less from the conversion of a rubber estate than the conversion of a tropical forest (high carbon stock land) into an oil palm estate (Castanheira et al., 2014; Hansen et al., 2014).

In Malaysia, the development of oil palm and rubber, are the primary causes of forest loss (Abdullah & Nakagoshi, 2008). The land conversion resulted in the loss of approximately 10,000 km² of forest cover (Otieno et al., 2016), also on former rubber and coconut plantations (Abdullah & Nakagoshi, 2007). This has resulted in a serious land cover challenges in Malaysia (Tao et al., 2013; Azizan et al., 2017). Also the oil palm plantation constitute about 77% of agricultural land or about 15 % of total land area (Board, 2012), the planted area increased from 5.23 million hectares in 2013 to 5.39 million hectares in 2014, an increase of 3.0 % (MPOB, 2015).

Hence, these conversions have affected soil C storage and there is still considerable uncertainty about soil CO_2 efflux and subsequently loss and accumulation rates in the tropical countries including Malaysia. Soil C pools change rapidly in response to land use change, and contributes to nearly 20% of GHG emissions Houghton et al., (2012). Soil C sequestration research has historically focused on the top 0–30 cm of the soil profile, ignoring deeper portions that might also respond to management (Syswerda et al., 2011; Meersmans et al., 2012).

However, the influence of soil depth on soil C dynamics as affected by land use changes still remain poorly understood. In particular, deep soils are a major reservoir of organic C in terrestrial ecosystems, thus are known to store more than half of the total soil C (Batej, 2016). Therefore, a small change in deep soil C can have a major effect on overall soil C dynamics (Lawrence et al., 2015; Wang et al., 2016).Consequently, a thorough understanding of how deep SOC mineralization is sensitive to fresh organic C input in relation to land use changes can be important for a better understanding of the responses of the soil C pools to global climatic changes (Perveen et al., 2014). This is because SOC mainly originates from terrestrial higher plants and the fractionation of SOC decomposition in soil is much lower than that of CO_2 fixation by plant photosynthesis (Natelhoffer & Fry, 1988; Zahang et al., 2014), the $\delta^{13}C$ of SOC is close to those of the plant from where it was derived.

Previous literature indicated proliferation of studies on the effect of land use on carbon distribution, about 45% abound from 1980- 2017. But studies relating to conversion of rubber to oil palm plantation are scarce. A United Nations Development Report indicated that carbon dioxide emissions in Malaysia has increased by 221% during the period of 1990 to 2004, and the country is included in the list of 30 biggest greenhouse gas emitters, Alam et al., (2015). Currently Malaysia ranks as the 26th largest greenhouse gas emitter in the world with a population of about 27 million, and it appears likely to move up the list quickly due to the growth rate of emissions (Alam et al., 2013).

In spite of this, knowledge of the impact of the different land conversion stages involved in the establishment of oil palm plantations, in terms of decomposition, C stocks and physic-chemical properties at subsoil is extremely limited, most previous work focused on binary comparison of intact forest and mature oil palm plantations at topsoil. In view of these, the objectives of this study were to determine the effect of soil depth and land cover on the soil physicochemical properties namely; bulk density (Bd), soil texture, pH, soil organic matter (SOM), total organic carbon (TOC), total organic nitrogen (TON) and their corresponding stable isotopes; $\delta^{13}C$ and $\delta^{15}N$ and the chemical composition of SOM.

1.3 Research Objectives

The general objective of this study is: To study the effect of land use change on the organic carbon distribution with regards to different soil depth.

Specific objectives:

1. **To** determine the effect of land use change on soil properties (Biochemical and physical properties).
2. **To** evaluate the effect of land use change on the amount and vertical distribution of C content and $\delta^{13}C$ & $\delta\ ^{15}N$ in bulk soil and in different particle size fractions of the soil at selected agricultural land use (rubber (R), pasture (P), oil palm with different age of plantations (OP), and secondary forest (SF) and at relevant different depth of a soil profile.
3. **To** investigate the impact of land use change on the structure characteristics of OM in the studies soil.
4. **To** estimate the relation between SOC and physio-chemical properties and $\delta^{13}C$ & $\delta\ ^{15}N$ of studied soil at selected sites.

1.4 Research Hypotheses

The hypothesis was put forward in this study according to the objectives of study:

H1: Impact of land use significantly changes in C storage as well as soil properties, and natural abundance of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes.

H2: There is a significant correlation among the soil characteristics, and natural abundance of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes.

H3: Soil organic carbon content, soil characteristics and natural abundance of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes significantly differ with depth increment across the land-use systems in agricultural soil, and secondary forest.

H4: Soil organic carbon content, nitrogen and natural abundance of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes significantly differ with particle size increment across the land-use systems in agricultural soil, and secondary forest.

1.5 Significant of the Study

It is a fact that conversion of rubber plantation to oil palm plantation will decrease the CO_2 emission or decrease the loss of OC storage from the soil (Allen et al., 2015). Therefore, this study will help in estimating the amount of C sequestered in the converted rubber plantation to oil palm plantation and pasture at different depth of profile and different age of plantation which is expected to be beneficial to the department of agricultural Malaysia in future planning and management of plantation.

The findings from this study will be significant to the realization of Malaysia's aspiration of reducing its GHG emissions intensity by 2020 as this study will provide an idea of different C sequestration levels at different agricultural plantation. This study is also expected to contribute to Malaysia policy thrust of increasing productivity as well as conservation and utilization of sustainable natural recourse base as outline in the Third National Agricultural Policy (NAP3).

Hence, using a precision, nontoxic, safe and fast method to measure C distribution and to remove the conflict about the emission of CO_2 from plantation is needed in soil and environmental research. This study will add data on C accumulation in sub soil. Furthermore, this study will contribute academically to the growing literature on the monitoring of the sources and the effects of land use on the accumulation of C in the soil.

1.6 Scope of the Study

Contribution of better understanding of C distribution with providing natural $\delta^{13}C$ and $\delta^{15}N$ stable isotope data in of both topsoil and subsoil during agricultural ecosystem development will increase our understanding of the effects of LUC on the environment. This study concerned about examines new and old soil OC distribution in different depth relating to agricultural plantation in Malaysia by using the natural $\delta^{13}C$ and $\delta^{15}N$ stable isotope technique.

This study was conducted in agricultural plantation of oil palm (*Elaeis guineensis*) aged five and fifteen years respectively as well as a rubber plantation (*Hevea brasiliensis*) and the pasture (*Pancium Maximum*) at the Universiti Putra Malaysia (UPM) farm, and the secondary forest one hundred years old at Puchong, Selangor (Ayer Hitam forest reserves in Puchong), as references material at various depth (0-30, 30-60 and 60-90 cm). Additionally, because SOC is more variable in space and time in oil palm plantation than other crops, the samples was collected from different distance (1.5m (weed circle, 3m (inter -rows)) and 4.5m (fruit bunches)). Natural carbon stable isotopes ($\delta^{13}C$ and $\delta^{15}N$), soil carbon stock (SOCs), total organic carbon (TOC), total organic nitrogen (TON) in bulk soil and in each physical fraction, water content, soil pH, bulk density, cation exchange capacity (CEC), chemical composition of SOM and soil texture in bulk soil were determined.

The location of this research is within the agricultural plantation at Universiti Putra Malaysia (UPM) farm, Serdang, and at secondary forest at Puchong as reference site. This study will helpfully bridge the knowledge gap in terms of soil carbon distribution data from different plantation, grass and forest and from different soil series at different vertical depth, and its impact on the land use and soil texture on carbon storage in tropical soil in the Peninsular Malaysia.

1.7 Thesis Outline

In order to meet the aims and objectives outlined in Chapter 1.3 this thesis will take the following format:

The first chapter presents a brief background of the effects of land cover conversion on the environment with focusing on the vertical distribution of carbon in agricultural systems and highlights the research problems. Additionally, describing the objectives of research, and defines the significant of study, and finally defines the boundaries of the work.

Information on the carbon cycle, effects of land use changes on carbon storage, and C stock as well as carbon and nitrogen stable isotopes have been reviewed in Second chapter.

In the third chapter, description of the study area and general material and methods have been presented and discussed.

The Fourth chapter reports the results and discussions of the effects of land use change on variability and vertical distribution of SOC within sites and at different depth of profile. The first section of the chapter presents the effects of conversion secondary forest to rubber plantation on the physio-chemical properties at different depth of profile as well as presents the effects of conversion of rubber plantation to oil palm planation with different age and pasture on the physio-chemical properties. The second section of the chapter present the effects of conversion secondary forest to rubber plantation, and then the conversion of rubber to oil palm plantation with different age and pasture on the natural abundance of carbon and nitrogen stable isotopes value at different depth of profile. The third section display the vertical distribution of SOC, SON and related natural abundance of carbon and nitrogen stable isotope in different particle size as effected by land use change. Fourth section visualizes the percentage of carbon derived from rubber and pasture at bulk soil and different particle size by using mass balance equation, the last section demonstrate the correlation between SOC and different physiochemical properties and naturel abundance of $\delta^{13}C$ and $\delta^{15}N$ stable isotopes at selected site.

The Fifth chapter provides summary and conclusions that were drawn from the research and recommendations for future study.

REFERENCES

Abdullah, S. A., & Nakagoshi, N. (2007). Forest fragmentation and its correlation to human land use change in the state of Selangor, peninsular Malaysia. *Forest ecology and Management,* 241(1), 39-48.

Abdullah, S. A., & Nakagoshi, N. (2008). Changes in agricultural landscape pattern and its spatial relationship with forestland in the State of Selangor, peninsular Malaysia. *Landscape and Urban Planning*, *87*(2), 147-155.

Abegaz, A., & Adugna, A. (2015). Effects of soil depth on the dynamics of selected soil properties among the highlands resources of Northeast Wollega, Ethiopia: are these sign of degradation?. *Solid Earth Discussions*, 7(3).

Abood, S. A., Lee, J. S. H., Burivalova, Z., Garcia‐ Ulloa, J., & Koh, L. P. (2015). Relative contributions of the logging, fiber, oil palm, and mining industries to forest loss in Indonesia. Society for conservation biology, *Conservation letters, 8*(1), 58-67.

Achten, W. M., Trabucco, A., Maes, W., Verchot, L., Aerts, R., Mathijs, E., vantomme,P., Singh, V.P.,& Muys, B. (2013). Global greenhouse gas implications of land conversion to biofuel crop cultivation in arid and semi-arid lands–Lessons learned from Jatropha. *Journal of Arid Environments, 98,* 135-145.

Acton, P., Fox, J., Campbell, E., Rowe, H., & Wilkinson, M. (2013). Carbon isotopes for estimating soil decomposition and physical mixing in well‐ drained forest soils. *Journal of Geophysical Research: Biogeosciences, 118*(4), 1532-1545.

Adachi, M., Bekku, Y. S., Rashidah, W., Okuda, T., & Koizumi, H. (2006). Differences in soil respiration between different tropical ecosystems. *Applied Soil Ecology*, *34*(2), 258-265.

Adiaha, M. S. (2017). The role of organic matter in tropical soil productivity. *World Scientific News*, 86(1), 1-66.

Adugna, A., & Abegaz, A. (2016). Effects of land use changes on the dynamics of selected soil properties in northeast Wellega, Ethiopia. *Soil, 2, (1), 2016*, 63-70.

Agresti, A. (1996). An introduction to categorical data analysis (Vol. 135): Wiley New York.

Ahmed, I. U. (2018). Forest Soil C: stock and stability under global change. http://dx.doi.org/10.5772/intechopen.74690.

Ajorlo, M., Abdullah, R., Hanif, A. H. M., Halim, R. A., & Yusoff, M. K. (2011). Impacts of livestock grazing on selected soil chemical properties in intensively managed pastures of Peninsular Malaysia. *Journal of Tropical Agricultural Science*, 34, 109-121.

Alam, A. F., Er, A., & Begum, H. (2015). Malaysian oil palm industry: prospect and problem. *Journal of Food, Agriculture & Environment*, 13(2), 143-148.

Alam, M. M., Siwar, C., Jaafar, A. H., Talib, B., & Salleh, K. B. O. (2013). Agricultural vulnerability and adaptation to climatic changes in Malaysia: Review on paddy sector.*current World Environment*, 8(1), 01-12.

Alaswad, F., Mohamat-Yusuff, F., Khairiah, J., Kusin, F. M., Ismail, R., & Asha-Ari, Z. H. (2018). Effects of depth and land cover on soil properties as indicated by carbon and nitrogen-stable isotope analysis. *Polish Journal of Environmental Studies*, 27(1), 1-10.

Alaswad, F., Mohmat-Yousff, F., Ismail, R., Kusin, F., Ashaari, Z., & Jusoh, K. (2017). Spatial Distribution of carbon and nitrogen stable isotope in soil of an oil palm plantation. *Advances in Environmental Biology*, 11(1), 16-25.

Allen, D. E., Pringle, M. J., Butler, D. W., Henry, B. K., Bishop, T. F. A., Bray, S. G & Dalal, R. C. (2016). Effects of land-use change and management on soil carbon and nitrogen in the Brigalow Belt, Australia: I. Overview and inventory. *The Rangeland Journal*, 38(5), 443-452.

Allen, K., Corre, M. D., Tjoa, A. & Veldkamp, E. (2015). Impacts of land-use conversion in Sumatra, Indonesia on soil nitrogen cycling, soil nutrient stocks and ecosystem dynamics. *Plos One* 10, e0133325.

Amelung, W., Zech, W., Zhang, X., Follett, R. F., Tiessen, H., Knox, E., & Flach, K. W. (1998). Carbon, nitrogen, and sulfur pools in particle-size fractions as influenced by climate. *Soil Science Society of America Journal*, 62(1), 172-181.

Angelo, C. L., & Pau, S. (2015). Root biomass and soil δ 13 C in C 3 and C 4 grasslands along a precipitation gradient. *Plant Ecology*, 216(4), 615-627.

Anwanane, N. B., Affinnih, K. O., & Olaniyan, J. O. (2017). Effect of slope and depth on soil chemical properties of a typical alfisol. *Poljoprivreda*, 23(2), 3-9.

Aprile, F., & Lorandi, R. (2012). Evaluation of cation exchange capacity (CEC) in tropical soils using four different analytical methods. Journal of Agricultural Science, 4(6), 278.

Arai, H., & Tokuchi, N. (2010). Factors contributing to greater soil organic carbon accumulation after afforestation in a Japanese coniferous plantation as determined by stable and radioactive isotopes. *Geoderma*, 157(3-4), 243-251.

Araujo , M. A., Zinn, Y. L., & Lal, R. (2017). Soil parent material, texture and oxide contents have little effect on soil organic carbon retention in tropical highlands. *Geoderma*, 300, 1-10.

Araujo, Q. R., Comerford, N. B., Ogram, A. V., Al-Agely, A., Santos Filho, L. P., & Santos, J. G. (2005). Soil carbon and physical property changes in Brazilian coastal tableland soils with land use following deforestation. *Agroforestry Systems*, 63(2), 193-198.

Asano, M., & Wagai, R. (2015). Distinctive organic matter pools among particle-size fractions detected by solid-state 13C-NMR, δ13C and δ15N analyses only after strong dispersion in an allophanic Andisol. *Soil Science and Plant Nutrition*, 61(2), 242-248.

Assad, E., Pinto, H., Martins, S., Groppo, J., Salgado, P., Evangelista, B., Vasconcellos, E., Sano, E.E., , Pavão, E., Luna, R., Camargo, P. B., & Martinelli, L. A. (2013). Changes in soil carbon stocks in Brazil due to land use: paired site comparisons and a regional pasture soil survey. *Biogeosciences*, 10(10), 6141-6160.

Assefa, D., Rewald, B., Sandén, H., Rosinger, C., Abiyu, A., Yitaferu, B., & Godbold, D. L. (2017). Deforestation and land use strongly effect soil organic carbon and nitrogen stock in Northwest Ethiopia. *Catena*, 153, 89-99.

Augustin, C., & Cihacek, L. J. (2016). Relationships between soil carbon and soil texture in the Northern great plains. *Soil Science*, 181(8), 386-392.

Aweto, A. (1995). Organic carbon diminution and estimates of carbon dioxide release from plantation soil. Environmentalist, 15(1), 10-15.

Awiti, A. O., Walsh, M. G., & Kinyamario, J. (2008). Dynamics of topsoil carbon and nitrogen along a tropical forest–cropland chronosequence: Evidence from stable isotope analysis and spectroscopy. *Agriculture, Ecosystems & Environment*, 127(3-4), 265-272.

Azizan, M. U., Bing, T. S., Mohd Raid, M., Mohammad, M. T. S., Hussin, K., Rahman, M. A.,& Nadzri, M. I. (2017). Conflicting role of land office and forestry department: a comparative discussion regarding to forest offences prevention in malaysia. Jurnal Ilmu Lingkungan Undip, 15(1), 11-19.

Baddeley, J., Edwards, A., & Watson, C. (2017). Changes in soil C and N stocks and C: N stoichiometry 21years after land use change on an arable mineral topsoil. *Geoderma*, 303, 19-26.

Bai, J., Zhang, G., Zhao, Q., Lu, Q., Jia, J., Cui, B., & Liu, X. (2016). Depth-distribution patterns and control of soil organic carbon in coastal salt marshes with different plant covers. *Scientific Reports*, 6, 34835.

Bakar, R. A., Darus, S. Z., Kulaseharan, S., & Jamaluddin, N. (2011). Effects of ten year application o empty fruit bunches in an oil palm plantation on soil chemical properties. *Nutrient Cycling in Agroecosystems*, 89(3), 341-349.

Baldock, J., & Nelson, P. (2000). Soil organic matter: CRC Press.

Baldock, J., & Skjemstad, J. (2000). Role of the soil matrix and minerals in protecting natural organic materials against biological attack. *Organic Geochemistry*, 31(7), 697-710.

Balesdent, J., Besnard, E., Arrouays, D., & Chenu, C. (1998). The dynamics of carbon in particle-size fractions of soil in a forest-cultivation sequence. *Plant and Soil*, 201(1), 49-57.

Balesdent, J., Chenu, C., & Balabane, M. (2000). Relationship of soil organic matter dynamics to physical protection and tillage. *Soil and Tillage Research*, 53(3), 215-230.

Balesdent, J., Girardin, C., & Mariotti, A. (1993). Site-Related^(13) C of Tree Leaves and Soil Organic Matter in a Temperate Forest. *Ecology*, 1713-1721.

Balesdent, J., Mariotti, A., Boutton, T., & Yamasaki, S. (1996). Measurement of soil organic matter turnover using 13C natural abundance. Mass spectrometry of soils., 83-111.

Banabas, M. (2007). Study of Nitrogen Loss Pathways in Oil Palm (Elaeis Guineensis Jacq.) Growing Agro-ecosystems on Volcanic Ash Soils in Papua New Guinea: A Thesis Presented in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy in Soil Science at Massey University, Palmerston North, New Zealand. (Doctoral dissertation, Massey University).

Barančíková, G., Makovníková, J., & Halas, J. (2016). Effect of land use change on soil organic carbon. *Agriculture (Polnohospodárstvo*), 62(1), 10-18.

Barré, P., Durand, H., Chenu, C., Meunier, P., Montagne, D., Castel, G., Billiou, D., LSoucémarianadin, L., & Cécillon, L. (2017). Geological control of soil organic carbon and nitrogen stocks at the landscape scale. *Geoderma*, 285, 50-56.

Barré, P., Fernandez-Ugalde, O., Virto, I., Velde, B., & Chenu, C. (2014). Impact of phyllosilicate mineralogy on organic carbon stabilization in soils: incomplete knowledge and exciting prospects. *Geoderma*, 235, 382-395.

Basile-Doelsch, I., Brun, T., Borschneck, D., Masion, A., Marol, C., & Balesdent, J. (2009). Effect of landuse on organic matter stabilized in organomineral complexes: A study combining density fractionation, mineralogy and δ13C. *Geoderma*, 151(3-4), 77-86.

Bassi, D., Mnossi, M., & Mattiello, L. (2018). Nitrogen supply influences photosynthesis establishment along the sugarcane leaf. *Scientific Reports*, 8(1), 2327.

Bate, B., Choo, H., & Burns, S. E. (2013). Dynamic properties of fine-grained soils engineered with a controlled organic phase. *Soil Dynamics and Earthquake Engineering*, 53, 176-186.

Batjes, N. H. (1996). Total carbon and nitrogen in the soils of the world. *European Journal of Soil Science*, 47(2), 151-163.

Batjes, N. H. (2016). Harmonized soil property values for broad-scale modelling (WISE30sec) with estimates of global soil carbon stocks. *Geoderma*, 269, 61-68.

Batlle-Bayer, L., Batjes, N. H., & Bindraban, P. S. (2010). Changes in organic carbon stocks upon land use conversion in the Brazilian Cerrado: a review. *Agriculture, Ecosystems & Environment*, 137(1), 47-58.

Baumert, S., Khamzina, A., & Vlek, P. L. (2016). Soil organic carbon sequestration in Jatropha curcas systems in Burkina Faso. *Land Degradation & Development*, 27(8), 1813-1819.

Behera, S. K., Suresh, K., Rao, B. N., Mathur, R. K., Shukla, A. K., Manorama, K., Ramachandrudu, K., Harinarayana, P., & Prakash, C. (2016). Spatial variability of some soil properties varies in oil palm (Elaeis guineensis Jacq.) plantations of west coastal area of India. *Solid Earth*, 7(3), 979-993.

Bejo Slameta, I. N. S. J., Hendrayantoc , Suria Darma Tarigan. (2015). Impact of land cover changes in tropical lowland rainforest transformation system to soil properties. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 22(2), 316-328.

Benites, V. D. M., Moutta, R. D. O., Coutinho, H. L. D. C., & Balieiro, F. D. C. (2010). Discriminant analysis of soils under different land uses in the atlantic rain forest area using organic matter attributes. *Revista Árvore*, 34(4), 685-690.

Bernoux, M., Cerri, C. C., Neill, C., & de Moraes, J. F. (1998). The use of stable carbon isotopes for estimating soil organic matter turnover rates. *Geoderma*, 82(1), 43-58.

Bhat, N. A., Riar, A., Ramesh, A., Iqbal, S., Sharma, M. P., Sharma, S. K., & Bhullar, G. S. (2017). Soil biological activity contributing to phosphorus availability in vertisols under long-term organic and conventional agricultural management. *Frontiers in plant science*, 8, 1523.

Bhuyan, S. I., Tripathi, O. P., & Khan, M. L. (2013). Soil nutrients status in prominent agro-ecosystems of East Siang district, Arunachal Pradesh. *International Journal of Environmental Sciences*, 3(6), 1957.

Bingham, A. H., & Cotrufo, M. F. (2016). Organic nitrogen storage in mineral soil: implications for policy and management. *Science of the Total Environment*, 551, 116-126.

Bird, C. (2014). Soils and plant nutrients. The fundamentals of horticulture: Theory and practice, 105.

Bird, M., Kracht, O., Derrien, D., & Zhou, Y. (2003). The effect of soil texture and roots on the stable carbon isotope composition of soil organic carbon. *Soil Research*, 41(1), 77-94.

Blagodatskaya, E., Yuyukina, T., Blagodatsky, S., & Kuzyakov, Y. (2011). Turnover of soil organic matter and of microbial biomass under C 3–C 4 vegetation change: Consideration of 13 C fractionation and preferential substrate utilization. *Soil Biology and Biochemistry*, 43(1), 159-166.

Blagodatsky, S., Xu, J., & Cadisch, G. (2016). Carbon balance of rubber (Hevea brasiliensis) plantations: A review of uncertainties at plot, landscape and production level. *Agriculture, Ecosystems & Environment*, 221, 8-19.

Blake, G. R. (1965). Bulk Density 1. *Methods of soil analysis. Part 1. Physical and mineralogical properties, including statistics of measurement and sampling*, (methodsofsoilana), 374-390.

Blažka, P., & Fischer, Z. (2014). Moisture, water holding, drying and wetting in forest soils. *Open Journal of Soil Science*, 4(05), 174.

Błońska, E., & Lasota, J. (2017). Soil Organic Matter Accumulation and Carbon Fractions along a Moisture Gradient of Forest Soils. *Forests*, 8(11), 448.

Board, M. P. O. (2012). Overview of the Malaysian oil palm industry 2011: Selangor: Economics & Industry Development Division.

Board, M. R. (2013). Natural rubber statistics 2015.

Boeni, M., Bayer, C., Dieckow, J., Conceição, P. C., Dick, D. P., Knicker, H., & Macedo, M. C. M. (2014). Organic matter composition in density fractions of Cerrado Ferralsols as revealed by CPMAS 13C NMR: Influence of pastureland, cropland and integrated crop-livestock. *Agriculture, Ecosystems & Environment*, 190, 80-86.

Bordonal, R. O., Lal, R., Ronquim, C. C., de Figueiredo, E. B., Carvalho, J. L. N., Maldonado, W., Pereira, D. M.,& Newton, L.S. (2017). Changes in quantity and quality of soil carbon due to the land-use conversion to sugarcane (Saccharum officinarum) plantation in southern Brazil. *Agriculture, ecosystems & environment*, 240, 54-65.

Bore, G., & Bedadi, B. (2015). Impacts of Land Use Types on Selected Soil Physico-Chemical Properties of Loma Woreda, Dawuro Zone, Southern Ethiopia. *Science, Technology and Arts Research Journal*, 4(4), 40-48.

Boutton, T. W., Archer, S. R., Midwood, A. J., Zitzer, S. F., & Bol, R. (1998). δ 13 C values of soil organic carbon and their use in documenting vegetation change in a subtropical savanna ecosystem. *Geoderma*, 82(1), 5-41.

Brady, N. C., & Weil, R. R. (1999). The nature and properties of soil 12th ed: Prentice-Hall Inc. Upper Saddle River, New Jersey.

Brahma, B., Nath, A. J., & Das, A. K. (2016). Managing rubber plantations for advancing climate change mitigation strategy., *Current Science*, 110(10), 2015-2019.

Brahma, B., Sileshi, G. W., Nath, A. J., & Das, A. K. (2017). Development and evaluation of robust tree biomass equations for rubber tree (Hevea brasiliensis) plantations in India. *Forest Ecosystems*, 4(1), 14.

Breulmann, M., Schulz, E., Weißhuhn, K., & Buscot, F. (2012). Impact of the plant community composition on labile soil organic carbon, soil microbial activity and community structure in semi-natural grassland ecosystems of different productivity. *Plant and Soil*, 352(1-2), 253-265.

Brevik, E. C., Cerdà, A., Mataix-Solera, J., Pereg, L., Quinton, J. N., Six, J., & Van Oost, K. (2015). The interdisciplinary nature of soil. *Soil*, 1(1), 117-129.

Brose, U., & Hillebrand, H. (2016). Biodiversity and ecosystem functioning in dynamic landscapes: The Royal Society. http://rstb.royalsocietypublishing.org/.pp,1-9

Brunn, M., Condron, L., Wells, A., Spielvogel, S., & Oelmann, Y. (2016). Vertical distribution of carbon and nitrogen stable isotope ratios in topsoils across a temperate rainforest dune chronosequence in New Zealand. *Biogeochemistry*, 129 (1-2)37-51.

Brunn, M., Spielvogel, S., Sauer, T., & Oelmann, Y. (2014). Temperature and precipitation effects on δ 13 C depth profiles in SOM under temperate beech forests. *Geoderma*, 235, 146-153.

Brunner, I., Børja, I., Dalsgaard, L., Deckmyn, G., Ekblad, A., Godbold, D. L., & Ostonen, I. (2013). Belowground carbon turnover in European forests: Fine roots, mycorrhizal mycelia, soil organic matter and soil models. *Institute for Biodiversity and Ecosystem Dynamics (IBED*).

Buol, S. W., Southard, R. J., Graham, R. C., & McDaniel, P. A. (2011). Soil genesis and classification, Sixth edition, John Wiley & Sons.

Burton, M. E., Poulsen, J. R., Lee, M. E., Medjibe, V. P., Stewart, C. G., Venkataraman, A., & White, L. J. (2016). Reducing carbon emissions from forest conversion for oil palm agriculture in Gabon. Conservation letters. *Society for Conversion Biology*, 10(3), 297-307.

Busari, M., Salako, F., & Tuniz, C. (2016). Stable isotope technique in the evaluation of tillage and fertilizer effects on soil carbon and nitrogen sequestration and water use efficiency. *European Journal of Agronomy*, 73, 98-106.

Busch, J., Ferretti-Gallon, K., Engelmann, J., Wright, M., Austin, K. G., Stolle, F., Turubanova, S., Potapov, P.V., Margono, B., Hansen, M. C., & Baccini, A. (2015). Reductions in emissions from deforestation from Indonesia's moratorium on new oil palm, timber, and logging concessions. *Proceedings of the National Academy of Sciences*, 112(5), 1328-1333.

Cade-Menun, B. J., Bainard, L. D., LaForge, K., Schellenberg, M., Houston, B., & Hamel, C. (2017). Long-term agricultural land use affects chemical and physical properties of soils from southwest Saskatchewan. *Canadian Journal of Soil Science*, 97(4), 650-666.

Calonego, J. C., dos Santos, C. H., Tiritan, C. S., & Júnior, J. R. C. (2012). Estoques de carbono e propriedades físicas de solos submetidos a diferentes sistemas de manejo. *Revista Caatinga*, 25(2), 128-135.

Cameron, K. C., Di, H. J., & Moir, J. L. (2013). Nitrogen losses from the soil/plant system: a review. *Annals of Applied Biology*, 162(2), 145-173.

Cardinael, R., Guenet, B., Chevallier, T., Dupraz, C., Cozzi, T., & Chenu, C. (2018). High organic inputs explain shallow and deep SOC storage in a long-term agroforestry system–combining experimental and modeling approaches. *Biogeosciences*, 15(1), 297.

Carlson, K. M. (2012). Effects of oil palm plantation development on land cover, carbon flux, and streams in Indonesian Borneo: Yale University.

Carroll, S., Goonetilleke, A., Khalil, W. A. S., & Frost, R. (2006). Assessment via discriminant analysis of soil suitability for effluent renovation using undisturbed soil columns. *Geoderma*, 131(1-2), 201-217.

Carvajal, A. F., Feijoo, A., Quintero, H., & Rondón, M. A. (2013). Soil organic carbon storage and dynamics after C3-C4and C4-C3vegetation changes in sub-Andean landscapes of Colombia. *Chilean Journal of Agricultural Research*, 73(4), 391-398.

Castanheira, É. G., Acevedo, H., & Freire, F. (2014). Greenhouse gas intensity of palm oil produced in Colombia addressing alternative land use change and fertilization scenarios. *Applied Energy*, 114, 958-967.

Catagña, C., Enrique, F., Rodríguez Llerena, M. V., Carrión, D., Armando, D., Recalde Moreno, C. G., & Santillán Lima, G. P. (2017). Analytical methods comparison for soil organic carbon determination in Andean Forest of Sangay National Park-Ecuador. *Acta Agronómica*, 66(3), 408-413.

Catoni, M., D'Amico, M. E., Zanini, E., & Bonifacio, E. (2016). Effect of pedogenic processes and formation factors on organic matter stabilization in alpine forest soils. *Geoderma*, 263, 151-160.

Ch, Y., Ahmed, O. H., Majid, N. M. A., & Jalloh, M. B. (2009). Effects of converting secondary forest on tropical peat soil to oil palm plantation on carbon storage. American Journal of *Agricultural and Biological Science*, 4(2), 123-130.

Chalk, P. M. (2016). From production to consumption: tracing C, N, and S dynamics in Brazilian agroecosystems using stable isotopes. *Pesquisa Agropecuária Brasileira*, 51(9), 1039-1050.

Chandler, R. D. (2016). Soil organic carbon distribution with depth: Implications for ecosystem services. (Doctoral dissertation, Clemson University).

Chao, W., Benjamin, Z. H., Dongwei L., Jianfeng, H., Weixin, C and Edith, B. (2017). Stable isotopic constraints on global soil organic carbon turnover. *Biogeosciences Discuss*. 1-16.

Chaplot, V., Dlamini, P., Chivenge, P., Manson, A. (2016). High density-short duration grazing to promote carbon sequestration in degraded grassland soils. *Geoderma*, 271,10-17.

Chaudhari, P. R., Ahire, D. V., Ahire, V. D., Chkravarty, M., & Maity, S. (2013). Soil bulk density as related to soil texture, organic matter content and available total nutrients of Coimbatore soil. *International Journal of Scientific and Research Publications*, 3(2), 1-8.

Chee, W. C., & Peng, C. C. (2006). Country Pasture/Forage Resource Profiles.

Chemeda, M. (2017). Assessment of soil physical and chemical properties as affected by different land use types in warandhab area of wollega zone, oromia regional state. *Journal of Advanced Studies in Agricultural, Biological and Environmental Sciences*, 4(1), 41-61.

Chemeda1, M., , Kibret, K., Fite,T. (2018). Influence of Different Land Use Types and Soil Depths on Selected Soil Properties Related to Soil Fertility in Warandhab Area, Horo Guduru Wallaga Zone, Oromiya, Ethiopia. *Int J Environ Sci Nat Res*, 4(2). 1-12.

Chen, C., Jia, Y., Chen, Y., Mehmood, I., Fang, Y., & Wang, G. (2018). Nitrogen isotopic composition of plants and soil in an arid mountainous terrain: south slope versus north slope. *Biogeosciences*, 15(1), 369-377.

Chen, F.-S., Zeng, D.-H., Fahey, T. J., & Liao, P.-F. (2010). Organic carbon in soil physical fractions under different-aged plantations of Mongolian pine in semi-arid region of Northeast China. *Applied Soil Ecology*, 44(1), 42-48.

Chen, J. S., Chung, T. L., Tian, G., & Chiu, C. Y. (2013). Characterization of soil organic matter in perhumid natural cypress forest: comparison of humification in different particle-size fractions. *Botanical Studies*, 54(1), 56.

Chen, L. F., He, Z. B., Zhu, X., Du, J., Yang, J. J., & Li, J. (2016). Impacts of afforestation on plant diversity, soil properties, and soil organic carbon storage in a semi-arid grassland of northwestern China. *Catena*, 147, 300-307.

Chen, Q., Shen, C., Sun, Y., Peng, S., Yi, W., Li, Z., & Jiang, M. (2005). Mechanism of distribution of soil organic matter with depth due to evolution of soil profiles at the Dinghushan Biosphere Reserve. *Acta Pedologica Sinica*, 42(1), 1-8.

Chen, R., Hu, J., Dittert, K., Wang, J., Zhang, J., & Lin, X. (2011). Soil total nitrogen and natural 15Nitrogen in response to long-term fertilizer management of a maize–wheat cropping system in Northern China. *Communications in Soil Science and Plant Analysis*, 42(3), 322-331.

Cheng, C. M., Wang, R.S., & Jiang, J.S. (2007). Variation of soil fertility and carbon sequestration by planting Hevea brasiliensis in Hainan Island, China. *Journal of Environmental Sciences*, 19(3), 348-352.

Chenu, C., & Plante, A. F. (2006). Clay- sized organo- mineral complexes in a cultivation chronosequence: revisiting the concept of the 'primary organo-mineral complex'. *European Journal of Soil Science*, 57(4), 596-607.

Chinade, A. A., Siwar, C., Ismail, S. M., & Isahak, A. (2015). A Review on Carbon Sequestration in Malaysian Forest Soils: Opportunities and Barriers. *International Journal of Soil Science*, 10(1), 17.

Chiti, T., Grieco, E., Perugini, L., Rey, A., & Valentini, R. (2014). Effect of the replacement of tropical forests with tree plantations on soil organic carbon levels in the Jomoro district, Ghana. *Plant and Soil*, 375(1-2), 47-59.

Choi, W.-J., Ro, H.-M., & Hobbie, E. A. (2003). Patterns of natural 15 N in soils and plants from chemically and organically fertilized uplands. *Soil Biology and Biochemistry*, 35(11), 1493-1500.

Choo, H., Bate, B., & Burns, S. E. (2015). Effects of organic matter on stiffness of overconsolidated state and anisotropy of engineered organoclays at small strain. *Engineering Geology*, 184, 19-28.

Choudhary, B. K., Majumdar, K., & Datta, B. (2016). Effects of land use on the Soil Organic Carbon storage potentiality and soil edaphic factors in Tripura, Northeast India. American Journal of Climate Change, 5(3), 417-429.

Choudhury, B., Mohapatra, K., Das, A., Das, P. T., Nongkhlaw, L., Fiyaz, R. A., Ngachan, V., Hazarika, S., Rajkhowa, D.,& Munda, G. C (2013). Spatial variability in distribution of organic carbon stocks in the soils of North East India. *Current Science(Bangalore)*, 104(5), 604-614.

Christensen, B. T. (1992). Physical fractionation of soil and organic matter in primary particle size and density separates. *In Advances in Soil Science,*1-90. Springer, New York, NY.

Christensen, B. T. (2001). Physical fractionation of soil and structural and functional complexity in organic matter turnover. *European Journal of Soil Science*, 52(3), 345-353.

Conti, G., Kowaljow, E., Baptist, F., Rumpel, C., Cuchietti, A., Harguindeguy, N. P., & Díaz, S. (2016). Altered soil carbon dynamics under different land-use regimes in subtropical seasonally-dry forests of central Argentina. *Plant and Soil*, 403(1-2), 375-387.

Cotrufo, M. F., Soong, J. L., Horton, A. J., Campbell, E. E., Haddix, M. L., Wall, D. H., & Parton, W. J. (2015). Formation of soil organic matter via biochemical and physical pathways of litter mass loss. *Nature Geoscience*, 8(10), ngeo2520, 1-6.

Craine, J. M., Brookshire, E. N. J., Cramer, M. D., Hasselquist, N. J., Koba, K., Marin-Spiotta, E., & Wang, L. (2015). Ecological interpretations of nitrogen isotope ratios of terrestrial plants and soils. *Plant and Soil*, 396(1-2), 1-26.

Cram, S., Sommer, I., Fernández, P., Galicia, L., Ríos, C., & Barois, I. (2015). Soil natural capital modification through landuse and cover change in a tropical forest landscape: implications for management. *Journal of Tropical Forest Science*, 189-201.

Curtin, D., Beare, H., Fraser, P., Gillespie, R., & Harrison-Kirk, T. (2010, August). Soil organic matter loss following land use change from long-term pasture to arable cropping: Pool size changes and effects on some biological and chemical functions. In 19th World Congress of Soil Science, Soil Solutions for a Changing World (pp. 1-6).

da Silva, Y. J. A. B., do Nascimento, C. W. A., Biondi, C. M., van Straaten, P., de Souza, V. S., & Ferreira, T. O. (2016). Weathering rates and carbon storage along a climosequence of soils developed from contrasting granites in northeast Brazil. *Geoderma*, 284, 1-12.

Dalal, R. C., Thornton, C. M., & Cowie, B. A. (2013). Turnover of organic carbon and nitrogen in soil assessed from δ 13 C and δ 15 N changes under pasture and cropping practices and estimates of greenhouse gas emissions. *Science of the Total Environment*, 465, 26-35.

Datta, A., Basak, N., Chaudhari, S., & Sharma, D. (2015). Soil properties and organic carbon distribution under different land uses in reclaimed sodic soils of North-West India. *Geoderma Regional*, 4, 134-146.

Davidson, E. A., de Carvalho, C. J. R., Figueira, A. M., Ishida, F. Y., Ometto, J. P. H., Nardoto, G. B., Saba, R. T., Hayashi, S.N., Leal, E. C., Vieira, I. C. G., & martinelli, L. A. (2007). Recuperation of nitrogen cycling in Amazonian forests following agricultural abandonment. *Nature*, 447(7147), 995-998.

Davis, M. (1994). Topsoil properties under tussock grassland and adjoining pine forest in Otago, New Zealand. New Zealand Journal of Agricultural Research, 37(4), 465-469.

de Blécourt, M., Brumme, R., Xu, J., Corre, M. D., & Veldkamp, E. (2013). Soil carbon stocks decrease following conversion of secondary forests to rubber (Hevea brasiliensis) plantations. *Plos One*, 8(7), e69357.

de Blécourt, M., Hänsel, V. M., Brumme, R., Corre, M. D., & Veldkamp, E. (2014). Soil redistribution by terracing alleviates soil organic carbon losses caused by forest conversion to rubber plantation. *Forest Ecology and Management*, 313, 26-33.

De Clercq, T., Heiling, M., Dercon, G., Resch, C., Aigner, M., Mayer, L., Yanling,M., Peter, S., Roel, M., & Leifeld, J. (2015). Predicting soil organic matter stability in agricultural fields through carbon and nitrogen stable isotopes. *Soil Biology and Biochemistry*, 88, 29-38.

de Vries, S. C., van de Ven, G. W., van Ittersum, M. K., & Giller, K. E. (2010). Resource use efficiency and environmental performance of nine major biofuel crops, processed by first-generation conversion techniques. *Biomass and Bioenergy*, 34(5), 588-601.

Deb, S., Bhadoria, P. B. S., Mandal, B., Rakshit, A., & Singh, H. B. (2015). Soil organic carbon: Towards better soil health, productivity and climate change mitigation. *Clim Change Environ Sustain*, 3, 26-34.

Degerickx, J., Almeida, J., Moonen, P. C., Vervoort, L., Muys, B., & Achten, W. M. (2016). Impact of land- use change to Jatropha bioenergy plantations on biomass and soil carbon stocks: a field study in Mali. *GCB Bioenergy*, 8(2), 443-455.

Deng, J., Li, J., Deng, G., Zhu, H., & Zhang, R. (2017). Fractal scaling of particle-size distribution and associations with soil properties of Mongolian pine plantations in the Mu Us Desert, China. *Scientific Reports*, 7(1), 6742.

Deng, L., Liu, G. B., & Shangguan, Z. P. (2014). Land- use conversion and changing soil carbon stocks in China's 'Grain- for- Green'Program: a synthesis. *Global Change Biology*, 20(11), 3544-3556.

Deng, L., Wang, G., Liu, G., & Shangguan, Z. (2016). Effects of age and land-use changes on soil carbon and nitrogen sequestrations following cropland abandonment on the Loess Plateau, China. *Ecological Engineering*, 90, 105-112.

Desjardins, T., Barros, E., Sarrazin, M., Girardin, C., & Mariotti, A. (2004). Effects of forest conversion to pasture on soil carbon content and dynamics in Brazilian Amazonia. *Agriculture, Ecosystems & Environment*, 103(2), 365-373.

DesRochers, A., Van Den Driessche, R., & Thomas, B. R. (2007). The interaction between nitrogen source, soil pH, and drought in the growth and physiology of three poplar clones. *Botany*, 85(11), 1046-1057.

Dieye, A. M. (2016). Land cover land use change and soil organic carbon under climate variability in the Semi-Arid West African Sahel (1960-2050). Electronic Theses and Dissertations. 998.

Din, A. K. (2016). Malaysian Oil Palm Industry Performance 2016 and Prospects for 2017.

Dislich, C., Hettig, E., Salecker, J., Heinonen, J., Lay, J., Meyer, K. M.,& Tarigan, S. (2018). Land-use change in oil palm dominated tropical landscapes—An agent-based model to explore ecological and socio-economic trade-offs. *Plos One*, 13(1), e0190506.

Djomgoue, P., & Njopwouo, D. (2013). FT-IR spectroscopy applied for surface clays characterization. Journal of Surface Engineered Materials and Advanced Technology, 3(04), 275.

Don, A., Rödenbeck, C., & Gleixner, G. (2013). Unexpected control of soil carbon turnover by soil carbon concentration. *Environmental Chemistry Letters*, 11(4), 407-413.

Don, A., Schumacher, J., & Freibauer, A. (2011). Impact of tropical land- use change on soil organic carbon stocks–a meta- analysis. *Global Change Biology*, 17(4), 1658-1670.

Dou, X., He, P., Cheng, X., & Zhou, W. (2016). Long-term fertilization alters chemically-separated soil organic carbon pools: Based on stable C isotope analyses. *Scientific Reports*, 6, 19061.

Drescher, J., Rembold, K., Allen, K., Beckschäfer, P., Buchori, D., Clough, Y., Faust,H., Fauzi, A., Gunawan, D., Hertel, D., Irawan, B., Jaya, I., Klarner, B., Kleinn, C., Knohl, A., Kotowska, M., Krashevska, V., Krishna, V., Leuschner, C., Lorenz, W., Meijide, A., Melati, D., Nomura, M., Cruzado, C., Qaim,M., Siregar ,I., Steinebach, S., Tjoa, A., Tscharntke, T., Wick, B ., Wiegand, K., Kreft, H., Scheu, S..(2016). Ecological and socio-economic functions across tropical land use systems after rainforest conversion. Phil. *Trans. R. Soc*. B, 371(1694), 1-8.

Drewer, J., Leduning, M., Kerdraon-Byrne, D., Sayer, E., Sentien, J., & Skiba, U. (2017). The impact of land-use change from forest to oil palm on soil greenhouse gas and volatile organic compound fluxes in Malaysian Borneo. In EGU General Assembly Conference Abstracts.19. 6495.

Duboc, O., Zehetner, F., Djukic, I., Tatzber, M., Berger, T. W., & Gerzabek, M. H. (2012). Decomposition of European beech and Black pine foliar litter along an Alpine elevation gradient: mass loss and molecular characteristics. *Geoderma*, 189, 522-531.

Durigan, M. R., Cherubin, M. R., de Camargo, P. B., Ferreira, J. N., Berenguer, E., Gardner, T. A., Gardner, T.A., Barlow, J., Dias,C. T., Signor, D ., Raimundo Cosme,R., Junior, R. C. d. O., & Cerri, C. E.P. (2017). Soil organic matter responses to anthropogenic forest disturbance and land use change in the eastern brazilian amazon. *Sustainability*, 9(3), 379.

Eclesia, R. P., Jobbagy, E. G., Jackson, R. B., Biganzoli, F., & Piñeiro, G. (2012). Shifts in soil organic carbon for plantation and pasture establishment in native forests and grasslands of South America. *Global Change Biology*, 18(10), 3237-3251.

Ehleringer, J. R., Buchmann, N., & Flanagan, L. B. (2000). Carbon isotope ratios in belowground carbon cycle processes. *Ecological Applications*, 10(2), 412-422.

Ellerbrock, R. H., Höhn, A., & Gerke, H. H. (1999). Characterization of soil organic matter from a sandy soil in relation to management practice using FT-IR spectroscopy. *Plant and Soil*, 213(1-2), 55-61.

Ellerbrock, R. H., & Gerke, H. H. (2013). Characterization of organic matter composition of soil and flow path surfaces based on physicochemical principles—A review. *In Advances in Agronomy*, 121, 117-177.

Emiru, N., & Gebrekidan, H. (2013). Effect of land use changes and soil depth on soil organic matter, total nitrogen and available phosphorus contents of soils in Senbat watershed, western Ethiopia. *ARPN J Agric Biol Sci*, 8(3), 206-212.

Eusterhues, K., Rumpel, C., Kleber, M., & Kögel-Knabner, I. (2003). Stabilisation of soil organic matter by interactions with minerals as revealed by mineral dissolution and oxidative degradation. *Organic Geochemistry*, 34(12), 1591-1600.

Fang, J., Yu, G., Liu, L., Hu, S., & Chapin, F. S. (2018). Climate change, human impacts, and carbon sequestration in China. *Proceedings of the National Academy of Sciences*, 115(16), 4015-4020.

FAO. (2002). FAO-UNESCO (1971–1981), Soil Map of the World (1:5,000,000), vol. 1–10, UNESCO, Paris, France.

FAO. (2010). (Food and Agriculture Organization of the United Nation). Global Forest Resources Assessment 2010. FAO Rome.

FAO. (2011). Southeast Asian Forests and Forestry to 2020: Subregional Report of the Second Asia-Pacific Forestry Sector Outlook Study. Food and Agricultural Organization of the United Nations.

FAO. (2015). Food and Agriculture Organization of the United Nations Rome, global forest resources assessment 2015.

Faridah, H., Lepun, P., & Kamaruzaman, J. (2007). Tree species distribution in Ayer Hitam Forest Reserve, Selangor, Malaysia. In Proceedings of the 3rd IASME/WSEAS International Conference on Energy, Environment, Ecosystems and Sustainable Development (pp. 24-26).

Fatai, A. A., Shamshuddin, J., Fauziah, C. I., Radziah, O., & Bohluli, M. (2017). Formation and characteristics of an Ultisol in Peninsular Malaysia utilized for oil palm production. *Solid Earth*, 60, 1-21.

Feldpausch, T. R., Rondon, M. A., Fernandes, E., Riha, S. J., & Wandelli, E. (2004). Carbon and nutrient accumulation in secondary forests regenerating on pastures in central Amazonia. *Ecological Applications*, 14(sp4), 164-176.

Feng, X. (2002). A theoretical analysis of carbon isotope evolution of decomposing plant litters and soil organic matter. *Global Biogeochemical Cycles*, 16(4),1-11.

Feng, X. (2009). The Molecular Composition of Soil Organic Matter (SOM) and Potential Responses to Global Warming and Elevated CO2. (Doctoral dissertation).

Ferchaud, F., Vitte, G., & Mary, B. (2016). Changes in soil carbon stocks under perennial and annual bioenergy crops. *GCB Bioenergy*, 8(2), 290-306.

Fissore, C., Dalzell, B. J., Berhe, A. A., Voegtle, M., Evans, M., & Wu, A. (2017). Influence of topography on soil organic carbon dynamics in a Southern California grassland. *Catena*, 149, 140-149.

Flynn, H. C., Keller, E., King, H., Sim, S., Hastings, A., Wang, S., & Smith, P. (2012). Quantifying global greenhouse gas emissions from land- use change for crop production. *Global Change Biology*, 18(5), 1622-1635.

Follett, R., Stewart, C., Pruessner, E., & Kimble, J. (2012). Effects of climate change on soil carbon and nitrogen storage in the US Great Plains. *Journal of Soil and Water Conservation*, 67(5), 331-342.

Frazão, L. A., Paustian, K., Cerri, C. E. P., & Cerri, C. C. (2014). Soil carbon stocks under oil palm plantations in Bahia State, Brazil. *Biomass and Bioenergy*, 62, 1-7.

Frazão, L. A., Paustian, K., Pellegrino Cerri, C. E., & Cerri, C. C. (2013). Soil carbon stocks and changes after oil palm introduction in the Brazilian Amazon. *GCB Bioenergy*, 5(4), 384-390.

Fujisaki, K., Perrin, A. S., Desjardins, T., Bernoux, M., Balbino, L. C., & Brossard, M. (2015). From forest to cropland and pasture systems: a critical review of soil organic carbon stocks changes in Amazonia. *Global Change Biology*, 21(7), 2773-2786.

Gao, W., Hodgkinson, L., Jin, K., Watts, C. W., Ashton, R. W., Shen, J., & Hedden, P. (2016). Deep roots and soil structure. *Plant, Cell & Environment*, 39(8), 1662-1668.

Gao, X., Wu, P., Zhao, X., Wang, J., & Shi, Y. (2014). Effects of land use on soil moisture variations in a semi- arid catchment: implications for land and agricultural water management. *Land Degradation & Development*, 25(2), 163-172.

Garten, C., Cooper, L. W., Post, W. M., & Hanson, P. J. (2000). Climate controls on forest soil C isotope ratios in the southern Appalachian Mountains. *Ecology*, 81(4), 1108-1119.

Gebreselassie, Y. (2002). Selected chemical and physical characteristics of soils of Adet research center and its testing sites in North-western Ethiopia. *Ethiopian Journal of Natural Resources.*

Gelaw, A. M., Singh, B., & Lal, R. (2014). Soil organic carbon and total nitrogen stocks under different land uses in a semi-arid watershed in Tigray, Northern Ethiopia. *Agriculture, Ecosystems & Environment*, 188, 256-263.

Gennaro, L. A. D., Souza, Z. M. d., Weill, M. d. A. M., Souza, G. S. d., & Alves, M. C. (2014). Soil physical and microbiological attributes cultivated with the common bean under two management systems. *Revista Ciência Agronômica*, 45(4), 641-649.

George, N., Killur, R. R. B., & Cornelio, D. L. (2013). Land use conversion and soil properties in a lowland tropical landscape of Papua New Guinea. *Jurnal manajemen hutan tropika*, 19(1), 39.

Ghimire, R., Machado, S., & Bista, P. (2017). Soil pH, soil organic matter, and crop yields in winter wheat–summer fallow systems. *Agronomy Journal*, 109(2), 706-717.

Gibbs, H. K., Ruesch, A. S., Achard, F., Clayton, M. K., Holmgren, P., Ramankutty, N., & Foley, J. A. (2010). Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. *Proceedings of the National Academy of Sciences*, 107(38), 16732-16737.

Gibson, L., Lee, T. M., Koh, L. P., Brook, B. W., Gardner, T. A., Barlow, J., Peres,C . A., Bradshaw,C.J.A., Laurance, W.F., Lovejoy, T. E., & Sodhi, N. S. (2011). Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature*, 478 (7369), 378-381.

Giniyatullin, K. G., Valeeva, A. A., & Smirnova, E. V. (2017). Application of cluster and discriminant analyses to diagnose lithological heterogeneity of the parent material according to its particle-size distribution. *Eurasian Soil Science*, 50(8), 917-924.

Gleixner, G. (2013). Soil organic matter dynamics: a biological perspective derived from the use of compound-specific isotopes studies. *Ecological Research*, 28(5), 683-695.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F.,Pretty,J.,Robinson, S., thomas, S.M., & Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. *Science*, 327(5967), 812-818.

Goh, K., Härdter, R., & Fairhurst, T. (2003). The Oil Palm–Management for Large and Sustainable Yields (in press). Singapore: Potash & Phosphate Institute of Canada.

Goldewijk, K. K., Beusen, A., Doelman, J., & Stehfest, E. (2017). Anthropogenic land use estimates for the Holocene–HYDE 3.2. *Earth System Science Data*, 9(2), 927.

Goodrick, I., Nelson, P. N., Banabas, M., Wurster, C. M., & Bird, M. I. (2015). Soil carbon balance following conversion of grassland to oil palm. *GCB Bioenergy*, 7(2), 263-272.

Gray, J. M., Bishop, T. F., & Wilson, B. R. (2015). Factors controlling soil organic carbon stocks with depth in eastern Australia. *Soil Science Society of America Journal*, 79(6), 1741-1751.

Gruba, P., & Socha, J. (2016). Effect of parent material on soil acidity and carbon content in soils under silver fir (Abies alba Mill.) stands in Poland. *Catena*, 140, 90-95.

Guardiola, M. D. E., Júnior, J. F. V., da Silva, E. E., Rossi, C. Q., & Pereira, M. G. (2017). Chemical and physical fractions of soil organic matter under various management regimes in Roraima, Brazil. *Semina: Ciências Agrárias*, 38(4Supl1), 2419-2432.

Guggenberger, G., Zech, W., Haumaier, L., & Christensen, B. T. (1995). Land- use effects on the composition of organic matter in particle- size separates of soils: II. CPMAS and solution 13C NMR analysis. *European Journal of Soil Science*, 46(1), 147-158.

Guillaume, T., Damris, M., & Kuzyakov, Y. (2015). Losses of soil carbon by converting tropical forest to plantations: erosion and decomposition estimated by δ13C. *Global Change Biology*, 21(9), 3548-3560.

Guillaume, T., Maranguit, D., Murtilaksono, K., & Kuzyakov, Y. (2016). Sensitivity and resistance of soil fertility indicators to land-use changes: new concept and examples from conversion of Indonesian rainforest to plantations. *Ecological Indicators*, 67, 49-57.

Gunarso, P., Hartoyo, M., Agus, F., & Killeen, T. (2013). Oil palm and land use change in Indonesia, Malaysia and Papua New Guinea. Reports from the Technical Panels of the 2nd greenhouse gas working Group of the Roundtable on Sustainable Palm Oil (RSPO), 29-64.

Gunina, A., & Kuzyakov, Y. (2014). Pathways of litter C by formation of aggregates and SOM density fractions: implications from 13 C natural abundance. *Soil Biology and Biochemistry*, 71, 95-104.

Guo, L. B., & Gifford, R. (2002). Soil carbon stocks and land use change: a meta analysis. *Global Change Biology*, 8(4), 345-360.

Guo, L., Halliday, M., Siakimotu, S., & Gifford, R. (2005). Fine root production and litter input: its effects on soil carbon. *Plant and Soil*, 272(1-2), 1-10.

Guo, X., Meng, M., Zhang, J., & Chen, H. Y. (2016). Vegetation change impacts on soil organic carbon chemical composition in subtropical forests. *Scientific Reports*, 6, 29607.

Haberhauer, G., & Gerzabek, M. H. (1999). Drift and transmission FT-IR spectroscopy of forest soils: an approach to determine decomposition processes of forest litter. Vibrational Spectroscopy, 19(2), 413-417.

Haberhauer, G., Rafferty, B., Strebl, F., & Gerzabek, M. H. (1998). Comparison of the composition of forest soil litter derived from three different sites at various decompositional stages using FTIR spectroscopy. *Geoderma*, 83(3-4), 331-342.

Hagenbo, A. (2017). Ectomycorrhizal fungal mycelial dynamics and its role in forest soil carbon cycling (Doctoral Dissertation).

Hamdan, J., Jafarzadeh-Haghighi, A., Shamshuddin, J., S., Anuar, R. (2011). Organo-mineral comlexation in soil of the tropical regions. In book: Advances in Tropical Soil Science Publisher: Universiti Putra Malaysia Press. 22-35.

Hamdan, O., Rahman, K. A., & Samsudin, M. (2016). Quantifying rate of deforestation and CO2 emission in Peninsular Malaysia using Palsar imageries. In IOP Conference Series: *Earth and Environmental Science*.37(1) p. 012028.

Hamilton, R. E. (2014). The impact of forest conversion to oil palm plantation on the internal nitrogen cycle of tropical lowland soils (Doctoral dissertation, University of Birmingham).

Hanke, D., & Dick, D. P. (2017). Organic matter stocks and the interactions of humic substances with metals in araucaria moist forest soil with humic and histic horizons. *Revista Brasileira de Ciencia do Solo*, 41.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S., Tyukavina, A., Thau, D., Stehman, V., Goetz, j. S., Loveland, T., Kommareddy, A., Egorov, L., Chini, A., Justice, C. O ., & Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. *Science*, 342(6160), 850-853.

Hansen, S. B., Olsen, S. I., & Ujang, Z. (2014). Carbon balance impacts of land use changes related to the life cycle of Malaysian palm oil-derived biodiesel. *The International Journal of Life Cycle Assessment*, 19(3), 558-566.

Häring, V., Fischer, H., Cadisch, G., & Stahr, K. (2013). Implication of erosion on the assessment of decomposition and humification of soil organic carbon after land use change in tropical agricultural systems. *Soil Biology and Biochemistry*, 65, 158-167.

Haron, K., Brookes, P., Anderson, J., & Zakaria, Z. (1998). Microbial biomass and soil organic matter dynamics in oil palm (Elaeis guineensis Jacq.) plantations, West Malaysia. *Soil Biology and Biochemistry*, 30(5), 547-552.

Harris, N. L., Brown, S., Hagen, S. C., Saatchi, S. S., Petrova, S., Salas, W., Hansen, M. C,5 Peter V. Potapov,, P. V., & Lotsch, A. (2012). Baseline map of carbon emissions from deforestation in tropical regions. *Science*, 336(6088), 1573-1576.

Hassink, J. (1997). The capacity of soils to preserve organic C and N by their association with clay and silt particles. *Plant and Soil*, 191(1), 77-87.

Hatton, P. J., Castanha, C., Torn, M. S., & Bird, J. A. (2015). Litter type control on soil C and N stabilization dynamics in a temperate forest. *Global Change Biology*, 21(3), 1358-1367.

Hattori, D., Sabang, J., Tanaka, S., Kendawang, J. J., Ninomiya, I., & Sakurai, K. (2005). Soil characteristics under three vegetation types associated with shifting cultivation in a mixed dipterocarp forest in Sarawak, Malaysia. *Soil Science & Plant Nutrition*, 51(2), 231-2.

Hazelton, P., & Murphy, B. (2016). Interpreting soil test results: What do all the numbers mean?. CSIRO publishing.

Heckman, K., Throckmorton, H., Horwath, W., Swanston, C and Rasmussen, C. (2018). Variation in the molecular structure and radiocarbon abundance of mineral-associated organic matter across a lithosequence of forest soils. *Soil Syst*, 2, 36, 1-12.

Helfrich, M., Ludwig, B., Buurman, P., & Flessa, H. (2006). Effect of land use on the composition of soil organic matter in density and aggregate fractions as revealed by solid-state 13C NMR spectroscopy. *Geoderma*, 136(1-2), 331-341.

Herold, N., Schöning, I., Michalzik, B., Trumbore, S., & Schrumpf, M. (2014). Controls on soil carbon storage and turnover in German landscapes. *Biogeochemistry*, 119(1-3), 435-451.

Heywood, P. F., & Turpin, S. (2013). Variations in soil carbon stocks with texture and previous landuse in north-western NSW, Australia. *Sustainable Agriculture Research*, 2(2), 124.

Hickmann, C., da Costa, L. M., Schaefer, C. E. G. R., Fernandes, R. B. A., & Andrade, C. d. L. T. (2012). Atributos físico-hídricos e carbono orgânico de um Argissolo após 23 anos de diferentes manejos. *Revista Caatinga*, 25(1), 128-136.

Hillel, D. (2013). Fundamentals of soil physics. Academic press.

Hobley, E. U., Baldock, J., & Wilson, B. (2016). Environmental and human influences on organic carbon fractions down the soil profile. *Agriculture, Ecosystems & Environment*, 223, 152-166.

Hobley, E., Willgoose, G. R., Frisia, S., & Jacobsen, G. (2013). Environmental and site factors controlling the vertical distribution and radiocarbon ages of organic carbon in a sandy soil. *Biology and Fertility of Soils*, 49(8), 1015-1026.

Hobley, E., Wilson, B., Wilkie, A., Gray, J., & Koen, T. (2015). Drivers of soil organic carbon storage and vertical distribution in Eastern Australia. *Plant and Soil*, 390(1-2), 111-127.

Holz, M., Zarebanadkouki, M., Kuzyakov, Y., Pausch, J., & Carminati, A. (2017). Root hairs increase rhizosphere extension and carbon input to soil. *Annals of Botany*, (00), 1-9.

Hossain, M., Jusoh, K., & Fatimah, S. (2017). Impact of Land Use Changes on Soil Properties and Organic Carbon Distribution Using Tracer Techniques in Selangor State of Malaysia. *Journal of Tropical Forestry and Environment*, 7(2), 68-77.

Houghton, R. A., House, J. I., Pongratz, J., Van Der Werf, G. R., DeFries, R. S., Hansen, M. C., & Ramankutty, N. (2012). Carbon emissions from land use and land-cover change. *Biogeosciences*, 9(12), 5125-5142.

Houghton, R., & Nassikas, A. A. (2017). Global and regional fluxes of carbon from land use and land cover change 1850–2015. *Global Biogeochemical Cycles*, 31(3), 456-472.

Huang, J.H. (2004). Long-term impacts of land-use change on dynamics of tropical soil carbon and nitrogen pools. *Journal of Environmental Sciences*, 16(2), 256-261.

Hugar, G. M., & Soraganvi, V. S. (2014). Impact of soil organic carbon on bulk density and plasticity index of arid soils of Raichur, India. *International Research Journal of Environment Sciences*, 3(2), 48-58.

Hughes, A. C. (2017). Understanding the drivers of Southeast Asian biodiversity loss. Ecosphere, 8(1).

Humpenöder, F., Popp, A., Stevanovic, M., Müller, C., Bodirsky, B. L., Bonsch, M., & Rolinski, S. (2015). Land-use and carbon cycle responses to moderate climate change: implications for land-based mitigation? *Environmental Science & Technology*, 49(11), 6731-6739.

Ishizuka, S., Iswandi, A., Nakajima, Y., Yonemura, S., Sudo, S., Tsuruta, H., & Murdiyarso, D. (2005). The variation of greenhouse gas emissions from soils of various land-use/cover types in Jambi province, Indonesia. *Nutrient Cycling in Agroecosystems*, 71(1), 17-32.

Islam, K. R., & Weil, R. (2000). Land use effects on soil quality in a tropical forest ecosystem of Bangladesh. *Agriculture, Ecosystems & Environment*, 79(1), 9-16.

Ito, A., & Wagai, R. (2017). Global distribution of clay-size minerals on land surface for biogeochemical and climatological studies. *Scientific Data*, 4, 170103.

Jacobs, L. M., Sulman, B. N., Brzostek, E. R., Feighery, J. J., & Phillips, R. P. (2018). Interactions among decaying leaf litter, root litter and soil organic matter vary with mycorrhizal type. *Journal of Ecology*, 106(2), 502-513.

Jafarzadeh-Haghighi, A. H., Shamshuddin, J., Hamdan, J., & Zainuddin, N. (2017). Preservation of organic matter in soils of a climo-biosequence in the Main Range of Peninsular Malaysia. *Journal of Mountain Science*, 14(9), 1763-1775.

Jafarzadeh-Haghighi, A. H., Shamshuddin, J., Hamdan, J., Zainuddin, N., & Roslan, I. (2015). Carbon contents and structural characteristics of organic matter in soils of a climo-biosequence in the Main Range of Peninsular Malaysia. *Asian Journal of Agriculture and Food Sciences*, (ISSN: 2321–1571), 3(05).

Janzen, H. H., & Gregorich, C. C. E. (2018). Soil Carbon Dynamics in Canadian A groecosystem s. In Soil processes and the carbon cycle (pp. 71-94). CRC Press.

Jiang, L., Han, X., Dong, N., Wang, Y., & Kardol, P. (2011). Plant species effects on soil carbon and nitrogen dynamics in a temperate steppe of northern China. *Plant and Soil*, 346(1-2), 331-347.

Jindaluang, W., Kheoruenromne, I., Suddhiprakarn, A., Singh, B. P., & Singh, B. (2013). Influence of soil texture and mineralogy on organic matter content and composition in physically separated fractions soils of Thailand. *Geoderma*, 195, 207-219.

Jobbágy, E. G., & Jackson, R. B. (2000). The vertical distribution of soil organic carbon and its relation to climate and vegetation. *Ecological Applications*, 10 (2), 423-436.

John, B., Ludwig, B., & Flessa, H. (2003). Carbon dynamics determined by natural 13C abundance in microcosm experiments with soils from long-term maize and rye monocultures. *Soil Biology and Biochemistry*, 35(9), 1193-1202.

Johnson, A., Xing, H. X., & Scatena, F. (2015). Controls on soil carbon stocks in El Yunque National Forest, Puerto Rico. *Soil Science Society of America Journal*, 79(1), 294-304.

Jones, E., & Singh, B. (2014). Organo-mineral interactions in contrasting soils under natural vegetation. *Frontiers in Environmental Science*, 2, 2.

Jusop, S., Paramananthan, S., & Wan, N. M. N. (1979). *Soil Map of the Universiti Pertanian Malaysia Farm*. Soil Science Department, Universiti Pertanian Malaysia.

Tessens, E., & Jusop, S. (1979). *Report and Map of the Detailed Soil Survey of the UPM-Farm in Puchong (Selangor-Malaysia)*. Jabatan Sains Tanah Fakulti Pertanian, UPM.

Kahle, M., Kleber, M., & Jahn, R. (2002). Carbon storage in loess derived surface soils from Central Germany: Influence of mineral phase variables. *Journal of Plant Nutrition and Soil Science*, 165(2), 141-149.

Kaiser, M., Zederer, D. P., Ellerbrock, R. H., Sommer, M., & Ludwig, B. (2016). Effects of mineral characteristics on content, composition, and stability of organic matter fractions separated from seven forest topsoil's of different pedogenesis. *Geoderma*, 263, 1-7.

Kalhoro, S. A., Xuexuan, X., Yuan, C., Rui, H., Raza, S., & Kang, D. (2017). Effects of Different Land-Use Systems on Soil Aggregates: A Case Study of the Loess Plateau (Northern China). *Sustainability*, 9(8), 1349.

Kanda, T., Tamura, K., Asano, M., Tsunekawa, A., & Nakamura, T. (2015). The 13C and 15N Natural Abundances to Characterize Soil Organic Matter Associated with Clay Minerals in Eurasian Steppe Soils. *Journal of Arid Land Studies*, 25(3), 153-156.

Kashi, H., Abdipoor, M., & Arastoo, B. (2016). The Impacts of Land Use Change in Soil Carbon and Nitrogen Stocks (Case Study Shahmirzad Lands, Semnan Province, Iran). *Journal of Rangeland Science*, 6(2), 156-167.

Kassa, H., Dondeyne, S., Poesen, J., Frankl, A., & Nyssen, J. (2017). Impact of deforestation on soil fertility, soil carbon and nitrogen stocks: the case of the Gacheb catchment in the White Nile Basin, Ethiopia. *Agriculture, Ecosystems & Environment*, 247, 273-282.

Katsumi, N., Yonebayashi, K., Fujitake, N., & Okazaki, M. (2015). Relationship between stable carbon and nitrogen isotope ratios of humic acids extracted from Andisols and non-Andisols. *Catena*, 127, 214-221.

Kaur, R., & Bhat, Z. A. (2017). Effect of different agricultural land use systems on physico-chemical properties of soil in sub-mountainous districts of Punjab, North-West India. *Journal of Pharmacognosy and Phytochemistry*, 6(3), 226-233.

Kayler, Z. E., Kaiser, M., Gessler, A., Ellerbrock, R. H., & Sommer, M. (2011). Application of δ 13 C and δ 15 N isotopic signatures of organic matter fractions sequentially separated from adjacent arable and forest soils to identify carbon stabilization mechanisms. *Biogeosciences*, 8(10), 2895-2906.

Keen, Y. C., Jalloh, M. B., Ahmed, O. H., Sudin, M., & Besar, N. A. (2011). Soil organic matter and related soil properties in forest, grassland and cultivated land use types. *International Journal of Physical Sciences*, 6(32), 7410-7415.

Keenan, R. J., Reams, G. A., Achard, F., de Freitas, J. V., Grainger, A., & Lindquist, E. (2015). Dynamics of global forest area: results from the FAO Global Forest Resources Assessment 2015. *Forest Ecology and Management*, 352, 9-20.

Keil, R.G., and L.M. Mayer. 2014. Mineral matrices and organic matter. In: B. Birrer et al., editors, *Treatise on Geochemistry*. Vol. 2. Elsevier, Amsterdam (in press)

Keller, K. M., Lienert, S., Bozbiyik, A., Stocker, T. F., Churakova, O. V., Frank, D. C., & Saurer, M. (2017). 20th century changes in carbon isotopes and water-use efficiency: tree-ring-based evaluation of the CLM4. 5 and LPX-Bernmodels. *Biogeosciences*, 14(10), 2641.

Khalid, H., Zin, Z., & Anderson, J. (2000). Soil nutrient dynamics and palm growth performance in relation to residue management practices following replanting of oil palm plantations. *Journal of Oil Palm Research*, 12(1), 25-45.

Kho, L. K., & Jepsen, M. R. (2015). Carbon stock of oil palm plantations and tropical forests in Malaysia: A review. *Singapore Journal of Tropical Geography*, 36(2), 249-266.

Kiba, T., & Krapp, A. (2016). Plant nitrogen acquisition under low availability: regulation of uptake and root architecture. *Plant and Cell Physiology*, 57(4), 707-714.

Kizilkaya, R., & Dengiz, O. (2010). Variation of land use and land cover effects on some soil physico-chemical characteristics and soil enzyme activity. *Zemdirbyste-Agriculture*, 97(2), 15-24.

Kleber, M., & Johnson, M. G. (2010). Advances in understanding the molecular structure of soil organic matter: implications for interactions in the environment. *In Advances in Agronomy* ,106, 77-142. Academic Press.

Kleber, M., Sollins, P., & Sutton, R. (2007). A conceptual model of organo-mineral interactions in soils: self-assembly of organic molecular fragments into zonal structures on mineral surfaces. *Biogeochemistry*, 85(1), 9-24.

Klecka, W. R. (1980). Discriminant analysis: (No. 19), Sage.

Knicker, H. (2011). Soil organic N-An under-rated player for C sequestration in soils?. *Soil Biology and Biochemistry*, 43(6), 1118-1129.

Knicker, H., Schmidt, M. W., & KoÈgel-Knabner, I. (2000). Nature of organic nitrogen in fine particle size separates of sandy soils of highly industrialized areas as revealed by NMR spectroscopy. *Soil Biology and Biochemistry*, 32(2), 241-252.

Koh, L. P., Kettle, C. J., Sheil, D., Lee, T. M., Giam, X., Gibson, L., & Clements, G. R. (2013). Biodiversity state and trends in Southeast Asia. In Levin, S (Ed.), Encyclopedia of biodiversity (2nd ed.), p. 509-527.

Kohl, L., Laganière, J., Edwards, K. A., Billings, S. A., Morrill, P. L., Van Biesen, G., & Ziegler, S. E. (2015). Distinct fungal and bacterial δ 13 C signatures as potential drivers of increasing δ 13 C of soil organic matter with depth. *Biogeochemistry*, 124 (1-3), 13-26.

Kotowska, M. M., Leuschner, C., Triadiati, T., Meriem, S., & Hertel, D. (2015). Quantifying above- and belowground biomass carbon loss with forest conversion in tropical lowlands of Sumatra (Indonesia). *Global Change Biology*, 21(10), 3620-3634.

Kramer, C., & Gleixner, G. (2008). Soil organic matter in soil depth profiles: distinct carbon preferences of microbial groups during carbon transformation. *Soil Biology and Biochemistry*, 40(2), 425-433.

Kramer, M. G., Sollins, P., Sletten, R. S., & Swart, P. K. (2003). N isotope fractionation and measures of organic matter alteration during decomposition. *Ecology*, 84(8), 2021-2025.

Krashevska, V., Klarner, B., Widyastuti, R., Maraun, M., & Scheu, S. (2015). Impact of tropical lowland rainforest conversion into rubber and oil palm plantations on soil microbial communities. *Biology and Fertility of Soils*, 1-9.

Krull, E. S., & Skjemstad, J. O. (2003). δ13C and δ15N profiles in 14C-dated Oxisol and Vertisols as a function of soil chemistry and mineralogy. *Geoderma*, 112(1-2), 1-29.

Krull, E. S., Skjemstad, J. O., & Baldock, J. A. (2004). Functions of soil organic matter and the effect on soil properties (p. 129). Cooperative Research Centre for Greenhouse Accounting.

Kucuker, M. A., Guney, M., Oral, H. V., Copty, N. K., & Onay, T. T. (2015). Impact of deforestation on soil carbon stock and its spatial distribution in the Western Black Sea Region of Turkey. *Journal Of Environmental Management*, 147, 227-235.

Kumar, R. (2015). The forest resources of Malaysia: their economics and development.

Kurniawan, S. (2016). Conversion of lowland forests to rubber and oil palm plantations changes nutrient leaching and nutrient retention efficiency in highly weathered soils of Sumatra, Indonesia (Doctoral dissertation, Georg-August-Universität Göttingen, Fakultät für Forstwissenschaften und Waldökologie). Chapter 2, 12-61.

Laceby, J. P., Olley, J., Pietsch, T. J., Sheldon, F., & Bunn, S. E. (2015). Identifying subsoil sediment sources with carbon and nitrogen stable isotope ratios. *Hydrological Processes*, 29(8), 1956-1971.

Lachenbruch, P. A. (1975). Discriminant analysis: Wiley Online Library.

Laganiere, J., Angers, D. A., & Pare, D. (2010). Carbon accumulation in agricultural soils after afforestation: a meta- analysis. *Global Change Biology*, 16(1), 439-453.

Lai, L., Huang, X., Yang, H., Chuai, X., Zhang, M., Zhong, T., Chen, Y., wang,X ., & Thompson, J. R. (2016). Carbon emissions from land-use change and management in China between 1990 and 2010. *Science Advances*, 2(11), 1-9.

Lai, R. (2004). Soil carbon sequestration in natural and managed tropical forest ecosystems. *Journal of Sustainable Forestry*, 21(1), 1-30.

Lajtha, K., Bowden, R. D., & Nadelhoffer, K. (2014). Litter and root manipulations provide insights into soil organic matter dynamics and stability. *Soil Science Society of America Journal*, 78(S1), S261-S269.300

Lal, R. (2004). Soil carbon sequestration impacts on global climate change and food security. *Science*, 304(5677), 1623-1627.

Lamade, E., Tcherkez, G., Darlan, N. H., Rodrigues, R. L., Fresneau, C., Mauve, C., Lamothe-Sibold, M., Sketriené, D., & Ghashghaie, J. (2016). Natural 13C distribution in oil palm (Elaeis guineensis Jacq.) and consequences for allocation pattern. *Plant, Cell & Environment*, 39(1), 199-212.

Larionova, A. A., Zolotareva, B. N., Kvitkina, A. K., Evdokimov, I. V., Bykhovets, S. S., Stulin, A. F., & Kudeyarov, V. N. (2015). Assessing the stability of soil organic matter by fractionation and 13 C isotope techniques. *Eurasian Soil Science*, 48(2), 157-168.

Lawrence, C. R., Harden, J. W., Xu, X., Schulz, M. S., & Trumbore, S. E. (2015). Long-term controls on soil organic carbon with depth and time: A case study from the Cowlitz River Chronosequence, WA USA. *Geoderma*, 247, 73-87.

Lawrence, D., & Vandecar, K. (2015). Effects of tropical deforestation on climate and agriculture. *Nature Climate Change*, 5(1), 27.

Le Quéré, C., Andrew, R. M., Friedlingstein, P., Sitch, S., Pongratz, J., Manning, A. C., & Boden, T. A. (2017). Global carbon budget 2017. *Earth System Science Data Discussions*, 1-79.

Lee-Cruz, L., Edwards, D. P., Tripathi, B. M., & Adams, J. M. (2013). Impact of logging and forest conversion to oil palm plantations on soil bacterial communities in Borneo. *Applied And Environmental Microbiology*, 79(23), 7290-7297.

Lefèvre, C., Rekik, F., Alcantara, V., & Wiese, L. (2017). Soil organic carbon: the hidden potential. Food and agriculture organization of the United Nations (FAO). Roma.

Leifeld, J., Bassin, S., & Fuhrer, J. (2005). Carbon stocks in Swiss agricultural soils predicted by land-use, soil characteristics, and altitude. *Agriculture, Ecosystems & Environment*, 105(1), 255-266.

Lemma, B., Kleja, D. B., Nilsson, I., & Olsson, M. (2006). Soil carbon sequestration under different exotic tree species in the southwestern highlands of Ethiopia. *Geoderma*, 136(3), 886-898.

Li, H., Li, J., He, Y., Li, S., Liang, Z., Peng, C & Luo, Z. B. (2013). Changes in carbon, nutrients and stoichiometric relations under different soil depths, plant tissues and ages in black locust plantations. *Acta Physiologiae Plantarum*, 35(10), 2951-2964.

Li, H., Ma, Y., Liu, W., & Liu, W. (2012). Soil changes induced by rubber and tea plantation establishment: comparison with tropical rain forest soil in Xishuangbanna, SW China. *Environmental Management*, 50(5), 837-848.

Li, W., MacBean, N., Ciais, P., Defourny, P., Lamarche, C., Bontemps, S., Houghton, R.A.,& Peng, S. (2018). Gross and net land cover changes based on plant functional types derived from the annual ESA CCI land cover maps (1992-2015). *Earth Syst. Sci. Data*, 74. 219-234.

Li, Y., Xia, Y., Lei, Y., Deng, Y., Chen, H., Sha, L., Sha, L., & Deng, X. (2015). Estimating changes in soil organic carbon storage due to land use changes using a modified calculation method. *iForest-Biogeosciences and Forestry*, 8(1), 45-52.

Li, Y., Zhang, J., Chang, S. X., Jiang, P., Zhou, G., Shen, Z., & Shen, M. (2014). Converting native shrub forests to Chinese chestnut plantations and subsequent intensive management affected soil C and N pools. *Forest Ecology and Management*, 312, 161-169.

Li, Z., Zhao, B., Wang, Q., Cao, X., & Zhang, J. (2015). Differences in chemical composition of soil organic carbon resulting from long-term fertilization strategies. *Plos One*, 10(4), e0124359.

Liao, C., Luo, Y., Fang, C., Chen, J., & Li, B. (2012). The effects of plantation practice on soil properties based on the comparison between natural and planted forests: a meta- analysis. *Global Ecology and Biogeography*, 21(3), 318-327.

Liao, K., Wu, S., & Zhu, Q. (2016). Can Soil pH be used to help explain soil organic carbon stocks? *Clean–Soil, Air, Water*, 44(12), 1685-1689.

Littke, K., Harrison, R., Briggs, D., & Grider, A. (2011). Understanding soil nutrients and characteristics in the Pacific Northwest through parent material origin and soil nutrient regimes. *Canadian Journal of Forest Research*, 41(10), 2001-2008.

Liu, C., Dong, Y., Li, Z., Chang, X., Nie, X., Liu, L., Xiao,H.,& Bashir, H. (2017). Tracing the source of sedimentary organic carbon in the Loess Plateau of China: An integrated elemental ratio, stable carbon signatures, and radioactive isotopes approach. *Journal of Environmental Radioactivity*, 167, 201-210.

Liu, D., Huang, Y., Yan, H., Jiang, Y., Zhao, T., & An, S. (2018). Dynamics of soil nitrogen fractions and their relationship with soil microbial communities in two forest species of northern China. *Plos One*, 13(5), e0196567.

Liu, S., Zhang, W., Wang, K., Pan, F., Yang, S., & Shu, S. (2015). Factors controlling accumulation of soil organic carbon along vegetation succession in a typical karst region in Southwest China. *Science of the Total Environment*, 521, 52-58.

Liu, T. Z., Liu, C. Q., Lang, Y. C., & Ding, H. (2014). Dissolved organic carbon and its carbon isotope compositions in hill slope soils of the karst area of southwest China: Implications for carbon dynamics in limestone soil. *Geochemical Journal*, 48(3), 277-285.

Lo Seen, D., Ramesh, B., Nair, K., Martin, M., Arrouays, D., & Bourgeon, G. (2010). Soil carbon stocks, deforestation and land- cover changes in the Western Ghats biodiversity hotspot (India). *Global Change Biology*, 16(6), 1777-1792.

Lombardo, L., Saia, S., Schillaci, C., Mai, P. M., & Huser, R. (2018). Modeling soil organic carbon with Quantile Regression: Dissecting predictors' effects on carbon stocks. *Geoderma*, 318, 148-159.

Loss, A., Pereira, M. G., Costa, E. M., Beutler, S. J., & Piccolo, M.(2016). Soil fertility, humic fractions and natural abundance of 13C and 15N in soil under different land use in Paraná State, Southern Brazil. *Idesia (Chile)*, 34(1), 27-38.

Lozano-García, B., Parras-Alcántara, L., & Brevik, E. C. (2016). Impact of topographic aspect and vegetation (native and reforested areas) on soil organic carbon and nitrogen budgets in Mediterranean natural areas. *Science of the Total Environment*, 544, 963-970.

Luo, Y., Su, B., Currie, W. S., Dukes, J. S., Finzi, A., Hartwig, U., Hungate, B., & Parton, W. J. (2004). Progressive nitrogen limitation of ecosystem responses to rising atmospheric carbon dioxide. *AIBS Bulletin*, 54(8), 731-739.

Ma, J., Kang, F., Cheng, X., & Han, H. (2018). Response of soil organic carbon and nitrogen to nitrogen deposition in a Larix principis-rupprechtii plantation. *Scientific Reports*, 8(1), 8638.

MacCarthy, P & Rice, J. A. (1985). Spectroscopic Methods (Other than NMR) for Determining Functionality in Humic Substances. In Humic Substances in Soil, Sedimen, and Water: Geochemistry, Isolation and Characerization; Aiken, G., McKnight, D., Wershaw, R., Eds.; John Wiley & Sons: New York; Chapter 21, pp 527-559.

Machado, M. R., Camara, R., Sampaio, P. d. T. B., Pereira, M. G., & Ferraz, J. B. S. (2017). Land cover changes affect soil chemical attributes in the Brazilian Amazon. *Acta Scientiarum. Agronomy*, 39(3), 385-391.

Maggiotto, S. R., Oliveira, D. d., Marur, C. J., Stivari, S. M. S., Leclerc, M., & Wagner-Riddle, C. (2014). Potential carbon sequestration in rubber tree plantations in the northwestern region of the Paraná State, Brazil. *Acta Scientiarum. Agronomy*, 36(2), 239-245.

Mahowald, N. M., Randerson, J. T., Lindsay, K., Munoz, E., Doney, S. C., Lawrence, P., & Hoffman, F. M. (2017). Interactions between land use change and carbon cycle feedbacks. *Global Biogeochemical Cycles*, 31(1), 96-113.

Malaysia, M. M. S. (2015). Department of Statistics, Malaysia.

Malik, M. A., Khan, K. S., & Marschner, P. (2013). Microbial biomass, nutrient availability and nutrient uptake by wheat in two soils with organic amendments. *Journal of Soil Science and Plant Nutrition*, 13(4), 955-966.

Mande, H. K., Abdullah, A. M., Aris, A. Z., & Ainuddin, A. N. (2015). Factors responsible for spatial and temporal variation of soil CO2 efflux in a 50 year recovering tropical forest, Peninsular Malaysia. *Environmental Earth Sciences*, 73(9), 5559-5569.

Mande, K. H., Makmom, A., Zaharin, A, Ainuddin, A., Nuruddin,A & Youssef, B. (2014). Forest Logging and It Impact on Soil Carbon Dioxide Effluxin the tropical Forest, Peninsular Malaysia. *Journal of Environmental Science, Toxicology and Food Technology*, 8(12), 69-77.

Måren, I. E., Karki, S., Prajapati, C., Yadav, R. K., & Shrestha, B. B. (2015). Facing north or south: Does slope aspect impact forest stand characteristics and soil properties in a semiarid trans-Himalayan valley? *Journal of Arid Environments*, 121, 112-123.

Margenot, A. J., Calderón, F. J., Bowles, T. M., Parikh, S. J., & Jackson, L. E. (2015). Soil organic matter functional group composition in relation to organic carbon, nitrogen, and phosphorus fractions in organically managed tomato fields. *Soil Science Society of America Journal*, 79(3), 772-782.

Margenot, A. J., Calderón, F. J., Goyne, K. W., Mukome, F. N. D., & Parikh, S. J. (2017). *IR Spectroscopy, Soil Analysis Applications*.

Marín- Spiotta, E., & Sharma, S. (2013). Carbon storage in successional and plantation forest soils: a tropical analysis. *Global Ecology and Biogeography*, 22(1), 105-117.

Marin- Spiotta, E., Silver, W. L., Swanston, C. W., & Ostertag, R. (2009). Soil organic matter dynamics during 80 years of reforestation of tropical pastures. *Global Change Biology*, 15(6), 1584-1597.

Marques, J. D. d. O., Luizão, F. J., Teixeira, W. G., Vitel, C. M., & Marques, E. M. d. A. (2016). Soil Organic Carbon, Carbon Stock and Their Relationships to Physical Attributes Under Forest Soils in Central Amazonia. *Revista Arvore*, 40(2), 197-208.

Martin, D., Lal, T., Sachdev, C., Sharma, J. (2010). Soil organic carbon storage changes with climate change, landform and land use conditions in Garhwal hills of Indian Himalayan mountains. *Agriculture, Ecosystems & Environment*, 138(1-2), 64 - 73.

Mathews, J., Tan, T., & Chong, K. (2010). Indication of soil organic carbon augmentation in oil palm cultivated inland mineral soils of Peninsular Malaysia. *Planter*, 86(1010), 293-313.

Mayes, M., Marin-Spiotta, E., Szymanski, L., Erdoğan, M. A., Ozdoğan, M., & Clayton, M. (2014). Soil type mediates effects of land use on soil carbon and nitrogen in the Konya Basin, Turkey. *Geoderma*, 232, 517-527.

Mayor, J. R., Wright, S. J., Schuur, E. A., Brooks, M. E., & Turner, B. L. (2014). Stable nitrogen isotope patterns of trees and soils altered by long-term nitrogen and phosphorus addition to a lowland tropical rainforest. *Biogeochemistry*, 119(1-3), 293-306.

Mbow, C., Smith, P., Skole, D., Duguma, L., & Bustamante, M. (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Current Opinion in Environmental Sustainability*, 6, 8-14.

McCorkle, E. P., Berhe, A. A., Hunsaker, C. T., Johnson, D. W., McFarlane, K. J., Fogel, M. L., & Hart, S. C. (2016). Tracing the source of soil organic matter eroded from temperate forest catchments using carbon and nitrogen isotopes. *Chemical Geology*, 445, 172-184.

McDowell, M. L., Bruland, G. L., Deenik, J. L., & Grunwald, S. (2012). Effects of subsetting by carbon content, soil order, and spectral classification on prediction of soil total carbon with diffuse reflectance spectroscopy. *Applied and Environmental Soil Science*, 2012, 1-14.

McElligott, K. M., Seiler, J. R., & Strahm, B. D. (2017). The Impact of Water Content on Sources of Heterotrophic Soil Respiration. *Forests*, 8(8), 299.

McKinnon, M. C., Cheng, S. H., Dupre, S., Edmond, J., Garside, R., Glew, L., & Oliveira, I. (2016). What are the effects of nature conservation on human well-being? A systematic map of empirical evidence from developing countries. *Environmental Evidence*, 5(1), 8.

Meena, R. K., Verma, A. K., Kumawat, C., Yadav, B., Pawar, A. B., & Trivedi, V. K. (2017). Impact of clay mineralogy on stabilization of soil organic carbon for long-term carbon sequestration. *Int. J. Curr. Microbiol. App. Sci*, 6(5), 2157-2167.

Meersmans, J., Martin, M. P., De Ridder, F., Lacarce, E., Wetterlind, J., De Baets, S., Louis, B.P., Orton, T. G., Bispo, A., & Arrouays, D. (2012). A novel soil organic C model using climate, soil type and management data at the national scale in France. *Agronomy for Sustainable Development*, 32(4), 873-888.

Meier, I. C., Knutzen, F., Eder, L. M., Müller-Haubold, H., Goebel, M. O., Bachmann, J., & Leuschner, C. (2018). The deep root system of Fagus sylvatica on sandy soil: structure and variation across a precipitation gradient. *Ecosystems*, 21(2), 280-296.

Melo, V. F., Orrutéa, A. G., Motta, A. C. V., & Testoni, S. A. (2017). Land Use and Changes in Soil Morphology and Physical-Chemical Properties in Southern Amazon. *Revista Brasileira de Ciência do Solo*, 41,1-14.

Mendez-Millan, M., Tu, T. N., Balesdent, J., Derenne, S., Derrien, D., Egasse, C., M'Bou,T., Zeller,B., & Hatté, C. (2014). Compound-specific 13C and 14C measurements improve the understanding of soil organic matter dynamics. *Biogeochemistry*, 118(1-3), 205-223.

Meng, F., Lal, R., Kuang, X., Ding, G., & Wu, W. (2014). Soil organic carbon dynamics within density and particle-size fractions of Aquic Cambisols under different land use in northern China. *Geoderma Regional*, 1, 1-9.

Meng, S., Jia, Q., Zhou, G., Zhou, H., Liu, Q., & Yu, J. (2018). Fine root biomass and its relationship with aboveground traits of Larix gmelinii trees in Northeastern China. *Forests*, 9(1), 35.

Mengistu, C., Kibebew, Kibret and Tarekegn, Fite. (2017). Influence of Different Land Use Types and Soil Depths on Selected Soil Properties Related to Soil Fertility in Warandhab Area, Horo Guduru Wallaga Zone, Oromiya, Ethiopia. *International Journal of Environmental Science & Natural Resources*, 4(2), 1-11.

Mganga, K. Z., & Kuzyakov, Y. (2014). Glucose decomposition and its incorporation into soil microbial biomass depending on land use in Mt. Kilimanjaro ecosystems. *European Journal of Soil Biology*, 62, 74-82.

Mganga, K. Z., Razavi, B. S., & Kuzyakov, Y. (2016). Land use affects soil biochemical properties in Mt. Kilimanjaro region. *Catena*, 141, 22-29.

Miettinen, J., Shi, C., & Liew, S. C. (2011). Deforestation rates in insular Southeast Asia between 2000 and 2010. *Global Change Biology*, 17(7), 2261-2270.

Miettinen, J., Shi, C., Tan, W. J., & Liew, S. C. (2012). 2010 land cover map of insular Southeast Asia in 250-m spatial resolution. *Remote Sensing Letters*, 3(1), 11-20.

Minasny, B., & McBratney, A. B. (2018). Limited effect of organic matter on soil available water capacity. *European Journal of Soil Science*, 69(1), 39-47.

Minasny, B., McBratney, A. B., Malone, B. P., & Wheeler, I. (2013). Digital mapping of soil carbon. *Advances in Agronomy*, 118(3), 1-47.

Mishra, U., Lal, R., Slater, B., Calhoun, F., Liu, D., & Van Meirvenne, M. (2009). Predicting soil organic carbon stock using profile depth distribution functions and ordinary kriging. *Soil Science Society of America Journal*, 73(2), 614-621.

Mohawesh, Y., Taimeh, A., & Ziadat, F. (2015). Effects of land use changes and soil conservation intervention on soil properties as indicators for land degradation under a Mediterranean climate. *Solid Earth*, 6(3), 857.

Mohd-Aizat, A., Mohamad-Roslan, M., Sulaiman, W. N. A., & Karam, D. S. (2014). The relationship between soil pH and selected soil properties in 48 years logged-over forest. *International Journal of Environmental Sciences*, 4(6), 1129.

Mosquera, O., Buurman, P., Ramirez, B., & Amezquita, M. (2010). Soil carbon stocks under improved tropical pasture and silvopastoral systems in Colombian Amazonia. *In 19th World Congress of Soil Science, Soil Solutions for a Changing World*.pp.1-6.

MPOB. (2015). Malaysian Oil Palm Statistics. http://bepi.mpob.gov.my/index.php/statistics/.

Mudge, P. L., Schipper, L. A., Baisden, W. T., Ghani, A., & Lewis, R. W. (2014). Changes in soil C, N and δ15N along three forest–pasture chronosequences in New Zealand. *Soil Research*, 52(1), 27-37.

Mueller, K. E., Eissenstat, D. M., Hobbie, S. E., Oleksyn, J., Jagodzinski, A. M., Reich, P. B., Chadwick, O.A., & Chorover, J. (2012). Tree species effects on coupled cycles of carbon, nitrogen, and acidity in mineral soils at a common garden experiment. *Biogeochemistry,* 111(1-3), 601-614.

Muhameed, A. S., & Saleh, A. M. (2014). Classification of some Iraqi soils using discriminant analysis. IOSR-JAVS, 7(1), 31-39.

Muhammad, S. A., Seow, E.-K., Omar, A. M., Rodhi, A. M., Hassan, H. M., Lalung, J., Lee, A. Z., & Ibrahim, B. (2017). Variation of δ 2 H, δ 18 O & δ 13 C in crude palm oil from different regions in Malaysia: Potential of stable isotope signatures as a key traceability parameter. *Science & Justice*, 58(1), 59-66.

Müller, K. (2017). Soil microbial assimilation and turnover of carbon depend on resource quality and availability. Doctoral Dissertation.

Murty, D., Kirschbaum, M. U., Mcmurtrie, R. E., & Mcgilvray, H. (2002). Does conversion of forest to agricultural land change soil carbon and nitrogen? A review of the literature. *Global Change Biology*, 8(2), 105-123.

Musinguzi, P., Tenywa, J. S., Ebanyat, P., Tenywa, M. M., Mubiru, D. N., Basamba, T. A., & Leip, A. (2013). Soil organic carbon thresholds and nitrogen management in tropical agroecosystems: concepts and prospects.

Mussa, M., Ebro, A., & Nigatu, L. (2017). Soil organic carbon and total nitrogen stock response to traditional enclosure management in eastern Ethiopia. *Journal of Soil Science and Environmental Management*, 8(2), 37-43.

Mustafa, G., Latif, I., & Egwuma, H. (2016). An Empirical Analysis of Supply Response of Rubber in Malaysia. *American Journal of Agricultural and Biological Sciences*, 12, 148-156.

Nadeesha, W. T. K. a. S. (2016). Effects of oil palm cultivation on the properties of soil in some selected areas of nagoda divisional secretariat in the galle district,sri lanka. International *Journal of Agriculture, Forestry and Plantation*, 3, 114-118.

Nadelhoffer, K., & Fry, B. (1994). Nitrogen isotope studies in forest ecosystems. *Stable isotopes in ecology and environmental science*. Blackwell, Oxford, 316. 22-44.

Nasution, Z., & Mulyanto, B. (2014). Effects of land use on the physico-chemical properties of Andisols in Mt. Sinabung, North Sumatera, Indonesia. *Malaysian Journal of Soil Science*, 18, 51-60.

Natelhoffer, K.J.,& Fry B. (1988). Controls on natural nitrogen-15 and carbon -13 abundances in forest soil organic matter. *Soil Science Society of American Journal*. 52 (6). 1633-1640.

Nath, A. J., Brahma, B., Sileshi, G. W., & Das, A. K. (2018). Impact of land use changes on the storage of soil organic carbon in active and recalcitrant pools in a humid tropical region of India. *Science of the Total Environment*, 624, 908-917.

Nath, T. N. (2014). Soil texture and total organic matter content and its influences on soil water holding capacity of some selected tea growing soils in Sivasagar district of Assam, India. *International Journal of Chemical Sciences*, 12, 1419-1429.

Navarrete, D., Sitch, S., Aragão, L. E., & Pedroni, L. (2016). Conversion from forests to pastures in the Colombian Amazon leads to contrasting soil carbon dynamics depending on land management practices. *Global Change Biology*, 22(10), 3503-3517.

Nelson, G. C., Valin, H., Sands, R. D., Havlík, P., Ahammad, H., Deryng, D & Kyle, P. (2014). Climate change effects on agriculture: Economic responses to biophysical shocks. *Proceedings of the National Academy of Sciences*, 111(9), 3274-3279.

Neto, V., Ainuddin, N. A., Wong, M., & Ting, H. (2012). Contributions of forest biomass and organic matter to above-and belowground carbon contents at Ayer Hitam Forest Reserve, Malaysia. *Journal of Tropical Forest Science*, 24(2),217-230.

Newbold, T., Hudson, L. N., Hill, S. L., Contu, S., Lysenko, I., Senior, R. A., Contu, S., Lysenko, I., Senior, R., Börger, L Collen, B. Bennett, D., Choimes, A., Collen, B., Day, J., De Palma, A., Díaz, S., Echeverria-Londoño, S., Edgar, M., Feldman, A., Garon, M., Harrison, M., Alhusseini, T., Ingram, D., Itescu, Y., Kattge, J., Kemp, V., Kirkpatrick, L., KleyerM., Correia, D., Martin, C., Meiri, S., Novosolov, M., Pan, Y., Phillips, H., Purves, D., Robinson, A., Simpson, J., Tuck, S., Weiher, E., White, H., Ewers, R., Mace, G., Scharlemann, J.,& Purvis, A. (2015). Global effects of land use on local terrestrial biodiversity. *Nature*, 520(7545), 2-49.

Newcomb, C. J., Qafoku, N. P., Grate, J. W., Bailey, V. L., & De Yoreo, J. J. (2017). Developing a molecular picture of soil organic matter–mineral interactions by quantifying organo–mineral binding. *Nature Communications*, 8(1), 396.

Nian-Peng, H., Ruo-Meng, W., Zhang, Y.-H., & Quan-Sheng, C. (2014). Carbon and nitrogen storage in inner mongolian grasslands: relationships with climate and soil texture. *Pedosphere*, 24(3), 391-398.

Nishida, M., & Sato, Y. (2015). Characteristics of the relationship between natural 15N abundances in organic rice and soil. *Plant Production Science*, 18(2), 180-186.

Niu, C., Musa, A., & Liu, Y. (2015). Analysis of soil moisture condition under different land uses in the arid region of Horqin sandy land, northern China. *Solid Earth*, 6(4), 1157-1167.

Novita, N. (2016). Carbon stocks and soil greenhouse gas emissions associated with forest conversion to oil palm plantations in Tanjung Puting tropical peatlands, Indonesia. PhD dissertation, Oregon State University.

Nurul-Shida, S., Faridah-Hanum, I., Wan Razali, W., & Kamziah, K. (2014). Community Structure of Trees in Ayer Hitam Forest Reserve, Puchong, Selangor, Malaysia. The Malaysian Forester, 77(1), 73-86.

Oades, J. (1988). The retention of organic matter in soils. *Biogeochemistry*, 5(1), 35-70.

Oades, J. (1989). An introduction to organic matter in mineral soils. *In: Minerals in soil environments*, 89-159.

Obidzinski, K., Andriani, R., Komarudin, H., & Andrianto, A. (2012). Environmental and social impacts of oil palm plantations and their implications for biofuel production in Indonesia. *Ecology and Society*, 17(1)25.

Olaniyi, A. O., Abdullah, A. M., Ramli, M. F., & Sood, A. M. (2012). Factors affecting agricultural land use for vegetables production-a case study of the state of Selangor, Malaysia. *African Journal of Agricultural Research*, 7(44), 5939-5948.

Oldfield, E. E., Wood, S. A., & Bradford, M. A. (2018). Direct effects of soil organic matter on productivity mirror those observed with organic amendments. Plant and Soil, 423(1-2), 363-373.

Oso, V., & Rajashekhar Rao, B. (2017). Land use conversion in humid tropics influences soil carbon stocks and forms. *Journal of Soil Science and Plant Nutrition*, 17(2), 543-553.

Otieno, N. E., Dai, X., De Barba, D., Bahman, A., Smedbol, E., Rajeb, M., & Jaton, L. (2016). Palm Oil Production in Malaysia: An Analytical Systems Model for Balancing Economic Prosperity, Forest Conservation and Social Welfare. *Agricultural Sciences*, 7(02), 55-69.

Ozalp, M., Erdogan Yuksel, E., & Yuksek, T. (2016). Soil property changes after conversion from forest to pasture in Mount Sacinka, Artvin, Turkey. *Land Degradation & Development*, 27(4), 1007-1017.

Pachauri, R. K., & Reisinger, A. (Eds.). (2007). Climate change 2007 synthesis report: summary for policymakers. IPCC Secretariat.

Panunzi, E. (2008). Are grasslands under threat? Brief analysis of FAO statistical data on pasture and fodder crops. Rome: UN Food and Agriculture Organization.

Parry, L. E., & Charman, D. J. (2013). Modeling soil organic carbon distribution in blanket peatlands at a landscape scale. *Geoderma*, 211, 75-84.

Patthanaissaranukool, W., & Polprasert, C. (2011). Carbon mobilization in oil palm plantation and milling based on a carbon-balanced model-a case study in Thailand. *Environment Asia*, 4(2), 17-26.

Pauli, N., Donough, C., Oberthür, T., Cock, J., Verdooren, R., Pasuquin, J., & Fisher, M. (2015). Changes in soil quality indicators under oil palm plantations receiving best management practices. *Better Crops with Plant Food*, 99(2), 13-15.

Paz Ferreiro, J., Pereira De Almeida, V., Cristina Alves, M., Aparecida De Abreu, C., Vieira, S. R., & Vidal Vázquez, E. (2016). Spatial variability of soil organic matter and cation exchange capacity in an Oxisol under different land uses. *Communications in Soil Science and Plant Analysis*, 47(sup1), 75-89.

Pérez-Pantoja, D., Leiva-Novoa, P., Donoso, R. A., Little, C., Godoy, M., Pieper, D. H., & González, B. (2015). Hierarchy of carbon source utilization in soil bacteria: hegemonic preference for benzoate in complex aromatic compound mixtures degraded by Cupriavidus pinatubonensis strain JMP134. *Applied and Environmental Microbiology*, 81(12), 3914-3924.

Peri, P. L., Ladd, B., Pepper, D. A., Bonser, S. P., Laffan, S. W., & Amelung, W. (2012). Carbon (δ13C) and nitrogen (δ15N) stable isotope composition in plant and soil in Southern Patagonia's native forests. *Global Change Biology*, 18(1), 311-321.

Perie, C., & Ouimet, R. (2008). Organic carbon, organic matter and bulk density relationships in boreal forest soils. *Canadian Journal of Soil Science*, 88(3), 315-325.

Perveen, N., Barot, S., Alvarez, G., Klumpp, k., Martin, R., Rapaport, A., Herfurth, D., Louault,F ., & Fontaine, S. (2014). Priming effect and microbial diversity in ecosystem functioning and response to global change: a modelling approach using the SYMPHONY model. *Global Change Biology*, 20 (4), 1174-1190.

Pierret, A., Maeght, J. L., Clément, C., Montoroi, J. P., Hartmann, C., & Gonkhamdee, S. (2016). Understanding deep roots and their functions in ecosystems: an advocacy for more unconventional research. *Annals of Botany*, 118(4), 621-635.

Pirker, J., Mosnier, A., Kraxner, F., Havlík, P., & Obersteiner, M. (2016). What are the limits to oil palm expansion? *Global Environmental Change*, 40, 73-81.

Pisani, O., Hills, K. M., Courtier-Murias, D., Haddix, M. L., Paul, E. A., Conant, R. T., Simpson, A ., Arhonditsis , G & Simpson, M. J. (2014). Accumulation of aliphatic compounds in soil with increasing mean annual temperature. *Organic Geochemistry*, 76, 118-127.

Poeplau, C., & Don, A. (2013). Sensitivity of soil organic carbon stocks and fractions to different land-use changes across Europe. *Geoderma*, 192, 189-201.

Portenga, E. W., & Bierman, P. R. (2011). Understanding Earth's eroding surface with 10 Be. *Geology society of America* , 21(8), 4-10.

Potapov, P., Hansen, M. C., Laestadius, L., Turubanova, S., Yaroshenko, A., Thies, C., & Esipova, E. (2017). The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. *Science Advances*, 3(1), e1600821.

Powers, J. S., Corre, M. D., Twine, T. E., & Veldkamp, E. (2011). Geographic bias of field observations of soil carbon stocks with tropical land-use changes precludes spatial extrapolation. *Proceedings of the National Academy of Sciences*, 108(15), 6318-6322.

Priatmadi, B. J., & Yanuwiadi, B. (2014). Plant Age Influence on Soil Chemical Properties of Oil Palm Plantation in East Kotawaringin, Central Borneo. *Academic Research International*, 5(3), 64.

Puissant, J., Mills, R. T., Robroek, B. J., Gavazov, K., Perrette, Y., De Danieli, S& Cécillon, L. (2017). Climate change effects on the stability and chemistry of soil organic carbon pools in a subalpine grassland. *Biogeochemistry*, 132(1-2), 123-139.

Pullin, A. S., Bangpan, M., Dalrymple, S., Dickson, K., Haddaway, N. R., Healey, J. R & Vigurs, C. (2013). Human well-being impacts of terrestrial protected areas. *Environmental Evidence*, 2(1), 19.

Qian, J., Liu, J., Wang, P., Wang, C., Li, K., & Shen, M. (2017, March). Riparian soil physicochemical properties and correlation with soil organic carbon of an inflowing river of Taihu Lake. In IOP Conference Series: Earth and Environmental Science (Vol. 59, No. 1, p. 012053). IOP Publishing.

Qin, Y., Feng, Q., Holden, N. M., & Cao, J. (2016). Variation in soil organic carbon by slope aspect in the middle of the Qilian mountains in the upper Heihe river basin, China. *Catena*, 147, 308-314.

Qiu, L., Wei, X., Ma, T., Wei, Y., Horton, R., Zhang, X., & Cheng, J. (2015). Effects of land-use change on soil organic carbon and nitrogen in density fractions and soil δ13C and δ15N in semiarid grasslands. *Plant and Soil*, 390(1-2), 419-430.

Quezada, J. C., Guillaume, T., Buttler, A., & Ruegg, J. (2017). Impact of savanna conversion to oil palm plantations on C stocks dynamics and soil fertility. In EGU General Assembly Conference Abstracts, 19, pp 5697.

Quiroga, A., Buschiazzo, D., & Peinemann, N. (1996). Soil organic matter particle size fractions in soils of the semiarid Argentinian pampas. *Soil Science*, 161(2), 104-108.

Rabbi, S.M., Tighe, M., Delgado-Baquerizo, M., Cowie, A., Robertson, F., Dalal, R., Page, K., Crawford, D., wilson, B., Schwenke, G., Mcleod, M.,Badgery, W., Dang, Y.P., Bell, M., O'leary,G., liu, D.L., & baldock,J. (2015). Climate and soil properties limit the positive effects of land use reversion on carbon storage in Eastern Australia. *Scientific Reports*, 5,17866.

Ramdani, F., & Hino, M. (2013). Land use changes and GHG emissions from tropical forest conversion by oil palm plantations in Riau Province, Indonesia. *Plos One*, 8(7), e70323.

Ramos, F. T., Dores, E. F. D. C., Weber, O. L. D. S., Beber, D. C., Campelo Jr, J. H., & Maia, J. C. D. S. (2018). Soil organic matter doubles the cation exchange capacity of tropical soil under no- till farming in Brazil. *Journal of the Science of Food and Agriculture*. 98(9):3595-3602.

Rasse, D. P., Rumpel, C., & Dignac, M.-F. (2005). Is soil carbon mostly root carbon? Mechanisms for a specific stabilisation. *Plant and Soil*, 269(1-2), 341-356.

Rathinasamy, A., & Saliha, B. B. (2017). Fundamentals of soil science: Scientific Publishers.

Rawat, M., Arunachalam, K., & Arunachalam, A. (2015). Plant functional traits and carbon accumulation in forest. *Climate Change and Environmental Sustainability*, 3(1), 1-12.

Rethemeyer, J., Kramer, C., Gleixner, G., John, B., Yamashita, T., Flessa, H., Andersen, N., Nadeau, M.,& Grootes, P. M. (2005). Transformation of organic matter in agricultural soils: radiocarbon concentration versus soil depth. *Geoderma*, 128(1), 94-105.

Riana, R. N. A., & Sahibin, A. R. (2015). Soil carbon stock and soil characteristics at Tasik Chini Forest Reserve, Pahang, Malaysia. In 2015 Postgraduate Colloquium of the Universiti Kebangsaan Malaysia, Faculty of Science and Technology, American Institute of Physics Inc.

Ribeiro, A. B., & Nielsen, A. A. (1997). An application of discriminant analysis to pattern recognition of selected contaminated soil features in. *Geoderma*, 76(997), 253-262.

Rittl, T. F., Oliveira, D., & Cerri, C. E. (2017). Soil carbon stock changes under different land uses in the Amazon. *Geoderma Regional*, (10), 138-143.

Robin, P., Morel, C., Vial, F., Landrain, B., Toudic, A., Li, Y., & Akkal-Corfini, N. (2018). Effect of three types of exogenous organic carbon on soil organic matter and physical properties of a sandy technosol. *Sustainability*, 10(4), 1146.

Rodríguez-Lado, L., & Martínez-Cortizas, A. (2015). Modeling and mapping organic carbon content of topsoils in an Atlantic area of southwestern Europe (Galicia, NW-Spain). *Geoderma*, 245, 65-73.

Rolando, J. L., Dubeux, J. C., Perez, W., Ramirez, D. A., Turin, C., Ruiz-Moreno, M., Comerford,N. B., Mares, V., . Garcia, S.,& Quiroz, R. (2017). Soil organic carbon stocks and fractionation under different land uses in the Peruvian high-Andean Puna. *Geoderma*, 307, 65-72.

Röll, A., Niu, F., Meijide, A., Hardanto, A., Knohl, A., & Hölscher, D. (2015). Transpiration in an oil palm landscape: effects of palm age. *Biogeosciences*, 12(19), 5619-5633.

Rose, A., Shakurideen, O., Kolawole, M., Davies, N., Ayejuyo, O., Friday, A., & Ogbe, R. (2017). An Investigation of the Role of Vegetation as a Determinant of the Vertical Distribution of Soil Organic Carbon. *Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS)*, 8(1), 43-53.

Roslee, R., Abd Rahim, S and Razi Idris, W.M. (2016). Soil Carbon Sequestration in Different Ages of Oil Palm Plantations. *American-Eurasian J. Agric. & Environ. Sci*., 16 (5), 1004-1007.

Rossi, C. Q., Pereira, M. G., Loss, A., Gazolla, P. R., Perin, A., & dos Anjos, L. H. C. (2013). Changes in soil C and N distribution assessed by natural δ 13 C and δ 15 N abundance in a chronosequence of sugarcane crops managed with pre-harvest burning in a Cerrado area of Goiás, Brazil. *Agriculture, Ecosystems & Environment*, 170, 36-44.

Routh, J., Bianchi, T., Hutchings, J., Kuhry, P., & Ranjan, R. (2016). Organic carbon characteristics in Swedish forest soil trace post- depositional carbon dynamics. European *Journal of Soil Science*, 67(4), 492-503.

Rumpel, C., & Kögel-Knabner, I. (2011). Deep soil organic matter—a key but poorly understood component of terrestrial C cycle. *Plant and Soil*, 338(1-2), 143-158.

Rumpel, C., Kögel-Knabner, I., & Bruhn, F. (2002). Vertical distribution, age, and chemical composition of organic carbon in two forest soils of different pedogenesis. *Organic Geochemistry*, 33(10), 1131-1142.

Ryabenko, E. (2013). Stable isotope methods for the study of the nitrogen cycle. *In Topics in Oceanography*. InTech.

Saidy, A., Smernik, R., Baldock, J. A., Kaiser, K., & Sanderman, J. (2013). The sorption of organic carbon onto differing clay minerals in the presence and absence of hydrous iron oxide. *Geoderma*, 209, 15-21.

Salimon, C. I., Wadt, P. G. S., & Souza Alves, S. d. (2009). Decrease in carbon stocks in an oxisol due to land use and cover change in southwestern Amazon. *Ambiente & Água-An Interdisciplinary Journal of Applied Science*, 4(2). 57-65.

Salome, C., Nunan, N., Pouteau, V., Lerch, T. Z., & Chenu, C. (2010). Carbon dynamics in topsoil and in subsoil may be controlled by different regulatory mechanisms. *Global Change Biology*, 16(1), 416-426.

Salton, J. C., Mercante, F. M., Tomazi, M., Zanatta, J. A., Concenço, G., Silva, W. M., & Retore, M. (2014). Integrated crop-livestock system in tropical Brazil: Toward a sustainable production system. *Agriculture, Ecosystems & Environment*, 190, 70-79.

Sanaullah, A., Akhtaruzzaman, M., & Uddin, M. (2016). Effect of Topography and Soil Depth on Clay Content, Organic Matter Content, Active Acidity, Reserve Acidity and Cation Exchange Capacity of Some Tea Soils of Bangladesh. *Journal of Scientific Research*, 8(2), 229-235.

Sanderman, J., Creamer, C., Baisden, W. T., Farrell, M., & Fallon, S. (2017). Greater soil carbon stocks and faster turnover rates with increasing agricultural productivity. *Soil*, 3(1), 1-16.

Sanderman, J., Hengl, T., & Fiske, G. J. (2017). Soil carbon debt of 12,000 years of human land use. *Proceedings of the National Academy of Sciences*, 114(36), 9575-9580.

Santana, G. S., Dick, D. P., Tomazi, M., Bayer, C., & Jacques, A. V. (2013). Chemical composition and stocks of soil organic matter in a south Brazilian oxisol under pasture. *Journal of the Brazilian Chemical Society*, 24(5), 821-829.

Scharlemann, J. P., Tanner, E. V., Hiederer, R., & Kapos, V. (2014). Global soil carbon: understanding and managing the largest terrestrial carbon pool. *Carbon Management*, 5(1), 81-91.

Schiedung, H., Tilly, N., Hütt, C., Welp, G., Brüggemann, N., & Amelung, W. (2017). Spatial controls of topsoil and subsoil organic carbon turnover under C 3–C 4 vegetation change. *Geoderma*, 303, 44-51.

Schmidt, M. W., Torn, M. S., Abiven, S., Dittmar, T., Guggenberger, G., Janssens, I. A.,& Manning, D. A. (2011). Persistence of soil organic matter as an ecosystem property. *Nature*, 478(7367), 49.

Schnecker, J., Wild, B., Hofhansl, F., Alves, R. J. E., Bárta, J., Čapek, P., & Hofer, A. (2014). Effects of soil organic matter properties and microbial community composition on enzyme activities in cryoturbated arctic soils. *Plos One*, 9(4), e94076.

Schroth, G., D'Angelo, S. A., Teixeira, W. G., Haag, D., & Lieberei, R. (2002). Conversion of secondary forest into agroforestry and monoculture plantations in Amazonia: consequences for biomass, litter and soil carbon stocks after 7 years. *Forest Ecology and Management*, 163(1), 131-150.

Schrumpf, M., Kaiser, K., Guggenberger, G., Persson, T., Kögel-Knabner, I., & Schulze, E.-D. (2013). Storage and stability of organic carbon in soils as related to depth, occlusion within aggregates, and attachment to minerals. *Biogeosciences*, 10, 1675-1691.

Schwendenmann, L., & Pendall, E. (2006). Effects of forest conversion into grassland on soil aggregate structure and carbon storage in Panama: evidence from soil carbon fractionation and stable isotopes. *Plant and Soil*, 288(1-2), 217-232.

Shahbaz, M., Kuzyakov, Y., & Heitkamp, F. (2017). Decrease of soil organic matter stabilization with increasing inputs: mechanisms and controls. Geoderma, 304, 76-82.

Shaliha, J. A., Arifin, A., Haz, A. H., Abdul-Latib, S., Majid, N. M., & Shamshuddin, J. (2012). Emphasizing the properties of soils occurring in different land use types of tropical rainforest in Sarawak, Malaysia. *African Journal of Agricultural Research*, 7(48), 6479-6487.

Shamshuddin, J. (1981). Asas Sains Tanah. Dewan Bahasa dan Pustaka, Kuala Lumpur.

Shamshuddin, J., & Daud, N. W. (2011). Classification and management of highly weathered soils in Malaysia for production of plantation crops. In Principles, application and assessment in soil science. InTech.

Shang, S., Jiang, P., Chang, S. X., Song, Z., Liu, J., & Sun, L. (2014). Soil Organic Carbon in Particle Size and Density Fractionations under Four Forest Vegetation-Land Use Types in Subtropical China. *Forests*, 5(6), 1391-1408.

She, D., Shao, M., Timm, L., Sentís, I. P., Reichardt, K., & Yu, S. (2010). Impacts of land-use pattern on soil water-content variability on the Loess Plateau of China. *Acta Agriculturae Scandinavica Section B–Soil and Plant Science*, 60(4), 369-380.

Siangjaeo, S., Gheewala, S. H., Unnanon, K., & Chidthaisong, A. (2011). Implications of land use change on the life cycle greenhouse gas emissions from palm biodiesel production in Thailand. *Energy for Sustainable Development*, 15(1), 1-7.

Singh, B., Fang, Y., & Johnston, C. T. (2016). A Fourier-transform infrared study of biochar aging in soils. *Soil Science Society of America Journal*, *80*(3), 613-622.

Singh, M., Sarkar, B., Biswas, B., Bolan, N. S., & Churchman, G. J. (2017). Relationship between soil clay mineralogy and carbon protection capacity as influenced by temperature and moisture. *Soil Biology and Biochemistry*, 109, 95-106.

Singh, M., Sarkar, B., Sarkar, S., Churchman, J., Bolan, N., Mandal, S., & Beerling, D. J. (2018). Stabilization of soil organic carbon as influenced by clay mineralogy. In Advances in Agronomy (Vol. 148, pp. 33-84). Academic Press.

Sinsabaugh, R. L., Lauber, C. L., Weintraub, M. N., Ahmed, B., Allison, S. D., Crenshaw, C., Contosta, A, R., Cusack, D., Frey, S., Gallo, M. E (2008). Stoichiometry of soil enzyme activity at global scale. *Ecology letters*, 11(11), 1252-1264.

Sistla, S. A., Xio-Guang,W., Xio-Bo, WXio-Tao,L., & Xing_Guo, H. (2016). Carbon and nitrogen contents in particle--size fractions of topsoil along a 3000 km aridity gradient in grasslands of northern China. *Biogeosciences*, 13(12), 3635-3646.

Six, J., Elliott, E., & Paustian, K. (2000). Soil macroaggregate turnover and microaggregate formation: a mechanism for C sequestration under no-tillage agriculture. *Soil Biology and Biochemistry*, 32(14), 2099-2103.

Six, J., Frey, S., Thiet, R., & Batten, K. (2006). Bacterial and fungal contributions to carbon sequestration in agroecosystems. *Soil Science Society of America Journal*, 70(2), 555-569.

Skjemstad, J., Spouncer, L., Cowie, B., & Swift, R. (2004). Calibration of the Rothamsted organic carbon turnover model (RothC ver. 26.3), using measurable soil organic carbon pools. *Soil Research*, 42(1), 79-88.

Smith, D. R., Townsend, T. J., Choy, A. W., Hardy, I. C., & Sjögersten, S. (2012). Short- term soil carbon sink potential of oil palm plantations. *GCB Bioenergy*, 4(5), 588-596.

Smith, E. G., Henry Janzen, H., & Ellert, B. H. (2018). Soil organic carbon changes as influenced by carbon inputs and previous cropping system. *Canadian Journal of Soil Science*, 98(0), 1-4.

Smith, P., House, J. I., Bustamante, M., Sobocká, J., Harper, R., Pan, G., West, P.,Clark, J., Adhya,T., Rumpel, C., paustian,K., Asakawa, S., Bondeau, A., Jain, A., Meersmans,J.,& Pugh,T. A.M (2016). Global change pressures on soils from land use and management. *Global Change Biology*, 22(3), 1008-1028.

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice, C., Scholes, B., Sirotenko,O., Howden, M., McAllister, T., Pan, G., Romanenkov,V., Schneider,U., Towprayoon, S., Martin Wattenbach,M., & Smith, J. (2008). Greenhouse gas mitigation in agriculture. Philosophical Transactions of the Royal Society B: *Biological Sciences*, 363(1492), 789-813.

Soares, M. R., & Alleoni, L. R. F. (2008). Contribution of soil organic carbon to the ion exchange capacity of tropical soils. *Journal of Sustainable Agriculture*, 32(3), 439-462.

Söderström, B., Hedlund, K., Jackson, L. E., Kätterer, T., Lugato, E., Thomsen, I. K., & Jørgensen, H. B. (2014). What are the effects of agricultural management on soil organic carbon (SOC) stocks?. *Environmental Evidence*, 3(1), 2.

Solly, E. (2015). The Role of Fine Root Litter for Organic Matter Storage in Soils (Doctoral dissertation).

Solomon, D., Fritzsche, F., Lehmann, J., Tekalign, M., & Zech, W. (2002). Soil organic matter dynamics in the subhumid agroecosystems of the Ethiopian highlands. S*oil Science Society of America Journal*, 66(3), 969-978.

Song, Q.H., Tan, Z.H., Zhang, Y.P., Sha, L.Q., Deng, X.B., Deng, Y., Zhou,W. J., Zhao,J. F., Zhao,J. B., Zhang, X., Zhao, W., Yu, G.R., Sun, X. M., Liang, N.S., Yang, L.Y. (2014). Do the rubber plantations in tropical China act as large carbon sinks? *iForest-Biogeosciences and Forestry,* 7(1), 42-47.

Souza, W. J. O. d., & Melo, W. (2003). Matéria orgânica em um Latossolo submetido a diferentes sistemas de produção de milho. *Revista Brasileira de Ciência do Solo*, 1113-1122.

Sparling, G., & Schipper, L. (2002). Soil quality at a national scale in New Zealand. *Journal of Environmental Quality*, 31(6), 1848-1857.

Sreekanth, N., Padmakumar, B., & Thomas, A. (2013). Effect of land use conversion on soil carbon storage in a tropical grassland. *Annals of Environmental Science*, 7, 101-112.

Stahl, C., Fontaine, S., Klumpp, K., Picon- Cochard, C., Grise, M. M., Dezécache, C., Ponchant, L., Freycon, V., Blanc, L., Bonal, D., Burban, B., Franc,J., Soussana, O.,& Blanfort, V. (2017). Continuous soil carbon storage of old permanent pastures in Amazonia. *Global Change Biology*, 23(8), 3382-3392.

Steinbeiss, S., Temperton, V., & Gleixner, G. (2008). Mechanisms of short-term soil carbon storage in experimental grasslands. *Soil Biology and Biochemistry*, 40(10), 2634-2642.

Stergiadi, M., Van Der Perk, M., De Nijs, T., & Bierkens, M. F. (2016). Effects of climate change and land management on soil organic carbon dynamics and carbon leaching in northwestern Europe. *Biogeosciences*, 13(5), 1519-1536.

Stevenson, F. J. (1994). Humus chemistry: genesis, composition, reactions. John Wiley & Sons.

Stibig, H.J., Achard, F., Carboni, S., Rasi, R., & Miettinen, J. (2014). Change in tropical forest cover of Southeast Asia from 1990 to 2010. *Biogeosciences*, 11(2), 247.

Stockmann, U., Adams, M. A., Crawford, J. W., Field, D. J., Henakaarchchi, N., Jenkins, M., & Singh, K. (2013). The knowns, known unknowns and unknowns of sequestration of soil organic carbon. *Agriculture, Ecosystems & Environment*, 164, 80-99.

Stolt, M. H., & Lindbo, D. L. (2010). Soil organic matter. In Interpretation of micromorphological features of soils and regoliths (pp. 369-396).

Strey, S., Boy, J., Strey, R., Weber, O., & Guggenberger, G. (2016). Response of soil organic carbon to land-use change in central Brazil: a large-scale comparison of Ferralsols and Acrisols. *Plant and Soil*, 408(1-2), 327-342.

Sun, C., Liu, G., & Xue, S. (2017). Land-use conversion changes the multifractal features of particle-size distribution on the Loess Plateau of China. *International Journal of Environmental Research and Public Health*, 13(8), 785.

Sun, H. R., Wu, R. X., Li, P. H., Shao, S., QiI, L. L., & Han, J. G. (2008). Rooting Depth of Alfalfa [J]. *Acta Agrestia Sinica*, 3, 020.

Sun, L., Liu, W., Liu, G., Chen, T., Zhang, W., Wu, X., Zhang, G., Zhang, Y., Li,L., Zhang, B.,Wang B., Yang, R .,& Zhang, B. (2016). Temporal and spatial variations in the stable carbon isotope composition and carbon and nitrogen contents in current-season twigs of Tamarix chinensis Lour. and their relationships to environmental factors in the Laizhou Bay wetland in China. *Ecological Engineering*, 90, 417-426.

Sun, W., Zhu, H., & Guo, S. (2015). Soil organic carbon as a function of land use and topography on the Loess Plateau of China. *Ecological Engineering*, 83, 249-257.

Suryawanshi, A., Rai, H. K., Mitra, N. G., & Upadhyay, S. D. (2018). Appraisal of changes in bulk density and nitrogen content of a vertisol as affected by land use practices and depth. *Journal of Pharmacognosy and Phytochemistry*, 7(2), 2080-2083.

Suuster, E., Ritz, C., Roostalu, H., Kolli, R., & Astover, A. (2012). Modelling soil organic carbon concentration of mineral soils in arable land using legacy soil data. *European Journal of Soil Science*, 63(3), 351-359.

Syswerda, S., Corbin, A., Mokma, D., Kravchenko, A., & Robertson, G. (2011). Agricultural management and soil carbon storage in surface vs. deep layers. *Soil Science Society of America Journal*, 75(1), 92-101.

Szpak, P. (2014). Complexities of nitrogen isotope biogeochemistry in plant-soil systems: implications for the study of ancient agricultural and animal management practices. *Frontiers in Plant Science*, 5.

Tabot, P. T., Fonge, B. A., & Bechem, E. (2012). Simulation of the impacts of three management regimes on carbon sinks in rubber and oil palm plantation ecosystems of South-Western Cameroon. *Journal of Ecology and the Natural Environment*, 4(6), 154-162.

Takele, L., Chimdi, A., & Abebaw, A. (2015). Impacts of Land use on Selected Physicochemical Properties of Soils of Gindeberet Area, Western Oromia, Ethiopia. *Science, Technology and Arts Research Journal*, 3(4), 36-41.

Tamanai, A., Pucci, A., Dohmen, R., & Gail, H. P. (2017). Optical properties of non-stoichiometric amorphous silicates with application to circumstellar dust extinction. *The Astrophysical Journal*, 845(1), 6.

Tanaka, S., Tachibe, S., Wasli, M. E. B., Lat, J., Seman, L., Kendawang, J. J., Iwasaki,K. Sakurai, K. (2009). Soil characteristics under cash crop farming in upland areas of Sarawak, Malaysia. *Agriculture, Ecosystems & Environment*, 129(1-3), 293-301.

Tanaka-Oda, A., Kenzo, T., Inoue, Y., Yano, M., Koba, K., & Ichie, T. (2016). Variation in leaf and soil δ15N in diverse tree species in a lowland dipterocarp rainforest, Malaysia. *Trees*, 30(2), 509-522.

Tangki, H. B. (2015). Impacts of Forest Degradation and Oil Palm Conversion on Ecosystem Structure and Functioning in Sabah, Malaysian Borneo. (Doctoral dissertation),pp 20-53.

Tao, B., Tian, H., Chen, G., Ren, W., Lu, C., Alley, K. D., Xu, X., Liu, M., Pan, S., & Virji, H. (2013). Terrestrial carbon balance in tropical Asia: Contribution from cropland expansion and land management. Global and Planetary Change, 100, 85-98.

Tate, R. (1987). Organic matter transformations: ecosystem examples. Soil Organic Matter, Biological and Ecological Effects. Wiley, New York, 26-53.

Tatzber, M., Mutsch, F., Mentler, A., Leitgeb, E., Englisch, M., Zehetner, F., Djukic, I & Gerzabek, M. H. (2011). Mid-infrared spectroscopy for topsoil layer identification according to litter type and decompositional stage demonstrated on a large sample set of Austrian forest soils. *Geoderma*, 166(1), 162-170.

Tazikeh, H., Khormali, F., Amini, A., Motlagh, M. B., & Ayoubi, S. (2017). Soil parent material relationship in a mountainous arid area of Kopet Dagh basin, North East Iran. *Catena*, 152, 252-267.

Tellen, V. A., & Yerima, B. P. (2018). Effects of land use change on soil physicochemical properties in selected areas in the North West region of Cameroon. *Environmental Systems Research*, 7(1), 3.

Thomas, G. (1996). Soil pH and soil acidity. Methods of Soil Analysis Part 3—Chemical Methods(methodsofsoilan3), 475-490.

Thomas, G. W. (1982). Exchangeable cations. Methods of soil analysis. Part 2. Chemical and microbiological properties, (methodsofsoilan2), 159-165.

Tian, Q., He, H., Cheng, W., Bai, Z., Wang, Y., & Zhang, X. (2016). Factors controlling soil organic carbon stability along a temperate forest altitudinal gradient. *Scientific Reports*, 6, 18783.

Tiessen, H., & Stewart, J. (1983). Particle-size fractions and their use in studies of soil organic matter: II. Cultivation effects on organic matter composition in size fractions. *Soil Science Society of America Journal*, 47(3), 509-514.

Tonks, A. J., Aplin, P., Beriro, D. J., Cooper, H., Evers, S., Vane, C. H., & Sjögersten, S. (2017). Impacts of conversion of tropical peat swamp forest to oil palm plantation on peat organic chemistry, physical properties and carbon stocks. *Geoderma*, 289, 36-45.

Tonucci, R. G., Nair, V. D., Nair, P. R., & Garcia, R. (2017). Grass vs. tree origin of soil organic carbon under different land-use systems in the Brazilian Cerrado. *Plant and Soil*, 419(1-2), 281-291.

Torres-Sallan, G., Schulte, R. P., Lanigan, G. J., Byrne, K. A., Reidy, B., Simó, I., & Creamer, R. E. (2017). Clay illuviation provides a long-term sink for C sequestration in subsoils. *Scientific Reports*, 7, 45635.

Townsend, A. R. (2012). New Perspectives on Nitrogen Cycling in the Temperate and Tropical Americas: Report of the International SCOPE Nitrogen Project: *Springer Science & Business Media*.

Tropika, T. C. (2014). Soil properties and variation between three forest types in tropical watershed forest of Chini Lake, Peninsular Malaysia. *Sains Malaysiana*, 43(11), 1635-1643.

Trumbore, S., Da Costa, E. S., Nepstad, D. C., Barbosa De Camargo, P., Martinelli, L. A., Ray, D., & Silver, W. (2006). Dynamics of fine root carbon in Amazonian tropical ecosystems and the contribution of roots to soil respiration. *Global Change Biology*, 12(2), 217-229.

Udom, B. E., Benwari, A. O., & Osaro, E. T. (2015). Organic carbon and nitrogen distribution in particle-size fractions of soils under cassava, plantain and rubber based land use. *Int. J. Soil Sci*, 10, 166-176.

Unkovich, M. (2013). Isotope discrimination provides new insight into biological nitrogen fixation. *New Phytologist*, 198(3), 643-646.

Ussiri, D. A., & Lal, R. (2017). Introduction to Global Carbon Cycling: An Overview of the Global Carbon Cycle. *In Carbon Sequestration for Climate Change Mitigation and Adaptation* (pp. 61-76) Springer, Cham.

Vågen, T.-G., Walsh, M. G., & Shepherd, K. D. (2006). Stable isotopes for characterisation of trends in soil carbon following deforestation and land use change in the highlands of Madagascar. *Geoderma*, 135, 133-139.

van der Laan, C., Wicke, B., Verweij, P. A., & Faaij, A. P. (2017). Mitigation of unwanted direct and indirect land- use change–an integrated approach illustrated for palm oil, pulpwood, rubber and rice production in North and East Kalimantan, Indonesia. *GCB Bioenergy*, 9(2), 429-444.

van der Werf, G. R., Morton, D. C., DeFries, R. S., Olivier, J. G., Kasibhatla, P. S., Jackson, R. B., Collatz, G.J &Randerson, J.T. (2009). CO_2 emissions from forest loss. *Nature Geoscience*, 2(11), 737-738.

Van Groenigen, J., Huygens, D., Boeckx, P., Kuyper, T. W., Lubbers, I. M., Rütting, T. P., & Groffman, P. M. (2015). The soil N cycle: new insights and key challenges. *Soil*, 1(1), 235-256.

van Noordwijk, M., Ningsih, H., & Rahayu, S. (2015). Carbon neutral? No change in mineral soil carbon stock under oil palm plantations derived from forest or non-forest in Indonesia. *Agriculture, Ecosystems & Environment*, 211, 195-206.

van Straaten, O., Corre, M. D., Wolf, K., Tchienkoua, M., Cuellar, E., Matthews, R. B., & Veldkamp, E. (2015). Conversion of lowland tropical forests to tree cash crop plantations loses up to one-half of stored soil organic carbon. *Proceedings of the National Academy of Sciences*, 112(32), 9956-9960.

Vendrame, P. R. S., Eberhardt, D. N., & Rodrigues, O. (2011). Formas de ferro e alumínio e suas relações com textura, mineralogia e carbono orgânico em Latossolos do Cerrado Iron and aluminum forms and their relationship with texture, mineralogy and organic carbon in the Cerrado Oxisol. *Semina: Ciências Agrárias, Londrina*, 32(1), 1657-1666.

Veum, K. S., Goyne, K. W., Kremer, R. J., Miles, R. J., & Sudduth, K. A. (2014). Biological indicators of soil quality and soil organic matter characteristics in an agricultural management continuum. *Biogeochemistry*, 117(1), 81-99.

Vicente, L. C., Gama-Rodrigues, E. F., & Gama-Rodrigues, A. C. (2016). Soil carbon stocks of Ultisols under different land use in the Atlantic rainforest zone of Brazil. *Geoderma Regional*, 7(3), 330-337.

Viscarra, R., Raphael, A., Webster, R., Bui, E. N., & Baldock, J. A. (2014). Baseline map of organic carbon in Australian soil to support national carbon accounting and monitoring under climate change. *Global Change Biology*, 20(9), 2953-2970.

Waalewijn-Kool, P. L., Rupp, S., Lofts, S., Svendsen, C., & van Gestel, C. A. (2014). Effect of soil organic matter content and pH on the toxicity of ZnO nanoparticles to Folsomia candida. *Ecotoxicology and Environmental Safety*, 108, 9-15.

Walsh, E., & McDonnell, K. P. (2012). The influence of added organic matter on soil physical, chemical, and biological properties: a small-scale and short-time experiment using straw. *Archives of Agronomy and Soil Science*, 58(1), 201-205.

Walthall, C.L., J. Hatfield, P. Backlund, L. Lengnick, E. Marshall, M. Walsh, S. Adkins, M. Aillery, E.A. Ainsworth, C. Ammann, C.J. Anderson, I. Bartomeus, L.H. Baumgard, F. Booker, B. Bradley, D.M. Blumenthal, J. Bunce, K. Burkey, S.M. Dabney, J.A. Delgado, J. Dukes, A. Funk, K. Garrett, M. Glenn, D.A. Grantz, D. Goodrich, S. Hu, R.C. Izaurralde, R.A.C. Jones, S.-H. Kim, A.D.B. Leaky, K. Lewers, T.L. Mader, A. McClung, J. Morgan, D.J.

Muth, M. Nearing, D.M. Oosterhuis, D. Ort, C. Parmesan, W.T. Pettigrew, W. Polley, R. Rader, C. Rice, M. Rivington, E. Rosskopf, W.A. Salas, L.E. Sollenberger, R. Srygley, C. Stöckle, E.S. Takle, D. Timlin, J.W. White, R. Winfree, L. WrightMorton, and L.H. Ziska. (2012). Climate Change and Agriculture in the United States: Effects and Adaptation. USDA Technical Bulletin 1935. Washington, DC: USDA.

Wang, B., Wu, Y., & Chen, D. (2017). Stable isotopes of carbon and nitrogen help to predict the belowground communities at a regional scale. *Scientific Reports*, 7(1), 7276.

Wang, C., Han, S., Zhou, Y., Zhang, J., Zheng, X., Dai, G., & Li, M. H. (2016). Fine root growth and contribution to soil carbon in a mixed mature Pinus koraiensis forest. *Plant and Soil*, 400(1-2), 275-284.

Wang, C., Houlton, B. Z., Liu, D., Hou, J., Cheng, W., & Bai, E. (2018). Stable isotopic constraints on global soil organic carbon turnover. *Biogeosciences*, 15(4), 987-995.

Wang, H. M., Wang, W. J., Chen, H., Zhang, Z., Mao, Z., & Zu, Y. G. (2014). Temporal changes of soil physic- chemical properties at different soil depths during larch afforestation by multivariate analysis of covariance. *Ecology and Evolution*, 4(7), 1039-1048.

Wang, J., Bai, J., Zhao, Q., Lu, Q., & Xia, Z. (2016). Five-year changes in soil organic carbon and total nitrogen in coastal wetlands affected by flow-sediment regulation in a Chinese delta. *Scientific Reports*, 6, 21137.

Wang, S., Fan, J., Song, M., Yu, G., Zhou, L., Liu, J., Zhong, H., Gao, L., Hu, Z., Wu, W., & Song, T. (2013). Patterns of SOC and soil 13C and their relations to climatic factors and soil characteristics on the Qinghai–Tibetan Plateau. *Plant and Soil*, 363(1-2), 243-255.

Wang, S., Wang, X., & Ouyang, Z. (2012). Effects of land use, climate, topography and soil properties on regional soil organic carbon and total nitrogen in the Upstream Watershed of Miyun Reservoir, North China. J. *Environ. Sci.*;243:387–395.

Wang, Z., & Liu, G. (2016). Monitoring and predicting the soil water content in the deeper soil profile of Loess Plateau, China. *International Soil and Water Conservation Research*, 4(1), 6-11.

Wasak, K., & Drewnik, M. (2015). Land use effects on soil organic carbon sequestration in calcareous Leptosols in former pastureland–a case study from the Tatra Mountains (Poland). *Solid Earth*, 6(4), 1103-1115.

Wawrik, B. (2014). Stable Isotope Probing the Nitrogen Cycle: Current Applications and Future Directions. *Metagenomics of the Microbial Nitrogen Cycle*, 87.

Wei, X., Huang, L., Xiang, Y., Shao, M., Zhang, X., & Gale, W. (2014). The dynamics of soil OC and N after conversion of forest to cropland. *Agricultural and Forest Meteorology*, 194, 188-196.

Wei, X., Shao, M., Fu, X., & Horton, R. (2010). Changes in soil organic carbon and total nitrogen after 28 years grassland afforestation: effects of tree species, slope position, and soil order. *Plant and Soil*, 331(1-2), 165-179.

Wicke, B., Sikkema, R., Dornburg, V., & Faaij, A. (2011). Exploring land use changes and the role of palm oil production in Indonesia and Malaysia. *Land use Policy*, 28(1), 193-206.

Wiese, L., Ros, I., Rozanov, A., Boshoff, A., de Clercq, W., & Seifert, T. (2016). An approach to soil carbon accounting and mapping using vertical distribution functions for known soil types. *Geoderma*, 263, 264-273.

Wiesmeier, M., Spörlein, P., Geuß, U., Hangen, E., Haug, S., Reischl, A., Schilling, B, Lu¨ tzow, M. V Kögel- Knabner, I. (2012). Soil organic carbon stocks in southeast Germany (Bavaria) as affected by land use, soil type and sampling depth. *Global Change Biology*, 18(7), 2233-2245.

Wild, B., Gentsch, N., Čapek, P., Diáková, K., Alves, R. J. E., Bárta, J., & Lashchinskiy, N. (2016). Plant-derived compounds stimulate the decomposition of organic matter in arctic permafrost soils. *Scientific Reports*, 6, 25607.

Wong, C. C. (2010). Forage selection, screening, evaluation and production. In: Crop-animal systems research workshop. Proceedings of a workshop. August 25-29, 1988. Serdang, Malaysia. MARDI/IDRC/Asian Rice Farming Systems Network, IRRI. pp. 635-650.

Worku, G. (2014). Effect of Land Use and Land Cover Change on Some Soil Chemical and Physical Properties in Ameleke Watershed, South Ethiopia. *Journal of Environment and Earth Science*, 4(13), 32-37.

Wright, A. L., & Inglett, P. W. (2009). Soil organic carbon and nitrogen and distribution of carbon-13 and nitrogen-15 in aggregates of everglades Histosols. *Soil Science Society of America Journal*, 73(2), 427-433.

Wynn, J. G., Harden, J. W., & Fries, T. L. (2006). Stable carbon isotope depth profiles and soil organic carbon dynamics in the lower Mississippi Basin. *Geoderma*, 131(1), 89-109.

Xiang-ru, X., Kun, L., Bao-ku, Z., Jing-kuan, W., Wen-ju, Z., & Ming-gang, X. (2015). Distribution and enrichment characteristics of organic carbon and total nitrogen in mollisols under long-term fertilization. *Yingyong Shengtai Xuebao*, 26(7).

Xiao, L., Xue, S., Liu, G.B., & Zhang, C. (2014). Soil moisture variability under different land uses in the Zhifanggou catchment of the Loess Plateau, China. *Arid Land Research and Management*, 28(3), 274-290.

Xiao, S., Zhang, W., Ye, Y., Zhao, J., & Wang, K. (2017). Soil aggregate mediates the impacts of land uses on organic carbon, total nitrogen, and microbial activity in a Karst ecosystem. *Scientific Reports*, 7, 41402.

Xin, Z., Qin, Y., & Yu, X. (2016). Spatial variability in soil organic carbon and its influencing factors in a hilly watershed of the Loess Plateau, China. *Catena*, 137, 660-669.

Xiong, X., Grunwald, S., Myers, D. B., Kim, J., Harris, W. G., & Comerford, N. B. (2014). Holistic environmental soil-landscape modeling of soil organic carbon. *Environmental Modelling & Software*, 57, 202-215.

Xu, Y., Pu, L., Liao, Q., Zhu, M., Yu, X., Mao, T., & Xu, C. (2017). Spatial Variation of Soil Organic Carbon and Total Nitrogen in the Coastal Area of Mid-Eastern China. *International Journal of Environmental Research and Public Health*, 14(7), 780.

Xue, Z., Cheng, M., & An, S. (2013). Soil nitrogen distributions for different land uses and landscape positions in a small watershed on Loess Plateau, China. *Ecological Engineering*, 60, 204-213.

Yang, J.-C., Huang, J.-H., Tang, J.-W., Pan, Q.-M., & Han, X.-G. (2005). Carbon sequestration in rubber tree plantations established on former arable lands in Xishuangbanna, SW China. *Journal of Plant Ecology*, 29(2), 296-303.

Yang, S., Sheng, D., Adamowski, J., Gong, Y., Zhang, J., & Cao, J. (2018). Effect of Land Use Change on Soil Carbon Storage over the Last 40 Years in the Shi Yang River Basin, China. *Land*, 7(1), 1-9.

Yang, X. M., Drury, C. F., Reynolds, W. D., & Yang, J. Y. (2016). How do changes in bulk soil organic carbon content affect carbon concentrations in individual soil particle fractions?. *Scientific Reports*, 6, 27173.

Yao, H., Wilkes, A., Zhu, G., Zhang, H., Liu, X., Ding, D & Huang, D. (2016). Stable carbon isotope as a signal index for monitoring grassland degradation. *Scientific Reports*, 6, 31399.

Yevenes, M. A., Soetaert, K., & Mannaerts, C. M. (2016). Tracing nitrate-nitrogen sources and modifications in a stream impacted by various land uses, South Portugal. *Water*, 8(9), 385.

Yonekura, Y., Ohta, S., Kiyono, Y., Aksa, D., Morisada, K., Tanaka, N., & Tayasu, I. (2012). Dynamics of soil carbon following destruction of tropical rainforest and the subsequent establishment of Imperata grassland in Indonesian Borneo using stable carbon isotopes. *Global Change Biology*, 18(8), 2606-2616.

Yonekura, Y., Ohta, S., Kiyono, Y., Aksa, D., Morisada, K., Tanaka, N., & Kanzaki, M. (2010). Changes in soil carbon stock after deforestation and subsequent establishment of "Imperata" grassland in the Asian humid tropics. *Plant and Soil*, 329(1-2), 495-507.

Yu, J., Lv, X., Bin, M., Wu, H., Du, S., Zhou, M., & Han, G. (2015). Fractal features of soil particle size distribution in newly formed wetlands in the Yellow River Delta. *Scientific Reports*, 5, 10540.

Yuniarti, A., Arifin, M., Sofyan, E. T., Natalie, B., Sudirja, R., & Dahliani, D. (2018). The effect of Sinabung volcanic ash and rock phosphate nanoparticle on CEC (cation exchange capacity) base saturation exchange (K, Na, Ca, Mg) and base saturation at Andisol soils Ciater, West Java. *In AIP Conference Proceedings*,1927(1), 030003.

Zatta, A., Clifton- Brown, J., Robson, P., Hastings, A., & Monti, A. (2014). Land use change from C3 grassland to C4 Miscanthus: effects on soil carbon content and estimated mitigation benefit after six years. *Global Change Bioenergy*, 6(4), 360-370.

Zeng, Z.-X., Liu, X.-L., Jia, Y., & Li, F.-M. (2008). The effect of conversion of cropland to forage legumes on soil quality in a semiarid agroecosystem. *Journal of Sustainable Agriculture*, 32(2), 335-353.

Zhang, C., Xue, S., Liu, G.-B., & Song, Z.-L. (2011). A comparison of soil qualities of different revegetation types in the Loess Plateau, China. *Plant and Soil*, 347(1-2), 163-178.

Zhang, K., Dang, H., Zhang, Q., & Cheng, X. (2015). Soil carbon dynamics following land- use change varied with temperature and precipitation gradients: evidence from stable isotopes. *Global Change Biology*, 21(7), 2762-2772.

Zhang, L., Zhao, R., & Xie, Z. (2014). Response of soil properties and C dynamics to land-use change in the west of Loess Plateau. *Soil Science and Plant Nutrition*, 60(4), 586-597.

Zhang, M., Fu, X.-H., Fang, W., & Zou, X. (2007). Soil organic carbon in pure rubber and tea-rubber plantations in southwestern China. *Tropical Ecology*, 48(2), 201-207.

Zhang, W. Q., Pang, J. L., Sai, X., An, L., & Gao, S. (2016). Response of soil particle composition and soil bulk density to land use change. *Journal of Inner Mongolia Normal University*, 45(6), 870-874.

Zhang, W., Zhang, F., Qi, J., & Hou, F. (2017). Modeling impacts of climate change and grazing effects on plant biomass and soil organic carbon in the Qinghai–Tibetan grasslands. *Biogeosciences*, 14(23), 5455.

Zhao, D., Wu, S., Dai, E., & Yin, Y. (2015). Effect of climate change on soil organic carbon in Inner Mongolia. *International Journal of Climatology*, 35(3), 337-347.

Zhao, L., Sun, Y., Zhang, X., Yang, X., & Drury, C. (2006). Soil organic carbon in clay and silt sized particles in Chinese mollisols: relationship to the predicted capacity. *Geoderma*, 132(3), 315-323.

Zhao, W., Hu, Z., Li, S., Guo, Q., Yang, H., & Zhang, T. (2017). Impact of land use conversion on soil organic carbon stocks in an agro-pastoral ecotone of Inner Mongolia. *Journal of Geographical Sciences*, 27(8), 999-1010.

Zhou, J., Jiang, X., Wei, D., Zhao, B., Ma, M., Chen, S., & Li, J. (2017). Consistent effects of nitrogen fertilization on soil bacterial communities in black soils for two crop seasons in China. *Scientific Reports*, 7(1), 3267.

Zhou, S. (2017). Evaluating soil physical and chemical properties following addition of non-composted spent coffee and tea for athletic fields. Doctoral dissertation.

Zhu, M., Feng, Q., Qin, Y., Cao, J., Li, H., & Zhao, Y. (2017). Soil organic carbon as functions of slope aspects and soil depths in a semiarid alpine region of Northwest China. *Catena*, 152, 94-102.

Zhu, S., & Liu, C. (2006). Vertical patterns of stable carbon isotope in soils and particle-size fractions of karst areas, Southwest China. *Environmental Geology*, 50(8), 1119-1127.

Zhu, X., Chen, H., Zhang, W., Huang, J., Fu, S., Liu, Z., & Mo, J. (2016). Effects of nitrogen addition on litter decomposition and nutrient release in two tropical plantations with N2-fixing vs. non-N2-fixing tree species. *Plant and Soil*, 399(1-2), 61-74.

Zuber, S. M., Behnke, G. D., Nafziger, E. D., & Villamil, M. B. (2018). Carbon and nitrogen content of soil organic matter and microbial biomass under long-term crop rotation and tillage in Illinois, USA. *Agriculture*, 8(3), 37.

Zulkifli, S. Z., Mohamat-Yusuff, F., Mukhtar, A., Ismail, A., & Miyazaki, N. (2014). Determination of food web in intertidal mudflat of tropical mangrove ecosystem using stable isotope markers: A preliminary study. *Life Science Journal*, 11(3), 427-431.