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Research Article

Effects of Land Use and Land Cover on Soil Properties and Watershed Geomorphology at West Harareghe, Zonal Watersheds, Oromia, Regional, National, State, Ethiopia

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Abstract

Land and soil degradation are very severe in the highlands of Ethiopia which was resulted from anthropogenic activities. The major factors of land and soil degradation were includes population pressures, poverty, socio-economic issues, bad culture, and deforestation overgrazing improper implementation of SWC, continues and extensive cultivation. This study will be entitled with: The of effects of land uses and land covers on soil properties and watershed geomorphology at west Harareghe, zonal watersheds, Oromia, Regional, National, State, Ethiopia. The objectives of the study were incudes: to observe the effects of land use and land cover on chemical, physical and biological soil properties; to assess land uses and land covers changes using 50 years LANDSAT satellite images; to observe land use and land covers effects on watershed geomorphology, to investigate the correlation of soil properties with watershed geomorphology, to observe soil infiltration rate of the land uses and land covers and to examine the land uses/land covers effects on watershed recharge and restoration in quality and quantity. This study will be considered the correlation of dependent and independent variables of different land uses and land covers on soil properties and watershed geomorphology. In order to answer the proposed hypotheses and questionnaires the study will be use the significant level of 0.01 or 99% confidence intervals. Composite soil samples will be collects at two layers of soil depth from 0-20cm and 20-40cm. The total composite soil samples considered for this study will be 216 (per watershed 108 composite soil samples will be collects). In similar to determine soil MC which is very important to examine watershed recharge separately the total of 216 soil samples will be collects. Field soil texture testing using un-graduated cylinder and 30 cm rural ratio will be determinate. Soil BD will be test using the Beyoncé force method of the field. Laboratory and field analyzed soil data will be subject to GLM multivariate multiple of AOVA of. Statistical analysis of SAS software to observe the variations between different treatments. Chi-square of F-test will be considered to observe the variations between different land uses/land covers. Parameters that will be studying under this particular study includes: soil BD and MC, SOC, Ca and Mg, K, P, soil pH and soil texture.

Keywords

Treatments, Observation Units, Experimental Units, Sample Plot, Watershed Recharge, Soil Properties, Respondents

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1. Introduction

1.1. Background and Justification

Land degradation which has resulted from the bad anthropogenic activities of human-being that were did/ will be doing on the soil surface of the earth considered as the major factors that is decline both soil quantity and soil health or soil quality which in turn affects the agronomic production and productivity, environmental quality, food security, water security and biodiversity [21]. It is the global issue of this 21st century [19]. Soil degradation negatively affects the watershed ecosystem functions, services and watershed ecology by caused on-sites and off-sites erosion and hence impacted soil quality [24].

The past study done by [13], had revealed that, soil quality has held soil nutrients for a better plant growth and development; and provide a vital functions that are sustain biological activity, biodiversity and productivity; regulating water and solute flow; filtering, buffering, degradation, immobilizing, and detoxifying of organic and inorganic materials, including agricultural, industrial and municipal by-products and atmospheric deposition; storing and cycling nutrients and other elements within the Earth's biosphere; maintain energy flow and providing support of socioeconomic structures and protection for archeological treasures associated with human habitation. So that, *"soil quality" has been refer to coined to describe the combination of chemical, physical, and biological characteristics that enables soils to perform a wide range of functions"*.

For the matter of the better land uses and land covers conducting soil surveying and testing the physical , biological and chemical soil properties are play a crucial role on soil management and conservation practices. [15], was revealed that soil surveying and classification are important to known the analysis of chemical, biological and physical properties of the soils, identification of major soil groups and series. Moreover evaluation of land capability classes, limitations and hazards.

Assessment of erosion rate under different spatial variations are varies. These differences are due to variations of land covers and land uses for example soil erosion under undisturbed natural forest is lower than cultivated land uses [22]. These are implies that soil properties indicate that there are different with erosion occurred under different land uses/land covers. So that studying and understanding of soil properties under different land uses and land covers are work as a pivot and input of soil and water conservation measures and soil management practices, but the preceding one is not the first applicable, whereas the latter one is the first applicable.

The change in depletion of watershed water resources and their physical characteristics, watershed ecosystem functions and services, decline or increase of soil properties and agricultural yield to search an alternative solutions should governed with understand of land uses and land covers [17]. For that matters studying land use and land cover changes using remote sensing of high resolutions of satellite images has play a crucial role on understanding of soil properties either improve or decline. Classification of land uses and land covers changes by resampling, georeferenced and to map the changes by use of spatial tool should strengthen the effects on soil properties [1].

1.2. Statement of the Problem

Agriculture is the backbone of Ethiopian economy [4, 20] while the most severely affected by soil erosion, sedimentation and flood. [18], as result of improper plan of watershed land use policy which difficult to implement at watershed level based on the proper utilization and conservation techniques of watershed natural resources, but not overexploitation of watershed natural resources that are destroyed watershed ecosystem functions, services and watershed ecology [2]. The major factors that were adversely affected watershed and their agriculture, natural resources and socio-economic setting of the societies include: weak local institution, bad habits and, population pressure, political instability, lack of land tenure and land use policy, improper watershed land use planning, improper implementation of SWC measures and site un-matching of SWC (considering topography, soil types and agro-climatic conditions), overgrazing, overexploitation of natural resources, deforestation, development of infrastructure without merge with SWC, and lack of property right on watershed natural resources utilization [22]. These factors and others related factors such as whole crop harvesting, toxic substance, soil erosion by itself, solid and liquid waste substances, intensive application of commercial fertilizers, continues use of monocropping, improper tillage and traffic vehicles, animal hooves, lack of land use policy and planning, and free grazing during dry seasons after crop harvests, are severely affects soil properties The consequences of these factors include: soil erosion, landslide, mudding, sedimentation, environmental pollution, damage of watershed ecological value and watershed ecosystem function and services, flooding, gully development, decline of essential soil fertility and soil properties and decline of land production and productivity either temporarily or permanently [3, 6, 10, 16]. Moreover, land and soil degradation results from erratic rainfall and long drought [30, 10].

The previous study done by [3, 6, 22], had revealed that degradation of soil and land under different spatial variation or land uses and land covers are different. According to these authors had reported, *measurements of soil loss from hill slopes in west Africa* [22], *ranging in steepness from 0.3 to 4° yield mean annual rates of 0.15, 0.20 and 0.03 t/ha under natural conditions of open savanna grassland, dense savanna grassland and tropical rain forest, respectively.* However, conversion of forested lands to agricultural lands to cultivate food crops increases the rates to 8, 26 and 90 t /ha, respectively. In contrast to that leaving the lands without cultivation as bare it increases more than twice and produces the rates of 20, 30 and 170 tonnes per hectare, respectively. Concurrently, decline of soil properties and crops yield are different under different land uses and land covers. The past study did by [7, 22], were reported in their studies, the rates of soil formation throughout the world ranges from 0.01 to 7.7mm per year. The fastest rates are exceptional, however the average value accounted about 0.1mm per year. But, the loss of soil by erosion based on soil loss tolerance it ranges from 2 to 11 t per ha which is tolerate based on the soil types or soil separates [28], had indicated that soil conservation was started at broad based of terraces built because of poor soil properties.

This study will be observing the effects of the factors of different land uses and land covers in association with watershed geomorphology on soil properties. Moreover the study will be assessing the 50-years of land uses and land covers changes by use of the LANDSAT satellite images with the help of ArcView GIS and observes the effects of land uses, and land covers on soil properties [1].

1.3. Objectives

1.3.1. General Objective

This research will be observing the difference between different land uses and land covers in association with watershed geomorphology on soil properties and with assessment of 50-years LANDSAT satellite images of land uses and land covers with the help of ArcView GIS at west Harareghe zonal watersheds.

1.3.2. Specific Objectives

1) To investigate the effects of land use and land cover and watershed geomorphology on chemical, biological, and physical soil properties between treatments and within the treatments.
2) To examine the effects land use and land cover on watershed recharge by the measurement between treatments.
3) To assess the effects of land use/land cover changes using 50-years LANDSAT satellite images and the help of ArcView GIS.
4) To observe the effects of the land use and land cover on soil infiltration rate.
5) To examine the effects of land use and land cover on soil properties in relation to soil depth.

1.4. Scope of the Study

The study will be covers land uses and land covers of maize land, sorghum land, teff land, chat land, home garden AF land, plantation forest and natural forest lands, coffee land. Soil samples will be collects at 0-20cm and 20-40cm soil depth. Moreover, they shall cover different structural SWC measures and control lands will be considered as a factors of the study. Specifically they will be study soil BD and MC, SOC, Ca and Mg, K, P, soil pH and soil texture.

1.5. Study Questionnaires

The following questionnaires will be clarify the study experimental design of soil properties and supported with land use and land cover changes and watershed geomorphology.

1) All the factors described under this study will be affects both the change of soil properties and watershed recharge?
2) How many factors /treatments to be study possible differences are statistically significant?
3) What are the smallest differences between the average treatments effects described?
4) Which statistical method or model preferable and use to analysis the data?
5) How should treatments be randomized to observation units? [13]

1.6. Hypotheses of the Study

The study will be start by considers the two hypotheses are no variations of soil properties under different land uses and land covers at west Harareghe watersheds. Although it will be study by no differences for selected soil properties under different structural SWC measures built to control erosion, runoff, sedimentation and flood in comparison to control land uses which are located beside in north, south, east and west direction on certain distance apart to each other's. These ideas are the concept of null hypothesis which even if true it will be reject and accept the alternative hypothesis.

$$H_o = \mu_o = \mu$$

The alternative hypothesis will be considered the concept of the opposite of null hypothesis. That is at least by one mean of representative sample population of the whole population even if the null hypothesis is true; it will be rejecting and accept alternative hypothesis.

$$H_a = \mu_o \neq \mu$$

The research will be proof these two hypotheses before reject or adopt one of them it will be testify the two hypotheses based on the sample size using the alpha of 0.01 significant levels which is refer to 99% confidence interval (CI). Considered a test of:

$$H_o \ vsersus \ H_a \ for \ distributio \ with \ a \ unkown \ parmeter \ \theta \ four \ possible$$

situations are available but two of which lead to a correct decision.

The probability of:

$P_\theta(rejeced\ H_o/H_o is\ true = P_\theta(H_o/H_a) \leq \alpha\ for\ all\ \epsilon H_o)$. Probability of type I error, α is to be fixed before experiment.

The probability of:

$P_\theta\left(H_o\ accepted \frac{\mu-\mu_o}{H_{o\ is\ false}}\right) = P_\theta\left(\frac{H_o}{H_a}\right) \geq \beta\ for\ all\ \epsilon H_a$

is called the probability of a type II error. This probability pends on the true value of $\theta\ such\ that\ the\ fuction\ of\ G(\theta) = P_\theta(rejected\ H_o)$ is called the power of the test.

Considered as an example the two factors of independent variables; applying the linear model to compared the two factors it will test the hypothesis $H_o: \mu_A = \mu_B\ using\ the\ statistics$

$$t_{n_1+n_2-2} = \frac{\bar{X}-\bar{Y}}{\delta\sqrt{\frac{n_1 n_2}{n_1+n_2}}}$$

$$Testing\ H_o: \sigma_A{}^2 = \sigma_B{}^2 = \sigma^2$$

$\sigma^2{}_x = \frac{\sum_{i=1}^{n_i}(X_i-\bar{X})^2}{n_1-1}\ and\ \sigma_y{}^2 = \frac{\sum_{i=1}^{n_2}(Y_i-\bar{Y})^2}{n_2-1}$ Follows a X^2 normal distribution with $n_1 - 1\ and\ n_2 - 1$ degree of freedom (df) respectively and the ratio follows an F- distribution

$$F = \frac{\sigma^2{}_x}{\sigma^2{}_y} \sim F_{n_1-1,n_2-1}$$

$$F_{n_1-1,n_2-1,\alpha/2} = \frac{1}{F_{n_1-1,n_2-1,1-\alpha/2}}$$

Decision of two sided

$H_o: \sigma^2{}_A = \sigma^2{}_B versus\ H_a: \sigma^2{}_A \neq \sigma^2{}_B\ \ H_o\ is\ rejected\ if$

$$F > F_{n_1-1,n_2-1,1-\alpha/2}$$

$$F < F_{n_1-1,n_2-1,\alpha/2}$$

The ratio follows an F-distribution

$$F = \frac{\sigma^2{}_A}{\sigma^2{}_B} \sim F_{n_1-1,n_2-1}$$

For one sided

$$H_o: \sigma^2{}_A = \sigma^2{}_B verses\ H_a: \sigma^2{}_A > \sigma^2{}_B$$

If $F > F_{n_1-1,n_2-1,1-\alpha}$, then H_o is rejected.

The hypotheses stated or presented above will disprove or prove by use of significant level of 0.01 depend on the techniques developed by statisticians [13].

1.7. Significance of the Study

The study will be significant to provide alternative solutions for different land uses, land covers and SWC conservation practices and to update teacher's professional on teaching and learning processes.

2. Literature Reviews

2.1. Soil Ammonium

Soil ammonium is determined by steam distillation method. But the method have two disadvantageous one it is time consuming method and second the materials uses to analysis is too expensive [15]. The most common method used to analyze the ammonium in Africa and *this tried and true method*, because *it is very accurate* and the *most laboratories have spectrophotometers or colorimeters that can be used for ammonium determination. Another, alternative method is the blue color requires two hours to develop, and is stable for 12 hours. The ammonia electrode is fast gaining popularity as a rapid and inexpensive method for nitrogen (N) determination.*

2.2. Soil pH

Soil pH determination is playing a crucial role on soil classification on the basis of acidity or/ and alkalinity and neutral. Soil pH value is a measure of the hydrogen or hydroxyl ions activity of the soil-water solutions [30].

2.3. Soil Organic Carbon

As [30] had revealed Organic carbon is oxidized with potassium dichromate in the presence of concentrated sulphuric acid. Potassium dichromate produces nascent oxygen, which combines with the carbon of organic matter to produce CO_2. The excess volume of $K_2Cr_2O_7$ is titrated against the standard solution of ferrous ammonium sulphate in presence of H_3PO_4, using ferroin to detect the first appearance of un-oxidized ferrous iron and thus volume of $K_2Cr_2O_7$ can be found out which is actually required to oxidize organic carbon.

Reaction:

$$2K_2Cr_2O_7 + 8H_2SO_4 \rightarrow 2K_2SO_4 + 2Cr_2(SO_4)_3 + 8H_2O + 6O$$

2.4. Calcium and Magnesium

WFP were described calcium and magnesium ions serve as plant nutrients in cation exchange capacity of soils calcium and magnesium forms the predominant exchangeable base, constituting 60 to 80% of total exchangeable cations [30]. *Calcium and Magnesium ions serve as plant nutrients in cation exchange capacity of soils. Calcium and magnesium forms the predominant exchangeable base, constituting 60 to 80% of total exchangeable cations* [11].

2.5. Soil Texture

The most important to recognized soil texture is the field testing method by use the method of un-graduated local cylinder and 30cm ratio rural reading method of soil layers after 1:30 hours but the universal conventional was read the soil layers admixture with water after 1.00hr. The method does not needs to sieve except separation of impurities such as stones, rocks, leaves, crop residues, weeds, grasses and twigs. No needs to crush the large soil clods while fill into local cylinder and string with stick thoroughly after add municipal/pipe water. Fill any height of cylinder such as 4cm, 5cm, and 6cm or 7cm and 8cm but not more than these are recommended, Because, the height to fill soil samples does not impacts on testing of soil texture separates.

2.6. Soil Bulk Density

The most method of soil BD determination in the field is by use of buoyance force method or capture of displaced water after immersed soil colds into another cylinder either graduated or not while taken field weight with beam balance on field. So that soil BD expressed with gm/cm^3. The volume of displaced water is captured by another wider graduated or ungraduated cylinder [30].

2.7. Soil Potassium

The most critical necessary element that is influencing plant growth and production. It is one of the elements which influence for dozens of enzyme’s responsible for plant processes. *Potassium is essential for photosynthesis, for protein synthesis, for starch formation and for translocation of sugars.* It is applies the equilibrium effects on the adverse effects of N and P. the aim of soil K determination is to know the available contents in soil either limited or over excess because both are negative impacts on plant growth and others essential elements found in the soil [28].

Purpose of potassium determination is to determine available potassium content in given soil. It affects plant photosynthesis, balancing effects of both soil nitrogen and soil phosphorus. Important to plant growth and production next to N and P [13].

2.8. Soil Phosphorous

The main reason why it needs to determine soil phosphorous; it is the second essential element needs for plant growth, production and productivity. It has the most important that are affects plant qualities and functions such metabolic activities which have both catabolic and anabolic activities of plant, nitrogen fixation, crop maturity, protein synthesis from sugar or starch root development, set a seeds, flower and vegetative biomass, which affects adversely our development by affecting available soil. Thus, P prediction is very crucial either limited or access [31].

2.9. Cation Exchange Capacity

According to the laboratory manual wrote by [31], had indicated, ECE is the total cations or positive charge of elements occurred in the soils. Soils that have contains the higher CEC retain the higher soil cations. *Soils that have the higher soil colloidal hold the higher CEC. CEC also increases as organic matter increases. CEC in clay mineral usually range from 10 to 150 meq. /100g, whereas CEC values in organic matter ranges from 200 to 400 meq/100g.*

Cation exchange capacity (ECE) is a measure of the quantity of readily exchangeable cations which are neutralizing the negative charges of cations that are available in the soils in the form of such ions: $Ca^{+2}, Mg^{+2}, K^{++}, NH_4{}^+, Na^+$ *and* Mn^{+2} [14]. CEC is important in causing and correcting soil acidity and basicity.

3. Materials and Methods

3.1. Description of the Study Area

Geographically the boundary of Ethiopia laid of land is located between 30 00□ N and 15000 N Latitude or 33000E and 48000E Longitude [21], whereas West Harareghe zone of Oromia National Regional State is situated in eastern Ethiopia and geographical boundary of the liad of the land located between $8°39'59.99''$ N Latitude and $40°29'59.99''$ E Longitude from the equator [26].

Geographical boundary of Chiro administration demarcation of the laid of the land is located between 9°00’ to 9°15’ N Latitude and 40°45’ to 41°00’ E Longitude from the equator whereas geographical boundary of Doba administration demarcation is located between 9°15’ to 9°30’ N Latitude and 41°00’ to 41°15’ E Longitude from the equator [12]. Altitude of the highlands of the Harareghe region is ranges from the lowest of 1000m to the highest of 3400 m a. s. l. [29]. The study Woreda were ranges between the mentioned altitudes [22]. The mean maximum temperature of Ethiopia is 45℃ and it covers from April to September whereas the mean maximum temperature is 40℃ from October to March is recorded in the Qafar Depression Valley North-East Ethiopia [29]. The mean maximum temperature in the hot area of the country, the north-western lowland area is about 40 ℃ in June. However, the western and south-eastern lowlands of the mean maximum temperature is between 35 ℃-40 ℃ in April. The lowest mean minimum temperature is 4 ℃ especially at night it is recorded in the highlands particularly, in the valley bottoms occasionally the ground frost is recorded. The annual average rainfall in Ethiopia is categorized into three groups: 1200mm to 1600mm in the lowland, 1600mm to 2600mm in the midland and > 3000mm in the highlands [28].

Ethiopia has five agro-climatic Zones that are defined by two factors altitude and temperature. Moreover, this study had been described; West Harareghe Zone of laid of the land is under the warm to cool semi-arid zones of the country and characterized with highland temperature. Its altitude ranges from 1500m to 2500 m a. s. l. It was also reported that; the annual average rainfall from <700mm in lowlands (Kolla/Gamojji) to 1200mm in Dega/Batta agro-climatic conditions are common. West Harareghe agro-climatic classifications are based on the altitude belts [28]. Accordingly 2500 to 4500m a. s. l. are Dega or Batta climate, 1500 to 2500 are Weynadega or BattaDare climate and the rest from 1000m to 1500m are Kolla or Gamojji climate conditions [31].

3.1.1. Soil Types

Ethiopian major soil types are accounted about 19 soil types and grouped into three types: these are Lithosols which covers about 163, 185 km^2 (14.7%), Fuvisols (soil deposits of parent materials laid down by Rivers and streams) covers to 882, 61.5 km^2 (7.9%) and Aluvisols which covers about 640, 63.5 km^2 (5.8%) of the areas [25].

3.1.2. Land Uses/Land Covers

The past study did by [25, 23], had stated that, Ethiopia has total land area of 1221480 km^2 (122,148,000 ha), while the study done by [19], was reported that 1127.127km^2. Out of this 1119.683 km^2 is terrestrial land and 7444km^2 is covers with water bodies [20]. The major land uses and land covers of Ethiopia is encompasses: 1115000 km^2 (111,500,000 ha) and among this total land area of the country include: cultivation land is covers about 14.7%, grazing and browsing lands are accounted about 56.9%, forest land is covers about 11.7% and bush land is covers about 18.7% [23, 25].

3.1.3. Topography

Topography of the Ethiopia is classified into five classes based on the slope of the land; 0-10% which held lowlands (703000km^2) area of the country (less than 15000 m a. s. l.) without the exception of the flat plain (11-25%) highland plateau (26-35%) and the valley bottoms (36-50%). The rest classes (>50%) are grouped into the Ethiopian highlands which occupies the large areas of the country [20]. During the transition of the Dirge Regime and the current government who are held the place and governing the country both the plantation and natural forests were deforested which heavily degraded in quantity and quality. However, the remnant forest covers are found in the form of patch and fragment are available. In provision of food-for-work as incentive to local people and by enforcement in massive the past socialism follower government were covers with forests on the vast degraded areas of the mountainous and along the public roads both in mixed and monoculture forest plantations of indigenous and exotic tree species. But after the failure of the Keyi shiber government the covered areas deforested including the remnant natural forests for growth of crops for staple food.

3.1.4. Vegetation Covers

Indigenous forest trees and shrubs found in the west Harareghe zone watershed include: Carprunea urea, Brucea antidisentrica, Olea african, Olea europeana, Coridia africana, Podocarpus africana (flactous), Junprous procera, Celtous africana, Croton mcroctichea, Vernonia amglenea, Bulntus egyptica, Acacia abssiynica, Acacia tortolious, Acacia nilotica, Acacia decrenous, Cacea edilous and Acacia polyicanta. All of these species currently found as endangered and threaten species. Exotic forest trees and shrubs species include: Acacia salegena, Gravilous robusta, Casurina equistifolia, Pinus patula, Pinus radiate, Cupressous lustanica, Shunous molle, Millita azendrichta, Azandrichata indica, Eucalyptus camadolosis, Phonex spicies, Eucalyptus globules, Eucalyptus citirodorea, Prosopius joleflora, and Lantana camera. The latter two species are Allen species in Ethiopia.

In the whole west Harareghe zone mixed farming system is a common practice. That is, crops growing and rearing animals with the special feeding which is refer to cut-and-carry system by ties animals at one place is the common in the zone. Common cereal crops growing for staple food in west Harareghe zone include sorghum, maize, teff, wheat, barely, pea, and bean. Root and tuber crops growing in zone both for subsistence and commercial purposes include cabbage, tomato, carrot, white and red onion, sugar bit, and potato. Commercial crops include *Kathea edulious*, and coffee species. Fruit crops growing in the zone include *prunus american, Mangifera indica, Pisdium gawave,* orange and leamon.

3.2. Methodology of the Study

After collected the essential and basic information from the zonal watersheds, Zone office, and Weroda offices; then the soil samples will be collects. Purposefully, systematic sampling techniques of the stratification will be decided and determined the representative sample size of the whole population. The major factors will be study under this research include: cultivated land, natural forest and, plantation forest lands, home garden agroforestry land, *katha eduilou*s land, and structural contour bund. The total of 6 factors will be decided to be study. Replicate three times for each factor to approach the accuracy and reduce biasness by measures the estimate error [13]. Soil samples will be collects from two layers of soil depth 0-20cm and 20-40cm. One Woreda from west Harareghe zone and two watersheds per Weroda will be selects. That is one from lowland and another one from middle land. The selected watershed will be divide into three sub-watersheds based on the slope of the landscape and the orientation of the watershed. These are upper stream watershed or water header, middle stream watershed or transition of watershed, bottom or downstream watershed. A total of 18 factors will be randomly selects. A grand total of treatments will be 2WS X3R X6 FR =36 factors. Samples will be distributed per EU by use the square design distributions on 50m distance apart. One on the upper, one on the middle and another on the bottom of EU systematically. Samples will be collects from the four corners and center of the square and made composite for laboratory analysis. Three OUs will be the placed of soil sample collections. 18 factors per watershed will be placed to study the variations of variables whereas 6 factors will be study per sub-watershed. 2 soil depth of layers will be considered and 3, observation units will be the place of soil sample collections. Per EU 6 composite soil samples will be collects. Per sub-watershed the total of 36 composite samples will be collects. Per watershed the total of 108 composite soil samples will be collects. Thus, from two watersheds about 216 composite soil samples will be collects to observe the variations between each factors by conduct the laboratory analysis. The volume of sample collection has hold the volume of the core sampler or auger; having 5.8cm diameter (2.9cm radius).and 25cm height with 5cm extra height which used to hammered. The calculated volume is 528.415cm^3.

$$V = A \times H = \pi \times r^2 \times H = \pi \times 2.9cm^2 \times 20cm = 528.415cm^3$$

The study will be considers the dependent and independent variables of land uses and land covers. Per watershed 108 undisturbed soil samples will be collect to observe the variations of soil BD and MC between factors and from two watershed 216 separate soil samples will be collects. Moreover 108 composite soil samples will be collects to observe soil texture on the field per watershed and from two watershed 216 composite soil samples will be collects [12].

3.3. Experimental Design

The past study done by [27], had revealed that, the choice of sampling design depends on the size and accessibility of the project area, modeling objectives, desired level of confidence and precision, expected variability of the soil feature(s), and the cost of obtaining samples. Statistical satisfaction limits with money, time and staff available. The study experimental design will use the stratified systematic sampling techniques. *The sampling region is spatially subset into different strata, and systematic sampling is applied to each strata*. *Strata are typically geographic, such as land cover type, landform, slope gradient, slope aspect, or parent material.* A design is the rule that determines the assignment of the experimental units to treatments or factors and *the simplest possible design is the completely randomized design [8]*.

Table 1. *Treatment label in randomization of random complete block design (RCBD).*

UTRS	UNRS	STRS	SRNS
1	B	4	A
2	C	2	D
3	D	1	B
4	A	3	C

Source: [8, 12]

UTRS-Unsorted treatments, URNS-Unsorted random numbers, STRS-Sorted treatments (contains the design after randomization) and SRNS-Sorted random numbers.

Completely randomized design model: statistical design and analysis of experiment studied by [8], had described that, in simple language and defined as a model is an equation that shows the dependence of the responses of variables upon the levels of the factors and involves block effects [13].

Y_{it} -represents a random variable that represents the response obtained on the r^{th} *observation of the* i^{th} *treatments*. The parameter μ_i -denote the "true response" of the i^{th} treatment. If *the responses that would always be obtained from the* i^{th} *treatments; if it could be observed under identical experimental conditions and measured without error*. Randomization plays a crucial role in gaining information about possible deference in the samples which may be due to a specific factor [25]. Sources of nuisance variations are usually represented by a single variables $\in_{it}$, called an *error variable*, which is a random variable with zero mean [7, 8].

$$Y_{it} = \mu_i + \epsilon_{it}, t = 1, 2, \ldots, r_i, i = 1, 2, \ldots, v$$

Where, v is the number of treatments and r^{th} is the number of observations to be taken on the i^{th} treatment. This equation can be rewrite as

$$Y_{it} = \mu + T_i + \epsilon_{it}, t = 1, 2, \ldots, r_i, i = 1, 2, \ldots, v$$

$\mu + T_i$ Denotes the true mean response for the i^{th} treatment, and examination of differences between the parameters μ_i in the first model is equivalent to examination of differences between the parameters τ_i in the second model.

$$Y_{it} = \mu + T_i + \epsilon_{it}$$

$$t = 1, 2, \ldots, r_{i,} \; i = 1,2, \ldots, v$$

$$\epsilon_{it}{'}_{-are\ mutually\ independent}$$

$$\epsilon_{it} \sim (0, \delta^2)$$

$Y_{it} \sim (0, \delta^2)$ Denotes normal distribution which has 0 mean and σ^2 of variance. Sometimes called one-way of analysis of variance model and has one source of variation only on the response effect. Such model of analysis has comparison of the measure source of variation measures. Since Y_{it} is modeled as the sum of a treatment mean $\mu + \epsilon_{it}$ and a normally distributed random variable ϵ_{it} it follows that:

$Y_{it} \sim (\mu + T_i, \delta^2)$. ϵ_{it}: -is mutually independent, the Y_{it} must also be mutually independent.

Statistical model and analyses are a function of the parameters of any model is said to be estimable if and only if it can be written as the expected value of a linear combination of the response variable [8]. In support to this the past study done by [12, 23], had described that, statistical model of two factors level as such:

$$Y_{ij} = \mu_i + \beta_j + \epsilon_{ij} = Y_{ij} \int \begin{matrix} i = 1, 2 \\ j = 1, 2, \ldots, n \end{matrix}$$

$$Y_{ij}\ is\ the\ observation\ of\ jth\ observation\ units\ of\ treatmet\ i$$

$$\mu_i\ is\ the\ effects\ of\ i^{th}\ treatments\ i\ \beta_j\ is\ the\ effects\ of\ jth\ replication$$

ϵ_{ij} *is experimental error*. A comparison of the treatments are possible by inspecting the individual differences.

$d_j = Y_{1j} - Y_{2j}, j = 1, 2, \ldots, j$, of concentrations on one specific treatment that is derive from

$$\mu_d = E(dj) = E(Y_{1j} - Y_{2j})$$

$$= \mu_1 + \beta_j - \mu_2 - \beta_j$$

$$= \mu_1 - \mu_2$$

Testing $H_o: \mu_1 = \mu_2$ is therefore equivalent to testing for the significance of $H_o: \mu_o = \mu = 0$. In this situation, the paired t (test for one sample may be applied, assuming $\mu_d \sim N(0, {\sigma_d}^2)$ with:

$$t_{n-1} = \frac{\bar{d}}{S_d}\sqrt{n}$$

$${S_d}^2 = \frac{\sum(d_i - \bar{d})^2}{n-1}$$

$$H_o: is\ rejected\ if$$

$$|t_{n-1}| > t_{n-1}, 1 - {}^{\alpha}/_{2}$$

If we compare the two experimental designs a loss in degrees of freedom becomes apparent in the latter design. The respective confidence intervals are given by

$$(\bar{X} - \bar{Y}) \pm t_{n-1,1-\frac{\alpha}{2}} S \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$$

Summation of the variables values: $Y = \sum_{i=}^{n}(a_{it}X_{it})$ and Mean of variables values: $\ddot{Y_{i.}} = \sum_{i=}^{n}(Y)_i / n$

Where, the corresponding observed sample mean as $\dot{Y}_{i.}$. The "dot" notation means "add over all values of the subscript replaced with a dot," and the "bar" means "divide by the number of terms that has been added up." This statement, called the *Gauss–Markov Theorem*, is true for all linear models whose error variables are independent and have common variance σ^2.

Variance of population and standard deviation of the population, respectively.

$\sigma^2 = \sum_{i=1}^{n}\left(Y_{it} - \dot{Y}_{i.}\right)^2$ and $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(Y_{it} - \dot{Y}_{i.})^2}{n-1}}$, whereas $E(\bar{Y}_{i.}) = \mu + T_i$ and $var(\bar{Y}_{i.}) = {}^{\sigma^2}/_{r_i}$. Therefore distribution of the least squares estimator $Y_{i.}$ of $\mu + T_i$ is:

$$Y_{i.} \sim \left(\mu + T_i, {}^{\sigma^2}/_{r_i}\right).$$

Estimator of variance σ^2 is the minimum possible value of the sum of squared errors: ($SSE = \sum_i \sum_{it} {\in_{it}}^2 = \sum_i \sum_{it}(Y_{it} - \mu - \tau_i)^2$ and $\epsilon_{it} = (Y_{it} - \mu - T_i) -$ is the deviation of the r^{th} observation on the i^{th} treatment from the estimated i^{th} treatment or factor mean. This is called the $(it)^{th}$ *residual*. Substituting the least squares estimates $\overline{Y_{it} = \mu + T_I}$ into the formula for *SSE*:

$$SSE = \sum_i^n \sum_i^n (Y_{it} - \bar{Y}_i)^2 \ and\ SSE = \sum \sum_I^n Y_{it}{}^2 - \sum r Y_i{}^2, SSE = \sum \sum_i^n Y_{it}{}^2 - {Y_i{}^2}/{r}$$

$$SSE = \sum \sum_i^n \left(Y_{it} - \bar{\bar{Y}}_i\right)^2, \ SSE = \sum \sum_i^n \left(Y_{it} - \bar{\bar{Y}}_i\right)^2 / (r-1)$$

$$E(SSE) = \sum (r_i - 1)\left(S_i{}^2\right) = (n-v)\sigma^2 \text{ and } \sigma^2 = \frac{SSE}{(n-v)} = MSE$$

Estimator of the standard deviation: $\sigma\sqrt{\frac{SSE}{(n-v)}}$. The corresponding unbiased estimate of σ^2 is the observed value of *MSE*, namely:

$$E = \frac{SSE}{(b-v)}\ .$$

Both *MSE* and, msE are called the *mean square for error* or *error mean square*. The estimate *msE* is sometimes called the "within groups (or within treatments) variation."

Sum of square of treatments

SST = SSE_0 − SSE the sum of squares for treatments or the treatment sum of squares.

$$SST = \sum_i^n r_i(\bar{Y}_{i.} - \bar{Y}_{..})^2, \ SSE = \sum_i (Y_{it} - \bar{Y}_{i.})^2$$

$$SST = \left(\sum \sum_i^n Y_{it}{}^2 - n\bar{Y}_{..}{}^2\right) - \left(\sum \sum_i \bar{Y}_{i.}{}^2 - r_i \bar{Y}_{..}{}^2\right) = \sum \left(r_i Y_{it}{}^2 - n\bar{Y}_{..}{}^2\right)$$

$$\bar{\bar{Y}}_{i.} = \frac{Y_{i.}}{r_i} \ and\ \bar{\bar{Y}}_{..} = \frac{Y_{..}}{n}$$

$$SST = \sum \ \frac{\bar{\bar{Y}}_{i.}{}^2}{r_i} - \frac{\bar{\bar{Y}}_{..}{}^2}{n}$$ [12]

Another equivalent formula to determine the sum of square treatment SST is

$$SST = \sum_i r_i\left(\bar{\bar{Y}}_{i.} - \bar{\bar{Y}}_{..}\right)^2$$

Since we will reject *H*0 if ssT/ssE is large, we need to know what "large" means. This in turn means that we need to know the distribution of the corresponding random variable.

SST/SSE when *H*0 is true, where,

$$SST = \sum_i r_i\left(\bar{\bar{Y}}_{i.} - \bar{\bar{Y}}_{..}\right)^2$$

$$SST = \sum_r \sum_t \left(Y_{it} - \bar{\bar{Y}}_{i.}\right)^2$$

Confidence bounded of variance: Chi-square test method will be used to observe the variations available between dependent and independent. So that the distribution of $\frac{SSE}{\sigma^2}$ is refer to chi-squared with N-V of df and this degree of freedom is denoted $X^2{}_{n-v},, \alpha - 1$ is the percentile of the chi-squared distribution with $n{-}v$ degrees of freedom (df) and with probability of $1 - \alpha$ in the right-hand tail. The probability of this distribution is indicated by this formula.

$$P\left(\frac{SSE}{\sigma^2} \geq X^2{}_{n-v,\alpha-1}\right) = \alpha - 1$$

Substitute the value of SSE with the observed value ssE and gives one-sided bound of confidence for σ^2 that is $100(1-\alpha)\%$. It is the upper bound which is refer to upper confidence limit of the factors that will be study that is the effects of land uses and land covers on soil properties and expressed by this formula [13].

$$\sigma^2 \leq \frac{ssE}{X^2{}_{n-v,\alpha-1}}$$

3.4. Method of Land Use and Land Cover Study

Multispectral Landsat10, ETM-7color of high resolutions will be applicable including satellite imagery-12 to understand LULC changes such as forest land, cultivation land, settlement land (both urban and rural settlement) and range land. These classification of LULC will be parallel with the past study done by [14].

3.5. Source of Data

The data will collects from two sources. Secondary data will be collects from concerned offices and internet. Primary data will be collects from the field as designed under the methodology of the study.

3.6. Data Collection Method

Requires communication with the concerned offices, agricultural and natural resources developmental agents, and local people or land users. Reconnaissance survey or field survey will be carry out to select the watersheds that will be fulfill the proposed objectives, hypotheses, questionnaires and title. Questionnaires will be develop or construct both in semi-closed, open and closed types and carry out interview by making stratification of Radom statistical techniques to obtain the genuine data on the assessment of the land uses and land covers changes in addition to use 50 years LANDSAT satellite images. Soil samples will be collects under three sub-watersheds after delineated the watershed drainage bounder of major kebele watersheds and their sub-watersheds. That is both major and sub-watersheds geomorphological physical characteristics such as compactness coefficient, form factor, shape factor and drainage density will be delineated and measured from satellite images by the ArcView GIS software 20 versions.

3.7. Results Presentation

The most common methods of presentation of the results of statistical analyzed of output include: table, bar graph, pichart, scattered graph and line graph. The three statistical tendency; mode, median and mean will be displayed with statistical descriptions.

3.8. Soil Analysis

Dean A. and Voss D, had revealed that, soil pH determination is more accurately in the laboratory by a glass electrometric method of soil to water ratios (1:2.5 ratios) [4, 6]. SOC is determined by Walkley and Black method [6]. Soil organic matter is determined by Walkley-Black Titration method [4]. Calcium and magnesium are determined by the past study done by [30, 13], who had been shown that Ca and Mg E.D.T.A. Titrimetric method by [10] is the most accurate. CEC is determined by ammonium saturation method [29, 24]. Potassium (K) is determined by flame photometer method [31, 14]. Phosphorous is determined by using Oslen's method [5, 30] and calculated by using this formula:

$\mathrm{P(ppm)} = \frac{\mathrm{GR \times 50 \times 5}}{\mathrm{corrected\ Wt.of\ soil}}$ and P (kg/ha) = P (ppm) x 2.24. Soil ammonium is determined by the method of steam distillation method [13]. Three soil samples either separate or composite will be collects to determine soil texture per EU on the field by use un-graduated cylinder and 30 cm ruler ratios. However, the method is not needs to sieve the soil whereas after separate from impurities fill into the testing cylinder and again fill with pipe water. After that string the two substances –water and soil clods very well either by use wood stick or metal stick and leave for 1:30 hours. Then, after the mentioned hours by use the 30cm ruler read and record on the field note book the measured soil separates (clay, silt and sand). The most important that should be considered during the measures of soil separates it is not the height to fill the soil alone, but also the height of the two substances mixed very well and attain.

Soil bulk density will be determined on the field using the buoyance force method. The dried soil clods (gm) will be tied very well with water proof plastic sheet and after take the weight of plastic and plastic with soil clods; it will be immerse into the cylinder that fill with water which will be place inside the another cylinder that is wider than the one which has contain water and immerse the soil clods. The second cylinder which is capture the amount of water displaced by plastic and soil clods tied together. The volume is the volume of displaced water as a result of immerse the soil clods and captured by the second cylinder. The volume of the displaced water will be calculated. The weight of clods measured in gm and the volume of the displaced water is measured in cubic centimeters. The soil bulk density calculated (gm per cm^3) [30, 9]. Another method of the soil BD determination is the auger or core sampler test method. Wet weight will be measure by using field beam balance or digital beam balance on the field and the oven dry soil samples after dried for 24 hours under 105℃ will be measure dry weight by use beam balance or digital balance. The volume will be the volume of core sampler or augur used to collect soil samples [30].

Soil MC will be determined using Gravimetric method called direct method or estimation method. It will be expressed in two methods of soil MC analysis in mass based and volume based:

Mass based $MC\% = \frac{Wet\ weight - Dry\ weight}{Dry\ weight} * 100$ following the method described by [15, 30].

Volume based $MC\% = \frac{MC\ in\ dry\ mass}{water\ density} * soil\ bulk\ density$ [30].

3.9. Data Preparation

Impurities will be separated in the field and in the preparation room for laboratory analysis. Impurities will be includes: tree leaves, bark, and twigs, stones, weeds, grasses, and crop residues. Large clods should be crushed by hammer and then, thoroughly mixed by use of mortar and pestle to keep the data homogeneity. Then, soil samples will be grinded very well and passed through sieve of 2mm diameter hole. Fill the grinded and sieved soils with plastic bag and label. Divide the samples after sieved into two parts and half of the sample will be keep for crosschecking of laboratory analyzed data and half of sample will be bring for laboratory analyses.

3.10. Data Analysis

If the proposed randomization complete block design cannot control of experimental error, the choice of appropriate data analysis can help greatly. *Covariance analysis is most commonly used for this purpose. By measuring one or more covariates- the characters whose functional relationships to the character of primary interest are known-the analysis of covariance can re-*

duce the variability among experimental units by adjusting their values to a common value of the covariates [12].

Laboratory analyzed soil data will be collects and give the codes. The coded data will be subjected to GLM multiple multivariate model of ANOVA of SAS software 20 version. Person's correlation between the proposed parameters will be observed. The study will be investigating the relationship between standard deviations, variances and means of statistical output. Mode, median, frequency, lower and upper bounded quartile, F- Test, t-test and chi square test statistical method of appropriate test procedures will be used to test the representative analyzed soil data and to observe the variations available between dependent and independent variables.

Standard deviations and variances will be study to observe the close correlation available between the independent and dependent variables of mean values of the factors or treatments proposed under this study.

Abbreviations

SSDS	Soil Science Division Staff
UNDP	United Nation Development Program
FAO	Food and Agricultural Organization
GIS	Geographical Information System
SWC	Soil and Water Conservation
AF	Agroforestry
n. d.	No Date
LANDSAT	Land Satellite
WRDDIRD	Water Resources Department Directorate of Irrigation Research & Development
SMWHZ	Satellite Map of West Harareghe Zone
EMA	Ethiopia Mapping Authority
ETAL	Extra
N	North
E	East
A.S.L.	Above Sea Level
R^{th}	Number Observation Units
I^{th}	Number of Treatments
BD	Bulk Density of Soil
MC	Moisture Contents
MM	Millimeter
KM^2	Square Kilo Meter
CM	Centimeter

Author Contributions

Mussa Abdula Ibro is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

Appendix

Appendix I: Activities

Table 2. Activity schedule.

Activities	Time to be accomplish
Field surveying	December 2018 E. C.
Proposal preparation	October to November 2018 E. C.
Field/primary and secondary data collection	January to February 2018 E. C.
Data preparation for laboratory analysis	March to April 2018 E. C.
Collecting laboratory output data	June to July 2018 E. C.
Data organization and giving codes	August 2018 E. C.
Subjected to statistical analysis	September 2018 E. C.
Result interpretation	October to December 2018 E. C.
Dissection of interpreted results or report writing	January to June 2018 E.C.
Presentation of repot and re-write based on the given comments	From July-August 2018 E.C. to October 2019 E. C.

Appendix II: Budetary Requirements

Table 3. Budget requirement for the study in ETB.

Activities	Estimated costs
Field surveying	16,000
Proposal preparation	25, 000
Field/primary and secondary data collection	30,000
Data preparation and laboratory analysis	80,000
Collecting laboratory output data	20, 000
Data organization and giving codes	15, 000
Subjected to statistical analysis	20, 000
Result interpretation	22, 000
Dissection of interpreted results or report writing	29,000
Presentation of repot and rewrite based on the given comments	19, 000

Activities	Estimated costs
Sub-total	155, 000
Contingency % 10%	15,500
Overall Total	170, 500
Messilanous cost	17, 000
Grand total	187, 500 ETB

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