Online ISSN : 2249-4626
Print ISSN : 0975-5896
DOI : 10.17406/GJSFR

Global Journal of Science Frontier Research: H

Environment & Earth Science

Determinants of the Adoption

Earthquake induced Landslides

Highlights

Projection of Future Changes

Sustainable Land Management

Discovering Thoughts, Inventing Future

VOLUME 17 ISSUE 1 VERSION 1.0

Global Journal of Science Frontier Research: H
Environment & Earth Science

Global Journal of Science Frontier Research: H
Environment & Earth Science

Volume 17 Issue 1 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: *Open Association of Research Society*
Open Scientific Standards

Publisher's Headquarters office

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals Pvt. Ltd.
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:

22 USD (B/W) & 50 USD (Color)

Yearly Subscription (Personal & Institutional):

200 USD (B/W) & 250 USD (Color)

Contents of the Issue

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Key Parameters that Contribute to the Occurrence of Earthquake Induced Landslides

By Dyson N. Moses
University of Malawi

Abstract- Earthquakes cause widespread landslides more than other geotechnical hazards. In this study, the controlling factors of earthquake induced landslides are identified and evaluated for the major earthquakes with magnitude ≥ 6.6 that occurred between 1998 – 2015 worldwide. A quantitative technique of data analysis was applied to correlate controlling variables and landslides occurrence to draw their relationship determined by regression coefficient. Data was drawn from secondary sources; scientific and technical papers, technical reports, internet sites and relevant books on landslides. The analysis reveal that earthquake induced landslides spatial distribution has no correlation with earthquake magnitude and peak ground acceleration, but a weak positive correlation with respect to peak ground acceleration times shaking duration and Arias intensity. Earthquake induced landslides occurrence also show a strong correlation with regards to geology, fault type, slope angle and slope height. A negative correlation was established between earthquake induced landslides spatial distribution and the distance from the epicentre and surface rupture.

Keywords: *earthquake induced landslides, magnitude, peak ground acceleration, arias intensity, lithology and slope angle.*

GJSFR-H Classification: *FOR Code: 260206*

KEYPARAMETERSTHATCONTRIBUTETOTHEOCCURRENCEOFEARTHQUAKEINDUCEDLANDSLIDES

Strictly as per the compliance and regulations of :

Key Parameters that Contribute to the Occurrence of Earthquake Induced Landslides

Dyson N. Moses

Abstract- Earthquakes cause widespread landslides more than other geotechnical hazards. In this study, the controlling factors of earthquake induced landslides are identified and evaluated for the major earthquakes with magnitude ≥ 6.6 that occurred between 1998 – 2015 worldwide. A quantitative technique of data analysis was applied to correlate controlling variables and landslides occurrence to draw their relationship determined by regression coefficient. Data was drawn from secondary sources; scientific and technical papers, technical reports, internet sites and relevant books on landslides. The analysis reveal that earthquake induced landslides spatial distribution has no correlation with earthquake magnitude and peak ground acceleration, but a weak positive correlation with respect to peak ground acceleration times shaking duration and Arias intensity. Earthquake induced landslides occurrence also show a strong correlation with regards to geology, fault type, slope angle and slope height. A negative correlation was established between earthquake induced landslides spatial distribution and the distance from the epicentre and surface rupture.

Keywords: earthquake induced landslides, magnitude, peak ground acceleration, arias intensity, lithology and slope angle.

I. Introduction

Earthquakes are among the most destructive natural hazards on Earth. An earthquake can cause a slope to become unstable by the inertial loading it imposes or by causing a loss of strength in the slope materials there by inducing failure. Catastrophic landslides characterised by large and extremely rapid movements are among the most destructive phenomena associated with failure of slopes during earthquakes. Landslides encompass many phenomena involving lateral and downslope movement of earth materials under the influence of gravity, and in most cases also water [1], [2]. According to [3], the horizontal and in fewer cases vertical ground acceleration resulting from seismic shaking exert additional transient shear stresses and increases the ambient pore water pressures through cyclic gravitational loading, thus negatively affecting slope stability.

It has been evidently recognised that loss of lives and damage attributed to earthquakes are to a significant fraction incurred by "secondary" earthquake effects such as tsunami, landslides and liquefaction rather than strong ground motion alone. [4] Estimated that approximately 5 % of all earthquake-related fatalities are a result of seismically induced landslides. [3] Argues that the use of the term "secondary hazards" to characterise these effects is potentially misleading, given that any of subsequent process cascades (downslope and downstream transfer of eroded soil and rock) may incur the highest fraction of total damage eventually. Therefore, in a bid to comprehend factors contributing to the occurrence of seismic slope failures this paper aims at documenting major earthquakes with moment magnitude M_w ≥ 6.6 that occurred between 1998 and 2015 in the world, which triggered landslides and evaluate the factors that contributed to the landsliding activities. In this respect attempts are made to establish relationship between earthquake parameters (magnitude, PGA, focal depth and distance from the epicentre), geology and topographic parameters and earthquake induced landslides (EIL) by carrying out a bivariate analysis of the parameters against EIL.

II. Methodology

A comprehensive and rigorous review of data on landslides induced by major earthquakes (Mw ≥ 6.6) that occurred between 1998 – 2015 in the world and studies of some well documented historical EIL have been considered. Data review entailed collection of all relevant information on EIL by historical major earthquakes in the world presented in Table. 1. In the analysis, some of the minor and major well documented cases like the Aysen, Chile 2007, Avaj, Iran 2002, Northridge, California 1994, the Finisterre Papua New Guinea 1993 and the Loma Prieta USA 1989 respectively for representativeness and validation of the study. Reviewed information include; scientific and technical papers, technical reports, seismological and landslides data by USGS. Valuable data was also gotten from internet sites and relevant books on EIL. In assessment of the EIL the parameters given in Figure 1 were considered.

Author: Instructor, Department of Geography and Earth Science at University of Malawi, Chancellor College.
e-mail: dysonmoses@gmail.com

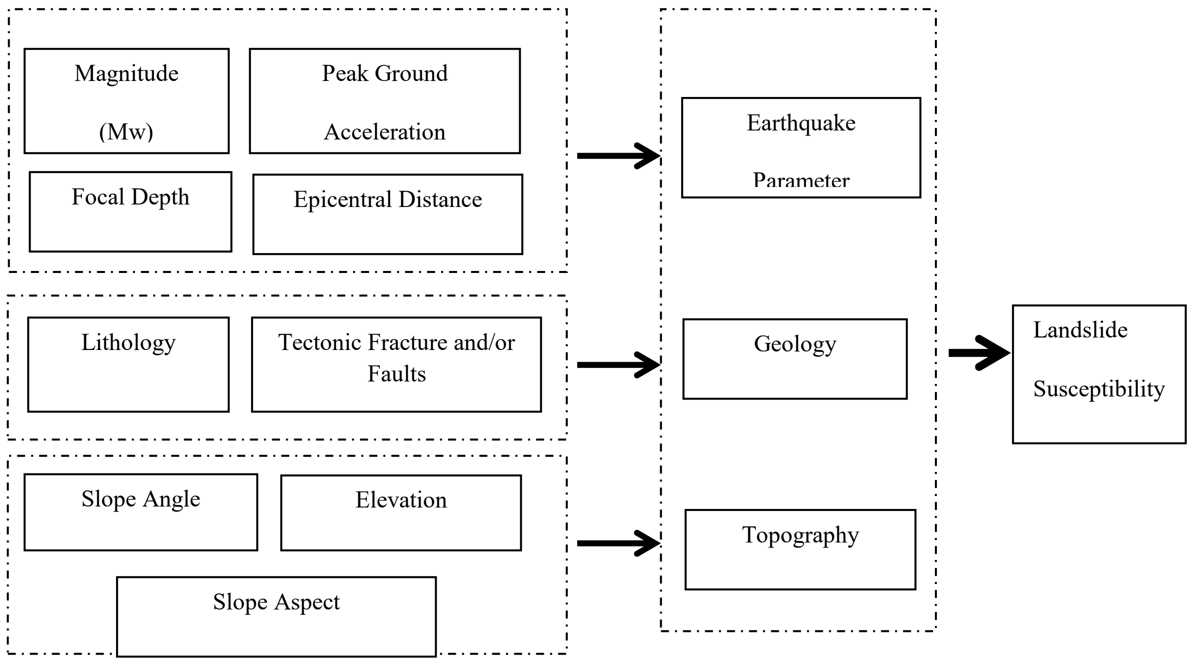


Figure 1: Flow-chart of the methodology used for assessing the EIL

III. Controlling Factors of Earthquake Induced Landslides

Seismic shaking is the principal cause of huge landslides often with disastrous consequences for the people and property concerned [1], [6]. A summary of the major earthquakes (Mw ≥ 6.6) that induced landslides between 1998 and 2015 in the world are presented in Table.1. In addition, 3 major (Northridge, California 1994, the Finisterre Papua New Guinea (PNG) 1993 and the Loma Prieta USA 1989) and 2 minor (Aysen, Chile 2007 and Avaj, Iran 2002) well documented earthquake cases are also presented for implementation and validation of the study. In the table, date of occurrence, name, magnitude, PGA, focal depth, duration of the earthquake, fault type, fault length, reported number of landslides, area affected by landslides and source of data are given. The paper complements the several researchers; [31], [41], [48] [15], [27] and [1]. [32] Stress that it is of primary significance to recognise the conditions that cause slopes to become unstable and the factors that trigger the movement. A great variety of slope movements reflect the diversity of factors that may disturb slope stability. Hence, this section presents the findings of the study.

Table 1: Summary of the major earthquakes that induced landslides between 1998-2015

No	Date	Name	Magnitude (Mw)	PGA (g)	Focal depth (km)	Duration (sec)	Fault Type*	Fault Length (km)	Reported No of Landslide	Landslide area (km2)	Source†
1	25/05/2015	Gorkha, Nepal	7.8	0.35	10-15	50	TF	160	25,000	1,000	[7]
2	20/05/2013	Lushan	6.6	1.00	13	20	TF	35	3,810	2,200	[8]
3	18/09/2011	Sikkim, India	6.9	0.55	10	10	TF	68-119	210	22	[9]
4	11/03/2011	Tohoku, Japan	9.0	0.80	24	360	TF	500	3,477	28,380	[10]
5	14/05/2010	Yushu, China	6.9	0.38	17	15	SSF	30-51	2,036	1,194	[11]
6	12/01/ 2010	Haiti	7.0	0.55	13	30	SSF	65	> 4,490	2,150	[12]
7	27/02/2010	Maule, Chile	8.8	0.65	35	180	TF	500	410	74,131	[13]
8	30/11/2009	Sumatra, Indonesia	8.0	0.60	71	12	TF	60	89	-	[14]
9	12/05/2008	Wenchuan, China	7.9	0.62	19	60	TF	200	>15,000	1,160	[15]
10	14/06/2008	Iwate-Miyagi , Japan	6.9	1.00	8	10	TF	20	4,161	600	[16]

11	21/04/2007	Aysen Fjord, Chile	6.2	0.50	10	-	SSF	12	538	17,000	[17]
12	16/07/2007	Niigata Chuetsu–Oki	6.6	1.01	10	10	TF	39	70	250	[18]
13	15/09/2007	Pisco, Peru	8.0	0.50	39	48	TF	103	866	-	[19]
14	08/10/2005	Kashmir, Pakistan	7.6	0.56	10	25	TF	75	2,424	61	[20]
15	23/10/2004	Mid-Niigata, Japan	6.6	0.48	9-14	30	TF	22	>1,353	250	[21]
16	21/01/2003	Tecoman, Mexico	7.6	0.38	24	30	TF	50	103	-	[22]
17	21/05/2003	Boumerdes, Algeria	6.8	0.58	12	15	TF	36	24	39	[23]
18	22/06/2002	Avaj, Iran	6.5	0.50	7.5	7	TF	13	14,000	3,600	[24]
19	03/11/2002	Denali fault, Alaska	7.9	0.36	5	140	TF	336	10,000	90,000	[25]
20	13/01/2001	Elsavado, USA	7.7	0.60	60	43	TF	65	600	-	[26]
21	21/09/1999	Chi-Chi, China Taiwan	7.5	0.75	33	40	TF	125	>10,000	127.8	[27]
22	17/01/1994	Northridge, California	6.7	0.64	19	20	TF	15	>11,000	10,000	[28]
23	13/10/1993	Finisterre PNG	6.9	0.35	19	20	TF	75	>4,700	55	[29]
24	17/10/1989	Loma Prieta USA	6.9	0.65	19	8-15	OF	35	4,000	15,000	[30]

**TF = Thrust Fault, OF = Oblique-slip Fault, SSF = Strike Slip Fault, = Data unavailabl*

a) Seismic Parameters

The relationship between the seismic parameters of the major earthquakes and reported number of landslides and area affected by EIL has been investigated. Table.2 gives the statistical relations obtained among the seismic parameters of earthquakes and EIL area affected by EIL.

i. *Earthquake Magnitude (M_w)*

According to [1], the strength of the earthquake shaking is a major parameter that determines the occurrence of landslides. Based on this statement, the study endeavoured to establish a relationship between earthquake magnitude and number of landslides. Table.2 shows that there is no relationship found between earthquake magnitude and number of landslides. This highlights the significance of the role played by other factors such as geology and topography in influencing the occurrence of EIL. To assess the likely impact of the EIL in an area, a relationship between earthquake magnitude and area affected by the EIL was tested. The relationship of earthquake magnitude and the area affected by EIL for the major earthquakes (1998-2015) is presented in Figure 2. In this Figure the upper bound curves presented by [5], [33] and [1] are also shown. Plotted values of the investigated EIL areas with respect to the magnitude of earthquakes are clustered below and above the upper bound curves (Figure 2). The plot given in Figure 2 has been extensively but it gives limited information with respect to the trends.

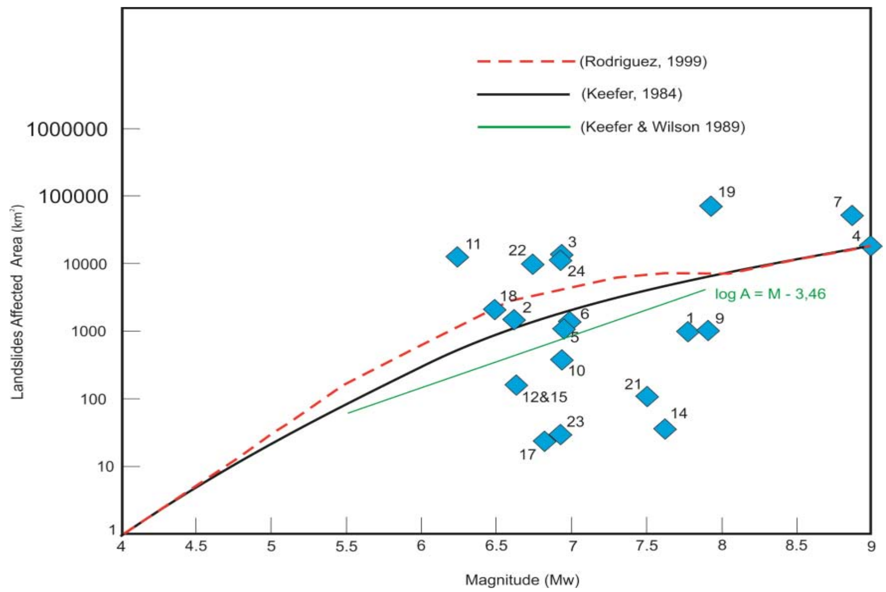


Figure 2: Relationship between earthquake magnitude and the area affected by landslides [5]

In view of this, the study applied a regression approach to establish a relationship between the landslides affected areas and magnitude of studied earthquake. The relationship between the variables yielded a low regression value of $R^2 = 0.40$ (Figure 3) implying that there is a weak correlation between magnitude and the square root of the area affected by EIL.

Table 2: A summary of statistical relationship between seismic parameters and reported landslides and landslides area

Parameters	Reported No of Landslides			Area Affected by Landslides		
	Model fitted	R^2	Comment	Model fitted	R^2	Comment
Magnitude (Mw)	$\sqrt{LN} = -10.679M^2 + 165.22M - 577.58$	0.02	Increasing trend	$\sqrt{LA} = 50.581M^2 - 708.93M + 2528.7$	0.40	Weak Correlation
PGA (g)	$LN = 12285PGA^2 - 21224PGA + 12492$	0.03	No correlation	$LA = -4947.2PGA^2 - 6795.9PGA + 16683$	0.01	No correlation
PGA times Earthquake duration (g*t)	$LN = -2.8329PGA{*}t^2 + 320.31PGA{*}t + 1907.5$	0.20	No correlation	$LA = 0.4931\ PGA{*}t^2 + 651.38PGA{*}t - 2563.3$	0.56	+ve correlation
Arias Intensity (I_A)	$LN = 2E\text{-}05Ia^2 - 0.4406Ia + 5346.2$	0.01	No correlation	$LA = 3814Ia^2 - 157.19Ia - 5795.6$	0.42	Weak Correlation
	$\sqrt{LN} = -3.326Ia^2 + 22.725Ia + 26.816$	0.02	No correlation	$\sqrt{LA} = 15.677Ia^2 - 6.263Ia$	0.45	Weak Correlation
Fault Length (FL)	$LN = 20.082Fl$	0.28	Increasing trend	$LA = 0.1266Fl^2 + 59.006Fl$	0.55	+ve correlation
Focal Depth (D)	$LN = -87.976D + 6601.3$	0.05	No correlation	$LA = -105.79D + 12468$	0.01	No correlation

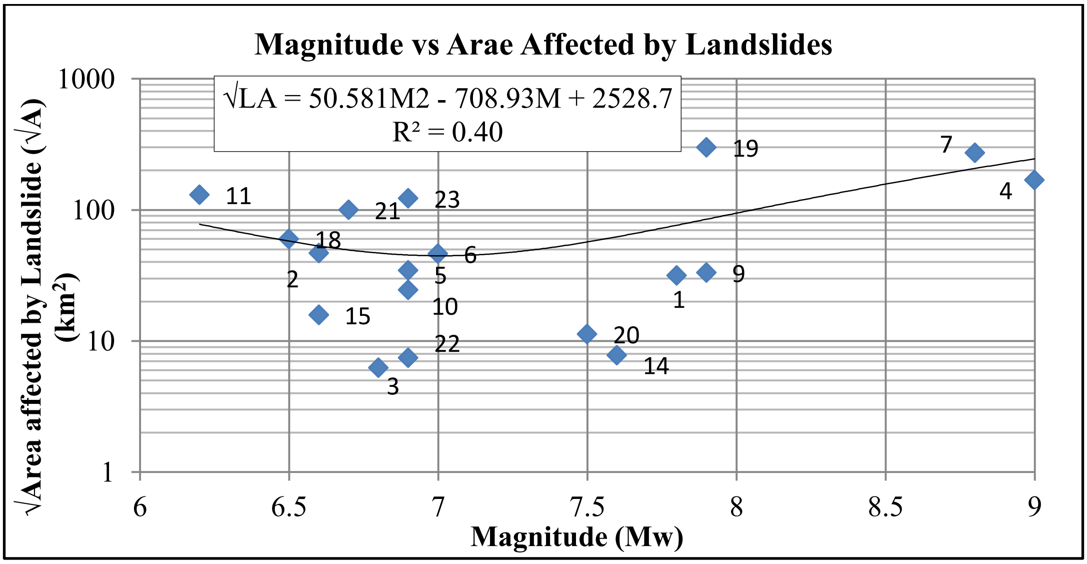


Figure 3: Relationship between the earthquake magnitude and Square root of area affected by EIL

ii. *Peak Ground Acceleration (PGA)*

PGA is a measure that describes the earthquake shaking reasonable to trigger landslides [11]. The statistical analysis between PGA and EIL is shown in Table. 2. The regression analysis indicates that there is no correlation between PGA and occurrence of landslides (Table. 2). For instance, while the Gorkhan, Nepal earthquake of 2015 with a PGA of 0.35g recorded 25,000 landslides the Niigata, Chuetsu-Oki Japan earthquake of 2007 with a PGA of 1.01g only caused 70 landslides. Thus, it is suggested that a good relationship of the two variables can be made if comparisons are made in the same geological and topographic settings. But it is important to point out that there seems to be a threshold value of PGA ≥ 0.3g for landslides occurrence during studied major earthquakes. This threshold PGA value is in agreement with the findings of [27].

Attempt was also made to find out a relationship between PGA and the area affected by landslides and PGA times earthquake duration against the area affected by landslides. Statistical information presented in Table. 2 shows that there is no correlation found between PGA and area affected by landslides. However, a good positive correlation is obtained when the duration of earthquake shaking is included (Table. 2). The coefficient of determination of R^2 = 0.56 was obtained when a square root of area affected by landslides is correlated with PGA*t (Figure 4) and a fairly high coefficient of determinatio is obtained when PGA*t is correlated against absolute numbers of landslides induced by earthquakes (Table 2). This indicates that duration of earthquake shaking has a significant effect in as far as EIL are concerned.

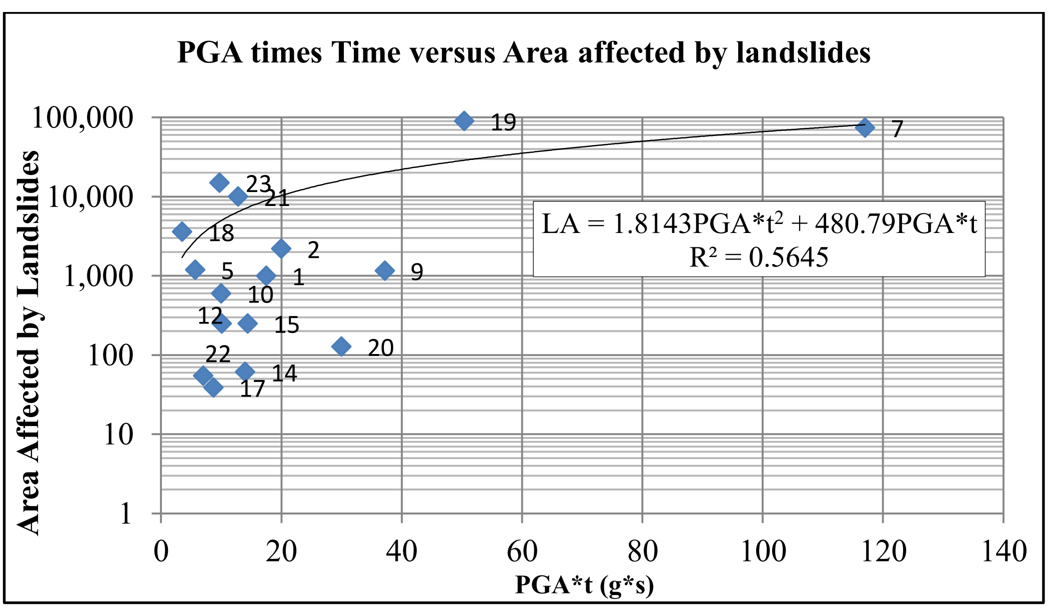


Figure 6: Relationship between PGA*t and area affected by EIL

Global Journal of Science Frontier Research (H) Volume XVII Issue I Version I Year 2017

iii. *Arias Intensity*

The Arias Intensity (I_A) is a measure of the strength of a ground motion developed by Arturo Arias in 1970. The measure was meant to determine the intensity of shaking by measuring the acceleration of transient seismic waves. Despite [39] conviction that I_A is a fairly reliable parameter to describe earthquake shaking necessary to trigger landslides, the measure had not gained support until the work of [35] who used the parameter. Although PGA is still the most commonly used parameter to describe earthquake ground motion, I_A is by far described as an improved seismic parameter [36], [37]. [36] Further explains that the use of the I_A has been proposed to quantify the effect of seismic shaking on ground failure phenomena more effectively. I_A is derived after Arias (1970) in [35] as follows

$$I_A = \frac{\pi}{2g}\int_0^{tf} \alpha(t)^2\, dt \qquad (1)$$

Where g is the acceleration due to gravity, a(t) is the recorded acceleration time-history and tf is the duration of the ground motion.

The principal advantage of I_A over PGA is that it measures the total acceleration content of the record rather than just the peak value, providing a more complete characterisation of the shaking energy than PGA [36]. The author further explains that Arias intensity is more objective and comparable from one earthquake to the other, making it a reliable indicator of the capacity of the earthquake shaking to trigger landslides. Thus, the study assessed the impact of I_A in inducing landslides and compares the results against the impact of PGA. The relationship between I_A and area affected by landslides is shown in Figure 5. The results indicate a weak positive correlation with a regression value of $R^2 = 0.45$ between I_A and square root of the area affected by landslides. In contrast, the relationship between PGA and area affected by landslides yielded no correlation. However, when PGA times time of earthquake shaking the coefficient of determination increase to $R^2 = 0.56$. A critical review of the I_A equation shows that it includes time in its derivation. This pattern clearly affirms that earthquake duration plays a key role in causing EIL.

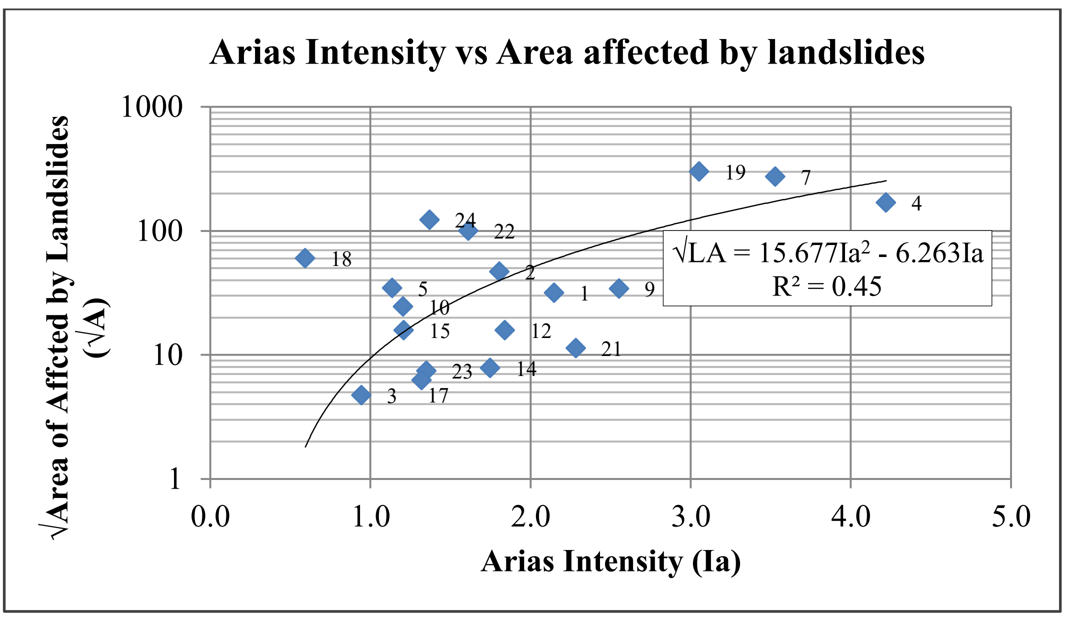


Fig. 5: Relationships between I_A and Area Affected by EIL

iv. *Focal Depth*

Focal depth describes the depth of an earthquake focus to the epicentre. Shallow focus earthquakes (≤ 35 km) are believed to cause widespread landslides than deep focus earthquakes [1]. Based on this statement, the study investigated the correlation between focal depth and area affected by landslides for the major earthquakes in order to understand the impact of focal depth on the occurrence of landslides. The results of the relationship are presented in Figure 6.

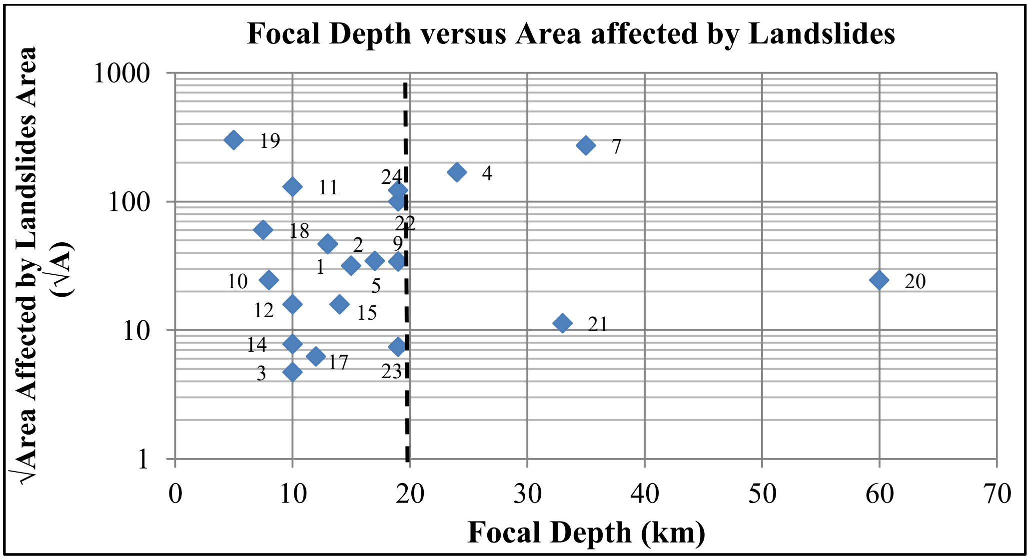


Figure 6: Relationship between focal depth and major EIL

It was observed that there is essentially no correlation between focal depth and EIL nor area affected by landslides, but it is interesting to note that majority of the landslides are concentrated within the depth ≤ 20 km. At depth > 20 km very few landslides are recorded. This finding validates a study by [38] who demostrated that most of the earthquaks that caused landslides had a focal depth of ≤ 35km and as the magnitude of the earthquake increased, they seem to have caused landslides over wider area. However, [33] in their study found some earthquakes that had focal depth > 40 km. This emphasises the dominating influence of other factors other than just focal depth though magnitude was high Mw ≥ 6.5 for studied earthquakes.

v. *Fault Length*

A relationship between fault length and EIL was also investigated. The results are presented in Figure 7.

It would be anticipated that the longer the earthquake produced fault length is, the more violently the ground will be shaken, and the more landslides will occur during the earthquake. However, the study established a very weak correlation between the fault length produced by earthquake and number of EIL for the studied earthquakes. The regression coefficient for the correlation is $R^2 = 0.28$ (Table 2). On the other hand, a fairly positive correlation between fault length and area affected by landslides with a coefficient of determination of $R^2 = 0.55$ which shows that fault length has somewhat a significant impact on the area affected by landslides.

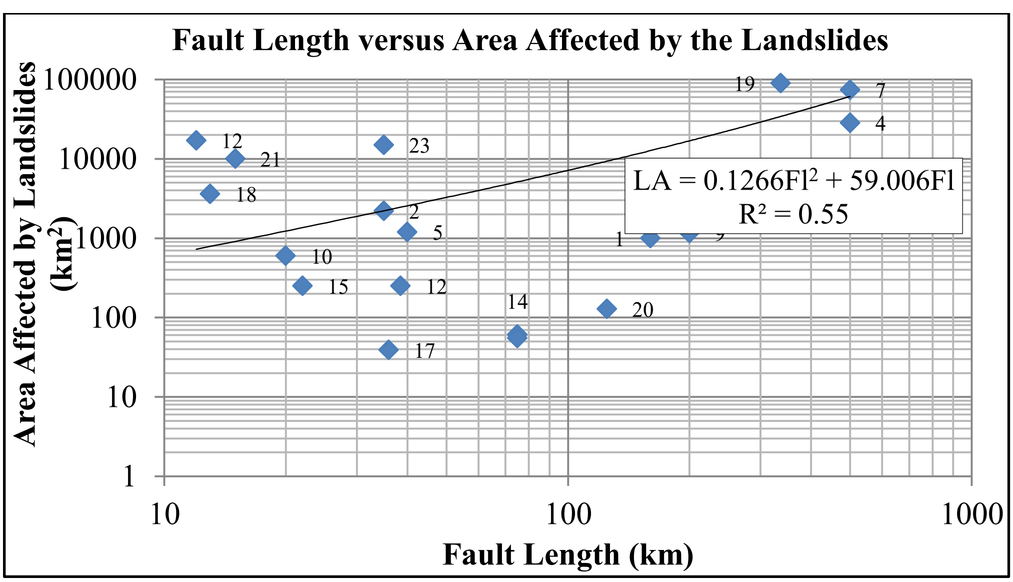


Figure 7: Relationship between fault length and area affected by landslides

vi. Distance from the Epicentre

In the scope of the study, efforts were made to establish the impact of distance from epicentre on occurrence of EIL. The findings are presented in Figure 8. EIL distributions as a function of distance from the epicentre indicate that most of the EIL occur within ≤ 50 km from the epicentre. The concentration of EIL gradually decrease with distance away from the epicentre, and landslide concentration values waned beyond the 50 km band for studied earthquakes adopted as epitome of the trend; 2013 Lushan earthquake by and the Italian Catalogue of Earthquake – Induced Ground Failures (CEDIT). The findings corresponded with the results for the Loma Prieta and Chi-Chi 1999 earthquake in which the concentration of landslides waned off at ≤ 60 km band [34].

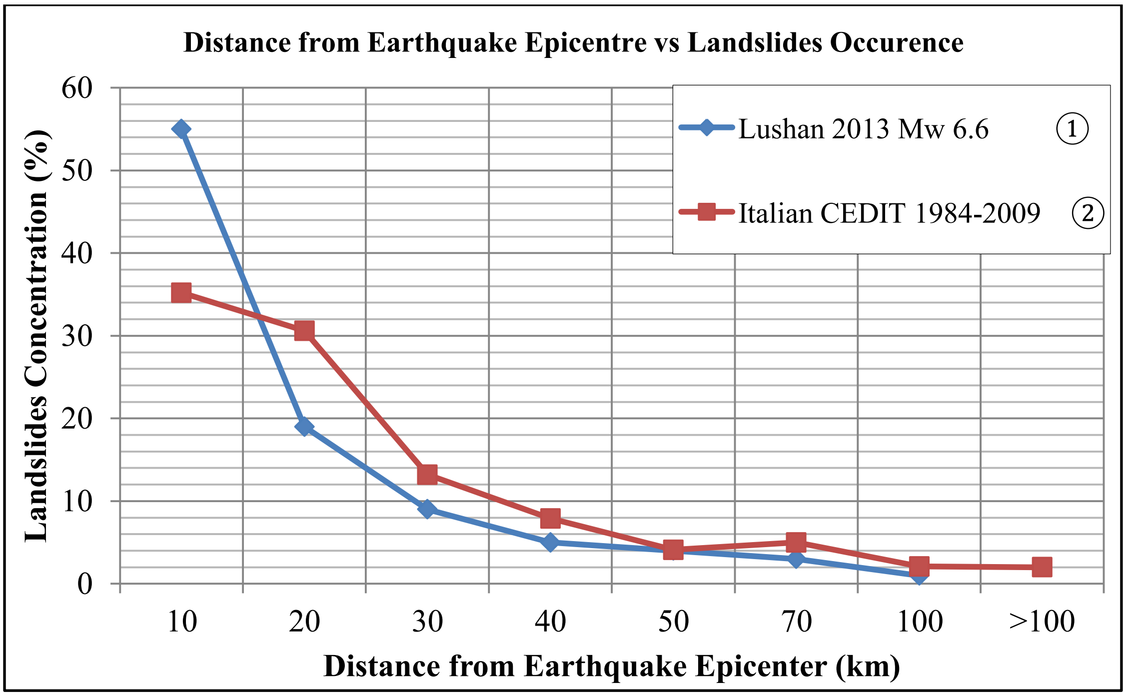


Figure 8: Distribution of landslide with respect to distance from the epicentre (Data from ①[26] and ②[15]

vii. Distance from the Fault Surface Rupture

The study also made efforts to understand the influence of distance from fault surface rupture on the occurrence of EIL. A plot of the distance from the fault plane against the EIL concentration is shown in Figure 9. The trend of the distribution reflects that of the distance from the epicentre against landslides. Data analysed from the studies of [41], [44], [15] and [20], show that landslides tend to concentrate on the hanging wall of the thrust faults than on the foot wall but on both walls the landslides concentration decrease away from the fault plane except for the Lushan earthquake, 2013 where the major landslides occurrence took place in the footwall (Figure 9). A similar pattern was found for the Loma Prieta 1989 and Chi-Chi 1999 earthquakes [34].

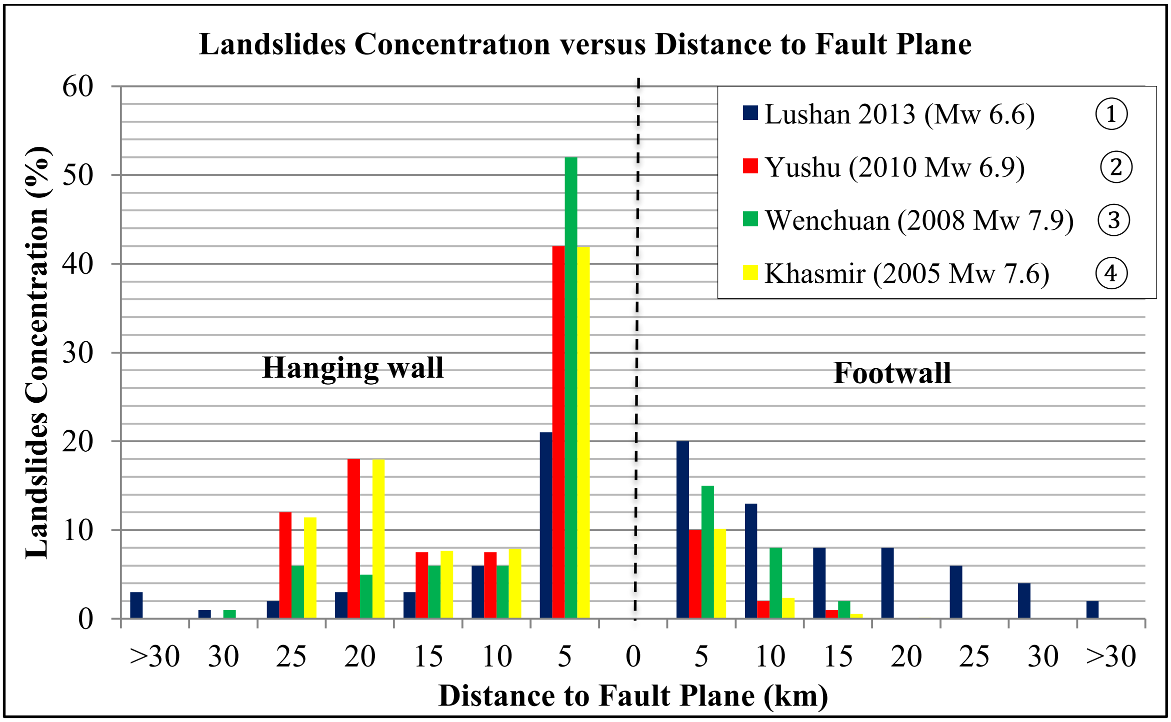


Figure 14: Landslides concentration with respect to distance from the fault plane (Data from ①[41], ②[11], ③[15] and ④[20]

b) Geological Environments

i. *Lithology*

It is widely recognised that lithology plays a significant role in seismic landslides occurrence because strength, structure, composition and related soil and rock properties consisting the slope determine the likelihood of landslides occurrence. Based on the study evaluated the influence of lithologic units on EIL. In this regard, a correlation between geology and landslides was done for 6 major landslides inducing earthquakes presented in Table 1. It can be observed that the distribution of landslides after the Tohoku 2011 earthquake recorded the highest value in the Neogene Sedimentary rocks (42%) followed by Quaternary Alluvium (Figure 10). During the Wenchuan 2008 earthquake, landslide occurrence was concentrated in the Cambrian sandstone and siltstone (49.6%) followed the Silurian slate and phylite (23%) (Figure 11)

Similary, after the 2007 Niigata Chuetsu–Oki Japan Earthquake several units indicate that they were particularly susceptible to landsliding, namely; Pliocene (56%) and Miocene (16%) sedimentary units, typically consisting of sandstones and mudstones, and Pleistocene dune sands (Figure 12). Weakly cemented sands were also particularly susceptible to failure from seismic shaking. In Taiwan, Neogene sandstone and shales after the Chi-Chi 1999 earthquake accounted for over 66% of the landslides induced by the ground shaking (Figure 13). The value is relatively lower than in 1994 Northridge Earthquake in which Tertiary sedimentary rocks accounted for 71% of the total landslides that occurred (Figure 14).

Lastly, for the 1989 Loma Prieta earthquake, sedimentary rocks were most susceptible to producing shallow disrupted landslides. More than 25% of the total landslides were concentrated in the formation, comprising of an interbedded sequence of sandstones, siltstones, and shales (Figure 15). It can be inductively concluded from these cases that Sedimentary rocks, particularly Tertiary sedimentary rocks, are highly susceptible to failure during earthquakes than other lithologic units.

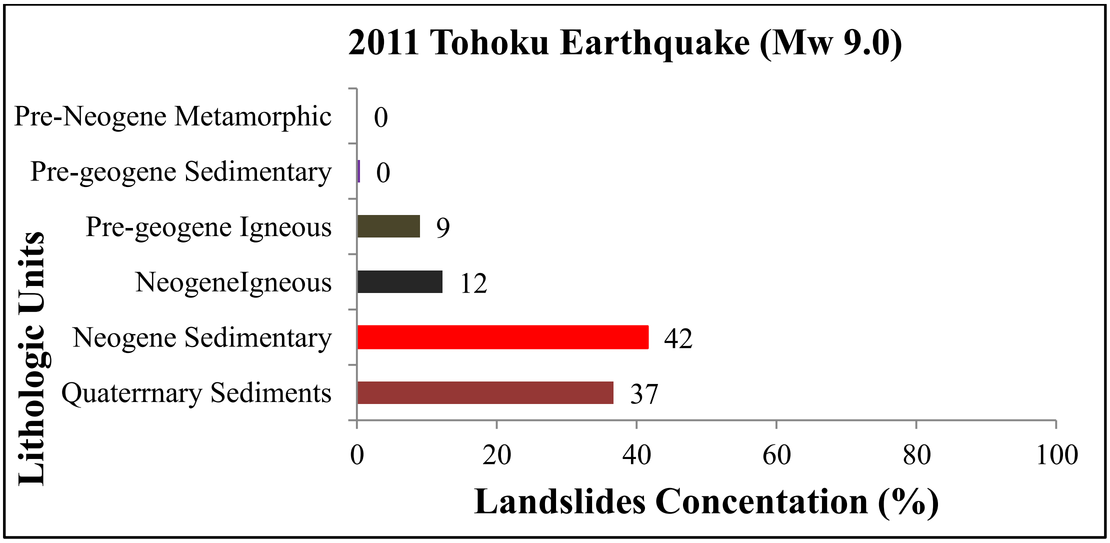


Figure 10: EI landslides concentration with respect to lithology after the 2011 Tohoku Japan earthquake [10]

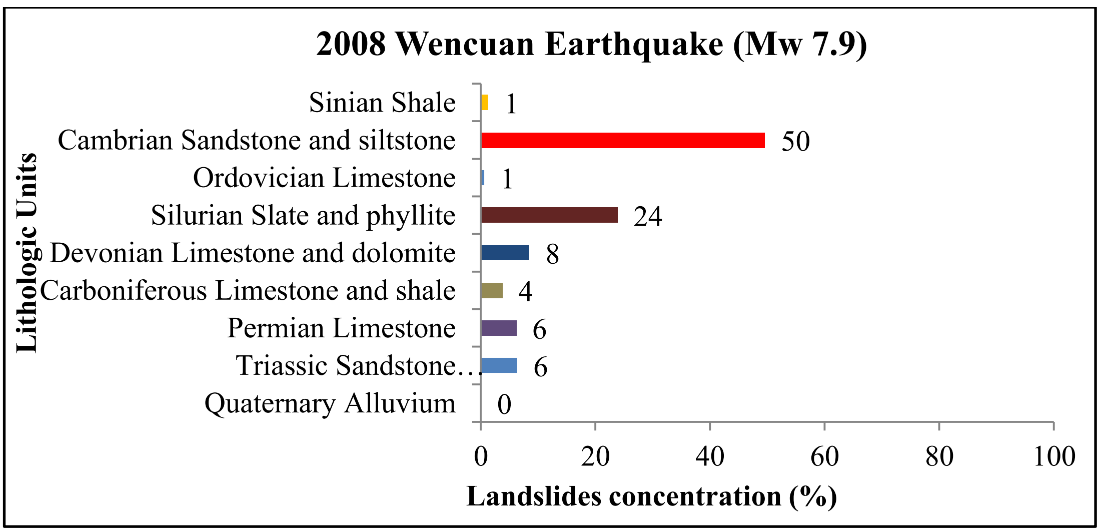


Figure 11: EI landslides concentration with respect to lithology after the 2008 Wenchuan Earthquake [15]

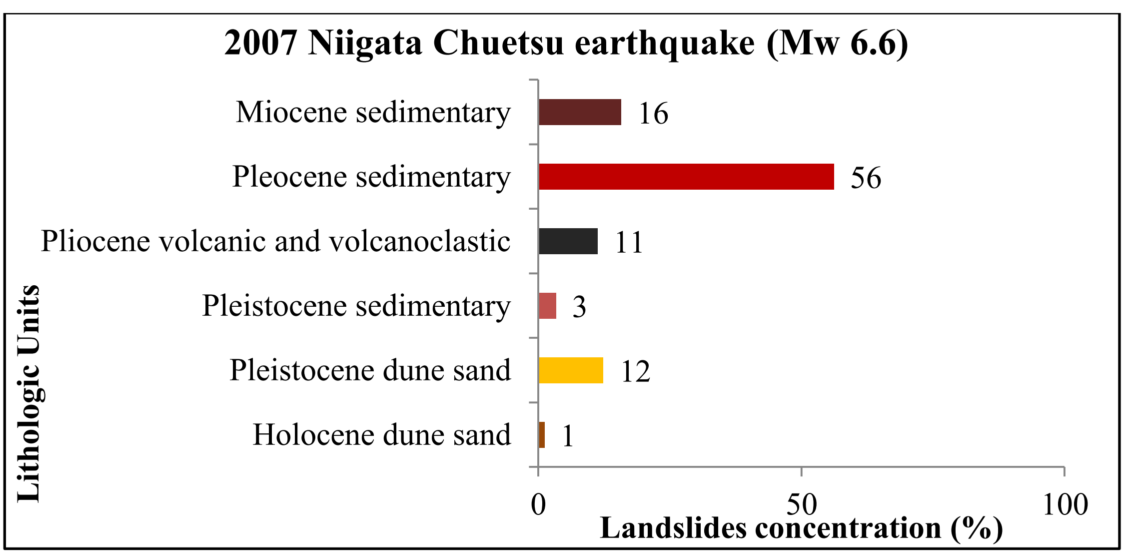


Figure 12: EI landslides concentration with respect to lithology after the 2007 Niigata earthquake after [9]

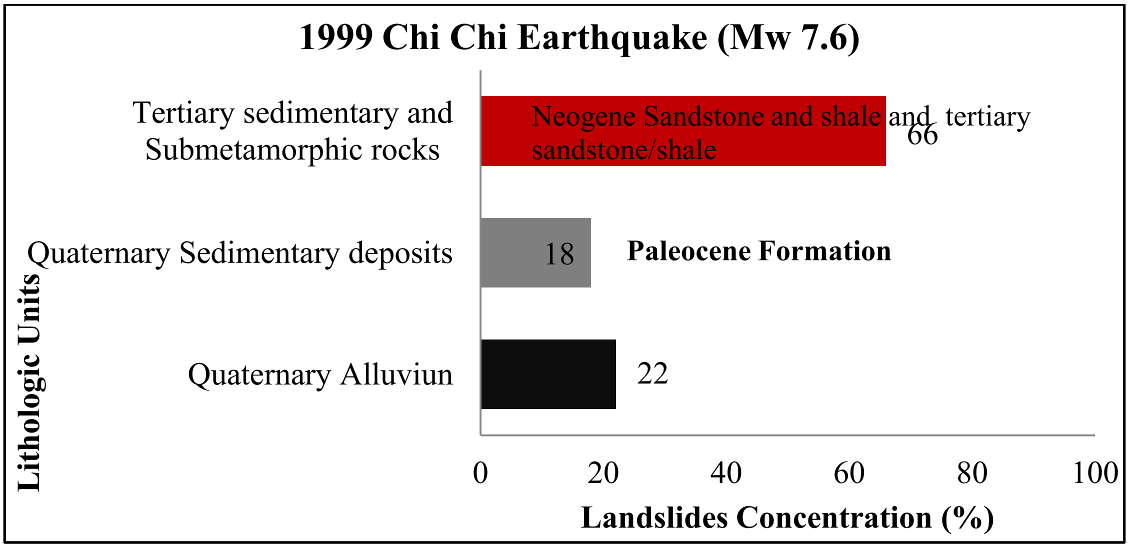


Figure 13: EI landslides concentration with respect to lithology after the 1999 Chi Chi earthquake after [34]

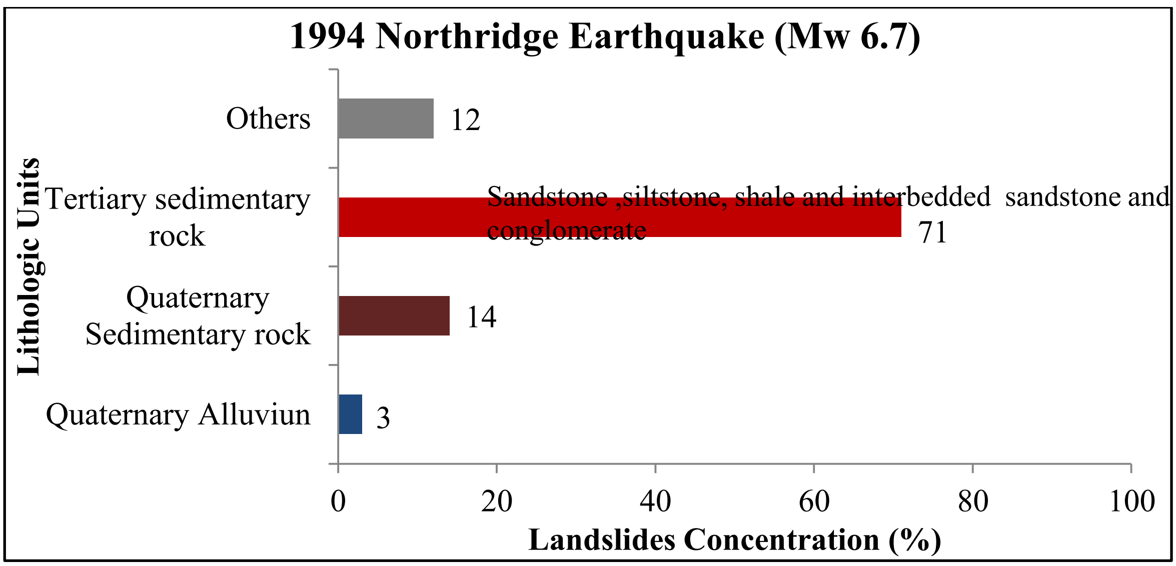


Figure 14: EI landslides concentration with respect to lithology after the 1994 Northridge Earthquake [28]

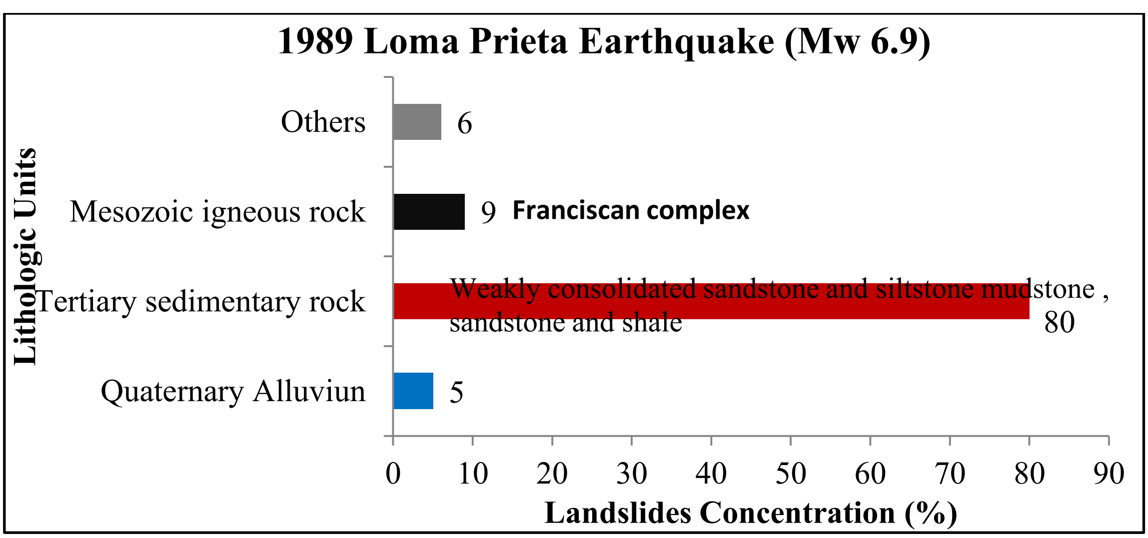


Figure 15: EI landslides concentration with respect to lithology after the 1989 Loma Prieta Earthquake [33]

ii. *Fault Type*

Fault types were analysed to assess their impact on the occurrence of landslides after an earthquake. The relationship between fault type and landslides generating earthquakes is presented in Figure 16 using the information from Table.1. It can be observed in Figure 16 that occurrence of landslides is strongly related to thrust fault type. Earthquakes on thrust faults recorded a frequency of 83% and have caused mass landslides of 91% of the total landslides generating earthquakes investigated followed by earthquakes that occurred on strike slip faults (6%) with a frequency of 13% and the least of the earthquake that induced landslides are on oblique fault with 3% of the total reported landslides and 4% frequency of earthquake occurrence.

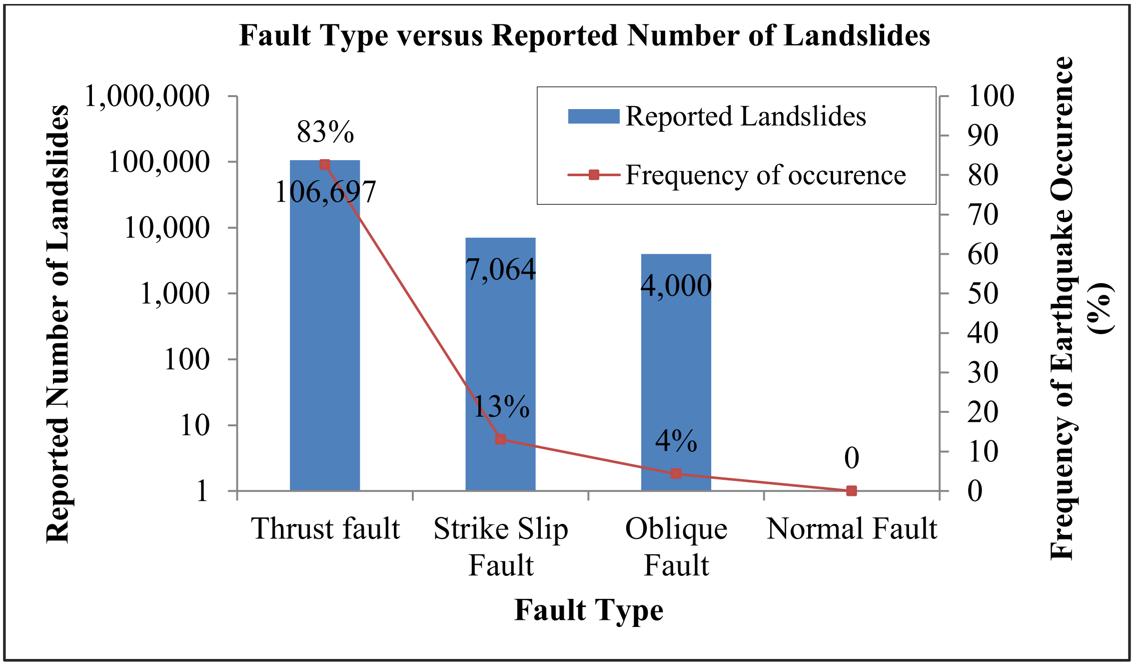


Figure 16: Relationship between fault type and reported number of landslides and their frequency (Source Table 1)

c) *Topography*

i. *Slope Angle*

Slope angle is one of the main factors that influence occurrence of landslides. [34] Argue that of all attributes of topography; slope angle is likely to be the strongest control on landsliding. Hillslope failures occur when the shear stress across a potential failure plane exceeds the substrate strength. Fundamentally, the stability of a hillslope is determined by its surface gradient, the density, cohesion and frictional properties of its substrate, the depth of potential failure plains, and the gravitational acceleration [34]. Slope angle of the EIL against the landslides concentration for the investigated major earthquakes from Table.1 have been presented in Figure 17.

Figure 17 shows that the trend line for Lushan 2013 earthquake recorded a peak landslides concentration the 40°-50° category and then declined with increase in slope angle. For Yushu 2010 earthquake, landslides are concentrated in the 40-50° category. However, the data on slope angle and landslides concentration for Yushu 2010 earthquake as presented by [11] was clumped for slope angles from ≥ 40 degree. The trend line for Wenchuan 2008, Niigata Chuetsu Oki 2007, Kashmir 2005 and Northridge 1994 earthquakes show a common trend where landslides concentration increases with increasing slope angle until the maximum is attained in the 30°–40° category, and then decreases steadily with increasing slope gradient. This implies that if the data for Yushu 2010 earthquake was provided for 40°-50° category and above the trend line would have similar pattern of Wenchuan 2008, Niigata Chuetsu Oki 2007, Kashmir 2005 and Northridge 1994 earthquake.

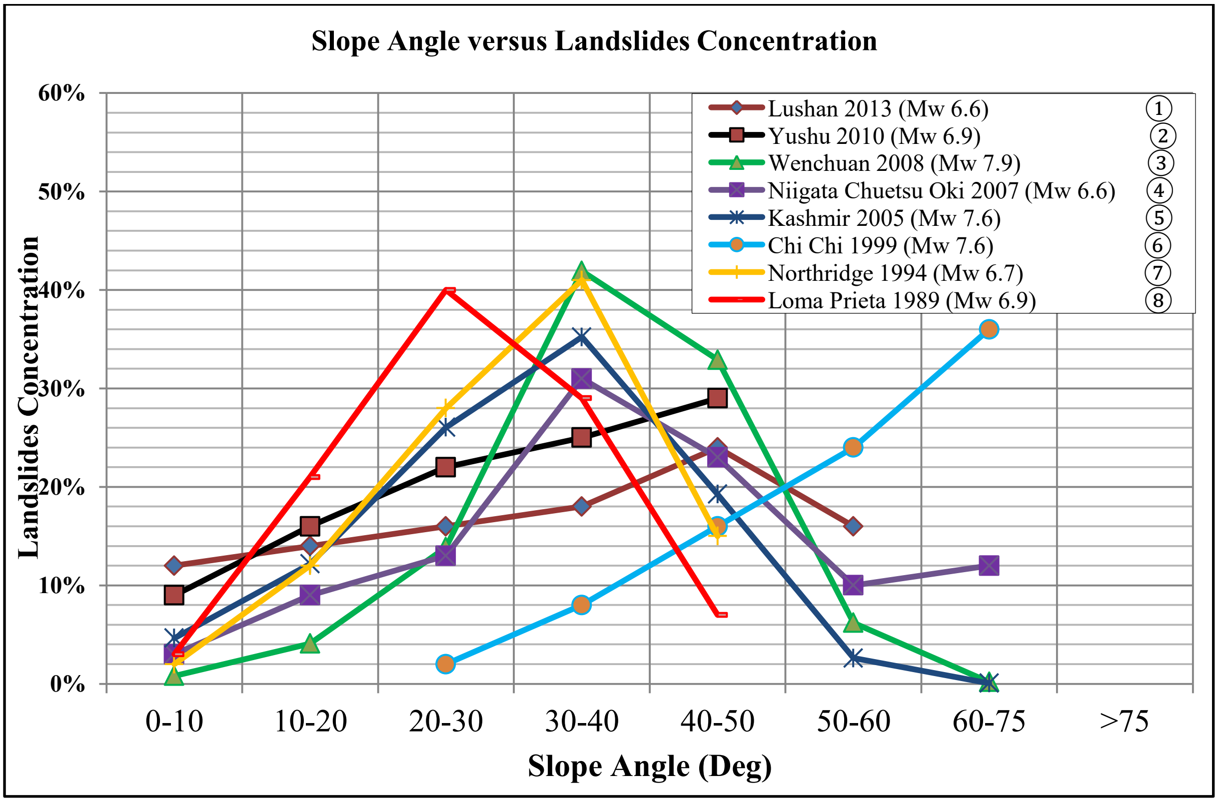


Figure 17: EIL concentration with respect to slope angles in degrees (Data from [8] ①, [11] ②, [15] ③, [9] ④[20] ⑤ [34] ⑥, [28] ⑦ and [33] ⑧)

In the case of the Chi-Chi 1999 earthquake, the landslides concentration increased continually in correspondence with the increasing slope angle. [34] Attribute this deviant trend of the Chi Chi 1999 landslides distribution to the fact that the steep slope angles of the young mountain ranges in Taiwan reflected the dominant type of failure since disrupted slides and toppling/rock falls typically occur on such kind of steep slopes.

ii. *Slope Height*

The impact of slope height cannot be ignored in the study of EIL. Elevation disparities and associated vegetation, weathering, slope material moisture content, and seismic wave amplificaton effect can control seismic landslides [42]. The histogram for elevetion and EIL concentration for representative Yushu, 2010, Wenchuan 2008 and Kashmir 2005 earthquakes is presented in Figure 18. The results of the studied earthquakes show that the highest landslides values occurred at elevations from 750 m to 1500 m, and the values started declining as elevations increase above 1750 m.

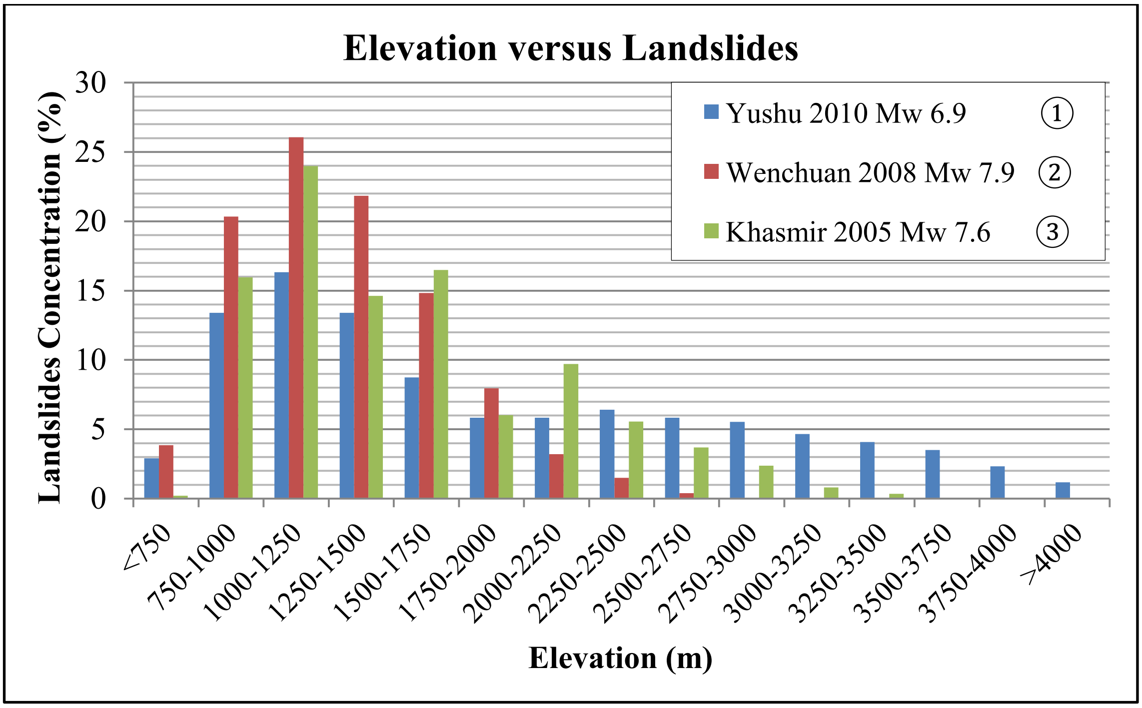


Figure 26: Distribution of landslides with respect to elevation; (Data from [11] ①, [15] ② and [31] ③)

IV. Discussion

In this technical analysis, the principal factors for landslides occurrence due to major earthquakes Mw ≥ 6.6 that occurred between 1998 – 2015 in the world, have been investigated. A quantitative technique of data analysis employed in this study to correlate variables so as to establish their relationship indicate that covariates found to be significantly associated with EI landsliding were; earthquake magnitude, peak ground acceleration and earthquake duration, proximity to the epicentre and/or fault rupture, geology, slopes angle and elevation.

The study has shown that earthquake magnitude has a weak correlation with the area affected by the landslides. However, when the earthquake magnitude are plotted against the square root of the landslides area, a better correlation with a regression coefficient of $R^2 = 0.40$ was obtained implying somewhat a significant influence of magnitude on area affected by EIL. The occurrence of landslides as a function of earthquake ground shaking reveals that PGA alone has no major influence unless it is combined with earthquake shaking duration. Similarly I_A gives a strong relationship with the EIL area since it incorporates the dimension of earthquake duration in the derivation of the parametric value. Focal depth also demonstrated an impact on the occurrence of EIL; swallow depths can be considered as a significant ingredient for occurrence of landslides which affect a considerably wide area as majority of the earthquakes that induced landslides recorded a depth ≤ 20 km.

Earthquakes at great depth in the ground virtually do not cause imminent landslides as the energy becomes lethargic upon reaching the surface of the earth [38]. The review of other studies show that earthquakes with a focal length of ≤ 35 km are likely to cause more landslides than deep seated ones although earthquakes with focal depth ≥ 35 might be register landslides. Landslides distribution as a function of distance from the epicentre and distance from the surface fault plane indicate that most of the landslides occur within 50 km from epicentre and/or fault plane and drastically reduce further away. This can be attributed to the attenuation of energy as the seismic waves travel through the ground.

In terms of geology, the analytical study revealed that geological setting has a great influence on occurrence of landslides during an earthquake. The main lithologic unit prone to landsliding due to seismic effect are the Tertiary sedimentary rocks with at least over 50% of landsliding concentration (Figures 10 - 15). Landslides also occur in metamorphic and igneous rocks if they could be weakened enough by discontinuities and/or weathering. Quaternary lithologic units recorded low landslides because they are usually in peneplains. However they could be prone to liquefaction if the loose sand and silt saturated are strongly shaken long enough by an earthquake causing them to behave like a liquid. It has also been discovered that landslides are strongly correlated to thrust fault type. Thrust fault type tends to register a high proportion and frequency of EIL seconded by strike slip fault type. This is because at thrust faults, compressional forces

Global Journal of Science Frontier Research (H) Volume XVII Issue I Version I Year 2017

cause the blocks on the fault plane to collide violently as the hanging wall runs over the foot wall during its upward movement along the fault plane. Interestingly, no landslides have been reported to have occurred on normal faults for the studied cases. This contrasting phenomenon is attributable to non-violent nature of the extensional forces operating on normal faults that might induce imperceptible deep seated failures with creeping effect. Furthermore, the hanging wall of the thrust fault generally tends to have a higher number of EIL than the foot wall of the thrust fault since it is the block that has relatively high motion. On the other hand, the strike slip fault tends to have almost an equal distribution of EIL on both sides of the fault ruptures.

Geographical environments cannot be ignored when considering seismically induced landslides. The paper has shown the general trend is such that landslides concentration increases corresponds with increasing slope angle until the maximum is reached in the 30°–40° category, and then decreases as slope gradient keeps increasing. It is also worth mentioning that the tendency of the slope to sliding is generally heightened by undercutting action of a river, proximity to drainages and roads as discussed by [43]. Regarding elevation, the results have shown that landslides increase with increasing slope elevation from 750m until the maximum is reached in the 1200–2500m range and then decrease as such heights are surpassed. Due to the complexity and negligible influence of slope aspect and curvature, the study did not focus but other studies might be conducted in that respect. These parameters have a strong reliance on location of the epicentre that determines the distribution of the seismic waves hence the outcomes are variant in individual earthquakes

V. Conclusion

The bivariate analysis applied in the study has demonstrated that no single factor could be picked out as the dominant causative agent of the EIL over the others because the effectiveness of one factor in inducing landslides is dependent on the other factors. Aside the interdependence of the controlling factors, the review of literature has shown that many earthquakes do not cause imminent landsliding activities. However, the earthquake cause slopes to become unstable by the inertial loading it imposes or by causing a loss of strength in the slope materials. so, when heavy rains pour down the ground shaking impact by an earthquake will have created conducive conditions for landsliding as was the case after the Chi-Chi earthquake [46]. Consequently, long-term landslide vulnerability assessments tend to under-represent EI landslide risks as the emphasis is typically put on rainfall-induced landslide events. Under-representation of EIL also comes from the complexity of the analysis because it involves numerous fields such as geology, geophysics, seismology and geotechnics as observed. Thus it is recommended that long-term EIL vulnerability assessments need to be intensively researched on.

References Références Referencias

1. Keefer, D. K. (1984). Landslides caused by earthquakes. *Geological.Society of.America.Bull. 95*, 406-421. United States Geological.
2. Walker, B.F. & Fell, R. (1987). *Landslide classification, geomorphology and site investigation.* Induced Balkema Rotterrdam.
3. Korup, O. (2010). *Earthquake-triggered landsldes Spartial pattern and impacts*. Swiss Federal Research İnstitutes WSL/SLF, CH-7260 Davos.
4. Budimir, M. E. A., Atikson, P. M., & Lewis, H. G. (2015). Seismically-induced landslides hazards and exposure modelling in southern California based on the 1994 Northridge, California earthquake event. *Landslides 12*, 895-910. Springer Verlag Berlin Heidelberg
5. Rodrigues, C. E, Bommer, J. J., & Chandler, R. J (1999). Earthquake induced landslides: 1980 – 1997. *Soil Dynamics and Earthquake Engineering 18*, 325-346.
6. Anderson, M. G., & Richards, K. S. (1989). *Slope stability; geotechnical engneering and geomorphology.* New York: John Wiley and Sons Ltd.
7. Aydan, O., & Ulusay, R. (2015). A quick report on the 2015 Gorkhan (Nepal) Earthquake and its geo-engineering aspects. *International Association for Engineering Geology and the Environment 10,* 25-35.
8. Tang, C., Ma, G., Chang, M., Li, W., Zhang, D. et al. (2015b). Landslides triggered by the 20 April 2013 Lushan earthquake, Sichuan, *Engineering Geology 187*, 45–55.
9. Chakraborty, I., Ghosh, S., Bhattacharya, D., & Bora, A. (2011). Earthquake induced landslides in the Sikkim-Darjeeling Himalayas - An aftermath of the 18 th September 2011 Sikkim earthquake. *Soil Dynamics and Eartquake Engineering 07*, 1–8.
10. Hashmoto, M., Fukushima, Y. & Takada, Y. (2012). Coseismic deformations of the 2011 Tohoku, Japan, earthquake and triggered events derived from Alos / Palsar*. Disaster Prevention Research Institute 661,* 5-9*. Fringe 2011* Workshop (ESA SP-167, 2012)
11. Xu, C., & Xu, X. (2014a). Statistical analysis of landslides caused by the Mw 6.9 Yushu, China, earthquake of April 14, 2010. *Natural Hazards 72*, 871–893. http://doi.org/10.1007/s11069-014-1038-2
12. Gorum, T., van Westen, C. J., Korup, O., van der Meijde, M., Fan, X. et al. (2013). Complex rupture mechanism and topography control symmetry of mass-wasting pattern, 2010 Haiti earthquake.

Geomorphology 184, 127–138. http://doi.org/10.1016/j.geomorph.2012.11.027
13. Delgado, J., Garrido, J., López-casado, C., Martino, S., & Peláez, J. A. (2011). On far fi eld occurrence of seismically induced landslides. *Engineering Geology, 123*, 204–213. http://doi.org/10.1016/j.enggeo.2011.08.002
14. Umar, Z., Pradhan, B., Ahmad, A., Neamah, M., & Shafapour, M. (2014). Earthquake induced landslide susceptibility mapping using an integrated ensemble frequency ratio and logistic regression models in West Sumatera Province, Indonesia. *Catena 118*, 124–135.
15. Qi, S., Xu, Q., Lan, H., Zhang, B., & Liu, J. (2010a). Spatial distribution analysis of landslides triggered by 2008 . 5 . 12 Wenchuan. *Engineering Geology 116* (1-2), 95–108. http://doi.org/10.1016/j.enggeo.2010.07.011
16. Yagi , H., Sato , G., Higaki, D., & Yam, M. (2009). Distribution and characteristics of landslides induced by the Iwate–Miyagi Nairiku Earthquake in 2008 in Tohoku District, Northeast Japan. Landslides (2009). *Landslides 6,* 335–344. *DOI 10.1007/s10346-009-0182-3*, 335–344.
17. Sepúlveda, S. A., Serey , A., Lara, M., Pavez , A., & Rebolledo, S. (2010). Landslides induced by the April 2007 Aysén Fjord earthquake, Chilean Patagonia. *Landslides 7,*483–492*. DOI 10.1007/s10346-010-0203-2*, 483–492.
18. Collins, B. D., Kayen, R., & Tanaka, Y. (2012). Spatial distribution of landslides triggered from the 2007 Niigata Chuetsu – Oki Japan Earthquake. *Engineering Geology 127*, 14–26. http://doi.org/10.1016/j.enggeo.2011.12.010
19. Wartman, J., Cox, B., Meneses, J., Moreno, V., & Olcese, M. (2008). Landslides triggered by the 15 August 2007 M8 . 0 Pisco , Peru earthquake, 10. *Earth and Planetary Science Letters*
20. Harp, B. E. L., & Crone, A. J. (2006). Landslides triggered by the October 8, 2005, Pakistan. Earthquake and associated landslide-dammed reservoirs. *Geomorphology 94*, 1-9
21. Kieffer, D. S., Eeri, M., Jibson, R., Eeri, M., Rathje, E. M. et al. (2006). Landslides Triggered by the 2004 Niigata Ken Chuetsu, Japan, Earthquake. *Earthquake Spectra 22 (03)*, 47–73. http://doi.org/10.1193/1.2173021
22. Keefer, D. K., Wartman, J., Navarro, C., Rodriguez-marek, A., & Wieczorek, G. F. (2006). Landslides caused by the M 7. 6 Tecomán, Mexico Earthquake. *Engineering Geology 86*, 183–197. http://doi.org/10.1016/j.enggeo.2006.02.017
23. Bouhadad, Y. (2010). Earthquakes- induced landslides in Algeria : The Laalam, March 20 th, 2006 earthquake. *Earthquake Engineering Center*, *12*, 5–9.
24. Mahdavifar, M. R., Solaymani, S., & Jafari, M. K. (2006). Landslides triggered by the Avaj , Iran earthquake of June 22 , 2002*. Engineering Geology 86,* 166–182. http://doi.org/10.1016/j.enggeo. 2006.02.016
25. Jibson, R. W., Harp , E. L., Schulz, W., & Keefer, D. K. (2004). Landslides triggered by the 2002 Denali fault, Alaska, earthquake and the inferred nature of the strong shaking. *Earthquake Spectra 20 (3)*, 669–691.
26. Garc-Rodriguez, M. J. (2010). Assessment of earthquake-triggered landslide susceptibility in El Salvador based on an Artificial Neural Network model. *Natural Hazards and Earth System Science 10*, 1307–1315. http://doi.org/10.5194/nhess-10-1307-2010
27. Khazai, B., & Sitar, N. (2003). Evaluation of factors controlling earthquake-induced landslides caused by Chi-Chi earthquake and comparison with the Northridge and Loma Prieta events. *Engineering Geology 71*, 79–95. http://doi.org/10.1016/S0013-7952(03)00127-3
28. Parise, M., & Jibson, R. W. (2000). A seismic landslide susceptibility rating of geologic units based on analysis of characteristics of landslides triggered by the 17 January, 1994 Northridge, California earthquake*. Engineering Geology 58*, 251–270.
29. Meunier, P., Hovius, N., & Haines, A. J. (2007). Regional patterns of earthquake-triggered landslides and their relation to ground motion. *Earth and Planetary Science Letters 34*, 1–5. http://doi.org/10.1029/2007GL031337
30. Keefer, D. K. (2000). Statistical analysis of an earthquake induced landslides distribution — the 1989 Loma Prieta, California event. *Geology Enginnering 58,* 231-249.
31. Kamp, U., & Owen, L. A. (2016). GIS-based landslide susceptibility mapping for the 2005 Kashmir earthquake region, (November 2008). *Geomorphology, 101*, 631-642. http://doi.org/10.1016/j.geomorph.2008.03.003
32. Zaruba, Q., & Mencl, V. (1982). *Landslides and their control.* Elsevier Scientific Publishing Co.
33. Keefer, D. K. (1989). Statistical analysis of an earthquake induced landslides. *Engineering Geology 58,* 231-249*.*
34. Khazai, B., & Sitar, N. (2004). Evaluation of factors controlling earthquake-induced landslides caused by Chi-Chi earthquake and comparison with the Northridge and Loma Prieta events. *Engineering Geology 71(1-2)*, 79–95. http://doi.org/10.1016/S0013-7952(03)00127-3
35. Wilson, R. C. (1993). *Relation of arias intensity to magnitude and distance in california*. U. S. Geological Survey. Menlo Park, California 94025

36. Chousianitis, K., Del Gaudio, V., Kalogeras, I., & Ganas, A. (2014). Predictive model of Arias intensity and Newmark displacement for regional scale evaluation of earthquake-induced landslide hazard in Greece. *Soil Dynamics and Earthquake Engineering*, *65*, 11–29. http://doi.org/10.1016/j.soildyn.2014.05.009
37. Travasarou, T., Bray, J.B. & Abrahamson, A. (2003). Empirical attenuation relationship for Arias Intensity. *Earthquake Engineering and Structural Dynamics 32*, 1133-1155.
38. Lei, C. I. (2012). Earthquake-Triggered Landslides. *1st Civil and Environmental Engineering Student Conference*, (June), 1–6.
39. Arias, A. (1970). *A measure of earthquake intensity. Seismic Design for Nuclear Power Plant*, ed. R.J. Hansen, MIT Press: Cambridge.
40. Fortunato, C., Martino, S., Prestininzi, A., & Romeo, R. W. (2012). Nuova versione del Catalogo italiano degli Effetti Deformativi Indotti da forti Terremoti (CEDIT) new release of the italian catalogue of earthquake-induced ground failures. *Engineering Geology and Environment 2*, 63–75. http://doi.org/10.4408/IJEGE.2012-02.O-05
41. Johnson, C. W.C, Bürgmann W. R and Pollitz, F. F. (2015). Rare dynamic triggering of remote M≥5.5 earthquakes from global catalog analysis. *Journal of Geophysical Research*: Solid Earth.
42. Meunier, P., Hovius, N., & Haines, J. A. (2008a). Topographic site effects and the location of earthquake induced landslides. *Earth and Planetary Science Letters 275(3-4)*, 221–232. http://doi.org/10.1016/j.epsl.2008.07.020
43. Kıncal, C., Akgün, K. A. M & Koca, Y. (2009). Landslide susceptibility assessment in the Izmir (West Anatolia, Turkey) city center and its near vicinity by the logistic regression method. *Environmental Earth Science 59*, 745-756.
44. Xu, C., Xu, X., Yao, X. & Dai, F. (2014). Three (nearly) complete inventories of landslides triggered by the May 12, 2008 Wenchuan Mw 7.9 earthquake of China and their spatial distribution statistical analysis. *Landslides 11*, 441–461
45. Mahmood, I., Qureshi, S. N., Tariq, S., Atique, L., & Iqbal, M. F. (2015). *Analysis of landslides triggered by October 2005, Kashmir Earthquake* – PLOS Currents Disasters
46. Lin, C.W, Liu, S.H, Lee, S.Y & Lin, C.C (2006). Impacts of the Chi-Chi Earthquake on subsequent raifall-induced landslides in central Taiwan. *Engineering Geology 89 (2)*, 87-101
47. Dai, F.C. & Lee, C.F. (2001). Frequency -volume relation and prediction of raifall-induced landslides. *Engineering Geology 59 (3)*, 253-266.
48. Collins, B.D & Znidarcic D. (2001). Stability Analyses of rainfall-induced landslides. *Geothechnical and Geoenvironmental Engineering 130 (4)*, 362-372.
49. Wang, G.F & Sassa, K. (2003). Pore-pressure generation and movement of rainfall-induced landslides: Effects of grain size and fine particle movement. Engineering Geology 69 (1), 109-125.
50. Chen, H & Lee, C.F. (2003). A dynamic model for rainfall induced landslides on natural slopes. *Geomorphology* 51 (4), 269–288. http://dx.doi.org/10.1016/S0169-555X(02)00224-6.

This page is intentionally left blank

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Projection of Future Changes in Landuse/Landcover using Multi-Layer Perceptron Markov Model Over Akure City, Nigeria

By I. A. Balogun & K. A. Ishola
Federal University of Technology

Abstract- The tropical areas of West Africa including Akure city are experiencing rapid urbanization due to the increasing socio-economic growth and opportunities in the cities. As a result, the demand for space has brought about man's alteration of the natural surface features, and this is likely to continue in the subsequent years. Urbanization processes in relation to Landuse/Landcover changes (LULCC) over Akure city were examined using Landsat TM, ETM+, and TIRS/OLI data for the periods 1986, 2000 and 2014. The Landsat images were subjected to pre-processing and classified based on the widely used supervised maximum likelihood classification scheme. Afterwards, the past and future (2028 and 2042) transitions, potential modification and extension of various land use/land cover types were carried out using Land Change Modeler (LCM) and the Multi-Layer Perceptron (MLP) Markov chain projection model.

Keywords: *urbanization, MLP, landuse/landcover, landsat.*

GJSFR-H Classification: *FOR Code: 960999*

PROJECTIONOFFUTURECHANGESINLANDUSELANDCOVERUSINGMULTILAYERPERCEPTRONMARKOVMODELOVERAKURECITYNIGERIA

Strictly as per the compliance and regulations of :

Projection of Future Changes in Landuse/Landcover using Multi-Layer Perceptron Markov Model Over Akure City, Nigeria

I. A. Balogun [α] & K. A. Ishola [σ]

Abstract- The tropical areas of West Africa including Akure city are experiencing rapid urbanization due to the increasing socio-economic growth and opportunities in the cities. As a result, the demand for space has brought about man's alteration of the natural surface features, and this is likely to continue in the subsequent years. Urbanization processes in relation to Landuse/Landcover changes (LULCC) over Akure city were examined using Landsat TM, ETM+, and TIRS/OLI data for the periods 1986, 2000 and 2014. The Landsat images were subjected to pre-processing and classified based on the widely used supervised maximum likelihood classification scheme. Afterwards, the past and future (2028 and 2042) transitions, potential modification and extension of various land use/land cover types were carried out using Land Change Modeler (LCM) and the Multi-Layer Perceptron (MLP) Markov chain projection model. The projected LULCC indicated a substantial increase in the built-up areas from 5.04% of the area covered in 2014 to 21.72% and 26.47% by 2028 and 2042 respectively. This was evident in the corresponding decrease in the areas covered by vegetation and bare soil. The observed rural (like Ipinsa, Ibule, Shasha, Airport, NTA, etc) and sub-urban (like FUTA, Oba-Ile, Ijoka, Aule, Igoba etc) areas with abundant vegetation in the earlier periods have all experienced significant depletion and surface modifications in the latter years. The study concludes that, unabated vegetation loss and degradation could trigger serious environmental problems that are linked to increased surface thermal response, reduced infiltration and increased surface runoff.

Keywords: urbanization, MLP, landuse/landcover, landsat.

I. Introduction

The fast increasing population due to the socio-economic and infrastructural growth has led to the demand for space in most of the cities around the globe. This has attracted the attentions of relevant scientific communities in most of the developing countries. Evidence has revealed that the world is becoming progressively urbanised, with 45% of the population already living in urban areas in the year 2000 (Arnfield, 2003). It has been estimated that by the year 2025, 60% of the world's population will live in cities (UNEP 2002; Ichimura 2003). World population is forecast to reach 9 billion by 2050, with almost all the growth in developing countries (UN Development Programme 2010). The UN predicts that 60% of the world's population will be living in cities by 2030 and that nearly all the population growth will be in the cities of developing countries. Urbanization process refers to the transformation of natural vegetation into anthropogenic surfaces which are lands covered with buildings, roads, parking lots, and other paved surfaces associated with socio-economic growth and development of an area. During this process, the surface biophysical properties including soil moisture, material heat capacity, surface reflectivity and emissivity are altered.

FAO (2010) reported that the rate of deforestation in Nigeria between 1990 and 2010 was averagely 409,650 ha or 2.38% per year. On a local scale, Ishola et al. (2016) noted that the modification of natural vegetation in a neighbouring Abeokuta city in Nigeria is the main driver of LULCC and attributed this to the compelling socio-economic factors like rural-urban migration, the demand for space as a result of increasing population, and lack of urban monitoring and planning. However, the future scenarios owing to these compelling factors were beyond the scope of the study.

LULCC assessment specifically involves identifying the spatial and temporal changes of living and non-living features that are occurring within ecosystems (Roy et al., 2014). It involves the ability to quantify the human-induced changes, alteration and transformation of the surface features using multi-temporal data sets. Detecting, describing and understanding such changes are of considerable interest, not only to ecologists or conservationist, but also to environmental scientists and resource managers (Salami, 1999). In fact, insights on land cover change especially in relation to natural vegetation are a pressing issue for sustainable development because these changes can lead to land use conflicts and other environmental consequences (EEA, 2007). Natural

Author α: Department of Meteorology and Climate Science, Federal University of Technology, Akure, Nigeria. Centre for Space Research and Applications (CESRA), Federal University of Technology, Akure, Nigeria.
Author σ: Centre for Space Research and Applications (CESRA), Federal University of Technology, Akure, Nigeria.
e-mail: skorchie126@yahoo.com

vegetation is a multifunctional land cover which could be retained to counter-balance built-up density, as well serve as carbon sinks, and aid ecosystem and biodiversity. Hence, their losses cannot be ignored because; they pose a major threat to the environment and ecosystem health. In this respect, it is imperative that the LULC dynamics be adequately monitored and analyzed. Furthermore, the decisions about the quantities, purposes, and related consequences of land use are still poorly understood (Oyinloye et al., 2004). Therefore, proper geo-management of land and availability of detailed, accurate and up-to-date geo-information require an urgent intervention (Lemmens, 2001). That is, understanding LULC dynamics is critical for the planning and protection of the environment, and ecosystem and biodiversity (Hansen et al., 2008; Gomez et al., 2011)

Land-cover mapping determines the current composition and distribution of land surface attributes, and this is subsequently used as the basis for assessing future change (McDermid et al., 2005; Miller and Rogan, 2007; Schulz et al., 2010;Carmelo et al., 2012). However, modeling the complex dynamic systems of the land surface features has been challenging (Ahmed, 2011). Some popular tools have been developed to model urban growth and land cover changes including Geomod (Pontius and Spencer, 2005), SLEUTH (Silva and Clarke, 2002), Land Use Scanner (Hilferink and Rietveld, 1999), Environment Explorer (Verburg et al., 2004), SAMBA (Castella et al., 2005), Land Transformation Model (Pijanowski et al., 2000), and CLUE (Kok and Veldkamp, 2001). These tools make use of a number of methods such as Markov Chain (Balzter, 2000), Cellular Automata (Sante et al., 2010), Logistic Regression (McConnell et al., 2004), and Artificial Neural Network (ANN) (Civco, 1993). More details on the characteristics of each tool are discussed in the literature (Pontius et al., 2008). This study used the Multi-layer Perceptron (MLP), a type Neural Network method with more than one hidden layer, in order to model and project future land cover change scenarios (Ahmed and Ahmed, 2012). The MLP decides about the parameters to be used and how they should be changed to better model the data. It undertakes the classification of remotely sensed imagery using the back propagation algorithm. The MLP also performs a non-parametric regression analysis between input variables and one dependent variable with the output containing one output neuron (Atkinson and Tatnall, 1997).

II. Materials and Methods

a) Study area

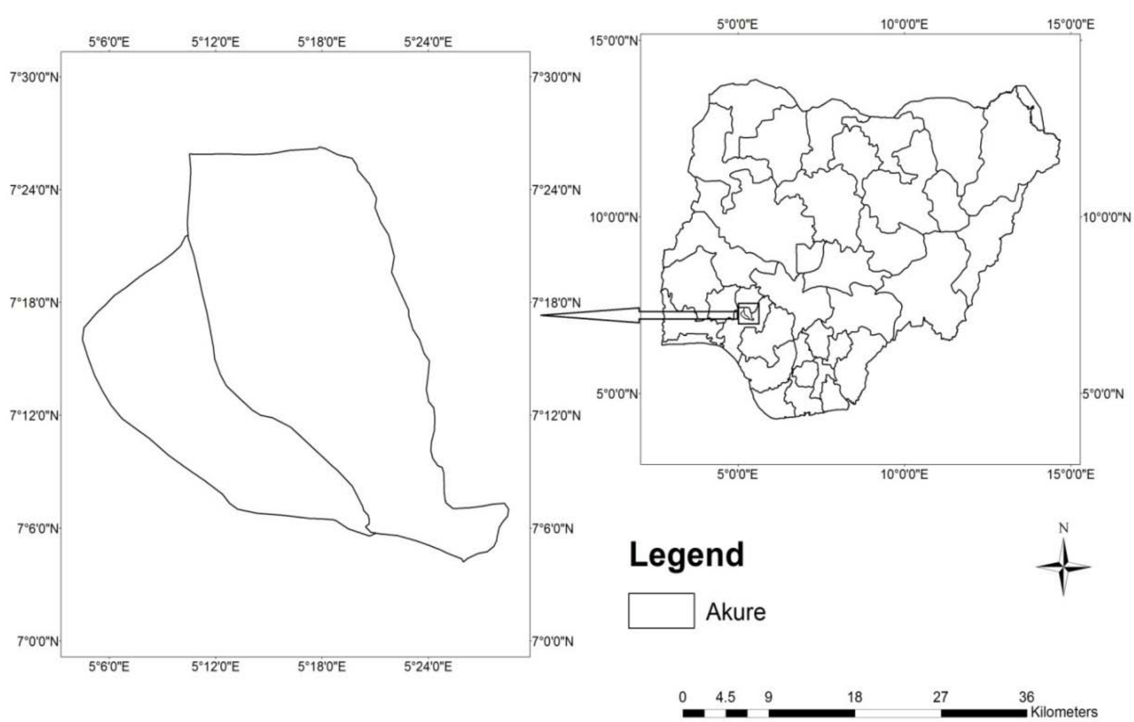


Figure 1: Map of Nigeria showing the location of the study area

The city of Akure in Ondo State, Nigeria has received wide attention in recent times. The rapid growth of the city, particularly within the last few decades, has made it one of the fastest growing metropolitan areas in the South-western Nigeria. Its increasing population and observed rapid rate of expansion in land use has been attributed to the socio-economic growth of the area (Balogun et al., 2012; Oyinloye and Fasakin, 2014). Akure area has witnessed tremendous growth in the size of built-up areas, number of immigrants, transportation and commercial activities. It is geographically situated between longitude 5°06'E to 5°38'E and latitude 7°07'N to 7°37'N (see figure 1) and lies on a relatively flat plain with roughly 370m above sea level. It is situated in the humid tropical region of Nigeria with average rainfall of about 1500 mm per annum. The annual average temperatures range between 21.4 and 31.1°C, and mean annual relative humidity is about 77.1% (NiMET, 2007). Its population has increased from 71,006 people in 1963 to 340,021 in 2006 (NPC, 2006), and has been estimated to increase annually by more than 5%. The increase in annual growth of the population has been tied to the administrative role of the town and its long standing role as a centre of economic activities attracting a large spectrum of immigrants into it.

b) Materials

The study adopted Landsat multisensory and multitemporal datasets acquired from the archives of United States Geological Survey (USGS) including, Landsat thematic mapper (TM), enhanced thematic mapper plus (ETM+), and operational land imager/thermal infrared sensor (OLI/TIRS) covering 1986, 2000, and 2014 respectively (see Table 1). The study area is located in the Landsat path 190 and row 055 of the World Reference System (WRS-2).

The images were captured at different periods, thus, the different atmospheric conditions of the imageries. However, the atmospheric corrections with other corrections like geometric, radiometric, and topographic of the imageries were carried out in GIS environment. The radiometric correction employed the algorithm of Chander and Markham (2003) with the addition of an atmospheric correction. The 2000 image was used as the base image for geometrical correction due to its better visual quality. Geometric correction of the 2000 scene was based on Ground Control Points (GCPs) identified on the topographical maps of the area, and nearest neighbour resampling to a 30-meter pixel size with RMS error of 0.25. The 1986 and 2014 imageries were co-registered to the base image using additional GCPs into UTM projection with geometric errors of less than one pixel, so that all the images have the same coordinate system (Adedeji et al., 2015).

Table 1: Description of the Landsat imageries used (USGS, 2014)

City	Path/row	Sensor	%Clou	Date acquired	Resolution
		Landsat5 TM	0.00	17/12/1986	30m/120m
Akure	190/055	Landsat7 ETM+	0.00	15/02/2000	30m/60m
		Landsat8 OLI/TIRS	0.59	14/12/2014	30m/100m

c) Methods

i. *Image classification*

The acquired satellite imageries for the three examined dates were classified into four broad land cover classes based on the sample set created according to a total of 100 identified training samples (see Table 2). Training samples are representative of the desired land use classes (Magidi, 2010) and were determined based on ground truthing, researcher's personal experience and physiographical knowledge of the study area (Jensen, 2007). On average, 20 to 25 training samples for each land cover class were selected. All the images were analyzed with respect to their spectral and spatial distribution in order to develop the training sites (Ahmed, 2011). A chosen band combination (RGB = 432) was used to develop polygons around each training site of similar land cover. Then a unique identifier was assigned to each known land cover type (Ahmed and Ahmed, 2012). Afterwards, the statistical characterizations (i.e., signatures) of each land cover class were developed and a supervised maximum likelihood classification method with a uniform prior was used for all classes. This procedure has proven to be a robust and consistent classifier for multi-date classifications (Wu et al., 2006). Each composed image was ordered into 4 area classes: water, vegetation, built-up and bare soil as described in Table 2. Furthermore, a distance threshold was adopted for each class to remove the pixels that probably do not belong to that class and was determined by examining interactively the histogram of each class in the generated distance image. Pixels with a distance value greater than the threshold were assigned a class value of zero in the thematic image. The accuracies of the classified imageries were checked with a stratified random sampling method of 200 reference pixels for each examined dates. This sampling number is thought to be a compromise between statistical rigor and practical limitations (Wu and Murray, 2003). The confusion/error matrices (not shown) were basically

Global Journal of Science Frontier Research (H) Volume XVII Issue I Version I Year 2017

used to assess the overall, producer's, and user's accuracy of classification results, as well as the kappa coefficient. This is an important method for evaluating per-pixel classification (Weng, 2002).

Table 2: Details of the land cover types

Land Cover Type	Description
Built-up Surface	All infrastructure—residential, commercial, mixed use and industrial surface areas, asphalt road network, pavements, rocks, parking lots, and other man-made structures.
Water Body	River, permanent open water, lakes, ponds, canals, permanent/seasonal wetlands, low-lying areas, marshy land, and swamps.
Vegetation	Trees, natural vegetation, mixed forest, gardens, parks and playgrounds, grassland, vegetated lands, agricultural lands, and crop fields.
Bare Soil	Fallow land, earth and sand land in-fillings, construction sites, developed land, excavation sites, open space, bare soils, and the remaining land cover

ii. *Land cover change detection analysis*

Change detection analysis was carried out on Landsat images of different years (i.e. 1986, 2000 and 2014) to analyze the pattern and trend of change in the study area using Land Change Modeller (LCM) for ecological sustainability and Markov Chain model (Eastman, 2006). Using LCM requires mainly two time categorical maps and so the classified maps (say 1984 (time-1) and 2003 (time-2)) were used as inputs for the change analysis. This enabled us to understand the gains and losses, the net transition of areas and contributions among the land use/land cover classes; and to quantify the changes that occurred from time-1 to time-2 (Eastman, 2006).

iii. *Projection of future land cover changes*

There exists several land use/cover change modeling techniques, but the right simulation technique / model depends on the scope of study, availability of datasets, objective of the research, and the accuracy of the prediction (Pontius et al., 2008; Ahmed, 2011). Considering accuracy and wide acceptability, both the Markov Chain (Basharin et al., 2004) and MLP modeling techniques (Atkinson and Tatnall, 1997) were applied in this study to project the future changes of land cover. A detailed description on the MLP Markov modeling technique has been comprehensively described by Ahmed and Ahmed (2012). The observed changes in land cover that is, the transitions from other land cover types to built-up areas, were used as the dependent variables; while the spatial variables such as the distance from all land cover types to built-up areas, water body, vegetation, and bare soil; the empirical likelihood transformation, were used as the independent variables. These two types of variables were used to train the MLP Markov model and to produce the transition potential maps between the historical years.

Afterwards, future scenarios of LULCC were predicted for 2028 and 2042 using the Multi-Objective Land Allocation (MOLA) algorithm (Khoi and Murayama, 2010). The quantities of modifications were determined by the Markovian conversion probabilities (Eastman et al., 1995). After this, a multi-objective allocation was run to allocate land for all receivers of a set class (Khoi and Murayama, 2010; Eastman, 2012). The results of the reallocation of each set class were then overlaid to produce the final predicted maps.

III. Results and Discussion

a) *Land cover changes*

This section presents the various classes of land use/ land cover adopted in this study, and the analysis of the changes that have taken place over time (Figure 2).The overall accuracies of the classified images revealed 91.67% in 1986, 85.83% in 2000, and 88.33% in 2014. The Kappa coefficients were observed to be 0.81, 0.74, and 0.76 for 1986, 2000, and 2014 respectively (Table 3). The Kappa coefficient is a measure of the proportional/percentage improvement by the classifier over a purely random assignment to classes (Ahmed et al., 2013).

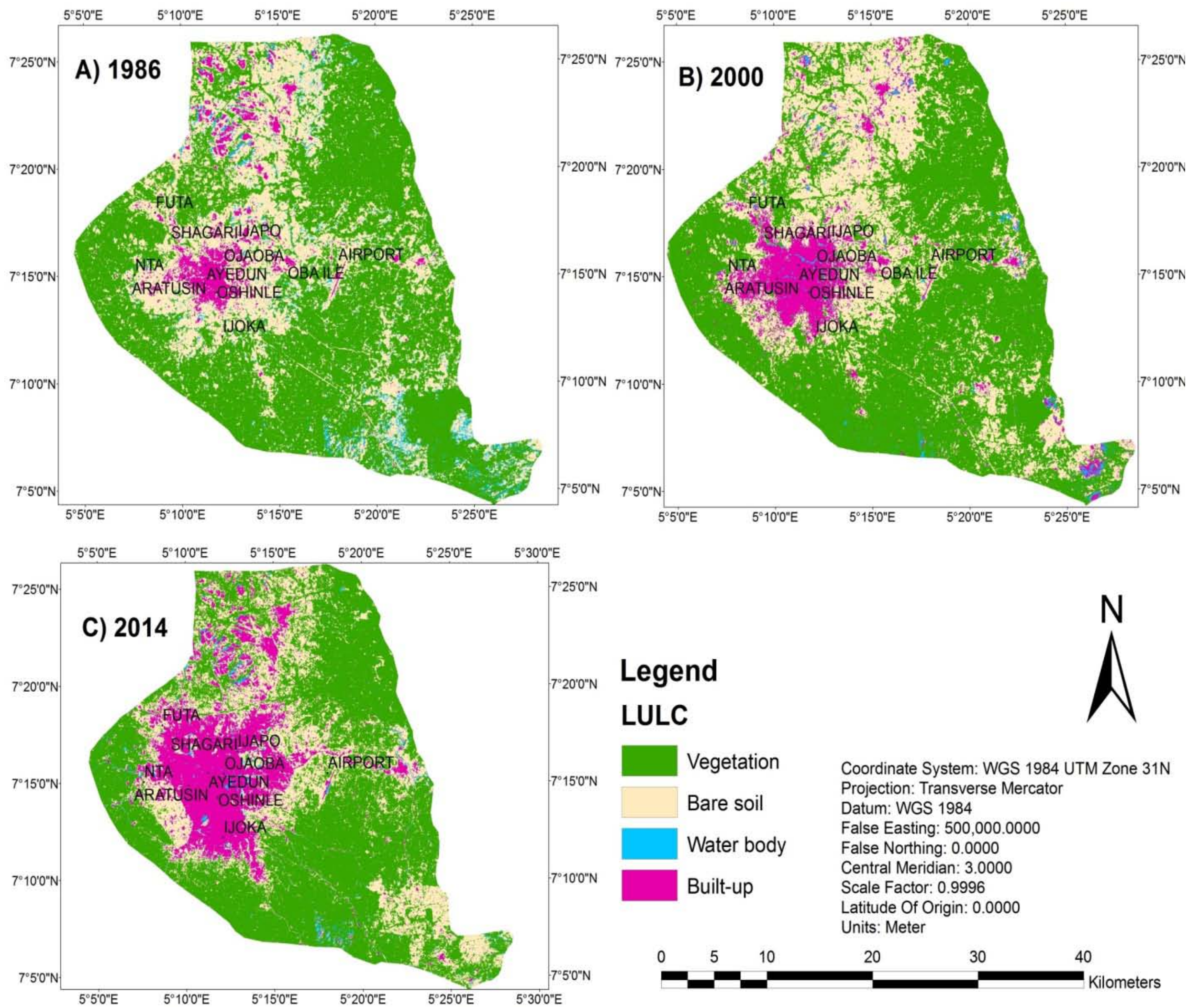


Figure 2: Spatial distribution of Landuse/Landcover maps of Akure for A) 1986 B) 2000 and C) 2014

Table 3: Accuracy assessments of the Land cover classes

	User's Accuracy (%)				Producer's Accuracy (%)				Overall	
Year	Water Body	Vegetation	Built-up Area	Bare Soil	Water Body	Vegetation	Built-up Area	Bare Soil	Accuracy (%)	Kappa Coefficient
1986	75.00	98.78	66.67	77.42	100.00	92.05	100.00	88.89	91.67	0.81
2000	0.00	83.33	88.89	93.75	0.00	98.48	72.73	69.77	85.83	0.74
2014	0.00	91.46	81.82	88.00	0.00	96.15	90.00	68.75	88.33	0.76

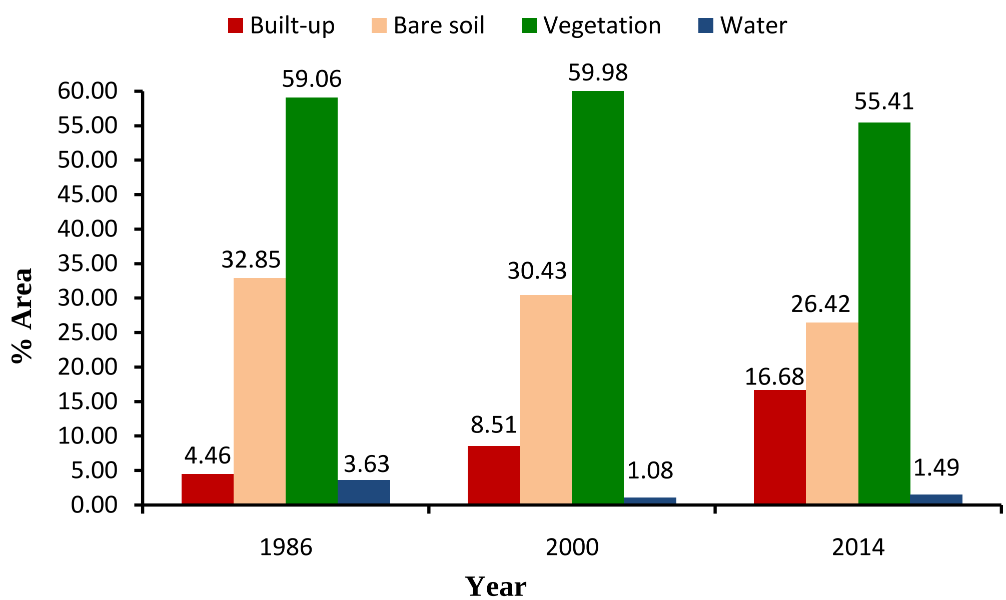
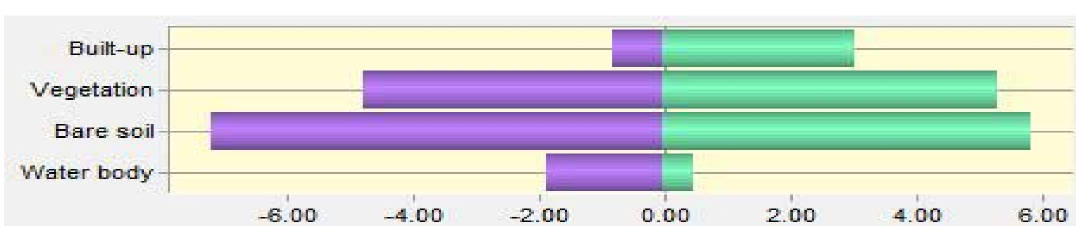
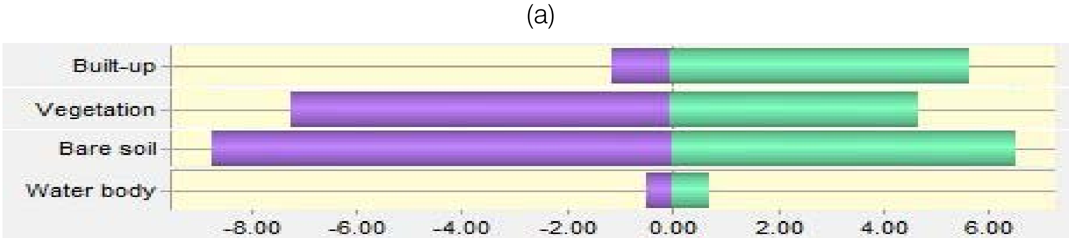


Figure 3: Percentages of area covered by landcover types in Akure

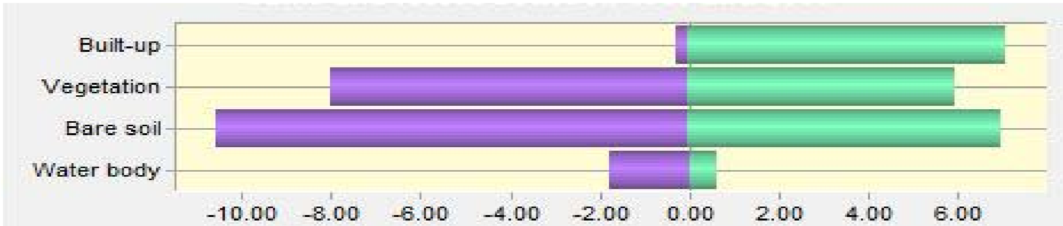
The analysis of the spatial-temporal pattern of the land cover changes presented in Figures 2 and 3 revealed that, the proportion of Built-up area exhibits an increasing trend, while other land cover classes decreased in the proportion of area covered over the years. Figure 3 shows that vegetation covers the largest proportion/percentage of this area followed by bare surfaces throughout the period under study. Although the percentage area covered by Built-up has increased over the years from 4.46% in 1986 to 16.68% in 2014. This is obvious in the loss of percentage area covered by vegetation (59.06%) and bare soil (32.85%) in 1986 to 55.41% and 26.42% respectively in 2014, as a result of the increasing socio-economic factors (population, economic, technological and institutional growth). These have triggered competition for space for various urban development purposes such as residential, commercial, recreation, institutional, industrial, transportation etc, thereby increasing the built-up area and consequently decreasing vegetation and bare soil areas. If the above enumerated factors are left unchecked with appropriate urban planning and development policies, the city might be facing serious environmental, bioclimatological and health challenges in no distant time. Balogun et al. 2011 reported the existence of urban heat island (UHI) intensity of 4°C in the city. The consistent increase in the built up area will continue to affect the environment through enhanced releasing of pollutants to the atmospheric environment and subsequent degradation of the local climate. Balogun et al. (2014) observed that the carbon monoxide (CO) concentrations at the urban area were 2-3 times higher than that of the rural site. The increase in built up area can often leads to continual loss of biodiversity on a long term and also increases potentials for flooding. Among all the land cover classification, there is little/no significant percentage area covered by the water body throughout the period under investigation Further analyses were conducted to understand these patterns of conversion throughout the period of study.



(a)

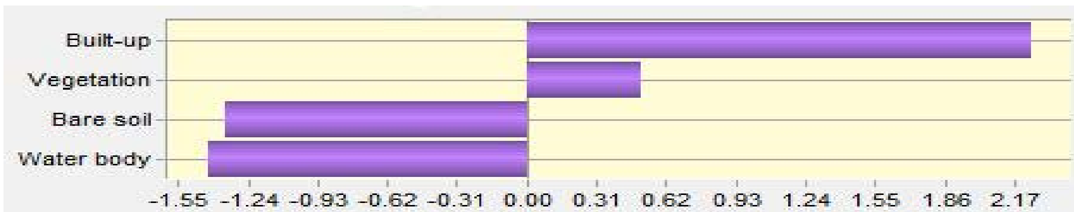


(b)

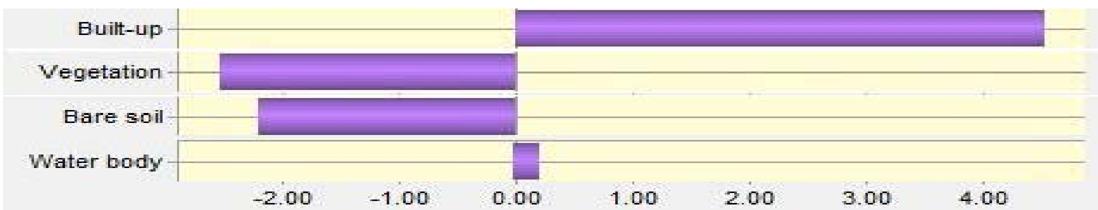


(c)

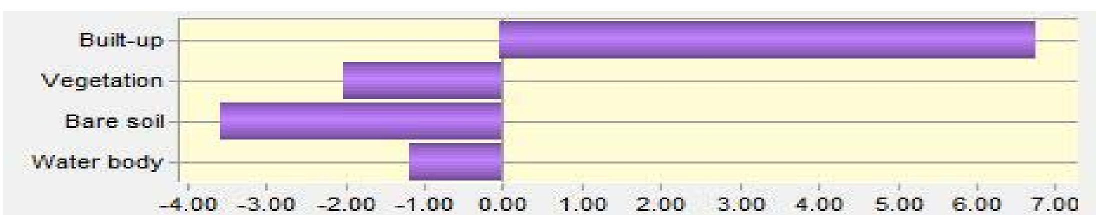
Figure 4: Gains and Losses in Land cover areas between (a) 1986 and 2000 (b) 2000 and 2014(c) 1986 and 2014



(a)

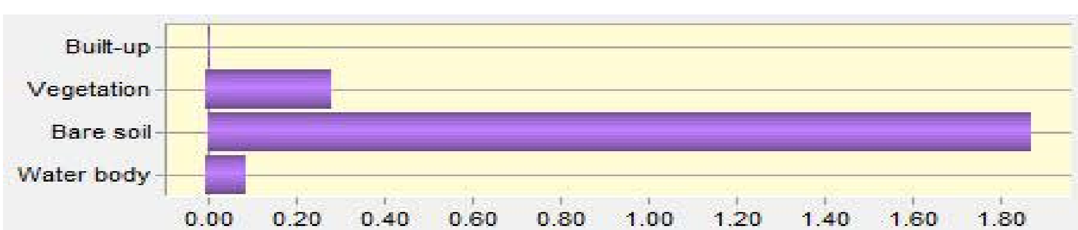


(b)

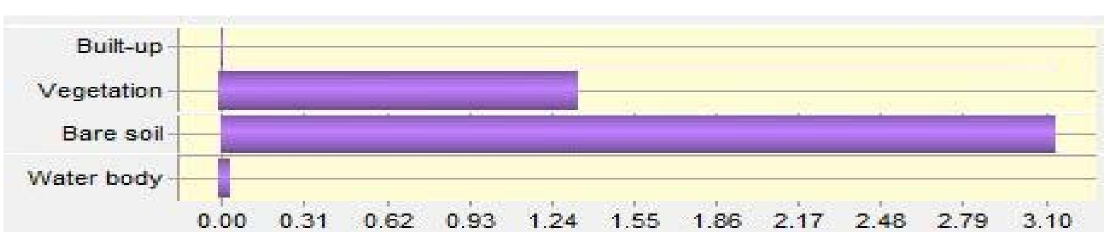


(c)

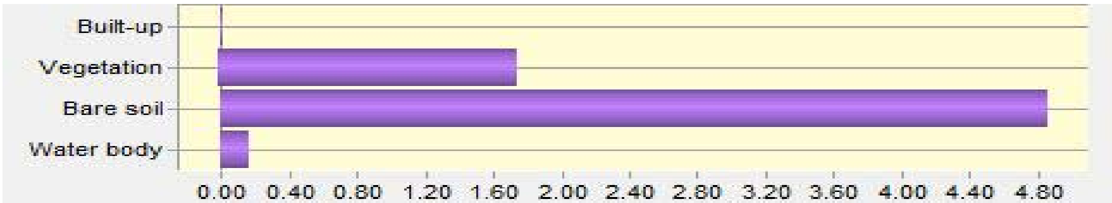
Figure 5: Net Change in Land cover areas between (a) 1986 and 2000 (b) 2000 and 2014 (c) 1986 and 2014



(a)

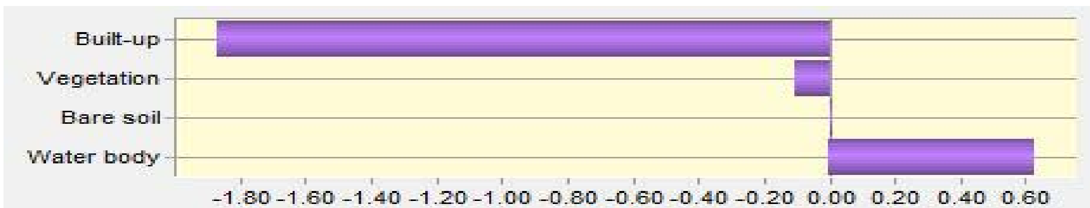


(b)

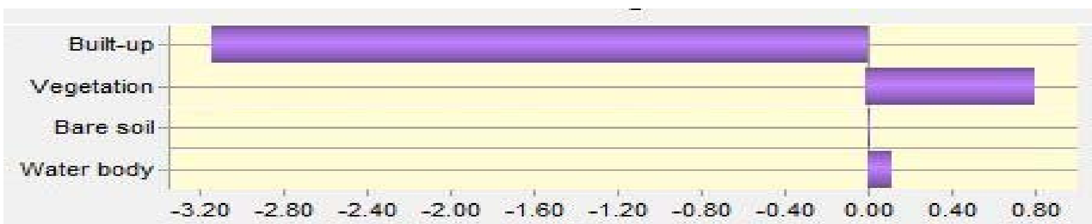


(c)

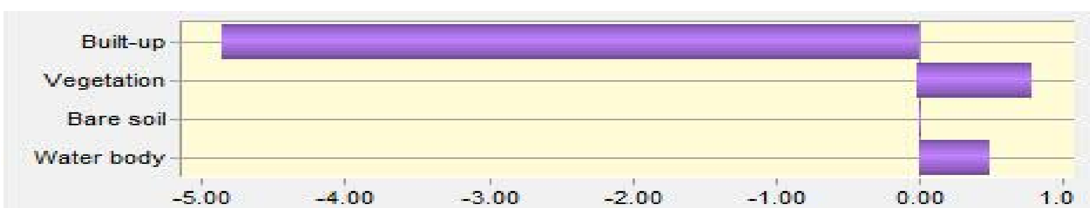
Figure 6: Contributions to Net Change in Built-up areas between (a) 1986 and 2000 (b) 2000 and 2014 (c) 1986 and 2014



(a)

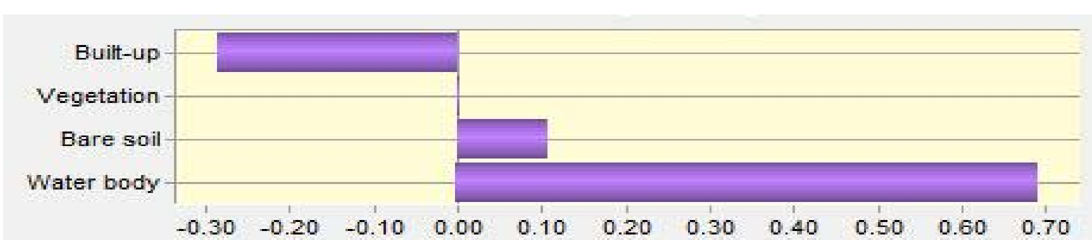


(b)

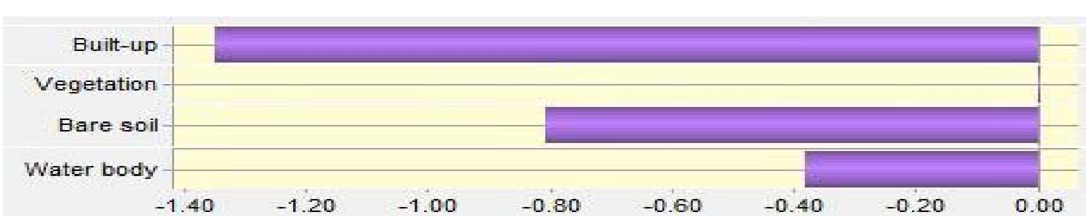


(c)

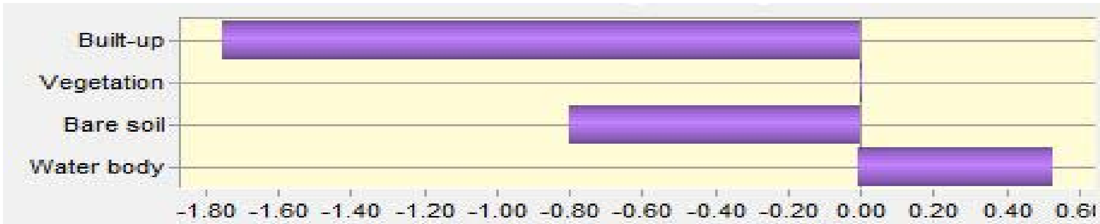
Figure 7: Contributions to Net Change in Bare soil areas between (a) 1986 and 2000 (b) 2000 and 2014 (c) 1986 and 2014



(a)



(b)



(c)

Figure 8: Contributions to Net Change in vegetated areas between (a) 1986 and 2000 (b) 2000 and 2014 (c) 1986 and 2014

The changes in land cover types presented in Figure 4 revealed that, only a small percentage (<2%) of area covered by built-up was lost to other land cover types in both periods (1986-2000, and 2000-2014). Most of the built-up were lost due to demolitions carried out for road expansions, construction of new road networks and buildings without appropriate government approval. However, a significant change occurred in the vegetation and bare soil categories in both periods. These land cover categories lost more land areas than they gained in each of the period (Figure 4). Analysis of the net change in the areas covered by the land cover classes show that, there was significant and progressive change (increased with magnitude >1.5%) in built-up areas in all the periods (Figure 5). The net change of bare soil and vegetation shows a general decrease except for the period (between 1986 and 2000) that vegetation showed a little increase in net change. The conversion patterns between the land cover categories are illustrated in Figures 6-8. It was observed that the bare soil was the major contributor to net change (increasing) in built-up areas followed by vegetation and no significant contribution from water body (Figure 6). Conversely, only water body was converted to bare soil between 1986 and 2000 (Figure 7a). More significant contributions to net change (increasing) in bare soil areas were seen from vegetation in other periods (Figure 7b-c).

Although a few proportion of water body still contributed to the extension of the bare soil areas but not as effective as vegetation in these later periods. However, there were no places where built-up was converted to bare soil type at all. In addition, Figure 8 revealed that the water body is the major contributor to extending vegetated areas. Although a few percentage of bare soil areas were modified to vegetation between 1986 and 2000 (Figure 8a), there was no contributions to net change in vegetation between 2000 and 2014 (Figure 8b). That one land cover category contributes to the net change of another was also established Ahmed et al. (2013).

b) Projection of future land cover change

The analysis of past changes in LULC distributions with regard to spatial explanatory variables enables assessment of the degree to which locations might likely change in the future. Markov Chain analysis was performed for the multi-temporal land cover images of 1986-2000, and 2000-2014 including predicting for 2028 and 2042 as shown in Figures 9 and 10 respectively. Results of the MLP Markov Chain models focused mainly on providing the knowledge of how much, where, what type of land use/land cover changes will occur from 2014 to 2028 and from 2028 to 2042. It has been observed that the built-up areas showed an increased trend, as other classified land cover types decreased in the previous years. The projected land cover scenarios indicates similar spatial distribution and trend with an expectation of continual expansion in the built-up areas and decreasing vegetation and bare soil surfaces from 2014 to 2028 (Figure 9), and more expansion between 2028 and 2042 (Figure 10). The observed rural (like Airport, NTA, etc) and sub-urban (like FUTA, Oba-Ile, Ijoka, etc) areas with abundant vegetation in the earlier periods will experience significant depletion and surface modifications between 2014 and 2028 (Figure 9). The built-up and the bare surface areas would have expanded towards and encroach these areas by 2028, provided the driving mechanisms such as continual growth in the socio-economic factors are sustained. Figure 10 also indicate that the urban centres are expected to widely extend to the rural areas (like Ipinsa, Ibule, some rural parts of Aule, Oba-Ile and Ijoka, Igoba, and Sasha) by 2042.

A quantitative assessment of the simulated land cover scenarios presented in Figure 11 suggests that approximately 5.04% of areas covered by both vegetation and bare soil in 2014 will be modified to built-up areas by 2028. Similarly, about 4.75% of the same areas will be converted to built-up by the year 2042. In all, there will be a substantial increase in the built-up areas to 21.72% and 26.47% by 2028 and 2042 respectively. This will be evident in the corresponding decrease in the areas covered by vegetation and bare soil. The prediction of the future scenarios of land use change in the study area reveals probable continuous degradation of the forests, light and thick vegetation which will result in more degraded lands. Unabated vegetation loss and degradation could trigger serious environmental problems that are linked to increased surface thermal response, reduced infiltration and increased surface runoff.

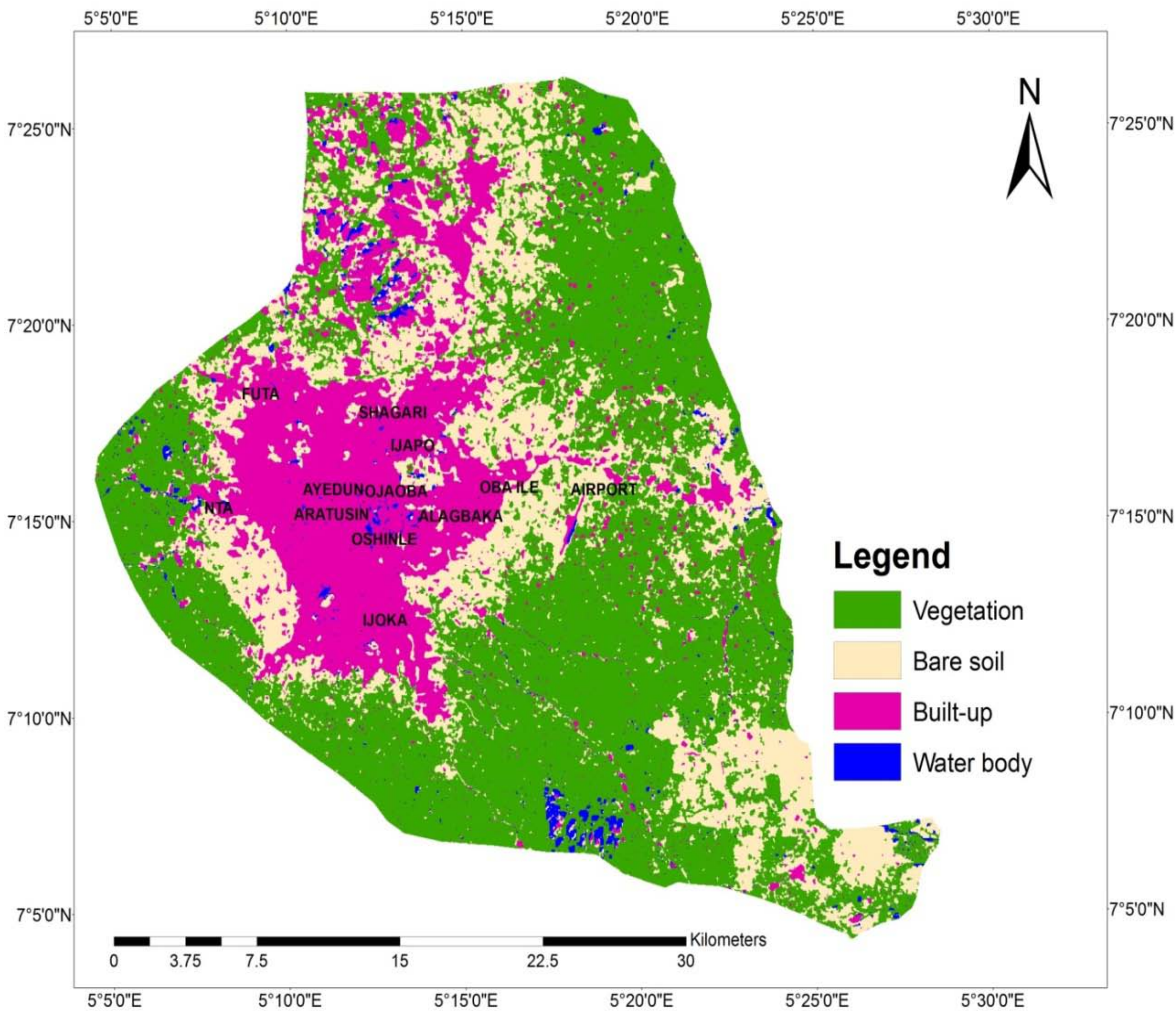


Figure 9: MLP Markov model projected land cover scenario of Akure area for 2028

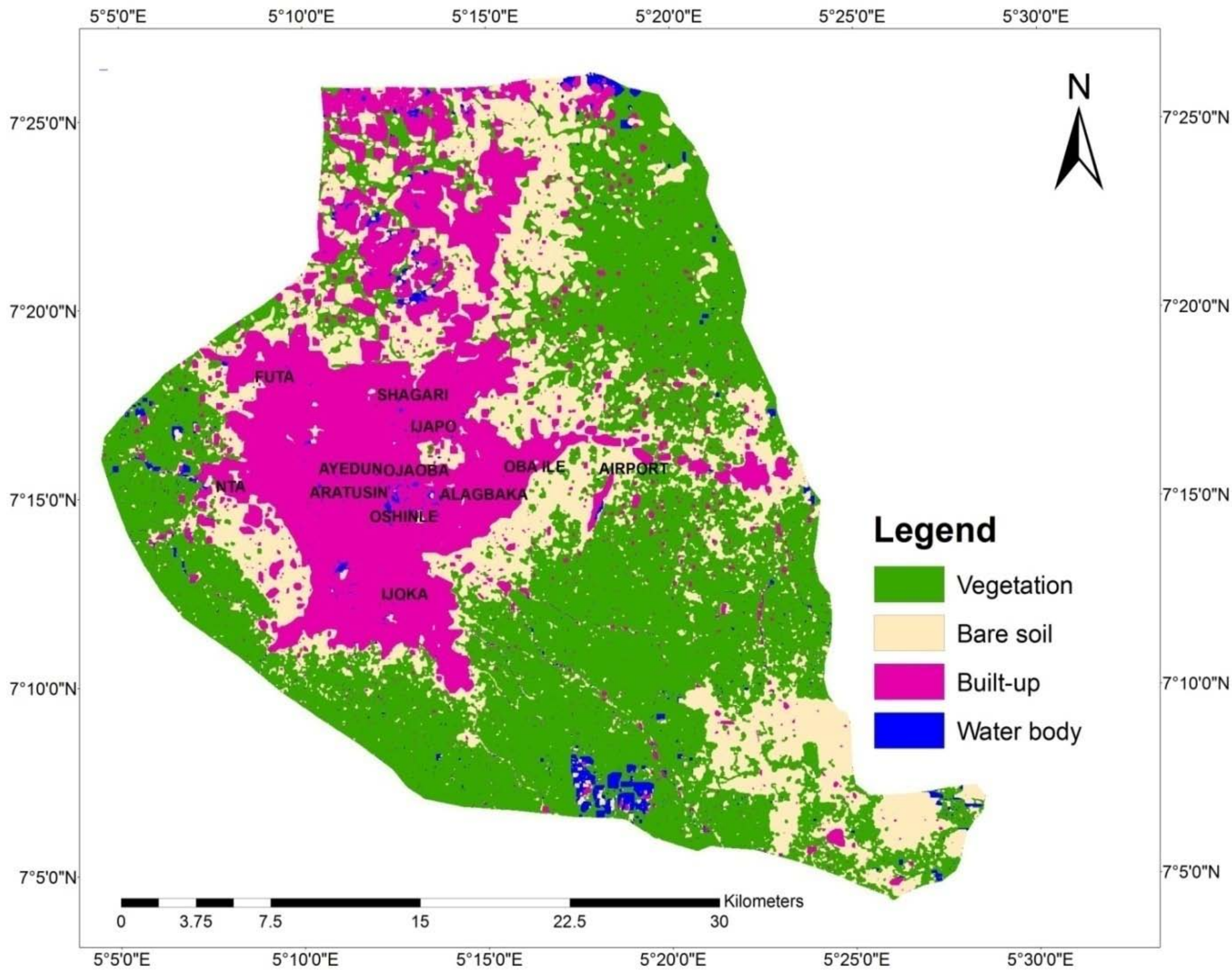


Figure 10: MLP Markov model projected land cover scenario of Akure area for 2042

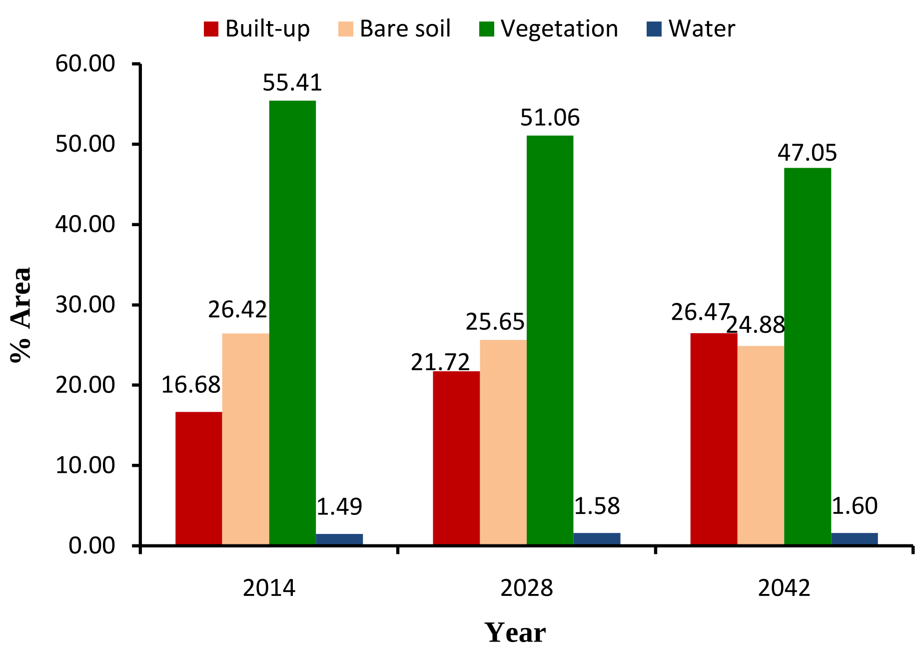


Figure 11: Simulated Percentages of Area covered by landcover types in Akure

III. Conclusions

This study has examined the past and future LULCC due to urbanization processes over Akure City in Nigeria. The observed rapid increase in built up areas and the continuous depletion of the vegetated areas calls for concern. Most especially, the projected future changes by the year 2028 and 2042 follows the trend of observed between 1984 and 2014, revealing that built-up areas will continue to increase rapidly and the vegetated areas will be reducing drastically. This will have serious implication on the local climate of the city coupled with the enhanced greenhouse gases through the depletion of the carbon sinks. This call for improved urban planning that accommodates urban greening in the future urban developments, considering the mitigating roles of vegetations on heat islands and global warming. Although, the potential modifications and extension of built-up density to the rural and sub-urban areas as projected by MLP model in the subsequent years pose major environmental threats, these areas can yet be explored for business opportunities which will inturn contribute to the socio-economic growth of the city.

Findings from the observed changes in LULC are consistent with that of previous studies, thus the projected changes are reliable because they are based on well-established MLP Markov technique in the literature. The model results can serve as guide to urban planners and policy makers. Furthermore, urbanization has been identified as the major driver of land cover changes. Thus, effective policies that are capable of ameliorating urban sprawl and the environmental impacts should be put in place. Further study will seek to quantitatively assess the impact of this LULCC on the urban thermal field in the future context.

IV. Acknowledgements

The authors thank the United States Geological Survey (USGS) for free access to the Landsat datasets used in this research, and as well as the developers of MLP Markov algorithms used in computations.

References Références Referencias

1. Adedeji O.H., Tope-Ajayi O.O., and Abegunde O. L. (2015) Assessing and Predicting Changes in the Status of Gambari Forest Reserve, Nigeria using Remote Sensing Techniques. *Journal of Geographic Information System.* 7, 301-318. http://dx.doi.org/10.4236/jgis.2015.73024
2. Ahmed, B., 2011. Urban land cover change detection analysis and modeling spatio-temporal Growth dynamics using Remote Sensing and GIS Techniques: A case study of Dhaka, Bangladesh. Master's Thesis, Erasmus Mundus Program, Universidade Nova de Lisboa (UNL), Instituto Superior de Estatística e Gestão de Informação (ISEGI), Lisbon, Portugal.
3. Ahmed, B.; Ahmed, R., 2012. Modeling urban land cover growth dynamics using multi-temporal satellite images: A case study of Dhaka, Bangladesh. *ISPRS Int. J. Geo-Inf.*, *1*, 3–31.
4. Ahmed B., Md. Kamruzzaman, X. Zhu, Md. Shahinoor R., and K. Choi. 2013. Simulating Land cover changes and their impacts on land surface temperature in Dhaka, Bangladesh. *J. of Remote Sens*. 2013, 5, 5969-5998; doi:10.3390/rs5115969
5. Ahmed, B.; Ahmed, R.; Zhu, X. 2013: Evaluation of model validation techniques in land cover dynamics. *ISPRS Int. J. Geo-Inf.*, *2*, 577–597.
6. Arnfield, A.J. 2003: Two decades of urban climate research: a review of turbulence, exchanges of energy and water, and the urban heat island. – *International Journal of Climatology* **23** (1): 1-26
7. Atkinson, P.M. and Tatnall, A.R.L. 1997: Introduction Neural networks in remote sensing. *Int. J. Remote Sens*., *18*, 699–709.
8. Balogun, I. A., A.A. Balogun and Z.D. Adeyewa 2012: Observed urban heat island characteristics in Akure, Nigeria. *African Journal of Environmental Science and Technology* **6** (1): 1-8
9. Balogun, I. A. and Balogun, A.A. 2014: Urban Heat Island and bioclimatological conditions in a hot humid tropical city: the example of Akure, Nigeria. *DIE ERDE* 145 (1-2): 3-15
10. Balogun, I. A., Balogun, A.A and Jimmy Adegoke 2014: Carbon Monoxide Concentration Monitoring in Akure—A Comparison between Urban and Rural Environment. *Journal of Environmental Protection*, 2014, 5, 266-273
11. Balzter, H. 2000: Markov chain models for vegetation dynamics. *Ecolog. Model*., *126*, 139–154.
12. Basharin, G.P.; Langville, A.N.; Naumov, V.A. 2004: The life and work of A.A. Markov. *Linear Algebra Appl*., *386*, 3–26.
13. Carmelo, R.F., Giuseppe, M. and Maurizio, P. (2012) Land Cover Classification and Change Detection Analysis Using Multi-Temporal Remote Sensed Imagery and Landscape Metrics. *European Journal of Remote Sensing*, **45**, 1-18.
14. Castella, J.C.; Boissau, S.; Trung, T.N.; Quang, D.D. 2005: Agrarian transition and lowland-upland interactions in mountain areas in northern Vietnam: Application of a multi-agent simulation model. *Agric. Syst*., *86*, 312–332.
15. Chander, G., and B. Markham, 2003. Revised Landsat-5 TM radiometric calibration procedures and postcalibration dynamic ranges, *IEEE Transactions on Geoscience and Remote Sensing*, 41(11):2674–2677.
16. Civco, D.L. 1993: Artificial neural networks for land-cover classification and mapping. *Int. J. Geogr. Inf. Sci*., *7*, 173–186.

17. Eastman, J.R. (2006) IDRISI Andes Guide to GIS and Image Processing, Worcester, Clark Labs.
18. Eastman, J.R. 2012: *IDRISI Selva Tutorial*; Clark University: Worcester, MA, USA, pp. 267–275.
19. Eastman, J.R.; Jin, W.; Kyem, P.A.K.; Toledano, R. 1995: Raster procedures for multi-criteria/multi-objective decisions. *Photogramm. Eng. Remote Sens*., *61*, 539–547.
20. EEA (2007) Land-Use Scenarios for Europe: Qualitative and Quantitative Analysis on a European Scale. EEA Technical Report 9/2007, European Environmental Agency (EEA), Luxembourg.
21. FAO (2010) Global Forest Resources Assessment (2005 and 2010) and the State of the World's Forests. Rome.
22. Gómez, C., White, J.C. and Wulder, M.A. (2011) Characterizing the State and Processes of Change in a Dynamic Forest Environment Using Hierarchical Spatio-Temporal Segmentation. *Science of the Total Environment*, **115**, 1665-1679. http://dx.doi.org/10.1016/j.rse.2011.02.025
23. Hansen, M.C., Roy, D.P., Lindquist, E., Adusei, B., Justice, C.O. and Altstatt, A. (2008) A Method for Integrating MODIS and Landsat Data for Systematic Monitoring of Forest Cover and Change in the Congo Basin. *Remote Sensing of Environment*, **112**, 2495-2513. http://dx.doi.org/10.1016/j.rse.2007.11.012
24. Hilferink, M.; Rietveld, P. Land Use Scanner 1999: An integrated GIS based model for long term projections of land use in urban and rural areas. *J. Geogr. Syst*., *1*, 155–177.
25. Ichimura, M. 2003: Urbanization, urban environment and land use: Challenges and opportunities. – Asia-Pacific Forum for Environment and Development, Expert Meeting, 23 January 2003, Guilin, People's Republic of China. – Online available at: http://www.kas.de/upload/dokumente/megacities/urbanization_urban_environment_and_land_use.pdf , 06/03/2014
26. Ishola K.A., Okogbue E.C., and Adeyeri O.E. (2016): Dynamics of Surface Urban Biophysical Compositions and its Impact on Land Surface Thermal Field. *Mod. Earth Syst. Environ*. 2:208, 1-20. DOI 10.1007/s40808-016-0265-9.
27. Jensen, J.R. (2007) Remote Sensing of the Environment: An Earth Resource Perspective. 2nd Edition, Pearson Prentice Hall, Upper Saddle River.
28. Khoi, D.D. and Murayama, Y. 2010: Forecasting areas vulnerable to forest conversion in the Tam Dao National Park Region, Vietnam. *Remote Sens.*, *2*, 1249–1272.
29. Kok, K.; Veldkamp, T.A. 2001: Evaluating impact of spatial scales on land use pattern analysis in Central America. *Agric. Ecosyst. Environ*., *85*, 205–221.
30. Lemmens, M. (2001) Geo-Information from LiDAR. GIM International, July 2003.
31. Magidi, J.T. (2010) Spatio-Temporal Dynamics in Land Use and Habitat Fragmentation in the Sandveld, South Africa. MSc Thesis, Department of Biodiversity and Conservation Biology, University of the Western Cape, Western Cape.
32. McConnell, W.; Sweeney, S.P.; Mulley, B. 2004: Physical and social access to land: Spatio-temporal patterns of agricultural expansion in Madagascar. *Agric. Ecosyst. Environ*., *101*, 171–184.Mishra,
33. McDermid, G.J., Franklin, S.E. and LeDrew, E.F. (2005) Remote Sensing for Large-Area Habitat Mapping. *Progress in Physical Geography*, **29**, 449-474. http://dx.doi.org/10.1191/0309133305pp455ra
34. Miller, J. and Rogan, J. (2007) Using GIS and Remote Sensing for Ecological Mapping and Monitoring. In: Mesev, V., Ed., *Integration of GIS and Remote Sensing*, John Wiley and Sons, Ltd., 233-268.
35. National Population Commission (NPC, 2006) Details of the breakdown of the national and state provisional population totals 2006 census.
36. Nigeria Meteorological Agency (2007). Nigeria Climate Review Bulletin. Nigeria Met. Agency No 001.
37. Oyinloye, R.O., Agbo, B.F. and Aliyu, Z.O. (2004) Land Use/Land Cover Mapping in Osun State Using NigeriaSAT-1Data.
38. Oyinloye M.A., and J. O. Fasakin.(2014) Modelling urban growth from medium resolution Landsat imageries of Akure, Nigeria. *Int. J. Innovation education and research Vol. 2-06*
39. Pijanowski, B.C.; Gage, S.H.; Long, D.T. 2000: A Land Transformation Model: Integrating Policy, Socioeconomics and Environmental Drivers using a Geographic Information System. In *Landscape Ecology: A Top down Approach*; Harris, L.; Sanderson, J., Eds.; CRC Press: Boca Raton, FL, USA, pp. 183–198.
40. Pontius, R.G., Jr.; Spencer, J. 2005: Uncertainty in extrapolations of predictive land change models. *Environ. Plan. B*, *32*, 211–230.
41. Pontius, R.G., Jr.; Boersma, W.; Castella, J.-C.; Clarke, K.; de Nijs, T.; Dietzel, C.; Duan, Z.; Fotsing, E.; Goldstein, N.; Kok, K. 2008: Comparing the input, output, and validation maps for several models of land change. *Ann. Reg. Sci*., *42*, 11–47.
42. Roy, H.G., Fox, D.M. and Emsellem, K. (2014) Predicting Land Cover Change in a Mediterranean Catchment at Different Time Scales. In: Murgante, B., Misra, S., Rocha, A.M.A.C., Torre, C., Rocha, J.G., Falcão, M.I., *et al*., Eds., *Proceedings of the 14th International Conference*, Part IV, Guimarães, 30 June-3 July 2014, 315-330.
43. Salami, A.T. (1999) Vegetation Dynamics on the Fringes of Lowland Humid Tropical Rainforest of

Southwestern Nigeria an Assessment of Environmental Change with Air Photos and Landsat TM. *International Journal of Remote Sensing*, **20**, 1169-1181. http://dx.doi.org/10.1080/014311699212920

44. Santé, I.; García, A.M.; Miranda, D.; Crecente, R. 2010: Cellular automata models for the simulation of real-world urban processes: A review and analysis. *Landsc. Urban Plan*., *96*, 108–122.
45. Schulz, J.J., Cayuela, C., Echeverria, C., Salas, J. and Rey Benayas, J.M. (2010) Monitoring Land Cover Change of the Dryland Forest Landscape of Central Chile (1975-2008). *Applied Geography*, **30**, 436-447. http://dx.doi.org/10.1016/j.apgeog.2009.12.003
46. Silva, E.A.; Clarke, K.C. 2002: Calibration of the SLEUTH urban growth model for Lisbon and Porto, Portugal. *Comput. Environ. Urban Syst*., *26*, 525–552.
47. UNEP United Nations Environment Programme 2002: Global Environment Outlook 3. – Online available at: http://www. unep.org/GEO/geo3/index.htm, 22/05/2013
48. United States Geological Survey (USGS) 2014, New Earth Explorer. Available online at http://earthexplorer.usgs.gov. (accessed on 18th December, 2014)
49. Weng, Q. (2002) Land Use Change Analysis in the Zhujiang Delta of China Using Satellite Remote Sensing, GIS and Stochastic Modelling. *Journal of Environmental Management*, **64**, 273-284. http://dx.doi.org/10.1006/jema.2001.0509
50. Wu, C., & Murray, A. T. (2003). Estimating impervious surface distribution by spectral mixture analysis. Remote Sensing of Environment, 84, 493−505.
51. Wu, Q., Li, H., Wang, R., Paulussen, J., Hec, Y., Wang, M., Wang, B. and Wang, Z. (2006)
52. Monitoring and Predicting Land Use Change in Beijing Using Remote Sensing and GIS. *Landscape and Urban Planning* **78**, 322-333. http://dx.doi.org/10.1016/j.landurbplan.2005.10.002

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Determinants of the Adoption of Sustainable Land Management Practices among Smallholder Farmers' in Jeldu District, West Shewa Zone, Oromia Region, Ethiopia

By Tesfaye Samuel Saguye
Ambo University

Abstract- Land degradation is a major cause of Ethiopia's low and declining agricultural productivity, continuing food insecurity, and abject rural poverty. The productivity of agricultural economy, which is the backbone of the country's economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing. Low land productivity due to land degradation in form of soil erosion is one of the leading challenges to improving the performance of the smallholder farming system sector in Ethiopia. In this context, the adoption of Sustainable Land Management practices/ technologies is quite crucial to increase agricultural productivity, ensure food security and improve the livelihoods of smallholder farmers. Farmers recommend various SLM practices/technologies for sustainable implementation, but adoption of such agricultural land management practices/ technologies is still very low. There is no clear understanding of the problems encountered by farmers in the adoption of recommended SLM practices/ technologies.

Keywords: sustainable land management practices, adoption, smallholder farmers.'

GJSFR-H Classification: FOR Code: 960999

DETERMINANTSOFTHEADOPTIONOFSUSTAINABLELANDMANAGEMENTPRACTICESAMONGSMALLHOLDERFARMERSINJELDUDISTRICTWESTSHEWAZONEOROMIAREGIONETHIOPIA

Strictly as per the compliance and regulations of :

Determinants of the Adoption of Sustainable Land Management Practices among Smallholder Farmers' in Jeldu District, West Shewa Zone, Oromia Region, Ethiopia

Tesfaye Samuel Saguye

Abstract- Land degradation is a major cause of Ethiopia's low and declining agricultural productivity, continuing food insecurity, and abject rural poverty. The productivity of agricultural economy, which is the backbone of the country's economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing. Low land productivity due to land degradation in form of soil erosion is one of the leading challenges to improving the performance of the smallholder farming system sector in Ethiopia. In this context, the adoption of Sustainable Land Management practices/ technologies is quite crucial to increase agricultural productivity, ensure food security and improve the livelihoods of smallholder farmers. Farmers recommend various SLM practices/technologies for sustainable implementation, but adoption of such agricultural land management practices/ technologies is still very low. There is no clear understanding of the problems encountered by farmers in the adoption of recommended SLM practices/ technologies. Therefore, the main purpose of this study was to assess the socio-economic, institutional, psychological and biophysical determinant factors that influence adoption of SLM practices/technologies among smallholder farmers in Jeldu district in West Shewa zone. Primary data were collected through household questionnaires surveys, focus group discussions, key informants interviews and personal observations while secondary data were collected from relevant local authority reports and records. A total of 224 households were interviewed. Both Descriptive statistics and binary logistic regression model were used to analyze the data. The computed independent T-test for the mean income difference was statistically highly significance between adopters and non-adopters, suggesting that adopters were in better-off position to improve their livelihood. From the 18 explanatory variables entered into the model, 14 variables were found to be statistically significant in determining adoption of SLM Practices by farmers in the study area at less than 5 to 10% probability levels. These are education level of the household head, farm size, perception of land degradation ,effectiveness of SLM practices, credit service access, frequency of development agent contact and livestock ownership significantly positively affect adoption of land management practices while distance to market affects it negatively at less 10% probability levels. Planners and policy makers should formulate appropriate policies and programs considering the farmers' interest, capacity, and limitation in promoting improved soil conservation technology for greater acceptance and adoption by the farmer.

Keywords: sustainable land, management practices, adoption, smallholder farmers.

Author: Department of Disaster Risk Management and Sustainable Development, Institute of Cooperatives and Development Studies, Ambo University, Ambo, Ethiopia. e-mail: gezegofa@gmail.com

I. Introduction

a) *Background and Justification of the study*

To feed the world's growing population which is projected to exceed 9.2 billion by 2050 (World Bank, 2009; FAO, 2013; Nkonya *et al*, 2011.), it will be compulsory to boost the production of food. However, land degradation is extensively increasing, covering approximately 23% of the globe's terrestrial area, increasing at an annual rate of 5-10 million hectares, and affecting about 1.5 billion people globally (Gnacadja, 2012). Processes of land degradation occur in all climatic regions, with 'land' interpreted to include soils, vegetation, and water, and with the concept of 'degradation' implying adverse consequences for humanity and ecological systems (Conacher, 2009; Vlek *et al*., 2010; Braun *et al*., 2012; Pingali *et al*., 2014). Land consists of not only the soil but also the associated natural resources such as water, vegetation, landscape, and microclimate that are components of a larger ecosystem(Thompson *et al.,* 2009; Chasek *et al.,* 2011; Reed *et al.,* 2011).As the land is inter-connected with other natural resources such as the air, water, fauna and flora, managing land well, in addition to guaranteeing food supplies, poverty reduction and socio-economic protect environment and natural resources and to provide ecological functions and services in a sustainable manner(World Bank, 2003; Bridges and Oldeman, 1999; Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*. 2008; Stoosnijder, 2007; Nachtergaele *et al*. 2010; Lal and Stewart, 2013; Zucca*et al.,* 2014) .Land degradation often results from immediate causes such as biophysical causes and unsustainable resource management practices, or with underlying causes including population density, poverty, institutional set up, land tenure and access to agriculture extension, infrastructure, opportunities and constraints created by market access as well as policies and general government effectiveness (Nkonyaet *al*., 2011; Lambin *et al*., 2001).

Ethiopia's economy has its foundation in the smallholder agriculture. Land degradation is a major cause of Ethiopia's low and declining agricultural productivity, continuing food insecurity, and abject rural poverty (Pender and Hazell, 2000; IFAD, 2001; Shiferaw and Bantilan, 2004; (FAO, 2012). Soil erosion is a major problem with substantial costs to agriculture in the Ethiopian highlands, amounting annually to a minimum of 2-3 percent of agricultural gross domestic product (World Bank, 2007). The productivity of agricultural economy, which is the backbone of the country's economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing lands (Leonard, 2003; Shiferaw and Holden 1998). At present extent and speed of land degradation, particularly due to soil erosion is distinguished as a serious threat to the viability of the subsistence agriculture in the country (Lakewet *al*., 2000; Le *et al*., 2014). Its severity is explained by a decline in productivity, formation of rills and gullies in both farming and grazing lands through time (Stringer and Reed, 2007; Bai *et al*., 2008; Nachtergaeleet *al*., 2010; Lal and Stewart, 2013; Zuccaet *al.,* 2014).Although the country endowed with enormous biophysical potential, it has been affected by the interlinked and reinforcing problems of land degradation and extreme poverty (Teshome *et al*., 2014). This is further aggravated by high population pressure, climatic variability, top-down planning systems, lack of appropriate and/or poor implementation of polices and strategies, limited use of sustainable land management practices, limited capacity of planners, land users as well as frequent organizational restructuring (Tesfaye *et al*., 2013; Kassie *et al*., 2009; Tiwari *et al*., 2008; Bewket, 2007; Shiferaw and Holden 1998). There is evidence that these problems are getting worse in many parts of the country, particularly in the highlands (areas >1500m above sea level). Furthermore, climate change anticipated to accelerate land degradation in Ethiopia (Pender and Gebremedhin, 2007). Nearly 85 percent of Ethiopia's population, 95 percent of its cultivated land, and 80 percent its 35 million cattle are found in the highlands. The considerable diversity of Ethiopia's highland areas means that many factors influencing the adoption of land management inputs and investments are highly sensitive to the local biophysical and socioeconomic context.

Recognizing the threat of land degradation, the government of Ethiopia has made several Natural Resource Management (NRM) interventions through various programmes such as productive safety net programme (PSFP),Food for Work programme and MERET and MERET PLUS Programme since mid-1970s and 80s (Aklilu, 2006;Shiferaw and Holden, 1998). As a result a range of land conservation practices, which include stone terraces, stone bunds, area closures, and other soil and water conservation technologies and practices have been introduced into individual and communal lands at massive scales. In 2008, Ethiopia launched Sustainable Land Management Programme (SLMP) in 36 woreda defined as the process of enhancing agricultural yields with minimal environmental impact and without expanding the existing agricultural land base (Tesfaye et al. 2013; Kassie et al. 2009; Tiwari *et al*., 2008; Bewket, 2007). The concept and definition of sustainability is broad and varies depending on the problems to be addressed. There is a need to give a clear working definition of sustainability in the context of our problem. WOCAT (2005), define Sustainable Land Management in more specific term as the use of both indigenous and introduced land management practices and technologies for agricultural and other purposes to meet human livelihood needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. In this regard, SLM is not only the use of physical SWC measures, which is a common mistake made by almost all actors in the country, but also includes the use of appropriate soil fertility management practices, agricultural water and rain water management, forestry and agroforestry, forage and range land management, and application of these measures in a more integrated way to satisfy community needs while solving ecological problems (Bridges and Oldeman, 1999; Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*., 2008; Stoosnijder, 2007; Lal & Stewart, 2013; Zuccaet *al.,* 2014; Geteet *al*., 2006). SLM is a combination of technologies, policies and activities integrating socio-economic and environmental concerns in order to reach simultaneously environmentally friendly, economic viable and socially acceptable production goals (Smyth and Dumanski, 1993; Hurni, 2000).

The downward spiral of land degradation and poverty cannot be reversed in a sustained fashion unless farmers adopt profitable and sustainable land management practices or pursue livelihood strategies that are less demanding of the land resource than current agricultural strategies (Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*. 2008; Stoosnijder, 2007; Nachtergaeleet *al*., 2010; Lal and Stewart, 2013; Zuccaet *al.,* 2014). Adoption of sustainable land management (SLM) practices plays a critical role in achieving food security, household income and poverty reduction through reducing soil erosionand improving soil fertility. However, studies reveals that farmers adoption of SLM practices/ technologies at lower rate and more often they dis-adopt them (Aklilu and de Graaff, 2007 (Thompson *et al.,* 2009; Chaseket *al.,* 2011; Akhtar-Schuster *et al.,* 2011; Reed *et al.,* 2011; ELD Initiative, 2013). In most places, implemented SWCStructure was either totally or partially destroyed by farmers (Tesfaye *et al*. 2013; Kassie *et al*., 2009 and Tiwari *et al*., 2008 and Bewket, 2007). For instance, of the total conservation measures implemented between 1976 and 1990, only 30% of soil bunds, 25% of stone bunds, 60% of hillside terraces, 22% of the planted trees, and 7% of the reserve areas survived (TGE, 1994; Nurhussen, 1995). A recent survey in the Amhara region also showed that only 30% of the implemented soil and water conservation structures of the past two and half decades of conservation, work has survived (EPLUA, 2005). The above two survey results, however, should be seen in time context. Better land and water management and increased use of soil conservation practices could help to reverse soil degradation and boost crop yields, but in many parts of the country, these practices are not yet widely adopted. The adoption and investment in sustainable land management is crucial in reversing and controlling land degradation, rehabilitating degraded lands and ensuring the optimal use of land resources for the benefit of present and future generations (Akhtar-Schuster *et al*., 2011).

Despite on-going land degradation and the urgent need for action to prevent and reverse land degradation, the problem has yet to be appropriately addressed. Identifying the determinants of SLM adoption is a step towards addressing them (Braun, *et al*., 2012). There is an urgent need for evidence-based economic evaluations, using more data and robust economic tools, to identify the determinants of adoption as well as economic returns from SLM (Tesfaye *et al*. 2013; Kassie *et al*. 2009; Tiwari *et al*., 2008; Bewket, 2007). Given this state of conditions, analysis of the issue of what specifically determines the decision taken by farmers to adopt SLM practices/technologies is very important and relevant to formulate policy options and support systems that could accelerate use of soil conservation technologies (Stoosnijder, 2007; Lal &Stewart, 2013; Zucca *et al.,* 2014). To ensure sustainable adoption and implementation of SLM practices and beneficial impacts on productivity and other outcomes, rigorous empirical research needed on where particular SLM interventions are likely to be successful(Brown *et al*., 2006; Fensholt and Proud, 2012; Beck *et al*., 2011). For a better understanding of the barriers faced by households when deciding to adopt SLM practices more detail context specific household-level studies focusing on the barriers of SLM practices adoption by farmers needed (Carthy, 2011; Tesfaye *et al*. 2013; Kassie et al., 2009; Tiwari *et al*.,2008; Bewket 2007; Shiferaw and Holden, 1998). An available evidence shows that studies on the determinants of adoption of SLM practices among smallholder farmers are few and far below adequacy. Further research on the adoption of land management practices is needed to build onthis understanding of what works, and where. Therefore, this study conducted in view of bridging this gap. It intends to add to the stock of knowledge on the factors that determine farmers' decision to implement certain sustainable land management practices. The general objective of this study was to assess the determinant of adoption of SLM practices/technologies among smallholder farmers' in Jeldu district in West Shewa zone of Oromia regional state, Ethiopia. So, this study is significant in that the identification of context based determinant factors of adopting sustainable land management practices will inform decision makers to design context-specific socio-economic, biophysical, institutional and demographic context based SLM technologies/ practices and avoids " one size fits to all" problem of the previous top down approaches. Such knowledge is important to guide policy makers and development agencies in crafting programs and policies that can better and more effectively address land degradation in Ethiopia.

II. Theoretical Framework of the Study

There are many perspectives involved in understanding farmers' views as to how and why they make decisions on whether or not to adopt the improved technology for soil conservation(). There are many complexities and regional variations in biophysical and socio-cultural factors so that conclusions drawn based on the condition of one area cannot necessarily be replicated in another area (ICIMOD, 1995; Thompson and Warburton, 1985). Adoption of agricultural technologies is affected by various factors, usually categorized into; farm specific characteristics, technology specific attributes, and farmer's socioeconomic characteristics. Examples of such variables that have been found to influence technology adoption include: farm size, farmer's age, education, social networks (e.g. membership of association), dependency ratio, gender, access to agricultural advice and information, land tenure security, soil fertility, soil type, income, input availability, access to markets, risk aversion behavior, technology awareness, farming experience, adequacy of farm tools, technical and economic feasibility of using the technology, agro-ecological conditions, access to credit and presence of enabling policies(Feder *et al*., 1985; Boyd and Turton, 2000; Olwande *et al*., 2009). Some of these factors increase adoption; others reduce adoption; while others have mixed effects,

Adoption of conservation technology should not be regarded as an end in itself, but rather as a continuous decision-making process. Individuals pass through various learning and experimenting stages from awareness of the problem and its potential solutions and finally deciding whether to adopt or reject the given technology. Adoption of new technology normally passes through four different stages, which include awareness, interest, evaluation, and finally adoption

Global Journal of Science Frontier Research (H) Volume XVII Issue I Version I Year 2017

(Rogers and Shoemaker 1971). At each stage, there are various constraints (social, economic, physical, or logistical) for different groups of farmers. In Ethiopia, the adoption of improved soil conservation technology has been very low at farm level and it is apparent that there is gaps between what technicians see as necessary and what the farmers are prepared to do in the field (Paudel and Thapa 2001). Adoption behavior is complex and often requires a blend of income, profit, and institutional support (Ervin and Ervin 1982; Feder and Umali, 1993). Farmers' adoption of SLM Practices is determined by interactive effects of household socio economic characteristics, resource availability, physical characteristics of the land and institutional support provided by the public or NGO sector (Garcia 2001; Mbaga-Semgalawe and Folmer, 2000; Paudel and Thapa, 2004). It is important to understand the relationship between these factors and the process of adoption of new technology to improve farm production and sustainable land management. It is assumed that the farmers will compare the advantages and appropriateness of different soil conservation technologies, based on the available resources at their disposal and their opportunity for profit. Therefore, the conceptual framework of the adoption of SLM practices in this article is based on the principal of absolute and comparative advantage to farmers in combination with some influence of the personal, socio-economical, institutional, and biophysical factors. The empirical binary logistic regression model used in this study explains the factors that influence the decision of farmers to adopt or not adopt improved soil conservation technologies.

III. Methodology of the Study

a) Description of the Study Area

The study was conducted at Jeldu district, West Shewa zone, Central Ethiopia, which is delineated by Meta Robi, Dendi and Ejere *Woredas* in East, Gindeberet *Woreda* in West, Abuna Gindeberet *Woreda* in North and Eliphata *Woreda* in South. The total population of the District is 202,655 (out of which 102,796 are female and 99,859 are males). The average household size is 7 persons in the District. From this, the Watershed has total area of 9260 ha, with variable agro ecology of high lands (80%), midlands (15%) and lowlands (5%). According to the Bureau of agriculture and rural development of the district, the average land holding in the area has a bi-modal rainfall pattern with two distinct rainy and cropping seasons. The main rainy season (*meher*), which is also the main cropping season, extends from June to September. The short rainy season, known as "*belg* rain", usually covers the period from February to April. The mean annual rainfall of the area ranges from1800 to 2200 mm. The maximum and minimum temperature of the area ranges from 17 to 22^{o}C. The farming system of the area is mainly rain-fed. The soil type is characteristic of clay and clay-loam type, but the riverbed has a loam and sandy-loam type of soil (Dereje, 2010). Eucalyptus (*Eucalyptus globules)* is the main tree planted in the area while there is almost no natural forest except some remnants of very few scattered trees of forest in the crop land and scattered vegetation around the steep slopes and gorge of Meja River. According to Birhanu (2011), 20-30 years go the area was fully covered by natural forest. *Hagenia abyssinica*, *Dombeya torrida*, *Buddleja polystachya* and *Chamaecytisus palmensis* (tree Lucerne) are among the fodder trees and shrubs species that are considered important contributors to grazing animal nutrition in the highlands of Galessa and Jeldu areas.. It has an area of 139, 389 hectares. Undulating slopes divided by V-shaped valleys of seasonal and/or relatively permanent streams characterize the topography of the study area. Steep slopes are found along the valley sides, where slopes greater than30% is very common. The district is characterized as a mixed crop livestock production system. Land preparation mainly done by ox-drawn plough. The main crops grown in the study areas include wheat (*Triticumaestivum*), teff (*Eragrostistef*), broad bean (*Viciafaba*), barley (*Hordeum vulgare*) and potato (*Solanum tuberosum*).Soil erosion in the area is mainly attributed to the steep slopes, population pressure, deforestation, poor farming methods and vulnerable soils. However, the major factor fuelling soil erosion on the steep slopes is that farmers are increasingly destroying contour bunds on terraces to pave way for more farmland. As a result, soil erosion has been accelerated which in periods of heavy rainfall results in silting and flooding of the valley-bottom fields and landslides are becoming very common.

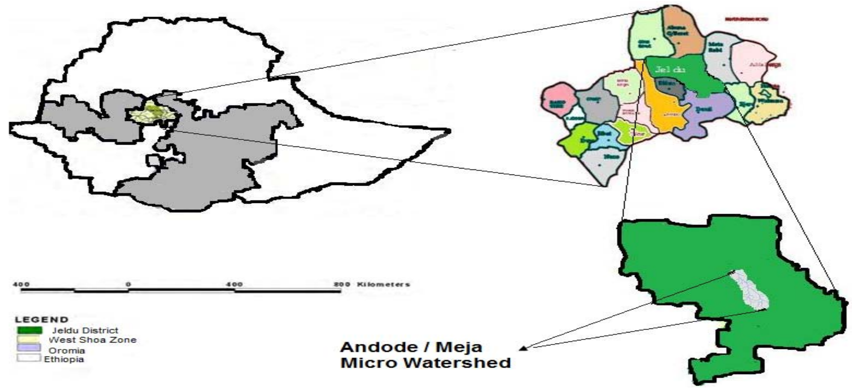


Figure 1: Map of the Study Area

b) Sampling Design of the Study

In this study, a multi-stage sampling procedure employed. First, Jeldu district was purposively selected because the district is one of severely affected by land degradation (Brihanu, 2011).The district is highly vulnerable to land degradation in particular soil compaction, deforestation and environmental degradation. Second, four *kebele (Edensa Galan, Seriti, KoluGalal and Chillanko)* were randomly selected from the existing 38 *kebeles (lowest administrative unit in Ethiopia)*. Thirdly, the sample respondent households were selected by simple random technique. The sample size of the study determined by using Gujarati sample size determination formula (Gujarati, 2004). Accordingly, 224 sample households from the selected *kebeles* drew using simple random sampling technique for the household questionnaire survey. The random selection of households based on the list of household heads found in each kebeles and proportional to the size population.

c) Data Collection Techniques and Instruments

Data for the study was collected from both primary and secondary sources. Primary data collected by employing household questionnaire survey, focus group discussion, field observation, and key informant interview to bring the study to realization. Information about personal characteristics of the household head, the knowledge of SLM practices/ technologies, the resource endowment of farmers, farm management practices, cropping patterns, crop yield, role of different institutions to improve farming, and adoption of improved and indigenous soil conservation technologies, such as the construction of check dams, terrace improvement, terrace bunds, hedge management, retention walls, waterways, and mulching, were collected through individual interviews by using a semi- structured questionnaire. Pilot-tests of questionnaires were made by distributing questionnaire to fifteen farmers in each site to assess whether the instruments were appropriate and suited to the study at hand. Necessary adjustments were made based on the comments obtained from pre-test responses from farmers to ensure reliability and validity. Data collectors were trained with respect to the survey techniques and confidentiality issues. Additional qualitative information, such as changes in soil conservation practices and cropping patterns over time, adoption of indigenous and improved soil conservation technologies, role of local level institutions in the promotion of SLM technologies/practices were collected through six focus group discussions, 12 key informant interviews, and through observation of the watershed. Focus group discussions were conducted with 8 to 10 farmers in each group. Audiocassettes were used to record the focus group discussions and key informant interviews.

d) Methods of Data Analysis

i. *Descriptive Analysis Techniques*

Data were analyzed through generation of descriptive statistics and binary regression model. Descriptive static techniques such as percentages, means, standard deviations and frequency counts, tables were generated for general information, t-tests were applied to compare the mean differences between adopters and non adopters, chi-square tests were applied to analyze categorical data, correlation and cross tabulation method were used to identify inter-dependence among various factors influencing the adoption of soil conservation technology. T-test was run to see if there is statistically significant difference in continuous variables of farm characteristics of household who have adopted introduced soil and water conservation practices and those have not done so. The chi- square was used to see if there is systematic association between decision on the use of introduced soil and water conservation practices and with some of the independent variables, for categorical data.

ii. *Binary Logistic Regression*

Binary logistic regression model was developed to assess the personal, social, economic, institutional, and bio-physical cal factors influencing the adoption of SLM practices in this study (Agresti, 1996). The Binary Logit Model was applied in this study to assists in estimating the probability of decision on the use of introduced soil and water conservation practices that

Global Journal of Science Frontier Research (H) Volume XVII Issue I Version I Year 2017

can take one or more of practices or do not practiced the technologies. In the study area farmers practice improved and traditional physical soil and water conservation structures. There are also non-adopters of these improved soil and water conservation measures. A logistic regression mode was developed to explore the personal/social, economic, institutional, and geographical factors influencing the adoption of SLM in this study. A regression model, and its binary outcomes, helps the researcher to explore how each explanatory variable affects the probability of the occurrence of events (Long and Freese, 2006). This model helps to explore the degree and direction of the relationship between dependent and independent variables in the adoption of improved soil conservation technology at the household level. The logistic regression model is an appropriate statistical tool to determine the influence of independent variable son dependent variables when the dependent variable has only two groups. In the logistic model, the coefficients are compared with the probability of an event occurring or not occurring and bounded between 0 and 1 (Sheikh, 2003). The dependent variable becomes the natural logarithm of the odds when a positive choice is made. The odds ratio and predicted probability of the independent variables indicate the influence of these variables on the likelihood of adoption of improved technology if other variables remain the same. Hence, if the estimated values of these variables are positive and significant, it implies that the farmers with higher values for these variables are more likely to adopt improved soil conservation technology

$$P_i = \frac{1}{1+e^{-Z_i}} \tag{1}$$

Where P (i) is a probability of adopting a given practice for ith farmer and Z (i) is a function of m explanatory variables (Xi), and is expressed as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + - - - + \beta_m X_m \tag{2}$$

Where,

B_0 Is the intercept and βiare the slope parameters in the model. The slope tells how the Log-odds in favor of adopting soil conservation practices change as independent variables change by a unit. Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds (Hosmer and Lemeshew, 1989.)Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds. The odds to be used can be defined as the ratio of the probability that a farmer uses or adopts the practice P_i to the probability that he or she will not P_{i-1}

But,

$$1\text{-}P_i = \frac{1}{1+e^{-z_i}} \tag{3}$$

Therefore,

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z(i)}}{1+e^{-Z_i}} = e^{Z_i} \tag{4}$$

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z(i)}}{1+e^{-Z_i}} = e^{\beta_0} + \sum_{i=1}^{M} \beta_i X_i \tag{5}$$

And

Taking the natural logarithm of the odds ratio of equation (5) will result in what is known as the log it model as indicated below:

$$L_n\left[\frac{P_i}{1-P_i}\right] = L_n\left[e^{\beta_0+\sum_{i=1}^{M}\beta_0 X_i}\right] = Z_i \tag{6}$$

If the disturbance term Ui is taken in to account the log it model becomes:

$$Z_i = \beta_0 + \sum \beta_0 X_i + U_i \tag{7}$$

Hence, the above econometric model was used in this study and was treated against potential variables assumed to affect the farmer decision of soil conservation practices. The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. The later yields unbiased and asymptotically efficient and consistent parameter estimates. Therefore, the above econometric model was used in this part of the study to identify determinant variables that influence adoption practices of land management in the study area.

Definition of Variables and Working Hypothesis

1. *Dependent Variable:* The dependent variable for the adoption model indicates whether a household has adopted SLM practices (''adopt'' versus ''not-adopt''). Therefore, in this study adopters are households who adopted at least one SLM practices while non-adopters are those who did not adopt any of these land management practices. SLM technologies/practices include adoption of improved terraces, hedge plantation, construction of check dams and terrace bunds, whereas indigenous technologies include mulching, slope terraces, retention walls, plantation of shrubs and trees at the edge of farm terraces, diversion drains, and waterways. Improved and indigenous SLM practices were identified based upon field observation and discussion with farmers. In this study, a farmer who has adopted at least one improved soil conservation technology, either as recommended by extension workers or with some modification, was defined as adopter. A value of ''1'' was assigned to all households who adopted at

least one improved SLM practices (the 'adopters'') and ''0'' was assigned to households using only indigenous SLM practices (the ''no adopters'').Whether or not to adopt any SLM practices is determined by personal, social, economic, institutional, and geographical factors. These variables we retreated as explanatory variables in this study.

2. *Selection of Explanatory Variables and Expected Impact on Adoption:* Adoption of SLM practices/technologies in the study area is a complicated process similar to the other research in agriculture technology adoption (Doss 2006; McDonald and Brown 2000) that may be influenced by a set of interrelated personal, social, economical, institutional, and biophysical factors (Table 1).

Table 1: Definition of all the explanatory variables used in the model

Variable		Description
Adoption		A value of ''1'' was assigned to all households who adopted at least one improved SLM practices (the ''adopters'') and ''0'' was assigned to households using only indigenous SLM practices (the ''no adopters'').
Demographic factors	AGE	Age of the household head in years
	HHSIZE	Number of people in the household
	EDUCTION	Literacy of the household head; 1if literate and 0 otherwise
	SEX	Gender of the household head; 1if male and 0 otherwise
	Family-labour	Potentially available family labour force
Institutional factors	TENURE	Whether a farmer perceives a risk of loss of land in the future; 1 if he/she perceives 0 otherwise
	MEMBSHIP	Membership in local organizations; 1if a farmer is a member and 0 otherwise
	TRAINING	Whether training about SLM practice received by the farmer; 1 if a farmer got training and 0 otherwise
	CREDIT ACCESS	Whether a farmer needed credit and was able to get it; 1 if he/she accessed 0 otherwise
	EXTENSION VISITS	Number of extension visits received
Physical Factors	FMSIZE	The size of the farm, in hectares
	DISTANCE	Average distance of a plot from homestead, in minutes
	SLOPE	Slope of the plot; 1 if steep and 0 otherwise
Economic Factors	OFFINCOM	Whether a farmer engaged in off-farm employment, 1 if a farmer has off-farm employment and 0 otherwise
	TOTAL INCOME	Estimated average income earned annually
	LIVESTOCK	Number of livestock's in TLU[1]
Attitudinal Factors	PERCEPTDEGRADATION	whether a farmer perceives land degradation as a problem; 1 if farmer had perceived land degradation as a problem and 0 otherwise
	PERCEPTSLM	whether a farmer anticipates introduced structures effective in retaining soil from erosion; 1 if a farmer anticipates soil retention due to structures and 0 otherwise

IV. Result and Discussion

a) *Descriptive Statistics*

In order to investigate the presence of group means difference with respect to the hypothesized socio-economic, biophysical and institutional factors uni-variate tests were used. Student's t-test and Chi-square test were used, respectively to identify potential continuous and dummy variables differentiating adopters from non- adopters. Adopters and non-adopters significantly different in three of the nine hypothesized continuous socio-economic variables (Table 2).The survey results showed that landholding size of total sample households ranges from 0.125 to 4.00 ha with a mean of 1.29 and standard deviation of 0.79 ha. The average landholding size of adopters and non-adopters were 1.54 and 1.27 ha with a standard deviation of 0.99 and 1.05, respectively. There was a slight difference in the mean size of landholding between the two groups. However, the result of t-test showed that the mean landholding size difference between the two groups was significant. Land is one of the most important production factors for agricultural production. In rural households, in the study area land and labor account for the largest share of agricultural inputs. Hence, the quality and quantity of land available for farm households largely determine the amount of production. When land holdings are intensively fragmented and scattered much time and energy are lost in moving from one plot to another and make difficulty in application of organic manure. Therefore it is possible to conclude that plots of land located relatively closer to one another and to homes of land users get the opportunity to be more conserved as compared to those located farther apart and fragmented. Land ownership system has its own impact on the way farmers adopt land management practices. Evidence from many parts of the world suggests that lack of control over resources is one of the major reasons for the degradation of natural resources. It is argued that farmers' decisions to investment on land management activities as well as their choice and implementations of land management practices are affected by tenure security. Some argue that private ownership is vital, because it encourages farmers to invest on and opt for efficient and lasting practices (Belay, 2000).

Table 2: Continuous Variables Differentiating Adopters from Non-Adopters of SLM Practice/ Technologies among 224 Sample Households

Variables	Adopters		Non-adopters		t-value
	Mean	Standard Deviation	Mean	Standard Deviation	
Household Size (in number)	6.4	1.7	6.7	1.8	0.232
Age of household head (in years)	51.5	14.4	49.05	13.76	-0.36
Education status of household head (in years)	3.1	1.06	3	0.99	3.46**
Land holding size (in hectares)	1.54	0.99	1.27	1.05	2.251**
Farming Experience (in years)	27	13.42	24	11.87	0.232
Distance of plots from residence (in Kms)	0.57	0.221	0.68	0.46	0.96
Off-farm income (in ETB)	452.5	123.67	376.42	99.56	0.87
Livestock holdings (in TLU)	3.45	1.02	3.04	1.20	2.86**
Extension contact(in number)	1.02	0.76	0.98	0.78	1.98*
Size of labour force	3.02	1.66	2.96	1.54	3.65**

***indicates significant at 10%and 5% probability level respectively. One TLU is equivalent to a 250-kilogram animal in terms of feed requirements.*

Livestock is an important component of the farming system in the study area. A vast majority of the sample households included in this survey own animals of different kind. Cattle, donkeys, horse sheep, goats and chicken are common domestic animals. Small ruminants and chickens were sold and serve the purpose of immediate cash needs at times of cash shortage. The size of livestock owned indicates the wealth status of the household. The average size of livestock in TLU was found to be 3.45, 3.79 and 3.04 for total sample households, SLM adopters and non-adopters with a standard deviation of 1.02, and 1.2, respectively. About 33% of total sample household heads has more than five TLU sizes of livestock. The main purpose of keeping livestock is for draught power. Livestock products such as milk and meat have secondary importance to the farmers. Small ruminants are mainly used as income sources as well as for household consumption. The livestock production system commonly found in the villages is an extensive system where open grazing is the main style of feeding. The t-test revealed that there is significant difference in the number of oxen owned by farmers who have adopted SLM practices and those who have not.

The number of labour force available in the family is assumed to influence decision of farmers to adopt SLM practices. Families with large household members will be able to supply the extra-labour that could be required for adoption and continuous implementation SLM activities. Family labour is the main source of farm labour except for potato production for which farmers commonly use hired labour. Labour is highly demanded during planting and harvesting seasons in the study area. Due to shortage of agricultural land in the area, some farmers may also leave their village looking for employment in other places during the months of September to December. In addition, the result of t-test revealed that there was significant difference in the mean size of labour force between adopters and non-adopters. The average available labour was calculated to be 2.95person per day for total sample households, 3.02person per day for adopters and 2.96 person per days for non-adopters, with a standard deviation of 1.68, 1.66, and 1.54, respectively.

In the study area, the most important sources of information cited were through communication with relatives and neighbors, community leaders, and the government's mainstream agricultural extension program. Farmers' pointed out the governments' extension service as the most important one. In addition, they further revealed that information about input supply and use, land management practices; and soil and water conservation practices are among the aspects covered by the extension services. Access to extension service is very important element of institutional support needed by farmers to enhance the use of agricultural technologies in general and soil and water conservation technologies in particular. Three Development Agents (DA's) were assigned in each sample *kebeles*. It was expected that sample farmers in the study area have an access to extension services through the DAs, attending field days and trainings. However, about 22% of adopters, 43% of non-adopters have reported that they did not get extension services (visits) in the year 2015/016. Development agents had visited about 56%

of sample households from one to three times per month. The average monthly frequency of extension visits was found to be 0.97 and 0.70 for users and non-users with a standard deviation of 0.80 and 0.83, respectively. The mean monthly extension visit difference of the two groups was found to be statistically significance.

b) Descriptive Statistics of Categorical Variables

Generally, adopters and non-adopters not only vary in terms of quantitative variables but also in terms of qualitative variables. It was, therefore, quite essential to use a method of testing the differences between adopters and non-adopters.

From the total 224 sample household heads, 84 (37.5%) were men's and 140(62.5%) were women's respectively (Table 3). The majority of adopters of the SLM Practices (63.36%) were male-headed households while only 36.63 % were female-headed households. Chi-square test results show that there is a statistically significant difference between adopters and non-adopters in terms of sex of the household heads at 10% probability level. Overwhelming majority of farmers disclosed that their land productivity is declining with each passing year due to soil erosion. Farmer's perception about the existence of land degradation problem on their farm plots, causes of the problems as well as its consequences might make farmers to adopt and continuously implement SLM measures. The majority of the sample household heads (78.12%) have perceived the problem of soil erosion on their farm plots. From this, only 58.28 % of households adopted SLM practices/ technologies at least in one of their plots. This can imply that perceiving the problem of land degradation problem is cannot always be a guarantee for adoption of SLM practices/ technologies. The difference between the two groups with respect to perceiving the existence of land degradation on farm plots was statistically significant.

Table 3: Dummy variables differentiating SLM adopters from non-adopters of SLM practices among 224 sample households

Variable	Score	Adopter	Non-adopter	Total	X^2
Sex	0	37	47	84	8.65***
	1	64	76	140	
	0	17	32	49	6.25***
Perception	1	102	73	175	
Degree of slope of the plot	0	34	52	85	1.34
	1	77	62	139	
Access to credit service	0	87	22	109	7.05***
	1	88	27	115	
Land certification	0	33	37	70	9.63***
	1	98	56	154	
Prior public conservation campaign	0	56	62	118	
	1	72	34	106	1.02

****: significant at <1 probability level.*

In the study area, it was found that only 51.34 % of the respondents have reported obtaining credit at least once since the last five years. Whereas, 48.66 % of respondents have not obtained credit from formal sources. When the data analyzed by disaggregating into adopters of SLM practices and that of non-adopters, it was assured that 79.81% of those who were adopted and continuously practiced SLM practices have obtained credit, but only 20.18% has got credit from those non-adopters. The Chi-square analysis disclosed that there is a significant association between access to credit service and adoption of SLM practices and it is significant at 10% level of significance. This could prove that farmers who have access to credit have a higher probability of adopting and retaining SLM practices/technologies than those with no access. Focus group discussions revealed that more than half of the farmers are cultivating erosion prone areas. It was revealed that there are some steep slope areas that shouldn't be under cultivation due to their nature, but are now coming under cultivation due to population pressure. This is a major challenge that seems to exacerbate land degradation. Key Informant Interview also confirmed that the slope of the farm land is highly related to the degree of involvement in management activities. Farmers living on steep slope are involved more in the continued use of management measures than those who own flat or gently sloping farm lands Credit sources for purchase of livestock and crop production are not satisfactory. Although credit facilities are available from microfinance institutions such as Oromia Saving and Credit Share Company and *Busa Gonofa* microfinance, most farmers do not use the services because of fear of risks associated with crop and livestock performance failures that could lead to failure of repayment of the loan. As survey result shows (table2) only 13.3% of the respondents used microfinance service. Moreover, the credit services provided by the micro-finance institutions are group based; which makes individual farmers accountable for the group members who are unable to pay their loan. It was also indicated that the service provision is limited to only once per year so that it may not be available when it is needed most.

c) Causes of land Degradation in the Study Area

The contributing factors for land degradation are multifaceted and miscellaneous. It is the result of complex interaction between physical, biological and socioeconomic issues. Response to the inquiry on whether the study area households perceived land degradation as a problem in their farm lands have shown (table 4) that 72% of the surveyed respondents perceived land degradation as being a serious problem in their farming and grazing plots. As indicated (*table 4*), the major cause of land degradation mentioned by 98 % farmers was lack of conservation structures. The farmers' perceived various causes of land degradation in their farmland and surrounding landscapes. Overwhelming majority of farmers' in the study areas were aware that land degradation in various forms and levels was happening on their farm lands as well as in the surrounding landscapes. Table 4 presents the locally perceived land degradation causes that were mentioned by the respondents as being the contribution of the farming practices to the observed land/soil degradation in the study areas. About 35 % of the respondents associated land degradation to low adoption and sustained implementation of soil and water conservation measures used in their farmlands while 32.5%, 30.83%, 28.33%, 27.5%, 25.83% and 18.33% considered Cultivation of marginal areas and steep slopes; overgrazing and continuous cropping; torrential rains (high intensity rainfalls); expansion of eucalyptus trees; deforestation and clearing of vegetation and soil erosion vulnerable soil type reported to be responsible for the land degradation and soil erosion proms respectively. This finding clearly corroborates with Bekele and Holden (1998) report which elucidates those vast areas of the highlands of Ethiopia could be classified as suffering from severe to moderate soil degradation. Increasing intensification and continuous cultivation on sloping lands without supplementary use of soil amendments and conservation practices poses a serious threat to sustainable land use. In addition, Brown and Wolf (1984) stated that the apparent increase of soil erosion over the past generation is not the result of a decline in the skills of farmers but rather the result of the pressures on farmers to produce more. Hence, farmers of the study area were aware of soil erosion but they are forced to intensify and produce more food crops for their basic livelihood.

Table 4: Farmers' Perception on Land Degradation and soil erosion in the study area

Farmers' perceived causes land degradation	Frequency (n=120)	Percentages
Overgrazing and continuous cropping	37	30.83
Deforestation clearing of Vegetation	31	25.83
Cultivation of marginal and steep slope areas	39	32.5
Low adoption of conservation measures and practices	42	35
Torrential rains/high intensity of rainfall (extreme weather events)	34	28.33
Erosion vulnerable soil type	22	18.33
Expansion of Eucalyptus Trees	33	27.5

* *Note: A multiple response frame was used. Hence, total count is more than the number of respondents*

d) Land Management Practices in the study area

Any land management practice, to be effective, needs to be economically feasible, socially acceptable and environmentally friendly. The researcher focused on the land management practices, especially introduced and indigenous land management practices

i. Adoption of Indigenous SLM Practices/ technologies

For generations farmers in different parts of the country used to apply their own indigenous SLM practices to halt land degradation, improve soil productivity and woody biomass production. Some of their indigenous practices were effective, despite some limitations. Farmers were asked to explain indigenous land management measures which were implemented on their farm and the surrounding land. Their answers were summarized in the table 5 below.

Table-5: Indigenous Land Management Practices

Indigenous land management practices	Frequency (n=224)	Percentage
Crop rotation	157	70
Crop residue	102	45.53
Fallowing	91	40.62
Traditional waterway	134	59.82
Mixed cropping	67	29.91
Animal manure	138	61.6
Furrow	149	66.51

As one can understand from Table-5, the most widely implemented indigenous were crop rotation (70%) followed by furrow (66.51%) of the respondents. Results of the FGD revealed that low implementation of crop rotation resulted from habitual cultivation of one type of crop on the same plot of land and from low awareness; however, less admission to fallowing was due to large population whereby no land is left fallow. Crop rotation is one of the most important means of improving soil fertility as well as conserving the soils. It is a system by which nitrogen restoration is attained by alternating different types of crops on the same cultivated land. This practice is considered to be very effective in maintaining the nitrogen status of the soils where leguminous plants are included in the rotation (Belay, 2000). Similarly, a study conducted in Tigray region indicated that farmers were choosing which crops to grow in rotation according to how they adapt to the soil and the rainfall pattern as well as economic consideration such as the price of the crops to be chosen (Corbeels et al 2000). Crop rotation, one of the most widely applied soil fertility enhancing measures has a number of functions as well as benefits to the farmer. According to Belay (2000), crop rotation improves the soil fertility and controls the spread of weeds and insects. High application of animal manure was attributed to livestock production by the mixed farmers in the study area. The use of animal dung, ash and household trash to crop land as manure is common practice to improve soil fertility. In the study area, this is well manifested in the homestead gardening or at backyards. Description of indigenous practices of manuring shows highest concentration of manure around the homesteads (Herweg, 2002).

ii. *Adoption of Introduced SLM practices/ Technologies*

The introduction of SLM practices in the country has dated back many hundred years. However, the most recent attempts, which are more focused and extensive, started after the 1973-74 droughts in parts of the country. Long-term productivity and sustainability of the land resource requires sound land conservation measures in the farming systems that enhance maintenance and/or improvement of soil and land quality in general. This is an important consideration as it influences agricultural productivity and local livelihoods. In many instances, environmental degradation has stimulated a variety of responses and adaptation mechanisms by local communities. This study made an enquiry on whether farmers had undertaken any deliberate efforts to protect their land holdings from soil degradation. Majority of respondents (63.75 %) indicated to have used one or more SLM Practices in their farms as a means of adjusting and adapting to land degradation processes. Graph2 presents the various SLM practices as mentioned by the interviewed farmers.

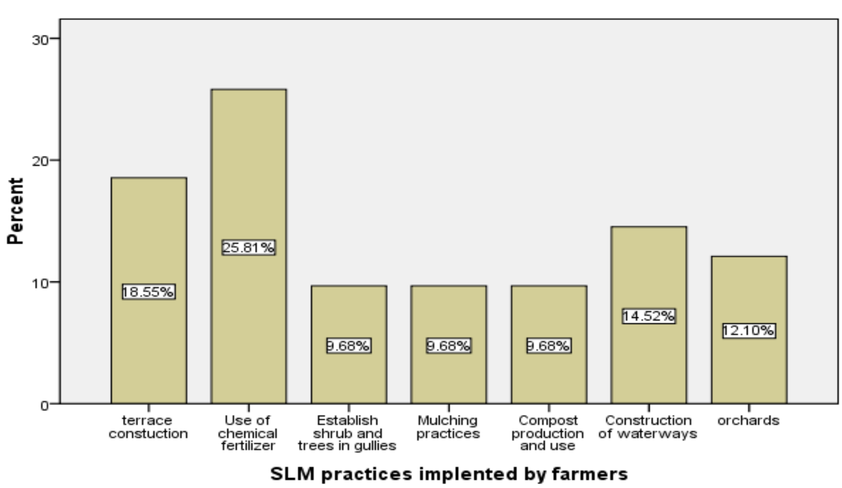


Figure 2: Adoption introduced of SLM practices implemented by farmers in the study area

As discussed by Shiferaw and Holden (1998), construction of bunds is arduous and labor intensive, requiring as much as 100 person days to construct a bund on a small quarter-hectare plot. Furthermore, opportunity costs can be very high, with bunds taking up 10–20 percent of cultivable area and even more on sloped plots. Bunds therefore actually reduce the area under cultivation by a significant percent. If farmers are to be benefited from installing bunds, productivity must not only increase, but must increase by more than is lost by the reductions in cultivation area. As found by Kassie, (2005), drier areas offer higher returns to bunds than wetter ones. The combination of wet conditions and complications associated with small plots where bunds occupy significant portions of cultivable area, and difficulties in plowing appear to drive these results. The reasons behind limited implementation of the modern measures of land management as reported by FGD participants were different. Mulching was implemented by more significant proportion of the sample household heads due to the fact that crop residue disposed on their farm brought about better result in keeping the land protected from evaporation of its moisture and also breaks up heavy rain drops thereby minimizing run off. Fairly more than half 60% of the sample households have developed grass strip. This measure has double advantage; for land management and for animal feeding.

e) Constraints to Community Participation in Sustainable Land Management (SLM) Practices

Community participation in sustainable land management practices is of great importance as it seeks to guarantee access and control over resources by the communities living in them, but who depend on these resources to satisfy their various needs (ecological, economic, social, cultural and spiritual needs). Community participation ensures more commitment in ensuring that resources are more sustainably managed, where apart from communities depending on these resources for a living and conserving them, they at the same time become their guardians (Arega and Hassan, 2003; Tesfaye, 2003; Lakew et al., 2000; Yilkal, 2007; Habtamu, 2006).The active participation of various stakeholders in decision making is crucial for ensuring the long term sustainability of community-based resource management initiatives. In several occasions however, sustainable land management has not received the expected involvement of local communities. Some of the reasons that have influenced the local people's participation SLM practices in the study area are discussed here.

Table 6: Constraints to Community Participation in Sustainable Land Management (SLM) Practices

Constraints to adoption of SLM practices	Frequency(n=224)	Percentage (%)
Lack of incentives	72	32.14
Labour intensiveness	66	29.46
Land shortage	69	30.8
Financial constraint(Poverty)	109	48.67
Complexity Conservation measures	76	33.93

**Note: n is frequency of responses (multiple) for each measure*

A financial constraint (poverty) was the main reason reported for not being able to implement SLM practices (mentioned by 48.67% of people as presented in table 7). Artificial fertilizer, ranked most highly in terms of their capacity to improve the soil is also the most expensive measures. It does not follow however that is the poorest that degrade the land most (or that it is the wealthiest who invest most in the land, as shown above). The poorest are often eager to sell their labor, as they are desperate for cash income to buy necessities. In so doing they are rarely able to cultivate all their own fields and so these fields benefit from more regular fallowing than those belonging to wealthier people. This defenses Dejene *et al* (1997) findings that the poor face financial and socio-economic constraints which seriously impede management practices and innovations. Lack of adequate incentive was the main reason that people cited for being unable to implement SLM Practices (reported by 32.14% of people as presented in table 7). Land quality is important variable affecting incentives in this area. The FGD data reveals that that 'the more productive or profitable the land use the more farmers will be willing to maintain and invest in better land management and erosion control practices. Relatively flat, irrigable land suitable for vegetable production generates greater returns to labor and capital, and therefore a stronger incentive to invest. Thus it receives much more attention than steeply sloping fields given to maize and beans.

Land shortage was the main reason that people cited for being unable to implement erosion prevention methods (30.8%) as trees and terraces both absorb land and trees further shade crops. It was also cited as a constraint to improving fertility by 37% of people (referring to the desire for longer and more frequent fallows). Thus population pressure, (as it lowers per capita land availability), could be regarded as a factor contributing to degradation in Study areas but other factors affect whether this results in intensification with soil improvement or degradation. Local people will not convert their ladder terraces into more permanent terraces because they say they would be too labor intensive to maintain (it would involve digging residues into the soil twice annually rather than pulling soil down slope to bury them). With significant rates of out-migration, labor can hardly be said to be a constraining variable to land improvement— thus returns to labor, as outlined above, must be regarded as more significant. The survey result also revealed conservation measures are so complex that they do not understand exactly how to go about their implementation (noted by 33.93 % of people). This arises due to lack of consultation with the community in enacting the policies. This point is consistent with the view of Rogers (Reed and Dougill, 2009; Reed et al, 2006), that innovations which are difficult to understand and implement are less likely to be adopted than technically simple ill innovations, although the scientifically rigorous indicators used in the top-down paradigm may be quite objective, they may also be difficult for local people to use. It was reiterated that some of these measures require financial investment which they do not have, and therefore they are unable to implement them.. This lowers the productivity and income of the poor and reinforces the "vicious cycle" of poverty and natural resource degradation. This means that if land degradation is to be managed sustainably, and then the communities need to be involved in the planning process and resourced to implement projects introduced by authorities

Also the others the reasons elucidated was the taking too lightly the severity of the land degradation risk by many people in the area. Where the tenure system is not guaranteed individual farmers may not be concerned with problems of land degradation regardless of their holdings being at risk as such land degradation is considered as a general community problem. Such attitudes may result in no action being taken against land degradation even when there are no clear hindrances. The implication of the foregoing is that effective conservation is likely to be achieved when land tenure systems are properly secured and articulated. Thus efforts are needed to ensure integrated community-level planning that could promote individual farmers efforts without undermining community interests. Adoption and/or practicing certain SLM measures are much influenced by the farmer's economic situation, including resource endowments. For instance, farmers with sufficient land holdings can afford to conserve by fallowing and constructing various physical SWC structures, while land constrained farmers may not. Similar experiences would be the case for other conservation measures that require heavy investment by the farmer, for example making of soil erosion control structures that may need additional labour, and using fertilizers and/or manure.

From the in-depth interviews held with FGDs participants on management, institutional barriers were identified as another challenge of community involvement. Poor coordination between farmers, traditional/local authorities and NGOs was seen as a major barrier to land management in the area. Reasons assigned for the lack of coordination were conflict of interest among stakeholders, especially concerning resource use and control, the seemingly entrenched stance of some traditional or local authorities on issues relating to land and its use, and the difficulty in convening meetings of all stakeholders to identify priority projects to be undertaken. The lack of coordination among stakeholders (farmers, traditional authorities, governmental agencies, NGOs, etc) sometimes results in duplication of efforts in some areas whereas other places receive little or no attention at all. Furthermore, lack of genuine involvement between local communities, NGOs and governmental agencies who undertake conservation projects is holding back sustainable land management in the in the study area. This situation often results in a top-down approach to planning. For example, authorities design conservation plans with the scientific knowledge available and then take them to the people for execution, a process which usually leads to inappropriate execution or to the failure of some conservation efforts. Also, a top-down approach may result in the location of projects at sites that may not be fitting to the inhabitants. The household survey reveals that most projects which did not involve the local people at certain levels of planning failed. 79% of the interviewed farmers held the view that their knowledge is very relevant to any intervention exercise and therefore should be sought before any plan is implemented, whereas 21% held a opposing view. Those who saw the relevance of local participation in land management stated that local people should not only be viewed as a labour pool for conservation projects but as people whose experience in the area as land users has given them enough knowledge to share.

Conservation practices are adopted when local communities have satisfied basic needs. Besides population pressure, other factors also need to be evaluated, such as the support of public institutions and sufficient cohesion of local communities, especially a strong community organization. The combination of these factors will result in the decision and the capacity of land users to invest time and resources in land conservation. Decision-making about land management and land degradation should encompasses, among others, factors that may be biophysical (agro-ecological conditions, location), economic (access to credit and markets, non-farm incomes, availability of technologies), social (organizational structure, labor availability, land tenure), historical (environmental history and that of land tenure) and cultural (traditional knowledge, environmental awareness, and gender). Socioeconomic and cultural factors should receive crucial attention in policy decision-making. For instance at a time, the attitude of local communities may be more critical than the availability of technology; the latter, although an important issue, may only be a tool to achieve goals in a social context.

f) Econometric Analysis of Determinants of Adoption of SLM Practices

Logistic regression model was used to address the second objective of the study. That is to identify the factors that affect adoption of the introduced land management practices in the study area. The likelihood ratio test statistic exceeds the chi-square critical value with 12degrees of freedom. The result is significant at less than 1% probability level indicating that the hypothesis that all the coefficients except the intercept are equal to zero is not acceptable. Likewise, the log likelihood value was significant at 1% level of significance. Another measure of goodness of fit used in logistic regression analysis is the Count-R^2, which indicates the number of sample observations correctly predicted by the model. TheCount-R^2 is based on the principle that if the estimated probability of the event is less than0.5, the event will not occur and if it is greater than 0.5 the event will occur. In other words, the i^{th} observation is grouped as non-adopters if the computed probability is greater than or equal to 0.5, and as adopter otherwise. The discussion about the significant variables is given below.

Age of the Household Head: This result suggests that older farmers are less likely to adopt SLM practices. This could be explained by the fact that older farmers have a short planning horizon compared with younger colleagues. This is in line with the findings of Anley et al. (2007) and Shiferaw& Holden (1998).

Off- Farm Activities: Adoption of SLM practices also found to be negatively influenced by off-farm activities. This is because farmers who are involved in off-farm activities may encounter time and labour constraints for investing in bunds. This is in line with other findings (Tenge *et al*., 2004; Amsalu and deGraaff, 2007).

Number of livestock owned: The number of TLUs is positively related to the decision of compost/manure investment. This is because animal manure is one of the major inputs for compost/manure production. As hypothesized, this variable affected adoption of SLM practices s positively and significantly at 5% probability level. The marginal effect for this variable shows that keeping all factors constant an increase in livestock ownership by one TLU increases the probability of SLM Practices adoption by 0.031.

Extension contact: As hypothesized, frequency of extension contact is found to have a significant positive effect on the adoption of SLM Practices s at 10% probability level. This may be explained by the fact that the message/contents that farmer gain from extension agents help them to initiate to use the newly introduced land management practices on their farm to protect their land from erosion and improve its fertility. Therefore, contact between a farmer and development agent and information gained accelerate the attitude of farmers towards SLM practices positively, and the decision of farmers to invest on SLM Practice on his/her land (Tesfaye 2006). Many other case studies too revealed that low adoption of rainwater harvesting technology were due to lack of extension services (Nasr, 1999; Kihara, 2002; Mitiku and Sorsa, 2002; Ngigi, 2003). The marginal effect value for farm size shows that keeping all factors constant an increase in extension contact by one e increases the probability of SLM Practice adoption by 0.032.

Farmers' perception on effectiveness of introduced land management practices: This variable is hypothesized to influence land management practices adoption either positively or negatively. The model results show that this variable has a significant positive impact on land management practices. The variable is significant at less than 5% probability level. As hypothesized, farmers' perception of effectiveness of SLM measures influence households' decision to invest on introduced land management practices positively.

Table 4: Analysis of Determinants Using Binary Logistic Regression Model result for perception of the effects of land degradation risks

Variable	β	SE	Z	Sig	Odd Ratio
AGE	2.142**	0.562	0.862	0.0671	0.025
HHSIZE	0.235	1.320	1.230	0.215	0.0670
EDUCATION	0.072*	1.892	2.290	0.021	0.201
SEX	0.040**	3.536	0.968	0.091	0.056
FAMILY-LABOUR	0.235*	0.360	0.386	0.026	0.024
TENURE	0.042**	1.765	0.564	0.086	0.210
MEMBERSHIP	0.246	1.156	1.961	0.534	0.056
TRAINING	0.836*	2.034	0.862	0.020	0.092
EXTENSION VISIT	0.865*	0.458	1.926	0.031	0.032
FRMSIZE	2.280	0.985	0.862	0.915	0.042
LIVESTOCK	0.965*	2.045	1.926	0.020	0.031
TOTAL INCOME	1.626	1.963	0.034	0.234	0.023
OFFINCOME	-0.025*	2.094	2.026	0.0251	0.031
DISATANCE	-0.965**	1.096	0.648	0.096	0.802
CREDIT ACESS	1.028*	2.064	1.025	0.020	0.035
SLOPE	2.860**	2.021	1.806	0.091	0.020
PERCEPDEGRADATION	0.689*	1.091	0.962	0.031	0.380
PERCEPTSLM	1.096**	2.026	0.863	0.062	0.031
Constant					

Model Chi-square 102.280
Log likelihood function 92.165
Nagelkerke (R^2) 0.75
Number of observation 224

***, * Significant at 0.1 and 0.05 probability levels, respectively*

Perception of severity of land degradation: This variable indicates the severity of soil erosion as perceived by the farm households. The variable positively influenced the adoption of SLM practices/ technologies at less than 1 percent level of significance. The reason for this is that farm households' awareness of the erosion hazard is attached to their perception of the negative consequences of soil erosion and benefits of soil and water conservation. This could be explained by the fact that those farmers who have perceived soil erosion as a serious problem were willing to participate in conservation strategies of land management. Those farmers, who have better perception of soil erosion, will develop good initiations towards management scheme and become less dependent on external assistance for undertaking land management activities.

Educational level of sampled household head: As hypothesized, education of the HH head was found to be positive and having a significant influence on the adoption of improved soil conservation technology. This implies that longer schooling of the HH head increased their ability to access information, and strengthened his/her analytical capabilities with new technology. Furthermore, a longer education leads to a better understanding of the new technology when reviewing the different extension materials, which enhanced adoption of improved technology. Many authors report that education has a positive impact in the adoption of improved soil conservation technology (Lapar and Ehui 2004; Mbaga-Semgalawe and Folmer 2000;). The findings of this study on the effect of education were close to that of other studies conducted previously. Adoption of a given technology is a behavioral change process, which is the result of a decision to apply that particular innovation. Farmers need enough information about the technology to make the right decision. Education enhances the capacity of individuals to obtain, process, and utilize information disseminated by different sources. This implies that literate farmers are in a better position to get information and use it in such a way that it contributes in their adoption of SLM Practices. As hypothesized, educational level of household heads was found to be a significant at less than five percent probability level. This may be explained by the fact that those farmers who were more educated are likely to use introduced land management than the non-educated farmers in the study area. This is because, educated farmers were more opt in understanding the problem of land degradation and could easily decide to take part in conservation strategies of land management practices . This is attributable to the fact that education reflects acquired knowledge of environmental amenities and educated farmers tend to spend more time and money on land management practices. The marginal effect value for education shows that keeping all factors constant an increase in education by one year increases the probability of adoption of SLM Practices by 0.201.

Land tenure: Farmer's feeling about the land belongs to him/she will have a positive effect on his/her decision to adopt land management practices. The lack of title to land is one important factor affecting adoption of SLM Practices because lack of tenure security means that people are reluctant to invest in new land management practices on a land which they do not formally own. Therefore, farmers' perception that the farmland he/she owns will remain his/her owns at least during his/her lifetime affects the decision on land management practices. For farmers' to be able to carry out long or medium term investment, they require security of tenure. This does not necessarily mean that they have to have individually documented proof of title rather need the feeling of ownership to make sure that the land will be theirs to work in the foreseeable future, and not unpredictably taken away and reallocate to somebody else. This variable is found to significantly and positively affect the independent variable, SLM Practice. This is because to adopt and invest on land management practices, first there should have a sense of ownership so that farmer can take care of his land.

Slope of the farm plots (SLOP): This variable positively influenced the adoption of SLM practices/ technologies at less than 1 percent level of significance. The significant positive terms in adoption of conservation practices indicate that farmers are inclined to invest in conservation practices where their farm plots are located on higher slopes. The slope of a plot also affects the adoption of land management structures because the steeper the slope, the more likely the land will be exposed to degradation. Hence, it is believed that adoption of physical land structures tends to be likely on steeper slopes This goes with the perception that those plots can only be productive if protected by conservation structures. On the other hand, Berhanu and Swinton (2003) have stated that an increase in the slope of the plots may create a disincentive to invest in soil conservation practices as the slope of the plot increase the distance between two consecutive terraces will decrease because the structures of SLM measures occupy more area of land and will create inconvenience for farm operation. Slope is an indicator of the likelihood of degradation on the land. But, Lapar (1999) in the Philippines found that the slope of a plot to be one of the factors significantly influencing the adoption of land management. Their results suggest that a farmer who operates a field with steeper slope is more likely to adopt the land management technology.

g) Conclusion and Policy Implication

The findings of this study have important policy implications for promoting sustainable land management practices and technologies in the study area. Descriptive data analysis showed that only 63.75 % of the HH adopted SLM practices. Farmers reported that the improved terraces are effective in reducing soil erosion, though they were not common due to high labor cost and inconveniency for ploughing with oxen. A range of socio-economic, institutional, personal and biophysical factors determines adoption of SLM practices in the study area. The result of the binary logistic regression model showed that SLM practices is significantly influenced by education, tenure security, livestock ownership, perception of severity of land degradation, perception of effectiveness of SLM measures, off-farm activities, credit services access, age of households, slop of the plot ant etc. Planners and policy makers should formulate appropriate policies and programs considering the farmers' interest, capacity, and limitation in promoting improved soil conservation technology for greater acceptance and adoption by the farmers. Any future land management efforts should give a due attention to genuinely involve farmers in entire process of any land management interventions from technology generation to final monitoring and evaluation. Generally, this study recommends that decision-making about land management and land degradation should encompasses factors that may be biophysical (agro-ecological conditions, location), economic (access to credit and markets, non-farm incomes, availability of technologies), social (organizational structure, labor availability, land tenure), historical (environmental history and that of land tenure) and cultural (traditional knowledge, environmental awareness, and gender.

V. Acknowledgement

This study was undertaken with a financial support from Ambo University, is sincerely acknowledged. The author also would like to thank the anonymous referees for their useful and pertinent comments on an earlier version of this paper. Many thanks are extended to the farmers in Jeldu District who are enthusiastically participated in this study and for their inspirations and willingness for the interview that paved a way towards completion of this work. The development workers of the Jeldu district are also sincerely thanked for their efforts to support the researcher by conducting the survey.

References Références Referencias

1. Aklilu, A. (2006). *Caring for the Land Best Practices in Soil and Water Conservation in Beressa Watershed, Highlands of Ethiopia*. Tropical Resource Management Papers, No. 76.
2. Amsalu, A. and de Graaff, J. (2007), Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. *Ecological Economics* 6:294-302
3. Amsalu, A. and de Graaff, J. (2007), Determinants of adoption and continued use of stone terraces for

soil and water conservation in an Ethiopian highland watershed. *Ecological Economics* 6:294-302

4. Assefa D. 2009. Assessment of Upland Erosion Processes and Farmer's Perception of Land Conservation inDebre-Mewi Watershed, Near Lake Tana, Ethiopia. A Thesis Presented to the Faculty of Graduate School ofCornell University in Partial Fulfillment of the Requirements for the Degree of Masters of ProfessionalStudies.104p.
5. Beddington, J. (2010). Food security: Contributions from science to a new and greener revolution.
6. Bekele S, Okello J, Ratna VR. 2009. Adoption and Adaptation of Natural Resource Management Innovations inSmallholder Agriculture: Reflections on Key Lessons and Best Practices. Environment, Development andSustainability, 11: 601-619.
7. Bekele, W. & Drake, L. (2003). Soil and Water Conservation Decision Behavior of Subsistence Farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto Area. Ecological Economics 46:437-451.
8. Bekele, W. and Drake, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. *Ecological Economics* 46 (2003) 437_/451
9. Bekele, W. and Drake, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. *Ecological Economics* 46 (2003) 437_/451
10. Belay, M. &Bewket, W. (2013). Farmers' livelihood assets and adoption of sustainable land management practices in north-western highlands of Ethiopia. International journal of environmental studies, 70(2), 284-301.
11. Betru, N. (2003). *Soil and Water Conservation Program in the Amhara National Regional* California Press.
12. Carucci, V. 2006. Sustainable Land Management as Key enabling Element to End Poverty in Ethiopia: gaps, dichotomies and opportunities. (A paper for dialogue). WFP, Addis Ababa, Ethiopia.
13. Dejene, A. (Ed.). (1997). Land degradation in Tanzania: perception from the village (Vol. 370). World Bank Publications.
14. Desta, L. Carucci, V., AsratWondem-Agegnehu and YitayewAbebe (eds). 2005. Community Based Participatory Watershed Development: A Guideline. Ministry of Gariculture and Rural Development, Addis Ababa, Ethiopia.
15. EEA/EEPRI (2004/05). *Report on the Ethiopian Economy: Transformation of The Ethiopian Agriculture: Potential, Constraints, and Suggested Intervention Measures*, Vol. IV, Addis Ababa.
16. ELD Initiative. (2013). The rewards of investing in sustainable land management. Interim Report for the Economics of Land Degradation Initiative: A global strategy for sustainable land management. accessed in September 1, 2015 Available at: www.eld-initiative.org/
17. EPA, 1997. The Federal Democratic Republic of Ethiopia Environmental Policy. Environmental Protection Agency (EPA), Addis Ababa, Ethiopia.
18. EPA, 2001. National Action Programme (NAP): Executive Summary, June 2001. Addis Ababa.
19. EPA, 2005. Concept Note: Sustainable Land Management Country Framework, PDF-A. Addis Ababa, Ethiopia.
20. EPLAUA, 2004. The State of Soil and Water Conservation Measures in Amhara National Regional State. Bahirdar, Ethiopia.
21. Ethiopian Economic Association/Ethiopian Economic Policy and Research Institute (EEA/EEPRI) (2002). *A Research Report on Land Tenure and Agricultural Development in Ethiopia,* Addis Ababa.
22. Eyasu, E. (2002). *Farmers' Perception of Soil Fertility Change and Management,* Institute for Sustainable Development and SOS Sahel International (UK), AddisAbaba.
23. FAO (2011). Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa. Rome, 2011.
24. FAO (UN Food and Agriculture Organization). 1996. World Food Summit: Rome declaration on world food security and world food summit plan of action. Rome, Italy: FAO.
25. FAO 2011. Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa. Rome, 2011.
26. FAO. (2007). Paying Farmers for Environmental Services, State of Food and Agriculture 2007, Rome: FAO. Rome, Italy.
27. FAO. (2009). Country support tool for scaling-up Sustainable Land Management in Sub-Saharan Africa. Version 1.0. A TerrAfrica partnership publication.
28. FAO. (2012). FAO publication - Combating Micronutrient Deficiencies: Food-based Approaches. Rome, Italy.
29. FAO. 2006. Preparation of a Global Report on the State of Land and Water Resources, SoLAW. Land and Water Development Division, FAO, Rome, 2006. In-progress Draft Report – Version 01.
30. FAO. 2007. Conservation agriculture in Tanzania: a case study. Rome, Food and Agriculture Organization of the United Nations.
31. FAO. 2009. Country support tool for scaling-up Sustainable Land Management in Sub-Saharan Africa. Version 1.0. A TerrAfrica partnership publication.

32. FAO. 2010. Investment Centre Database of Projects. Rome, Food and Agriculture Organization of the United Nations.
33. FAO/WOCAT. 2009. SLM in Practice. promoting Knowledge on Sustainable Land Management for Action in Sub-Saharan Africa Roma, Food and Agriculture Organization of the United Nations.
34. Gebremedhin B. and Swinton S. M. (2003). Investment in soil conservation in Northern Ethiopia: the role of land tenure security and public programs. *Agricultural Economics* 29: 69–84.
35. Gebremedhin, B. 1998. "The Economics of Soil Conservation Investments in the Tigray Region of Ethiopia". Unpublished PhD Dissertation, Michigan State University, Department of Agricultural Economics, East Lansing, USA.
36. Gebremedhin, B. and S. Swinton. 2002. Sustainable management of private and communal lands in northern Ethiopia. In: C.B. Barrett, F. Place and A.A. Aboud (eds.), *Natural Resources Management in African Agriculture*. International Centre for Research in Agroforestry, CABI Publishing, New York.
37. Gebremedhin, B., J. Pender, and G. Tesfaye. 2003. Community resource management: The case of woodlots in northern Ethiopia. *Environment and Development Economics* 8: 129-148.
38. Gerber, N., Nkonya, E., & von Braun, J. (2014). Land Degradation, Poverty and Marginality. In Marginality (pp. 181-202). Springer Netherlands.
39. Gerber, N., Nkonya, E., & von Braun, J. (2014). Land Degradation, Poverty and Marginality. In Marginality (pp. 181-202). Springer Netherlands.
40. Getahun, A. (1991). Agricultural growth and sustainability: Conditions for their compatibility in the tropical East Africa highlands. In: S. Vosti, T. Reardon, and
41. GeteZeleke, Menale Kassie, John Pender & Mahmud Yesuf 2006 Stakeholder Analysis for Sustainable Land Management (SLM) in Ethiopia: Assessment of Opportunities, Strategic Constraints, Information Needs, and Knowledge Gaps
42. GeteZeleke. 2000. Landscape Dynamics and Soil Erosion Process Modelling in the North-western Ethiopian Highlands. African Study Series A 16, Geographica Bernensia, Berne, Switzerland
43. GeteZeleke. 2003. Concept Note on Prtnership for Rural Livilihoods Improvement as a First Step Towards Implimenting UNDAF: Touching the Ground. World Food Programme. Addis Ababa, Ethiopia.
44. GeteZeleke. 2005 (forthcoming): Integrated Watershed Management Experiences in ECA Countries: Lessons from Ethiopia. ICRISAT, Nairobi Kenya.
45. GeteZeleke. and Hurni H. 2001. Implication of Land Use and Land Cover Dynamics for Mountain Resource Degradation in the North-western Ethiopian Highlands. Journal of Mountain Research and Development. Vol. 21, No. 2. University of Bern, Switzerland.
46. Global Environmental Facility (2003), Operational Program 15 on Sustainable Land Management.
47. Global Environmental Facility (2003), Operational Program 15 on Sustainable Land Management.
48. Godfray HCJ, Beddington JR, Crute IR, *et al*. 2010. Food security: the challenge of feeding 9 billion people. *Science* 327: 812 18.
49. Green, W. H. (2003). Econometric Analysis, 2nd Edition, New York, Macmillan.
50. Greene, H. W. (2003). Econometric Analysis: Pearson Education Inc. New York University.
51. Greene, W. H. (2000). Econometric analysis (International edition). New York University.
52. Greene, W.H. (2012). Econometric Analysis, 7th edition. Prentice Hall, Boston, USA.
53. Grepperud, S. (1996) Population pressure and land degradation: The case of Ethiopia. Journal of Environmental Economics and Management 30:18-33.
54. Gujarati, D.N. (2004). Basic Econometrics, 4th ed. McGraw-Hill, New York, 2007
55. Habtamu, E. (2006). *Adoption of Physical Soil and Water Conservation Structures in Anna Watershed, Hadiya Zone, Ethiopia*. (Masters ThesisAddis Ababa University, 2006).
56. Holden, S. T. and Shiferaw, B. 2002. Poverty and Land Degradation: Peasants' Willingness to Pay to Sustain Land Productivity. In C. B. Barrett, F. M. Place, and A.
57. Holden, S. T. and Shiferaw, B. 2004. Land Degradation, Drought and Food Security in a Less-favoured Area in the Ethiopian Highlands: A Bio-economic Model with Market Imperfections. *Agricultural Economics* 30 (1): 31-49.
58. Holden, S., B. Shiferaw, and J. Pender. 2005. *Policy analysis for sustainable land management and food security: a bio-economic model with market imperfections*. International Food Policy Research Institute Research Report No. 140. Washington, D.C.
59. Holden, S., S. Benin, B. Shiferaw, and J. Pender. 2003. Tree planting for poverty reduction in less-favoured areas of the Ethiopian highlands. Small-scale Forest Economics, Management and Policy 2(1), 63-80.
60. Hosmer, D., and S. Lemeshew, 1989. Applied Logistic Regression. A Wiley-Inter Science Publication. New York.
61. Hurni, H. 1988. Degradation and conservation of the resources in the Ethiopian highlands. Mountain research and development, vol. 8, Nos. 2/3, 1988, pp. 123-130,. University of Bern, Switzerland.
62. Hurni, H.,.1996. with the assitance of an international group of contributers,. Precious Earth:

From Soil and Water Conservation to Sustainable Land Management. International Soil Conservation Organization (ISCO), and Center for Development and Environment (CDE), Berne, Switzerland.
63. IFAD. 2011. Rural poverty report. New realities, new challenges: new opportunities for tomorrow's generation. Rome, International Fund for Agricultural Development.
64. IPCC. 2007. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 8-Agriculture. Climate Change 2007:Mitigation. Cambridge, United Kingdom and New York, NY, USA Cambridge University Press.
65. Kassie, M., & Holden, S. (2007). Sharecropping efficiency in Ethiopia: threats of eviction and kinship. Agricultural Economics, 37(2-3), 179-188.
66. Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: evidence from rural Tanzania. Technological forecasting and social change, 80(3), 525-540.
67. Kassie, M., Shiferaw, B., &Muricho, G. (2011). Agricultural technology, crop income, and poverty alleviation in Uganda. World Development, 39(10), 1784-1795
68. Kidane G. 2001. Factors Influencing the Adoption of New Wheat Verities, in Tigray, Ethiopia: the Case ofHawizen District. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University.164p.
69. Kidane T. 2008. Determinants of Physical Soil and Water Conservation Practices: The Case of Bati District, Oromyia Zone, Amhara Reion, Ethiopia. M.Sc. Thesis Presented to the School of Graduates of AlemayaUniversity, Alemaya. 162p.
70. Kirubel M, Gebreyesus B. 2011. Impact assessment of soil and water conservation measures at Medegowatershed in Tigray, northern Ethiopia. *Maejo International Journal of Science and Technology. 5*(03): 312-330.
71. Lal, R., & Stewart, B. A. (Eds.). (2013). Principles of Sustainable Soil Management in Agroecosystems (Vol. 20). CRC PressILlc.
72. Lal, R., Safriel, U., & Boer, B. (2012). Zero Net Land Degradation: A New Sustainable Development Goal for Rio+ 20. [A report prepared for the Secretariat of the United Nations Convention to Combat Desertification].
73. Mahmud Yesuf and J. Pender. 2005. Determinants and Impacts of Land Management Technologies in the Ethiopian Highlands: A Litreature Review. EDRI/EEPFE. Addis Ababa, Ethiopia.
74. Mahmud Yesuf, AlemuMekonnen, Menale Kassie, and J. Pender. 2005. Cost of Land Degradtion in Ethiopia: A Critical review of Past Studies. EDRI/EEPFE. Addis Ababa, Ethiopia.
75. Million Alemayehu. 1992. The Effect of Traditional Ditches on Soil erosion and Production. Research Report 22. Soil Conservation Research Project. University of Bern. Bern, Switzerland.
76. Million Alemayehu. 2003. Characterization of Indegenous Stone Bunding*(Kab)* and its Effect on Crop Yield and Soil Productivity at Mosobit-Gedeba, Sorth Shewa Zone of Amhara Region. MSc Thesis. Alemaya University. Alemaya, Ethiopia.
77. Million T, Belay K. 2004. Factors influencing adoption of soil conservation measures in southern Ethiopia: TheCase of Gununo Area. *Journal of Agriculture and Rural Development in the Tropics and Subtropics,* 105 (1): 49-62
78. Million Taddesse and Belay Kassa. (2007). Factors influencing adoption of soil conservation measures in southern Ethiopia: The Case of Gununo Area. *Journal of Agriculture and Rural Development in the Tropics and Subtropics* 105(1): 49-62
79. Nkonya E. (2002). Soil conservation practices and non-agricultural Land use in the south western highlands of Uganda. A Contribution to the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission.
80. Nkonya E., D, Phillip, E. Kato, B. Ahmed, A. Daramola, S. B., Ingawa, I. Luby, E.A. Lufadeju, M. Madukwe, and A.G. Shettima. 2012. Medium-term impact of Fadama III project. IFPRI mimeo.
81. Nkonya E., P. J., Kaizzi C., Kato Edward K., Mugarura S., 2005. Policy options for increasing crop productivity and reducing soil nutrient depletion and poverty in Uganda. Submitted to EPTID to be considered as Discussion Paper Publication
82. Nkonya, E. M., Pender, J. L., Kaizzi, K. C., Kato, E., Mugarura, S., Ssali, H., &Muwonge, J. 2008. Linkages between land management, land degradation, and poverty in Sub-Saharan Africa: The case of Uganda (No. 159). International Food Policy Research Institute (IFPRI).
83. Nkonya, E., Gerber N, Baumgartner P, von Braun J, De Pinto A, Graw V, Kato E, Kloos J, Walter T. 2011. The Economics of Land Degradation: toward an integrated global assessment, Development Economics and Policy Series vol. 66, Heidhues F, von Braun J and Zeller M (eds), Frankfurt A.M., Peter Lang GmbH.
84. Nkonya, E., J. Pender, D. Sserunkuuma, and P. Jagger. (2002). Development Pathways and Land Management in Uganda. In *Policies for Sustainable Land Managementin the East African Highlands*, edited by S. Benin, J. Pender and S. Ehui. Washington, D.C. and Nairobi, Kenya: International Food Policy Research Institute and International Livestock Research Institute.

85. Nkonya, E., Von Braun, J., Mirzabaev, A., Le, Q. B., Kwon, H. Y., &Kirui, O. (2013). Economics of Land Degradation Initiative: Methods and Approach for Global and National Assessments (No. 158663).
86. Pender J. (2002). Overview of Findings and Implications. In Policies for Sustainable Land. Washington, D.C. and Nairobi, Kenya: International Food Policy Research Institute and International Livestock Research Institute.
87. Pender, J. 2004. "Development pathways for hillsides and highlands: some lessons from Central America and East Africa". Food Policy. 29: 339-367.
88. Pender, J. and B. Gebremedhin. 2004. Impacts of policies and technologies in dryland agriculture: evidence from northern Ethiopia. In: S.C. Rao (Ed.), *Challenges and Strategies for Dryland Agriculture*, American Society of Agronomy and Crop Science Society of America, CSSA Special Publication 32, Madison, WI.
89. Pender, J. and B. Gebremedhin. 2006. Land management, crop production and household income in the highlands of Tigray, northern Ethiopia. In: Pender, J.,Place, F., and Ehui, S. (eds.), *Strategies for Sustainable Land Management in the East African Highlands*. IFPRI, Washington, D.C. In press.
90. Pender, J., B. Gebremedhin, S. Benin and S. Ehui. 2001. "Strategies for sustainable development in the Ethiopian highlands". American Journal of Agricultural Economics. 83(5): 1231-40.
91. Pender, J., B. Gebremedhin, S. Benin and S. Ehui. 2001. Strategies for sustainable development in the Ethiopian highlands. *American Journal of Agricultural Economics* 83(5): 1231-40.
92. Pender, J., E. Nkonya, P. Jagger, D. Sserunkuuma, and H. Ssali. 2004b. "Strategies to increase agricultural productivity and reduce land degradation: evidence from Uganda". Agricultural Economics. 31(2-3): 181-195.
93. Pender, J., P. Jagger, E. Nkonya and D. Sserunkuuma. 2004. "Development pathways and land management in Uganda". World Development. 32(5): 767-792. *Philosophical Transactions of the Royal Society B: Biological Sciences, 365* (1537), 61 – 71.
94. Pretty J, Toulmin C, and Williams S. 2011. Sustainable intensification in African agriculture. *Int J Agr Sustain* **9**: 5–24. Pretty JN. 1997. The sustainable intensification of agriculture. *NatResour Forum* **21**: 247–56.
95. Seid H. 2009. Determinants of Physical Soil and Water Conservation Practices: The Case of Bati District,Oromyia Zone, Amhara Reion, Ethiopia. M.Sc. Thesis Presented to the School of Graduates of AlemayaUniversity, Alemaya. 162p.
96. Sonneveld, B. G. J. S. 2002. Land Under pressure: The Impact of Water Erosion on Food Production in Ethiopia. Shaker Publishing (PhD disertation). Netherlands. *State.* In: Tilahun Amede (ed.) *Proceeding of a Conference on Natural Resource Degradation and Environmental Concerns in the Amhara National Regional State: Impact on Food Security*. P. 109-125, Bahir Dar, Ethiopia.
97. Sutcliffe, J. P. 1993. Economic assessment of land degradation in the Ethiopian highlands: a case study. Addis Ababa: National Conservation Strategy Secretariat, Ministry of Planning and Economic Development, Transitional Government of Ethiopia.
98. Tamene L, Park SJ, Dikau R, Vlek PLG (2006). Reservoir siltation in the semi-arid highlands of northern Ethiopia: sediment yield-catchment area relationship and a semi-quantitative approach for predicting sediment yield. Earth Surface Process. Landforms 31(11):1364-1383.
99. Tenge, A. J., De Graaff, J. and Hella, J. P. (2004). Social and Economic Factors Affecting the Adoption of Soil and Water Conservation in West Usambara Highlands, Tanzania. *Land Degradation and Development,* 15: 99–114
100. TerrAfrica. (2006). Assessment of the Nature and Extent of Barriers and Bottlenecks to Scaling Sustainable Land Management Investments throughout Sub-Saharan Africa. Unpublished TerrAfrica report.
101. TerrAfrica. 2006. Assessment of the Nature and Extent of Barriers and Bottlenecks to Scaling Sustainable Land Management Investments throughout Sub-Saharan Africa. Unpublished TerrAfrica report.
102. Tesfa, A., &Mekuriaw, S. (2014). The Effect of Land Degradation on Farm Size Dynamics and Crop-Livestock Farming System in Ethiopia: A Review. Open Journal of Soil Science, 4, 1.
103. Teshome A, Rolker D, de Graaff J (2012). Financial viability of soil and water conservation technologies in northwestern Ethiopian highlands. Appl. Geogr. 37:139 -49
104. Troeh FR, Hobbs AJ, Danahue RL (1980). Soil and water conservation for productivity and environmental protection. Prentice-hall, Inc., Englewood Cliffs. pp.718.
105. Wagayehu B, Drake L (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. Ecol. Econ. 46 (3):437-451.
106. WOCAT. 2011. "Database on SLM Technologies." Retrieved August, 2016, from http://www.wocat.net/.
107. Woldeamlak B (2006). Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: acceptance and

adoption by farmers'. Land Use Policy 24(2):404-416.

108. Woldeamlak B, Sterk G (2003). Assessment of soil erosion in cultivated fields using a survey methodology for rills in the Chemoga watershed, Ethiopia. Agric. Ecosyst. Environ. 97:81-93.
109. Woldeamlak, B. (2003). *Land Degradation and Farmers' Acceptance and Adoptionof Conservation Technologies in the Degil Watershed, Northwestern Highlands of Ethiopia,* Social Science Research Report Series no.29, OSSREA, Addis Ababa.
110. Woodfine, A. 2009. The Potential of Sustainable Land Management Practices for Climate Change Mitigation and Adaptation in Sub-Saharan Africa. Rome, Food and Agriculture Organization of the United Nations.
111. World Bank (2007). *Ethiopia: Accelerating Equitable Growth Country Economic Memorandum Part II: Thematic Chapters.* Poverty Reduction and Economic Management Unit; Report No. 38662-ET
112. World Bank (WB). 2012. Managing land in a changing climate: an operational perspective for Sub- Saharan Africa. Draft version Report No.: 54134-AFR. WB, Washington D.C.
113. World Bank. (2010). Managing land in a changing climate: an operational perspective for Sub- Saharan Africa. Draft version Report No.: 54134-AFR. WB, Washington D.C.

This page is intentionally left blank

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Determinants of Adoption of Sustainable Land Management (SLM) Practices among Smallholder Farmers' in Jeldu District, West Shewa Zone, Oromia Region, Ethiopia

By Tesfaye Samuel Saguye
Ambo University

Abstract- Land degradation in form of soil erosion and fertility loss are ruthless problems in developing countries including Ethiopian Highlands, which have serious implications for food security and livelihoods of local farmers in particular and the nation in general. Low land productivity due to land degradation in form of soil erosion is one of the leading challenges to improving the performance of the smallholder farming system sector in Ethiopia. In this context, the adoption of Sustainable Land Management practices/ technologies is quite crucial to increase agricultural productivity, ensure food security and improve the livelihoods of smallholder farmers. Farmers recommend various SLM practices/technologies for sustainable implementation, but adoption of such agricultural land management practices/ technologies is still very low. There is no clear understanding of the problems encountered by farmers in the adoption of recommended SLM practices/ technologies.

Keywords: *sustainable land management practices, adoption, smallholder farmers'.*

GJSFR-H Classification: *FOR Code: 960999*

Strictly as per the compliance and regulations of :

Determinants of Adoption of Sustainable Land Management (SLM) Practices among Smallholder Farmers' in Jeldu District, West Shewa Zone, Oromia Region, Ethiopia

Tesfaye Samuel Saguye

Abstract- Land degradation in form of soil erosion and fertility loss are ruthless problems in developing countries including Ethiopian Highlands, which have serious implications for food security and livelihoods of local farmers in particular and the nation in general. Low land productivity due to land degradation in form of soil erosion is one of the leading challenges to improving the performance of the smallholder farming system sector in Ethiopia. In this context, the adoption of Sustainable Land Management practices/ technologies is quite crucial to increase agricultural productivity, ensure food security and improve the livelihoods of smallholder farmers. Farmers recommend various SLM practices/technologies for sustainable implementation, but adoption of such agricultural land management practices/ technologies is still very low. There is no clear understanding of the problems encountered by farmers in the adoption of recommended SLM practices/ technologies. Therefore, the main purpose of this study was to assess the socio-economic, institutional, psychological and biophysical determinant factors that influence adoption of SLM practices/technologies among smallholder farmers in Jeldu district in West Shewa zone. Primary data were collected through household questionnaires surveys, focus group discussions, key informants interviews and personal observations while secondary data were collected from relevant local authority reports and records. A total of 224 households were interviewed. Both Descriptive statistics, binary logistic regression model were used to analyze the data. The computed independent T-test for the mean income difference was statistically highly significance between adopters and non-adopters, suggesting that adopters were in better-off position to improve their livelihood. From the 18 explanatory variables entered into the model, 14 variables were found to be statistically significant at less than 5 to 10% probability levels. These are education level of the household head, farm size, perception of land degradation, effectiveness of SLM practices, frequency of development agent contact and livestock ownership significantly positively affect adoption o land management practices while distance to market affects it negatively at less 10% probability levels. Planners and policy makers should formulate appropriate policies and programs considering the farmers' interest, capacity, and limitation in promoting improved soil conservation technology for greater acceptance and adoption by the farmer.

Author: Department of Disaster Risk Management and Sustainable Development, Institute of Cooperatives and Development Studies, Ambo University, Ambo, Ethiopia. e-mail: gezegofa@gmail.com

Keywords: sustainable land management practices, adoption, smallholder farmers'.

I. Introduction

a) *Background and Justification of the study*

To feed the world's growing population which is projected to exceed 9.2 billion by 2050 (World Bank, 2009; FAO, 2013; Nkonya *et al*, 2011.), it will be necessary to boost the production of food. However, land degradation is extensively increasing, covering approximately 23% of the globe's terrestrial area, increasing at an annual rate of 5-10 million hectares, and affecting about 1.5 billion people globally (Gnacadja, 2012). Processes of land degradation occur in all climatic regions, with 'land' interpreted to include soils, vegetation, and water, and with the concept of 'degradation' implying adverse consequences for humanity and ecological systems (Conacher, 2009; Vlek *et al*., 2010; Braun *et al*., 2012; Pingali *et al*., 2014). Land consists of not only the soil but also the associated natural resources such as water, vegetation, landscape, and microclimate that are components of a larger ecosystem(Thompson *et al.,* 2009; Chasek *et al.,* 2011; Akhtar-Schuster *et al.,* 2011; Reed *et al.,* 2011).As the land is inter-connected with other natural resources such as the air, water, fauna and flora, managing land well, in addition to guaranteeing food supplies, poverty reduction and socio-economic protect environment and natural resources and to provide ecological functions and services in a sustainable manner(World Bank, 2003; Bridges and Oldeman, 1999; Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*. 2008; Stoosnijder, 2007; Nachtergaele *et al*. 2010; Lal and Stewart, 2013; Zuccaet *al.,* 2014).Land degradation often results from immediate causes such as biophysical causes and unsustainable resource management practices, or with underlying causes including population density, poverty, institutional set up, land tenure and access to agriculture extension, infrastructure, opportunities and constraints created by market access as well as policies and general government effectiveness (Nkonyaet *al*., 2011; Lambinet *al*., 2001).

Ethiopia's economy has its foundation in the smallholder agriculture. Land degradation is a major cause of Ethiopia's low and declining agricultural productivity, continuing food insecurity, and abject rural poverty (Pender and Hazell, 2000; IFAD, 2001; Shiferaw and Bantilan, 2004; (FAO, 2012).The productivity of agricultural economy, which is the backbone of the country's economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing lands (Leonard, 2003; Shiferaw and Holden 1998). At present extent and speed of land degradation, particularly due to soil erosion is distinguished as a serious threat to the viability of the subsistence agriculture in the country (Lakew*et al*., 2000; Le *et al*., 2014)). Its severity is explained by a decline in productivity, formation of rills and gullies in both farming and grazing lands through time (Stringer and Reed, 2007; Bai *et al*., 2008; Nachtergaele*et al*., 2010; Lal and Stewart, 2013; Zucca*et al.,* 2014).Although the country endowed with enormous biophysical potential, it has been affected by the interlinked and reinforcing problems of land degradation and extreme poverty (Teshome*et al*., 2014). This is further aggravated by high population pressure, climatic variability, top-down planning systems, lack of appropriate and/or poor implementation of polices and strategies, limited use of sustainable land management practices, limited capacity of planners, land users as well as frequent organizational restructuring (Tesfaye et al. 2013; Kassie *et al*., 2009; Tiwari *et al*., 2008; Bewket, 2007; Shiferaw and Holden 1998). There is evidence that these problems are getting worse in many parts of the country, particularly in the highlands (areas >1500m above sea level). Furthermore, climate change anticipated to accelerate land degradation in Ethiopia (Pender and Gebremedhin, 2007).

Recognizing the threat of land degradation, the government of Ethiopia has made several Natural Resource Management (NRM) interventions through various programmes such as productive safety net programme (PSFP),Food for Work programme and MERET and MERET PLUS Programme since mid-1970s and 80s (Aklilu, 2006;Shiferaw and Holden, 1998). As a result a range of land conservation practices, which include stone terraces, stone bunds, area closures, and other soil and water conservation technologies and practices have been introduced into individual and communal lands at massive scales. In 2008, Ethiopia launched Sustainable Land Management Programme (SLMP) in 36 woreda defined as the process of enhancing agricultural yields with minimal environmental impact and without expanding the existing agricultural land base (Tesfaye et al. 2013; Kassie et al. 2009; Tiwari *et al*., 2008; Bewket, 2007). The concept and definition of sustainability is broad and varies depending on the problems to be addressed. There is a need to give a clear working definition of sustainability in the context of our problem. WOCAT (2005), define Sustainable Land Management in more specific term as the use of both indigenous and introduced land management practices and technologies for agricultural and other purposes to meet human livelihood needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. In this regard, SLM is not only the use of physical SWC measures, which is a common mistake made by almost all actors in the country, but also includes the use of appropriate soil fertility management practices, agricultural water and rain water management, forestry and agroforestry, forage and range land management, and application of these measures in a more integrated way to satisfy community needs while solving ecological problems (Bridges and Oldeman, 1999; Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*., 2008; Stoosnijder, 2007; Lal & Stewart, 2013; Zucca*et al.,* 2014; Getee*t al.*, 2006). SLM is a combination of technologies, policies and activities integrating socio-economic and environmental concerns in order to reach simultaneously environmentally friendly, economic viable and socially acceptable production goals (Smyth and Dumanski, 1993; Hurni, 2000).

The downward spiral of land degradation and poverty cannot be reversed in a sustained fashion unless farmers adopt profitable and sustainable land management practices or pursue livelihood strategies that are less demanding of the land resource than current agricultural strategies (Berry *et al*., 2003; Jones *et al*., 2003; Stringer and Reed, 2007; Bai *et al*. 2008; Stoosnijder, 2007; Nachtergaele *et al*., 2010; Lal and Stewart, 2013; Zucca*et al.,* 2014). Adoption of sustainable land management (SLM) practices plays a critical role in achieving food security, household income and poverty reduction through reducing soil erosionand improving soil fertility. However, studies reveals that farmers adoption of SLM practices/ technologies at lower rate and more often they dis-adopt them (Aklilu and de Graaff, 2007 (Thompson *et al.,* 2009; Chasek*et al.,* 2011; Akhtar-Schuster *et al.,* 2011; Reed *et al.,* 2011; ELD Initiative, 2013). In most places, implemented SWCStructure was either totally or partially destroyed by farmers (Tesfaye *et al*. 2013; Kassie *et al*. 2009 and Tiwari *et al*., 2008 and Bewket, 2007). For instance, of the total conservation measures implemented between 1976 and 1990, only 30% of soil bunds, 25% of stone bunds, 60% of hillside terraces, 22% of the planted trees, and 7% of the reserve areas survived (TGE, 1994; Nurhussen, 1995). A recent survey in the Amhara region also showed that only 30% of the implemented soil and water conservation structures of the past two and half decades of conservation, work has survived (EPLUA, 2005). The above two survey results, however, should be seen in time context. Better land and water management and increased use of soil conservation practices could help to reverse soil degradation and boost crop yields, but in many parts of the country, these practices are not yet widely adopted. The adoption and investment in sustainable land management is crucial in reversing and controlling land degradation, rehabilitating degraded lands and ensuring the optimal use of land resources for the benefit of present and future generations (Akhtar-Schuster *et al*., 2011).

Despite on-going land degradation and the urgent need for action to prevent and reverse land degradation, the problem has yet to be appropriately addressed, especially in the developing countries, including in Eastern Africa. Identifying the determinants of SLM adoption is a step towards addressing them (Braun, *et al*., 2012). There is an urgent need for evidence-based economic evaluations, using more data and robust economic tools, to identify the determinants of adoption as well as economic returns from SLM (Tesfaye *et al*. 2013; Kassie *et al*. 2009; Tiwari *et al*.2008; Bewket, 2007). One size- fits-all approaches will not solve land management problems in the heterogeneous environment of the Ethiopian highlands (Brown *et al*., 2006; Fensholt and Proud, 2012; Beck *et al*., 2011).The growing consensus appears to be that many past soil conservation programs were disappointing for a number of reasons: they used a flawed "environmental narrative" to promote large-scale, top-down interventions; gave inadequate consideration to farmers' perspectives, constraints, and local conditions; provided limited options to farmers; and in some contexts promoted options of very limited profitability (Shiferaw and Holden, 1999; Keeley and Scoones, 2000; Dejene 2003; Rahmato, 2003; Bekele, 2004).Implementation of SLM should be seen within the specific local context.

Given this state of conditions, analysis of the issue of what specifically determines the decision taken by farmers to adopt SLM practices/technologies is very important and relevant to formulate policy options and support systems that could accelerate use of soil conservation technologies (Stoosnijder, 2007; Lal &Stewart, 2013; Zucca *et al.,* 2014). To ensure sustainable adoption and implementation of SLM practices and beneficial impacts on productivity and other outcomes, rigorous empirical research needed on where particular SLM interventions are likely to be successful(Brown *et al*., 2006; Fensholt and Proud, 2012; Beck *et al*., 2011). For a better understanding of the barriers faced by households when deciding to adopt SLM practices more detail context specific household-level studies focusing on the barriers of SLM practices adoption by farmers needed (Carthy, 2011; Tesfaye*et al*. 2013; Kassie et al. 2009; Tiwari et al.2008; Bewket 2007; Shiferaw and Holden 1998). An available evidence shows that studies on the determinants of adoption of SLM practices among smallholder farmers are few and far below adequacy. Therefore, this study conducted in view of bridging this gap. It intends to add to the stock of knowledge on the factors that determine farmers' decision to implement certain sustainable land management practices. The general objective of this study was to assess the determinant of adoption of SLM practices/technologies among smallholder farmers' in Jeldu district in West Shewa zone of Oromia regional state, Ethiopia. So, this study is significant in that the identification of context based determinant factors of adopting sustainable land management practices will inform decision makers to design context-specific socio-economic, biophysical ,institutional and demographic context based SLM technologies/ practices and avoids " one size fits to all" problem of the previous top down approaches. Such knowledge is important to guide policy makers and development agencies in crafting programs and policies that can better and more effectively address land degradation in Ethiopia.

II. Theoretical Framework of the Study

There are many perspectives involved in understanding farmers' views as to how and why they make decisions on whether or not to adopt the improved technology for soil conservation. There are many complexities and regional variations in biophysical and socio-cultural factors so that conclusions drawn based on the condition of one area cannot necessarily be replicated in another area (ICIMOD, 1995; Thompson and Warburton, 1985). Adoption of agricultural technologies is affected by various factors, usually categorized into; farm specific characteristics, technology specific attributes, and farmer's socioeconomic characteristics. Examples of such variables that have been found to influence technology adoption include: farm size, farmer's age, education, social networks (e.g. membership of association), dependency ratio, gender, access to agricultural advice and information, land tenure security, soil fertility, soil type, income, input availability, access to markets, risk aversion behavior, technology awareness, farming experience, adequacy of farm tools, technical and economic feasibility of using the technology, agro-ecological conditions, access to credit and presence of enabling policies(Feder et al., 1985; Boyd and Turton, 2000; Olwande *et al*., 2009). Some of these factors increase adoption; others reduce adoption; while others have mixed effects,

Adoption of conservation technology should not be regarded as an end in itself, but rather as a continuous decision-making process. Individuals pass through various learning and experimenting stages from awareness of the problem and its potential solutions and finally deciding whether to adopt or reject the given technology. Adoption of new technology normally passes through four different stages, which include awareness, interest, evaluation, and finally adoption

Global Journal of Science Frontier Research (H) Volume XVII Issue I Version I Year 2017

(Rogers and Shoemaker 1971). At each stage, there are various constraints (social, economic, physical, or logistical) for different groups of farmers. In Ethiopia, the adoption of improved soil conservation technology has been very low at farm level and it is apparent that there is gaps between what technicians see as necessary and what the farmers are prepared to do in the field (Paudel and Thapa 2001). Adoption behavior is complex and often requires a blend of income, profit, and institutional support (Ervin and Ervin 1982; Feder and Umali, 1993)

Farmers' adoption of SLM Practices is determined by interactive effects of household socio economic characteristics, resource availability, physical characteristics of the land and institutional support provided by the public or NGO sector (Garcia 2001; Mbaga-Semgalawe and Folmer, 2000; Paudel and Thapa, 2004). It is important to understand the relationship between these factors and the process of adoption of new technology to improve farm production and sustainable land management. It is assumed that the farmers will compare the advantages and appropriateness of different soil conservation technologies, based on the available resources at their disposal and their opportunity for profit. Therefore, the conceptual framework of the adoption of SLM practices in this article is based on the principal of absolute and comparative advantage to farmers in combination with some influence of the personal, socio-economical, institutional, and biophysical factors. The empirical binary logistic regression model used in this study explains the factors that influence the decision of farmers to adopt or not adopt improved soil conservation technologies.

III. Methodology of the Study

a) *Description of the Study Area*

The study was conducted at Jeldu district, West Shewa zone, Central Ethiopia, which is delineated by Meta Robi, Dendi and Ejere *Woredas* in East, Gindeberet *Woreda* in West, Abuna Gindeberet *Woreda* in North and Eliphata *Woreda* in South. The area has a bi-modal rainfall pattern with two distinct rainy and cropping seasons. The main rainy season (*meher*), which is also the main cropping season, extends from June to September. The short rainy season, known as "*belg* rain", usually covers the period from February to April. The mean annual rainfall of the area ranges from1800 to 2200 mm. The maximum and minimum temperature of the area ranges from 17 to 22ºC. The farming system of the area is mainly rain-fed. The soil type is characteristic of clay and clay-loam type, but the riverbed has a loam and sandy-loam type of soil (Dereje, 2010). *Eucalyptus globules* are the main tree planted in the area. It has an area of 139, 389 hectares. Undulating slopes divided by V-shaped valleys of seasonal and/or relatively permanent streams characterize the topography of the study area. Steep slopes are found along the valley sides, where slopes greater than30% is very common. The district is characterized as a mixed crop livestock production system. Land preparation mainly done by ox-drawn plough. The main crops grown in the study areas include wheat (*Triticumaestivum*), teff (*Eragrostistef*), broad bean (*Viciafaba*), barley (*Hordeum vulgare*) and potato (*Solanum tuberosum*).Soil erosion in the area is mainly attributed to the steep slopes, population pressure, deforestation, poor farming methods and vulnerable soils. However, the major factor fuelling soil erosion on the steep slopes is that farmers are increasingly destroying contour bunds on terraces to pave way for more farmland. As a result, soil erosion has been accelerated which in periods of heavy rainfall results in silting and flooding of the valley-bottom fields and landslides are becoming very common.

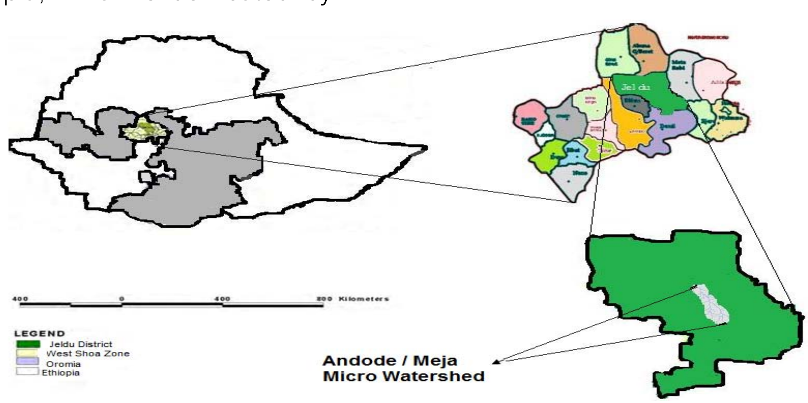


Figure 1: Map of the Study Area

b) *Data Collection Techniques and Instruments Adopted*

Data for the study was collected from both primary and secondary sources. Primary data collected by employing household questionnaire survey, focus group discussion, field observation, and key informant interview to bring the study to realization. Information about personal characteristics of the household head, the knowledge of SLM practices/ technologies, the resource endowment of farmers, farm management practices, cropping patterns, crop yield, role of different institutions to improve farming, and adoption of improved and indigenous soil conservation technologies, such as the construction of check dams, terrace improvement, terrace bunds, hedge management, retention walls, waterways, and mulching, were collected through individual interviews by using a semi- structured questionnaire. Pilot-tests of questions were made by distributing questionnaire to five farmers in each site to assess whether the instruments were appropriate and suited to the study at hand. Necessary adjustments were made based on the comments obtained from pre-test responses from farmers to ensure reliability and validity. Data collectors were trained with respect to the survey techniques and confidentiality issues. Additional qualitative information, such as changes in soil conservation practices and cropping patterns over time, adoption of indigenous and improved soil conservation technologies, role of local level institutions in the promotion of SLM technologies/practices were collected through six focus group discussions, 12 key informant interviews, and through observation of the watershed. Focus group discussions were conducted with 8 to 10 farmers in each group. Audiocassettes were used to record the focus group discussions and key informant interviews. A secondary data source includes journal articles, research reports and other publications, including internet sources of information.

c) Sampling Design of the Study

In this study, a multi-stage sampling procedure employed. First, Jeldu district was purposively selected because; the district is one of severely affected areas by land degradation (Brihanu, 2011).The district is highly vulnerable to land degradation in particular soil compaction, deforestation and environmental degradation. Second, four *kebele (Edensa Galan, Seriti, KoluGalal and Chillanko)* were randomly selected from the existing 38 *kebeles (lowest administrative unit in Ethiopia)*. Thirdly, the sample respondent households were selected by simple random technique. The sample size of the study determined by using Gujarati sample size determination formula (Gujarati, 2004). Accordingly, 224 sample households from the selected *kebeles* drew using simple random sampling technique for the household questionnaire survey. The random selection of households based on the list of household heads found in each kebeles and proportional to the size population.

d) Methods of Data Analysis

i. *Descriptive Analysis Techniques*

Data were analyzed through generation of descriptive statistics and estimation of double-hurdle models. Descriptive static techniques such as percentages, means, standard deviations and frequency counts, tables were generated for general information, t-tests were applied to compare the mean differences between adopters and non adopters, chi-square tests were applied to analyze categorical data, correlation and cross tabulation method were used to identify inter-dependence among various factors influencing the adoption of soil conservation technology. T-test was run to see if there is statistically significant difference in continuous variables of farm characteristics of household who have adopted introduced soil and water conservation practices and those have not done so. The chi- square was used to see if there is systematic association between decision on the use of introduced soil and water conservation practices and with some of the independent variables, for categorical data.

ii. *Binary Logistic Regression*

Binary logistic regression model was developed to assess the personal, social, economic, institutional, and bio-physical cal factors influencing the adoption of ISCT in this study (Agresti, 1996). The Binary Logit Model was applied in this study to assists in estimating the probability of decision on the use of introduced soil and water conservation practices that can take one or more of practices or do not practiced the technologies. In the study area farmers practice improved and traditional physical soil and water conservation structures. There are also non-adopters of these improved soil and water conservation measures. A logistic regression mode was developed to explore the personal/social, economic, institutional, and geographical factors influencing the adoption of SLM in this study. A regression model, and its binary outcomes, helps the researcher to explore how each explanatory variable affects the probability of the occurrence of events (Long andFreese, 2006). This model helps to explore the degree and direction of the relationship between dependent and independent variables in the adoption of improved soil conservation technology at the household level. The logistic regression model is an appropriate statistical tool to determine the influence of independent variable son dependent variables when the dependent variable has only two groups. In the logistic model, the coefficients are compared with the probability of an event occurring or not occurring and bounded between 0 and 1 (Sheikh, 2003). The dependent variable becomes the natural logarithm of the odds when a positive choice is made. The odds ratio and predicted probability of the independent variables indicate the influence of these variables on the likelihood of adoption of improved technology if other variables remain the same. Hence, if the estimated values of these variables are positive and significant, it implies that the farmers with higher values for these variables are more likely to adopt improved soil conservation technology

$$P_i = \frac{1}{1+e^{-Z_i}} \qquad (1)$$

Where P (i) is a probability of adopting a given practice for ith farmer and Z (i) is a function of m explanatory variables (Xi), and is expressed as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + - - - + \beta_m X_m \qquad (2)$$

Where,

B_0 Is the intercept and βi are the slope parameters in the model. The slope tells how the Log-odds in favor of adopting soil conservation practices change as independent variables change by a unit. Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds (Hosmer and Lemeshew, 1989.)Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds. The odds to be used can be defined as the ratio of the probability that a farmer uses or adopts the practice P_i to the probability that he or she will not $Pi-1$

But,

$$1\text{-}P_i = \frac{1}{1+e^{-z_i}} \qquad (3)$$

Therefore,

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z(i)}}{1+e^{-Z_i}} = e^{Z_i} \qquad (4)$$

And

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z(i)}}{1+e^{-Z_i}} = e^{\beta_0} + \sum_{i=1}^{M} \beta_i X_i \qquad (5)$$

Taking the natural logarithm of the odds ratio of equation (5) will result in what is known as the log it model as indicated below:

$$L_n[\frac{P_i}{1-P_i}] = L_n[e^{\beta_0 + \sum_{i=1}^{M} \beta_0 X_i}] = Z_i \qquad (6)$$

If the disturbance term Ui is taken in to account the log it model becomes:

$$Z_i = \beta_0 + \sum \beta_0 X_i + U_i \qquad (7)$$

Hence, the above econometric model was used in this study and was treated against potential variables assumed to affect the farmer decision of soil conservation practices. The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. The later yields unbiased and asymptotically efficient and consistent parameter estimates. Therefore, the above econometric model was used in this part of the study to identify determinant variables that influence adoption practices of land management in the study area.

Definition of Variables and Working Hypothesis

1. *Dependent Variable:* The dependent variable for the adoption model indicates whether a household has adopted SLM practices (''adopt'' versus ''not-adopt''). Therefore, in this study adopters are households who adopted at least one of these practices while non-adopters are those who did not adopt any of these land management practices.SLM technologies/practices include adoption of improved terraces, hedge plantation, construction of check dams and terrace bunds, whereas indigenous technologies include mulching, slope terraces, retention walls, plantation of shrubs and trees at the edge of farm terraces, diversion drains, and waterways. Improved and indigenous SLM practices were identified based upon field observation and discussion with farmers. In this study, a farmer who has adopted at least one improved soil conservation technology, either as recommended by extension workers or with some modification, was defined as adopter. A value of ''1'' was assigned to all households who adopted at least one improved SLM practices (the 'adopters'') and ''0'' was assigned to households using only indigenous SLM practices (the ''no adopters'').Whether or not to adopt any SLM practices is determined by personal, social, economic, institutional, and geographical factors. These variables we retreated as explanatory variables in this study.
2. *Selection of Explanatory Variables and Expected Impact on Adoption:* Adoption of SLM practices/technologies in the study area is a complicated process similar to the other research in agriculture technology adoption (Doss 2006; McDonald and Brown 2000) that may be influenced by a set of interrelated personal, social, economical, institutional, and biophysical factors (Table 1).

Table1: Definition of all the explanatory variables used in the model

Variable		Description
Adoption		A value of ''1'' was assigned to all households who adopted at least one improved SLM practices (the ''adopters'') and ''0'' was assigned to households using only indigenous SLM practices (the ''no adopters'').
Demographic factors	Age	Age of the household head in years
	Hhsize	Number of people in the household
	Eduction	Literacy of the household head; 1if literate and 0 otherwise
	Sex	Gender of the household head; 1if male and 0 otherwise
	Family-Labour	Potentially available family labour force
Institutional factors	Tenure	Whether a farmer perceives a risk of loss of land in the future; 1 if he/she perceives 0 otherwise
	Membship	Membership in local organizations; 1if a farmer is a member and 0 otherwise
	Training	Whether training about SLM practice received by the farmer; 1 if a farmer got training and 0 otherwise
	Credit Access	Whether a farmer needed credit and was able to get it; 1 if he/she accessed 0 otherwise
	Extension Visits	Number of extension visits received
Physical Factors	Fmsize	The size of the farm, in hectares
	Distance	Average distance of a plot from homestead, in minutes
	Slope	Slope of the plot; 1 if steep and 0 otherwise
Economic Factors	Offincom	Whether a farmer engaged in off-farm employment, 1 if a farmer has off-farm employment and 0 otherwise
	Total Income	Estimated average income earned annually
	Livestock	Number of livestock's in TLU
Attitudinal Factors	Perceptdegradation	whether a farmer perceives land degradation as a problem; 1 if farmer had perceived land degradation as a problem and 0 otherwise
	Perceptslm	whether a farmer anticipates introduced structures effective in retaining soil from erosion; 1 if a farmer anticipates soil retention due to structures and 0 otherwise

IV. Result and Discussion

a) *Descriptive Statistics*

In order to investigate the presence of group means difference with respect to the hypothesized socio-economic, biophysical and institutional factors uni-variate tests were used. Student's t-test and Chi-square test were used, respectively to identify potential continuous and dummy variables differentiating adopters from non- adopters. Adopters and non-adopters significantly different in three of the nine hypothesized continuous socio-economic variables (Table 2).The survey results showed that landholding size of total sample households ranges from 0.125 to 4.00 ha with a mean of 1.29 and standard deviation of 0.79 ha. The average landholding size of adopters and non-adopters were 1.54 and 1.27 ha with a standard deviation of 0.99 and 1.05, respectively. There was a slight difference in the mean size of landholding between the two groups. However, the result of t-test showed that the mean landholding size difference between the two groups was significant. Land is one of the most important production factors for agricultural production. In rural households, in the study area land and labor account for the largest share of agricultural inputs. Hence, the quality and quantity of land available for farm households largely determine the amount of production.

Table 2: Continuous variables differentiating adopters from non-adopters of SLM practice/ technologies among 224 sample households

Variables	Adopters		Non-adopters		*t-value*
	Mean	Standard Deviation	Mean	Standard Deviation	
Household Size (in number)	6.4	1.7	6.7	1.8	0.232
Age of household head (in years)	51.5	14.4	49.05	13.76	-0.36
Education status of household head (in years)	3.1	1.06	3	0.99	3.46**

Land holding size (in hectares)	1.54	0.99	1.27	1.05	2.251**
Farming Experience (in years)	27	13.42	24	11.87	0.232
Distance of plots from residence (in Kms)	0.57	0.221	0.68	0.46	0.96
Off-farm income (in ETB)	452.5	123.67	376.42	99.56	0.87
Livestock holdings (in TLU)	3.45	1.02	3.04	1.20	2.86**
Extension contact(in number)	1.02	0.76	0.98	0.78	1.98*
Size of labour force	3.02	1.66	2.96	1.54	3.65**

***indicates Significant at 10%and 5% probability level respectively*

Livestock is an important component of the farming system in the study area. A vast majority of the sample households included in this survey own animals of different kind. Cattle, donkeys, horse sheep, goats and chicken are common domestic animals. Small ruminants and chickens were sold and serve the purpose of immediate cash needs at times of cash shortage. The size of livestock owned indicates the wealth status of the household. The average size of livestock in TLU was found to be 3.45, 3.79 and 3.04 for total sample households, SLM adopters and non-adopters with a standard deviation of 1.02, and 1.2, respectively. About 33% of total sample household heads has more than five TLU sizes of livestock. The t-test revealed that there is significant difference in the number of oxen owned by farmers who have adopted SLM practices and those who have not.

The number of labour force available in the family is assumed to influence decision of farmers to adopt SLM practices. Families with large household members will be able to supply the extra-labour that could be required for adoption and continuous implementation SLM activities. In addition, the result of t-test revealed that there was significant difference in the mean size of labour force between adopters and non-adopters. The average available labour was calculated to be 2.95person per day for total sample households, 3.02person per day for users and 2.96person per days for non-users, with a standard deviation of 1.68, 1.66, and 1.54, respectively.

In the study area, the most important sources of information cited were through communication with relatives and neighbors, community leaders, and the government's mainstream agricultural extension program. Farmers' pointed out the governments' extension service as the most important one. In addition, they further revealed that information about input supply and use, land management practices; improved cultural practices and soil conservation practices are among the aspects covered by the extension services. Access to extension service is very important element of institutional support needed by farmers to enhance the use of agricultural technologies in general and soil conservation technologies in particular. Three Development Agents (DA's) were assigned in each sample *kebeles*. It was expected that sample farmers in the study area have an access to extension services through the DAs, attending field days and training. However, about 22% of users, 43% of non-adopters have reported that they did not get extension services (visits) in the year 2015/016. Development agents had visited about 56% of sample households from one to three times per month. The average monthly frequency of extension services/visits/ was found to be 0.97 and 0.70 for users and non-users with a standard deviation of 0.80 and 0.83, respectively. The mean monthly extension visit difference of the two groups was found to be statistically significance.

b) Descriptive Statistics of Categorical Variables

Generally, adopters and non-adopters not only vary in terms of quantitative variables but also in terms of qualitative variables. It was, therefore, quite essential to use a method of testing the differences between adopters and non-adopters.

Table 3: Dummy variables differentiating SLM adopters from non-adopters of SLM practices among 224 sample households

Variable	Score	Adopter	Non-adopter	Total	X^2
Sex	0	37	47	84	8.65***
	1	64	76	140	
	0	17	32	49	6.25***
Perception	1	102	73	175	
Degree of slope of the plot	0	34	52	85	1.34
	1	77	62	139	
Access to credit service	0	87	22	109	7.05***
	1	88	27	115	
Land certification	0	33	37	70	9.63***
	1	98	56	154	
Prior public conservation campaign	0	56	62	118	
	1	72	34	106	1.02

****: significant at <1 probability level.*

From the total 224 sample household heads, 84 (37.5%) were men's and 140(62.5%) were men's respectively (Table 3). The majority of adopters of the SLM Practices (63.36%) were male-headed households while only 36.63 % were female-headed households. Chi-square test results show that there is a statistically significant difference between adopters and non-adopters in terms of sex of the household heads at 10% probability level.

Overwhelming majority of farmers disclosed that their land productivity is declining with each passing year due to soil erosion. Farmer's perception about the existence of land degradation problem on their farm plots, causes of the problems as well as its consequences might make farmers to adopt and continuously implement SLM measures. The majority of the sample household heads (78.12%) have perceived the problem of soil erosion on their farm plots. From this, only 58.28 % of households adopted SLM practices/ technologies at least in one of their plots. This can imply that perceiving the problem of land degradation problem is cannot always be a guarantee for adoption of SLM practices/ technologies. The difference between the two groups with respect to perceiving the existence of land degradation on farm plots was statistically significant.

In the study area, it was found that only 51.34 % of the respondents have reported obtaining credit at least once since the last five years. Whereas, 48.66 % of respondents have not obtained credit from formal sources. When the data analyzed by disaggregating into adopters of SLM practices and that of non-adopters, it was assured that 79.81% of those who were adopted and continuously practiced SLM practices have obtained credit, but only 20.18% has got credit from those non-adopters. The Chi-square analysis disclosed that there is a significant association between access to credit service and adoption of SLM practices and it is significant at 10% level of significance. This could prove that farmers who have access to credit have a higher probability of adopting and retaining SLM practices/technologies than those with no access.

c) Smallholder Farmers' Status of Adoption of SLM Practices/Technologies

Long-term productivity and sustainability of the land resource requires sound land conservation measures in the farming systems that enhance maintenance and/or improvement of soil and land quality in general. This is an important consideration as it influences agricultural productivity and local livelihoods. In many instances, environmental degradation has stimulated a variety of responses and adaptation mechanisms by local communities. This study made an enquiry on whether farmers had undertaken any deliberate efforts to protect their land holdings from soil degradation. Majority of respondents (63.75 %) indicated to have used one or more SLM Practices in their farms as a means of adjusting and adapting to land degradation processes. Graph2 presents the various SLM practices as mentioned by the interviewed farmers.

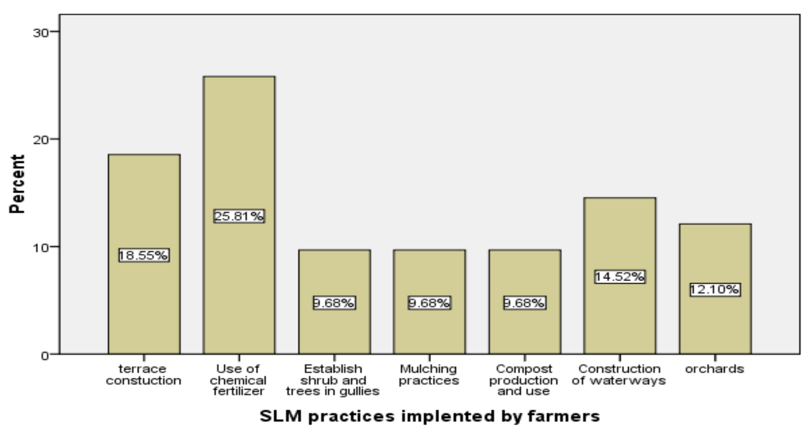


Figure 2: SLM practices implemented by farmers in the study area

d) Farmers perceived Constraints of adoption of SLM Practices

In previous discussions, it was indicated that land degradation in the study area has been the major problem farmers faced with. In addition, the initiatives taken to tackle the problem and efforts have been end up with mixed results of both success and failure. In terms of problems with the conservation activity, about 56.24% of the respondents complained that they face problems in putting up conservation structures. Only 23% of the respondents do not encounter any problem. The most important problem mentioned by the respondents was conservation practices compete for labor that could have allocated for other activities. Local people will not convert their terraces into more permanent terraces because they perceive that the SLM Practices would be too labour intensive to maintain (it would involve digging residues into the soil twice annually rather than pulling soil down slope to bury them). With significant rates of out-migration, labour can hardly be said to be a constraining variable to land improvement— thus returns to labor, as outlined above, must be regarded as more significant. Land shortage was also another main reason that people cited for being unable to implement erosion prevention methods (27%) as trees and terraces both absorb land and trees further shade crops. Among institutional factors, low credit availability and access (62%) and lack of community participation before farmers applying introduced SLM practices (78%) were mentioned by the majority. In addition, the presence of different drawback associated with introduced SLM practices such as narrowing land, inconvenient for ploughing and damage of structures by rain or livestock were the other restraining factor explained by the majority.

e) Multicollinearity Test

Prior to running the logistic regression analysis, the existence of Multicollinearity among the explanatory variables were checked using variance inflation factor (VIF). The VIF values for all the explanatory variables were found to be very small (much less than 10) indicating that absence of Multicollinearity between the explanatory variables. For this reason, all of the explanatory variables were included in the final analysis.

f) Econometric Analysis of Determinants of Adoption of SLM Practices

Logistic regression model was used to address the second objective of the study. That is to identify the factors that affect adoption of the introduced land management practices in the study area. The likelihood ratio test statistic exceeds the chi-square critical value with 12degrees of freedom. The result is significant at less than 1% probability level indicating that the hypothesis that all the coefficients except the intercept are equal to zero is not acceptable. Likewise, the log likelihood value was significant at 1% level of significance. Another measure of goodness of fit used in logistic regression analysis is the Count-R^2, which indicates the number of sample observations correctly predicted by the model. TheCount-R^2 is based on the principle that if the estimated probability of the event is less than0.5, the event will not occur and if it is greater than 0.5 the event will occur. In other words, the i^{th} observation is grouped as non-adopters if the computed probability is greater than or equal to 0.5, and as adopter otherwise. The discussion about the significant variables is given below.

Table 4: Analysis of Determinants Using Binary Logistic Regression Model result for perception of the effects of land degradation risks

Variable	βSE	Z	Sig	Odd	Ratio
Age	2.142**	0.562	0.862	0.0671	0.025
Hhsize	0.235	1.320	1.230	0.215	0.0670
Education	0.072*	1.892	2.290	0.021	0.201
Sex	0.040**	3.536	0.968	0.091	0.056
Family-Labour	0.235*	0.360	0.386	0.026	0.024
Tenure	0.042**	1.765	0.564	0.086	0.210
Membership	0.246	1.156	1.961	0.534	0.056
Training	0.836*	2.034	0.862	0.020	0.092
Extension Visit	0.865*	0.458	1.926	0.031	0.032
Frmsize	2.280	0.985	0.862	0.915	0.042
Livestock	0.965*	2.045	1.926	0.020	0.031
Total Income	1.626	1.963	0.034	0.234	0.023
Offincome	-0.025*	2.094	2.026	0.0251	0.031
Disatance	-0.965**	1.096	0.648	0.096	0.802
Credit Acess	1.028*	2.064	1.025	0.020	0.035
Slope	2.860**	2.021	1.806	0.091	0.020
Percepdegradation	0.689*	1.091	0.962	0.031	0.380
Perceptslm	1.096**	2.026	0.863	0.062	0.031
Constant					

Model Chi-square 102.280
Log likelihood function 92.165
Nagelkerke (R^2) 0.75
Number of observation 226

***, * Significant at 0.1 and 0.05 probability levels, respectively*

Age of the Household Head: This result suggests that older farmers are less likely to adopt SLM practices. This could be explained by the fact that older farmers have a short planning horizon compared with younger colleagues. This is in line with the findings of Anley et al. (2007) and Shiferaw & Holden (1998).

Off- Farm Activities: Adoption of SLM practices also found to be negatively influenced by off-farm activities. This is because farmers who are involved in off-farm activities may encounter time and labour constraints for investing in bunds. This is in line with other findings (Tenge et al., 2004; Amsalu & deGraaff, 2007).

Number of livestock owned: The number of TLUs is positively related to the decision of compost/manure investment. This is because animal manure is one of the major inputs for compost/manure production. As hypothesized, this variable affected adoption of SLM practices s positively and significantly at 5% probability level. The marginal effect for this variable shows that keeping all factors constant an increase in livestock ownership by one TLU increases the probability of SLM Practices adoption by 0.031.

Extension contact: As hypothesized, frequency of extension contact is found to have a significant positive effect on the adoption of SLM Practices s at 10% probability level. This may be explained by the fact that the message/contents that farmer gain from extension agents help them to initiate to use the newly introduced land management practices on their farm to protect their land from erosion and improve its fertility. Therefore, contact between a farmer and development agent and information gained accelerate the attitude of farmers towards SLM practices positively, and the decision of farmers to invest on SLM Practice on his/her land (Tesfaye 2006). Many other case studies too revealed that low adoption of rainwater harvesting technology were due to lack of extension services (Nasr, 1999; Kihara, 2002; Mitiku and Sorsa, 2002; Ngigi, 2003). The marginal effect value for farm size shows that keeping all factors constant an increase in extension contact by one e increases the probability of SLM Practice adoption by 0.032.

Farmers' perception on effectiveness of introduced land management practices: This variable is hypothesized to influence land management practices adoption either positively or negatively. The model results show that this variable has a significant positive impact on land management practices. The variable is significant at less than 5% probability level. As hypothesized, farmers' perception of effectiveness of SLM measures influence households' decision to invest on introduced land management practices positively.

Perception of severity of land degradation: This variable indicates the severity of soil erosion as perceived by the farm households. The variable positively influenced the adoption of SLM practices/ technologies at less than 1 percent level of significance. The reason for this is that farm households' awareness of the erosion hazard is attached to their perception of the negative consequences of soil erosion and benefits of soil and water conservation. This could be explained by the fact that those farmers who have perceived soil erosion as a serious problem were willing to participate in conservation strategies of land management. Those farmers, who have better perception of soil erosion, will develop good initiations towards management scheme and become less dependent on external assistance for undertaking land management activities.

Educational level of sampled household head: As hypothesized, education of the HH head was found to be positive and having a significant influence on the adoption of improved soil conservation technology. This implies that longer schooling of the HH head increased their ability to access information, and strengthened his/her analytical capabilities with new technology. Furthermore, a longer education leads to a better understanding of the new technology when reviewing the different extension materials, which enhanced adoption of improved technology. Many authors report that education has a positive impact in the adoption of improved soil conservation technology (Lapar and Ehui 2004; Mbaga-Semgalawe and Folmer 2000;). The findings of this study on the effect of education were close to that of other studies conducted previously. Adoption of a given technology is a behavioral change process, which is the result of a decision to apply that particular innovation. Farmers need enough information about the technology to make the right decision. Education enhances the capacity of individuals to obtain, process, and utilize information disseminated by different sources. This implies that literate farmers are in a better position to get information and use it in such a way that it contributes in their adoption of SLM Practices. As hypothesized, educational level of household heads was found to be a significant at less than five percent probability level. This may be explained by the fact that those farmers who were more educated are likely to use introduced land management than the non-educated farmers in the study area. This is because, educated farmers were more opt in understanding the problem of land degradation and could easily decide to take part in conservation strategies of land management practices . This is attributable to the fact that education reflects acquired knowledge of environmental amenities and educated farmers tend to spend more time and money on land management practices. The marginal effect value for education shows that keeping all factors constant an increase in education by one year increases the probability of adoption of SLM Practices by 0.201.

Land tenure: Farmer's feeling about the land belongs to him/she will have a positive effect on his/her decision to adopt land management practices. The lack of title to land is one important factor affecting adoption of SLM Practices because lack of tenure security means that people are reluctant to invest in new land management practices on a land which they do not formally own. Therefore, farmers' perception that the farmland he/she owns will remain his/her owns at least during his/her lifetime affects the decision on land management practices. For farmers' to be able to carry out long or medium term investment, they require security of tenure. This does not necessarily mean that they have to have individually documented proof of title rather need the feeling of ownership to make sure that the land will be theirs to work in the foreseeable future, and not unpredictably taken away and reallocate to somebody else. This variable is found to significantly and positively affect the independent variable, SLM Practice. This is because to adopt and invest on land management practices, first there should have a sense of ownership so that farmer can take care of his land.

Slope of the farm plots (SLOP): This variable positively influenced the adoption of SLM practices/ technologies at less than 1 percent level of significance. The significant positive terms in adoption of conservation practices indicate that farmers are inclined to invest in conservation practices where their farm plots are located on higher slopes. This goes with the perception that those plots can only be productive if protected by conservation structures. On the other hand, Berhanu and Swinton (2003) have stated that an increase in the slope of the plots may create a disincentive to invest in soil conservation practices as the slope of the plot increase the distance between two consecutive terraces will decrease because the structures of SLM measures occupy more area of land and will create inconvenience for farm operation.

g) Conclusion and Policy Implication

The findings of this study have important policy implications for promoting sustainable land management practices and technologies in the study area. Descriptive data analysis showed that only 63.75 % of the HH adopted SLM practices. Farmers reported that the improved terraces are effective in reducing soil erosion, though they were not common due to high labor cost and inconveniency for ploughing with oxen. A range of socio-economic, institutional, personal and biophysical factors determines adoption of SLM practices in the study area. The result of the binary logistic regression model showed that SLM practices is significantly influenced by education, tenure security, livestock ownership, perception of severity of land degradation, perception of effectiveness of SLM measures, off-farm activities, credit services access, age of households, slop of the plot ant etc. Planners and policy makers should formulate appropriate policies and programs considering the farmers' interest, capacity, and limitation in promoting improved soil conservation technology for greater acceptance and adoption by the farmers. Any future land management efforts should give a due attention to genuinely involve farmers in entire process of any land management interventions from technology generation to final monitoring and evaluation. *Generally, this study recommends that decision-making about land management and land degradation should encompasses factors that may be biophysical (agro-ecological conditions, location), economic (access to credit and markets, non-farm incomes, availability of technologies), social (organizational structure, labor availability, land tenure), historical (environmental history and that of land tenure) and cultural (traditional knowledge, environmental awareness, and gender*.

V. Acknowledgement

I am extremely grateful to Ambo University for funding this research project. Also I wish to thank all farmers who provided their valuable time and shared their experiences on SLM practices.

References Références Referencias

1. Aklilu, A. (2006). *Caring for the Land Best Practices in Soil and Water Conservation in Beressa Watershed, Highlands of Ethiopia*. Tropical Resource Management Papers, No. 76.
2. Amsalu, A. and de Graaff, J. (2007), Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. *Ecological Economics* 6:294-302.
3. Amsalu, A. and de Graaff, J. (2007), Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. *Ecological Economics* 6:294-302.
4. Assefa D. 2009. Assessment of Upland Erosion Processes and Farmer's Perception of Land Conservation inDebre-Mewi Watershed, Near Lake Tana, Ethiopia. A Thesis Presented to the Faculty of Graduate School ofCornell University in Partial Fulfillment of the Requirements for the Degree of Masters of ProfessionalStudies.104p.
5. Beddington, J. (2010). Food security: Contributions from science to a new and greener revolution.
6. Bekele S, Okello J, Ratna VR. 2009. Adoption and Adaptation of Natural Resource Management Innovations inSmallholder Agriculture: Reflections on Key Lessons and Best Practices. Environment, Development and Sustainability, 11: 601-619.
7. Bekele, W. & Drake, L. (2003). Soil and Water Conservation Decision Behavior of Subsistence Farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto Area. Ecological Economics 46:437-451.
8. Bekele, W. and Drake, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. *Ecological Economics* 46 (2003) 437_/451
9. Bekele, W. and Drake, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. *Ecological Economics* 46 (2003) 437_/451
10. Belay, M. &Bewket, W. (2013). Farmers' livelihood assets and adoption of sustainable land

management practices in north-western highlands of Ethiopia. International journal of environmental studies, 70(2), 284-301.
11. Betru, N. (2003). *Soil and Water Conservation Program in the Amhara National Regional* California Press.
12. Carucci, V. 2006. Sustainable Land Management as Key enabling Element to End Poverty in Ethiopia: gaps, dichotomies and opportunities. (A paper for dialogue). WFP, Addis Ababa, Ethiopia.
13. Dejene, A. (Ed.). (1997). Land degradation in Tanzania: perception from the village (Vol. 370). World Bank Publications.
14. Desta, L. Carucci, V., AsratWondem-Agegnehu and Yitayew Abebe (eds). 2005. Community Based Participatory Watershed Development: A Guideline. Ministry of Gariculture and Rural Development, Addis Ababa, Ethiopia.
15. EEA/EEPRI (2004/05). *Report on the Ethiopian Economy: Transformation of The Ethiopian Agriculture: Potential, Constraints, and Suggested Intervention Measures*, Vol. IV, Addis Ababa.
16. ELD Initiative. (2013). The rewards of investing in sustainable land management. Interim Report for the Economics of Land Degradation Initiative: A global strategy for sustainable land management. accessed in September 1, 2015 Available at: www.eld-initiative.org/
17. EPA, 1997. The Federal Democratic Republic of Ethiopia Environmental Policy. Environmental Protection Agency (EPA), Addis Ababa, Ethiopia.
18. EPA, 2001. National Action Programme (NAP): Executive Summary, June 2001. Addis Ababa.
19. EPA, 2005. Concept Note: Sustainable Land Management Country Framework, PDF-A. Addis Ababa, Ethiopia.
20. EPLAUA, 2004. The State of Soil and Water Conservation Measures in Amhara National Regional State. Bahirdar, Ethiopia.
21. Ethiopian Economic Association/Ethiopian Economic Policy and Research Institute (EEA/EEPRI) (2002). *A Research Report on Land Tenure and AgriculturalDevelopment in Ethiopia,* Addis Ababa.
22. Eyasu, E. (2002). *Farmers' Perception of Soil Fertility Change and Management,* Institute for Sustainable Development and SOS Sahel International (UK), Addis Ababa.
23. FAO (2011). Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa. Rome, 2011.
24. FAO (UN Food and Agriculture Organization). 1996. World Food Summit: Rome declaration on world food security and world food summit plan of action. Rome, Italy: FAO.
25. FAO 2011. Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa. Rome, 2011.
26. FAO. (2007). Paying Farmers for Environmental Services, State of Food and Agriculture 2007, Rome: FAO. Rome, Italy.
27. FAO. (2009). Country support tool for scaling-up Sustainable Land Management in Sub-Saharan Africa. Version 1.0. A TerrAfrica partnership publication.
28. FAO. (2012). FAO publication - Combating Micronutrient Deficiencies: Food-based Approaches. Rome, Italy.
29. FAO. 2006. Preparation of a Global Report on the State of Land and Water Resources, SoLAW. Land and Water Development Division, FAO, Rome, 2006. In-progress Draft Report – Version 01.
30. FAO. 2007. Conservation agriculture in Tanzania: a case study. Rome, Food and Agriculture Organization of the United Nations.
31. FAO. 2009. Country support tool for scaling-up Sustainable Land Management in Sub-Saharan Africa. Version 1.0. A TerrAfrica partnership publication.
32. FAO. 2010. Investment Centre Database of Projects. Rome, Food and Agriculture Organization of the United Nations.
33. FAO/WOCAT. 2009. SLM in Practice. promoting Knowledge on Sustainable Land Management for Action in Sub-Saharan Africa Roma, Food and Agriculture Organization of the United Nations.
34. Gebremedhin B. and Swinton S. M. (2003). Investment in soil conservation in Northern Ethiopia: the role of land tenure security and public programs. *Agricultural Economics* 29: 69–84.
35. Gebremedhin, B. 1998. "The Economics of Soil Conservation Investments in the Tigray Region of Ethiopia". Unpublished PhD Dissertation, Michigan State University, Department of Agricultural Economics, East Lansing, USA.
36. Gebremedhin, B. and S. Swinton. 2002. Sustainable management of private and communal lands in northern Ethiopia. In: C.B. Barrett, F. Place and A.A. Aboud (eds.), *Natural Resources Management in African Agriculture*. International Centre for Research in Agroforestry, CABI Publishing, New York.
37. Gebremedhin, B., J. Pender, and G. Tesfaye. 2003. Community resource management: The case of woodlots in northern Ethiopia. *Environment and Development Economics* 8: 129-148.
38. Gerber, N., Nkonya, E., & von Braun, J. (2014). Land Degradation, Poverty and Marginality. In Marginality (pp. 181-202). Springer Netherlands.
39. Gerber, N., Nkonya, E., & von Braun, J. (2014). Land Degradation, Poverty and Marginality. In Marginality (pp. 181-202). Springer Netherlands.

40. Getahun, A. (1991). Agricultural growth and sustainability: Conditions for their compatibility in the tropical East Africa highlands. In: S. Vosti, T. Reardon, and
41. GeteZeleke, Menale Kassie, John Pender & Mahmud Yesuf 2006 Stakeholder Analysis for Sustainable Land Management (SLM) in Ethiopia: Assessment of Opportunities, Strategic Constraints, Information Needs, and Knowledge Gaps
42. GeteZeleke. 2000. Landscape Dynamics and Soil Erosion Process Modelling in the North-western Ethiopian Highlands. African Study Series A 16, Geographica Bernensia, Berne, Switzerland
43. GeteZeleke. 2003. Concept Note on Prtnership for Rural Livilihoods Improvement as a First Step Towards Implimenting UNDAF: Touching the Ground. World Food Programme. Addis Ababa, Ethiopia.
44. GeteZeleke. 2005 (forthcoming): Integrated Watershed Management Experiences in ECA Countries: Lessons from Ethiopia. ICRISAT, Nairobi Kenya.
45. GeteZeleke. and Hurni H. 2001. Implication of Land Use and Land Cover Dynamics for Mountain Resource Degradation in the North-western Ethiopian Highlands. Journal of Mountain Research and Development. Vol. 21, No. 2. University of Bern, Switzerland.
46. Global Environmental Facility (2003), Operational Program 15 on Sustainable Land Management.
47. Global Environmental Facility (2003), Operational Program 15 on Sustainable Land Management.
48. Godfray HCJ, Beddington JR, Crute IR, *et al*. 2010. Food security: the challenge of feeding 9 billion people. *Science* 327: 812 18.
49. Green, W. H. (2003). Econometric Analysis, 2nd Edition, New York, Macmillan.
50. Greene, H. W. (2003). Econometric Analysis: Pearson Education Inc. New York University.
51. Greene, W. H. (2000). Econometric analysis (International edition). New York University.
52. Greene, W.H. (2012). Econometric Analysis, 7th edition. Prentice Hall, Boston, USA.
53. Grepperud, S. (1996) Population pressure and land degradation: The case of Ethiopia. Journal of Environmental Economics and Management 30:18-33.
54. Gujarati, D.N. (2004). Basic Econometrics, 4th ed. McGraw-Hill, New York, 2007
55. Habtamu, E. (2006). *Adoption of Physical Soil and Water Conservation Structures in Anna Watershed, Hadiya Zone, Ethiopia*. (Masters Thesis Addis Ababa University, 2006).
56. Holden, S. T. and Shiferaw, B. 2002. Poverty and Land Degradation: Peasants' Willingness to Pay to Sustain Land Productivity. In C. B. Barrett, F. M. Place, and A.
57. Holden, S. T. and Shiferaw, B. 2004. Land Degradation, Drought and Food Security in a Less-favoured Area in the Ethiopian Highlands: A Bio-economic Model with Market Imperfections. *Agricultural Economics* 30 (1): 31-49.
58. Holden, S., B. Shiferaw, and J. Pender. 2005. *Policy analysis for sustainable land management and food security: a bio-economic model with market imperfections.* International Food Policy Research Institute Research Report No. 140. Washington,D.C.
59. Holden, S., S. Benin, B. Shiferaw, and J. Pender. 2003. Tree planting for poverty reduction in less-favoured areas of the Ethiopian highlands. Small-scale Forest Economics, Management and Policy 2(1), 63-80.
60. Hosmer, D., and S. Lemeshew, 1989. Applied Logistic Regression. A Wiley-Inter Science Publication. New York
61. Hurni, H. 1988. Degradation and conservation of the resources in the Ethiopian highlands. Mountain research and development, vol. 8, Nos. 2/3, 1988, pp. 123-130,. University of Bern, Switzerland.
62. Hurni, H.,.1996. with the assitance of an international group of contributers,. Precious Earth: From Soil and Water Conservation to Sustainable Land Management. International Soil Conservation Organization (ISCO), and Center for Development and Environment (CDE), Berne, Switzerland.
63. IFAD. 2011. Rural poverty report. New realities, new challenges: new opportunities for tomorrow's generation. Rome, International Fund for Agricultural Development.
64. IPCC. 2007. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 8-Agriculture. Climate Change 2007:Mitigation. Cambridge, United Kingdom and New York, NY, USA Cambridge University Press.
65. Kassie, M., & Holden, S. (2007). Sharecropping efficiency in Ethiopia: threats of eviction and kinship. Agricultural Economics, 37(2-3), 179-188.
66. Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: evidence from rural Tanzania. Technological forecasting and social change, 80(3), 525-540.
67. Kassie, M., Shiferaw, B., &Muricho, G. (2011). Agricultural technology, crop income, and poverty alleviation in Uganda. World Development, 39(10), 1784-1795
68. Kidane G. 2001. Factors Influencing the Adoption of New Wheat Verities, in Tigray, Ethiopia: the Case ofHawizen District. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University.164p.

69. Kidane T. 2008. Determinants of Physical Soil and Water Conservation Practices: The Case of Bati District, Oromyia Zone, Amhara Reion, Ethiopia. M.Sc. Thesis Presented to the School of Graduates of Alemaya University, Alemaya. 162p.
70. Kirubel M, Gebreyesus B. 2011. Impact assessment of soil and water conservation measures at Medegowatershed in Tigray, northern Ethiopia. *Maejo International Journal of Science and Technology. 5*(03): 312-330.
71. Lal, R., & Stewart, B. A. (Eds.). (2013). Principles of Sustainable Soil Management in Agroecosystems (Vol. 20). CRC PressILlc.
72. Lal, R., Safriel, U., & Boer, B. (2012). Zero Net Land Degradation: A New Sustainable Development Goal for Rio+ 20. [A report prepared for the Secretariat of the United Nations Convention to Combat Desertification].
73. Mahmud Yesuf and J. Pender. 2005. Determinants and Impacts of Land Management Technologies in the Ethiopian Highlands: A Litreature Review. EDRI/EEPFE. Addis Ababa, Ethiopia.
74. Mahmud Yesuf, Alemu Mekonnen, Menale Kassie, and J. Pender. 2005. Cost of Land Degradtion in Ethiopia: A Critical review of Past Studies. EDRI/EEPFE. Addis Ababa, Ethiopia.
75. Million Alemayehu. 1992. The Effect of Traditional Ditches on Soil erosion and Production. Research Report 22. Soil Conservation Research Project. University of Bern. Bern, Switzerland.
76. Million Alemayehu. 2003. Characterization of Indegenous Stone Bunding*(Kab)* and its Effect on Crop Yield and Soil Productivity at Mosobit-Gedeba, Sorth Shewa Zone of Amhara Region. MSc Thesis. Alemaya University. Alemaya, Ethiopia.
77. Million T, Belay K. 2004. Factors influencing adoption of soil conservation measures in southern Ethiopia: TheCase of Gununo Area. *Journal of Agriculture and Rural Development in the Tropics and Subtropics,* 105 (1): 49-62
78. Million Taddesse and Belay Kassa. (2007). Factors influencing adoption of soil conservation measures in southern Ethiopia: The Case of Gununo Area. *Journal of Agriculture and Rural Development in the Tropics and Subtropics* 105(1): 49-62
79. Nkonya E. (2002). Soil conservation practices and non-agricultural Land use in the south western highlands of Uganda. A Contribution to the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission.
80. Nkonya E., D, Phillip, E. Kato, B. Ahmed, A. Daramola, S. B., Ingawa, I. Luby, E.A. Lufadeju, M. Madukwe, and A.G. Shettima. 2012. Medium-term impact of Fadama III project. IFPRI mimeo.
81. Nkonya E., P. J., Kaizzi C., Kato Edward K., Mugarura S., 2005. Policy options for increasing crop productivity and reducing soil nutrient depletion and poverty in Uganda. Submitted to EPTID to be considered as Discussion Paper Publication
82. Nkonya, E. M., Pender, J. L., Kaizzi, K. C., Kato, E., Mugarura, S., Ssali, H., & Muwonge, J. 2008. Linkages between land management, land degradation, and poverty in Sub-Saharan Africa: The case of Uganda (No. 159). International Food Policy Research Institute (IFPRI).
83. Nkonya, E., Gerber N, Baumgartner P, von Braun J, De Pinto A, Graw V, Kato E, Kloos J, Walter T. 2011. The Economics of Land Degradation: toward an integrated global assessment, Development Economics and Policy Series vol. 66, Heidhues F, von Braun J and Zeller M (eds), Frankfurt A.M., Peter Lang GmbH.
84. Nkonya, E., J. Pender, D. Sserunkuuma, and P. Jagger. (2002). Development Pathways and Land Management in Uganda. In *Policies for Sustainable Land Managementin the East African Highlands*, edited by S. Benin, J. Pender and S. Ehui. Washington, D.C. and Nairobi, Kenya: International Food Policy Research Institute and International Livestock Research Institute.
85. Nkonya, E., Von Braun, J., Mirzabaev, A., Le, Q. B., Kwon, H. Y., &Kirui, O. (2013). Economics of Land Degradation Initiative: Methods and Approach for Global and National Assessments (No. 158663).
86. Pender J. (2002). Overview of Findings and Implications. In Policies for Sustainable Land. Washington, D.C. and Nairobi, Kenya: International Food Policy Research Institute and International Livestock Research Institute.
87. Pender, J. 2004. "Development pathways for hillsides and highlands: some lessons from Central America and East Africa". Food Policy. 29: 339-367.
88. Pender, J. and B. Gebremedhin. 2004. Impacts of policies and technologies in dryland agriculture: evidence from northern Ethiopia. In: S.C. Rao (Ed.), *Challenges and Strategies for Dryland Agriculture*, American Society of Agronomy and Crop Science Society of America, CSSA Special Publication 32, Madison, WI.
89. Pender, J. and B. Gebremedhin. 2006. Land management, crop production and household income in the highlands of Tigray, northern Ethiopia. In: Pender, J.,Place, F., and Ehui, S. (eds.), *Strategies for Sustainable Land Management in the East African Highlands*. IFPRI, Washington, D.C. In press.
90. Pender, J., B. Gebremedhin, S. Benin and S. Ehui. 2001. "Strategies for sustainable development in the Ethiopian highlands". American Journal of Agricultural Economics. 83(5): 1231-40.
91. Pender, J., B. Gebremedhin, S. Benin and S. Ehui. 2001. Strategies for sustainable development in the

Ethiopian highlands. *American Journal of Agricultural Economics* 83(5): 1231-40.

92. Pender, J., E. Nkonya, P. Jagger, D. Sserunkuuma, and H. Ssali. 2004b. "Strategies to increase agricultural productivity and reduce land degradation: evidence from Uganda". Agricultural Economics. 31(2-3): 181-195.
93. Pender, J., P. Jagger, E. Nkonya and D. Sserunkuuma. 2004. "Development pathways and land management in Uganda". World Development. 32(5): 767-792. *Philosophical Transactions of the Royal Society B: Biological Sciences, 365* (1537), 61 – 71.
94. Pretty J, Toulmin C, and Williams S. 2011. Sustainable intensification in African agriculture. *Int J Agr Sustain* **9**: 5–24. Pretty JN. 1997. The sustainable intensification of agriculture. *NatResour Forum* **21**: 247–56.
95. Seid H. 2009. Determinants of Physical Soil and Water Conservation Practices: The Case of Bati District, Oromyia Zone, Amhara Reion, Ethiopia. M.Sc. Thesis Presented to the School of Graduates of Alemaya University, Alemaya. 162p.
96. Sonneveld, B. G. J. S. 2002. Land Under pressure: The Impact of Water Erosion on Food Production in Ethiopia. Shaker Publishing (PhD disertation). Netherlands. *State.* In: Tilahun Amede (ed.) *Proceeding of a Conference on Natural Resource Degradation and Environmental Concerns in the Amhara National Regional State: Impact on Food Security*. P. 109-125, Bahir Dar, Ethiopia.
97. Sutcliffe, J. P. 1993. Economic assessment of land degradation in the Ethiopian highlands: a case study. Addis Ababa: National Conservation Strategy Secretariat, Ministry of Planning and Economic Development, Transitional Government of Ethiopia.
98. Tamene L, Park SJ, Dikau R, Vlek PLG (2006). Reservoir siltation in the semi-arid highlands of northern Ethiopia: sediment yield-catchment area relationship and a semi-quantitative approach for predicting sediment yield. Earth Surface Process. Landforms 31(11):1364-1383.
99. Tenge, A. J., De Graaff, J. and Hella, J. P. (2004). Social and Economic Factors Affecting the Adoption of Soil and Water Conservation in West Usambara Highlands, Tanzania. *Land Degradation and Development,* 15: 99–114
100. TerrAfrica. (2006). Assessment of the Nature and Extent of Barriers and Bottlenecks to Scaling Sustainable Land Management Investments throughout Sub-Saharan Africa. Unpublished TerrAfrica report.
101. TerrAfrica. 2006. Assessment of the Nature and Extent of Barriers and Bottlenecks to Scaling Sustainable Land Management Investments throughout Sub-Saharan Africa. Unpublished Terr Africa report.
102. Tesfa, A., & Mekuriaw, S. (2014). The Effect of Land Degradation on Farm Size Dynamics and Crop-Livestock Farming System in Ethiopia: A Review. Open Journal of Soil Science, 4, 1.
103. Teshome A, Rolker D, de Graaff J (2012). Financial viability of soil and water conservation technologies in northwestern Ethiopian highlands. Appl. Geogr. 37:139 -49
104. Troeh FR, Hobbs AJ, Danahue RL (1980). Soil and water conservation for productivity and environmental protection. Prentice-hall, Inc., Englewood Cliffs. pp.718.
105. Turner BL and Robbins P. 2008. Land-change science and political ecology: similarities, differences, and implications for sustainability science. *Annu Rev Environ Resour***33**: 295–316.
106. Turner, R. K., D. Pearce, and I. Bateman. 1994. Environmental Economics. London: Harvester Wheat sheaf.
107. UNCCD (United Nations Convention to Combat Desertification). (2007). Africa action programs. http://www.unccd.int/actionprogrammes/africa/africa.php.
108. UNDP, 2005: Human Development Report (2005). United Nations Development Programme, New York, 388 pp. available at: http://hdr.undp.org/en/reports/global/2005/pdf/%20HDR05_complete.pdf
109. W. Von Urff (Eds.). Agricultural sustainability, growth and poverty alleviation: Issues and policies, pp. 451–468. Washington, D.C., IFPRI.
110. Wagayehu B, Drake L (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. Ecol. Econ. 46 (3):437-451.
111. WOCAT, 2005. World Overview of Conservation Approaches and Technologies. Based on http://www.wocat.net/about1.asp accessed in August 2016.
112. WOCAT. 2007. Where the Land is Greener – Case Studies and Analysis of Soil and Water Conservation Initiatives Worldwide. H. Liniger, Critchley W., World Overview of Conservation Approaches and Technologies.
113. WOCAT. 2011. "Database on SLM Technologies." Retrieved August, 2016, from http://www.wocat.net/.
114. Woldeamlak B (2006). Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: acceptance and adoption by farmers'. Land Use Policy 24(2):404-416.
115. Woldeamlak B, Sterk G (2003). Assessment of soil erosion in cultivated fields using a survey methodology for rills in the Chemoga watershed, Ethiopia. Agric. Ecosyst. Environ. 97:81-93.
116. Woldeamlak, B. (2003). *Land Degradation and Farmers' Acceptance and Adoptionof Conservation*

Technologies in the Degil Watershed, Northwestern Highlands of Ethiopia, Social Science Research Report Series no.29, OSSREA, Addis Ababa.

117. Woodfine, A. 2009. The Potential of Sustainable Land Management Practices for Climate Change Mitigation and Adaptation in Sub-Saharan Africa. Rome, Food and Agriculture Organization of the United Nations.
118. World Bank (2007). *Ethiopia: Accelerating Equitable Growth Country Economic Memorandum Part II: Thematic Chapters.* Poverty Reduction and Economic Management Unit; Report No. 38662-ET
119. World Bank (WB). 2012. Managing land in a changing climate: an operational perspective for Sub- Saharan Africa. Draft version Report No.: 54134-AFR. WB, Washington D.C.
120. World Bank. (2010). Managing land in a changing climate: an operational perspective for Sub-Saharan Africa. Draft version Report No.: 54134-AFR. WB, Washington D.C.

Global Journals Inc. (US) Guidelines Handbook 2017

www.GlobalJournals.org

Fellows

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (FARSS)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards “FARSS” title to individuals. The 'FARSS' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

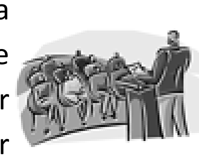
- The “FARSS” is a dignified title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., FARSS or William Walldroff, M.S., FARSS.

FARSS accrediting is an honor. It authenticates your research activities. After recognition as FARSB, you can add 'FARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSS designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSB title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA). The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

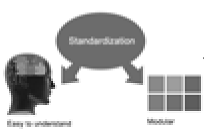


You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.



The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSS members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSS member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The “MARSS” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSS member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

Auxiliary Memberships

Institutional Fellow of Global Journals Incorporation (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

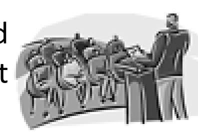
The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.



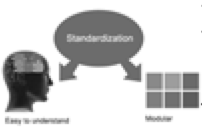
The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.



After nomination of your institution as “Institutional Fellow” and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone. "

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

Preferred Author Guidelines

MANUSCRIPT STYLE INSTRUCTION **(Must be strictly followed)**

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, “Abstract” word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board’s decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

CRITERION FOR GRADING A RESEARCH PAPER (COMPILATION) BY GLOBAL JOURNALS INC. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

Index

save our planet

Global Journal of Science Frontier Research

Visit us on the Web at www.GlobalJournals.org | www.JournalofScience.org
or email us at helpdesk@globaljournals.org

ISSN 9755896