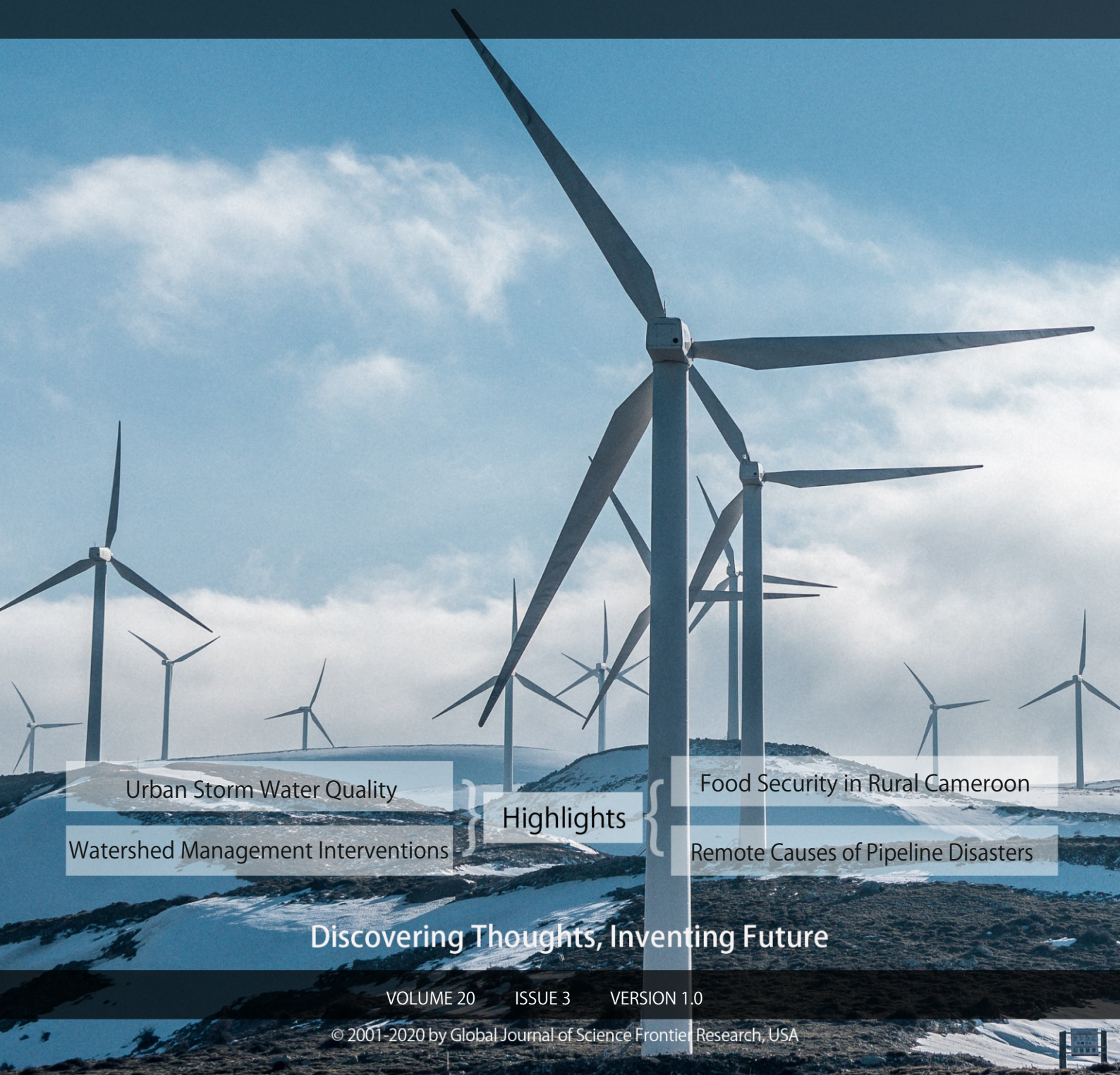


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Identifying the Immediate and Remote Causes of Pipeline Disasters in Nigeria

By Francis I. Johnson & Marianthi Leon

Robert Gordon University

Abstract- Several occurrences of the transport system of the natural gas vandalisms in Nigeria, especially in the Niger Delta part of Nigeria is so upfront and seem never-ending. However, this seemed also to be a result of many factors ranging from the unemployment of youths and the inadequate management and necessary government policies to be put in place to ensure guaranteed security. Past researchers have observed and given the fact that the major causes of this disaster are attached to a technical fault and some failures in aging, corrosion, and mechanical challenges like those welding effects. This research work examined immediate and remote causes of pipeline disasters considering the dimension of factors, the level of preparedness of people for the pipeline disasters, and the risk perception of people, the socioeconomic characteristics and the destruction of the pipelines.

Keywords: oil spill, oil theft, pipeline attacks vandalism interdiction, GIS, environmental impact mitigation, data, nigeria.

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IDENTIFYING THE IMMEDIATE AND REMOTE CAUSES OF PIPELINE DISASTERS IN NIGERIA

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Identifying the Immediate and Remote Causes of Pipeline Disasters in Nigeria

Francis I. Johnson ^α & Marianthi Leon ^σ

Abstract- Several occurrences of the transport system of the natural gold vandalisms in Nigeria, especially in the Niger Delta part of Nigeria is so upfront and seem never-ending. However, this seemed also to be a result of many factors ranging from the unemployment of youths and the inadequate management and necessary government policies to be put in place to ensure guaranteed security. Past researchers have observed and given the fact that the major causes of this disaster are attached to a technical fault and some failures in aging, corrosion, and mechanical challenges like those welding effects. This research work examined immediate and remote causes of pipeline disasters considering the dimension of factors, the level of preparedness of people for the pipeline disasters, and the risk perception of people, the socioeconomic characteristics and the destruction of the pipelines. This study posted the analytically with the use of confirmatory factor analysis (CFA) and descriptive statistics. This analytical tool is regarded as a superior model of analysis because its purpose is to establish a figurable relationship between observed and unobserved variables. The study involved 300 respondents out of which 286 is regarded valid, which is way above 90% of the respondents who were selected within Nigeria using the multi-sampling method, and the method is the simple random method. The results from the study show the existence of a significant factor such as poverty, poor management of pipelines, political factors and all other factors treated in the study contribute to the pipeline disaster in Nigeria. Further, it was also observed that preparedness and risk perceptive factors also contribute to pipeline disaster in Nigeria. After all views and detailed explanations put to test by the respondents and researchers respectively; the result suggests that there should be a provision of employment for citizens, especially the active youths that could lead such vandalism. Also, it recommends that there should be a provision of social amenities and infrastructural facilities such as roads, electricity, pipe-borne water, and reduction in land devastation so as to reduce violence.

Keywords: oil spill, oil theft, pipeline attacks vandalism interdiction, GIS, environmental impact mitigation, data, nigeria.

1. INTRODUCTION

In simple terms, crude oil is a naturally occurring fuel (liquid) that is found under the ground. It is regarded as one of the natural resources which have benefited humanity alongside others like air, water, food, and many more. Crude oil can be gotten from the ground through extraction by drilling. Crude oil is referred to as

fossil fuel because of its origins. Over the years, crude oil has gained popularity mostly because of its economic impact but also because of its diversified usable products refined from it. It has gradually become the source of national development in terms of economic value and also infrastructural growth to South America, North America, Europe and the Middle East (Karl, 1997). As it is a natural resource, it's no news that most oil-producing countries have their government involvement in its management. As seen in countries like Argentina, Bohemia, Great Britain, Egypt, and even around the world. Modern strategies like the one employed by the British government such that they established a petroleum administration which owns a controlling partnership with veto powers on the board of directors in the Anglo-Persian oil company. They also control the oil resources of the greater part of Iran; offers funds to support the development of oil and as such giving rooms to promoting the acquisition of sub-companies and companies under companies exclusively British or under British control.

In Nigeria, the Niger-Delta region is highly ranked in the world And as such the first in Africa which has a landmass covering about 36, 000² km (square-kilometers) of lagoons and marshlands. The region harbors the Nation's reserves to the tune of fewer than 35 billion barrels of crude oil, which is suspended for further needs and less than 165 trillion cubic feet of natural gas (Omotola, 2009). Nigeria's major source of earning is petroleum, and most of the petroleum is found in the Delta state part of the country. Despite that the Niger-delta has access to this crude oil in abundant quantity, the state is considered as one of the states that are suffering from the activities of crude oil as a result of many factors (UNEP, 2011). Although it is significant, we note that Nigeria ranks first in Africa and eighth in the world when it comes to oil export according (Umar, 2014). So, oil production contributes about a billion investments to boost the country's economy as well as the development of related sectors such as infrastructures, provision of employment for Nigerians as well as improvement of the standard of living of the people. In an aim to develop, quite a few African countries have enabled extreme measures and jeopardized the wellbeing, both health-wise and socially, of their citizens, thereby leading to environmental hazards as a result of crude oil extraction. For example, as explained by Pepper using the Friedman's core-

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periphery model in (Friedman, 1973), the areas where petroleum resources are exploited are often categorized based on economic and environmental impoverishment caused by continuous exploitation in those oil-based areas while the development of the urban center which are usually a government administrative seat is improved upon. Although the urban areas also face challenges of environmental degradation and kinds, it tends to be tactically under control, unlike the rural areas where this extraction takes place.

There have been numerous hazards, most resulting from human negligence for wellbeing, which resulted in detrimental incidences such as from gas flaring, industrial pollution, farmland losses, oil spillage, and eventually leading to loss of lives and properties. All these effects are results of irregular exploitation of crude oil and the acts of citizens of the country bringing about vandalism of pipelines. Eze (2004) stated that Vandalization which can be define as the "illegal act of destroying or puncturing oil pipelines either to disrupt oil supply or steal crude oil – or its refined products– to appropriate for personal use or sale on the black market or any other outlet; is outlawed by the provisions of 'Production and Distribution (Anti-sabotage) Act' and the 'Criminal Justice (miscellaneous provisions) Decree of 1974". Because Pipeline vandalism and ruptures are the regular incidents that cause oil spillages, fires, and explosions in Nigeria, leading to pipeline disasters.

Also, factors contributing to these pipeline disasters, some of which are majorly technical failures such as inadequate maintenance and regular inspection, operational failures, and natural disasters are some factors causing pipeline disasters. It poses as one of the problems associated with pipeline disasters, which are affecting the source of revenue for government and oil companies operating in Nigeria. Pipelines vandalism may be a result of a natural situations but could also be for selfish reasons to personal gain by greedy individuals through the deliberate use of explosives or machines to cut or drill pipelines. It could sometimes not be for greed for some scary interest, which is unfair to the citizens such as; Scarcity of petroleum products, protest neglect from government, and degradation of the environment as a result of oil companies' activities. Very many incidents resulting from pipeline disasters in Nigeria have summoned the attention of other countries to the consistent death, property loss, and water pollution resulting from this disaster. Not to mention the soil contamination, air pollution, destruction of the ecosystem (flora and fauna), property and infrastructures, and loss of crude oil and refined products.

a) *Research gap*

The study are a confirmed that there is wide-spread of oil pipeline and its channel towards petrol

products. It makes all parts of the study area vulnerable to attack such as vandalism by Citizen for selfish gains and endangering the lives of the less concerned. Therefore, a quantitative approach which identifies the statistical significance of crude oil transport system vandalism based on the regional classification within Nigeria.

b) *Statement of the Problem*

As the never relenting disasters of transport systems of crude oil are increasing, so also does the limitation to the number of barrels of petroleum in Nigeria and of course, in turn, affects the revenue generation for the country and oil companies. Also, it does also have effects on the socioeconomic characteristics of the victims in such areas and on the farmlands, thereby also endangering food security. Although efforts are been put to place to identify other possible causes of pipeline disasters it rings round the possibility of vandalism and irregular maintenance of petroleum production.

c) *Research Questions*

- (i) What Is the Dimension of the Factors that Causes Pipeline Disaster in Nigeria ?
- (ii) What is the Level of Preparedness for Pipeline Disaster ?
- (iii) What is the Risk Perception of Respondents on Pipeline Disaster?
- (iv) What is the Impact of Risk Perception of People, Preparedness a and Demographic Factors on Pipeline Disaster in Nigeria?

d) *Research Objectives*

The Broad Objective of this Study is to Determine the Immediate and Remote Cause of Pipeline Disaster in Nigeria.

The specific objectives taking a case study of 20 years; from year 2000 to 2019, are to:

- (i) Determine the !dimension of the factors that causes Pipeline Disaster in Nigeria.
- (ii) Examine the level of Preparedness of people on pipeline disaster in Nigeria using Confirmatory Factor. Analysis (CFA).
- (iii) Determine the risk Perception of Respondents on Pipeline disaster.
- (iv) Examine the impact of risk perception of people, preparedness and demographic factors on pipeline disaster in Nigeria using Confirmatory Factor Analysis (CFA).

e) *Hypothesis of the study*

The hypothesis for the study is stated in the null form, thus:

Ho: There is no significant effect of socio-economic characteristics of the respondents and the pipeline vandalism.

f) *Significance of the Study*

The revenues from oil, of course, presented accumulated level of wealth, giving room for investing more and planning for other sectors based on income generated from crude oil. However, the source of this revenue is invariably becoming the main source of income for the country, and the macro-economic management begins to rely more on the report and result of crude oil sales as a determinant of the state of the economy. Even though crude oil seems to contribute more to the country's national economic development, the problems of the economy are still not limiting or mitigating. Such problems has an unemployment rate, manufacturing decline rate, increasing poverty level, and poor infrastructural development. The dismal performance of the Nigerian economy in the face of huge rents from oil and high income that is still not limiting the problems of the country has shown that the importance of oil to the country's economic development is questionable. It is also from the obvious that as a result of personal gain seekers, the whole of crude oil becomes an endangering source leading to loss of valuables, including lives. The above therefore indicates that the advantages offer as tremendous effect to get on just like that of the disadvantage also cause for attention.

II. EMPIRICAL LITERATURE REVIEW

a) *History of Crude Oil in Nigeria*

Although it may seem like Nigeria came into their oil and gas bloom overnight, the fact is, oil discovery in Nigeria stands as far back as 1903 with the Nigerian Bitumen Corporation. They had just started conducting an exploratory project when the attack of world war I began, and as such, all operations of the firm had to be on hold. After that, some other small oil companies tried to pick up the slack but were handicapped by limited facilities as there were not many funds to acquire the needed technology until the many oil-producing sectors commenced with another company that came into the scene and took over the exploration of commercial crude oil in Nigeria.

In 1923, exploration licenses were awarded to D'Arcy Exploration Company and Whitehall Petroleum, still, the two companies did not see reasons to believe that oil has a value in the market as a result of the record sales and potential gains in view. In 1937, after another license was issued to the Shell D'Arcy petroleum development company of Nigeria, a consortium of Shell and British Petroleum, they began their explorations all over the country. In 1953, Oil was discovered in Akata, Afam, and Bomu in Ogoni territory but all in non-commercial quantities till 1956, when oil of commercial quantity was discovered in Oloibiri, Niger Delta area of Nigeria. So, the commercial oil filed began

production in 1958. Other non-British companies like Mobil, Gulf Oil, Chevron, and Elf were also issued licenses to explore oil in the 1950s. Although this marked a decline in the production of agricultural export crops (which used to be the pillar of the economy), the economy of Nigeria experienced a boost with this discovery. After 1960, exploration rights were extended to other foreign companies to explore oil in both theinshore and offshore areas of the Delta state.

The discovery of oil in Nigeria placed Nigeria in rank with other oil producers countries when its first oil field started producing commercial quantities of about 5,100 BPD. The first EA filed was discovered by Shell in shallow water southeast of Warri. The end of the Biafran war in 1970 coincided with the rise in the world oil price, and Nigeria was able to accumulate noncapital demanding riches that are spontaneous from the production of oil. During the period of the late 1960s to early 1970s, Nigeria was able to level up to the production of fewer than 3 million barrels of crude oil daily.

It is worthwhile to also know that the Nigerian Government officials have been the ones accessing the profits derived from oil exploration. In 1971, as a result of the level of crude oil available for Nigeria and its potential export rate. Nigeria because she discovered crude oil and relevance to oil matters made rejoined the organization of Petroleum Exporting Countries (OPEC) and simultaneously needs to set up her own petroleum company which led to the establishment of the Nigerian National Petroleum Company (NNPC) in 1977, which is state-owned and controlled company which was to play a key role in both streaming sectors. Strategies were then put in place to increase the production of 4 million barrels per day by the year 2010.

The production of crude oil and its export has played a vital role in national development and so accounts for about almost 100% of her total revenue. In the last two decades, oil and gas exports accounted for more than 98% of export earnings and approximately 83% of federal government revenue, as well as generating more than 14% of its GDP. It also yields 95% of foreign exchange earnings and about 65% of government budgetary revenues.

b) *Pipeline Network in Nigeria*

Although Nigeria has a total of 159 oil field and 1,482 oil wells in operation. According to the Department of Petroleum resources, the most productive region in terms of quantity derived is from the Niger Delta Basin in Niger Delta, which encompasses 78 of the 159 oil fields. Most of the other oil fields in Nigeria are minute and not in a single place, and as a result of this, an extensive and well-developed pipeline network was developed to transport the oil.

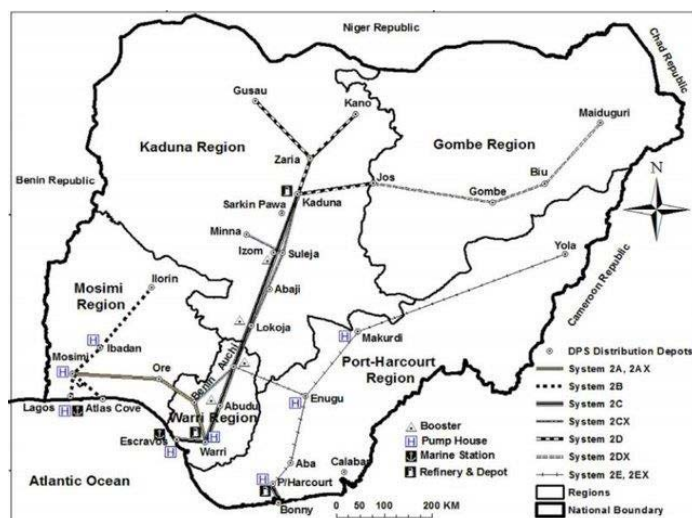


Fig. 1: Pipeline network in Nigeria

Pipelines in Nigeria (NNPC, 2019) in figure 1 shows the pipeline systems used for transporting petroleum products (mainly Premium Motor Spirit (PMS), Automated Gas Oil (AGO), and House Hold Kerosene (HHK)) in Nigeria. The pipeline system is strategically classified into five (5) operational regions. The Nigerian National Petroleum Corporation (NNPC) own and operate the 5001 km asset through its subsidiary, the Pipeline Petroleum Marketing Company (PPMC). The PPMC pipeline network is made up of multiproduct systems for product supply: the buried pipelines link the refineries with distribution depots.

Proper and effective pipeline Network for the transport of petroleum and other natural resources was put in place in 1979. This form of bulk transport system increased the connection to improve the country's oil production and meet its growing needs for further distribution and consumption. Today, the pipeline network extends to 3,000km, linking together the major refineries with nineteen depots. There are four refineries in the country: one each in Kaduna and Warri; and two in PortHarcourt, with a nameplate capacity of 438,750 billion b/d. The Kaduna refinery is also linked to the Escravos(Lagos) terminal, through Warri, by a crude oil pipeline. The pipelines are then divided into nine. Since 1979, the advent of this pipeline mode of transport has accounted for 68 percent of all refinery products transported and this number has increased over the years.

c) Pipeline Disasters (PPMC, 2018)

Disaster is any occurrence in shock which could either be naturally occur in, or otherwise, which has way impact, and severity on the individual, community or society and they must respond to this sudden or progressive effect by taking standard measures. It's no news that the familiarity of this word is a growing concern in the world today. This phenomenon of disaster is becoming rampant in society

and concern throughout the world at large. The challenges associated with pipeline alone are enormous and, as such, trend more risks to the lives of people, their properties, and even making their environment unsafe to them. Also, the sources of income of the people tend to be threatened there's more risk in the level of occurrence of disasters for large populations in recent years as a result of pipeline disaster due to the volatile nature of petroleum products. The occurring disasters have led to the loss of lives and properties in Nigeria.

The Risk management board of Bovas (2018) states:

September 2017 : > 160 killed in Asaba

April 2011 : > 175 killed in Lagos

July 2008: > 200 killed in Delta

Dec 2006: >270 killed in Lagos;

May 2006: >160 killed in Lagos;

Dec 2004: >30 killed in Lagos;

Sept 2004: > 70 killed in Lagos;

June 2003: >125 killed in Abia;

Jul 2000: >310 killed in Warri; Mar 2000: >70 killed in Abia;

Oct 1998: >1,170 killed in Jesse.

d) Immediate Causes of Pipeline Disasters

Petroleum is a complex mixture of hydrocarbons. It is a natural occurring fossil fuel as it is an accumulation of the remain of dead organic matter such as animals and plants that decayed several years ago. These remains sank to the bottom of water bodies and passed through a lot of processes under pressure, temperature, and heat, which makes sediment and then referred to as sedimentary rocks. Although Petroleum is a general word in describing a wide range of hydrogen and carbon compounds that are either gases, liquids, or solids under the earth's surface. There are several forms of petroleum, but the common ones are natural

gas and crude oil, which is sometimes used for the world petroleum. Petroleum consists of complex hydrogen, and carbon compounds like alkanes, alkenes and alkynes. They possess different colors and vary depending on the chemical composition, which could be red, brown, black, red, yellow, and sometimes green.

There are causes of pipeline disasters, and many are grouped into Structural problem (40%), operational error (6%), outside force damage (27%), control problems (2%) and others (25%). In 2005, Moffat and Linden published compiled background research and information associated with oil pipeline failures. The report showed that the causes of downfall on the part of the pipeline are not accrued to a particular sector, which is why it's random. Whenever the transport system also blow up, the crude oil been transported at the moment is lost, and that brings shortage to the crude oil and the subsequent passage of petrol transport to other countries either as export or import. This will also bring about an increase in the value attached to the selling of crude oil as a result of damages caused to the transport system. (UNDP, 2006). Research studies have proved that there is more factual evidence of the relationship between the unstable oil-producing regions in Nigeria and the prices they are put for sale (Khalifa, Alsarhan, & Bertuccelli, 2017). There's a higher level of unstable production in oil-producing regions as there will be no exact quantity expectancy of crude oil and as such causes disruption in the chain supply as stated in (Misund and Oglend 2016) and (Chen and Xiao, 2015). They also pointed out that petroleum companies usually try to find ways of controlling expected destruction in the supply chain by adopting strategies which may affect the demand and supply more effectively (Liu, Liu, Zhu, Wang, and Liang (2016).

Another important factor contributing to the pipeline vandalism in Nigeria is Institutional factors, just like it is in many other African countries. Practical results show that there's a high level of correspondence between poor governance and pipeline vandalism. Several African and Latin American Cities are faced large socioeconomic challenges, which were observed to have a ripple effect on macroeconomic instability such as high government budgets with little or no positive results, high inflation rate, and weak legal systems. Weak institutions promote macroeconomic instability, which leads to unstable property rights and also a lack of equal opportunities for education, which may lead to state failure (Acemoglu, Johnson, Robinson, & Thacharoen, 2003). This factor also points to the reason why many developing countries have a high level of corruption promoting weak law and the absence of accountability. This also explains the low freedom level enforced by the government on her citizens (Bräutigam & Knack, 2004). OSHA (2017) also emphasized that some acts of the government and some stakeholders also accounts for this usual pipeline

explosions, of which such attributes include; Negligence, carelessness, and violations of Occupational Safety and Health Administration, workplace safety regulations, are few among the regular factors. Another factor that causes Pipeline explosions is when carelessness of citizens in such that when heavy-duty machines like drilling borehole machines hit a pipeline, which may eventually lead to an explosion.

In Addition to all the factors causing pipeline accidents, other factors that can cause a pipeline accident include:

- Poor maintenance of pipes, joints, and valves
- Metal fatigue
- Corrosion
- Mechanical damages.
- unduly repair welds
- Faulty products
- Chemically caused accidents.
- Mis input of application codes.
- Inadequate safety practices
- Pipeline companies are often

It is no news that the institutions such as governmental agencies guiding Nigeria has failed in years back, which is leading to the counter-reaction by her citizens. UNDP (2006) also observed that even though a large amount of funds is allocated to NDDC, OMPADEC, and derivation fund to enhance the development of the region, less is achieved. This is believed to be a result of corruption, mismanagement of funds, and abuse of constitutional rights acclaimed to citizens. The reason why there has been no meaningful development through infrastructural provision as environmental protection is not prioritized as a result of bad governance. In addition, D'Agostino et al. (2016) posted that on the note that there are abundant resources that are meant to benefit and improve the lives of Africans, which turns out to be natural resources of curse leading to conflict as a result of greediness, and corruption. It is reasoned that a country's institution in which the legal, social and political system influences the economic performance of the country could not do much to make a difference. (Ambituuni, Amezaga & Emeseh, 2014; Kherallah & Kirsten, 2002). Sadly, weak government institutions results in failures to protect the environment because of the poor enactment of environmental laws (Amezaga, 2015). This will not only happen but also inspires the host communities and make youths see more reasons to vandalize governmental properties, especially the pipelines with the aim of reacting to the negligence of government and destruction of their lands and water bodies.

This then turns to a channel for sustenance of life and occupation for many active abled bodies and

even community leaders in the Niger Delta part of Nigeria. Countless researches claimed that weakness of organization bodies, both governmental and nongovernmental, injustices, and corrupt acts force people to retaliate back in a negative channel and quite self-destructive (Dzhumashev, 2014). Also, D'Agostino et al. (2016) blamed governmental bodies for ever-increasing budget without putting to priority the well being of the citizens in terms of basic amenities, which will promote corruption and encourage the citizens to strive for themselves either legally or otherwise. All these are resulting in anger and loss of confidence in government by the youths triggers the vandalism of pipelines. This evidence is spare head has the number of programs set up by the Nigerian government such as the NDDC, OMPADEC, MND, which failed to serve the proposed purpose as a result of corruption, which has inspired pipeline vandalism. Akpomera (2015) observed that policies enacted by these ruling political institutions of rationalize always support unfair act by their team circus of elites and government officials, which in turn lessen the people's trust in the government and justice system. Ulman and Bujancă (2014). Although the military option was taken to deal with authority body in the pipeline disasters of Niger delta region of Nigeria which led to the befall on the citizens even victims that has little or no idea about the vandalism and there death was recorded as many civilian death as reported by Lutz, 2013).

Nigeria exports a substantial quantity of crude oil as a revenue generation channel, and the United States is a spring day customer as they consume about 40% of Nigeria's total oil exports. Although, Nigeria only provides 10% of its imports but ranks as the fifth-largest source for the U.S. imported oil (Bovas, 2018). Nigeria has been a member of the Organization of Petroleum Exporting Countries (OPEC), in mid-2001, it's crude oil production was averaging around 2.2 million barrels (350,000 mi) per day. Recent studies show that Nigeria's proven oil reserves is estimated to be 35 billion barrels; natural gas reserves are well over 100 trillion ft³ (2,800 km³). These quantities of petroleum is high and well enough to sustain some countries. Still sadly, vandalism as a result of poor incorporation of community members, severe environmental and ecological disasters, security challenges and greediness of the active youths and top leaders have cut through the Niger Delta oil which plagues into the oil sector (Bovas, 2018). Despite all these, there's no government program guiding the citizens or sensitizing them on how to limit these disasters, the major multinational oil companies have launched their community development programs. One of these new entities include, the Niger Delta Development Commission (NDDC). This was created to catalyze and sensitize the social development in the region Even though it has not fully launched all its programs; It has

created help to that economic and social development in the region.

III. RESEARCH METHODOLOGY

a) Study Area

The study area is Nigeria, and it stretches through 923,769 Km² a range of which 13,000 square kilometers is covered by water across 36 states from north to south. With a population of 187 *million* in 2017, the nation has substantial resources including crude oil. In Nigeria, states which are the largest oil-producing states and make up the 9 Federating States in the Niger Delta Region of Nigeria are, Cross River, Abia, Akwa Ibom, Ondo, Rivers, Delta, Bayelsa, Imo and Edo States.

b) Data source

This study used both primary and secondary data. The primary data from a collection of data with well-structured questionnaires and employed the use of Structural Equation Model (SEM) for analyzing the proposed objectives. The well-structured questionnaires were shared among the respondents and they were administered to them in the study area with adequate explanation and guide for putting them to the right response from their perspective. The respondents were given enough time to see to the different sets of questions relating to causes of pipeline disasters and its reaction on the environmental issues, their awareness about the effects, and their consent level about the significance of environment using the Likert-scale options. The total respondents did not fully capture all questionnaires, but the returned ones consist of 196 males and 90 females. The socio-economic characteristics of the respondents such as age as follows: 33.6% fall within the age group of 20–30, 36.4 % made up characters between the age group of 31–40, while 10.1 % is made up of the age group of 41–50 and 5.2% is made of up the ages of 50 and above. Age is necessary to this study because the focus is on young and sharp minds of the communities affected by pipeline disasters.

c) Normality assessment

The normality assessment is not compulsory for justifying this research; it becomes necessary before undertaking SEM analysis. Although, there are a rising interest of different consent between scholars on the cut off points for skewness and kurtosis. Some researchers opined that there should be a normal distribution with the two signs basis of positive and negative sign. (DeCarlo, 1997; Kline, 2011). Factually, no agreement has been reached on the normality assessment (Kline, 2011). For this study, absolute kurtosis values ranging from ± 2.0 to ± 7.0 and higher have been proposed as possible early departure points of non-normality (Byrne, 2013 citing Boomsma & Hoogland, 2001; DeCarlo, 1997; West, Finch, & Curran, 1995).

d) Formulation of the Confirmatory Factor Analysis Model

The Confirmatory Factor Analysis (CFA) is an alignment of EFA, and CFA is theory-driven which tries to test specific hypotheses or theories about the dimensional structure that underlines some set of variables. This analytical tool is regarded as a superior model of analysis because its purpose is to establish a figurative relationship between observed and unobserved variables. Amos graphics version 22 was used in analysing of the study. The CFA postulate and analysis research works based on the relationship between variables and indicators. This makes a researcher put a theory to test and have access to a full observation of the latent variables (Kline, 2011; Loehlin, 2004). The model for the study, even though affirmed, was validated by other expert researchers in the field after a series of pre-tests.

IV. DATA ANALYSIS AND RESULTS PRESENTATION

This chapter gives an analysis of data collected from the field. It also presents, interprets, and discusses the findings as contained in the study. The structured Questionnaire serves as the basis for statistical analysis in which data retrieved was analyzed using appropriate statistical tools. The descriptive analysis of the data involves the use of tables, percentages frequency, and mean. While inferential statistics were carried out using Confirmatory Factor Analysis (CFA) and regression, to understand the intermediate and remote causes of pipeline disaster in Nigeria. A study of selected areas was carried out.

a) Data Analysis and Presentation

Survey copies of questionnaires were administered directly to respondents in selected listed areas. Out of three hundred (300) questionnaires distributed and sample selected, the study was able to accomplished a ninety-five-point three percent (95.3%) response rate, which makes the study to be more reliable and valid. Also, the whole retrieved questionnaire was deemed fit, and usage for the study. The response rate is considered adequate for the study.

i. Demographic Data Analyses

Six (6) demographic variables are included in this study. They are age, gender, marital status, education level, employment status and income level. The results in below tables and figures represent the distribution of sample individuals according to demographic variables.

Table 1: Respondents Age

Response	Frequency	Percent
Less than 20years	42	14.7
20-30years	96	33.6
31-40years	104	36.4
41-50years	29	10.1
50years and above	15	5.2
Total	286	100.0

Source: Field Survey (2020)

Table 1 shows the age distribution of the respondents; it revealed that the mean age of the respondents is 57 years. This implies that on average, the respondent's age is 57 years. Put differently; it was observed that majority 36.4% of the respondents, 14.7% were less than 20years, 33.6% were 20-30years, 10.1% were 41-50years and only 5.2% were 50years, and above. Table 2 shows the gender of respondents. It revealed that the majority 196(68.5%) of the respondents are male, while 90(31.5%) are female.

Table 2: Gender

Response	Frequency	Percent
Male	196	68.5
Female	90	31.5
Total	286	100.0

Source: Field Survey (2020)

Table 3: Marital Status

Response	Frequency	Percent
Single	88	30.8
Married	102	35.7
Divorced	32	11.2
Widow	34	11.9
Separated	30	10.5
Total	286	100.0

Source: Field Survey (2020)

Table 3 shows the gender of respondents. It revealed that the majority (35.7%) of the respondents are married, follow by 30.8% who showed they are single. Further, 11.2% revealed they are divorce, and 10.5% are separated.

Table 4: Employment Status

Response	Frequency	%
Unemployed	106	37.1
Employed	180	62.9
Total	286	100.0

Source: Field Survey (2020)

Table 4 shows the employment status of respondents. It revealed that the majority 180(62.9%) of the respondents are employed while 106(37.1%) are unemployed.

Table 5: Education Level

Response	Frequency	Percent
No formal Education	56	19.6
Primary	81	28.3
Secondary	77	26.9
Tertiary	72	25.2
Total	286	100.0

Source: Field Survey (2020)

Table 5 shows the education level of respondents. It revealed that the majority (28.3%) of the respondents had attained primary school certificate, 19.6% had no formal education, 26.9% had attained secondary school certificate, and 25.2% had attained tertiary school certificate. This result implies that the majority of the respondents had a formal education certificate.

Table 6: Income Level

Response	Frequency	Percent
Less than 200k	90	31.5
200k - 399k	82	28.7
400k - 699k	40	14.0
700k – 999K	42	14.7
1m and above	32	11.2
Total	286	100.0

Source: Field Survey (2020)

Table 6 shows the income level of the respondents. It revealed that the majority (31.5%) of the respondents earned between less than N200k annually, 28.7% earned between N200k – N399K, 14% earned between N400k – 699k annually, 14.7% earned between N700k – N999K. And lastly, 11.2% of the respondent earned 1m and above.

b) Reliability

Hair et al. (2010), state that reliability is a measure of the degree to which a set of indicators of a latent construct is internally consistent in its measurement based on the degree to which the indicators are interrelated. Cronbach's Alpha is normally used to measure this internal consistency or reliability (A scale is considered reliable when Cronbach's alpha is greater than 0.7.).

i. Cronbach's Alpha Reliability

Cronbach's Alpha for each variable was calculated to reach the threshold. Causes of pipeline disaster produced a Cronbach's Alpha value of 0.983,

and there were no lower values for the individual item correlations. This showed that the scale was acceptable for further multivariate analysis. Risk perception of pipeline disaster was considered next, and this produced the highest Cronbach's Alpha value of 0.985. It was therefore proven that all four scales were sufficiently reliable for further analysis. Lastly, the preparedness of pipeline disaster produced a Cronbach's Alpha value of 0.983, and there were no lower values for the individual item correlations (see table 7 below).

Table 7: Cronbach's alpha reliability of latent variables

	Items	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Causes of Pipeline disaster	Poor management of pipes, joints and valves	.939	.982	
	Pipeline vandalisation	.978	.976	
	Black Market	.944	.980	.983
	poverty	.919	.982	
	Weak political factors	.949	.979	
	Unemployment	.957	.978	
Preparedness of pipeline disaster	I have considered the risk of pipeline the explosion when deciding to live in the house I do now	.954	.975	
	I have obtained a working fire extinguisher	.973	.972	
	I have arranged a place to meet with family or friends in case of pipeline explosion	.965	.973	.981
	I have attended a meeting on how to better prepare for the pipeline explosion	.881	.986	
	I have purchased first aid kit	.954	.975	
Risk perception	How often do you think about preparing for the possibility of a pipeline disaster	.966	.981	
	How often do you think about the threat of pipeline disaster	.942	.984	
	How often do you think about the potential of a pipeline disaster	.957	.982	.985
	How much do you care about pipeline disaster	.953	.982	
	How aware do you think the public is concerning the issue of a pipeline disaster	.972	.979	

Source: Field Survey (2020)

c) Analysis Based on latent variables

The weightings adopted for the section are SA=5, A=4, N=3, D=2, and SD=1. Mean value = $(5 + 4 + 3 + 2 + 1)/5 = 15/3 = 3.00$. A cut off point of 3.0 will

be adopted for decision taking. If the item mean value is equal to or greater than 3.0 the item is accepted, but if it is less than 3.0, the item is rejected

Table 8: Environment Awareness of Pipeline disaster

Responses	SD(%)	D(%)	N(%)	A(%)	SA(%)	MEAN	Remark
Environment Awareness of Pipeline disaster	42 (14.7)	16 (5.6)	78 (27.3)	95 (33.2)	55 (19.2)	3.37	AGREE

Source: Field Survey (2020)

As revealed in Table 8 above it was obvious that the environment is aware of pipeline disaster dues to the agreement and disagreement of respondents to the statement under construct.

Table 9: Factors that causes pipeline disaster

Responses	SD(%)	D(%)	N(%)	A(%)	SA(%)	MEAN	RANK
Poor management of pipes, joints and valves	88 (30.8)	27 (9.4)	36 (12.6)	62 (21.7)	73 (25.5)	3.02	6TH
Pipeline vandalisation	36 (12.6)	53 (15.7)	44 (15.4)	70 (24.5)	83 (29.0)	3.39	4TH
Black Market	42 (14.7)	16 (5.6)	78 (27.3)	95 (33.2)	55 (19.2)	3.37	5TH
poverty	23 (8.0)	18 (6.3)	34 (11.9)	98 (34.3)	113 (39.5)	3.91	1ST
Weak political factors	15 (5.2)	81 (28.3)	19 (6.6)	102(35.7)	69 (24.1)	3.45	3RD
Unemployment	65 (22.7)	38 (13.3)	70 (24.5)	93 (32.5)	100 (35)	3.61	2ND

Source: Field Survey (2020)

As shown in table 9, the causes identified by respondents as the least causes of pipeline disaster are poor management of pipes, joint and valves, black market sale of petroleum products, and pipeline

vernalization which ranked 6th 5th 4th respectively. On the other hand, we can deduce from table 9 that poverty, weak political factors, and unemployment, are the most influential causes of pipeline disaster in Nigeria.

Table 10: level of preparedness of pipeline disaster

Responses	SD(%)	D(%)	N(%)	A(%)	SA(%)	MEAN	DECISION
I have considered the risk of pipeline explosion when deciding to live in the house I do now	79 (27.6)	58(20.3)	40(14.0)	92(32.2)	17 (5.9)	2.69	DISAGREE
I have obtained a working fire extinguisher	89 (31.1)	34(11.9)	70(24.5)	45(15.7)	48 (16.8)	2.75	DISAGREE
I have arranged a place to meet with family or friends in case of pipeline explosion	94 (32.9)	72(25.2)	29(10.1)	58(19.9)	33 (11.9)	2.53	DISAGREE
I have attended a meeting on how to better prepare for pipeline explosion	42 (14.7)	16 (5.6)	78(27.3)	95(33.2)	55 (19.2)	3.37	AGREE
I have purchased a first aid kit	102 (35.7)	67(23.4)	39(13.6)	36(12.6)	42 (14.7)	2.47	DISAGREE

Source: Field Survey (2020)

As showed in table 10, the variables for disaster preparedness as measured through actual preparedness behaviours such as acquiring a first-aid kit, having a family evacuation plan, attending meetings of how to better prepared and purchase of fire extinguisher. This is driven mainly by the need to increase preparedness at the individual level. As indicated by Miller, Adame, and (2013): "Some large

amount of the respondents revealed they are unprepared for pipeline disaster; due to their response towards preparedness for pipeline disaster. For instance, the majority 58.4% and 67.5% disagree and strongly disagree to the arrangement of a place to meet with family or friends in case of a pipeline explosion and obtaining a working fire extinguisher, respectively.

Table 11: Risk perception of individual on pipeline disaster

Responses	N (%)	NO (%)	S (%)	VO (%)	A (%)
How often do you think about preparing for the possibility of pipeline disaster	34 (11.9)	56 (19.6)	67 (23.4)	76 (26.6)	53 (15.7)
How often do you think about the threat of pipeline disaster	42 (14.7)	16 (5.6)	78 (27.3)	95 (33.2)	55 (19.2)
How often do you think about the potential of pipeline disaster	67 (23.4)	51 (17.8)	13 (4.5)	112(39.2)	43 (15.0)
How much do you care about pipeline disaster	89 (31.1)	34 (11.9)	70 (24.5)	45 (15.7)	48 (16.8)
How often do you think the public is concerning the issue of pipeline disaster	36 (12.6)	53 (15.7)	44 (15.4)	70 (24.5)	83 (29.0)

Source: Field Survey (2020)

Note: N = Never, NO = Not Often, S = Sometimes, VO = Very Often, A = Always

As showed in table 11, it was obvious that most of the respondents perceived more risk of pipeline disaster, this was observed due to reaction of the respondents to the questions under risk perception. For instance, about 53.5% of the respondent very often and

always think the public is concerning the issue of pipeline disaster.

d) Test of Normality

It is important to check the normality of data before embarking on Confirmatory Factor Analysis. The skewness and Kurtosis were adopted in this study to examine the normality of the data collected through the filed survey. It has been observed that there is a lack of consensus among scholars and in different kinds of literature on the cut-off points for determining normality

of data using skewness and kurtosis with a base of the positive and negative sign of kurtosis and the skewness (DeCarlo, 1997; Kline, 2011). However, some scholars agree on absolute kurtosis values ranging from ± 2.0 to ± 7.0 and higher to be a sign of non-normality of data set (see Byrne, 2013; Decarlo, 1997; West, Finch, & Curran 1995). The normality test of the data for this study is presented in table 12 -:

Table 12: Normality Test

				N	Sum	Mean	Skewness	Kurtosis
		Awareness		286	963	3.37	-.582	-1.585
Causes of Pipeline disaster		C1		286	863	3.02	-.106	-1.584
		C2		286	969	3.39	-.351	-1.206
		C3		286	963	3.37	-.582	-1.285
		C4		286	1118	3.91	-1.112	1.325
		C5		286	987	3.45	-.338	-1.239
		C6		286	1033	3.61	-.764	-1.837
Preparedness of pipeline disaster		D1		286	768	2.69	.036	-1.423
		D2		286	787	2.75	.160	-1.319
		D3		286	723	2.53	.432	-1.235
		D4		286	963	3.37	-.582	-1.324
		D5		286	707	2.47	.557	-1.089
Risk perception		E1		286	916	3.20	-.193	-1.039
	E2	286	963	3.37	-.582	-1.585		
	E3	286	871	3.05	-.245	-1.464		
	E4	286	787	2.75	.160	-1.319		
	E5	286	969	3.39	- .351	- 5.206		

Source: Field Survey (2020) SPSS 25.0

As shown in Table 12 above, following the study of Byrne (2013) by using kurtosis within the range of ± 2.0 and ± 7.0 . The skewness of the data for this study falls within -1.112 to -.160, while kurtosis 1.194 to -5.206, which is still within the acceptable limit. From the questionnaire the respondents were asked set of questions relating to causes of pipeline disaster, risk perception of pipeline disaster, awareness about pipeline disaster and level of preparedness of pipeline disaster as indicated in the questionnaire from the Likert-scale options 1–5: Strongly Disagree = 1; Disagree = 2; Disagree = 3; Agree = 4 and Strongly

Agree = 5. As well as 1 = Never, 2 = Not Often, 3 = Sometimes, 4 = Very Often, 5 = Always

e) Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) was adopted in this study to provide analysis of the relationship between the key variables (such as demographic characteristics, risk perspective, and preparedness of pipeline disaster) and their corresponding indicators.

Table 13: Model Fit Evaluation of the Confirmatory Factor Analysis

Metric/Statistic	Observed Value	Recommended value
CMIN/df	3.904	between 1 and 3
CFI	1.000	>0.950
RMSEA	0.042	<0.060
CLOSE	0.904	>0.050

Source: Field Survey (2020) AMOS 24.0

As showed in table 13 above, it was observed that the fitted CFA model showed goodness-of-fit to the

data. All the factors showed high loading values, and thus, none of the factors were removed. The model fit

indices showed values which are above the threshold and was reported as such. Table 4 below shows that the goodness of fit for the measurement model is sufficient (see appendix.)

f) *Structural Model*

Composite variables were created using factors from AMOS version 24. The data was imputed to derive

the composite variables and they were used to create the composite model. The path diagram for the CFA was present in figure 1 below:

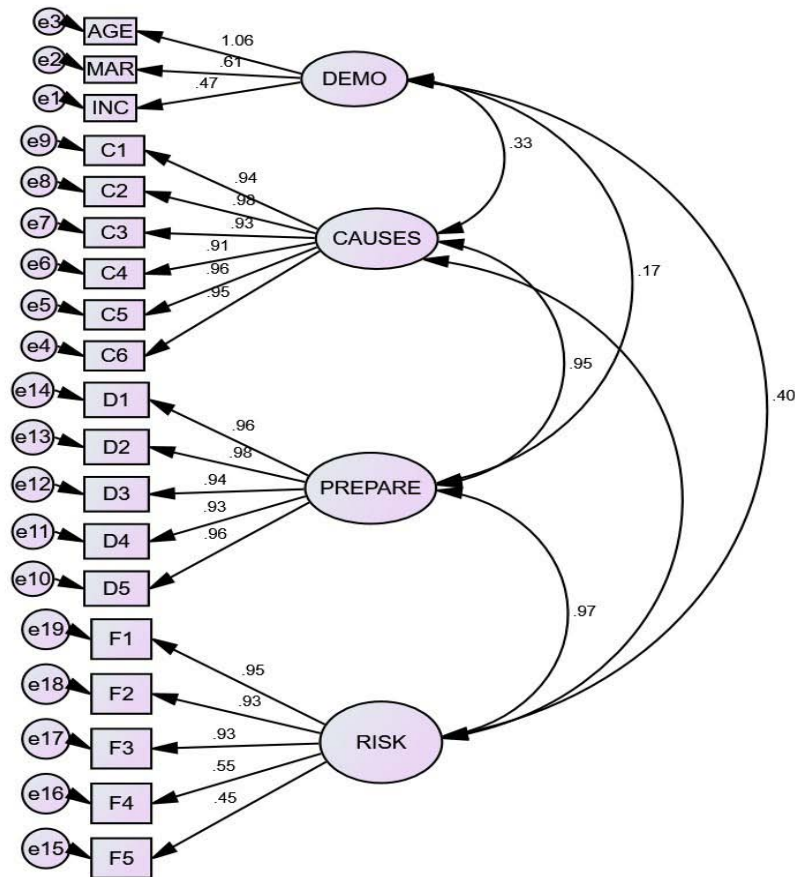


Figure 2: Confirmatory Factor Analysis (CFA)

Notes for Model (Default model)

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	190
Number of distinct parameters to be estimated:	44
Degrees of freedom (190 - 44):	146

Result (Default model)

Minimum was achieved

Chi-square = 7614.019

Degrees of freedom = 146

Probability level = .000

Note: C inputs represent causes of pipeline disaster, D inputs represent, Preparedness for pipeline disaster and F input represent risk perspective of pipeline disaster.

Table 14: Structural Equation (Model)

			Estimate	S.E.	C.R.	P
Pipeline Disaster	<---	Demo	0.923	0.019	48.018	***
Pipeline Disaster	<---	Causes	0.844	0.022	38.951	***
Pipeline Disaster	<---	Prepared	0.887	0.022	41.19	***
Pipeline Disaster	<---	Risk	1.023	0.018	57.224	***

Source: Field Survey (2020) AMOS 24.0

Note: *** indicate variable significance at 1%

From the model in table 14 above, the results generated indicated that demographic factors (such as age, marital status, and income level) significantly contribute to pipeline disaster in Nigeria (Coefficient = 0.923, CR = 48.018 & P value = 0.000). The study also revealed that factors such as poverty, poor management of pipelines, political factor and all other factors treated in the study contribute to pipeline disaster in Nigeria. Further, it was also observed that preparedness and risk perceptive factors also contribute to the pipeline disaster in Nigeria.

V. CONCLUSION AND RECOMMENDATIONS

Base on the findings of the research, the demographic details of the respondents, shows they are majorly active youths (gender; male and age; 31–40 years), with the majority of them having primary school certificates. The researchers conclude that poverty, weak political factors, and unemployment, are the most influential causes of pipeline disaster in Nigeria, while some of the least significant factors are; poor management of pipes, joint and valves, black market sale of petroleum products, and pipeline vandalization. It was also affirmed that a large percentage of the respondents are unprepared for the disasters to the fact that, the majority disagree and strongly disagree to the arrangement of a place to meet with family or friends in case of a pipeline explosion and obtaining a working fire extinguisher respectively. The researchers also conclude that increase in the creation of wealth by providing employment opportunities and also social amenities in the form of infrastructure such as good roads, health facilities, stable electric supply, pipe-borne water and reduction in land degradation will bring an end to vandalism of pipelines thereby reducing the disasters level and sustain lasting peace within the society. Furthermore, the researchers also recommend that:

- (i) Technical know-how with the pipeline should be handled by experts and the coatings of the outside should be tackled by improved Coatings such as the use of polyethylene at multiple layers for longer life. The degradation on any of the pipelines should be regularly checked, and as soon as it is detected of leaks should be a tester with hydrostatic testing.

- (ii) Internal corrosion should also be prevented by dehydration of gases and periodic pigging of lines to remove accumulated deposits or water.

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Characterization of Urban Storm Water Quality for Different Land uses in Rajshahi City, Bangladesh

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Abstract- Urbanization results increased fraction of impervious surfaces, which leads to the generation of pollutants through various anthropogenic activities during dry periods and washout these pollutants during rainfall events that finally enter into the receiving water bodies. This further deteriorate the water quality and unbalance the aquatic ecosystem. Hence, characterization of urban stormwater quality is critically important for selecting a suitable treatment system to safeguard the receiving water sources. The paper focused on the analysis of urban stormwater quality parameters (e.g., pH, turbidity, electric conductivity (EC), suspended solids (SS) and biochemical oxygen demand (BOD) for three different land uses such as residential, commercial and, industrial. The stormwater samples were collected from three different land-use areas in Rajshahi City. The laboratory test results showed that SS, turbidity, EC were found significant for industrial areas where pH and BOD show higher value in residential and industrial areas, respectively. The study results will provide guidelines to the stormwater management authority for the selection of suitable treatment systems to protect the receiving water quality for different land types in Rajshahi city.

Keywords: *stormwater runoff, stormwater quality, land use, rajshahi city, principal component analysis.*

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Anupam Chowdhury ^α, Protik Chakraborty ^σ & Tamanna Tanjum ^ρ

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1. INTRODUCTION

Water pollution is a crucial concern now- a -days. It has created many problems for human beings and water bodies. People are suffering from a lot of water-born diseases. It has become a threat to the fishes and other water bodies. Soni et al. (2019) conducted a study on categories, causes, and control of water pollution. Their study results showed that water pollution affects the aquatic ecosystem, including plants that are exposed to the water.

Currently, stormwater runoff has become one of the major sources of water pollution. Due to the rapid urbanization process, natural land turns into the impervious surface, which is a suitable platform for pollutant build-up and wash-off by rainfall events (Goonetilleke et al., 2005). The stormwater runoff enters into the nearby water bodies through drainage systems

or overland flow without treatment and deteriorates the receiving water quality. The type and amount of pollutant generation depend on many factors such as the geology of the land, topography, geography, rainfall intensity and pattern, and land use type (Sarukkalgige, 2011). Guzman et al. (2018) conducted a study to examine the physical-chemical parameters of urban stormwater runoff using artificial rain for different land uses in Bogota, Colombia. They showed that nitrates, nitrites, alkalinity, COD and suspended solids concentration were found higher in the industrial area compared to residential and recreational areas. Also, they showed a similar variations of these pollutants for residential and recreational areas due to the presence of traffic and vegetal species.

A similar study conducted by Lucke et. al. (2018), where the variability of pollutant build-up parameters was investigated for seven residential and five commercial areas in Australia. They showed that the values of suspended solid, nitrogen, and phosphorus were higher in urban residential areas than the commercial areas. In another study, Maharjan et. al. (2017) focused on the development of the build-up model for a large urban Mustoja catchment in Tallinn for different land-use types. Their study results showed that the build-up rate was found higher in the industrial areas compared to commercial and residential areas. Also, commercial areas showed a higher build-up rate than a residential area. A similar study conducted by Khatun et al. (2014), where the variability of pollutant build-up parameters was investigated in five different land uses such as industrial, commercial, residential, heavy traffic, and recreational around Guwahati city, Assam, India. They showed that industrial areas had a higher value of co-efficient of variations compared to other land-use types. In another study, Jarvelainen (2014) estimated the stormwater pollutant load and designed the monitoring system for different land-use types in Lahti city, Finland. In this study, the quality and quantity of stormwater being generated in different land-use areas were estimated. He found that industrial and commercial areas had a higher amount of heavy metals and pollutants compared to other land uses. In another study, Liu (2011) investigated the influence of rainfall and catchment characteristics on urban stormwater

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quality in Gold Coast, Australia. In this study, pollutants build-up samples that were collected from twelve road surfaces in residential, industrial, and commercial areas. Study results showed that commercial and residential areas had relatively higher variations of nutrients and organic carbon build-up than an industrial areas.

Based on the above review, it was understood that the types and amount of pollutants generated vary with different land-use types. Hence, proper characterization of urban stormwater quality for different land-use types is essential for the selection of suitable treatment methods. The aim of this study is to characterize the urban stormwater quality for three different land uses, such as residential, commercial, and industrial areas in Rajshahi City. The study will show us the variation among the parameters of urban stormwater in residential, commercial, and industrial areas after a regular time interval.

II. METHODOLOGY

a) Study Site Selection

The stormwater samples were collected from three different land-use, such as residential,

commercial, and industrial areas in Rajshahi city. Rajshahi is the 4th largest among the eight divisions in Bangladesh (RCC, 2006). It's being developed day by day due to many industries and educational institutes. Due to the rapid urbanization process, stormwater gets polluted by the pollutants generated in road surfaces and washout during rainfall events. The sample collection point was six different road surface runoff such as Alokarmor, New market; Belderpara Mor; Zero-point, Shaheb Bazar; Moni Chattar; BSCIC, Sapura and Match Factory Mor in Rajshahi City (Figure 1). The characteristics of these study sites are discussed in Table 1.

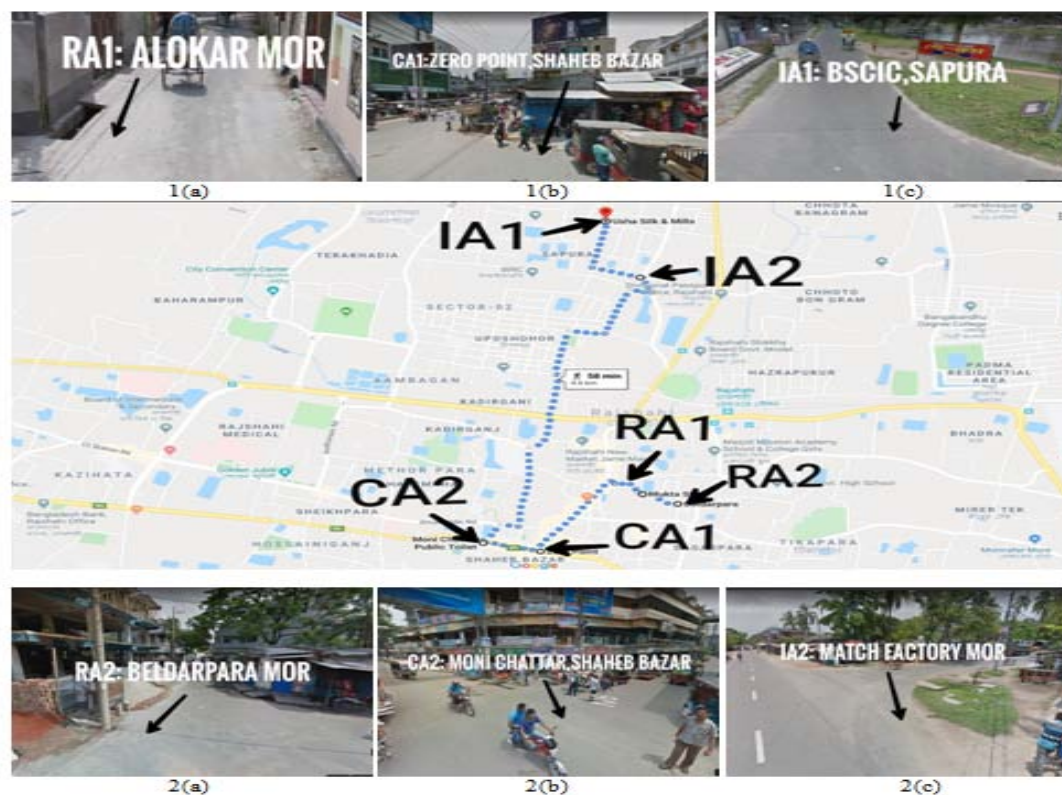


Figure 1: Study sites

Table 1: Characteristics of Study Sites

Land use type	Site Name	Road type	Texture depth (mm)	Location Coordinate
Residential	Alokarmor	Main road	1.78	24°22'1.0"N 88°36'10.8"E
	Belderparamor	Branch road	1.63	24°22'7.1"N 88°36'22.5"E
Commercial	Zero- point, Shaheb Bazar	Main road	2.67	24°21'55.5"N 88°35'59.9"E
	Moni chattar	Main road	2.39	24°21'58.0"N 88°35'50.8"E
Industrial	Bscic, Sapura	Branch road	2.58	24°23'14.3"N 88°36'19.8"E
	Match factory mor	Main road	2.92	24°23'12.8"N 88°36'20.6"E

b) Sample Collection and Laboratory Testing

The stormwater samples were collected from selected six locations (see section II (a)) for three consecutive rainfall events according to the schedule mentioned in Table 2. This further enables to investigate the effect of antecedent dry days on pollutants deposition rate on the road surfaces. The standard sample collection procedure recommended by Simpson et al. (2017) were followed during sample collection. The collected sample bottles were sealed with airtight tape. A permanent marker was used to level each sample bottle for future identification. The collected samples were tested in the public health Engineering laboratory of RUET using the standard test method specified by APHA (2017). Accordingly, stormwater quality parameters such as pH, turbidity, electric conductivity, total suspended solids, and BOD were tested and results were recorded for further data analysis.

Table 2: Sample collection time

Sample collection date	Sample no.
02/06/2019	RA1-1, CA1-1, IA1-1
09/06/2019	RA1-2, CA1-2, IA1-2
25/06/2019	RA1-3, CA1-3, IA1-3
29/08/2019	RA2-1, CA2-1, IA2-1
04/09/2019	RA2-2, CA2-2, IA2-2
09/09/2019	RA2-3, CA2-3, IA2-3

c) Data Analysis Method

To understand the variation of stormwater quality parameters for three different land-use types, univariate analysis was undertaken. However, the correlation among the parameters and their influence on land use types were investigated using a multivariate analysis technique.

i. Univariate Analysis Tools

Mean: The average of a set of data points is measured by it.

$$\bar{X} = \frac{\sum x_n}{N} \quad (1)$$

Here, $\sum x_n$ = sum of data values.

N = the total number of data points.

\bar{X} = mean

Standard Deviation (SD): The dispersion of the data set is measured from its mean.

$$\sigma = \sqrt{\frac{\sum (x - \bar{X})^2}{N-1}} \quad (2)$$

Here, x = individual data points

\bar{X} = mean/average of the data points

N = total number of data point,

σ = standard deviation

Coefficient of variation (CV): The level of dispersion around the mean is measured by CV.

$$CV = \frac{\sigma}{\bar{X}} \quad (3)$$

Here, σ = Standard deviation.

\bar{X} = mean

ii. Multivariate Analysis Tools

Principal Component Analysis (PCA) is a multivariate data analysis technique. PCA is generally used to identify the correlations among the variables and objects which are of similar characteristics. PCA transforms the large datasets into independent new variables called principal component (Abdi & Williams, 2010). The total number of variables influence the number of principal components to be reproduced during transformation. In this transformation, the first principal components represent the highest variance and gradually decrease to end components. Hence, the first two principal components are used to produce PCA bi-plot (Huang et al., 2007). PCA bi-plot is the two-dimensional graphical representation where any two

principal components are plotted in the x and y-axis, respectively. The correlations among the variables and data points can be determined from the PCA bi-plot.

III. RESULT AND DISCUSSION

The summary of the analysis results for different land-use type is presented in Table 3. As seen in Table 3, stormwater pollutants concentration was found variable for different land-use types. This suggests that the distribution of pollutants throughout the catchment is

not uniform and significantly influence by different land use types.

Suspended solids (SS) can be considered as one of the main indicator pollutants due to their capacity to absorb other pollutants such as heavy metals, nutrients, hydrocarbons, and transport them into stormwater runoff (Herngren et al., 2006). The amount of SS was found lower for residential areas compared to commercial and industrial areas. This indicates comparatively clear water in residential area than other sites.

Table 3: Average pollutant loading for each specified land use

Land use type	Sites	Ph			Turbidity (Ntu)			Ec (Ms/Cm)			Suspended Solids (Mg/L)			Bod (Mg/L)		
		MEAN	SD	CV (%)	MEAN	SD	CV (%)	MEAN	SD	CV (%)	MEAN	SD	CV (%)	MEAN	SD	CV (%)
Residential	Alokar Mor	6.90	0.20	1.95	10.00	0.40	3.58	1066.7	115.5	10.82	115.73	10.8	9.39	2.22	0.02	1.82
	BeldarPara Mor	6.78	0.02	0.29	10.16	0.28	2.76	1050.0	50.00	04.76	117.85	2.65	2.25	2.15	0.13	6.04
Commercial	Zero Point	6.57	0.10	1.64	08.52	0.10	1.54	1433.3	57.74	04.02	189.99	4.30	2.26	8.23	0.30	3.06
	Moni-Chattar	6.55	0.05	0.76	08.36	0.26	3.11	1483.3	28.86	01.94	189.87	0.93	0.49	8.32	0.16	1.92
Industrial	Bscic, Sapura	6.42	0.10	0.80	13.17	0.90	6.85	1533.3	57.72	03.76	394.45	4.32	1.09	3.17	0.30	9.11
	Match Factory Mor	6.38	0.02	0.31	12.93	0.02	0.15	1566.6	57.73	03.68	394.31	03.67	0.93	3.27	0.02	0.62

The stormwater runoff from industrial area represents highly polluted compared to other land-use. This can be due to the presence of high amount of SS and turbidity in the industrial area. Also, the BOD value was found slightly higher in the industrial area compared to the residential area. This can be due to the presence of fine organic matters produce from industrial processes and distributed by wind during loading and unloading conditions.

Commercial stormwater resulted in containing low concentrations of suspended solids and turbidity value than industrial sites. But commercial areas are recorded the highest amount of BOD compared to other land uses. This may be due to the generation of the highest organic waste, which decomposed on road surfaces and washout through stormwater runoff. The organic wastes in commercial areas are produced from the local market, fruit seller, decomposed fruit bunch or vegetable waste and distribute along the road side. In contrast, the industrial area produces small amount of organic waste, that's why the value of BOD is lower than the commercial areas.

The comparison of stormwater quality parameters among three different land uses was presented by Box Whisker plot in Figures 2-6.

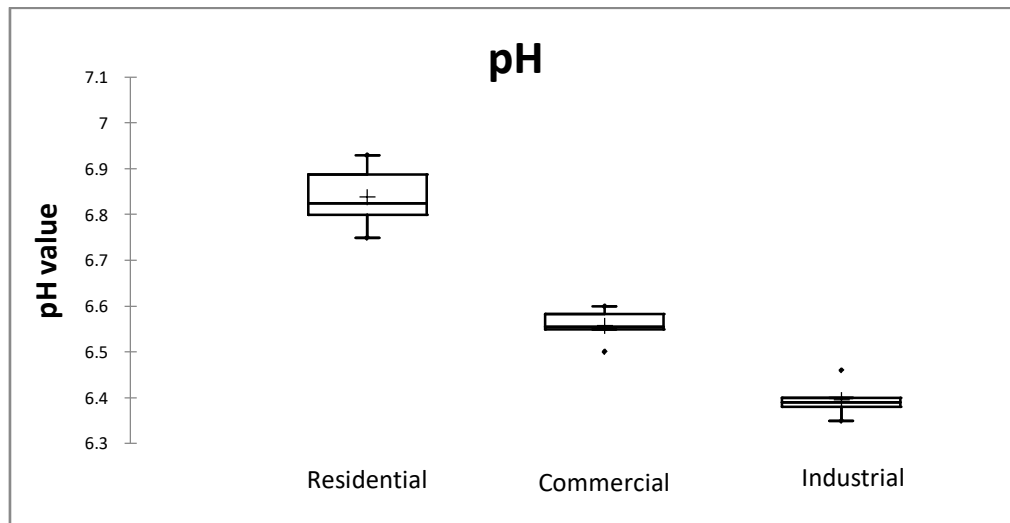


Figure 2: Variation of pH for different land uses

As seen in Figure 2, the highest pH value was found 6.93 in the residential areas where the mean value was 6.83. The commercial area shows the highest value of 6.6, and the mean value is about 6.55. The residential area has a higher concentration compared to industrial and commercial areas. From Table 2, pH value in

residential area displays the highest standard deviation among the three different land uses. This indicates high variability in the value of pH concentration. pH value was found lower for both commercial and industrial areas. This can be due to the presence of chemical and metal that reacts with water and decrease the pH value.

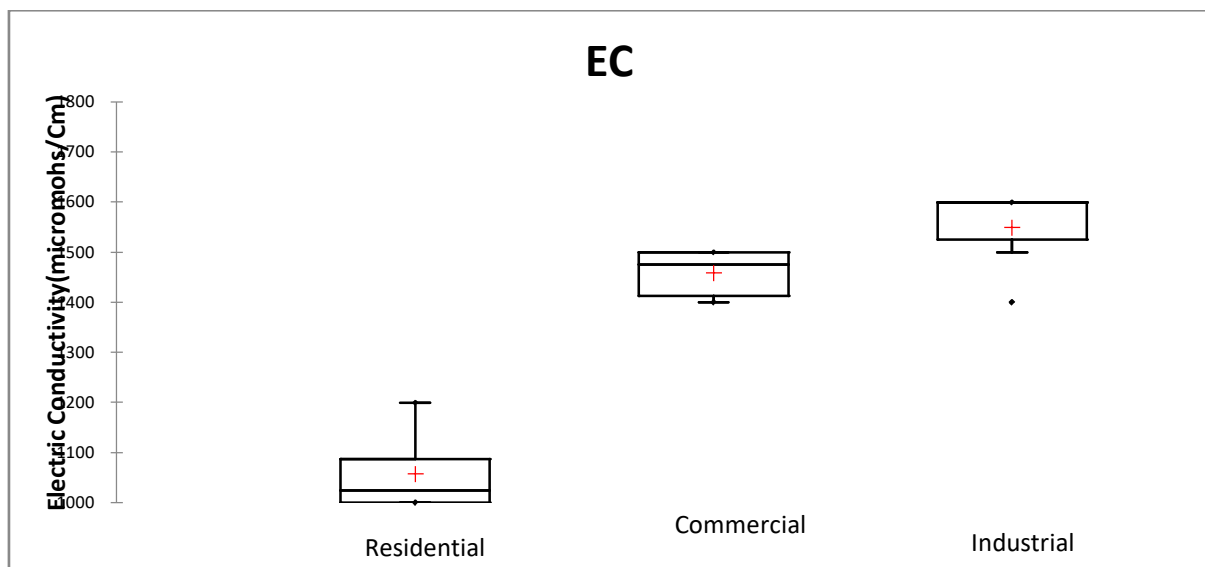


Figure 3: Variation of Electric Conductivity for different land uses

The variation of Electric Conductivity (EC) is shown in Figure 3. The industrial area has the highest conductivity (mean 1550 micromohs/Cm) than residential (mean 1060 micromohs/Cm) and commercial (mean 1460 micromohs/Cm) areas. The reaction of chemical and metal substances with the water flowing from the industrial area is the reason for having a higher value of EC in the industrial area.

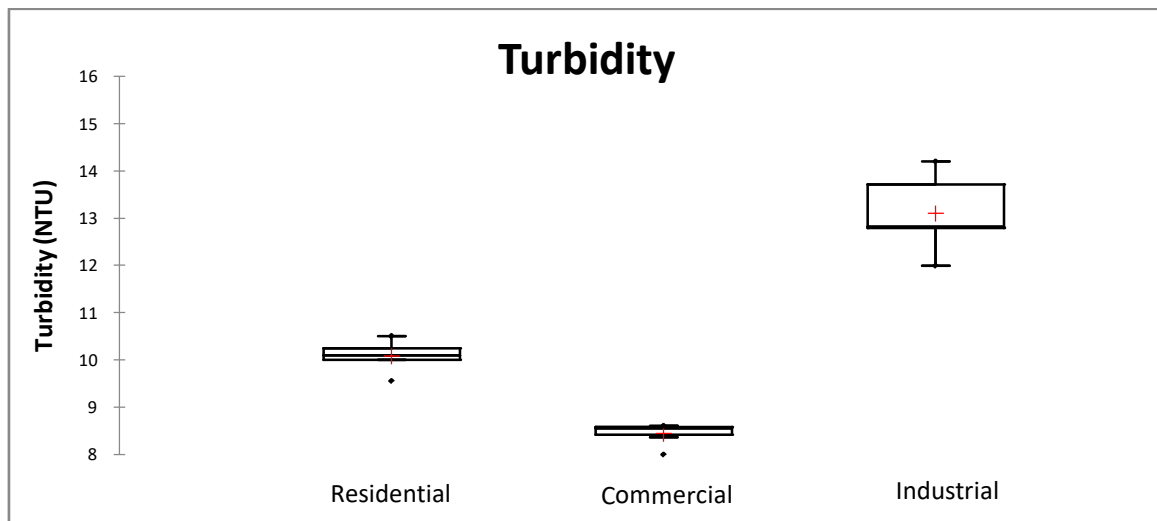


Figure 4: Variation of Turbidity for different land uses

The significant differences of turbidity among three land uses are presented in Figure 4. Water turbidity is directly caused by the presence of suspended matters such as clay, silt, etc. The overall patterns of SS and turbidity concentration in different land uses were similar. Commercial land-use type was significantly less turbid (mean value is 8.45 NTU) than all

other land use types. The highest turbidity was found in the industrial area (mean value 13.15 NTU). This can be due to the presence of the fine particles from the production process of goods and distributed on the road surface by traffic, wind, workers during loading, and unloading time.

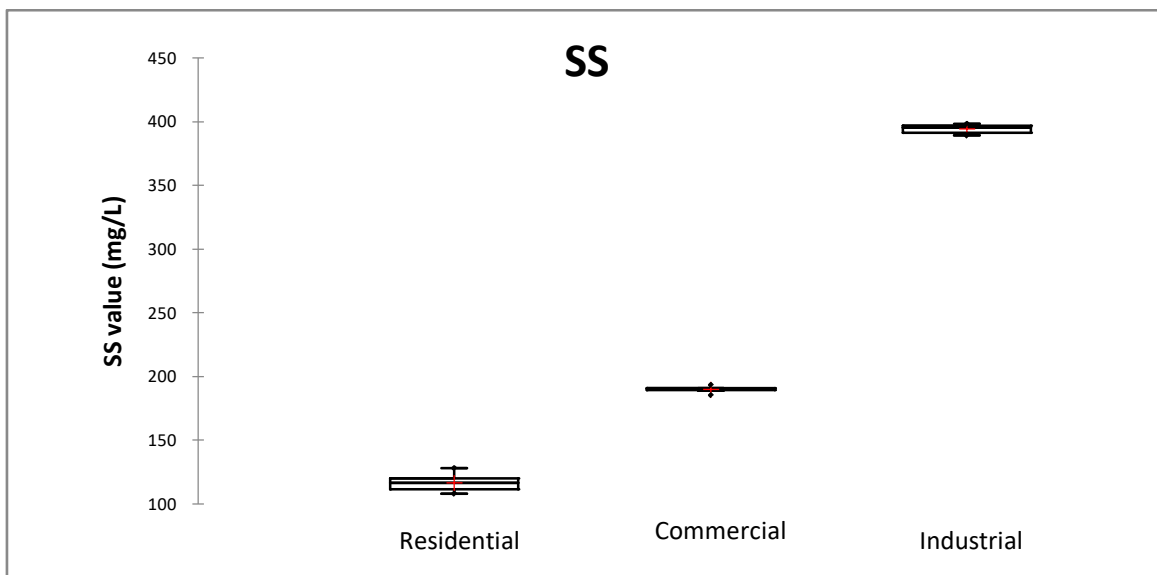


Figure 5: Variation of Suspended Solids for different land uses

The variation of SS for three different land uses shown in Figure 5. The residential area has a lower mean SS value (116.75 mg/l) compared to other land uses. This can be due to the periodic cleaning of road surfaces by street sweepers. It can be seen that the average concentration of SS in the industrial area (394.25 mg/l) was almost two and a half times the values for residential areas. The commercial and industrial area produces a high level of SS. This is due to high population density, traffic density and various

anthropogenic activities occur by human and distribute by traffic and wind.

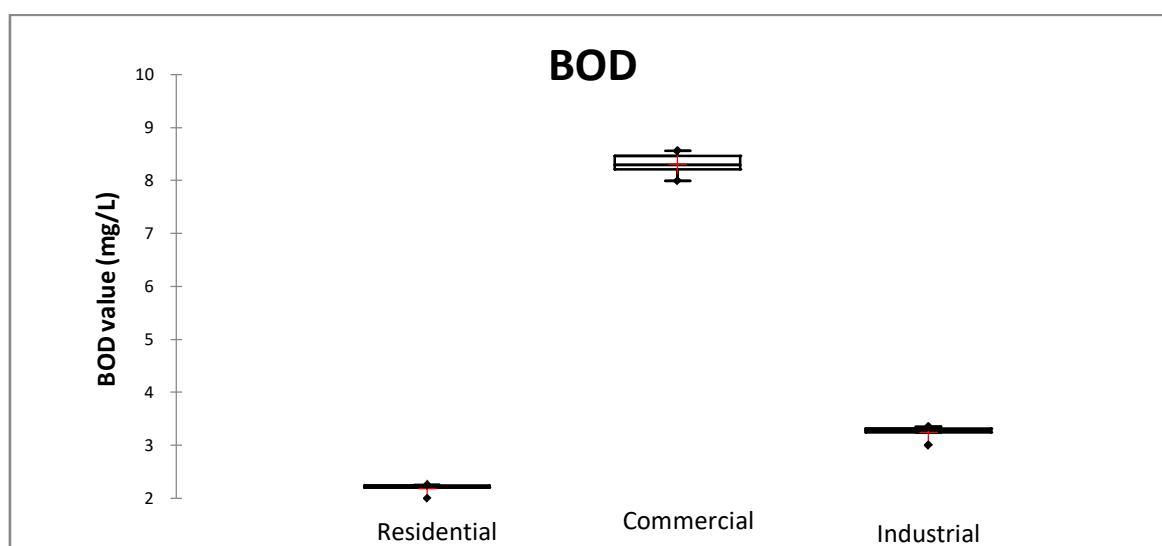


Figure 6: Variation of BOD for different land uses

The variation of BOD concentration is shown in Figure 6. The highest BOD value in a residential area is found 2.25 mg/l, and the mean value is 2.18 mg/l. The commercial area shows the highest value of 8.5 mg/l mean value is about 8.3 mg/l. The residential area has a lower concentration compared to industrial and commercial areas. From Table 3, BOD value in commercial area displays the highest standard deviation. This indicates high variability in the value of

BOD concentration. As we know, the BOD value measures the amount of dissolved oxygen to biologically decompose organic matter. The presence of organic matter is higher in a commercial area that is produced from the local market, fruit seller, decomposed fruit bunch or vegetable waste and distribute along the road side. The residential area produces a small amount of organic waste. That's why the value is lowest among the others.

Table 4: Pearson correlation matrix

Variables	pH	EC	Turbidity	SS	BOD
pH	1	-0.913	-0.464	-0.888	-0.302
EC	-0.913	1	0.278	0.789	0.472
Turbidity	-0.464	0.278	1	0.792	-0.638
SS	-0.888	0.789	0.792	1	-0.102
BOD	-0.302	0.472	-0.638	-0.102	1

The correlation among water quality parameters is essential to identify a possible relationships between them. Table 4 shows the Pearson correlation co-efficient between each water quality parameter. The correlation between variables would be positive if the correlation co-efficient becomes greater than zero. When the correlation co-efficient value becomes greater than zero, then a negative correlation exists. When the value becomes zero, then no relationship exists between the variable. The highest negative correlation is between pH and EC. That means if the value of pH increases, the EC decreases. Turbidity and SS shows the highest positive relationship. That indicates the proportional relation between them. As the value of turbidity increases, the value of SS also increases. SS has a similar relationship with EC and Turbidity. pH has a negative correlation with other water quality parameters. EC has a positive correlation with turbidity, SS and BOD. However, BOD has only a positive correlation with EC.

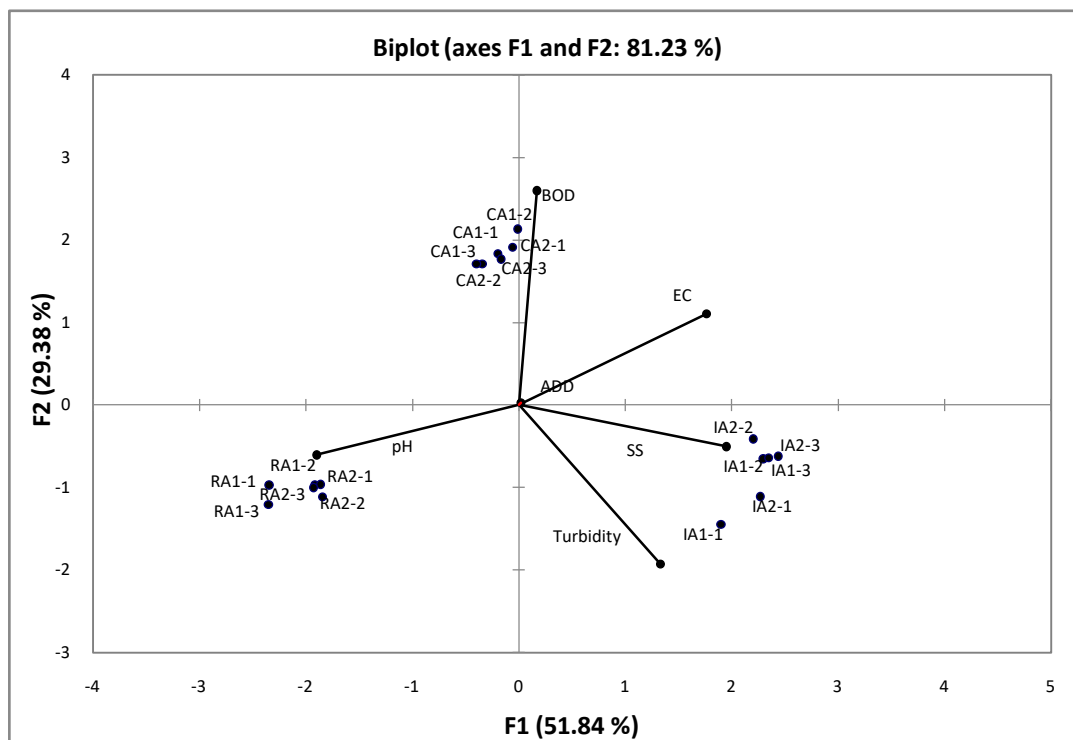


Figure 7: Principal component analysis bi-plots

Multivariate techniques were applied to identify linkage among various water quality parameters for three different land use. The principal component analysis bi-plot of the first two components is presented in Figure 7. This is because the first two components explain most of the data variance. As seen in Figure 7, principal component F1 and F2 explain 51.84% and 29.38% data variance, respectively. Both components explain 81.22% variance of the total dataset.

The angle between the loading vector is significant as the degree of correlation between water quality parameters is inversely related to it as the angle reduces the degree of correlation increases. Vectors situated closely together indicate those variables are highly correlated, while orthogonal vectors represent variables that are uncorrelated. The relative distance traveled along the attribute vectors from different areas represent the relative differences in performances among them.

Commercial and industrial areas perceived to be similar as they are close to each other. They perform similarly concerning the pH and EC. For commercial and industrial areas, the relative distance from pH is much greater than residential areas. In that case, pH has much influence on residential areas. Commercial and industrial areas are performed similarly concerning EC value as their relative distance from the attribute vector are the same.

Water quality parameters such as SS and turbidity are very close to each other. That's why they are highly correlated with each other. Industrial areas

are close to SS and turbidity. So, they exhibited a high correlation with SS and turbidity. Residential areas and commercial areas perform similarly concerning SS and turbidity. The residential and industrial areas are performed similarly concerning BOD value as their relative distance from the attribute vector are the same. Commercial areas are highly influenced by BOD as they are very close to each other.

IV. CONCLUSIONS

This paper characterises the urban stormwater quality for three different land-use types. pH is the most influential parameter in the residential area, where in commercial areas BOD is the most significant water quality parameter. Industrial areas are highly influenced by suspended solids and turbidity. Also, EC has an almost similar influence on commercial and industrial areas compared to residential areas. Industrial sites contributed substantially to higher value of SS, turbidity, EC compared to commercial and residential areas. The study results will provide guidelines to the stormwater management authority for the selection of suitable treatment systems or management systems for different land uses in Rajshahi City.

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Rights to land Ownership, Gender Inequality and Food Security in Rural Cameroon: The Case of Women in the North West Region

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Rights to land Ownership, Gender Inequality and Food Security in Rural Cameroon: The Case of Women in the North West Region

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Abstract- This paper examines the relationship between land ownership, gender inequality and food security in Cameroon with a particular focus on women as food producers, consumers, and family food managers. It examines the constraints women face as farmers in terms of their rights to land ownership, access to production inputs, technology, and food. In most rural areas of Cameroon, women have access to land but are denied ownership rights. Access to land meets the practical gender needs of women but fails to meet the strategic gender needs of land ownership. Besides, women have inadequate access to production inputs and technology in rural Cameroon. In most cases, women still rely on traditional farming methods, limited farm inputs, and rudimentary tools for food production. Most women are also generally excluded from every inheritance and do not benefit from their natal or marital clans and thus have no possibility to control and take decisions over land. In most of the villages studied, cultural stereotypes shape the mentality of men and women in that a woman who is considered a property cannot own property but can be allowed access to it since she has as a role to produce food to feed her family. Closing the gender gaps in food production, by allowing women to own land and providing them with improved technology and farm inputs, would significantly increase agricultural output in rural Cameroon.

Keywords: land ownership, gender inequality, technology, food security, practical gender needs, strategic gender needs.

I. INTRODUCTION

The agriculture sector is underperforming in Cameroon, and one of the key reasons is that women do not have access to the resources and opportunities they need to be more productive. Rural women form the majority of persons at the bottom of the ladder in terms of ownership to productive resources like land. According to the FAO (2012), achieving the Millennium Development Goal 3 (MDG3) can help us attain the MDG1. It implies that closing the gender gap in agricultural yields could help reduce the number of hungry people by as much as 100-150 million people. Women are the dominant food actors producing over 50% of the food consumed in most societies in Africa (Boserup, 1970). In the North west region, land

ownership, use and inheritance are regulated in practice by customary laws mostly unwritten but influential and based on gender distinctions. These customary laws have even superior influence than statutory law when it comes to women's property rights.

The role of gender in agriculture has been marked by the growing attention among researchers, donor agencies, and policy makers. The FAO's state of food and agriculture 2010-2012 and the World Bank's development report 2012 turned their attention to gender issues in agriculture. There is a growing recognition worldwide that gender bias and blindness constitute significant constraints that contribute to food insecurity (FAO, 2012). Women play a critical role in determining and guaranteeing food security as food producers, food providers, and contributors to household nutritional security. Furthermore, there is a likelihood that reducing gender disparities promotes agricultural growth, better income for women, and healthier food and nutrition for all (Bina, 2011). The integration of a gender perspective that recognizes the different roles, constraints and, access to and control over resources of men and women in agriculture and rural development must, therefore, be at the center of any strategy for food security and poverty alleviation (Tempelman, 2002). Aggregate data shows that women comprise 43% of the agricultural labor force globally but, this figure varies according to regions and countries. Women constitute 70 - 90 % of the agricultural labor force in many Sub Saharan African countries (FAO, 1984). Women in Cameroon, for example, play a significant role in agricultural activities, particularly in subsistence food production, where they contribute an estimated 60-80% of the total labor force (Ministry of agriculture, 2003).

Despite the central role played by women in food production, in many developing countries, they face gender-specific constraints that reduce their productivity and limit their contributions to agricultural production (Boserup, 1970). They face a serious gender gap in access to productive resources. These gender gaps include the fact that women control less land than men, and the land they control is often of poor quality (Boserup, 1970). Women in some societies do not also control the income they get from their farms and are less likely than men to use modern inputs such as improved

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seeds, fertilizers, and pest control measures. Besides, the chemicals and equipment required to control pests and diseases caused by poor tropical climate and soil conditions are scarce and expensive to the rural farmers. Female Farmers also lack financial means and skills to identify and control crop diseases (UNO, 2008). Deconstructing the notion of food security, Alcock (2009), argues that the world food problem is most often constructed as a natural phenomenon devoid of a political component. The international community and governments should instead develop new policies that will protect the world against the risk posed by the uncertainty and malice of nature rather than attributing food insecurity to environmental degradation and climate change. One of such policies could be closing the gender gap in access to food production resources. Governments need to come up with improved seeds, new technologies, gender-sensitive policies that can help solve the food crisis shortages in the world. Global food problems should not be seen as a supply problem; instead, the emphasis should be on the food production base of developing countries by promoting their self-sufficiency (FAO, 1974).

Maxwell (1988), on his part stated that, the focus on global hunger should not be on the availability of food but access to the hungry population. He emphasizes on shifts in thinking with the replacement of the old by the new. The global and national concern on food supply and production should be replaced by a new and more enlightened attention for the household or individual level of food demand and entitlements. The statement made by Maxwell implies that women who are responsible for about 80% of all agricultural production in Cameroon, for example, must be involved in agricultural policies and programs and the focus should be on the access to food by the different members of the household and not on global or national situations. The contribution of women in food production should be evaluated and more value attached to their work.

The attainment of global food security is described as a situation in which all people at all times have access to adequate, affordable, safe and nutritious food to meet their dietary requirements and food preferences for productive and healthy life (FAO, 1996). Food security is presently being subverted by several challenges such as fast increasing demand and variations in consumption patterns, the competition of agricultural land for other uses, the effects of global environmental change, degradation of agricultural soil, erosion of the genetic base of agricultural biodiversity, water scarcity, poor governance and others (pretty, 2009). The government should reconsider the shift in farming practices from subsistence to mechanized agriculture with the use of improved technologies and seeds to increase food production. Globally, indicators of growth in agricultural production and food security are no longer as encouraging as they were before the

1980s (FAO, 2012). The strengthening of agriculture as a result of an increased demand and limited land requires the development and use of better tools, techniques, and organization of production thus an increase in the mobilization and use of capital. The outcome of the increase in output may even encourage innovation in technologies that can improve long term sustainability of resources contrary to Malthusian views (Dermont et al. 2007). Women in the North West region has weak economic autonomy as compared to men in that they are assigned or given parcels of land to work on by their husbands or relations. The above statement implies that women may have access to land, but the decision on the quantity, quality, and location of the land does not depend on the women themselves but their husbands or fathers. This explains why according to Boserup 1970, the fertile lands that are closer to homes are reserved by men for cash crops while women go further and in less productive valuable lands to plant food for subsistence.

A gendered role of women hinders access to technology, agricultural training, and rural infrastructure (World Bank, 2008). Women make crucial contributions in agriculture in all developing countries as farmers and workers. They face gender specific constraints that reduce their productivity and limit their contributions to agricultural production. Women face serious gender gap in access to productive resources. These gender gaps include the fact that women control less land than men and the land they control is often of poor quality (UNO, 2006). The Food and Agricultural Organization (FAO, 2009), indicates that women produce as much as 80% of basic food stuffs for household consumption and sales in sub-Saharan Africa (FAO-ILO-IUF, 2005). Achieving gender equality and empowering women is, therefore, crucial for agricultural development and food security. Closing the gender gap in agriculture will generate significant gains for the agricultural sector and society. If women were allowed same access to productive resources as men, they could increase yields on their farms by 20 – 30%. Access to these resources by women could raise total agricultural output in developing countries by 2.5 to 4 %, which could, in turn, reduce the number of hungry people in the world by 12 - 17 % (U N O, 2006). In particular, it has been suggested that the position of women farmers in both indigenous social organisations and national economies is different from men's; they work under diverse constraints in their farming and have different opportunities for alternative employment (Boserup 1970; Meillassoux 1975). If the gender division of labor is a vital aspect of farming, men's and women's differential access to resources might be expected to have an independent effect on cropping patterns.

II. METHODOLOGY

The study made use of both the qualitative and quantitative approaches with inter views, direct observation, focus group discussions, and questionnaires as our data collection techniques. We randomly selected some villages, which were Bafut, Bali, Santa, Akum, Bambui, Bambili, and Belo, as our study areas. The choice of the study site was because the culture of the North West is made up of patrilineal and matrilineal kinship systems. Researchers were, therefore, interested in understanding how land issues

are being managed in the two sub-systems. The only matrilineal society studied was Belo, while all the other areas were patrilineal societies. This is because, only two matrilineal societies in the North West region. Our sampling method was snow-ball. This is because of the gender-sensitive nature of the study. Our entry point was palaces, where we met the chiefs of the different villages, and from them, we could identify our key informants. Figure one below shows the number of informants who participated in the study based on kinship ties.

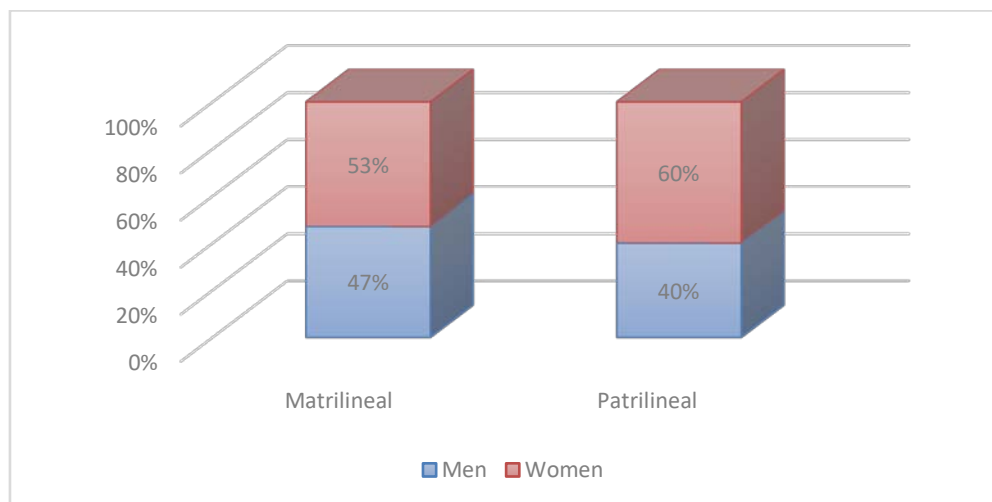


Fig. 1: Number of persons in the two kinship systems in the North West region

In the two sub-systems (matrilineal and patrilineal), our study population was made up of more men than women because men could easily make out time to talk to us than women who are always very busy. The daily activities of women in both areas were so charged that they leave their homes as early as 6am

and only return between 5-6pm to prepare supper for their families. We therefore, had only the market days to interview the women, while men often returned from their farms much earlier than women and had much more time for our interview conversations.

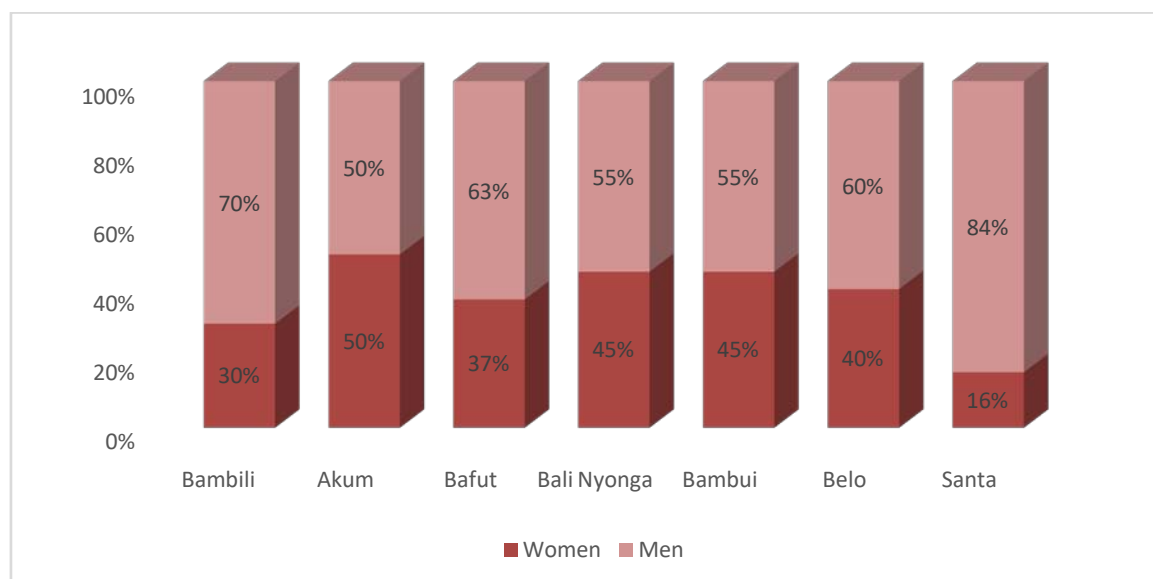


Fig. 2: Villages studied and gender distribution of the study sample

Figure 2 above shows the different villages studied in the North West region and the gender distribution of the studied population. Our study sample

was 160 people with a gender distribution 97 men and 63 women.

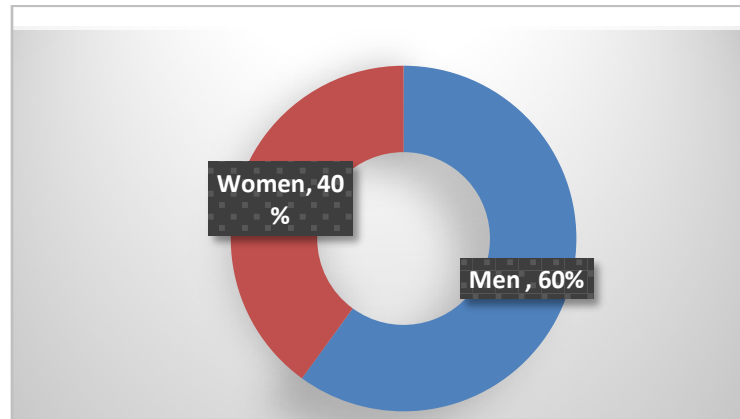


Fig. 3: The Sample size of the study

III. DATA MANAGEMENT AND ANALYSIS

• Data analysis

The data analysis methods used in this study were the descriptive statistics Analysis and Content Analysis.

a) Management of qualitative data

- Transcribing Tape-Recorded Data and Completing Field notes

All tape-recorded materials of conversations and interviews were transcribed as well as field notes completed for all discussions. Time was spent listening and transcribing recorded interviews. Field notes taken in the course of conversations were completed. The transcripts and documentary evidence were typed into word processing software. The transcripts captured features of discussions such as emphasis, speed, tone of voice, timing, and pauses. These elements made up the crucial aspect of interpreting data, given the multiple events that produced them. The data from transcripts were read transcript by transcript. Reading and completing the transcripts and making notes from them permitted the researchers to identify ideas, make observations and get insights, and inferences. All transcripts were labeled with file names, typed in a word processing package and stored using these file names. Once each transcript was read and classified, it was dissected, pulled apart and scrutinized transcript by transcript to enable the full understanding of the nature of the data collected.

IV. MANAGEMENT OF QUANTITATIVE DATA

The descriptive statistics method was used to describe the basic features of data in this study. This method provides simple summaries about the sample and the measures to describe what the data shows and makes available some comparisons across people or

other units. Only one of these characteristics of the descriptive statistics method was considered -the distribution, which is a summary of the frequency of individual values or ranges of values for a variable. Distribution was therefore represented in two ways which are, tables using percentages and graphs or diagrams. The Descriptive Statistics Analysis was calculated with excel version 2016. The steps used in calculating were: typing data into an excel table, labeling the rows, making graphs, and transferring them from the excel table to the word document.

V. RESULTS

a) Ownership and sale of land in patrilineal societies

In the North West region Land is a valuable and personal asset for the people and can be used for farming and construction of houses. It remains key to the livelihoods and survival of everybody in the region, and it is owned by individuals, but, still the Fon is the custodian of all the land in most communities. In Santa for example, the Fon said that he owns all the land and can sell it whenever he wants though he acknowledged the fact that individuals own land but must sell it in consultation with the Fon. Statistics from the fieldwork in the North West region show that 65% of all the informants said that land is owned by the traditional authorities while 28% said it men own it, and only 7% of the informants acknowledged that land is owned by women.

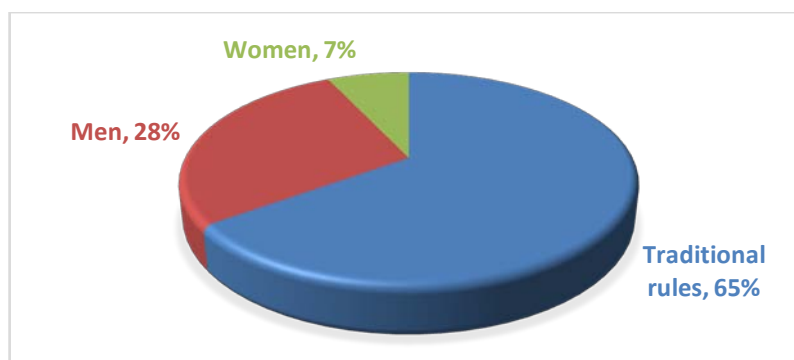


Fig. 4: Land ownership in the North West region

The few informants who agreed that women own land are probably the ones who have gone to school and are aware of the rights of women over land and those who do not understand the difference between land ownership and access to land. We discovered that, traditionally, Women in this region have the users right and not ownership rights over land.

The decision to sell land or not to sell depends mostly on the cultures of the areas studied. Though it remains a valuable asset in all the communities studied as earlier mentioned, there have cultural variations when it comes to the sale. In an interview with a quarter head in Bambui, Pa Gogomoh said: *"In the pas, t it was a taboo to sell the land because it had to be passed down to the younger generation. It is of recent that land is sold in Bambui because of the need for money. To date, the sale of land is discouraged though it can be bought for group farming. Individuals who had bought land can sell, but the tradition does not approve of it. This is because*

land belongs to families and not individuals. It is of recent that overzealous successors sell land to make money".

In Santa, the Fon and men can sell land, but a woman cannot since she does not own it. If a woman has to sell land, an investigation is made to verify where she got the land. Land owned by women is expected to be handed over to their children and not to be sold. Women in Santa can, therefore, buy land but they cannot sell it.

In most cases, tradition handicaps women from enjoying their rights over land, especially as most of them are not well educated. Their inability to organize themselves and because they are ignorant of their rights to land ownership is a setback to women. Statistics from the field prove that 49% of the informants involved in the study said that only men could sell land in the areas studied in comparison to, 39% who said traditional authorities could sell land and only 12% acknowledged that women can sell it.

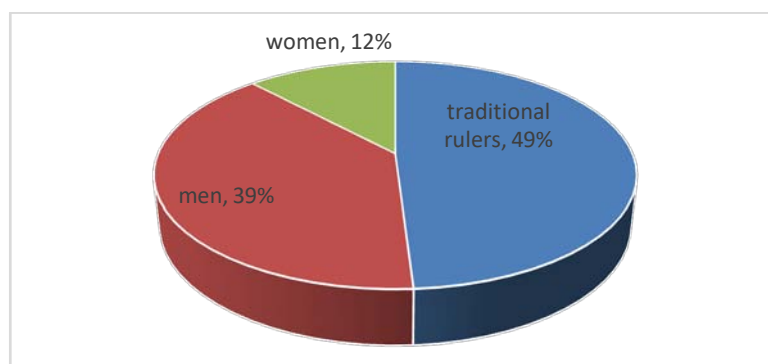


Fig. 5: Perception of who owns land in the North West region

From the above statistics, it is clear that with the changing economic situation of the country and the demands of the monetary economy, the culture of communal land ownership is giving way to that of individual land ownership with people becoming very individualistic in the North West region. Gender gaps in land ownership continue to widen as the traditional stereotype, which says women can use the land but cannot own it is still being promoted. Women still lack behind, perhaps because the culture has succeeded in

maintaining them in a subordinate position when it comes to land ownership.

VI. INHERITANCE OR SUCCESSION OF LAND IN THE NORTH WEST REGION

In the North West region, there exist two kinship systems, which are the matrilineal and patrilineal systems. Inheritance or succession largely depends on the kinship system of the study area. In the areas where

the patrilineal system is practiced such as Bambui, Akum, Santa, Bambili, Bafut, and Bali; It is possible for a woman to inherit her husband's land, but she is only a custodian, and once the male children are grown up, it is handed over to them. Most often, men prefer to hand their prosperities to their successors. These successors are usually male children. Female children can inherit from their fathers' only when they are no male children in the family or when the male children are very irresponsible. In the case where the man had no male child and handed his property to his daughter, it is expected that the daughter will give birth to a son who will inherit his grandfather. In the Bambui community, the male child succeeds the father, and the female child succeeds the mother. Inheritance in this community equally depends on the will of the deceased. According to the chief of Akum, the successor is designated without him knowing, the father can confine in an older adult, quarter head, or a lawyer or tell his best friend. In an interview conversation with Pa Gogomoh a notable in Bambi, he said,

"My wife cannot inherit my land; rather, my son will inherit and remain in the compound. My wife can only control my properties and not inherit it".

Customs and traditions of the North West region impose certain conditions that are detrimental to women when it comes to inheritance or succession. In Bali, for example, 'a woman whose dowry was never paid has no right over her husband's properties even if she has children. Usually, it is the children who take over their father's property. In this situation, when the woman dies, her corpse might not be buried in the late husband's compound, but the children can decide where to bury their mother. The relatives of the man can choose to take the corpse back to the woman's family. According to Mrs. Gemoh, a leader of a women's group in Bambui, tradition has evolved with many changes taking place in the community. Unlike in the past, where a deceased man's brother was supposed to inherit his properties and wife, it is no longer the same today. This is because many families have fought against it and also, men are becoming conscious of the need to hand over their wealth to their children. Field statistics show that 43% of all informants said that children are those who inherit from their parents while 31% said wives inherit their husband's property after death. The other informants who made up 16% for husbands' brothers and 10% for husband's nephews are from the matrilineal society where succession is traced through the female line.

VII. OWNERSHIP AND SALE OF LAND IN MATRILINEAL SOCIETIES

In matrilineal societies like Kom and Belo, it is the deceased man's brother who inherits his property. If

there is no living brother, the nephew inherits. In the Kom tradition there are no traditional rites carried out when the brother of a deceased man inherits, but when a nephew is a successor, certain rituals are performed. In this case the brother is usually considered as the care taker while the real successor is the nephew. The tradition detects that the successor collaborates with the widow so that proper care and control will be taken over the properties of the deceased, but still it is not usually the case because, most successors do not want to take care of the widow and the children of the deceased. They rather most often sell all the properties, and this sometimes ends up causing problems between the widow and successor. In some cases, where the widow cannot defend her rights, she abandons the compound and goes somewhere else. Most successors do not like to be under the control of the widow because they feel that a man should always be in control and not a woman.

VIII. CONFLICT RESOLUTION AND ACCESS TO LAND BY WOMEN IN THE NORTH WEST REGION

Women in the North West region, be it in the patrilineal or matrilineal societies, are expected to remain in their husband's families after the death of their husbands. Talking about instances where a woman has had a conflict, Mrs. Lemma said "suppression of women by men is part of their culture, and has been maintained over the years. She said a typical example is when, *"I bought my land with my money and the land documents were registered under my name but when I got home my husband was advised not to accept by his friends and kin. This matter brought us problems until we had to go back to the landowner to change the document. My name was replaced with my son's name on the documents."* I was however, finally satisfied with the way the case was resolved".

In the North West, land conflicts are usually judged in the community at different levels, but women are most often not part of those who assess cases in the Fon's palace. According to Mrs. Lemma, *"I will like women to be part of the court sitting so that they can defend other women in matters of land"*. The fact that very few women own land certificates in all the areas studied is an indicator that proves women have very little control over land in the North West region and, therefore, cannot make key decisions concerning it. This is because one cannot control something that does not belong to him or her.

Statistics from the field shows that 8% of women get land on which they plant crops through self-purchase, 31% through renting, 24% inherit from husbands, 22% inherit from their parents, in comparison 15% of women acquire land through donations (women are allowed to work on land for as

long as the real owner desire).This implies that women in the North West region are still being marginalized on issues of land ownership.30% of the women in the North West region are farmers, while only 20 % of men have

farming as their major livelihood. Since women's main occupation is farming, they are supposed to be given the right to land ownership.

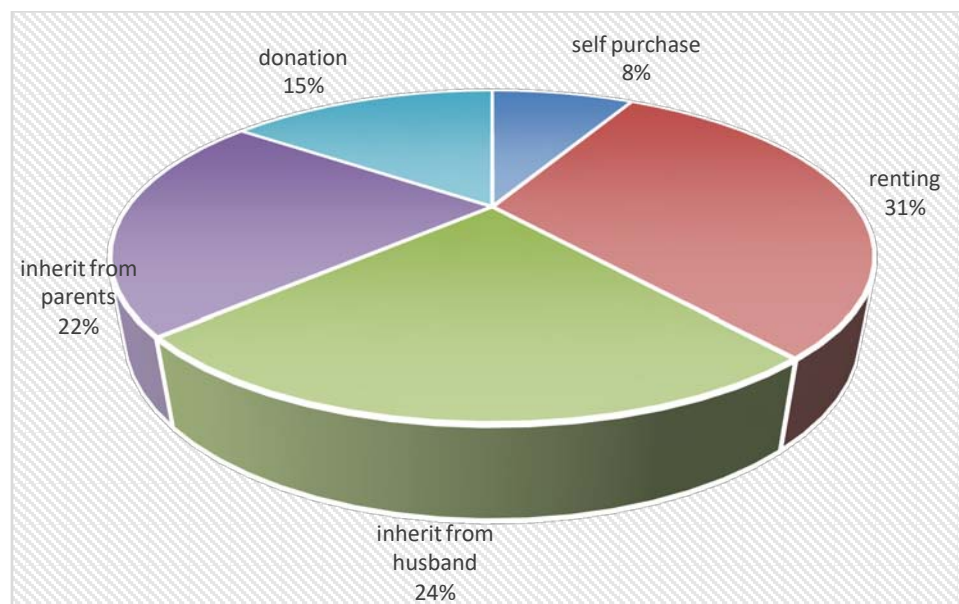


Fig. 6: Access to land for farming by women in the North West region

IX. GENDER AND FOOD SECURITY IN THE NORTH WEST REGION

According to Desjardins (2008), The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Food insecurity refers to the unavailability and the inaccessibility to food in sufficient quantity and quality. Article 25 of the Universal Declaration of Human Rights also states that, food is a basic need and right of every human being. Food security is also a situation where at the individual, household, national, regional and global levels people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life(FAO, 2001). Food security, according to the FAO, does not only require an adequate supply of food but also entails availability, access, and utilization by all men and women of all ages, ethnicities, religions and socioeconomic levels. This implies that to achieve food security; there must be social justice and access to productive resources by both men and women. This is far from being the situation in the North West region of Cameroon. This social injustice is seen in their types of crops cultivated and the fact that many do not plant certain crops because of cultural constraints. Women in this region are still mostly responsible for subsistence as opposed to men who produce for the market. Food crops cultivated by most women in the North West region include: cocoyams, yams, maize, cassava,

plantains, and Irish potatoes. Also, market gardening crops commonly cultivated by women and men are; carrots, green beans, tomatoes, green spices, beans, lettuce, and cabbages. While agro forestry crops like coffee and cocoa were identified as crops cultivated mostly by men in the North West Region. This is because it takes a longer period to get to maturity, and it is believed that only men who own much land can cultivate agro forestry crops and still have land for food crops. Formally, men were not interested in food crop production because it was destined only for subsistence. The sudden interest of men in food crop production is probably for power negotiation in that men want to have money all year round. According to our informants, food crops now fetch them more money than agro forestry or cash crops. We found out that only 0.6% of women plant coffee or agro forestry crops in the North West region. Most of the women involved in this coffee cultivation inherited the produces from their late husbands or their parents. The reasons why women do not cultivate certain crops ranges from constraints, a choice, and tradition.

In the study, 69.4% of women say that the main reason why they do not grow agro forestry crops is because of constraints and not choice. Most women are not allowed to cultivate crops that take many years to be matured. This is because they do not own the land and therefore have no right to plant crops with long growth duration. These types of crops are meant for men who are land owners. Also, 21.9% hold that they do not cultivate crops like coffee, cocoa and cotton as a matter of choice, most women consider the cultivation of these

crops as strenuous, and meant for the men, while 8.7% said it was because of tradition. Cultural stereotypes shape the mentality of men and women in that coffee, for example, is considered a male crop by both men and women.

According to Gaymard et al. (2015), the effects of climate change on food production shows that Cameroon is one of the countries most threatened by climate change. The North West region is not left out of this phenomenon. In the field, the farmers complained of falling yields in food production due to extension of the dry or rainy seasons and the difficulties for them to adapt to the new climatic alterations. According to our respondents, women are most affected by the environmental, and climatic changes. However, they are struggling of adapt to these changes in different indigenous ways. If gender aspects are incorporated into the national agricultural policies, crop yields will undoubtedly increase and the region will be more food secured.

X. CONCLUSION

Land remains a strategic gender need for women in rural Cameroon. Unfortunately, women in the North West region are denied ownership of this very vital agricultural need. They are often allowed the practical gender need of access to land but do not have control or take key decisions on the land. However, in the field, we discovered that most women in this region have control over what they produce, sell, donate, and consume though it varies from one household to another. Land remains key to the livelihoods and survival of everybody in the North West region, and it is owned by individuals still, the Fon is the custodian of all the land in most communities. The decision to sell or not to sell it depends mostly on the cultures of the areas studied. Traditionally, Women in this region have the user's right and not ownership rights over land. Inheritance or succession largely depends on the kinship system of the study area. Land disputes are part and parcel of their daily lives. According to the Fon, cases judged in the palace are out for justice, and the verdict does not depend on whether the victim is a man or woman. Despite the fair judgments as pronounced by the Fon, women remain at the losing end due to the customary laws that are discriminatory. It was discovered that very few women own land certificates, and the majority of the women said they have never seen a land certificate. Land ownership issues in the North West region are therefore fundamentally regulated by the customary laws, which are most often gender bias.

Trefry et al. (2014), in the article 'Culture and food security, explore the relationship between culture and food security in a local context. An inductive approach to field research on cultural analysis reveals

that several elements of culture have direct influences on local food production. These elements include: gender, power, identity, and cultural change. The study offers insights into the multi-level dimensions of authority as it relates to individuals, households, and broader community dynamics that are central to understanding the local dynamics of food security. Trefry (1988) sees a lack of adequate technologies as the main problem of agricultural sustainability in Africa. This lack of technology is often at the level of maintaining soil fertility. The practice of leaving fields to fallow for long periods has been abandoned due to increase in population. This has forced farmers to make intensive use of land that was cultivated only after long cycles. To him, reduced fallows have led to an increase in nutrient depletion rate, erosion, and changes in soil texture, an increase in insects and pests and crop diseases.

Women in the North West region can be more productive if they are allowed ownership of land, provided with modern farm inputs and better technology. Many of these women need to be educated on their elementary human right to own land. The region could be better food secured if micro- financial institutions could help farmers, especially women, access loans, which they can use to acquire land, buy modern farm tools and inputs. Besides breaching the gaps in food production by eliminating all gender discriminatory laws and changing stereotypes that continue to maintain the women at a subordinate position will further boost the food production capacity of the region.

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Assessing the Impact of Watershed Management Interventions on Livelihood of Small- Scale Farmers and Ecosystem Services in Choke Mountains, East Gojjam Zone of Amhara Region, Ethiopia

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Yenealem Gemi ^α & Belay Semane ^σ

Abstract- In Ethiopia, natural resources management interventions have been implemented since the 1980s to restore degraded landscapes. However, little efforts have been made to investigate the impacts of natural resources management interventions on ecosystem services and livelihood. This study was conducted in the Choke Mountain, Northern Ethiopia, to investigate the effects of community-based watershed management interventions on ecosystem services and livelihood of smallholder farmers. Both qualitative and quantitative methods were used to collect and analyze data. The results indicated that deforestation, population pressure, topography, overgrazing, and continued cultivation are major causes of land degradation. Consequences of land degradation include a reduction in farm size, a decrease in soil fertility and crop production, drought, food insecurity, and poverty. Also, the results demonstrated that a shortage of clean water and a decline in vegetation composition are among the impacts of land degradation on ecosystem services. The local communities perceive that watershed management interventions support to restore ecosystem services and improve livelihood. They are also optimistic that degraded landscapes can be restored through the implementation of watershed management interventions, and have been contributing to the establishment of watershed management interventions on communal and private lands mainly through providing free labor. Collaboration among local communities, government, and non-governmental organizations is key to sustain the implemented watershed management interventions.

Keywords: benefit-sharing, land degradation, local communities, watershed management interventions, participation.

1. INTRODUCTION

Land degradation includes all process that diminishes the capacity of land resources to perform essential functions and provide ecosystem services (Hurni et al., 2010). It is usually caused by two

complex interlocking systems: the natural ecosystem and the human social interaction. The impact of land degradation on livelihood is particularly severe in Sub-Saharan Africa because 65% of the population is rural and the main livelihood of about 90% of the population is agriculture (Project Development Facility, 2007).

Ethiopia is one of the rich countries in Sub-Saharan Africa in terms of natural resources (Gete et al., 2006). However, natural resource degradation in Ethiopia has been going on for centuries (Hurni et al., 2010). The problem is getting worst as the population pressure and the demand for food, fuel wood, building materials, and land for cultivation increases (Hurni et al., 2010).

The Choke Mountain and its associated watersheds, located in the Blue Nile highland regions of Ethiopia, is broadly representative of many of the challenges related to land degradation. The Choke Mountain ecosystems are under threat from multiple sources, including the pressure from population growth, soil erosion, deforestation, overgrazing, and decline of soil fertility (Simane et al., 2013). In turn, it has affected the livelihood of local communities through mainly reducing water availability, and livestock feed (Simane et al., 2013).

To combat land degradation and restore degraded landscapes, the Ethiopian government launched a massive soil and water conservation program in the middle of the 1970's (Hawando, 1997). Particularly, soil and water conservation campaign has been implemented since 2010 to increase agricultural productivity through improved natural resource management (Mekuria et al., 2017). The objectives of the study was to (1) Investigate the causes and consequences of land, (2) Investigate the contribution of the implemented watershed management interventions to enhancing ecosystem services and livelihood of smallholder farmers, (3) Identify the concerns of local communities on watershed management practices, (4) Investigate factors affecting the preference of the intervention by the communities, and (5) Explore the

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contribution and responsibilities of the society in managing natural resources and restoring the degraded ecosystem.

II. MATERIALS AND METHODS

a) Description of the study area

The study was conducted at Choke Mountains (Figure 1). It is located on plateaus that rise from a block of meadows and valleys and have elevation ranging from approximately 800 to 4200 m above sea level. The central peak is located at 10°50'24" N and 37°05'24" E. The watershed is found entirely in Eastern Gojjam Zone of six Woredas such as; Bibugne, Debay Tiltatgin,

Gozamen, Hulet Eju Enssie, Machakel, and Senan (Bewket, 2010). As measured at Debre-Markos weather station, mean annual temperature is 14.50°C with a range from 13.2°C in July and August to 17.3°C in March. Average annual precipitation ranges from 600 to 2000 mm year⁻¹, and exhibits local variability associated with topographic gradients (Simane 2011). Dominant soil types are volcanic in origin, derived from Mio-Pliocene shield volcano lavas and, at lower elevations, Oligocene flood. The dominant agricultural practice in the Choke Mountain watersheds is crop-livestock mixed systems (Simane 2013).

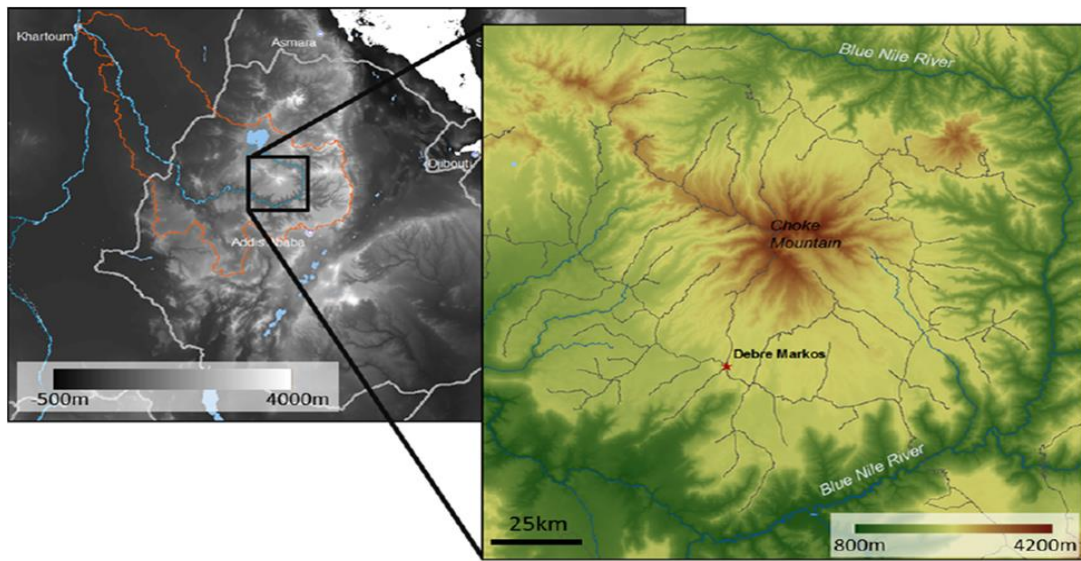


Figure 1: The location map and topography of Choke Mountain watersheds

In figure 1 above, the red line indicates the outline of the Blue Nile River basin and shading is topography. In the Choke Mountain region inset, colors are topography, blue lines are major rivers, and grey lines are roads (Simane, 2013).

b) Sampling technique, sample size and data sources

Purposive sampling was used to select the study Woredas and Kebeles as well as the specific watersheds. The main criteria used to select the study woreda and kebeles was based on their agro-ecology, the presence or absence of well-designed watershed management interventions, and accessibilities. Accordingly, four Kebeles with well-designed watershed management interventions and four less sustained were selected. Then from each kebele, a watershed was selected to investigate the effectiveness of watershed management interventions to enhancing ecosystem services and improving livelihood. In total, eight watersheds were selected. Systematic random sampling was used to select respondents for the household survey. A total of 120 respondents were selected from

the 1897 total number of households using the (Cochran, 1977) formula.

$$n0 = \frac{z^2pq}{d^2} \rightarrow n = \frac{n0}{1 + \frac{n0-1}{N}}$$

Where, n_0 = the desired sample size when the population is greater than 10,000. n = number of sample size when the population is less than 10,000 z = is statistical certainty at 95% confidence limit i.e. 1.96 $p = 0.1$ (proportion of the population to be included in the sample i.e. 10%). $q = 1 - p$ i.e. (0.9) N = total number of the households (1897), d = degree of accuracy desired (0.05).

Also, 20 key informants (five from each of the selected Woreda; were selected for key informant's interviews. The Key informants comprise of watershed management experts at district and regional level, development agents and watershed committee. Further, focus group discussion was held to strengthen the information gathered through household surveys and key informant interviews. During the entire study, 12

focus group discussions were held (i.e., three from each Woreda).

The qualitative design approach was applied to describe meaning, concepts and definition of data in word when the quantitative approach was applied to describe quantitative data in the statistical method. And also have applied both primary and secondary data sources and data collection techniques. Primary data was generated through a household survey, focus group discussion, and key informant interview. Secondary data was collected from published and grey literature as well as from government official documents obtained from district agricultural offices. To investigate changes in ecosystem services and human livelihood following watershed management interventions, participatory tools such as household survey, focus group discussion, key informant interviews, and transect walk was used.

i. Qualitative data collection

a. Assessment of the perception of local communities

Semi-structured questionnaires were prepared to gather data. Both open and close-ended questions were included in the questionnaires. The open ended questions were developed to enable the respondents to give responses by their language freely. The questions in this study were prepared in a simple and clear way and arranged in a logical order to make it more inclusive. The questionnaires were first developed in English language and then translated into Amharic language. The questions focused on land degradation problems, participation, and perception of the communities towards the implementation of watershed management interventions, changes in ecosystem services, and livelihood following the implementation of interventions, the rate of adoption of interventions, tradeoffs of interventions, and local communities concerns on interventions.

c) Data analysis

The methodologies employed to analyze the data for this study was included descriptive statistics. Descriptive statistics (frequency, percentage, mean, minimum and maximum values of the variables used to summarize a collection of data in a clear and understandable way as well as constructed tables and figures was used to show respondents' attitude towards individual items of the questionnaire. Inferential Statistics was used to draw inferences about a population from a sample. All the gathered data were carefully entered into Microsoft Excel. Editing and coding of numerical symbols to answers were made. After completion of editing, assigning, or coding, finally, data were exported from the program Microsoft Excel to Statistical Package for Social Science, version 20. Then, descriptive statistics, and correlation were used for analysis. The qualitative data from individual interviews were analyzed using content analysis (Bernard, 2006).

III. RESULTS AND DISCUSSIONS

a) Driving forces of land degradation

Survey respondents and key informants considered that population pressure and over utilization of natural resources as the main driving forces of land degradation. Consequently, 40% of respondents in Mechakel woreda considered over utilization of natural resources as main driving force, while population pressure was considered as the main cause by 26.7% of respondents. In Shebel Berenta woreda, 26.7% of respondents considered over utilization of natural resources as the main driving force, while a population pressure was considered as the main cause by 40.0% of respondents. In Shewa k/mihret kebele 66.7% of sampled households considered the topographic condition of the areas as the main driving force of land degradation and also this are supported by field observation (Picture 1). Few (5%) of respondents considered road construction and poorly designed diversion ditches as driving forces of land degradation. The results from focus group discussion also confirmed that population pressure, lack of implementation of conservation measures, and poor land management, as the main driving forces of land degradation. The result also demonstrated that family size and land degradation is positively correlated ($r = 0.24$; $p < 0.05$) (Table 5 below).

The results also revealed that poor implementation of policies related to NRM, lack of awareness raising campaigns towards the implementation of natural resources management interventions and lack of rules and regulation that support the sustainable management of natural resources contributed to land degradation in the study areas.



Picture 1: Topographic features of Shewa k/mihret, source: photo taken during field observation 2016/17 (Photo source. Yenealem Mekuria)

Simane et al. (2013) also demonstrated that land degradation in the highland areas (i.e. Areas above 1500 m.a.s.l) had been a concern for many years and steep slopes that promote rapid erosion as well as limited agricultural land characterize the Choke environment. Similarly, the study conducted in Choke Mountain (Shegaw, 2011) and the southern part of Ethiopia, revealed that steep topography and population pressure are the main driving forces of land degradation (Worku, 2016).

b) Pressures on the natural environment

Survey respondents, key informants, and field observation confirmed that deforestation, overgrazing, and high rate of soil erosion are the main pressures on

the natural environment that lead to severe land degradation. A considerable proportion of respondents (19.2%) considered overgrazing as the main pressure on natural environment and aggravates soil erosion and land degradation. Similarly, 8.3% of respondents reflected deforestation and overgrazing, as the major pressures (Table 4). In this line, (Simane et al., 2013) indicated that soil erosion in Choke Mountain watersheds is a well-recognized problem and a priority area for intervention. The results demonstrated that the perception of local communities on major driving forces of land degradation and pressures varies across the studied kebeles (Table 1).

Table 1: Driving forces of land degradation and pressures on the natural environment as perceived by sampled respondents

	Shebel berenta		Mechakel		Sinan		Awabel		Agg in (%)
	Led	Geda	A.Z	D.K	S.K/M	Dan	E.C	Yek	for n= 120
Deforestation	0.0	33.3	13.3	26.7	6.7	0.0	26.7	20.0	10.8
Overgrazing	33.	13.3	0.0	0.0	20.0	0.0	46.7	13.3	19.2
Continuous cultivation	6.7	6.7	6.7	0.0	20.0	6.7	6.7	26.7	10.0
Limited use of conservation structures	6.7	20.0	6.7	26.7	6.7	6.7	20.0	40.0	12.5
If 1,2	6.7	20.0	0.0	13.3	6.7	0.0	0.0	0.0	8.3
If 1,2,3	6.7	0.0	26.7	26.7	0.0	0.0	0.0	0.0	2.5
If 1,2,3,4	13.	0.0	20.0	6.7	13.3	80	0.0	0.0	19.2
If 1,3,4	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	3.3
If 2,3	0.0	0.0	0.0	6.7	6.7	0.0	0.0	0.0	2.5
If 2,3,4	0.0	6.7	0.0	13.3	6.7	0.0	0.0	0.0	4.2
If 2,4	0.0	0.0	0.0	6.7	6.7	0.0	0.0	0.0	1.7
If 3,4	0.0	0.0	0.0	13.3	0.0	0.0	0.0	0.0	0.8
If others	26	0.0	0.0	0.0	6.7	6.7	0.0	0.0	5.0
Missing	6.7	40.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: computed from household survey data 2016/17

Note: one is for Deforestation, two is for overgrazing, and three is for continues cultivation, and four is for limited use of conservation structures

Note: Led is for Ledie, Geda is for Gedayasu, A.Z is for Amanuel Zuria, D.K is for Debre Kelemo, S.K/M is for Shewa Kidane Mihret, Dan is for Dangule, E.C is for Enebiy Chifar, YEK is for Yekeyit, and Agg is for Aggregate

The results of this study indicated that existence and severity of soil erosion varies across studied kebeles (Table 5). According to the survey respondents, Sinan and Mechakel districts are the most affected compared to Awabel and Shebel berenta districts. Also, all of the respondents in Sinan district in Dangule kebele confirmed the existence of soil erosion in their area as high. In contrast, the majority of respondents in Awabel woreda in Enebiy Chifar and Yekeyit kebele (93% and 60%) respectively, confirmed that they did not observe soil erosion in their farmland.

The majority (45%) of respondents indicated the severity of soil erosion in the studied areas as high, while an equal proportion of respondents indicated the severity of soil erosion as medium and low (Table 2). (Lal, 1981, Eswaran et al., 2001 and Tesfahunegn, 2013) have mentioned that exploitation of soil resources by farmers, resulting from a need to increase agricultural productivity, aggravates soil erosion. The study further claims that the severity of soil erosion is higher in developing countries, where the economy mainly depends on agriculture.

Table 2: The severity of soil erosion as perceived by respondents

Severity of soil erosion	Shebel berenta		Mechakel		Sinan		Awabel		Agg in % for n=120
	Led	Geda	A.Z	D.K	S.K/M	Dan	E.C	YEK	
Low	13.3	40.0	13.3	0.0	6.7	0.0	93.3	60.0	28.3
Medium	53.3	40.0	46.7	13.3	20.0	0.0	6.7	33.3	26.7
High	33.3	20.0	40.0	86.7	73.3	100.0	0.0	6.7	45.0

Source: computed from own household survey data 2016/17

Note: Led is for Ledie, Geda is for Gedayasu, A.Z is for Amanuel Zuria, D.K is for Debre Kelemo, S.K/M is for Shewa Kidane Mihret, Dan is for Dangule, E.C is for Enebiy Chifar, YEK is for Yekeyit, and Agg is for Aggregate

The rate of soil erosion, as the majority of respondents, confirmed the rate of soil erosion as high, while the other respondents do not consider soil erosion as a major problem. In the Choke Mountain, soil erosion is a key environmental and socio-economic problem.

Topography has a strong influence on aggravating soil erosion. On the other hand, the result indicates that the implementation of NRM interventions in Choke Mountain is a key to control soil erosion and restore degraded landscapes. Also it is consistent with the perception of local communities; the majority of respondents confirmed the effectiveness of the implemented natural resource management intervention in reducing soil erosion (see section 3.4).

c) State of the natural environment in Choke Mountain

The majority of (87.5%) survey respondents perceive that the productivity and the size of their farm land have declined through time. For example, 93.4 % of respondents in Dangule and Gedayasu kebele considered that their farm land is reduced; fertility of agricultural soil and productivity is declined due to increased soil erosion, whereas 40.0 % of respondents in D/kelemo elaborated that, land degradation has resulted in reduced land size and agricultural production. Similarly, 40% of respondents in Yekeyit kebele discussed a reduction in farm size due to land degradation (Table 3). The results also indicated that the deterioration of the natural environment as a consequence of land degradation varied across the studied kebeles, and is more severe in Gedayasu and Dangule kebeles than the other studied kebeles. A

survey respondent elaborated the state of the natural environment as:

"The decline in soil fertility and reduced workability of farm lands due to land degradation has led to reduction in crop production. Also, land fragmentation due to land degradation has resulted in reduced crop production. This, in turn, resulted in food insecurity, reduced income, and poverty". (Interview 2016/17)

The reduction in agricultural productivity could be attributed to poor land management and land degradation due to soil erosion. The survey respondents have mentioned that they started to use different land management practices such as crop rotation, application of inorganic fertilizers and compost, and fallowing to restore degraded farm lands. Also, farmers also use irrigation and planting of fruit trees to diversify their livelihood. However, 9.2% of the respondents did not perceive that the productivity of their land is declining.

Table 3: State of the current natural environment in Choke Mountain as perceived by respondents

		Shebel berenta		Mechakel		Sinan		Awabel		Agg in % for n= 120
		Led	Geda	A.Z	D.K	S.K/M	Dan	E.C	YEK	
Consequence of LD	Reduce in farm size	20.0	0.0	0.0	0.0	20.0	0.0	20.0	40.0	12.5
	Rise in soil erosion	0.0	0.0	0.0	0.0	0.0	0.0	33.3	13.3	0.8
	Decreasing SF and LP	20.0	6.7	13.3	6.7	20.0	6.7	26.7	13.3	25.8
	If 1,2,3	13.3	93.4	66.7	53.4	13.3	93.4	0.0	6.7	38.6
	If 1,3	40.0	0.0	13.3	40.0	40.0	0.0	0.0	6.7	15.1
	If 2,3	6.7	0.0	0.0	0.0	6.7	0.0	0.0	0.0	2.5
	If others	0.0	0.0	0.0	0.0	0.0	0.0	20.0	20.0	0.0
	Drought	40.0	33.3	33.3	33.3	53.3	46.7	13.3	26.7	35.0
	Food insecurity	0.0	0.0	6.7	26.7	0.0	0.0	46.7	53.3	16.7
	Poverty	6.7	0.0	0.0	0.0	0.0	0.0	20.0	20.0	5.8
	If 1,2	46.7	53.3	26.7	33.3	0.0	6.7	20.0	0.0	23.3
	If 1,2 ,3	6.7	13.3	33.3	0.0	46.7	26.7	0.0	0.0	15.8
	If 1,3	0.0	0.0	0.0	6.7	0.0	20.0	0.0	0.0	3.3

Source: computed from own household survey data 2016/17

Note: one is for reducing in farm size, two is rise in soil erosion, and three is for decreasing soil fertility and land productivity

Note: one is for drought, two is for food insecurity, and three is for poverty

Note: LD is Land Degradation, SF is Soil Fertility and LP is Land Productivity

Note: Led is for Ledie, Geda is for Gedayasu, A.Z is for Amanuel Zuria, D.K is for Debre Kelemo, S.K/M is for Shewa Kidane Mihret, Dan is for Dangule, E.C is for Enebiy Chifar, YEK is for Yekeyit, and Agg is for Aggregate

d) Impact of land degradation on ecosystem services and livelihood

The survey respondents, key informants, and focus group discussion confirmed that, shortage of clean air and water (mentioned by 27.5% of respondents), and decline in vegetation composition (24.2%) are among the impacts of land degradation on ecosystem services (Table 4). The majority of survey respondents confirmed that, they experienced deterioration of their livelihood due to degradation of ecosystem services.

Particularly, 100.0% of respondents in Gedayasu kebele revealed that, they faced a serious problems including drying up of water bodies due to degradation of ecosystem services (Picture2).

A survey respondent elaborated this as:

"The negative impacts of land degradation on ecosystem services has resulted in drought, drying up of water bodies and shortage of water supply as well as shortage of animal feed, occurrence of flood, and out migration"(Interview2016/17)

Another respondent further elaborated on this as:-

"Degradation of ecosystem services due to land degradation has resulted in decline in productivity (e.g., reductions in honey, milk, and meat), loss of soil fertility, loss of shelter for animals, food insecurity, loss of living house due to flood, shortage of clean water and exposing to water borne diseases"(Interview 2016/17).

Table 4: Perceptions of respondent's on impact of land degradation on ecosystem services

	Shebel berenta		Mechakel		Sinan		Awabel		Agg in %for n=120
	Led	Geda	A.Z	D.K	S. K/M	Dan	E.C	YEK	
Shortage of clean water	66.7	20.0	26.7	6.7	33.3	6.7	20.0	40.0	26.7
Creates complexity to regulate erosion problem	0.0	0.0	6.7	33.3	6.7	13.3	0.0	0.0	7.5
Leads to high emission rate of carbon dioxide	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leads to decline in vegetation composition	0.0	0.0	13.3	20.0	33.3	0.0	60.0	40.0	23.3
If 1,2	6.7	0.0	0.0	6.7	6.7	20.0	0.0	0.0	4.2
If 1,2,3	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	2.5
If 1,2,4	0.0	0.0	20.0	20.0	0.0	20.0	0.0	0.0	7.5
If 1,3	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.8
If 1,4	26.7	53.3	0.0	6.7	6.7	6.7	20.0	20.0	18.3
If 1,2,3,4	0.0	6.7	33.3	0.0	6.7	0.0	0.0	0.0	5.8
If 2,4	0.0	0.0	0.0	13.3	0.0	13.3	0.0	0.0	3.3

Source: computed from own household survey data 2016/17

Note: one is for shortage of clean water, two is for creates complexity to regulate erosion problem, three is for Leads to high emission rate of carbon Dioxide, and four is for leads to decline in vegetation composition.

Note: Led is for Ledie, Geda is for Gedayasu, A.Z is for Amanuel Zuria, D.K is for Debre Kelemo, S.K/M is for Shewa Kidane Mihret, Dan is for Dangule, E.C is for Enebiy Chifar, YEK is for Yekeyit, and Agg is for Aggregate.

Also, the household survey respondents pointed out that drought and food insecurity are among the impacts of land degradation. For example, drought was mentioned by 35% of respondents as the main impact of land degradation. Similarly, food insecurity was mentioned by 16.7% respondents. Both food insecurity and drought were mentioned as impact of land degradation by 23.3% of respondents. Few (3.3%) of the survey respondents has mentioned the reduction in the number of livestock as one of the impacts of land degradation.

Different studies have revealed that the impacts of land degradation on ecosystem services have direct

impacts on human societies (Cardinale et al., 2012; Berendse et al., 2015; Brevik et al., 2015; Yazdani et al., 2015). Thus, the prevention of land degradation for sustaining the food and energy security is a significant concern for mankind. A study indicated that soil erosion which is particularly severe in Ethiopia is the major indicator of soil loss and soil fertility decline (Haile et al., 2015). The positive correlation between impact of land degradation on ecosystem service and on human livelihood ($r = 0.168$, $p > 0.05$) also supports that enhancing ecosystem services through reducing land degradation is key to improve the livelihood of rural communities (Table 5).

Table 5: Correlation analysis result Correlations

Correlations	MS	EDU	TLS	TFS	OCC	Impacts of LD on HLV	Impacts of LD on ES
MS							
EDU	-.322**						
	.000						
TLS	.040	-.091					
	.670	.325					
TFS	.156	-.216*	.329**				
	.089	.018	.000				
OCC	.013	.178	-.063	.032			
	.888	.051	.498	.730			
Impacts of LD on HLV	.094	-.039	.277**	.125	.067		
	.308	.671	.002	.174	.469		
Impacts of LD on ES	.203*	-.065	.071	.099	.040	.168	
	.026	.479	.443	.280	.665	.067	

Note: MS is for marital status, EDU is educational status, TLS is total land size, TFS is total family size, OCC is occupational status, LD is land degradation, HLV is the human livelihood, and ES is ecosystem services.

e) Response to land degradation in the Choke Mountain and benefits from the watershed management interventions

The implemented Watershed management interventions in the studied kebeles includes terraces, trench, exclosure, afforestation, and diversion ditches to address land degradation and improve ecosystem services and livelihoods (Picture 2). The survey respondents, key informants and results from FGD confirmed that the implementation of watershed management interventions was jointly done by the government and local communities.

A survey respondent elaborated on this as:

"We adopted the construction of terraces and bunds mainly to protect our land from soil erosion and thereby improve the fertility of soil and agricultural productivity. Also, we adopted soil and water conservation measures to harvest water for the dry season, improve water holding capacity of the soil and increase the workability of farm lands as well as enhance the effects of inorganic fertilizers in increasing crop yield".

The majority (68.9%) of the respondents confirmed that they implemented at least one conservation measure to control soil erosion and restore degraded landscapes. Although there is variability in the adoption rate of conservation measures, the majority (64.8%) of respondents confirmed that they adopted soil and water conservation measures on their farm land. The result also indicated that soil and water conservation measures had been more adopted in Sinan district than the other studied districts. The most adopted conservation measures are the construction of terraces on farm lands (mentioned by 53-87% of respondents). The results also confirmed that the implemented soil and water conservation measure had been introduced to the local community by the agricultural development agents. However, the local communities have participated during the implementation stages.

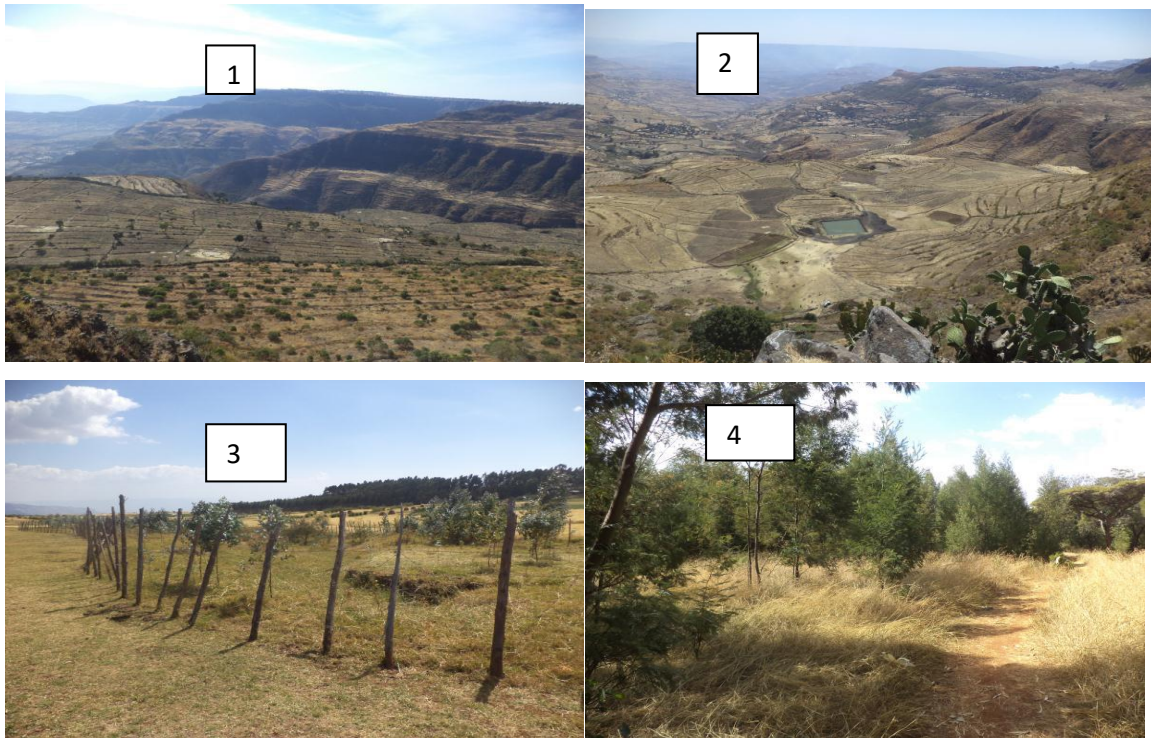


Figure 2: Implemented natural resources management interventions in the studied kebeles

Note: pic. One, is in Gedayasu, pic. Two, is in Ledie, pic. Three, is in Enebiy Chifar, and pic. Four, is in D/kelemo kebele. (Photo source: Yenealem Mekuria, captured during the field visit 2016/17)

The majority of survey respondents perceive that, land degradation minimized through different watershed management interventions. However, out of the total households, 14% of respondents perceive that the problem of land degradation can't solve using watershed management interventions. Those survey respondents who were optimistic about the possibility of minimizing land degradation suggested several natural resources management interventions such as terrace, diversion ditches, afforestation, and controlled and rotational grazing. Also, these respondents recommended that, planting of grasses and forage trees on the banks of soil and water conservation measures to stabilize the structures and produce livestock feed. Those who are pessimistic justified their opinion that, once a land has lost its fertility, it is difficult to restore within a short period and convert it in to productive land. However, soil degradation can reverse by restoring degraded land and the implementation of recommended management practices (Lal, 2015). Protection and restoration of land use on slopes are very important to minimize soil erosion, which will not only contribute to greater safety in many land uses around the world but will also help to maintain soil and quality of water in a watershed (Giménez Morera et al., 2010; Wildemeersch et al. 2015; Mekonnen et al., 2014; Yazdani et al., 2015).

The survey respondents and key informants stated that all groups of local communities are benefiting from watershed management. For instance, out of the total respondents, 53.4% of respondents confirmed that the poor, medium and rich members of a community are benefiting equally. The sampled households were discussed on the idea and they have mentioned their views; such as the benefit from watershed management practice has brought considerable change on the livelihood of all community as well as on the ecosystem, and there is no difference depending on the wealth status. The watershed management practice has implemented for all, and all the communities are participating in watershed management practices because it has become the source of animal feed and fuel wood and shelter for animals. But, 12.5% of the respondents confirmed that the relatively wealthy members benefit more than the poor ones. These members of the community argue that the poor farmers forced to sell one of the tangible benefits of watershed management (i.e., grass) with a cheap price as they don't have livestock to feed. When there is the training they have the opportunity to be selected primarily, and the poor are needed only for their labor. Rich is protecting the land by using improved materials and producing much by participating in different production practices like

farming and animal husbandry. In contrast to this, 30 % of respondents confirmed that the poor member of a community benefits more. Due to small agricultural land holdings, the poor are participating in protecting and restoring degraded land and changing it to give benefit for them in such approach, they are benefiting more through producing twice in a year, and they got good crop production due to reduction of soil erosion and improvement in soil fertility. Also, they got financial support from a safety net program.

The results of this study are inconsistent with the study by (Assefa, 2011) who reported that poor households in the Choke Mountain upper Muga watershed in East Gojjam, Ethiopia were fewer participants and beneficiaries of NRM interventions. A study conducted in central Tigray (Meaza, 2015) also

shown that poor households are not equally benefiting from watershed management practices compared to the relatively wealthy families.

The key informant confirmed that the youth was also getting benefits from the interventions by providing opportunities for them to participate in animal husbandry, stone, and soil supply from the highly degraded areas with the support of technical advice by experts (Picture 3). According to the discussions with the key informants and as it's observed during field observation, the way they are getting the benefits from the watershed management intervention practices was almost similar in all the studied areas. There are benefit-sharing mechanisms in the studied communities, which is led by the watershed committee members.



Picture 3: Benefit for the youths in animal husbandry by cutting grass from the WS in Ledie kebele, (Photo source: Yenealem Mekuria) taken during household survey 2016/17)

The local communities also have bylaws that support the management and use of natural resources. The main tangible benefit of watershed management interventions are livestock feed (mainly of grasses). As it

was observed during the field visits, members of a watershed use the produced grass through a cut and carry system (Picture. 4). The bylaw is a key to ensure equity in benefit-sharing and control free riders.



Picture 4: Livestock feed (i.e., grass) obtained from the restored watershed, (source: photo taken during the field observation 2016/17)

f) *The preference and effectiveness of watershed management intervention by the local community*

The majority of the survey respondents, key informants, and results from focus group discussions confirmed that the implemented watershed management practices were effective. For instance, 78.7% of respondents revealed that, the interventions are vital and effective. However, 18% of respondents considered the interventions are ineffective. The majority (90%) of respondents considered as the implemented natural resource management activities are preferable in their area.

A survey respondent on the effectiveness of the interventions elaborated as:

"We preferred and implemented the interventions, as the practice has brought changes to the livelihood condition of the local communities through reducing soil erosion, increasing livestock feed, enhancing soil fertility, and agricultural productivity, and creating job opportunities. Also, the implemented conservation measures improve access to water supply and restoring degraded landscapes" (Interview 2016/17).

A key informant also elaborated on this as:

"By looking at the benefits obtained from watershed management interventions, the local communities are motivated to expand conservation measures and cover degraded landscapes by vegetation. The implemented conservation measures have already brought changes in vegetation cover, availability of livestock feed, and increase the income of local communities". (Key informant interview 2016/17).

The respondents who considered the implemented watershed management interventions ineffective justified their opinion as the implemented conservation measures are not sustainable, doesn't cover all the degraded land, all the communities are not protecting and controlling it and the implementation of watershed management interventions lacks participatory approach.

The sampled household respondents have mentioned main factors affecting the favorite of the intervention by the local community as;

The main factors affecting the preference of the measures by the local community were improvement in soil fertility and agricultural productivity, the lack of sustainability and short term benefit of the implemented soil and water conservation measures, the structures consume more land and lead to a decline in land size.

g) *Contributions and responsibilities of communities related to the implementation of natural resource management interventions*

Almost all of the survey respondents in all studied areas and key informants have confirmed that the members of the studied communities have contributions in the management of watersheds. The

societies have been contributing to the implementations of natural resource management interventions on communal and private lands mainly through contributing free labor (Picture 3.6) (mentioned by 37.5% of respondents). Other studies also reported a similar result in that farmers in central Tigray, Ethiopia, provide support to the implementation of natural resource management interventions through providing free labor (Meaza, 2015). Such collaboration of local communities in watershed management activities can enhance the success of watershed management activities, as the participation of local communities is key to sustain natural resource management practices (Pretty and Ward, 2001 as cited in Meaza, 2015).

h) *Conditions which initiates the community to participate in NRM activities*

The participation of communities in natural resource management activities varies within the studied areas. For instance, 98.3% of the survey respondents in most of the studied kebeles have confirmed that all of the local communities have been participating in watershed management interventions in comparison 1.7% of respondents in D/kelemo kebele have confirmed that, all of the local communities have no any contributions in watershed management intervention practices.

The survey respondents and key informants indicated that the main factor that initiates local communities to participate in the implementation of natural resource management interventions is the severity of soil erosion in their locality. Other factors that affect the participation of local communities in watershed management include implementation period (majority indicated that watershed management activities needs to implement after March), material and financial support and follow-up by agricultural experts, and availability of short-term benefits from interventions. The respondents stressed that financial support and availability of short-term economic benefits from the interventions is key to participate in watershed management activities. The results suggest that generating short term economic benefits from watershed management activities could enhance the participation of local communities and the sustainability of implemented natural resource management interventions.

Some of the household survey respondents have also mentioned that, they have the interest in contributing and participate in watershed management practices if communities must control and protect the implemented natural resource management practices from damage. The respondents mentioned that awareness-raising and experience sharing campaigns are needed to enhance the interest of local communities to participate in watershed management activities. According to the respondents, training facilities, for

example on afforestation practices, crop and animal husbandry systems as well as natural resource management practices could support to enhance the participation of local communities in the implementation of watershed management activities.

IV. CONCLUSION AND RECOMMENDATIONS

The results demonstrated that a large proportion of the available land assigned for cultivation compared to grazing and other uses. The majority (55.7 %) of survey respondents perceive that the productivity of their farm land has declined through time. This could be attributed to poor land management (i.e., monocropping) and land degradation due to soil erosion. Land degradation resulted from population pressure, topography, deforestation, overgrazing, poor implementation of policies and strategies related to natural resource management, lack of awareness-raising campaigns is one of the major environmental and socio-economic problems of the study areas. The results indicated that the local communities well understood the negative consequences of land degradation on human livelihoods and ecosystem services. Local communities are also optimistic on the possibility of reversing degraded landscapes into productive land through the implementation of natural resource management interventions. The results of study also indicated that different types of natural resource management interventions were adopted in most of the studied areas, and the local communities considered the implemented natural resource management interventions are effective in restoring degraded landscapes and improving livelihood. The local communities perceived that providing training on afforestation practices, crop production, and animal husbandry systems as well as natural resource management practices could support to enhance the participation of local communities in watershed management activities. From the result of this study we recommend that, designing mechanisms to enhancing the short-term benefits of natural resource management interventions is key to increase the participation of local communities as well as integrating income generating activities such as livestock fattening and beekeeping could support to sustaining watershed management interventions through generating short-term economic benefits and building a sense of ownership. Finally, further studies are required to generate empirical evidence on the impact of natural resource management interventions on livelihood and ecosystem services and to inform decision makers.

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Acknowledgments

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Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.



Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
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- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
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- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
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Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

- a) A title which should be relevant to the theme of the paper.
- b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
- c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
- d) An introduction, giving fundamental background objectives.
- 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.
- f) Results which should be presented concisely by well-designed tables and figures.
- g) Suitable statistical data should also be given.
- h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

- i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
- j) There should be brief acknowledgments.
- k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

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

All manuscripts submitted to Global Journals should include:

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The title page must carry an informative 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) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

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A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

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

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning 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 a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be 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. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.



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Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

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TIPS FOR WRITING A GOOD QUALITY SCIENCE FRONTIER RESEARCH PAPER

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. 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.

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

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

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

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10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. 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 for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

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

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.



20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon 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 through which your research is going to be in print for 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 of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

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- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to 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 progression.

General style:

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To make a paper clear: Adhere to recommended page limits.



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- Submitting a manuscript with pages out of sequence.
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- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

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

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite 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 approaches 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. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a 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 limit the initial two items to no more than one line each.

Reason for writing the article—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 for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity 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 of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.



The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
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- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
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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 for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

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This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate 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 to give the least amount of information that would permit another capable scientist to replicate 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 section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show 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:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the 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—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and 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 as 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. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give 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 manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit 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 section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

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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 implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully 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 the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



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- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
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Describe generally acknowledged facts and main beliefs in present tense.

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